Detroit River Remedial Action Plan

Stage 1

June 1991

Canada Ontario

Canada Ontario Agreement Respecting
Great Lake Water Quality

DNR

Michigan Department of Natural Resources
Surface Water Quality Division

Stage I

Remedial Action Plan

For

DETROIT RIVER

Area of Concern

June 3, 1991

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PRINTED BY AUTHORITY OF: Michigan Department of Natural Resources
TOTAL NUMBER OF COPIES PRINTED: 40 TOAL COST: $812.04 COST PER COPY: $20.30

ACKNOWLEDGMENTS

The Michigan Department of Natural Resources, Surface Water Quality Division and the Ontario Ministry of the Environment, Detroit/St. Clair/St. Marys Rivers Project would like to thank the many individuals that participated over the last few years in the development of this document.

The Agencies would like to thank the members of the Remedial Action Plan (RAP) Team who have attended many meetings and provided drafts and comments in the preparation of this document. The efforts of these members in communicating the issues involved and the progress of the RAP to their respective agencies has resulted in a broad base of understanding and support in specific state and federal program areas for this important effort.

The Agencies also express appreciation to the officers and members of the Detroit River Binational Public Advisory Council for their efforts through numerous meetings to provide advice to the RAP Team enabling the completion of this document. It is through the work of this Council that the document reflects the local interests and support needed to implement remedial actions which will be identified in subsequent stages of this planning effort. The Agencies are grateful to those who took the time to become involved in this project.

The Agencies also recognize and appreciate the efforts of the Technical Advisory Committee for their review of the draft RAP in their respective areas of expertise.

The Agencies would especially like to thank the Southeast Michigan Council of Governments for providing continued assistance and expertise in the area of public participation throughout this project. The first draft of Chapter 5, Description of the Areas, was completed by Limno-Tech Inc. and Dr. Ralph Kummler under a grant from MDNR and SEMCOG.

Special thanks goes to Lynda Jones, Laura Smith and Ellen Hamburger for their patience, understanding and conscientious efforts in the preparation of this RAP; and to Scott Sobiech and Becky McGraw for their technical assistance in providing graphics and compiling data for use in this document.

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CHAPTER 1
EXECUTIVE SUMMARY

The Detroit River has been listed as one of forty-three Great Lakes Areas of Concern (AOCs) by the International Joint Commission (IJC) because degraded water quality conditions impair certain beneficial uses as defined by the Great Lakes Water Quality Agreement of 1978 (as amended). The Detroit River is an international boundary between United States (Michigan) and Canada (Ontario). Both jurisdictions, Michigan and Ontario, have agreed to develop a joint Remedial Action Plan (RAP) with Michigan as the lead to address water quality concerns in the Detroit River. The purpose of this Stage I RAP is to:

1) define and describe in detail the environmental problems in the Detroit River including a definition of the beneficial uses that are impaired, the degree of impairment and the geographical extent of impairment; and

2) define the causes of impairment, including a description of all known sources of pollutants involved and an evaluation of other possible sources.

THE RAP PROCESS

In 1987, the U.S. and Canadian governments signed a Protocol amending the Great Lakes Water Quality Agreement (GLWQA). The Protocol added specific programs, activities and timetables that more fully address issues identified in the 1978 GLWQA. Annex 2 of the 1987 Protocol requires the development and implementation of Remedial Action Plans for the Great Lakes Areas of Concern. These RAPs are to serve as an important step toward virtual elimination of persistent toxic substances and toward restoring the maintaining the chemical, physical and biological integrity of the Great Lakes Basin ecosystem. The GLWQA requires the Parties to cooperate with state and provincial governments to ensure that RAPs are developed and implemented for Areas of Concern. The Canadian and Ontario governments recognize a shared responsibility in protecting the Great Lakes Basin and the framework for this cooperation is the Canada-Ontario Agreement on Great Lakes Water Quality (COA). Through this arrangement Canada/Ontario RAPs are being developed.

Annex 2 of the Protocol Amending the GLWQA identifies what must be included in each RAP, and specifies that the RAP should be submitted to the IJC for review and comment at three stages. The three stages and the contents of the RAP at each stage as defined in the GLWQA are as follows:

1) Stage I. This portion of the RAP will include (1) a definition and detailed description of environmental problems in the AOC, including a definition of the beneficial uses that are impaired, the degree of impairment and the geographical extent of the impairment; and (2) a definition of the causes of the use impairment, including a description of all known sources of pollutants involved and an evaluation of other possible sources.

2) Stage II. This portion of the RAP will define the water use goals for the AOC and describe the remedial and regulatory measures selected to meet those goals. The Stage II RAP will include (1) an evaluation of remedial measures in place; (2) an evaluation of alternative additional measures to restore beneficial uses; (3) a selection of additional remedial measures to restore beneficial uses and a schedule for their implementation; and (4) an identification of the persons, agencies, or organizations responsible for implementation of the selected remedial measures. If some impaired beneficial uses cannot be restored, this stage must contain an explanation of why they cannot be restored.

3) Stage III. This portion of the RAP will be submitted when identified impaired beneficial uses are restored. The Stage III RAP will include (1) a process for evaluating the implementation and effectiveness of remedial measures; and (2) a description of surveillance and monitoring processes to track the effectiveness of remedial measures and the eventual confirmation of the restoration of uses.

The RAP for the Detroit River was initiated in 1986 with the establishment of a team of representatives from the Federal, State, and Provincial governments. This effort was concurrent with the Upper Great Lakes Connecting Channels Study (UGLCCS), a bilateral multi-agency investigation begun in 1984 and completed in December of 1988. The RAP incorporates much of the data gathered under UGLCCS, and actual writing of the RAP did not begin until mid-1989.

Early in the process, the need for a comprehensive public participation program was recognized. The objectives of this program were to: (1) educate and inform the public on various water quality aspects of the Detroit River, including information on the regulatory programs in place on both sides of the river; (2) gain information and advice from the public on key aspects of the RAP preparation and adoption; (3) to gain support for Plan implementation; and (4) provide a mechanism for communication and accountability to the public. As a result of a series of public workshops and meetings held in 1986 and 1987, a Binational Public Advisory Council (BPAC) was created in December of 1987. The BPAC consists of twenty Michigan and twenty Ontario members from various interest groups whose charge is to advise the RAP Team on all aspects of the planning process. Four members of the BPAC were included on the RAP Team in June of 1988 to represent the public interest in the RAP development and to facilitate communication between the BPAC and the RAP Team. The process of developing the RAP for the Detroit River included review and comment by the BPAC on the Plan as written by the RAP Team. To assist in this process, the RAP Team provided information and arranged for presentations to the BPAC as work progressed on the RAP. The BPAC members were responsible for relaying planning information and decisions to members of the groups they represented and to the general public. Several public meetings were held in the Detroit and Windsor areas to assist in this task.

Impaired beneficial uses were determined by comparing available data with: (1) the beneficial uses described in the Great Lakes Water Quality Agreement (GLWQA) (Annex 2) and the IJC Listing/Delisting Criteria; (2)

other provisions of the GLWQA; (3) Michigan's Water Quality Standards (WQS); and (4) Ontario's Provincial Water Quality Objectives (PWQO). During this process, the RAP Team noted that some environmental problems in the Detroit River are common to the entire Great Lakes Basin, and other problems are caused by physical factors (such as land use) as opposed to water quality issues. These environmental concerns are discussed in this RAP as they need to be highlighted for basinwide remediation (such as Lakewide Management Plans) or should be considered for action by local land use planning agencies or other similar groups.

ENVIRONMENTAL DESCRIPTION

The Detroit River is the lowest link of the upper Great Lakes connecting channels, conveying water from Lakes Michigan, Superior, and Huron to Lake Erie. It has a natural drainage basin of 700 square miles (1800 km^2) and receives the discharge from the sewage collection system for an additional 107 mi^2 (297 km^2). The population of the drainage basin is approximately 4 million. The mean discharge into Lake Erie is 185,000 cubic feet/second (5,240 m^3/sec), which accounts for approximately 80% of the inflow to Lake Erie. The quality of Detroit River water no doubt significantly influences Lake Erie's water quality and fish productivity. The velocity of the river is 1 to 3 feet/second (0.3 to 1 m/sec) and the average time for water to pass through the Detroit River is 21 hours. There are five tributaries on the Michigan side and three on the Ontario side, however greater than 95% of the total flow enters the river from Lake Huron via the St. Clair River and Lake St. Clair. The most significant tributary to the river is the Rouge River. The Rouge River is also one of the 42 designated AOCs and has a RAP which addresses the water quality concerns in that drainage basin. For purposes of the Detroit River RAP, the Rouge River is considered a point source discharge.

Land use in the Detroit River Source Area of Concern (SAOC) differs significantly in Michigan and Ontario. Almost 10 percent of Michigan's land use is commercial or industrial, compared to 2 percent in Ontario. Thirty percent of the Michigan SAOC is undeveloped or used for agricultural purposes, compared to 90 percent in Ontario. Similarly, shoreline use in Michigan is 61 percent industrial or commercial, versus 33 percent of the Ontario shoreline. Thirty-one percent of the Ontario shoreline is residential and 22 percent recreational, compared to 16 and 6 percent, respectively, on the Michigan shoreline. There are twelve islands in the river including Fighting Island and Grassy Island, portions of which have been used as confined disposal facilities. In Michigan, there are approximately 94 hazardous waste sites and landfill disposal sites within the SAOC and Monroe County, Michigan; sixteen of these have been identified by the U.S. Geological Survey as being of concern with respect to potential groundwater contamination impacts on the Detroit River. Twenty-three sites of known or potential groundwater contamination were identified on the Ontario side of the Detroit River. Groundwater flow is estimated to contribute less than a tenth of a percent of the total Detroit River discharge.

The Detroit River is used extensively for diverse activities and needs including commercial navigation, industrial and municipal drinking water supply, recreational activities, and as a receiving water for treated industrial and municipal wastewater. Agricultural use of the Detroit River is minimal.

The Detroit River is part of the Great Lakes - St. Lawrence Seaway and is the busiest port in the Great Lakes. Commercial navigation channels are dredged by the U.S. Corps of Engineers (U.S. waters) and the Canadian Coast Guard (Canadian waters) to a depth of 27 feet (8.23 m) below low water datum. Contaminant levels in sediments affect the cost of dredging activities and the disposal of dredged materials.

A major use of the Detroit River is as an industrial and drinking water supply. The river supplies approximately 25 industries with process or cooling water. There are six municipal drinking water intakes serving approximately 4.1 million people in nearly 100 communities in the SAOC.

As a receiving water, approximately 30 industries and power plants discharge cooling water and/or treated process water directly to the river. The principal industrial discharge area is on the Michigan shoreline from Zug Island downstream to Gibraltar in the Trenton Channel. Major industries include steel mills, petroleum refineries, electrical power generating plants, and manufacturers of chemicals, automotive parts, rubber products, salt, and plastics. An additional 46 facilities discharge to Detroit River tributaries.

Ten municipal wastewater treatment plants discharge treated industrial and domestic wastewater to the Detroit River. The largest facility is the Detroit Water and Sewerage Department which discharges an average of 715 million gallons per day (MGD). The total average discharge for the remaining nine facilities is approximately 135 MGD. The Detroit River also receives urban and industrial runoff through the eight tributaries and the storm sewer system.

The river is significantly influenced by storm runoff and combined sewer overflows. The sewer systems in Detroit and Windsor convey combined sanitary, industrial and storm wastewater. Excess combined wastewater is discharged through combined sewer overflows (CSOs) directly to the Detroit River and its tributaries during rain events to protect the treatment plants from excessive hydraulic loadings. There are approximately seventy-seven CSOs which discharge directly to the river (56 from Michigan, 21 from Ontario) and an additional 168 CSOs that discharge to the Rouge River and eleven CSOs which discharge to the Ecorse River (a Michigan tributary to the Detroit River). The total discharge from the City of Detroit's CSOs to the Detroit River was estimated to be an average of 34 MGD in 1979.

Recreational use of the Detroit River includes boating, fishing, and hunting. Swimming occurs at the three beaches (all located near the head of the river), and at marinas and shoreline parks to a limited extent, prohibited in some areas by strong currents, and in others by the degraded bacteriological quality of the water. The river is a major recreational boating area supporting approximately seventy-five marinas with over 5500 boat slips. Although there is currently no commercial fishery on the Detroit River, the sport fishery is a very important and thriving resource. The value of the sport fishery for the Detroit-St. Clair River system was estimated at ten million dollars annually (1975-77). White bass, walleye, freshwater drum, yellow perch, and rock bass are the most commonly caught of the sixty-five species currently found in the river. Duck hunting occurs primarily near the mouth of the Detroit River. The average duck harvest (10,080) in Wayne County (1961-70) was the sixth highest in Michigan.

IMPAIRED BENEFICIAL USES

The determination of impaired beneficial uses in the Detroit River was made using the IJC Listing/Delisting Criteria as well as State and Provincial water quality criteria. A description of the aquatic ecosystem and pertinent data used to determine the support status of the fourteen beneficial uses is presented in Chapter 6 and summarized in Chapter 7. This document identifies the following impaired uses in the Detroit River:

Restrictions on Fish Consumption.

Fish contaminant monitoring programs in the Detroit River have found elevated levels of PCBs and mercury in some species of fish. The Michigan Department of Public Health (MDPH) has issued a "no consumption" advisory for carp. Seventy percent of the carp collected in 1985-86 exceeded the level of concern for total PCBs (2.0 mg/kg) as defined by the U.S. Food and Drug Agency and MDPH.

The Ontario Ministry of Natural Resources (OMNR) and Ministry of Environment (OME) have issued a "restricted" consumption advisory for carp due to elevated levels of PCBs (greater than 3.3 mg/kg) based on 1986 and 1987 collections. Restricted consumption advisories for rock bass, freshwater drum, and walleye have been issued due to elevated concentrations of mercury (greater than 0.5 mg/kg) based on 1982 and 1986 fish collections. A "no consumption" advisory has also been issued for larger freshwater drum (between 45-55 cm, 14-18 inches) due to elevated levels of mercury.

The MDNR initiated a trend monitoring program for the Detroit River in 1990 and has been collecting Detroit River fish since the early 1970's. The OMOE has analyzed fish from the Detroit River since 1978.

Tumors in Fish.

The incidence of oral and dermal tumors in Detroit River fish was similar to or less than incidence rates found in fish from other Great Lakes tributaries and harbors. A survey of liver tumor incidence in Detroit River fish found elevated levels of tumors in bullhead, walleye, bowfin, redhorse sucker and white sucker. The liver tumor prevalence was comparable with the incidence rates found in other highly industrialized areas within the Great Lakes Basin. Based on tumor incidence levels, this beneficial use is considered to be impaired.

Degraded Benthic Communities.

Surveys of the benthic communities of the Detroit River indicate that although there have been significant improvements since the 1960's, the macroinvertebrate communities are severely degraded along Michigan's Trenton Channel. Pollution tolerant organisms indicative of extreme organic enrichment comprised 95 percent of the macroinvertebrates collected in this reach in 1985-86. Mid-river benthic communities were considerably better than those found along the Michigan shoreline, however communities were depressed in the depositional zones of the navigation channels. A balanced benthic community structure indicative of satisfactory water quality conditions was noted along the Ontario shoreline. Canadian inputs to the Detroit River did not seriously disrupt the macrozoobenthos.

Improvements in the benthic communities were noted in 1980 in the entire river and especially along the Michigan shoreline from Belle Isle to the mouth of the Rouge River and along most of the Ontario shoreline.

Contaminants in Sediments.

Detroit River sediments were found to contain metals, PCBs, and oil and grease at various concentrations. Contaminants in sediments were measured and compared to U.S. and Ontario guidelines as a preliminary indication of sediment quality to assist in the determination of disposal options for dredged sediments. Using these guidelines as a basis for comparison indicates that dredging activities in the Detroit River are impaired. On a site specific basis, sediments removed may be subject to disposal restrictions. Sediments from the Michigan shoreline downstream of Connors Creek (located near the head of the river) to Lake Erie contained elevated levels of metals (arsenic, cadmium, chromium, copper, cyanide, iron, lead, manganese, mercury, nickel, and zinc), PCBs, oil and grease. Mid-river sediments contained elevated levels of oil and grease and some metals primarily near the mouth of the river. Data indicate elevated levels of some metals (lead, arsenic, chromium, copper, iron, zinc, cyanide and mercury) along the Windsor area shoreline.

The concern for sediment toxicity is a relatively new area of scientific study and standards for acceptable levels of contaminants in sediments for the protection of aquatic life have not been developed by any jurisdiction. Some toxicity tests have been conducted using Detroit River sediments, however field validation and direct cause linkages have not been established.

Taste and Odor Problems.

Taste and odor problems in drinking water were noted in the summer of 1990 by residents of Windsor and the downriver communities served by the City of Detroit. The City of Windsor and the Detroit Water and Sewerage Department treated the water (increased chlorination and carbon treatment, respectively) to alleviate the problem. The cause of the taste and odor problem has not been confirmed, however geosmin, a natural chemical secretion from aquatic plants, is suspected. Both facilities have established laboratory facilities and procedures in anticipation of a similar problem in subsequent summers. Taste and odor problems were also noted in Detroit drinking water in December 1990. Turnover in Lake St. Clair, compounded by a recent storm, was thought to be the cause.

Bacteriological Water Quality.

Recent bacteriological data indicate that Michigan Water Quality Standards are not met downstream of the Rouge River. The Rouge River RAP has identified the numerous CSOs as the source of bacteriological contamination, and the Detroit River has a similar situation. As indicated previously, seventy-seven CSOs (in addition to the Rouge River and Ecorse River CSOs) discharge inadequately treated sewage into the river especially following rainfall events, causing a substantial bacteriological problem along both shorelines. In Michigan, the nearshore areas immediately downstream of CSOs have been identified as impaired. In addition, areas along the Ontario shoreline which have been found to exceed Ontario Provincial Water Quality Objectives for fecal coliform are downstream of Little River, Turkey Creek, and the Amherstburg Water Pollution Control Plant. Two beaches on the Ontario side, both located upstream of the mouth of Little River, have been posted as unsafe for swimming due to periodic exceedances of PWQO for fecal coliforms.

Contaminants in Ambient Water.

The Michigan Department of Natural Resources has an extensive monitoring program for metals and conventional parameters in the Detroit River. Conventional parameters (dissolved oxygen, biological oxygen demand, suspended solids, chlorides, phosphorus and nitrogen) are well within criteria as specified by MDNR, OMOE, and the GLWQA (except for BOD, for which no criteria have been developed). Levels of most of these parameters have improved substantially from 1970 to 1980, and remained fairly static through to 1990. This situation is reflective of the increased pollution control requirements for industrial and municipal dischargers during the 1970's. Pollutant inputs from combined sewer overflows and diffuse sources (nonpoint sources) may currently have a more substantial impact on water quality than other point sources.

Ambient levels of mercury measured during the Upper Great Lakes Connecting Channels Study (UGLCCS) (1985-86) exceeded Michigan Water Quality Standards throughout the river. Levels of mercury in ambient water were higher in the Trenton Channel and, in this area, they also exceeded Ontario Provincial Water Quality and GLWQA Objectives (both are less restrictive than Michigan's WQS). Although the MDNR monitoring program includes mercury analysis, detection levels are not sufficient to determine if current levels of mercury would exceed criteria. Any detection of mercury would exceed the Michigan Rule 57(2) value of 0.0006 ug/l.

Ambient levels of PCBs also exceeded Michigan, Ontario, and GLWQA criteria based on UGLCCS data. Concentrations averaged 1.4 ng/L at the head and 3.3 ng/L at the mouth of the river; concentrations in the Trenton Channel ranged from 1 to 385 ng/L.

Ambient concentrations of zinc, copper, cadmium and lead have, at times, been found to exceed Michigan's WQS, Ontario PWQO or GLWQA criteria based on MDNR 1984-1988 monitoring data. The location, frequency and severity of exceedances varied.

Data for ambient concentrations of organic compounds are scarce, however analysis indicates levels of hexachlorobenzene and other organochlorines and polynuclear aromatic hydrocarbons are below water quality criteria (where criteria have been developed).

Degradation of Aesthetics.

The IJC listing/delisting criteria includes the presence of persistent objectionable deposits, unnatural color, turbidity, oil slicks, surface scums, or odor as aesthetically degrading. There is no quantitative method for determining aesthetic degradation, and supporting documentation is scarce. However, large volumes of combined sewer overflows frequently discharging to the river following wet weather events contribute discolored water (e.g. from slaughter houses), oil and grease, and other types of objectionable deposits and debris. Due to the high flow of the river, these effects are not persistant, with the exception of remaining debris along the shorelines.

Spills of various materials have been noted in the river. A total of 12 oil related spills were reported to the U.S. Coast Guard Marine Safety Office in 1989. Industrial development and urbanization have detracted from the natural beauty of the area, however these are not water quality impacts.

Loss of Fish and Wildlife Habitat.

A significant loss of fish and wildlife habitat and, in particular, wetlands in the Detroit River AOC has occurred as a result of a number of factors including poor substrate quality, diking, dredging, the construction of bulkheads and filling. The total area of emergent vegetation and large submersed macrophyte beds on the Michigan side is currently estimated at 634 ha, forty-four percent of the estimated area which existed in 1967. Less extensive losses have been recorded on the Ontario side. Wetlands and submersed macrophyte beds provide important habitat for fish and wildlife in the Detroit River. Their role in the biological production of the river is probably significant although it has not been well defined. Draft fish community goals and objectives for Lake St. Clair and connecting waters have been developed. They emphasize the achievement of no net loss of the productive capacity of fish habitats and the restoration of habitats wherever possible. Fish and wildlife management goals are needed to help further determine the extent of impairment and guide future rehabilitation strategies.

The loss of, or impact to specific habitats such as wetlands, as a consequence of water quality issues has not been well documented. Sediment toxicity tests have been conducted on Detroit River sediments, however the precision and ability of these tests to predict field conditions has not been adequately studied. Although sediment toxicity can be demonstrated for the Detroit River and these patterns resemble contaminant distributions and resident benthos distributions, field validation and direct cause linkages have not been established. It is recommended that additional research be conducted. Sediment toxicity tests need to be standardized and criteria developed for regulatory and remedial decision making purposes.

CAUSES OF USE IMPAIRMENTS

Environmental programs have resulted in improved water quality in the Detroit River over the last twenty years, particularly due to the increased control of industrial and municipal discharges. As a result, control of diffuse or nonpoint sources is becoming critical to the attainment of water quality criteria in the Detroit River. Existing sources of the contaminants listed above include CSOs, industrial and municipal discharges, and nonpoint sources such as stormwater runoff from urban and industrial areas.

Michigan CSOs are a major source of contaminants that cause fish consumption advisories, total body contact advisories, exceedances of ambient water quality criteria and degradation of aesthetics. Michigan point sources were also a large source of many of the contaminants that cause use impairments. Several Michigan and Ontario wastewater treatment plants were identified as contributors of bacteria to the Detroit River, although their contributions were insignificant compared to CSOs.

Detroit River sediments have likely been accumulating contaminants since the SAOC became industrialized. The loads of pollutants have decreased since the 1970s and the data are insufficient to determine if sediments continue to be contaminated. Pollutant loads to the river from contaminated sediments are unknown.

OTHER ENVIRONMENTAL CONCERNS

In addition to impaired beneficial uses, several other environmental concerns are discussed in the RAP. Some of these concerns, such as the zebra mussel situation and the sparse population of bald eagles, are issues throughout the Great Lakes Basin. Remediation of these issues would be best achieved through basinwide efforts but can be enhanced through local initiatives. Other concerns such as the loss of wetlands and other critical habitat can be addressed locally as well and will assist in contributing to the overall health of the river.

Zebra Mussels.

The inadvertent introduction of the zebra mussel to the Detroit River probably occurred as result of ballast water exchange from commercial ships in Lake St. Clair. Populations of the mollusk have spread quickly throughout the Great Lakes. The impact of zebra mussel colonies on the biota in the river is not yet certain, however initial economic impacts have occurred as the result of mussel colonies clogging water intake pipes and fouling navigational buoys.

Fish Populations.

Over sixty species of fish are presently found in the Detroit River with fish occupying all niches, including forage, planktivores, piscivores, omnivores and detritivores. Historically, forty species have been lost from the river and the community is now structured more toward bottom feeding fish than it was originally. The causes of the changes include several factors such as the invasion of new species, habitat changes and losses, losses due to dredging of the navigation channel in the lower river, and overfishing.

Due to the changes in the fish community structure, it has been suggested that some degradation of fish populations has occurred. However, a return to a historic fish community structure is not possible or realistic. Improved or increased fish habitat in the Detroit River may result in increased biomass and community diversity. The draft fish community goals and objectives for Lake St. Clair and connecting waters support the current fish community structure.

Wildlife Populations.

The wildlife carrying capacity of the Detroit River is much reduced from its precolonial condition. Industrial and urban development has resulted in decreased populations, primarily through the loss of habitat. Wildlife management goals for the Detroit River AOC have not been established.

Currently, the Detroit River supports a fairly substantial and diverse population of fish-eating waterbirds. However, there has been some loss of reproductive capacity among species such as bald eagles. These losses have not been documented as being specific to the Detroit River AOC but rather appear to be reflective of conditions within the Great Lakes Basin. Historically, reproductive failures occurring in Great Lakes cormorants during 1950-70 due to eggshell thinning as a result of environmental levels of DDT and its metabolites have been documented.

Reproductive problems and bird or animal deformities specific to the Detroit River as a result of water quality concerns have not been documented. Levels of contaminants in herring gull eggs from Fighting Island have decreased notably since 1974 but have not declined appreciately since the mid-1980s. Herring gull eggs collected from Fighting Island have significantly higher levels of DDE, HCB and PCBs than eggs from other colonies in Lake Erie and the Niagara River.

GLWQA BENEFICIAL USES NOT IMPAIRED

Several of the beneficial uses outlined in the IJC Listing/Delisting Criteria (Proposed 1988) were not considered to be impaired in the Detroit River. They include the following:

Tainting of Fish and Wildlife Flavor.

There have been no reports of fish, wildlife or waterfowl tainting in the Detroit River. Therefore, this use is not considered to be impaired.

Eutrophication or Undesirable Algae.

This condition has not been documented in the river and is unlikely to occur due to the short retention time of the river.

Added Cost to Agriculture or Industry.

There are no known added costs to agriculture or industry due to water quality conditions in the Detroit River.

Phytoplankton and Zooplankton.

Data on phytoplankton and zooplankton populations in the Detroit River are sparse. Phytoplankton and zooplankton communities appear to be reflective of communities found upstream in Lake St. Clair, however, no data exists for the more permanent nearshore populations. Impairment has not been documented in the river.

CHAPTER 2
INTRODUCTION

2.1 BACKGROUND

The Great Lakes are a unique natural resource containing 20% of the world's fresh surface water. These lakes also form a portion of the international boundary between the United States and Canada, and both countries have jurisdiction over their use. To protect this vast resource and cooperatively address problems along their common border, the U.S. and Canada interact through an agency known as the International Joint Commission (IJC).

The IJC was established by the U.S. and Canada under the authority of the Boundary Waters Treaty of 1909 which set forth the rights and obligations of both countries regarding all common boundary waters. The responsibilities of the IJC, as identified in the Boundary Waters Treaty include collecting, analyzing and disseminating data, and tendering recommendations to the U.S. and Canadian government regarding water quality problems in the boundary waters. As far back as 1912, the U.S. and Canadian governments asked the IJC to investigate the extent and causes of pollution in the Great Lakes. The IJC identified specific locations, including the Detroit River, that were polluted with raw sewage, identified pollution sources, and recommended specific actions to control the pollution. Water borne disease epidemics were eventually eliminated from the Great Lakes Basin as a result of such efforts. Concern about other water quality problems, specifically cultural eutrophication, over the years resulted in the signing of the 1972 Great Lakes Water Quality Agreement (GLWQA) by the U.S. and Canadian governments. This agreement affirmed both countries' determination to restore and enhance Great Lakes water quality, and established general and specific water quality objectives for the Great Lakes system.

Since 1973, the IJC Water Quality Board has identified specific areas throughout the Great Lakes basin having serious water quality problems. These problem areas have been described and evaluated in the annual and biennial Water Quality Board reports. In 1973, these areas were called "Problem Areas", and they varied in scope, complexity, and severity. Over the years, many of the problems in these areas have been resolved through the implementation of water quality standards, effluent regulations, industrial pretreatment programs, and construction and upgrading of waste water treatment plants. As a result of these programs, and the identification of new concerns, there have been many subtractions from and additions to the original list of Problem Areas.

The Water Quality Board soon realized that the Problem Areas approach lacked consistency in problem identification and assessment, and relied on water quality indications alone. In 1981, the Problem Areas were renamed "Areas of Concern" (AOCs). The name change reflected the IJC's desire to shift the problem perspective from limited water quality issues to a broader approach based on environmental quality data for water, sediments and biota, and to evaluate the areas with uniform criteria. This new approach was consistent with the GLWQA of 1978.

An AOC was defined by the Water Quality Board as an area where there is known impairment of a beneficial water use. In 1981, there were 39 AOCs that were divided into 2 classes based on the severity of the identified problems.

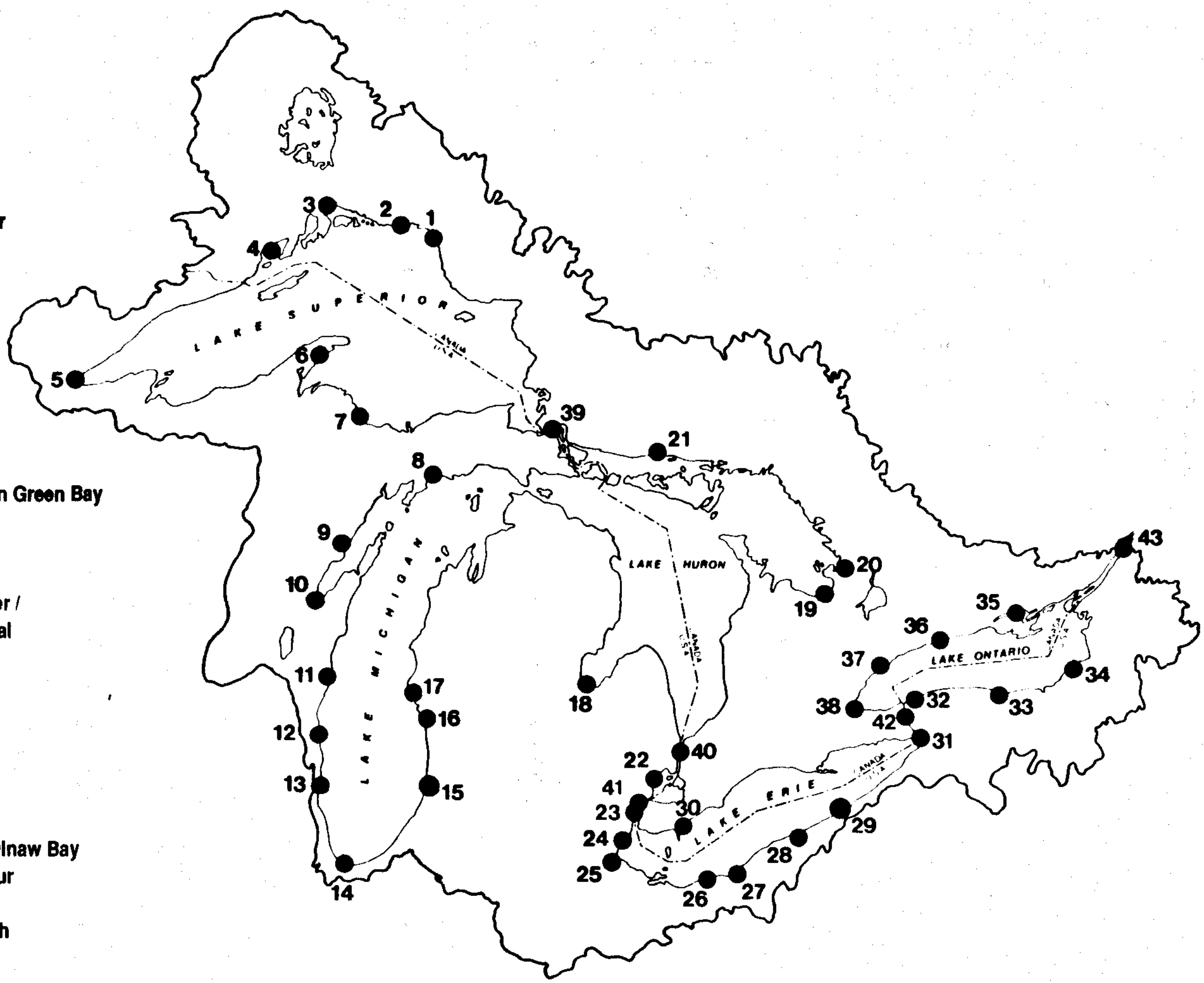
The 1985 Water Quality Board's Report on Great Lakes Water Quality identified 42 AOCs (Figure 2-1). In 1991, Presque Isle Bay, Pennsylvania was identified as the forty-third AOC. The 1985 report identifies the Detroit River as an AOC due to the following types of problems: conventional pollutants (e.g. phosphorus, bacteria), heavy metals, toxic organics, contaminated sediments, fish consumption advisories, impacted biota, eutrophication, beach closings, and aesthetics. Sources of the problems were cited as municipal and industrial point sources, urban and rural nonpoint sources, combined sewer overflows and contaminated sediments.

In their 1985 report, the Water Quality Board also presented a new approach for categorizing the AOCs based on the status of the data base, programs underway to fill data gaps, and remedial actions taken to address the identified problems. No effort was made to classify the AOCs on the severity of the problems. The jurisdictions and the IJC acknowledged that additional, specific guidance was needed to resolve the persistent pollution problems that remained in most of these AOCs. Therefore, the eight Great Lakes States and the Province of Ontario agreed to develop Remedial Action Plans (RAPs), or clean up plans, for the AOCs within their jurisdictional boundaries. Three of the 43 AOCs are within the boundaries of both Michigan and Ontario. One RAP will be developed by Michigan and Ontario, jointly, for each of these three AOCs.

2.2 REMEDIAL ACTION PLANS AND THE AREAS OF CONCERN PROGRAM

In 1987, the U.S. and Canadian governments signed a Protocol amending the Great Lakes Water Quality Agreement. The Protocol added specific programs, activities and timetables that more fully address issues identified in the 1978 GLWQA. Annex 2 of the 1987 Protocol requires the development and implementation of Remedial Action Plans for the Great Lakes Areas of Concern. These RAPs are to serve as an important step toward virtual elimination of persistent toxic substances and toward restoring and maintaining the chemical, physical and biological integrity of the Great Lakes Basin ecosystem. The GLWQA requires the Parties to cooperate with state and provincial governments to ensure that RAPs are developed and implemented for Areas of Concern. The Canadian and Ontario governments recognize a shared responsibility in protecting the Great Lakes Basin and the framework for this cooperation is the Canada-Ontario Agreement on Great Lakes Water Quality (COA). The RAPs are to be submitted to the IJC for review and comment.

An AOC is defined in Annex 2 as "a geographic area that fails to meet the General or Specific Objectives of the Agreement where such failure has caused or is likely to cause impairment of beneficial use or of the area's ability to support aquatic life". Impairment of beneficial use is defined as a change in the chemical, physical, or biological



Lake Superior

1 Peninsula Harbour
2 Jackfish Bay
3 Nipigon Bay
4 Thunder Bay
5 St. Louis Bay / River
6 Torch Lake
7 Deer Lake - Carp Creek / River

Lake Michigan

8 Manistique River
9 Menominee River
10 Fox River / Southern Green Bay
11 Sheboygan River
12 Milwaukee Estuary
13 Waukegan Harbor
14 Grand Calumet River / Indiana Harbor Canal
15 Kalamazoo River
16 Muskegon Lake
17 White Lake

Lake Huron

18 Saginaw River / Saginaw Bay
19 Collingwood Harbour
20 Severn Sound
21 Spanish River Mouth

Lake Erie

22 Clinton River
23 Rouge River
24 River Raisin
25 Maumee River
26 Black River
27 Cuyahoga River
28 Ashtabula River
29 Presque Isle Bay
30 Wheatley Harbour

Lake Ontario

31 Buffalo River
32 Eighteen Mile Creek
33 Rochester Embayment
34 Oswego River
35 Bay of Quinte
36 Port Hope
37 Metro Toronto
38 Hamilton Harbour

Connecting Channels

39 St. Marys River
40 St. Clair River
41 Detroit River
42 Niagara River
43 St. Lawrence River (Cornwall / Massena)

Figure 2-1. Areas of Concern in the Great Lakes Basin.

integrity of the Great Lakes System sufficient to cause any of the following:

(i)	Restrictions on fish and wildlife consumption;
(ii)	Tainting of fish and wildlife flavor;
(iii)	Degradation of fish and wildlife populations;
(iv)	Fish tumors or other deformities;
(v)	Bird or animal deformities or reproductive problems;
(vi)	Degradation of benthos;
(vii)	Restrictions on dredging activities;
(viii)	Eutrophication or undesirable algae;
(ix)	Restrictions on drinking water consumption, or taste and odor problems;
(x)	Beach closing;
(xi)	Degradation of aesthetics;
(xii)	Added costs to agriculture or industry;
(xiii)	Degradation of phytoplankton and zooplankton populations; and
(xiv)	Loss of fish and wildlife habitat.

In November of 1987, the U.S. EPA updated the "Guidance for Preparing an Area of Concern Remedial Action Plan." This document provides direction regarding the purpose, intent and expectations for each of the chapters to be included in a RAP. The Guidance defines a Source Area of Concern (SAOC) as an area "within which remedial actions could include: a) removal or containment of pollutants in the environment, or b) control of pollutants within or at the point of discharge. The Source Area is not necessarily restricted by river basin boundaries and should include the entire sewer service area of all POTWs within the Area of Concern."

In 1988, the Water Quality Board developed additional guidance for the Parties to the GLWQA and the jurisdictions to identify AOCs and the impaired uses. The Listing/Delisting Criteria for Great Lakes Areas of Concern (Appendix 2-1) identifies specific types of geographic areas that are eligible to be AOCs, and establishes listing and delisting criteria for each of the 14 impaired uses. These criteria were developed and finalized concurrent with the drafting of this document. Both the draft and final versions of the criteria were used in the process to identify impaired uses in the RAP.

As some of the criteria tend to be subjective, the jurisdictions, Parties and IJC must exercise good judgment when listing AOCs, and when defining impaired uses. The goal of the AOC program, to address specific problems that affect the Great Lakes, must be kept in mind at all times.

Annex 2 of the Protocol Amending the GLWQA identifies what must be included in each RAP, and specifies that the RAP should be submitted to the IJC for review and comment at three stages. The three stages and the contents of the RAP at each stage as defined in the GLWQA are as follows:

1) Stage I. This portion of the RAP will include (1) a definition and detailed description of the environmental problem in the AOC, including a definition of the beneficial uses that are impaired, the degree of impairment and the geographical extent of the impairment; and (2) a definition of the causes of the use

impairment, including a description of all known sources of pollutants involved and an evaluation of other possible sources.

2) Stage II. This portion of the RAP will define the water use goals for the AOC and describe the remedial and regulatory measures selected to meet those goals. The Stage II RAP will include (1) an evaluation of remedial measures in place; (2) an evaluation of alternative additional measures to restore beneficial uses; (3) a selection of additional remedial measures to restore beneficial uses and a schedule for their implementation; and (4) an identification of the persons, agencies, or organizations responsible for implementation of the selected remedial measures. If some impaired beneficial uses cannot be restored, this stage must contain an explanation of why they cannot be restored.

3) Stage III. This portion of the RAP will be submitted when identified impaired beneficial uses are restored. The Stage III RAP will include (1) a process for evaluating the implementation and effectiveness of remedial measures; and (2) a description of surveillance and monitoring processes to track the effectiveness of remedial measures and the eventual confirmation of the restoration of uses.

2.3 DETROIT RIVER RAP

This document is intended to meet the requirements of a Stage I RAP for the Detroit River. The problems, their causes, and the sources of pollutants of concern, as known to date, have been defined by the public, Michigan Department of Natural Resources (MDNR), Ontario Ministry of the Environment (OME), Ontario Ministry of Natural Resources (OMNR), Environment Canada, the U.S. EPA and other participating agencies. This RAP contains the technical documentation that will be used by the agencies and public when determining the water use and quality goals for development of the Stage II RAP for the Detroit River. In turn, the goals will establish the general direction for future remedial actions.

In developing this Stage I RAP, available environmental quality data were compared with the Listing Criteria for Great Lakes Areas of Concern (Appendix 2-1) to determine which beneficial uses are impaired in the Detroit River. Other problems may have also been identified due to exceedances of Michigan Water Quality Standards, Ontario Provincial Water Quality Objectives, effluent requirements, or by comparing ambient data to the General or Specific Objectives of the GLWQA. Once the impaired beneficial uses and (any) other aquatic ecosystem problems were identified, the causes of those problems (e.g. specific pollutants, activities such as dredging, etc.), and the sources and loadings of specific contaminants of concern were determined. The public (both individuals and organizations) and various levels and types of government agencies were included throughout the Stage I RAP development process (see Chapter 3, Participants) in reaching consensus on the problems in the Detroit River. The active involvement of those people and agencies not directly responsible for developing this RAP will continue through the Stage III RAP. This broad-based public participation effort is viewed as a critical part of the RAP process to ensure that the efforts to restore the impaired beneficial uses reflect the scientific and economic realities, and the public desires. Thereby, the chances of successfully implementing the selected remedial options will be greatly enhanced.

The Stage I RAP is a technical planning document for addressing aquatic ecosystem problems in the Detroit River. This RAP is not the first of such efforts -- water pollution reduction programs have been ongoing for over 40 years -- nor is it the only effort. Regulatory agencies intend to continue their efforts to control pollutant sources and improve environmental quality as the RAP is developed. Remedial actions and regulatory measures that are identified and immediately implementable have been initiated and will proceed regardless of the status of RAP development.

The RAP process is viewed as a long-term, iterative process. Periodic updates and revisions may be required as more data become available, remedial measures are implemented, and environmental conditions improve. The RAP process itself will end when data confirm that all identified beneficial uses have been restored, or it is shown that further use restoration is not possible. Although the RAP process may end, efforts to restore and enhance environmental quality will continue.

CHAPTER 3
PARTICIPANTS

3.1 RAP TEAM

The Remedial Action Plan (RAP) for the Detroit River Area of Concern was initiated in 1985. Since the Detroit River is a shared international boundary, the State of Michigan, the Province of Ontario, the U.S. Environmental Protection Agency, and Environment Canada have jointly accepted the responsibility for the RAP preparation. In 1985, an agreement (the Ontario-Michigan Letter of Intent on Shared Areas of Concern) was signed by Governor James Blanchard of Michigan and Premier David Peterson of Ontario establishing that a joint RAP would be prepared and giving Michigan the lead role for this endeavor. In 1986 a binational steering committee, called the RAP Team, was established to develop the Plan and determine the type and level of public involvement.

The RAP Team includes representatives from the Federal, State, and Provincial governments. These representatives are policy-level decision makers and implementation level staff. The Team is co-chaired by representatives from the Michigan Department of Natural Resources (MDNR) and from the Ontario Ministry of the Environment (OME). A complete list of RAP Team members is included in Appendix 3-1. In June of 1988, four members of the Binational Public Advisory Council (BPAC) (described in Section 3.2.3) were elected as delegates to the RAP Team to represent the public interest in the RAP development and to facilitate communication between the RAP Team and the BPAC. In June of 1989, the BPAC Chairman also joined the RAP Team. The governmental members of the RAP Team are responsible for the actual writing of the Plan. Meetings of the RAP Team are held as needed, generally occurring bi-monthly.

To assist in the dissemination of information, the RAP Team developed a Detroit Remedial Action Plan Newsletter. The newsletter is available to all interested citizens. It is used to highlight various issues of concern regarding Detroit River water quality and to keep citizens apprised of the activities of the BPAC and the RAP Team.

3.2 PUBLIC PARTICIPATION

Development of the RAP has two major components: technical information compilation and public participation. Public participation is an important and necessary component as it serves to inform the public, improve the plan by gaining information and advice from the public, gain support for plan implementation and provide a mechanism for accountability to the public.

The need for a comprehensive public participation program in the development of the Detroit River RAP was recognized early in the process. As the agreed upon leader for the Detroit RAP, the State of Michigan engaged a consultant, the Southeast Michigan Council of Governments (SEMCOG), to assist in the development of a public participation program plan (Appendix 3-2). In April of 1987, the Ontario Ministry of the Environment also retained a consultant, Michael Michalski Associates, to assist with public participation. In October of 1989, OME retained D.E. Schmidtmeyer Consultants to assist with public participation.

3.2.1 Stakeholders Workshops

In the Spring of 1987, four stakeholder workshops were organized for the purpose of identifying Detroit River issues, concerns and water quality protection goals, as viewed by the particular interest group participating in each meeting. Stakeholder workshops were held as follows:

- Fishing, boating and recreational organizations;
- Industry and shipping representatives;
- Environmental and conservation organizations; and
- Local government representatives.

Representatives of selected organizations were invited to participate in each workshop. It was recognized that a small group of concerned and informed representatives would be a useful first step in building the list of key issues and concerns for the Detroit River Remedial Action Plan. Extensive contacts were made with umbrella organizations, citizen leaders, and local government agencies to identify appropriate persons to invite to the stakeholder workshops. An effort was made to identify specific individuals and leaders within selected organizations who had some experience with the Detroit River. Strong efforts were made to balance participation between Ontario representatives and Michigan representatives. Some contacts with state-wide organizations were also made to identify local organizations and individuals with an interest in Detroit River water quality.

Participants at each workshop were asked to identify beneficial uses of the Detroit River and their concerns regarding the use of the river. A total of 42 persons participated in the four workshops. A wide variety of concerns regarding water quality were expressed, including concerns for contaminants in the fish and water, surface runoff and pollution from land uses in the watershed, stringent enforcement of government regulations and public participation and education. A more detailed summary of the four stakeholders meetings is included in Appendix 3-3.

3.2.2 Public Meetings

An initial public meeting was organized by the MDNR Office of the Great Lakes and held October 9, 1986. The meeting focused on the Detroit River as an Area of Concern. A technical presentation by MDNR staff discussed the Remedial Action Plan development process and the water quality issues pertinent to the Detroit River. Citizen concerns regarding the Detroit River were also gathered from the 35 persons who attended the meeting.

The four stakeholder workshops culminated in a second public meeting held in Windsor, Ontario on June 8, 1987 (attended by 60 persons). This meeting provided government officials an opportunity to listen to public concerns and views about the Detroit River, including discussion of water quality problems and impaired uses, goals for remedial action planning, and options for future public participation. Issues raised at the previous stakeholders meetings were also reviewed and discussed.

A third public meeting was held on October 29, 1987 at the Detroit Yacht Club. The purpose of the meeting was to update interested citizens on technical studies and public participation activities. Approximately 90 persons attended the meeting.

Subsequent public meetings have been held approximately every nine months, alternating locations between the U.S. (Detroit area) and Canada (Windsor area). Topics presented for discussion vary at each meeting and have included presentations on public health issues, aquatic life, surface water discharge permits and the Upper Great Lakes Connecting Channels Study. The purpose of these meetings is to update the public and obtain input on the process from the public. A complete listing of the public meetings, including locations and presentation topics, is found in Appendix 3-4.

3.2.3 Binational Public Advisory Council

The public participation plan which was agreed to by the Detroit River RAP Team included the formation of a Binational Public Advisory Council (BPAC) to provide for informed and continuous public participation. The Detroit River BPAC was created in December of 1987 for the purpose of advising the RAP Team on all aspects of the planning process. The Council consists of twenty Ontario members and twenty Michigan members (and alternates) from the following interest groups:

- Environmental groups;
- Recreation users;
- Industry, shippers and port authority;
- Labor;
- Agriculture/nonpoint sources;
- Municipalities;
- Academic; and
- Citizens at large.

Michigan nominees for the BPAC were identified by SEMCOG and Ontario nominees were identified by the public participation consultant to the Ontario Ministry of the Environment, Michael Michalski Associates. Many of the persons nominated for the BPAC were identified as a result of their interest and informed participation at previous public meetings. A complete list of BPAC representatives is included in Appendix 3-5. Technical experts as well as a wide range of stakeholder groups are represented on the BPAC.

The BPAC's adopted charge is as follows:

> The Advisory Council shall advise the RAP Team on key aspects of Remedial Action Plan preparation and adoption. This includes: the goals of the plan, problems to be addressed, planning methodology, technical data, remedial action alternatives, plan recommendations, plan implementation, plan financing, methods of enforcement, and plan adoption. The goal of all concerned should be to arrive at plan recommendation to which both the RAP Team and the Advisory Council agree.

Members of the Council should relay planning information and decisions to members of the groups they represent and to the general public.

The process of developing the Remedial Action Plan for the Detroit River includes review and comment by the BPAC on the Plan as written by the RAP Team. To assist in this process, the RAP Team provided information and arranged for presentations to the BPAC as work progressed on the RAP. BPAC meetings were held as necessary, generally bi-monthly. A complete listing of BPAC meeting dates (up to the date of this writing) and discussion topics is included in Appendix 3-6. In addition, as previously mentioned, four members of the BPAC were elected as delegates to the RAP Team. The BPAC representation on the RAP Team added input from the BPAC to the RAP writing process. The entire BPAC reviewed and commented on the individual draft chapters as they were completed by the RAP Team.

3.2.4 Detroit River Celebration

In 1988, a Detroit River Celebration festival was initiated by the Southeast Michigan Council of Governments as a part of the contract with MDNR to assist in the attainment of public participation and public education. Celebration activities over the weekends of September 17-18 and September 24-25, 1988 included cultural events centered at the Hart Plaza on Detroit's shoreline as well as bicycle tours along both sides of the river, tours of Great Lakes vessels, and fishing tournaments and derbies. In Ontario, the Windsor area fishing clubs held a fish fry dinner on June 16, 1988 and on September 23, 1988 had a fishing derby to bring awareness of the Detroit River RAP to the area anglers. The goal of the Celebration was to focus attention on the river's aesthetic and recreational potential, providing an opportunity to educate the public with regard to the Detroit River as a resource and to garner support for the development of the RAP.

A similar celebration was held the following year (May 19-21, 1989) at Detroit's Hart Plaza in a continuing effort to educate the public. Activities included musical entertainment, tours of Great Lakes vessels, and many displays set up by various divisions of MDNR.

3.3 TECHNICAL ADVISORY COMMITTEE

A Technical Advisory Committee was organized in 1986 to gather relevant data and to review the draft RAP for technical content and completeness. The committee has representatives from state and federal governments including the U.S. EPA, Ontario Ministry of the Environment, Ontario Ministry of Natural Resources, Environment Canada, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, Michigan Department of Public Health, local health departments, and the Michigan Department of Natural Resources (e.g. Fisheries, Waste Management, Environmental Response) and various universities and others who have data to share. The committee as a whole do not have regularly scheduled meetings but are called on individually to assist with specific issues as questions arise. In addition, members of the committee are utilized on occasion to present technical data to the BPAC and at public meetings as experts on various issues pertinent to the development of the RAP.

The Technical Advisory Committee was also asked to review and comment on the draft RAP. The committee comments were then reviewed by the RAP Team for inclusion. A listing of the Technical Advisory Committee is contained in Appendix 3-7.

3.4 GOVERNMENT AGENCIES

Government agencies participating in the development of the RAP include Environment, Canada, the U.S. Environmental Protection Agency, Ontario Ministry of the Environment, Ontario Ministry of Natural Resources, and the Michigan Department of Natural Resources. Members of the RAP Team from Federal and Provincial/State governments are responsible for the actual writing of all stages of the RAP. Upper level management from these agencies are responsible for review of all stages of the RAP to be implemented by their respective agencies. Final versions of the RAP are approved by the lead agencies (MDNR and OME) and then submitted, by stages, to the IJC for review and comment. The agencies will incorporate appropriate IJC comments into future revisions of the RAP.

3.5 RESPONSIBILITY FOR IMPLEMENTATION

Overall responsibility for implementation of the RAPs lies with the two lead agencies; the Michigan Department of Natural Resources and Ontario Ministry of the Environment. Specific remedial actions may be conducted by Federal, Provincial/State and local governments depending on the particular action and jurisdiction. The IJC is responsible for tracking the implementation of the RAPs.

CHAPTER 4
REGULATORY PROGRAMS

Numerous programs, regulations, objectives, guidelines and agreements to maintain and enhance environmental quality are in place and/or under development in Ontario, Michigan, and at the federal levels in both Canada and the United States. Many of the programs and regulations relevant to the control and enhancement of environmental quality in the Detroit River AOC are outlined in this chapter. Legislation applicable to this discussion is listed in Appendix 4-1. The discussion is intended to outline the major aspects of the most important regulatory programs that affect environmental quality in the AOC. The chapter is organized by jurisdiction to point out the regulatory tools that each has to work with at this time. It is not the intent to compare or contrast programs, but rather to present information that will form the basis of many decisions affecting the AOC.

The determination of whether a beneficial use is impaired will be based on the IJC listing/delisting criteria (discussed in Chapter 2) and also to a large degree on compliance with existing policies, regulations, standards, etc. Of particular importance in this regard are the ambient water quality criteria that are established for the protection of water quality and/or water uses (by humans and other life). Although these criteria and their applications are discussed in detail under the appropriate jurisdictional section, Table 4-1 is provided as a quick reference. This table summarizes the Michigan Water Quality Standards, Ontario Provincial Water Quality Objectives and the Great Lakes Water Quality Agreement Specific Objectives for toxic substances. All will be used to assist in the determination of whether a use is impaired and whether exceedances of water quality standards occur. U.S. EPA criteria are not included because they are not directly applicable to the AOC.

The Stage II RAP will contain recommendations that are consistent with the legislation, policies, standards and programs described in this Charter. Recommendations in the Stage II RAP may also include new programs or changes to existing regulatory programs, if existing programs have been shown to be ineffective in protecting beneficial uses.

4.1 ONTARIO

4.1.1 Environmental Legislation

Environmental quality of the Great Lakes in Ontario is regulated by the province through federal and provincial environmental statutes (Table 4-2). Regulations promulgated under these statutes, (e.g. Ontario Water Resources Act, the Ontario Environmental Protection Act and the Pesticides Act) are intended to ensure that the quality of the water, biota, air, and lands are maintained within the province.

Table 4-1. Applicable surface water quality criteria for toxic substances.

Chemical Name	Michigan Rule 57(2) Allowable Level (ug/l) (a)	Ontario Provincial Water Quality Objective (ug/l)	GLWQA Specific Objective (ug/l)
Metals			
Arsenic	184.0	100	50.0
Cadmium	0.41 (b)	0.2 (e)	0.2
Chromium	48.10 (b)	100	50.0
Chromium, hexavalent	2.0	---	---
Copper	10.72 (b)	5 (f)	5.0
Lead	2.88 (b)	1, 3, 5(g)	25.0
Mercury, filtered	---	0.2	---
Mercury, methyl	0.0006	---	---
Mercury, total filtered	---	---	0.2
Molybdenum	800.0	---	---
Nickel	33.34 (b)	25	25.0
Selenium	20.0	100	10.0
Silver	0.1	0.1	---
Vanadium	3.73	---	---
Zinc	49.57 (b)	30	30.0
Pesticides/Esters Sources include agricultural and industrial use.			
Acrolein	3.0	---	---
Acrylonitrile	2.20	---	---
Aldrin/Dieldrin	---	0.001 (i)	0.001
Chlordane	0.00053	0.06	0.06
Chlorpyrifos	---	0.001	---
Dalapon	---	110	---
DBNPA	4.0	---	---
DDT + metabolites	0.00023	0-0.003 (i)	0.003
Diazinon	---	0.08	---
Dibutylphthalate	---	4	---
Dicamba	---	200	---
2,4-dichlorophenol	37.74 (c)	0.2	---
2,4-dichlorophenoxy acetic acid	46.7	4.0	---
Dieldrin	0.0000315	---	---
Diethylhexylphthalate	---	0.6	---
Dinoseb	0.80 (c)	---	---
Diquat	---	0.5	---
Diuron	---	1.6	---
Endosulphan	---	0.003	---
Endrin	---	0.002	0.002
Ethylene dibromide	1.10	---	---
Fenthion	---	0.006	---
Formaldehyde	200.0	---	---
Guthion	---	0.005	---
Heptachlor	0.002	---	---
Heptachlor/Heptachlor epoxide	---	0.001	0.001
Hexachlorobenzene (HCB)	0.0018	0.0065	---
Lindane	0.097	0.01	0.01
Malathion	---	0.1	---
Methoxychlor	---	0.04	0.04
Mirex (mg/l)	---	0-0.001 (i)	(k)

Table 4.1. (continued)

Chemical Name	Michigan Rule 57(2) Allowable Level (ug/l) (a)	Ontario Provincial Water Quality Objective (ug/l)	GLWQA Specific Objective (ug/l)
Pesticides/Esters Sources include agricultural and industrial use.			
Other phthalates	---	0.2	---
Paraquat	16.0	---	---
Parathion	---	0.008	---
Pentachlorophenol = pH 8.1	20.23 (c)	0.5	---
Pentachlorophenol = pH 8.1	23.0	0.5	---
Phthalatic esters	---	---	0.2-4.0
Pyrethrum	---	0.01	---
Silvex	21.3	---	---
Simazine	---	10	---
Tetrachlorophenols	---	1.0	---
Toxaphene	---	0.008	0.008
Trichlorophenols	---	16	---
2,4,6-trichlorophenol	1.5	---	---
Other Compounds			
Acetone	500.0	---	---
Acrylamide	900.0	---	---
Ammonia, total	---	200	500.0
Ammonia, unionized (coldwater)	20.0	20	20.0
Ammonia, unionized (warmwater)	50.0	---	---
Aniline	4.0	---	---
Benzene	60.0	---	---
Benzidine	0.0399	---	---
Bis(2-chloroethoxy)methane	4.60	---	---
Bis(2-chloroethyl)ether	4.20	---	---
Bis(chlorobutyl)ether	60.0	---	---
Bromodichloromethane	50.0	---	---
Bromoform	65.0	---	---
Bromomethane	11.0	---	---
Carbon tetrachloride	20.0	---	---
Chlorine	6.0	2.0	---
Chlorobenzene	71.0	---	---
Chlorodibromomethane	50.0	---	---
Chloroform	43.0	---	---
4-chloro-3-methylphenol	4.4	---	---
2-chlorophenol	10.0	---	---
4-chlorophenol	9.3	7.0	---
Cyanide	4.0	5	---
1,2-dichlorobenzene	7.0	2.5	---
1,3-dichlorobenzene	179.0	2.5	---
1,4-dichlorobenzene	15.0	4.0	---
3,3-dichlorobenzidine	0.06	---	---
1,2-dichloroethane	560.0	---	---
1,1-dichloroethylene	2.6	---	---
t-1,2-dichloroethylene	300.0	---	---
1,2-dichloropropane	64.0	---	---
2,4-dinitrophenol	9.8	---	---
1,4-dioxane	2000.0	---	---
Di-n-propyl formamide	63.0	---	---
Ethylbenzene	30.0	---	---
Ethylene oxide	56.0	---	---

Table 4.1. (continued)

Chemical Name	Michigan Rule 57(2) Allowable Level (ug/l) (a)	Ontario Provincial Water Quality Objective (ug/l)	GLWQA Specific Objective (ug/l)
Other Compounds			
Fluorides (soluble fluorides)	2000.0	---	---
Fluoride, total	---	---	1200.0
Hexachlorocyclopentadiene	0.5	---	---
Hexachloroethane	13.0	---	---
Hydrogen sulfide	0.55	2.0	---
Isophorone	860.0	---	---
Methylene chloride	59.0	---	---
Naphthalene	29.0	---	---
Pentachlorobenzene	---	0.03	---
Phenol	135.0	1	---
Polybrominated Biphenyls (PBBs)		0 (i)	---
Polychlorinated Biphenyls (PCBs)	0.00002	0.001	---
Polynuclear aromatic hydrocarbons (PAHs)	---	60 pg/l (h)	
Styrene	19.0	---	---
2,3,7,8-TCDD	0.000000014	---	---
Tetra n-butyl ammonium bromide	140.0	---	---
1,2,3,4-tetrachlorobenzene	0.76	0.1	---
1,2,3,5-tetrachlorobenzene	---	0.1	---
1,2,4,5-tetrachlorobenzene	---	0.15	---
1,1,2,2-tetrachloroethane	30.0	---	---
Tetrachloroethylene	16.0	---	---
Toluene	100.0	---	---
Total resin acids	---	1-61.5 (j)	---
Trichloroethylene	94.0	---	---
1,2,3-trichlorobenzene	---	0.9	---
1,2,4-trichlorobenzene	22.0	0.5	---
1,1,1-trichloroethane	117.0	---	---
1,1,2-trichloroethane	65.0	---	---
Vinyl chloride	3.1	---	---
Xylene	59.0	---	---

Comment Codes

a) See Table 4-12 for basis. July 16, 1990 update.
b) Based on a water hardness of 100 mg/l.
c) Based on a pH of 8.0.
d) pH and temperature dependent, not to exceed 20 ug/l unionized.
e) In waters with hardness between 0-100 mg/l as CaCO3. For waters with hardness 100 mg/l PWQO is 0.5 ug/l.
f) PWQO is 1 ug/l for hardness between 0-20 ug/l as Ca CO3; 5 ug/l for hardness 20 ug/l as CaCO3.
g) Inorganic lead for hardness of 0-30, 30-80 and 80 mg/l, respectively.
h) Provincial Water Quality Guidelines (PWQG) for Benzo(a)pyrene.
i) As per narrative outlined in MOE 1984 "Blue Book".
j) pH dependent (note: PWQG Guideline).
k) Substantially absent, meaning less than available detection levels.

Table 4-2. Environmental legislation affecting the Great Lakes and Connecting Channels.

Ontario Acts	Media or Activity Addressed												
	A	B	C	D	E	F	G	H	I	J	K	L	M
Ontario Water Resources Act (OWRA)	1	3	1	1	1					2		1	
Ontario Environmental Protection Act (EPA)	3	2	3	1	1	1		2	1	3	1		2
Environmental Assessment Act	3	3	3	3	3	3		3	3				
Dangerous Goods Transportation Act						1					1		
Drainage Act								2					
Pesticides Act							1			1			
Public Lands Act			1										

Key to Codes:

A: Ambient Surface Water and Ground Water Quality and Management
B: Sediment Quality and Management
C: Biota Quality and Habitat Management
D: Industrial Point Source Discharge Control
E: Municipal Point Source Discharge Control
F: Solid and Hazardous Waste Management
G: Pesticide Manufacture and Management
H: Urban Runoff and Combined Sewer Overflow Management
I: Air Point Source Discharge and Ambient Air Quality Control
J: Agricultural Land Management
K: Spills and Shipping Activities
L: Drinking Water Quality Control and Management
M: Fish Consumption Guidelines or Advisories

1: Legislation is responsible for legally enforceable standards and/or has direct authority over the media or activity.

2: Legislation provides non-enforceable guidance or authority over media or activity.

3: Legislation is not directly applicable to the media or activity, but media/activity may be impacted by execution of its legislative mandate.

Many of these acts and regulations provide the legislative authority to control and restrict the discharge of contaminants into the air or water or onto the land. They specify numerous prohibitions that define what constitutes a contaminant and permitible discharges. The acts specify abatement mechanisms and procedures, such as Control Orders, Minister's Orders, etc., which are used to specify legally enforceable control strategies. The acts and regulations also specify permitting processes (Certificates of Approval) to ensure adequate collection, handling, treatment and disposal of wastes, including wastewaters, atmospheric discharges and solid wastes.

4.1.2 Water Quality Objectives

Ontario established goals and policies for the management of the quality and quantity of surface and groundwaters in 1978 under the Ontario Water Resources Act (OWRA). This Act was preceeded by the Ontario Water Resources Commission Act R.S.O. 1960 c.281. In 1970, the Ontario Water Resources Commission published the "Guidelines and Criteria for Water Quality Management in Ontario". The 1978 publication was revised and expanded. Surface water quality must be satisfactory for aquatic life, recreation and potable water supply. The Provincial Water Quality Objectives (PWQOs) are a set of numerical and narrative criteria to protect aquatic life and recreation in and on surface water (OME 1984). Numerical PWQOs are given in Table 4-3. PWQOs represent a desirable level of water quality that the OME strives to maintain in surface waters of the province. They are often the starting point in deriving effluent requirements.

The PWQOs are under constant review and may be revised as more information becomes available. In 1984 the Ministry of the Environment had more than 70 substances with undefined tolerance limits for which there was insufficient scientific data to establish PWQOs (OME 1984). The list continues to grow. In 1989 the Ministry issued the Handbook for the Parameter Listing System which summarized the various drinking water quality limits established by some 16 agencies worldwide for more than 600 compounds. The presence and/or discharge of these compounds is evaluated on a case-by-case basis.

The protection and control of surface water quantity is another key component to Ontario's surface water management strategy. Surface water quantity is protected through a permit process.

4.1.3 Point Source Controls

Municipal and industrial direct discharges to receiving waters are controlled by Ontario's Municipal and Industrial Effluent Objectives (Table 4-4) established under the OWRA and the EPA. In addition, site-specific effluent requirements protect the quality of the receiving water. Site specific requirements are based on Policy 3 of the Ministry's Water Management Goals, Policies, Objectives and Implementation Procedures (OME 1984).

Table 4-3. Ontario Provincial Water Quality Objectives (PWQO) for the protection of aquatic life and recreational uses.

Parameter	PWQO[1]
Alkalinity	25% decrease[2]
Ammonia, mg/l	0.02[2]
Barium, mg/l	
Boron, mg/l	
Chloride, mg/l	
Chlorine, mg/l	0.002
Color, TCU	
Copper, mg/l	
Cyanide (free), mg/l	0.005
Dissolved Gases	110% Sat.
Dissolved Oxygen, mg/l	4-8
Fluoride, mg/l	
Hydrogen Sulfide, mg/l	0.002
Manganese, mg/l	
Methane, l/m^3	
Nitrate (as N), mg/l	
Nitrite (as N), mg/l	
Heavy Metals, ug/l	
Arsenic	100
Beryllium	11-1100[2]
Cadmium	0.2
Chromium	100
Copper	5
Iron	300
Lead	5-25[2]
Mercury	0 to 0.2[2]
Nickel	25
Selenium	100
Silver	0.1
Zinc	30
Uranium, mg/l	
Bacteria (per 100ml)[1]	
Standard Plate Count	
Total Coliform	1000
Fecal Coliform	100
Fecal Streptocci	
Pseudomonas aeruginosa	
Staphylococcus aureus	
Trihalomethanes, mg/l	
Industrial Organics, mg/l	
Dibutylphthalate	4
Diethylhexyphthalate	0.6
Other Phthalates	0.2

Table 4-3. (continued)

Parameter	PWQO[1]
Mirex	0-0.001[2]
Polychorinated Biphenyls	0-0.001[2]
Polybrominated Biphenyls	0[2]
Oil & Grease	(2)
Organic Nitrogen, mg/l ($TKN-NH_3$)	
pH	6.5-8.5
Phenols, ug/l	1
Phosphorus(total),mg/l	10-30[2]
Radionuclides, Bq/l[1]	
Cesium 137	50
Iodine 131	10
Radium 226	1
Strontium 90	10
Tritium	40,000
Sulphate, mg/l	
Taste	
Temperature, °C	10°C increase or max 30°C[2]
Total Dissolved Solids, mg/l	
Total Organic Carbon, mg/l	
Turbidity	10% secchi depth increase
Pesticides, ug/l	
Aldrin/Dieldrin	0.001[2]
Carbaryl	
Chlordane	0.06
Chlorpyrifos (Dusban)	0.001
Diazinon	0.08
Dicamba (Banvel)	200
Diquat	0.5
Diuron	1.6
Dalapon	110
Endosulphan	0.003
Endrin	0.002
Fenthion (Baytex)	0.006
Guthion	0.005
Heptachlor & Heptachlor Epoxide	0.001
Lindane	0.01

Table 4-3. (continued)

Parameter	PWQO[1]
Malathion	0.1
Methoxychlor	0.04
Methyl Parathion	
Parathion	0.008
Pyrethrum	0.01
Simazine	10
Toxaphene	0.008
DDT & Metabolites	0-0.003[2]
2,4-D (BEE)	4
2,4,5-TP	
Dibenzofurans/dioxins (pg/l)	

(1) From Ontario Ministry of the Environment, 1984 Water Management, Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment, Toronto.

(2) As per narrative in above reference.

Table 4-4. Ontario municipal and industrial effluent objectives (mg/l unless noted).

Parameter	Ontario Industrial Effluent Objectives	Ontario Municipal Effluent Objectives
BOD5	15	20
Suspended Solids	15	25
Oil and Grease	15	15
Ammonia-Nitrogen	10	-
Fecal Coliforms, MF/100ml	-	400
pH, SU Units	5.5 - 9.5	6-9
Total Phenols	0.02	0.02
Total Phosphorus	-	1
Total Residual Chlorine	-	0.5
Cadmium	0.001	-
Chromium*	1.0	-
Copper*	1.0	-
Lead	1.0	-
Mercury*	0.001	-
Nickel*	1.0	-
Tin*	1.0	-
Zinc*	1.0	-

* Total metals concentration not to exceed 1.0 mg/l

Policy 3 dictates that effluent limits will be established based on the waste receiving capacity of a waterbody and the Provincial Water Quality Objectives. Consideration will also be given to the Federal or Provincial effluent regulations or guidelines, and control of nonpoint sources of pollution. Effluent requirements will be determined following appropriate site specific receiving water assessments. This effluent requirement will be compared to Federal effluent regulations or Provincial effluent regulations or guidelines for existing or proposed new or expanded effluent discharges. The more stringent of the effluent requirement, regulations or guidelines will be imposed. The effluent requirement derived from this procedure for proposed new or expanded discharges will be incorporated into a Certificate of Approval in both waste loadings and concentrations.

Certificates of Approval (C of A) for treatment works are issued under the OWRA. In the past, the C of A was an approval to install pollution control equipment with the design specifications shown in the C of A. Recently, some approvals include legally enforceable effluent limits which appear in the C of A.

Certificates of Approval are also issued to municipal Water Pollution Control Plants (WPCPs). These C of A's usually only describe control equipment modifications or specifications; however, some do contain effluent limits.

The provincial EPA Sewage System Regulations set standards for the construction and operation of sewage systems and the licensing of related businesses. Municipal storm sewer-use by-law control parameters and limits specify the concentration of various parameters, mainly conventional pollutants and metals. Municipal sanitary sewer-use by-law control parameters are similar in scope and degree of control, and apply to all industrial dischargers to the municipal facility. Additional pretreatment requirements, such as technology-based pretreatment, are not specified. However, these by-laws contain a clause enabling the municipality to require oil interceptors, flow monitors, manholes and treatment, as necessary, to meet the by-law limits (without dilution).

Legally enforceable Control Orders may be issued under Section 113 of the EPA to any existing plant. Control Orders define tasks and compliance dates by which specific tasks must be completed.

The Guidelines for Control of Industrial Phosphorus Discharges in Liquid Effluents, issued under EPA, are intended to provide guidelines for phosphorus discharges and water quality management consistent with municipal sewage systems. The objective of 1 mg/l phosphorus concentration in industrial effluents is based on the use of practicable control technology to control or eliminate phosphorus. Facilities discharging one million gallons per day or more of effluent are subject to the phosphorus limitation of 1 mg/l.

The provincial government, in consultation with Environment Canada, published a White Paper entitled "Municipal-Industrial Strategy for Abatement (MISA)" in June, 1986. The White Paper provides the framework for the control of toxic contaminants in industrial and municipal effluents; initially, through a regulatory component to enforce technology-based effluent limits. The minimum pollution control requirement will be based on the implementation of "Best Available Technology Economically Achievable (BATEA)". As treatment technologies are advanced, BATEA requirements will be adjusted, moving towards the goal of virtual elimination of persistent toxic contaminants. This is consistent with the policies stated in the Great Lakes Water Quality Agreement as amended in 1987. Development of these controls will be accomplished through the promulgation of Effluent Monitoring Regulations and Effluent Limits Regulations directed at municipal and industrial sectors in order to achieve water pollution control at its source.

Opportunity for public involvement has been afforded and is summarized in Public Review of the MISA White Paper and the MOE's Response (OME 1987d). Under the MISA program, a monitoring and reporting regulation will set legal requirements for submission, accuracy and reliability of self-monitoring information (including sampling and analytical protocols). This new regulation will specify a list of pollutants as per the Effluent Monitoring Priority Pollutants List (EMPPL) (OME 1987d) and a set of sampling schedules for each defined industrial and municipal sector.

The EMPPL is a list of toxic pollutants that have been detected or are potentially present in Ontario municipal and industrial effluent and pose a hazard to the receiving environment. The 1988 EMPPL update (OME 1989b) contains 266 chemicals and includes 179 parameters from the 1987 EMPPL and 87 additional parameters.

Plants which directly discharge wastewater to surface watercourses and which are subject to the MISA regulations of Ontario, are required to prepare Initial Reports. These Reports provide details on the plans of each discharger to monitor effluent streams during a one year information gathering period.

The content of Initial Reports is defined by two regulations made under the Environmental Protection Act. These are Ontario Regulation 695/88 Effluent Monitoring - General, called the General Regulation, and a regulation covering an industrial grouping or sector called the Sector Regulation. When implemented, the regulations will expand the available data base on toxic substances and result in greater uniformity in reporting.

Effluent Monitoring Regulations for the nine industrial sectors were promulgated as per the schedule shown in Table 4-5. The Ministry of the Environment is now in the process of formulating effluent limit regulations for each industrial sector based on the best available technology economically achievable. It is anticipated that the Limits Regulations for the nine industrial sectors will be promulgated during 1992. The data collected under the Monitoring and Reporting Regulations will be used to establish these limits. Later, receiving water quality-based requirements will be determined and the more stringent of the water quality-based and technology-based limits will be imposed.

Table 4-5. MISA monitoring regulations promulgation dates.

Sector	Monitoring Regulation
Petroleum	July 1988
Organic	April 1989
Iron & Steel	May 1989
Mining	August 1989
Pulp & Paper	July 1989
Inorganic Chemicals	June 1989
Metal Casting	October 1989
Electric Power	November 1989
Municipal STP	Being Revised
Industrial Minerals	December 1989

Sampling methodologies and frequencies, analytical protocols, definitions and a list of the priority pollutants are presented in the following reports:

• A Policy and Program Statement of the Government of Ontario on Controlling Municipal and Industrial Discharges into Surface Waters (White Paper)	June, 1986
• The Public Review of the MISA White Paper and the MOE's Response to It	January, 1987
• The Effluent Monitoring Regulation for the Petroleum Refining Sector (Draft)	July, 1987
• Effluent Monitoring Priority Pollutants List (Draft)	August, 1987
• Report on the 1986 Industrial Direct Discharges in Ontario	October, 1987
• Estimation of Analytical Method Detection Limits (MDL)	March, 1988
• Kraft Mill Effluents in Ontario (Report by the Expert Committee members)	April, 1988
• The Public Review of the Draft Effluent Monitoring Regulation for the Petroleum Refining Sector and the Ministry of the Environment's Response to It	July, 1988
• Cost Estimates and Implications of the "Effluent Monitoring - General" and "Effluent Monitoring - Petroleum Refining Sector" Regulations for Ontario Petroleum Refineries	July, 1988
• Effluent Monitoring Regulations for the Petroleum Sector	July, 1988
• Inventory and Critical Review of Laboratory Resources (Final Report)	July, 1988
• The Economic and Financial Profile of the Petroleum Refining Sector (Summary Report)	August, 1988
• Model Sewer Use By-Law	August, 1988
• Controlling Industrial Discharges to Sewers	September, 1988
• The Development Document for the Draft Effluent Monitoring Regulation for the Organic Chemical Manufacturing Sector	October, 1988

- Report on the 1987 Industrial Direct Discharges in Ontario — October, 1988
- Effluent Monitoring Priority Pollutants List-1988 Update — March, 1989
- The Development Document for the Draft Effluent Monitoring Regulation for the Metal Casting Sector — April, 1989
- Interim Pollution Reduction Strategy for Ontario Kraft Mills — April, 1989
- The Development Document for the Draft Effluent Monitoring Regulation for the Electric Power Generation Sector (and Monitoring Cost Estimates Report) — August, 1989

4.1.3.1 Compliance and Enforcement

A number of enforcement options are available under the Environmental Protection Act to ensure compliance where an adverse effect on the environment will or is likely to occur.

Legally enforceable Control Orders may be issued to any existing plant under Section 6 of the EPA when a contaminant that causes or is likely to cause adverse effects is being discharged. Control Orders define tasks and compliance dates by which specific tasks must be completed.

Control Orders as set out in Section 113 of the Act may require a facility to perform any of the following:

- stop or limit a discharge;
- install necessary equipment;
- produce a contingency plan and have spill response equipment;
- provide financial assurance;
- repair/remediate damage to the environment.

Under Section 5 of the Act, Stop Orders may be issued if there is an immediate danger to human life or health. In addition, an order for preventative measures may be served under Section 17. There are federal regulation limits under the Fisheries Act for some sources. Certificates of Approval (C's of A) for sewage works are issued under the Ontario Water Resources Act. In the past, the C of A was an approval to install pollution control equipment with the expected effluent quality, used as the basis for design, sometimes shown in the C of A. Recently, new sewage work approvals have begun to include effluent limits which are legally enforceable, since the required performance of the treatment system is explicitly defined.

For non-compliance with legally enforceable limits, the Ministry's approach is to take abatement action to return the discharger to compliance. Such action could include enforcement measures, abatement negotiations or issuance of Control Orders.

For exceedance of guideline limits, regional abatement staff assess whether the exceedance caused or would likely cause impairment to the receiving waters. If so, then enforcement actions may be initiated as for non-compliant sources above. Otherwise, Ministry staff request dischargers to take voluntary abatement measures and/or Ministry staff work together with the company to eliminate the exceedances.

Remedial actions are often complex, involving problem definition, development of appropriate remedial measures, negotiation of abatement plans including public consultation, design, approval, construction and commissioning of works, and may extend over several years in some situations.

Under the EPA, offenses may result in fines to individuals of up to $10,000 plus one year in jail for a first offense, and up to $25,000 per day plus one year in jail for subsequent offenses. Corporations may receive penalties of up to $200,000 and $400,000 for first and subsequent offenses, respectively.

Only the exceedances of legally enforceable limits in Control Orders, Requirement and Direction, and Certificates of Approval could directly result in prosecutions under existing legislation. The guidelines in and of themselves, are not directly legally enforceable. Consequently, a separate review of guideline limit exceedances is provided.

The Ministry will continue to expect industrial dischargers to meet any numerical limits including guidelines until they are replaced by the technology based requirements of MISA being phased in for major industrial sectors over the next few years.

4.1.4 Non-Point Sources

There are limited controls under the OWRA and EPA for urban and rural/agricultural runoff. No control strategies exist for the treatment of combined sewer overflows (CSOs). However, the province has worked with municipalities to segregate sanitary and storm sewers to reduce CSOs and sewage treatment plant bypasses. The MISA program will consider abatement requirements for CSOs. Stormwater quality management is discussed in Section 4.1.4.4.

Guidelines for snow disposal and de-icing operations in Ontario require that snow dumps be located on land, remote (greater than 600 feet) from surface water, and should not seriously obstruct natural drainage or contaminate groundwater. The bulk use of de-icing compounds, other than salts, is restricted to special circumstances (e.g. airport runways). A program is underway to control and mitigate leachate from salt storage facilities.

Agriculture Canada and the Ontario Ministry of Agriculture and Food have instituted the Soil and Water Environmental Enhancement Program (SWEEP) to educate farmers on new tillage, crop rotation and soil conservation practices, and have provided soil testing services to assist in determining appropriate application rates for fertilizers and lime. Under the Ontario Environmental Protection Act, farmers are required to comply with the 1973 Agricultural Code of Practice for Ontario to reduce contaminant loads to receiving streams. The Ontario Ministry of the Environment has restricted application rates, times and contaminant levels in sewage sludges applied to agricultural land (Table 4-6).

Ontario Ministry of Agriculture and Food's Land Stewardship Program provides grants for the adoption of conservation farming practices that will enhance and sustain agricultural production, and improve soil resources and water management by 1) reducing soil erosion and soil compaction, 2) restoring soil organic matter and structure, and 3) minimizing potential for environmental contamination from agricultural practices. The Land Stewardship Program consists of four components: financial assistance, research, education and extension, and program delivery and service.

The Farm Pollution Advisory Committee (FPAC) is comprised of four farmers appointed by the Minister of the Environment under Section 3(1) of the Environmental Protection Act. The FPAC's role is to advise the Minister about whether in a specific situation, animal waste is being handled and disposed of in accordance with "normal farming practice", and thereby not impacting the quality of nearby water bodies. This advise is crucial to the Minister due to exemptions in the EPA for agriculture.

4.1.4.1 Shipping

Pleasure crafts are controlled by Ontario's Boating and Marine Regulations, pursuant to the Environmental Protection Act. Small boats must be fitted with holding tanks to contain wastewater, which are emptied by special pumps at marinas. Non-waste water is not regulated under provincial regulations. Commercial shipping activities that may affect water quality are regulated under the Canada Shipping Act. These regulations are discussed in Section 4.2.3.1.

The provincial Dangerous Goods Act reiterates the measures outlined under the federal Transportation of Dangerous Goods Act. Provincial Guidelines for Environmental Protection Measures at Chemical Storage Facilities recommend preventive procedures consistent with those of the Manufacturing Chemists Association. For liquids, this would entail diked containment at a location away from piping and drainage systems, the compatibility of liquids stored in proximity and the use of safety alarms. Gases and volatile liquids are stored more safely in appropriately vented roof tanks with water deluge systems to capture any escaping soluble compounds. All drainage and leakage from storage areas should be collected and treated prior to disposal.

4.1.4.2 Spills

Part IX of the Environmental Protection Act, referred to as the "Spills Bill", deals with spills of pollutants into the natural environment from or out of a structure, vehicle or other container, that are abnormal in light of all circumstances, and which cause, or are likely to cause, adverse effects. The "Spills Bill" establishes notification requirements, responsibilities and compensation mechanisms, in addition to other factors. The Ontario Spills Action Centre, whose origin was spawned by

Table 4-6. Ontario metal criteria for land application of sewage sludge.*

Metals	Maximum Permissible Concentration (mg/kg solids)
Arsenic	170
Cadmium	34
Cobalt	340
Chromium	2800
Copper	1700
Mercury	11
Molybdenum	94
Nickel	420
Lead	1100
Selenium	34
Zinc	4200

*These values are for all aerobic sewage sludge and all dried and dewatered anaerobic sewage sludge. Other regulations apply for liquid anaerobic sewage sludge.

the "Spills Bill", coordinates the Ministry's response network, working closely with the Canadian Coast Guard, police and fire departments, and other reporting centers, as well as downstream water users in Ontario and Michigan.

In the event of a major spill to the Detroit River, the Ministry obtains preliminary estimates of concentrations and durations from the source. Using a model designed specifically for the Detroit River, the concentration and duration of the pollutant is predicted at downstream water intakes in Ontario and Michigan. If the Provincial Water Quality Objectives (PWQOs) and/or Drinking Water Quality Objectives (DWQOs) are exceeded at the intakes the users are advised and withdrawal of water from the Detroit River may be terminated while the plume passes. For chemicals for which the Ministry does not have established water quality objectives, the Ministry will refer to standards or objectives enforced by any other agency worldwide (refer to PALIS, 1984 in Section 4.2.2 preceding), in consultation with experts in the Drinking Water Section of the Ministry's Water Resources Branch. Since few short-term exposure limits exist for most compounds, the Ministry has relied on the more common long-term exposure limits for guidance in such incidents.

4.1.4.3 Sediment Quality

The quality of sediments is assessed against contaminant concentrations established in the 1978 Revised Guidelines for Open Water Disposal of Dredged Spoils (Table 4-7). The OME allows open water disposal of dredged materials with contaminant levels less than established guidelines, providing existing water uses are not affected. Any other suspected contaminants in the sediments are evaluated on a case-by-case basis.

Contaminated sediments constitute a significant environmental concern in the Great Lakes Basin, and existing guidelines are under review by most agencies. Special advisory groups, such as the Polluted Sediment Subcommittee under the Canada-Ontario Agreement, have been established to review sediment guidelines and assessment criteria, to evaluate dredging activities and in-place remedial options, and to provide expert advice on in filling practices. Under the EPA the OME can order the removal of contaminated sediments. Biologically-based guidelines for contaminant concentrations in sediments are under development.

Most navigational dredging in Canada is done by the federal government and there is no regulatory approval process. Although overall agency responsibility for dredging projects depends upon the project type and location, all projects involve review by several agencies.

Transport Canada is responsible for navigational dredging, but Public Works Canada usually undertakes the overall management of the project. These projects fall under the federal Environmental Assessment and Review Process (EARP) which is undertaken and assessed by the project sponsor; in this case Transport Canada. EARP has two major stages:

1. Transport Canada would seek advice from the various federal agencies, ports and harbor commissions, and in Ontario, OME and OMNR. The information from these agencies is used to assess the

Table 4-7. Ontario MOE guidelines for dredged material disposal in open water.

Parameter	Ontario OME Guidelines (mg/kg)
Total Phosphorus	1000
Total Kjeldahl Nitrogen	2000
Ammonia	100
Volatile Solids (Loss on Ignition)	60,000
Oil & Grease	1,500
Aresenic	8
Cadmium	1
Chromium	25
Cobalt	50
Copper	25
Cyanide	0.1
Iron	10,000
Lead	50
Mercury	0.3
Nickel	25
PCB	0.05
Silver	0.5
Zinc	100

project for possible environmental concerns. If it is determined that the environmental effects are not significant then the project can proceed.

2. If the initial assessment indicates that there may be environmental problems, the the project is referred to the Federal Environmental Assessment Review Office for a major environmental assessment. Thus far, no dredging projects in Ontario have gone through this process.

Federal legislation is expected in the near future to improve EARP's public consultation process and strengthen requirements.

Environment Canada is reviewing Ontario's newly proposed sediment quality guidelines, and is likely to adopt them as interim guidelines and ask for federal agencies to abide by them.

No remedial dredging in Canadian AOCs has occurred thus far.

Under the federal Great Lakes Program, Request for Proposals (RFPs) are being developed to solicit projects to demonstrate state-of-the-art technologies for the remediation of contaminated sediments. This effort will be coordinated with the ARCs program so as not to duplicate efforts.

At present, there is no single specific policy in Ontario for the management of contaminated sediments in circumstances other than those where dredging is proposed. Most dredging projects in Ontario are undertaken for navigational purposes and are subject to a variety of federal and provincial legislation. The federally coordinated review of dredging proposals includes input from the Ontario MOE and the Ontario Ministry of Natural Resources (MNR).

Proposals are evaluated on a case-by-case basis, using OME bulk chemical guidelines, to determine whether the dredged material requires confined disposal. These guidelines will soon be replaced with new, biologically based, sediment guidelines. In addition, guidelines for the classification of dredged material requiring disposal as hazardous waste are also under development. In addition to an evaluation of sediment quality, the proposed dredging, transport, and disposal methods are examined along with the timing of the project. Project approval generally requires that certain mitigative measured by undertaken and that monitoring be carried out during and after the dredging operation.

4.1.4.4 Stormwater

The Interim Stormwater Quality Guidelines have been developed jointly by the Ontario Ministries of the Environment (OME) and Natural Resources (MNR) to address the need for stormwater quality management in new developments in developing areas in Ontario. These guidelines are consistent with the approach outlined in the Urban Drainage Design Guidelines (OME 1987e).

The purpose of these interim guidelines is:

(a) To provide guidance to OME and MNR staff in the review of planning documents and development proposals.

(b) To provide guidance to OME and MNR staff in the requirements, evaluation and approval of stormwater management facilities for water quality control for developments proposed under the Planning Act.

(c) To provide municipalities with OME's information requirements for the review of planning documents and planning proposals for stormwater management facilities for stormwater quality control for new developments.

(d) To provide guidance to proponents for stormwater management for water quality control.

The Interim Stormwater Quality Guidelines are intended to be reviewed and updated on an ongoing basis. Offices of the OME and MNR request and review quality components of stormwater management proposals for new development under the Planning Act. MOE has the legislative authority to review and approve stormwater treatment works under Section 24 of the Ontario Water Resources Act.

The Water Management Goals, Policies and Implementation Procedures of the Ministry of the Environment (OME 1984) require conservation and remedial measures for the control of nonpoint sources such as stormwater discharges if they are shown to cause or contribute significantly to violations of the Provincial Water Quality Objectives.

The interim stormwater guidelines are applicable to any new development in developing areas reviewed under the Planning Act. Application of the guidelines will depend on the sensitivity of the waterbody that the stormwater is being discharged to. These guidelines could also provide direction in the review of undertakings subject to the Environmental Assessment Act, other legislation or other agency programs.

The development criteria contained in the Interim Stormwater Quality Control Guidelines can be implemented within legislative, policy and administrative procedures already available to the two ministries. Therefore, it represents no new policy intiatives or development design techniques, rather, it formalizes how established design and planning tools can be applied and how the two ministries can coordinate their activities and effectively relate to other agencies.

Related Programs and Studies

The Ontario Urban Drainage Management Program (UDMP) is designed to encourage good drainage planning and apply good practices in stormwater management, including preparation of Watershed Plans, Master Drainage Plans, and Stormwater Management Plans; major and minor drainage systems in design, and erosion and sediment control during construction. Two documents have been released by the Ontario Urban Drainage Implementation

Committee in support of the UDMP: Urban Drainage Design Guidelines, 1987, and Guidelines on Erosion and Sediment Control for Urban Construction Sites, 1987.

The UDMP deals mainly with stormwater quantities. Control of stormwater pollution in new developments is envisioned mainly as erosion and sediment control during construction. The UDMP is voluntary at this time. This position will be re-evaluated after sufficient experience is gained.

The approach presented in the Urban Drainage Design Guidelines for stormwater quantity management planning is similar to the approach presented here for stormwater quality management (Figure 4-1). OME's Pollution Control Planning (PCP) Program funds the abatement of pollution in existing urban areas. This PCP Program is carried out on an "as needed basis", separately from urban drainage planning such as Master Drainage and Stormwater Management Plans. The PCP Program does; however, provide input to urban drainage planning activities where multi-source water quality problems (especially wet weather sources) exist.

4.1.5 Wetlands and Shorelands

Physical alterations to Ontario Crown lake, river and stream beds and adjacent shorelands are regulated by the Public Lands Act (1980). This act provides for a work permit and associated review process which, among other things, allows authorities to ensure critical fish and wildlife habitat will not be destroyed or harmed by the work proposed. Fisheries habitat such as spawning nursery and feeding sites, as well as migration routes, is afforded more direct protection by means of the Fisheries Act. This is a federal statute which is enforced by both provincial and federal agencies.

Ontario provincial agencies and the federal government have entered into a Habitat Management Agreement whereby fish habitat which includes many wetland areas, are to be protected and opportunities for rehabilitation are considered where feasible. A draft wetlands policy is currently under review and is expected to be in place soon. It will give special recognition to the values provided by the most significant classes of wetlands in the province.

4.1.6 Solid, Liquid & Hazardous Waste Controls

Solid and hazardous waste programs are implemented by the provincial government mainly under the Environmental Protection Act (EPA). The EPA Waste Management-General Regulations describe the classification and approval of waste disposal sites and waste management systems. Standards for the location, maintenance and operation of a landfill site are outlined, including measures to be taken for the collection and treatment of contaminants for the prevention of water pollution. These include locating the landfill site above, or isolated from, the maximum ground water level to protect the aquifer, and allowing sufficient distance from water sources to prevent contamination, unless all leachate is collected and treated. The implementation of the Waste Management General Regulations and related policies are summarized in "The Incorporation of

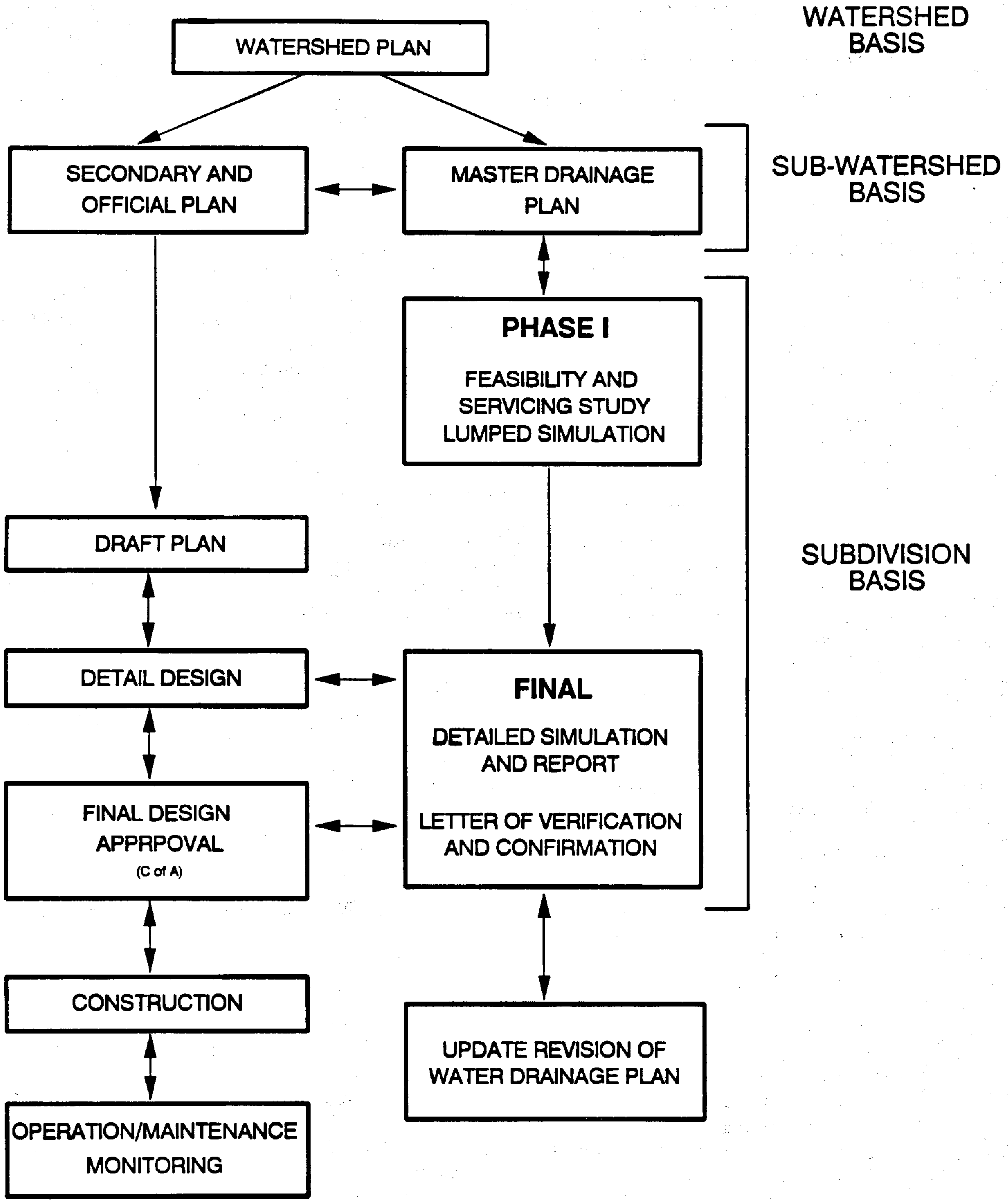


Figure 4-1. Stormwater management planning and design procedures.

the Reasonable Use Concept into the Ground Water Management Activities of the Ministry of the Environment." In addition to landfill record-keeping requirements, an expanded manifest system was recently implemented under EPA Regulation 309 to ensure the registration of wastes by generators, and proper handling, shipping and disposal by carriers and receivers. The Hauled Liquid Industrial Waste Disposal Sites Regulations (EPA Regulation 808) prescribes standards for the operation and maintenance of all Ministry-approved industrial sites. One requirement is that ground water and surface water quality in and around the site shall be regularly monitored.

The Guidelines for the Treatment and Disposal of Liquid Industrial Wastes in Ontario applies to Ministry-approved waste treatment and disposal processes or sites (except those covered by other regulations or guidelines). These Guidelines list various industrial wastes and recommend a corresponding treatment and disposal process.

The provincial Waste Management PCB Regulations require owners or generators of PCB wastes to keep records regarding the waste's nature, quantity, storage method and location on-site (or transporation offsite), while awaiting final resolution of the waste. Standards for the location, maintenance and operation of mobile PCB destruction facility waste disposal sites are included in the Mobile PCB Destruction Facilities Regulation. Two such companies operate in Ontario. Maximum point of impingement levels are imposed on air emissions of PCBs, chlorinated dibenzodioxins, and chlorinated dibenzofurans. All solid wastes generated must be disposed of at a certified waste disposal site.

Ontario Regulation 303, under CEPA, prohibits disposal of any liquid industrial waste, except oil field brine, into the Detroit River Group geological formation. These prohibitions came into effect in 1974.

4.1.7 Pesticides

The provincial Pesticides Act (1980) prohibits, in general, the discharge or emission of pesticides that would cause or be likely to cause damage to the environment, animal or plant life, or human health greater than the impairment that would necessarily result from the proper use of the pesticide. A license to carry out exterminations and other requirements such as application methods, permits, safety precautions, and use restrictions for specific pesticides are outlined in the Pesticides (General) Regulations.

The only agricultural pesticide program is the Integrated Pest Management Program, administered by OMAF, which provides advice on pesticide use to farmers. This program is not directed at environmental or water quality protection.

4.1.8 Air Quality

Air quality in Ontario is regulated under Regulation 308 of the Ontario Environmental Protection Act. Under this regulation, the Ministry of Environment may prepare an "Air Quality Index (AQI)" to express the relative levels of air pollution. As an index level is approached or exceeded, the Ministry of Environment, in consultation with the Ministry of Health, may order curtailment of the operation of sources of air pollution. The Regulation also identifies the maximum concentration of contaminants at a point of impingement from a source of contaminant, other than a motor vehicle. The maximum concentrations are outlined in Appendix 4-1.

Ontario MOE, in conjunction with the Michigan DNR, the Lambton Industrial Society, and representatives from Wayne County, Michigan, prepare a yearly summary of transboundary air contaminant movement. Monitoring is most extensive for ozone, sulfur dioxide, carbon monoxide, total suspended particles and particle-bound lead. Less extensive monitoring is conducted for oxides of nitrogen, hydrocarbons, reduced sulfur and other constituents of the particulate matter. Ontario MOE also conducts ambient air quality monitoring in Sarnia, Windsor and Sault Ste. Marie, measuring similar parameters as above. A report is issued annually.

The Ontario MOE Air Resources Branch conducts studies of long range transportation and deposition to the Great Lakes, specifically for toxic contaminants. There are two permanent air monitoring stations involved in this study area; one near Lake Huron and one near Lake Erie.

Ontario MOE, with Environment Canada, is also monitoring the effect of the City of Detroit incinerators on air quality, with air monitoring stations in Windsor. Ontario MOE also has air monitoring stations in Amhertsburg and Windsor, measuring radioactivity in particulate matter originating from a nearby accelerator laboratory.

4.1.9 Fish Consumption Advisories

Most ambient water quality limits and guidelines were developed for the protection of aquatic life. The quality of aquatic biota is also important from a human health perspective, when biota are consumed as a food source. Fish consumption advisories are developed by regulatory agencies to provide guidance to the public on the safety of consuming fish which are, or may be, contaminated. These advisories are based on the concentration of contaminants contained in the edible portion of fish, and restrict consumption to varying degrees when contaminant concentrations exceed specified levels.

Ontario has established concentration limits for boneless skinless fillets of dorsal muscle based on guidance from Health and Welfare Canada and the Federal Food & Drug Act (Table 4-8). Ontario has used these limits to establish restricted consumption guidelines. Fish contaminant data is not generally evaluated on the basis of mean or average contaminant values. Rather a geometric regression analysis of length verus contaminant concentration is done to determine at what size a particular sample collection analyzed individual may exceed a particular Health and Welfare Canada criterion. At the size where the concentration exceeds the criterion, restricted consumption is advised (or no consumption, in the cases of women of child-bearing age and children under 15 years of age) for fish in that size category and above. Mercury also has a "No Consumption" guideline, above which no consumption is

Table 4-8. Canadian legal limits for contaminants in fish (mg/kg).

Parameter	Concentration in Edible Portion OMOE/H&WC[1]
Mercury	0.5
PCBs	2.0
Dieldrin	0.1
DDT + metabolites	5.0
Endrin	0.1
Heptachlor/H. epoxide	0.1
Lindane	0.1
Mirex	0.1
2,3,7,8-TCDD	0.000020
Lead	1.0
Toxaphene	3.0
Chlordane	0.1[2]
Malathion	0.1[2]
Parathion	0.1[2]
Total PCDD/PCDFs	0.000020[3]

(1) Environment Canada 1991.

(2) U.S. EPA, 1989. Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual, September 1989. EPA-503/8-89-002. Washington, D.C.

(3) Calculated as toxic equivalents to 2,3,7,8-TCDD.

advised for all populations. Ontario publishes its consumption advisories for various fish species, sizes and locations annually in "Guide to Eating Ontario Sport Fish". The advisory for the Detroit River AOC is discussed in Chapter 6.

While there are no Federal guidelines for the levels of arsenic, cadmium, chromium, copper, magenese, selenium, nickel and zinc in fish, they are usually only detected in trace levels in Ontario sport fish. Based on guidelines for levels in other food stuffs and a typically low propensity to bioaccumulate or biomagnify, there appears to be no need to suggest restrictions on the consumption of fish for these parameters.

4.1.10 Drinking Water Objectives

The Ontario Drinking Water Objectives (ODWOs) are used to assess the suitability of surface water supplies for treatment and public consumption. The ODWOs specify that three types of drinking water quality objectives shall be recognized; Maximum Acceptable Concentrations, Interim Maximum Acceptable Concentrations, and Maximum Desirable Concentrations. These are described below. Drinking water quality objectives are provided in Appendix 4-2.

Maximum Acceptable Concentration (MAC)

This term is used for limits above which there are known or suspected adverse health effects. The presence of a substance in drinking water at a level in excess of its maximum acceptable concentration shall be grounds for rejection of the water unless effective treatment is available. The length of time the maximum acceptable concentrations can be exceeded without injury to health will depend on the nature and concentration of the contaminant; however, no drinking water can be permitted to exceed these limits continuously. The MACs are developed under the authority of the Ontario Water Resources Act. They are based on known or suspected human health effects, and are enforceable standards for drinking water supplies in Ontario.

Interim Maximum Acceptable Concentration (IMAC)

This term is used to describe limits for substances of current concern with known chronic effects in mammals and for which there are no established maximum acceptable concentrations. Although toxicological, epidemiological and health data are available for such substances the data are subject to public and scientific debate before agreement on a maximum acceptable concentration. The IMAC will generally be a conservative value subject to change as more precise information becomes available. When a substance is detected at a concentration above its IMAC, it will signal the need for more sampling and investigation. Requirements for corrective action will be on a case-by-case basis.

Maximum Desirable Concentration (MDC)

This term is used for limits on substances which, when present at concentrations above the limits, are either aesthetically objectionable to an appreciable number of consumers or may interfere with good water quality control practices. These limits are not legally enforceable; however, should not be exceeded whenever a more suitable supply or treatment process is, or can be made available at a reasonable cost. The establishment of a limit should not be regarded as implying approval of the degradation of a high quality supply to the specific level. The limits have been derived from the best information currently available; however, the development of drinking water objectives is an ongoing process. Scientific knowledge of the complex inter-relationships that determine water quality continues to increase, as does the understanding of the physiological effects of the substances present in water. Also, man continues to introduce new chemical substances into the environment, many of which may contaminate drinking water supplies. Therefore, it may be necessary to revise the established limits or determine limits for other substances as additional and more significant data become available.

Application of Limits

A water supply system is defined as including the works and auxiliaries for collection, treatment, storage and distribution of the water from the source of supply to the free-flowing outlet of the ultimate consumer.

The limits apply to all water supply systems which provide water for domestic purposes and serve more than five private residences or are capable of supplying water at a rate greater than 0.5 litres per second (OWRA, R.S.O. 1980). Although a water supply serving five or fewer private residences is excluded from the application of the limits, it is desirable that the quality of water from these supplies should not be inferior to that supplied to the public in general.

4.2 CANADA

4.2.1 Environmental Legislation Relevant to the Great Lakes

Under the Canadian Constitution Act of 1867, the provinces and territories have been given authority over most natural resources and water quality except on federal property, international issues and in other specific areas of federal jurisdiction. However, the federal government acts in an advisory capacity on many issues by recommending guidelines to the provinces. Table 4-9 lists the significant legislation from which specific environmental regulations and programs are derived.

4.2.2 Point Sources

The Fisheries Act is the most significant Federal Statute for the protection of fish habitat from chemical pollution. Promulgated in 1977, the habitat protection provisions of the Act provide for the protection of fish and fish habitat from disruptive and destructive activities.

Section 36(3) of the Act provides comprehensive powers to protect fish, fish habitat and human use of fish by prohibiting the discharge of deleterious substances to Canadian Fisheries waters and is legally enforceable when an impact on fish or fish habitat can be shown. A deleterious substance is defined by Section 34(1) as any substance or

Table 4-9. Canadian environmental legislation.

Canada Legislation	Media or Activity Addressed												
	A	B	C	D	E	F	G	H	I	J	K	L	M
Fisheries Act *	1	3	1	1	1	3	3			3			3
Canada Water Act	2	2	3									2	
Canadian Environmental* Protection Act (CEPA)	3	3	3	1	1	1	1	2	1		1	2	
Food and Drug Act													1
Canada Shipping Act*	3	3	3								1		
Transportation of Dangerous Goods Act (TDGA)	3	3	3			1					1		
Pest Control Products Act (PCPA)							1			3			
Canadian Clean Air Act									1				
Environmental Contaminants Act* (repealed)						1							

* Significant Act elaborated on in the text.

Key to Codes:

A: Ambient Surface Water and Ground Water Quality and Management
B: Sediment Quality and Management
C: Biota Quality and Habitat Management
D: Industrial Point Source Discharge Control
E: Municipal Point Source Discharge Control
F: Solid and Hazardous Waste Management
G: Pesticide Manufacture and Management
H: Urban Runoff and Combined Sewer Overflow Management
I: Air Point Source Discharge and Ambient Air Quality Control
J: Agricultural Land Management
K: Spills and Shipping Activities
L: Drinking Water Quality Control and Management
M: Fish Consumption Guidelines or Advisories

1: Legislation is responsible for legally enforceable standards and/or has direct authority over the media or activity.
2: Legislation provides non-enforceable guidance or authority over media or activity.
3: Legislation is not directly applicable to the media or activity, but media/activity may be impacted by execution of its legislative mandate.

water that has been processed or changed which, if added to the system, would degrade the quality of the water so that it is rendered deleterious to fish or fish habitat.

Federal effluent regulations and guidelines for various industrial sectors are promulgated under Section 36 of the Fisheries Act, and are based on the application of best practicable technology. In general, regulations set national effluent limitations that apply to new and expanded plants, and guidelines set minimum acceptable standards that apply to existing plants. To date, Fisheries Act regulations and guidelines have been promulgated for the pulp and paper, mining, petroleum refining, metal finishing, chlor-alkali and mercury sectors. Some of these regulations and guidelines are currently being updated.

Federal guidelines for effluent quality and wastewater treatment at federal establishments apply to all effluents discharged from landbased establishments under the direct authority of the federal government, excluding vehicles and vessels. These guidelines have been developed and are administered by Environment Canada, and are revised and amended periodically to reflect new developments in technology and changing circumstances. Effluent guidelines for wastewater from federal facilities are to be equal to or more stringent than provincial standards. The guidelines contain both general and specific limits, and apply primarily to domestic-type effluents. General limits describe, qualitatively, the effluent quality (e.g., it should be free from materials harmful to aquatic life). Specific limits set numerical concentrations for conventional pollutants (Table 4-10).

The Canada Water Act provides for water quality management authorities under agreement with the province of Ontario. The Canada-Ontario Agreement Respecting Great Lakes Water Quality (COA) covers water quality objectives, monitoring requirements and shared cost programs. This agreement is a public contract between the federal and provincial government in which those governments agree to undertake and coordinate activities within their jurisdiction to fulfill the GLWQA requirements.

The federal government restricts the phosphorus content in detergents to 5% by weight (expressed as phosphorous pentoxide) or 2.2% by weight (expressed as elemental phosphorous) under the Canadian Environmental Protection Act, 1988 (and formerly the Canada Water Act). Municipal effluent objectives have been recommended to the provincial governments who, in turn, have established minimum treatment requirements for their municipal facilities by limiting the concentration of total phosphorus in their effluents.

Regulations on effluent discharges may be established under the Canadian Environmental Protection Act if priority substances are assessed to be toxic.

4.2.3 Non-Point Sources

The Soil and Water Environmental Enhancement Programme (SWEEP) has been instituted by Agriculture Canada and the Ontario Ministry of Agriculture to educate farmers about new technologies, the benefits of crop rotation, and other soil conservation practices. New agricultural practices such

Table 4-10. Canadian and Ontario effluent guidelines.

Parameter	Ontario Industrial Effluent Objectives	Canadian Municipal Effluent Objectives
BOD5 mg/l	15	20
Suspended Solids mg/l	15	25
Oil and Grease mg/l	15	15
Ammonia-Nitrogen mg/l	10	-
Fecal Coliforms MF/100 ml	-	400
pH SU units	5.5-9.5	6-9
Total Phenols mg/l	0.020	0.02
Total Phosphorus mg/l	-	1
Total Residual Chlorine mg/l	-	0.5
Cadmium mg/l	0.001	-
Chromium mg/l	1.0	-
Copper mg/l	1.0	-
Lead mg/l	1.0	-
Mercury mg/l	0.001	-
Nickel mg/l	1.0	-
Tin mg/l	1.0	-
Zinc mg/l	1.0	-

as these are being promoted in an effort to reduce contaminant and nutrient loadings and soil erosion to adjacent surface water.

4.2.3.1 Shipping

The Canada Shipping Act controls pollution from ships. Regulations have been passed under this Act directed at shipping activities that may impact water quality, including the control of the discharge of oil, vessel wastes and shipboard wastes. Under these regulations, the vessel may be fitted with a patent sewage treatment plant, which treats sewage to secondary standards, and reduces both suspended solids and the five day biological oxygen demand to 50 mg/l. The alternative requires the vessel to be fitted with a holding tank which must be emptied on shore. In both cases, a 90 percent reduction occurs, and the remaining treated effluent is disinfected.

The protection of the environment and human health from chemical spills during transportation or storage is regulated by both the provincial and federal governments. The Transportation of Dangerous Goods Act prescribes safety requirements, standards and safety marks on all means of transport across Canada.

4.2.4 Hazardous Waste Control

Under the Canadian Environmental Protection Act, Environment Canada has the authority to control the manufacture, transport, use, disposal, import and export of chemicals and wastes (e.g. PCBs, PCB products and Mirex). The main thrust of this Act is the creation of 1) the Domestic Substances List, which will eventually be a list of all chemicals manufactured and imported to Canada, including toxicity data; 2) the Priority Substances List, which is a list of chemicals under active study by Environment Canada due to concerns over their toxicity; and 3) the Toxic Substances List, which is a list of all chemicals deemed a danger to the environment and for which regulations must be promulgated. The Toxic Substances List includes PCBs, polybrominated biphenyls, chlorofluorocarbons, polychlorinated terphenyls, asbestos, lead, mercury and vinyl chloride.

4.2.5 Pesticides

The principal statute controlling pesticides in Canada is the Pest Control Products Act (PCPA) administered by Agriculture Canada. The PCPA sets out regulations regarding the registration, safety and manufacturing of control products (except 2,4-D) to protect human health, and the host plant, animal or article.

Registering pesticides and other control products under the PCPA in Canada provides additional information on registration and labeling requirements such as warning symbols and content description. Under the PCPA, the Minister of Agriculture Canada can establish independent Boards of Inquiry to advise him/her on whether pest control products should be registered. For example, in the recent case of alachlor, a Board of Inquiry was established and then disbanded after making their recommendation to the Minster.

Nonregulatory programs at the federal level include a pest management scheme that may reduce reliance on pesticides. The principal approach to reducing reliance on chemical pest control is known as integrated pest management, and is currently being researched by Agriculture Canada.

4.2.6 Air Quality

Air quality objectives have been established as a guide in developing programs to reduce the damaging effects of air pollution. These national objectives assist in establishing priorities for reducing contaminant levels and the extent of pollution control needed, provide a uniform yardstick for assessing air quality in all parts of Canada, and indicate the need for and extent of monitoring programs.

The Maximum Acceptable Level is intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being. The Maximum Desirable Level defines the long-term goal for air quality and provides a basis for an anti-degradation policy in unpolluted areas of the country. The Maximum Tolerable Level denotes concentrations of air contaminants that require abatement without delay to avoid deterioration to an air quality which may ultimately pose substantial risk to public health.

4.2.7 Fish Consumption Advisories

The federal Food and Drug Act authorizes Health and Welfare Canada to establish tolerances for chemical substances in fish and fishery products intended for human consumption. These criteria have been adopted by the Province of Ontario, and are discussed in Section 4.1.9.

4.2.8 Great Lakes Water Quality Working Group

A federal interdepartmental Great Lakes Water Quality Working Group has been established to encourage interdepartmental cooperation in government programs which are designed to help restore and secure the chemical, physical and biological integrity of the Great Lakes. More specific objectives of the Working Group include ensuring and preserving an adequate water quality and quantity for use by wildlife, fish and other organisms, and humans.

4.3 MICHIGAN AND UNITED STATES

4.3.1 Water Quality Standards

Existing and future uses of Michigan surface waters are protected under the Michigan Water Resources Commission Act, 1929 PA 245, as amended. The Act, under Sections 2 and 5, provides for the Part 4 Rules of the Water Resources Commission (WRC) which are Michigan's Water Quality Standards (WQS). These Standards (1) establish water quality requirements applicable to the Great Lakes, their connecting waterways, and all other surface waters of the state, (2) protect public health and welfare, (3) enhance and maintain the quality of water, (4) protect the state's natural resources, (5) meet the requirements of the federal Clean Water Act, (6) are consistent with the U.S.-Canada Great Lakes Water Quality Agreement, and (7) are legally enforceable.

The WQS, filed with the Secretary of State on November 14, 1986, were approved by the U.S. EPA pursuant to Section 303 of the Clean Water Act. Therefore, Michigan WQS supercede the U.S. EPA criteria for Michigan surface waters. This discussion focuses on the Michigan WQS. Copies of the Water Resources Commission Act and the Water Quality Standards are available upon request from the Michigan Department of Natural Resources (MDNR), Surface Water Quality Division.

Michigan WQS are currently undergoing a triennial review, as required by the Clean Water Act. No substantive changes to the standards are proposed at this time. Therefore, the following discussion will also be applicable once the new standards are approved. As part of the triennial review, a comparison was made of Michigan's WQS and the Great Lakes Water Quality Agreement (GLWQA) objectives. The WQS were found, overall, to be consistent with the goals and specific objectives of the GLWQA. The report of the comparison is provided in Appendix 4-3.

The Water Quality Standards designate specific uses as a minimum basis for which all Michigan surface waters must be protected. These uses include agricultural, industrial, and public water supply; use by warmwater fish, other indigenous aquatic life, and wildlife; navigation; and partial body contact recreation (e.g. fishing and boating). Additional protection is afforded to waters that are protected for use by coldwater fish; this includes the Great Lakes, their connecting waters (except for the Keweenaw Waterway), and all waters designated by the Michigan Department of Natural Resources (MDNR) as trout streams or trout lakes. All waters of the state are designated for, and shall be protected for, total body contact recreation (e.g. swimming) from May 1 to October 31. The WQS also specify that all waters be protected for the most restrictive of all applicable designated uses. The standards also define parameters and criteria levels necessary to protect a waterbody for its designated uses. Specific WQS are stated which set forth minimum and maximum levels for certain water quality parameters (Table 4-11).

Toxic substances are controlled under a narrative rule (Rule 323.1057) specifying that they shall not be present in Michigan waters at concentrations that are, or may become, injurious to the public health, safety or welfare; plant and animal life; or the designated uses of those waters. Rule 57 is applicable to the 256 chemicals and classes of chemicals listed on the 1984 Michigan Critical Materials Register; the priority pollutants and hazardous chemicals in the Code of Federal Regulations; and any other toxic substances determined by the WRC to be of concern at a specific site.

Specific, allowable levels of toxic substances may be established by the MDNR under Rule 57. Specific guidelines for the development of allowable levels of toxic substances in surface water have been developed and are available upon request from the MDNR, Surface Water Quality Division. Following these guidelines, concentrations of toxic substances in surface water necessary to protect aquatic life, wildlife and human health (life cycle safe and cancer risk) are calculated. The most restrictive concentration is used as the allowable level in surface water. Allowable levels of toxic substances in surface water are given in Table 4-12. Allowable levels for certain toxic substances may be water body specific.

Table 4-11. Summary of Michigan Surface Water Quality Standards.

Parameter	Limit
Turbidity Color Oil films Solids (floating, suspended or settleable) Foams Deposits	Waters of the state shall not have any of these unnatural physical properties in quantities which are or may become injurious to any designated use.
Total dissolved solids (TDS)	The addition of any dissolved solids shall not exceed concentrations which are or may become injurious to any designated use. In no instance shall they exceed 500 mg/1 monthly average or 750 mg/1 maximum for any waters of the state.
Chlorides	A maximum of 125 mg/1 monthly average is allowed for waters of the state designated as public water supply sources, except for the Great Lakes and their connecting waters where chlorides shall not exceed a 50 mg/1 monthly average.
Hydrogen Ion Concentration (pH)	6.5-9.0 in all waters of the state. Any artificially induced variation in natural pH shall remain within this range and shall not exceed 0.5 units of pH.
Taste and Odor	Waters of the state shall contain no taste-producing or odor-producing substances in concentrations which impair or may impair their use for a public, industrial or agricultural water supply source or which impair the palatability of fish.
Toxic Substances	Substance specific as determined by Rule 57. (See text for description, and Table 4-11 for Rule 57(2) levels.)
Radioactive Substances	Standards prescribed by the U.S. Nuclear Regulatory Commission and the U.S. Environmental Protection Agency.
Phosphorus	1.0 mg/1 as a maximum monthly average for effluent discharges.

Table 4-11. (continued)

Parameter	Limit
Nutrients	In addition to the maximum phosphorus discharge levels allowed, nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended and floating plants, fungi or bacteria, which are or may become injurious to the designated uses of the waters of the state.
Fecal Coliform	All waters of the state shall contain not more than 200 fecal coliforms per 100 milliliters as determined on the basis of a geometric average of any series of 5 or more consecutive samples taken over not more than a 30-day period. This concentration may be exceeded if such concentration is due to uncontrollable nonpoint sources. The WRC may suspend this limit from November 1 through April 30 upon determining that designated uses will be protected.
Dissolved Oxygen (DO)	A minimum of 7 mg/l in all Great Lakes and connecting waterways, and lakes and streams designated for coldwater fish. In all other waters a minimum of 5 mg/l shall be maintained.
Temperature	No heat load which would warm receiving waters at the edge of the mixing zone more than 3 degrees Fahrenheit above existing natural water temperature for the Great Lakes and their connecting waters; 2 degrees Fahrenheit for coldwater streams; and 5 degrees Fahrenheit for warmwater streams.

Table 4-12. Allowable levels of toxic substances in surface water. July 16, 1990 update.

Chemical Name	Rule 57(2) Allowable Level (ug/l)	Basis (1)	Comments
Metals			
Arsenic	184.0	ACV	
Cadmium and Inorganic Salts	0.41	ACV	2
Chromium and Inorganic Salts	48.10	ACV	2
Chromium, hexavalent	2.0	ACV	
Copper and Inorganic Salts	10.72	ACV	2
Cyanide	4.0	ACV	
Lead and Inorganic Salts	2.88	ACV	2
Mercury, methyl	0.0006	HLSC	
Molybdenum	800.0	TLSC	
Nickel and Inorganic Salts	33.34	ACV	2
Selenium and Inorganic Salts	20.0	TLSC	
Silver and Inorganic Salts	0.1	ACV	
Vanadium	3.73	TLSC	
Zinc and Inorganic Salts	49.57	ACV	2
Pesticides/Esters Sources include agricultural and industrial use.			
Acrolein	3.0	ACV	
Acrylonitrile	2.20	CRV	3, 5
Chlordane	0.00053	CRV	
DBNPA	4.0	ACV	
DDT	0.0023	CRV	3
2,4-dichlorophenol	37.74	ACV	4
2,4-dichlorophenoxy acetic acid	46.7	ACV	
Dieldrin	0.0000315	CRV	
Dinoseb	0.80	ACV	4
Ethylene dibromide	1.10	CRV	3, 5
Formaldehyde	200.0	TLSC	3
Heptachlor	0.002	CRV	
Hexachlorobenzene	0.0018	CRV	3
Lindane	0.097	CRV	3
Paraquat	16.0	ACV	
Pentachlorophenol = pH 8.1	20.23	ACV	4
Silvex	21.3	HLSC	
2,4,6-trichlorophenol	1.5	CRV	3
Other Organics			
Acetone	500.0	TLSC	
Acrylamide	900.0	TLSC	
Ammonia, unionized (coldwater)	20.0	ACV	
Ammonia, unionized (warmwater)	50.0	ACV	

Table 4-12. (continued)

Chemical Name	Rule 57(2) Allowable Level (ug/l)	Basis (1)	Comments
Other Organics			
Aniline	4.0	ACV	3
Benzene	60.0	TLSC	3
Benzidine	0.0399	CRV	3, 5
Bis(chlorobutyl)ether	60.0	TLSC	
Bis(2-chloroethoxy)methane	4.60	TLSC	
Bis(2-chloroethyl)ether	4.20	CRV	3
Bromodichloromethane	50.0	TLSC	
Bromoform	65.0	ACV	
Bromomethane	11.0	ACV	
Carbon tetrachloride	20.0	CRV	3
Chlorine	6.0	ACV	
Chlorobenzene	71.0	ACV	
Chlorodibromomethane	50.0	TLSC	
Chloroform	43.0	CRV	3
4-chloro-3-methylphenol	4.4	ACV	
2-chlorophenol	10.0	ACV	
4-chlorophenol	9.3	ACV	
1,2-dichlorobenzene	7.0	ACV	
1,3-dichlorobenzene	179.0	ACV	
1,4-dichlorobenzene	15.0	CRV	3
3,3-dichlorobenzidine	0.06	CRV	3, 5
1,2-dichloroethane	560.0	CRV	3
1,1-dichloroethylene	2.6	CRV	3
1,1-dichloropropane	64.0	CRV	
2,4-dinitrophenol	9.8	ACV	
1,4-dioxane	2000.0	CRV	3
Di-n-propyl formamide	63.0	TLSC	
Ethylbenzene	30.0	ACV	
Ethylene oxide	56.0	CRV	3
Fluorides (soluble fluorides)	2000.0	TLSC	
Hexachlorocyclopentadiene	0.5	ACV	
Hexachloroethane	13.0	CRV	3
Hydrogen sulfide	0.55	ACV	
Isophorone	860.0	ACV	
Methylene chloride	59.0	ACV	3
Napthalene	29.0	ACV	
Phenol	135.0	HLSC	
Polychlorinated Biphenyls (PCBs)	0.00002	CRV	3
Styrene	19.0	CRV	3
2,3,7,8-TCDD	0.000000014	CRV	3, 5
1,2,3,4-tetrachlorobenzene	0.76	HLSC	
1,1,2,2-tetrachloroethane	30.0	TLSC	3
Tetrachloroethylene	16.0	CRV	3
Tetra n-butyl ammonium bromide	140.0	TLSC	
Toluene	100.0	ACV	
1,2,4-trichlorobenzene	22.0	HLSC	

Table 4-12. (continued)

Chemical Name	Rule 57(2) Allowable Level (ug/l)	Basis (1)	Comments
Other Organics			
1,1,1-trichloroethane	117.0	ACV	
1,1,2-trichloroethane	65.0	CRV	3
Trichloroethylene	94.0	ACV	3
t-1,2-dichloroethylene	300.0	ACV	
Vinyl chloride	3.1	TLSC	5
Xylene	59.0	ACV	

Comment Codes

1- ACV = Aquatic Chronic Value
   TLSC = Terrestrial Life-cycle Safe Concentration
   CRV = Cancer Risk Value
   HLSC = Human Life-cycle Safe Concentration
2- Rule 57(2) Level based on a water hardness of 100mg/l (as $CaCO_3$).
3- This chemical is regulated as a carcinogen. The Rule 57(2) Level is not necessarily based on its 1 in 100,000 cancer risk value.
4- Rule 57(2) Level is based on a pH of 8.0.
5- Professional Judgement was used - minimum data not available.

For example, the toxicity of some heavy metals is dependent on the hardness of the water. Therefore, allowable levels for those metals are also dependent on water hardness.

Portions of waterbodies can be designated as mixing zones which are defined as areas where point source discharges are mixed with the receiving water. However, there are several requirements that apply to the water quality within the mixing zone. As a minimum restriction, waters may not be acutely toxic to fish or fish food organisms anywhere within the mixing zone. Exposures in mixing zones may not cause deleterious effects to populations of aquatic life or wildlife, and the mixing zone shall not prevent the passage of fish or fish food organisms in a manner which would result in adverse impacts on their immediate or future populations.

The Water Quality Standards are minimally acceptable water quality conditions. Ambient water quality should be equal to or better than the Water Quality Standards 95% of the time. Antidegradation requirements exist for waters that have better water quality than the established Water Quality Standards, or that is needed to protect existing uses. The Antidegradation Rule of the WQS states that waters may not be lowered in quality unless it is determined by the WRC that degradation of the these waters will not impair designated uses or be unreasonable and against public interest in view of the existing conditions.

The rules also declare that Michigan waters which do not meet the Water Quality Standards shall be improved to meet those Standards. Where the water quality of a certain waterbody does not meet the Water Quality Standards as a result of natural causes or conditions, further reduction of water quality is prohibited.

4.3.1.1 Great Lakes Initiative

The Great Lakes Initiative (GLI) is a joint effort by the U.S. EPA and the eight Great Lakes states to coordinate activities under the Federal Clean Water Act (CWA) to meet the goals of the Governors Great Lakes Toxic Substances Control Agreement, and to achieve the objectives of the Great Lakes Water Quality Agreement (GLWQA). The GLI will provide a basis for proceeding toward the long term goal of virtual elimination of the discharge of toxic substances to the Great Lakes, and for negotiating Great Lakes programs and water quality objectives with Canada under the GLWQA.

The GLI will develop numeric water quality criteria for a select list of chemicals and a narrative procedure for developing water quality criteria for other chemicals. In both cases, the water quality criteria will include criteria for the protection of human health, wildlife and aquatic life. The GLI will also address issues such as mixing zones, procedures for establishing water quality-based effluent limits in permits, biomonitoring requirements, pollution prevention, and antidegradation. The expected outcome of the GLI is to develop guidance which will be used by the Great Lakes States in reviewing and revising their water quality standards. The projected completion date of the GLI is late 1991.

4.3.2 Point Source Discharge Permits

Effluent requirements for wastewater discharged to Michigan surface waters are established in National Pollutant Discharge Elimination System (NPDES) permits. The NPDES permitting system was established for the entire nation in 1972 by the federal Water Pollution Control Act ("Clean Water Act"; PL 92-500). NPDES permits are required for all point source discharges of pollutants under the Clean Water Act and the Michigan Water Resources Commission Act.

Operation of the NPDES permitting program was delegated to Michigan by the U.S. EPA in October 1973. Effluent limits are required to be at least as stringent as the national effluent guidelines. The Michigan WRC is responsible for issuance or denial of NPDES permits. Effluent requirements and other conditions of a permit are recommended to the WRC by MDNR staff, with assistance from other state departments including the Michigan Department of Public Health. The general responsibility for enforcement of NPDES permit requirements lies with the Department of Natural Resources. The Michigan Department of the Attorney General works with the MDNR as needed to enforce NPDES permit requirements.

The NPDES permits are complex legal documents. Each permit contains the following general parts: specific authorization to discharge wastewater; effluent limitations and monitoring requirements; special conditions applicable to the particular discharge; special conditions applicable for certain general types of programs, such as industrial pretreatment program requirements, management requirements for sludges and other residuals, combined sewer overflow requirements, etc; and the general requirements applicable to all permits, such as what to do in emergency situations, operator certification, permit modification procedures, etc.

The permit is the primary legal document which states under what conditions a discharge is authorized. There are, however, two other areas that are critical to the success of the NPDES program. Prior to permit issuance, water quality studies, surveillance, and monitoring on both the point source discharges and the receiving water body are conducted as needed to determine what limitations should be placed in the permit. This includes both chemical and biological (toxicity tests, biological surveys) characterization. The facility desiring a permit to discharge is required to submit a permit application detailing the treatment process and discharge characteristics (e.g. flow, chemical characteristics). After permit issuance, enforcement followup is needed to ensure compliance with the permit.

One goal of the Clean Water Act is to move toward zero discharge of pollutants by use of treatment technology-based standards, and requiring that minimum receiving Water Quality Standards be achieved. Treatment technology-based discharge standards and effluent limitations based on the Water Quality Standards are determined for a given discharger. Since both must be met, the permits contain the more stringent of the two limits.

Treatment technology based standards are promulgated by the U.S. EPA based on the category of the industrial or municipal facility. National standards have been developed for 26 industrial categories, and involve over 125 toxic pollutants commonly discharged by these industries. Treatment technology-based standards are promulgated for direct discharges to lakes and streams, and for indirect discharges to surface water via sanitary sewer systems. Discharges to storm sewers which do not receive subsequent treatment are considered direct discharges. As treatment technologies improve, these federal standards are expected to become more restrictive in order to progress toward the goal of zero discharge.

Treatment technology-based effluent limitations (TTBELs) are often collectively referred to as the "Effluent Limit Guidelines". When Effluent Limit Guidelines do not exist for a certain discharge, either because none of the industrial categories cover the specific type of operation, or because Effluent Limit Guidelines have not been promulgated for the category yet, treatment technology-based limits must be determined. In this case, the "best professional judgement" of the permit writer is used to determine what the treatment technology-based effluent limits should be for the specific facility. The primary factors that are considered in establishing best professional judgement limits are the type of waste and pollutants, and available technology for a specific discharge. Other factors which may also be considered include costs and benefits of installing a certain treatment technology, and the age of the facility and equipment.

Water quality based effluent limits are determined following the WQS and associated guidelines to ensure that Water Quality Standards are achieved in the receiving waters. The WQS apply at flows greater than the design (drought) flow of the receiving streams. The design flow is the most restrictive of the 12 monthly 95% exceedance flows, a statistically-derived, low-flow value that occurs very infrequently. The applicable flows at which Water Quality Standards apply may be different than the 95% exceedance flow if the WRC determines that a more restrictive design flow is necessary, or that seasonal design flows may be granted. All Water Quality Standards for conventional pollutants apply after mixing with the design flow. For toxic substances, not more than one-fourth of the receiving water design flow is used for mixing. This is applied to both chemical specific values and biological toxicity endpoints determined through standardized toxicity tests.

Each surface water discharge permit application is reviewed to ensure that appropriate water quality-based control requirements are incorporated in the NPDES permit. All potential contributors (including nonpoint sources) are considered in a wasteload allocation process used by MDNR to establish these water quality-based control requirements. Site specific determinations are made based upon existing data and design conditions for the discharge and the receiving water. Water quality-based effluent limits are proposed when there is the reasonable potential that a point source discharge will cause or contribute to an excursion above any WQS. Water quality based effluent limits are determined by mathematical models used to simulate the substances in the receiving waters. For most toxic pollutants, a simple materials balance is used for calculations. When there are multiple dischargers to a single receiving waterbody, the assimilative capacity must be allocated among them.

Another consideration when issuing permits is "Antibacksliding". This concept has been contained in federal regulations for several years, and was incorporated into the federal Clean Water Act by the 1987 amendments. It is a complex concept which, roughly translated, means that limitations in a previous permit will not be made less stringent when the permit is reissued. Exceptions to the "antibacksliding" rule include when the permittee was unable to achieve the previous permit limits, and when production is increased.

NPDES permits have a maximum life of 5 years. When permits expire, they are reviewed and reissued. A complete cycle of reissuance occurs every 5 years, with approximately 20% of the permits being reissued each year. Under Michigan law, an expired permit remains in effect until a new permit is issued or denied.

4.3.2.1 Industrial Pretreatment Program

An important component of the NPDES permitting program is the Industrial Pretreatment Program (IPP). The IPP was developed in recognition of the fact that many industrial operations discharge their wastewater to municipal wastewater treatment plants (WWTP). This industrial wastewater may contain pollutants in concentrations that can interfere with the operations of the WWTP, damage equipment, destroy the bacteria required in the treatment process, pass through the system untreated, or contaminate sludge. To prevent these problems, any Michigan municipality that operates a wastewater treatment plant and receives a discharge from an industrial categorical discharger or an industrial discharger whose discharge could cause any of the following four conditions must develop and implement an industrial pretreatment program:

1. Physical damage to the sewers or the treatment process

2. Inhibition of the WWTP processes

3. Pass-through of pollutants which could cause problems in the receiving stream or result in an NPDES permit violation

4. Accumulation of pollutants in the sludge which could cause problems during its disposal

The IPP contains details as to how the industrial wastewater will be treated prior to discharge to the municipal collection system, establishes local limits and outlines monitoring and compliance requirements. The industrial discharger must also comply with applicable federal treatment technology-based limitations.

The municipality that operates the WWTP is responsible for developing, implementing and enforcing the local IPP. The IPPs are reviewed by the municipality on an annual basis to ensure that compliance with all applicable policies and regulations is maintained. The State reviews and approves the local IPP in accordance with established State and federal IPP regulations. The State functions in an "oversight" role to the local

IPP Control Authority, and the U.S. EPA functions in an "oversight" role to the State. An NPDES permit is issued to the municipality for its discharge to the surface water.

4.3.2.2 Combined Sewer Overflows

Combined sewer overflows (CSOs) constitute a serious environmental concern because they constitute a discharge of raw sewage which is illegal under Act 245 in Michigan and pose public health concerns. NPDES permits are required for all CSOs. The permits contain date certain schedules for development of CSO corrective programs. The corrective program established in the NPDES permit is a phased approach intended to provide flexibility for individual communities to develop site-specific corrective programs.

Phase I of the CSO corrective program requires operational improvements of the existing system to minimize overflows, sampling and other monitoring requirements to establish a strong database on the existing system, and construction of interim CSO control projects where feasible. Under Phase I, all CSO communities are required to notify the MDNR when there is a discharge of raw sewage to surface waters from CSOs. The MDNR will notify the local public health agency when appropriate. The health agency will issue appropriate advisories. Phase I also requires development of a final program to eliminate or adequately treat CSOs. The final program must also contain a fixed-date schedule to achieve the maximum feasible progress in accomplishing these corrections, taking into account technical and economic considerations.

Phase II is the implementation of the final program under subsequent NPDES permits. The schedule developed under Phase I will be incorporated into the NPDES permit, and the permittee required to proceed with implementation. The permits require that final programs provide for elimination or adequate treatment of CSOs. This will be accomplished on a case-by-case basis with professional staff of the Department working closely with municipalities to define appropriate corrective programs.

4.3.2.3 Compliance and Enforcement

NPDES permits are required under the Clean Water Act and the Michigan Water Resources Commission Act for all point source discharges to surface waters of the State. Any violation of a permit condition, compliance schedule or effluent limit specified in the permit, or a point source discharge to surface water without a permit is a violation of the Clean Water Act and the Michigan Water Resources Commission Act. Such violations of the Acts may be subject to civil and/or criminal action for injunction relief, substantial monetary penalities, and reimbursement for environmental damages.

A permit violation may be detected by the MDNR through routine review of compliance schedules and discharge monitoring reports (DMR) prepared by the permittee, and various types of inspections by MDNR staff. Violations may also be directly reported to MDNR. Upon recognition of a permit violation or a violation of related sections of the CWA or the Michigan Water Resources Commission Act, an appropriate compliance/

enforcement action is taken. The compliance/enforcement response will be timely, and appropriate for the nature and severity of the violation.

The MDNR is developing an Enforcement Management System (EMS) to assure that all dischargers are treated fairly, and to consistently enforce the NPDES program as required by the Clean Water Act and the Michigan Water Resources Commission Act. The EMS is a tool to assist professional staff in assuring that timely and appropriate enforcement actions are taken. Guidance is provided in the EMS to assist the state in assessing the magnitude and severity of the violation, and a range of enforcement responses that would be appropriate for the violation. The EMS also establishes a system for identifying priorities and directing the flow of enforcement actions based on these priorities and available resources. The measure of effectiveness of an enforcement response is whether and how expeditiously the noncompliant source is returned to compliance.

4.3.2.4 Stormwater

The federal Clean Water Act as amended in February 1987 contains language which specifically addresses the regulation of stormwater discharges (Section 405). The Act specifies that stormwater discharges will be regulated through the NPDES permit program.

The amendment states, in part, that no stormwater permits shall be required prior to October 1, 1992, except for the following: (1) currently permitted stormwater outfalls; (2) stormwater outfalls from industrial plant sites; (3) municipal storm sewer systems serving more than 250,000 population; (4) municipal storm sewer systems serving between 100,000 and 250,000 population; and (5) any point source of stormwater causing water quality violations.

The U.S. EPA published the final regulations concerning stormwater discharges on November 16, 1990. The regulations defined what facilities would be considered industrial stormwater dischargers and established November 16, 1991 as the date by which these facilities must apply for a stormwater discharge permit. The regulations also established a two part application process for municipalities. Part 1 for municipalities greater than 250,000 are due November 16, 1991. Part 1, for municipalities greater than 100,000, but less than 250,000 are due by May 18, 1992. Part II for municpalities greater than 250,000, are due on November 16, 1992 and for municipalities greater than 100,000, but greater less than 250,000 on May 17, 1993.

The regulations establish application requirements that for industrial facilities include sampling, topographic maps, impervious surface area estimates and spill history. Applications for municipalities covered by the regulations will include sampling, topographic maps and legal authority of the municipality. Detroit, Livonia, Sterling Heights and Warren are the municipalities within the SAOC identified in the regulations as meeting the population requirements of either greater than 250,000 or greater than 100,000.

Industrial permits will contain technology and water quality-based requirements. Municipal permits will require the development and implementation of comprehensive stormwater management programs to identify and eliminate illicit dischargers to storm sewers and to reduce the discharge of pollutants in stormwater to the maximum extent practicable. Compliance with stormwater permits will be required three years after permit issuance.

4.3.3 Critical Materials and Wastewater Report

A Critical Materials and Wastewater Report must be filed annually with the MDNR by all businesses that discharge wastewater to lagoons, deep wells, the surface of the ground, surface waters, septic tanks, or municipal sewer systems according to the Michigan Water Resources Commission Act. The types of wastewater that must be reported are process water, non-contact cooling water, condenser water, commercial laundry and commercial car wash water. Sanitary wastewater which is discharged to any system other than a municipal sewer or septic tank must also be reported.

The Critical Materials and Wastewater Report sets forth the nature of the business, a list of materials used in or incidental to its manufacturing process, including by-products and waste products, and the estimated volume of wastewater discharged. The materials which must be reported appear on the Critical Materials Register (CMR) as compiled by the MDNR with the advice of a technical advisory committee. The most recent CMR, published October 1, 1988, contains 284 chemicals. The information provided in the report may be used for purposes of pollution control including the determination of parameters to be limited by the NPDES permit.

4.3.4 Nonpoint Sources

The regulation and control of nonpoint sources of pollution in Michigan is the responsibility of a number of state, federal and local agencies, under a variety of programs and legislative directives. Until recently, however, the state lacked a comprehensive, coordinated plan to address nonpoint sources of pollution.

In November 1988, Michigan submitted a four year management plan to the U.S. EPA to address pollution problems caused by nonpoint sources. This management plan, and an assessment of the extent of surface and groundwater contamination due to nonpoint sources (also submitted in November 1988), are required under Section 319 of the Clean Water Act of 1987.

Michigan's Nonpoint Source Management Plan and Assessment Report have been approved by EPA. The Management Plan meets the requirements of the Clean Water Act and qualifies Michigan for federal funding to reduce nonpoint source pollution. Michigan received 1.3 million dollars through Section 319 of the Clean Water Act in Fiscal Year 1990. These funds are being used to implement programs in the Nonpoint Source Management Plan.

Solving nonpoint source pollution problems in Michigan will require the implementation of abatement programs through the cooperative efforts of federal, state and local agencies. Nonpoint source program implementation can occur on either a statewide or watershed basis. One of Michigan's priorities is to emphasize implementation of nonpoint source programs on a watershed basis. Approximately 30 watershed projects are either in the planning or implementation phases throughout the state. A number of statewide programs including development of best management practices, hydrologic analysis, construction site erosion control, technical assistance and information/education programs are underway.

4.3.4.1 Erosion

Soil erosion from construction sites is regulated through the Soil Erosion and Sedimentation Control Act, 1972 PA 347. The Act requires permits for all earth changing activities within 500 feet of a lake or stream, or that are likely to disturb an acre or more of land area. The program is administered by the Department of Natural Resources through local designated enforcement agencies.

Agricultural soil erosion is controlled through the use of conservation practices on farms. The Soil Conservation Service and local Soil Conservation Districts assist landowners in developing conservation practices for their property.

4.3.4.2 Spills

The prevention of and response to spills of oil and polluting materials (salt and any material listed on the Critical Materials Register, in solid or liquid form) to waters of the state are addressed in the Part 5 Rules of the Michigan Water Resources Commission Act, as amended. These rules require Pollution Incident Prevention Plans for spills prevention and cleanup for oil storage facilities and facilities that store, handle, discharge, manufacture, receive or process polluting materials. The rules also require that spill containment equipment and adequate personnel be available at sites where oil is on-loaded or off-loaded through a conduit to a vessel on the waters, and at sites adjacent to a watercourse where oil is stored and handled. Further, the rules specify that adequate surveillance be maintained at all times such that a spill can be immediately detected. When a spill is detected, the rules require immediate response. Under these rules, storage and use areas for oil, salt, and other polluting materials must be adequately diked or contained to prevent escape of spilled materials to groundwater and surface water both directly and indirectly (e.g. through sewers and drains). If a spill occurs from a vessel or a facility, a report must be filed with the WRC outlining the cause, discovery, and actions taken to remove the spilled material from the water.

The Oil and Gas Act, PA 61 requires operation of production and disposal wells in such a manner as to prevent the escape of oil, gas, saltwater, brine or oil field wastes which would pollute, damage or destroy freshwater resources.

The MDNR operates a Pollution Emergency Alert System (PEAS). A toll free telephone line (1-800-292-4706) is maintained for the reporting of suspected pollution incidences. MDNR staff investigate and respond to emergency spill occurrences, and coordinate actions with other agencies. A spill of any quantity of any material is reportable under PEAS.

There are several federal Acts and regulations that pertain to spills prevention and response. Federal regulations under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) identify "hazardous substances", notification requirements in the event of a spill and reportable quantities. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) established under CERCLA concerns the release of oil and hazardous materials into navigable waters. The Clean Water Act also prohibits the discharge of oil in harmful amounts, and requires owners of facilities which present a threat of an oil release to surface water to prepare a Spill Prevention Control and Countermeasure (SPCC) plan. The Solid Waste Disposal Act requires transporters to take appropriate action, and to notify the National Response Center in the event of a spill. The Emergency Planning and Community Right-to-Know Act of 1986 requires that any facility that produces, uses or stores chemicals regulated under this Act participate in emergency planning procedures for spills. Cleanup policy for PCB spills is contained in the Toxic Substances Control Act.

In the event of an unauthorized release of pollutants to the U.S. waters of the Great Lakes or connecting channels, the U.S. Coast Guard would have the lead responsibility in investigating and responding to the incident. Michigan and Ontario have established an emergency notification protocol to be used in the event of an accidental release to the water or air that may have transboudanry impacts. This protocol is discussed in Section 4.5.

4.3.4.3 Ballast Water Exchange

The exchange of ballast water from commercial ships has not been regulated as of this writing. However, the need for such regulation has been recognized due to nuisance conditions caused by the unintentional introduction of exotic aquatic species such as the sea lamprey via the discharge of ballast water from commercial ships. In March, 1990 proposed legislation was introduced which would initiate a national ballast exchange program, and coordinate and manage regulatory programs for the control of aquatic nuisance species. The draft legislation would institute a voluntary ballast exchange program for two years, after which the program would become manditory for the Great Lakes. The proposed legislation is expected to be passed in 1990 (S2244, Non-indigenous Aquatic Nuisance Act, and HR 5390, Aquatic Nuisance Prevention and Control Act).

4.3.4.4 Contaminated Sediments

Chemical contamination of freshwater sediments has the potential to adversely affect aquatic life. However, there are, as of this writing, no federal or state sediment quality standards, or guidelines on how to identify sediments that may be detrimental to aquatic life or to assess the severity of the effect. The U.S. EPA is currently investigating several approaches to developing sediment quality criteria (e.g. equilibrium partitioning, apparent effects threshold, tissue residue).

Draft criteria have not yet been proposed. The U.S. EPA's Interim Guidelines for the Disposal of Great Lakes Harbor Sediments" of 1977 have been used as a yardstick of contamination. The guidelines are not biologically based, however, and are not indicative of potential effect levels.

Assessing the effects of chemical contamination on aquatic life is complicated by the many variables that affect the toxicity and availability of the contaminants. Therefore, the State is pursuing an assessment protocol that includes a combination of biological field surveys, chemical and physical analyses of sediments, and sediment toxicity tests. MDNR currently conducts biological field surveys, and chemical and (limited) physical analyses of sediments. Work is underway at the MDNR Aquatic Toxicity Evaluation Laboratory (ATEL) to develop and validate procedures for conducting sediment toxicity tests and culturing the required test organisms. ATEL staff is focusing on a solid phase chronic toxicity test with Chironomus tentans, an interstitial acute toxicity test with Daphnia magna and an interstitial chronic test with Ceriodaphnia dubia.

A great deal of information is still required on how to interpret the results of laboratory tests with respect to instream responses, and how to integrate results of the various investigations to determine whether a sediment related problem exists. There are many ongoing efforts in both the regulatory and scientific communities to answer these questions, and Michigan has taken an active interest in a number of them. Probably the most comprehensive of these efforts is the Assessment and Remediation of Contaminated Sediments (ARCS) Program which is administered by the U.S. EPA Great Lakes National Program Office (GLNPO). This is a five year study and demonstration project relating to the control and removal of toxic substances from the Great Lakes. The program was authorized in Section 118 (c)(3) of the Clean Water Act as amended in 1987. The primary objective of the ARCS program is to develop guidance on the assessment of contaminated sediment problems and the selection and implementation of remedial actions. Guidance documents and case study final reports are expected to be completed by October 1993.

4.3.5 Navigational Dredging and Sediment Disposal

Dredging projects in Michigan are evaluated by MDNR and the Michigan Department of Transportation following the International Joint Commission (IJC) Guidelines presented in "Guidelines and Register for Evaluation of Great Lakes Dredging Projects," Report of the Dredging Subcommittee, January 1982 and the U.S. EPA Region V Guidelines for the Classification of Great Lakes Harbors Sediments of 1977. All dredging projects proposed in Michigan are subject to review and certification under Sections 401(a) and 404(t) of the Federal Clean Water Act, PL 92-500. Through the certification process Michigan addresses water quality impacts which may occur during the proposed dredging and disposal, impacts to fish and wildlife, recreational use concerns and scheduling of the proposed operation.

Water quality concerns may also be addressed under Rule 92 of Michigan's Water Quality Standards. This rule provides that the Water Resources Commission may determine that a dredging activity results in unacceptable impacts on designated uses, and that the Water Quality Standards are applicable during and subsequent to the dredging activity. In these cases, the "401 water quality certification", issued under Section 401 of the Clean Water Act, would reflect any restrictions on the dredging and/or disposal operation. Acting under the authority of Rule 92, the Commission determined that the use of overflow dredging in areas with contaminated sediments (not suitable for open water disposal due to contamination) results in unacceptable impacts on designated uses. Each dredging project where the use of a hopper dredge is proposed is evaluated to determine whether the use of hopper overflow should be prohibited due to sediment contamination. Evaluation of the portions of the Detroit River navigation project currently maintained by the Corps of Engineers found that overflow dredging should not be restricted. However, in recognition of concern with contamination in the Trenton Channel sediments, it was recommended that prior to dredging this area, data be evaluated for the suitability of overflow dredging.

Dredging permits and 401 Water Quality Certifications may also be required under the Inland Lakes and Streams Act, 1972 PA 346, and the Great Lakes Submerged Lands Act, 1955 PA 247, as amended. All 346/247 permit applications are reviewed with respect to existing sediment contaminant data, and all sites are visited by MDNR personnel regardless of the degree of contamination. Projects proposed in areas with known sediment contamination are reviewed by the MDNR Surface Water Quality Division. Sediment sampling and analysis and/or project modification may be required prior to permit issuance.

The disposal method for dredged sediment is determined following an evaluation of the sediment type, contaminant type and concentration, potential beneficial uses of the material to be dredged, and availability of disposal sites. The U.S. EPA Interim Guidelines for the Disposal of Great Lakes Harbor Sediment, 1977 (Table 4-13) are used as a preliminary indicator as whether the sediments are suitable for open water disposal, or require confinement. Dredged sediments may be suitable for various types of upland disposal depending on the presence of leachable substances and the hazard to the environment. The Solid Waste Management Act, 1978 PA 64, as amended, and the Michigan Environmental Response Act, 1982 PA 307, as amended, and the administrative rules adopted pursuant to these Acts govern upland disposal options.

The Michigan Hazardous Waste Regulations, under the Hazardous Waste Management Act, 1979 PA 64, as amended, and 40 CFR 261 (1986) may be applied to sediments when disposal in a landfill is proposed. Under these regulations, the person(s) doing the dredging may be requested to conduct an extraction procedure toxicity (EP toxicity) and/or the toxicity character leaching procedure (TCLP) to determine if the material is "hazardous". If the material is classified as "hazardous" under the Resource Conservation and Recovery Act (PL 94-586), disposal in a licensed hazardous waste landfill is required.

4.3.6 Wetlands and Shorelines

Wetlands protection and management in Michigan is governed by ten state and two federal statutes that include a variety of specific protection and permitting programs. The state statutes are listed and briefly described in Table 4-14. The two federal statutes, the Clean Water Act

Table 4-13. U.S. EPA Region V guidelines for the classification of Great Lakes harbor sediments, 1977.

Parameter	Nonpolluted	Moderately Polluted	Heavily Polluted
Volatile Solids	5%	5% - 8%	8%
COD	40000	40000 - 80000	80000
TKN	1000	1000 - 2000	2000
Oil & Grease (Hexane Solubles)	1000	1000 - 2000	2000
Lead	40	40 - 60	60
Zinc	90	90 - 200	200
Ammonia	75	75 - 200	200
Cyanide	0.10	0.10 - 0.25	0.25
Phosphorus	420	420 - 650	650
Iron	17000	17000 - 25000	25000
Nickel	20	20 - 50	50
Manganese	300	300 - 500	500
Arsenic	3	3 - 8	8
Cadmium	*	*	6
Chromium	25	25 - 75	75
Barium	20	20 - 60	60
Copper	25	25 - 50	50
Mercury			1
Total PCB**			10

NOTE: all values in mg/kg dry weight unless otherwise noted

* lower values not determined

** Pollutional classification of sediments with total PCB concentration between 1.0 and 10.0 mg/kg dry weight determined on case-by-case basis.

Table 4-14. Summary of State statutes impacting wetland protection and management in Michigan.

Statute	Description
Goemaere-Anderson Wetland Protection Act, 1979 PA 203	Recognizes wetland values; requires permit for many activities in wetlands.
Inland Lakes & Streams Act, 1972 PA 346	Requires permit for dredging, filling and construction activities in inland lakes and streams and associated wetlands below the ordinary high water mark.
Great Lakes Submerged Lands Act, 1955 PA 247	Requires permit for construction activities in Great Lakes and connecting waters.
Michigan Environmental Protection Act, 1970 PA 127	Prohibits any conduct which is likely to pollute, impair, or destroy a lake, stream or wetland, unless certain public interest conditions are met.
Shorelands Protection and Management Act, 1970 PA 245	Regulates environmental areas (primarily wetlands) along the Great Lakes.
Soil Erosion and Sedimentation Control Act, 1972 PA 347	Requires permit based on soil erosion control plan (issued locally with MDNR oversight) for earth change activities which disturb one or more acre or are within 500 feet of a lake or stream.
Natural Rivers Act, 1970 PA 231	Regulates land use along designated natural rivers through state and local zoning based on corridor management plans.
Subdivision Control Act, 1968 PA 288	Requires approval of the Water Resources Commission for any subdivision plat containing lots in the flood plain, and additional review by MDNR for any subdivision plan involving land abutting a lake or stream.
Administrative Procedures Act, 1969 PA 306	Governs the promulgation of administrative rules for state statutes, and defines the appeal process followed when permit applications under various statutes are denied.

Table 4-14. continued.

Statute	Description
Water Resources Commission Act, 1929 PA 245	Creates a Water Resources Commission to regulate state water resources. The Commission promulgates water quality standards and regulates discharges to state waters and related floodplains. Requires a permit to alter a flood plain.

of 1972 and the Rivers and Harbors Act of 1899, deal mainly with navigation issues. The Clean Water Act regulates the discharge of dredged or other fill material into navigable waters and their adjacent wetlands. The U.S. EPA is currently developing a Great Lakes Basin Wetlands Strategy to guide the State, Federal and Provincial jurisdictions on the protection and management of wetlands.

The most recent and comprehensive of the state laws is the Wetland Protection Act, 1979 PA 203. This act provides for the preservation, management, protection and use of wetlands; requires permits to alter wetlands; and provides penalties for illegal wetland alteration. Act 203 established a state policy to protect the public against the loss of wetlands and make explicit determinations on the benefits wetlands provide. It also established a permit program to regulate some activities in wetlands that are above the ordinary high water marks of lakes and streams. Additionally, Act 203 explicitly authorized more stringent and broader regulation of wetlands by local governments, and set up a cooperative process for the sharing of information and expertise between the MDNR and local governments.

Activities in wetlands contiguous to waterbodies are regulated without regard to the size of the wetland because of the close relationship these areas have to surface waters. Non-contiguous wetlands, however, are regulated by permit only if they are greater than five acres in size. In counties of less than 100,000 people, activities in non-contiguous wetlands are not regulated until a wetland inventory is completed. The MDNR can also regulate some activities in wetlands anywhere in the state, regardless of size, if they are determined to be essential to the preservation of natural resources and the landowner has been so notified by the Department.

The Shorelands Protection and Management Act provides for the designation of protected environmental areas along Michigan's Great Lakes shoreline that are important for the preservation and maintenance of fish and wildlife. Environmental areas covered by the Act are usually wetlands or marshes, although some are upland areas or islands. The Act applies to designated property that lies up to 1,000 feet landward of the ordinary high water mark of the Great Lakes or a connecting waterway, and those lands bordering other waters affected by levels of the Great Lakes. The Act does not apply to wetland areas already protected in national parks. Currently, 295 miles of Great Lakes or connecting waters shoreline have been designated as protected environmental areas. This is 9.0% of Michigan's 3,288 coastal shoreline miles. Fifty-two miles of protected environmental areas border Lake Superior, 85 are on Lake Michigan, 140 border Lake Huron, 6 are along the Detroit River, and 12 are located on Lake Erie.

Wetland water quality is determined by characteristics and conditions different from those used to evaluate the quality of lakes and streams. In general, natural wetlands are characterized as having very shallow water with abundant vegetation, high organic bottom deposits, and the periodic absence of oxygen throughout the water and bottom sediments (Kadlec 1976). In essence, wetlands are characterized by conditions that are considered undesirable in lakes and streams. Consequently, the quality of wetlands is generally described in terms of their use.

Wetlands are included in Michigan's WQS under the general category "other surface waterbodies within the confines of the state". The antidegradation rule contained in the standards provides some protection to wetlands. However, few of the criteria currently included in the standards are directly applicable to wetlands because of their unique environmental conditions relative to traditional measurements for good water quality.

4.3.7 Hazardous Waste

The generation, treatment, transport, storage and disposal of hazardous wastes are controlled by programs developed under the Hazardous Waste Management Act, 1979 PA 64. Waste disposal sites are also regulated under the federal Resource Conservation and Recovery Act (RCRA), 1976 PL 94-580. Clean ups and other responses to contaminated sites may occur under two programs, the U.S. Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 1980 PL 96-510, commonly referred to as "Superfund", and the Michigan Environmental Response Act (MERA), 1982 PA 307. Both programs utilize risk assessments to evaluate the severity of contamination at specific sites based on known or potential impacts to (mainly) human health and the environment. Sites are then ranked according to their relative severity, thereby establishing priorities for remedial actions. The major difference between the programs is that Superfund sites are assessed based on conditions when the site was at its worst, and site assessments conducted under PA 307 are based on conditions at the time of assessment. Both of these programs may provide funding, on a priority basis, for remedial investigations, feasibilie studies and clean up actions prior to identification of, and/or agreement on the course of action with a responsible party.

4.3.8 Pesticides

The use of pesticides is addressed through the Michigan Pesticide Control Act, 1976 PA 171. This act specifies requirements for registration of pesticide products, certification and licensing of pesticide applicators, and investigations of suspected pesticide problems. Public Act 171 adopts major portions of the Federal Insecticide, Fungicide and Rodenticide Act at the state level. This allows the state primacy in the areas of pesticide registration, labeling and distribution; licensure of pesticide dealers; certification of pesticide applicators; and, enforcement. In all other areas, the federal pesticide requirements apply. Pesticide programs are under the jurisdiction of the Michigan Department of Agriculture, which also manages programs for emergency response in cases where contaminants may enter food chains.

4.3.9 Air Quality

The Federal Clean Air Act, as amended in 1970 and 1977, directs the U.S. EPA to establish National Ambient Air Quality Standards. Since 1971, the U.S. EPA has established standards for seven pollutants: suspended particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone (photochemical oxidants), hydrocarbons and lead. Air pollution control is addressed through a permitting process similar to the NPDES process, under the authority of the federal Clean Air Act and the Michigan Air Pollution Act, 1965 PA 348.

The Clean Air Act is presently undergoing reauthorization, and Michigan has been advocating amendments to the Act that would protect the Great Lakes. Three basic concepts put forth are: 1) reasonable controls should be required nationally, in a timely fashion, for air pollution source categories which account for 90% of the air emissions of seven critical pollutants (selected for the problems they have caused in the Great Lakes); 2) the assessment of any residual risks remaining after this control should consider indirect routes of exposure to humans such as fish consumption, in addition to the direct inhalation route; and 3) additional air monitoring and research studies should be conducted. At this time, both the Senate and House bills include significant Great Lakes protection provisions.

A 14 member Air Toxics Policy Committee was established in December of 1987 by the Michigan Air Pollution Control Commission and the MDNR to develop a long-range strategy for developing rules to regulate, control, and abate the emission of toxic air pollutants from both new and existing sources. The Committee decided to develop rules for new and modified sources first. Atmospheric deposition of toxic pollutants to the Great Lakes was a consideration in the rules development. The Committee presented the proposed regulations for new sources to the Commission in September 1989. Public hearings have been held and a summary of public comments and responses have been submitted. The rules package is expected to be returned to the Air Pollution Control Commission for approval to send to the Legislative Service Bureau by September 1990.

The Michigan Toxics Air Monitoring Program was established in January 1990. Sampling is being conducted to obtain information on 29 organic compounds and 13 trace metals surrounding three urban areas. The current sampling locations are in Kalamazoo, Midland and Detroit.

A second Air Quality Division Toxics Air Monitoring Program is scheduled to begin in November 1990. This program will be funded, in part, by a grant awarded to the MDNR Air Quality Division from the Great Lakes Protection Fund. This fund was established by the eight Great Lakes states to fund research and demonstration projects that focus on the enhancement of Great Lakes ecosystem health. Air monitors will be established in three rural areas in Michigan; Sault Ste. Marie, Traverse Bay and Saginaw Bay. Sampling will be conducted every month for one year for compounds considered by the International Joint Commission to be "critical pollutants" in the Great Lakes ecosystem. Ambient air samples will be collected and analyzed for four critical pollutant groups (total polychlorinated biphenyls (PCB), polynuclear aromatic hydrocarbons (PAH), hexachlorobenzene and dieldrin) and 13 trace metals of concern. The goal of this project is to confirm the presence and magnitude of these pollutants to develop baseline data for further investigations.

4.3.10 Fish Consumption Advisories

The Michigan Department of Public Health (MDPH) has issued fish consumption advisories since the early 1970s in an effort to provide guidance to the public on ways to reduce their exposure to contaminants from fish. The advisories are intended primarily for the frequent fish consumer because body burdens and risk of health problems from contaminants increase over time with repeated exposure. Because the impacts on reproduction and child development are largely unknown, pregnant women, nursing mothers, women who anticipate having children and children age 15 and under are especially advised not to consume contaminated fish.

The MDPH has adopted contaminant concentrations for edible portions of fish which, when exceeded, trigger consideration of a fish consumption advisory (Table 4-15). These "trigger levels" are based on U.S. Food and Drug Administration (FDA) regulatory guidelines, and the application of risk assessments.

Three different types of advisories may be issued depending on the percentage of specimens from a sample that exceed the trigger level(s). Advice on fish consumption for organic compounds is based on the following criteria:

a) No advisory for limiting consumption will be issued when contaminants are undetected or when 10% or less of the tests for a particular fish species and location exceed any of the advisory trigger levels as shown in Table 4-15.

b) An advisory for reduced consumption to no more than one meal per week will be issued when any of the advisory trigger levels are exceeded by more than 10% but less than 50% of the specimens tested for a particular species and location, and the mean concentrations do not exceed the trigger levels for the contaminants found. Nursing mothers, pregnant women, women who anticipate bearing children and children age 15 and under would be advised not to eat these fish. Michigan is likely to change this advisory to "Nursing mothers ..., and children under age 15 ..." in the 1991 advisory to promote consistency among the Great Lakes jurisdictions.

c) A "No Consumption" advisory will be issued when any advisory trigger level is exceeded by 50% or more of the specimens tested of a particular species and location.

Advice on fish consumption for mercury is based on a regression analysis of fish length versus mercury concentration. Consumption advisories due to mercury contamination would be issued for paricular size categories as follows:

a) No advisory for limiting consumption will be issued when concentrations of mercury for a particular fish species and location are less than 0.5 ppm.

b) An advisory for reduced consumption to no more than one meal per week will be issued when mercury concentrations in a particular species from one location are between 0.5 and 1.5 ppm. Nursing mothers, pregnant women, women who intend to have children, and children age 15 and under should eat no more than one meal per month of the identified fish.

Table 4-15. Trigger levels currently used by MDPH in establishment of fish consumption advisories.

Chemical	MDPH Advisory Trigger
Chlordane	0.3 ppm
DDT	5.0 ppm
DDT metabolites (DDE, DDD)	5.0 ppm
Dieldrin (aldrin)	0.3 ppm
Dioxin (2,3,7,8 TCDD)	10 ppt*
Endrin	0.3 ppm
Heptachlor	0.3 ppm
Mercury	0.5 ppm*
Mirex	0.1 ppm
PCB	2.0 ppm
Toxaphene	5.0 ppm

* Different than FDA Regulatory or Advisory Guidelines; FDA uses 25 ppt for dioxin and 1.0 ppm for mercury; all others are currently the same.

c) A "No Consumption" advisory will be issued when the mean mercury concentration in a particular species from one location exceeds 1.5 ppm.

When sufficient information to fully characterize the degree of contamination or human health risk does not exist, a precautionary position will be advocated until the situation can be fully evaluated.

The Health Advisory on fish consumption is published annually as part of the Michigan Fishing Guide. The advisory for the Detroit River AOC is discussed in Chapter 6. The fishing guide is provided to each individual who purchases a fishing license, and is available free of charge from MDNR, MDPH and local health departments. Notices of consumption advisories are provided to the press and editors of sports journals.

4.3.11 Drinking Water Standards

The responsibility for drinking water regulations at the federal level is with the U.S. EPA. The federal Safe Drinking Water Act (SDWA) as amended in 1986 (PL 99-339, 100 State. 642) requires U.S. EPA to publish "maximum contaminant level goals" (MCLGs) for contaminants which in the judgement of the Administrator may have any adverse human health effects and which are known or anticipated to occur in public water systems. In addition to publishing a MCLGs, which are non-enforceable health goals, the U.S. EPA must promulgate National Primary Drinking Water Regulations (NPDWR). The NPDWR may include either (a) a maximum contaminant level (MCL) or (b) a treatment technique. A treatment technique may be set only if it is not economically or technologically feasible to ascertain the level of a contaminant. An MCL must be set as close to the MCLG as feasible.

The 1986 amendments to the SDWA require the U.S. EPA to promulgate NPDWRs for 83 contaminants in three phases, by June 19, 1989. EPA has not met this schedule. In December of 1975, EPA published National Interim Primary Drinking Water Regulations for ten inorganic chemicals, six pesticides, and two microbiological indicator contaminants (total coliforms and turbidity). Some of these Interim Regulations, such as fluoride and coliform, have been finalized as NPDWRs. Other parameters such as Giardia and viruses, are being addressed by U.S. EPA through the establishment of required treatment techniques. The U.S. EPA is continuing to develop and promulgate NPDWRs for the remaining 83 contaminants.

National Primary Drinking Water Regulations under the SDWA are also to include monitoring requirements which assure a drinking water supply will dependably comply with the MCLs. The SDWA also contains public notification requirements should a public water supply (1) fail to comply with the MCL or treatment technique; (2) fail to comply with any monitoring requirements; (3) obtain a variance or exemption; or (4) fail to comply with any requirements of any schedule prescribed pursuant to a variance or exemption.

The federal SDWA delegates authority for the implementation of the Act to the states where the state has legislation which equals or exceeds the requirements of the Act. Any modifications to or deviations from the requirements must be approved by U.S. EPA.

The MDPH has had a drinking water program since 1913. The Michigan Safe Drinking Water Act, 1976 PA 399, was passed in 1976 with rules becoming effective in 1978. The Michigan SDWA authorizes the MDPH to provide for the supervision and control of public water supplies. The State regulations adopt the federal MCLs for organic and inorganic chemicals, microbiological contaminants, turbidity and radioactivity contained in the federal act with a few exceptions. There is no MCL for corrosivity, however monitoring requirements exist, and the water must be noncorrosive. The Michigan standards have been approved by the U.S. EPA as equivalent to or more stringent than the federal MCLs. A comlete list of the MCLs and monitoring requirements for community water systems in Michigan is given in Appendix 4-4.

Drinking water standards apply after treatment either at the point of entry into the distribution system (plant tap), or at the point of use (the customer's tap) depending on the contaminant. The required sampling location for each contaminant is identified in Appendix 4.4. Drinking water standards do not apply to the raw water as taken from the waterbody (i.e. before treatment).

4.3.12 <u>Michigan's Waste Prevention Strategy</u>

In February of 1991, MDNR completed the development of a comprehensive strategy to reduce, at the source, waste generated by individuals, businesses and state government. The concept of waste prevention is relatively simple: If a waste is not created in the first place, it can never cause damage later. By avoiding the generation of waste at the source, waste prevention strategies are inherently the most protective of human health and the environment.

While is is true that progress has been made over the past several decades through expanded use of pollution controls and waste management practices, many persistent environmental problems remain. Environmental problems have become more difficult to predict and avoid when relying on pollution control alone. In short, such practices can no longer be relied on as the primary strategy to protect the environment, human health and, ultimately economic sustainability.

Michigan's Waste Prevention Strategy provides a vision in which future discharges to the air, water and land would be allowed only after a determination is made that there is no prudent and feasible alternative to its creation and discharge; and even then, only after sufficient treatment has been applied to meet the best available treatment technology requirements and other applicable standards. To realize this vision will mean a fundamental shift in permitting programs, which requires changes in statutes and rules.

A number of actions and recommendations to speed the implementation of waste prevention by individual's businesses and state government are set forth in the strategy document. Recommendations include: enhanced education and promotion efforts for waste prevention; training programs; on-site technical assistance provisions to businesses; convening groups to discuss the feasibility of waste prevention initiatives in compliance and enforcement orders, environmental permits, cross-media inspections, banning certain toxic chemicals, etc.; and developing and implementing waste prevention plans for all state departments.

An implementation plan for the strategy is currently under development and will identify priority recommendations, funding sources, responsible parties and timelines. Waste prevention initiatives, particularly as they relate to the regulated community, will be stressed in the consideration of the conduct of various demonstration projects and in the consideration of remedial action options to address use impairments in the Stage 2 RAPs.

4.4 UNITED STATES - CANADA GREAT LAKES WATER QUALITY AGREEMENT

The Great Lakes Water Quality Agreement (GLWQA) was first signed by the governments of the United States and Canada in 1972 as a result of concern about degraded water quality in the Great Lakes. The Agreement confirmed both governments' commitment to enhance and restore Great Lakes water quality. The 1972 GLWQA provided the focus for a coordinated effort to control phosphorus inputs to the lakes, thereby addressing the eutrophication problem. In 1978, the GLWQA was revised and expanded in recognition of the need to understand the effects of toxic substances and control their discharge to the Great Lakes. The concept of an ecosystem approach to Great Lakes water quality management was also incorporated into the 1978 GLWQA. A protocol amending the GLWQA was signed by the two governments in 1987. The protocol adds specific programs, activities and timetables to address the issues identified in the 1978 Agreement.

The Agreement adopts General and Specific Objectives for the Great Lakes system, and sets forth the basic requirements for RAPs and Lakewide Management Plans (LMPs). Annexes of the GLWQA address specific issues such as the control of phosphorus, discharges of polluting substances and wastes from vessels, dredging, surveillance and monitoring, point and nonpoint sources, etc. The GLWQA objectives, and the Annexes are described in the following sections.

4.4.1 General Objectives

The General Objectives of the GLWQA are found in Article III. General Objectives are broad descriptions of desired water quality conditions consistent with the protection of beneficial uses. These conditions include the absence of sludge deposits, floating materials, materials and heat producing color, odor, taste impairment or toxicity, and excessive nutrients. The General Objectives are intended to provide overall water management guidance to achieve a level of environmental quality to which both governments have agreed.

4.4.2 Specific Objectives

The specific objectives are described in Article IV of the GLWQA and listed in Annex 1. The objectives represent minimum levels of water quality and maximum concentrations of toxic substances in fish tissue agreed to by both federal governments. Under the agreement, the objectives may be amended, or new objectives added by mutual consent of both governments.

The 1987 amendments to the Agreement clarify that the Specific Objectives are consistent with the other portions of the Agreement (e.g. to virtually eliminate the discharge of any or all persistent toxic substances). Therefore, the Specific Objectives identified in Annex 1 for persistent toxic substances are adopted as Interim Objectives. A persistent toxic substance is defined as any toxic substance with a half-life in water of greater than eight weeks. A summary of the Specific Water Quality Objectives from Annex 1 is provided in Table 4-16. The reader is referred to the GLWQA for a complete listing.

Specific objectives for contaminant concentrations in fish for the protection of human health, and fish eating birds are shown in Table 4-17.

4.4.3 GLWQA Annexes

There are 17 annexes to the GLWQA. They are an integral part of the Agreement and set forth objectives, principles, programs, and reporting requirements to which both federal governments have agreed. As such, the annexes must also be considered in the development of the RAP.

Annex 1, previously described, lists the Specific Objectives and requires the compilation of three lists of substances which are present or potentially present within the water, sediment or aquatic biota of the Great Lakes System and believed to have acute or chronic toxic effects on aquatic, animal or human life. The first list identifies known toxicants present in the aquatic ecosystem. The second list identifies compounds which are present and suspected of causing toxic effects on aquatic, animal or human life. The third list is used to identify known toxicants which may be present in the aquatic ecosystem. To date, the Parties have made little progress toward compilation of these lists.

Annex 2 discusses the Remedial Action Plans (RAPs) and Lakewide Management Plans (LMPs), including the designation of Areas of Concern (AOCs), and the contents and reporting requirements for RAPs and LMPs. While most of the jurisdictions have actively worked toward development of RAPs for the AOCs, the Parties have made little progress in development of LMPs for the Great Lakes.

Annex 3 includes programs for the control of point and non-point sources of phosphorus into the Great Lakes System. For example, in 1976, the estimated total phosphorus load to Lake Erie was 20,000 metric tons per year. The estimated load that will be discharged when all municipal waste treatment facilities over 1 MGD achieve compliance with the 1 mg/l effluent concentration (as required by Article VI of the GLWQA) will be 13,000 metric tons per year to Lake Erie. The phosphorus target load (point and non-point sources combined) for Lake Erie is 11,000 metric tons/year to meet ecosystem objectives.

Annexes 4, 5, 6, 8, and 9 address the discharge of oil and hazardous polluting substances and wastes from vessels and onshore and offshore

Table 4-16. Great Lakes Water Quality Agreement Specific Objectives for ambient water quality. (All concentrations are in ug/l unless otherwise noted.)

Parameter	Specific Objectives (ug/1)
INORGANICS[a]	
Arsenic	50.0
Cadmium	0.2
Chromium	50.0
Copper	5.0
Iron	300.0
Lead	b
Mercury	0.2
Nickel	25.0
Selenium	10
Zinc	30.0
Fluoride	1200.0
Total Dissolved Solids (mg/1)	200 [c]
Ammonia, unionized	20.0
total	500.0
ORGANICS	
Aldrin + Dieldrin	0.001
Chlordane	0.06
DDT + metabolites	0.003
Endrin	0.002
Heptachlor + Heptachlor Epoxide	0.001
Lindane	0.01
Methoxychlor	0.04
Mirex	d
Toxaphene	0.008
Dibutyl phthalate	4.0
Di(2-ethylhexyl)phthalate	0.6
Other phthalic acid esters	0.2
Phenol	1.0
Diazinon	0.08
Guthion	0.005
Parathion	0.008
Unspecified, persistent organic compound	d

[a]All metals (except mercury) are the total of all forms present in an unfiltered sample. Total mercury shall be measured in a filtered sample.

[b]Value for Lake Superior - 10 ug/l; Lake Huron - 20 ug/l; remaining Great Lakes - 25 ug/l.

[c]Present (as of 1978) levels should be maintained, but 200 mg/l must not be exceeded.

[d]Should be less than detection levels as determined by the best scientific methodology available.

Table 4-17. GLWQA Specific Objectives for fish tissue. Concentrations are given in ug/g on a wet weight basis.

Parameter	Concentration in Edible Portion[1]	Whole Fish[2]
Mercury	---	0.5
PCB	---	0.1
Aldrin + Dieldrin	0.3	---
DDT + metabolites	---	1.0
Endrin	0.3	---
Heptachlor + Heptachlor epoxide	0.3	---
Lindane	0.3	---
Mirex	---	(3)

(1) Great Lakes Water Quality Agreement objectives for protection of human consumers of fish.
(2) GLWQA specific objectives for protection of birds and animals which consume fish.
(3) Concentrations should be less than detection as determined by the best scientific methodology available.

Note: "---" indicates that the GLWQA does not contain specific objectives.

facilities. These annexes set forth criteria to be adopted by both countries for (1) the prevention of discharges of oil and hazardous polluting substances; (2) the prohibition of discharge of garbage; (3) the prohibition of discharge of wastewater (including ballast water) in harmful amounts or concentrations; and (4) the requirement for vessels to contain, incinerate, or treat sewage to an adequate degree.

Efforts to prevent introductions of zebra mussels by way of ballast water were undertaken by the U.S. and Canadian Coast Guards, acting under the GLWQA. The Canadian Coast Guard in consultation with the U.S. Coast Guard, St. Lawrence Seaway Authority, Shipping Association, Fisheries and Oceans Canada, Environment Canada and the Great Lakes Fisheries Commission, established voluntary guidelines that became effective May 1, 1989. These guidelines specify that ships entering the Seaway should exchange their ballast off the continental shelf at depths greater than 2000 meters. In the event that this is not possible, ballast water may be exchanged in the Laurentian Channel in the Gulf of St. Lawrence.

The Canadian Coast Guard and U.S. Coast Guard are responsible for the review of services, systems, programs, recommendations, standards and regulations relating to shipping activities for the purpose of maintaining or improving Great Lakes water quality. Annex 9 provides for the continued maintenance of the joint contingency plan (CANUSLAK) developed under Annex One of the Canada - United States Joint Marine Contingency Plan. The purpose of the plan is to provide for a coordinated and integrated response to pollution incidents in the Great Lakes System.

Annex 7 establishes a subcommittee under the IJC Water Quality Board to review dredging practices and to develop guidelines and criteria for dredging activities in the boundary waters of the Great Lakes Systems. The subcommittee is also responsible for development of specific criteria to classify contaminated sediments of designated areas of intensive and continuing dredging activities in the Great Lakes System.

Annex 10 directs the Parties to establish and maintain two lists of substances known to have, or potentially have, toxic effects on aquatic or animal life of which there is a risk of being discharged into the Great Lakes System. These lists are included as Appendices 1 and 2 of the Annex. The two governments are directed to develop and implement programs to minimize or eliminate the risk of release of these substances into the Great Lakes System.

Surveillance and monitoring activities are outlined in Annex 11. In general, the purpose of these activities is: (1) to ensure that jurisdictional control requirements are being met, (2) to gather data to measure the progress toward achieving the General and Specific Objectives, (3) to evaluate water quality trends, and (4) to identify emerging water quality problems. This annex supports the development of RAPs and LMPs pursuant to Annex 2.

Annex 12 defines persistent toxic substances and sets forth regulatory strategies and programs to be adopted by both countries for controlling or preventing the input of such substances into the Great Lakes Systems.

Monitoring and research programs, including the establishment of an early warning system to anticipate future toxic substances problems and the establishment of action levels to protect human health, are addressed in this annex. The general principles to be followed in the development and adoption of regulatory strategies and programs under this Annex include the virtual elimination of the input of persistent toxic substances, and the reduction in generation of contaminants.

Annex 13 further delineates programs and measures for the abatement and reduction of nonpoint sources of pollution from land-use activities. These measures include efforts necessary to further reduce nonpoint source inputs of phosphorus, sediments, toxic substances and microbiological contaminants contained in drainage from urban and rural land, including waste disposal sites, in the Great Lakes Systems. The annex refers to RAPs and LMPs as information sources to identify nonpoint source concerns, and to assist in the development and implementation of watershed management plans. The annex also calls for the identification and preservation of wetland areas and the determination of nonpoint source pollutant loadings to the Great Lakes System.

Annex 14 is an agreement between the two countries to study the issue of contaminanted sediments, determine the impact of contaminated sediment on the Great Lakes Basin Ecosystem, and develop a standard approach and agreed procedures for the management of contaminated sediment. The annex requires the governments of both countries to evaluate existing technologies for the management of contaminated sediment and to implement demonstration projects at selected AOCs. Information obtained through this research should be used to guide the development of RAPs and LMPs.

Atmospheric deposition of toxic substances to the Great Lakes Ecosystem is addressed in Annex 15. The annex requires that the Parties conduct research to determine pathways, fate and effects of airborne toxic substances in the Great Lakes Systems. An Integrated Atmospheric Deposition Network is to be established to (1) identify and track airborne toxic substances; (2) determine atmospheric loadings of toxic substances to the Great Lakes System; and (3) define temporal and spacial trends in the atmospheric deposition of toxic substances. Pollution control measures will be developed and implemented for sources found to have significant adverse impacts on the Great Lakes System.

Annex 16 directs the governments of both countries to identify and assess the impact of contaminated groundwater on the Great Lakes System. This information should be used in the development of RAPs and LMPs. The governments agree to control the sources and the contaminated groundwater itself.

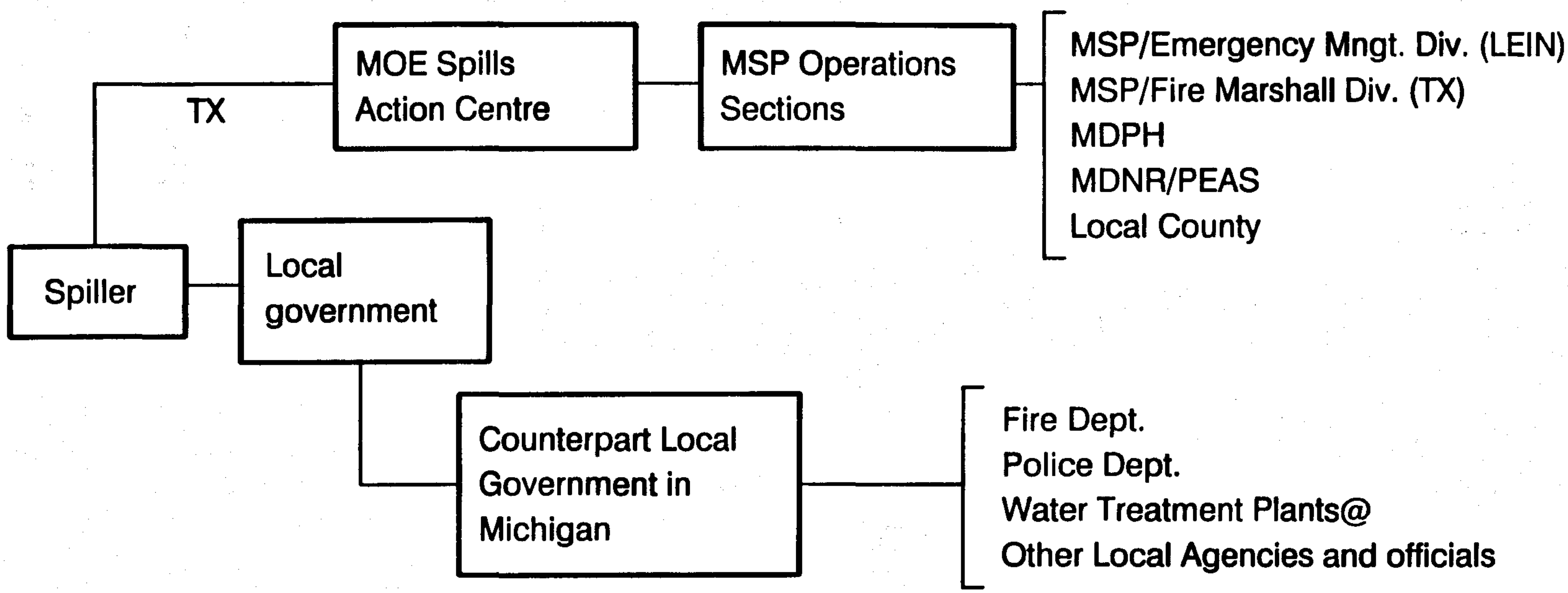
Annex 17 describes research necessary to achieve the goals of the GLWQA. This includes research of the sources and fate of toxic substances in the Great Lakes System, and their ecotoxicity. Also addressed are research needs on the effects of varying the lake levels, and the impact of water quality and the introduction of non-native species on fish and wildlife populations and habitats. The need for the development of control technologies for point source discharges, for action levels for contamination which incorporate multimedia exposure, and for epidemiological studies to determine the long-term, low-level effects of toxic substances on human health are also discussed in this annex.

4.5 ONTARIO-MICHIGAN EMERGENCY NOTIFICATION PROTOCOL

The Province of Ontario and the State of Michigan have agreed to notify each other and provide appropriate information in the event of an accidental discharge to the water or air in areas that may have transborder impacts. Detailed emergency notification procedures outlining contact responsibilities and orders have been established for spills originating in both Michigan and Ontario. Notification flow diagrams are provided in Figures 4-2 and 4-3.

In the event of a spill in the transborder area of Ontario the spiller will contact the local government in Ontario and the OMOE-Spills Action Center. The local government contacts their Michigan counterpart while the OMOE Spills Action Center will contact the Michigan State Police (MSP) Operations Section. The local governments in Michigan will contact the Fire Department, Police Department, water treatment plants and other local agencies. The MSP Operations Section will contact MSP/Emergency Management Division, MSP/Fire Marshall Division, Michigan Department of Public Health, MDNR/Pollution Emergency Alert System and the local county sheriff departments.

In the event of a spill in the transborder area of Michigan the spiller will contact the local government who will contact the MSP/Operation Section and their Ontario counterpart. The MSP Operations Section will contact the MSP/Emergency Management Division, MSP/Fire Marshall Division, Michigan Department of Public Health, MDNR/Pollution Emergency Alert System and OMOE Spills Action Center.



@ notified of all events

Figure 4-2. Notification flow diagrams for spills originating in Ontario.

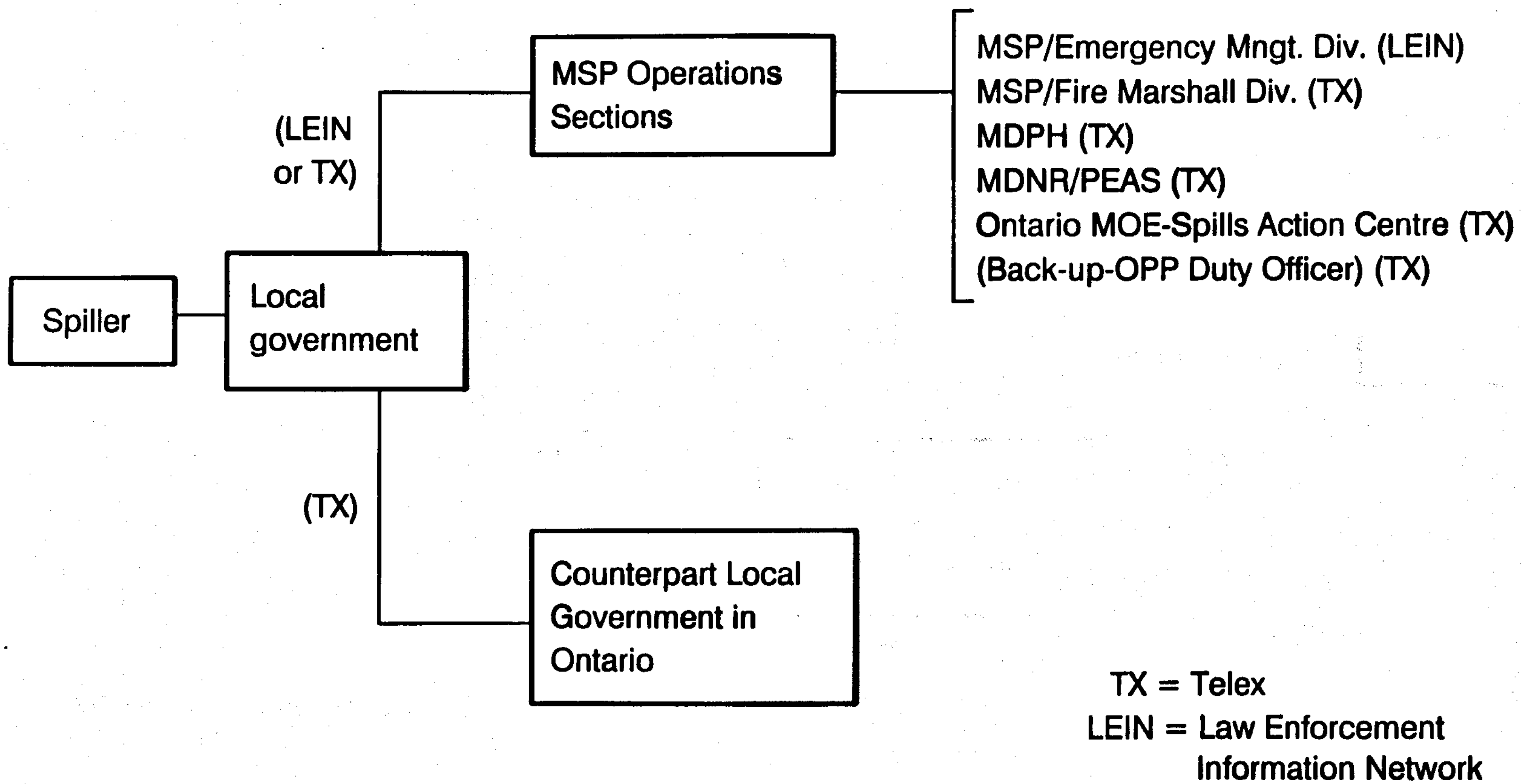


Figure 4-3. Notification flow diagrams for spills originating in Michigan.

CHAPTER 5
DESCRIPTION OF THE AREA

This chapter of the Remedial Action Plan (RAP) defines the Area of Concern (AOC) and provides background information on:

- Geographic location
- Political jurisdictions
- Natural features and hydrologic conditions
- Land uses
- Water uses

Each Remedial Action Plan concentrates on a specific AOC identified by the International Joint Commission. The physical boundaries are defined after consideration of sources and the effects on the Great Lakes and Connecting Channels. For this RAP, the AOC was defined as the Detroit River from Windmill Point at Lake St. Clair to the Detroit Light at Lake Erie (Figure 5-1). The Source Area of Concern (SAOC) (Figure 5-2) is the Detroit River watershed including the land and tributaries which drain directly to the river, and the Detroit sewerage district which discharges to the river. The Rouge River is included in the source area, however, it is also an AOC and has its own RAP. The Rouge River and watershed will be considered as a point source for purposes of this RAP.

5.1 LOCATION

The Detroit River flows from Lake St. Clair to Lake Erie. The Detroit River comprises the lowest link of the Upper Great Lakes Connecting Channels, conveying water from Lakes Michigan, Superior, and Huron to Lake Erie. The river forms part of the international boundary between the Province of Ontario, Canada and the State of Michigan, United States. The SAOC is defined in part by the basins of the eight tributaries which drain the surrounding land and convey flow to the River.

There are over eighty political jurisdictions in the Detroit River AOC that are responsible for the resource management of the Detroit River. These agencies are represented in the RAP development through the public participation program (see Chapter 3, Participants). Michigan counties in the SAOC include Wayne, Oakland, Washtenaw and Macomb. The City of Detroit, and seventy-five suburban cities and townships are also located in the U.S. portion of the SAOC. Michigan communities bordering the river include Detroit, River Rouge, Ecorse, Wyandotte, Riverview, Trenton, Grosse Ile, and Gibraltar. The Canadian SAOC includes the City of Windsor, the Towns of Amherstburg and Tecumseh, and the Townships of Anderson, Malden, and Sandwich West, all of which are in Essex County, Ontario.

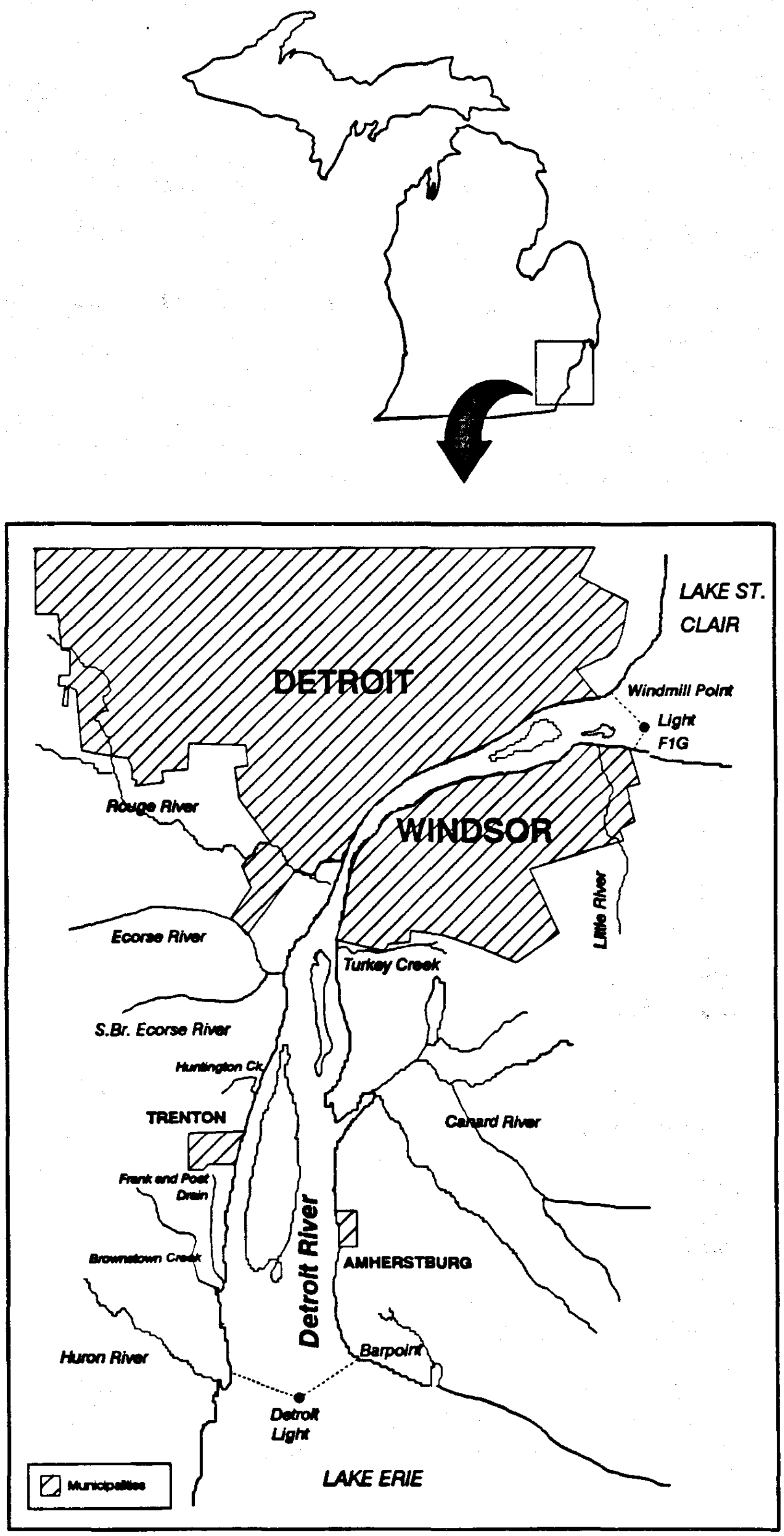


Figure 5-1. The Detroit River, a designated Area of Concern.

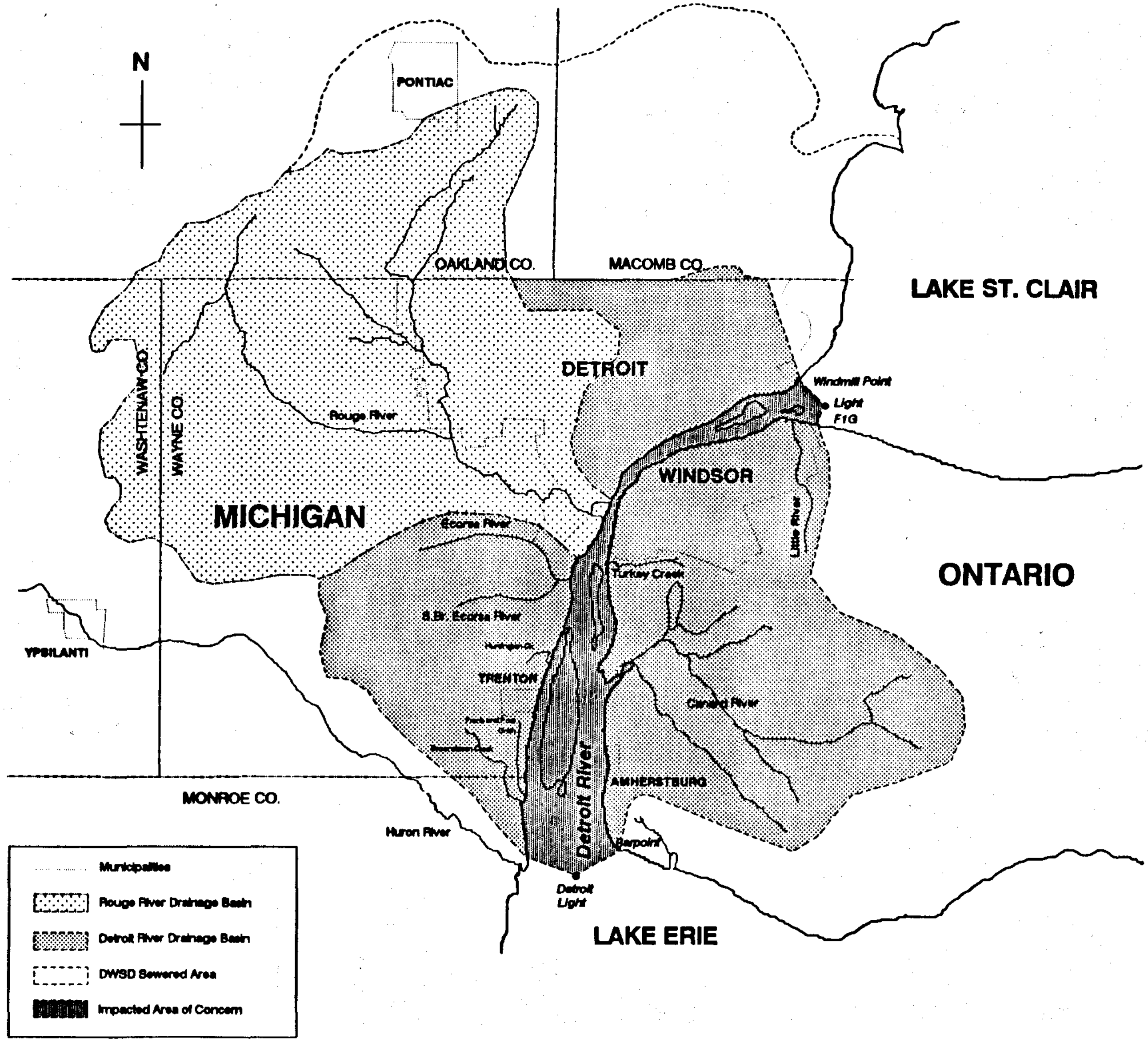


Figure 5-2. Detroit River Area of Concern and Source Areas of Concern boundaries.

5.2 NATURAL FEATURES

5.2.1 Drainage Basin

Tributaries and sewers drain an estimated total of approximately 807 square miles (2097 square kilometers) directly to the Detroit River. These include direct overland runoff and areas serviced by combined sewers (Detroit Water and Sewerage District in Michigan) that drain directly to the Detroit River. There are five Michigan tributaries -- the Rouge River, Ecorse River, Frank and Poet Drain, Brownstown Creek and Huntington Creek (also known locally as Monguagon Creek), and three Ontario tributaries -- the Little River, Turkey Creek, and the Canard River (Figure 5-3). Drainage basin size and flow data for the tributaries is presented in Table 5-1.

The Rouge River is the largest tributary and drains an area of 467 square miles (1210 square kilometers) having an estimated population of 1.2 million (MDNR 1989b). Its four branches are very event-responsive with frequent flooding along the Middle Rouge. Its average discharge into the Detroit River is 1090 cubic feet per second (cfs) (31 cubic meters per second (m^3/sec)), most of which originates in urban and industrial areas (D. Hamilton, Personal Communication). The Rouge River collects considerable stormwater runoff and overflow from combined sewers during wet weather, and because the lower Rouge is partially concrete lined, runoff rapidly reaches the Detroit River during storms. The mouth of the Rouge is located in the upper reach of the Detroit River, a few miles north of the midpoint between Lake St. Clair and Lake Erie. As previously mentioned, the Rouge River is also a designated AOC and is considered a point source for purposes of this RAP.

Ecorse River drains an area of approximately 45 square miles (117 km^2), having a total population of 198,000 in 1980. Ecorse River has two branch tributaries which drain largely urban and industrial areas. It enters the Detroit River about 6 miles south of the Rouge River with a mean discharge of 29 cfs (0.9 m^3/sec) (D. Hamilton, Personal Communication).

Huntington Creek drains about 2.6 square miles (7 km^2) of heavily industrialized area in Trenton and Riverview. It discharges to the Detroit River just south of the Grosse Ile toll bridge (upper) with a mean discharge of 1.7 cfs (0.05 m^3/sec) (D. Hamilton, Personal Communication).

The Frank and Poet Drain drains approximately 25 square miles (65 km^2) of urban and agricultural lands before entering the lower Detroit River near its mouth south of Grosse Ile. The mean discharge is 16 cfs (0.5 m^3/sec) (D. Hamilton, Personal Communication).

Brownstown Creek has two branches which drain approximately 35 square miles (91 km^2) and discharges one half mile south of the Frank and Poet Drain in the lower Detroit River. The average discharge is 22 cfs (0.6 m^3/sec) (D. Hamilton, Personal Communication).

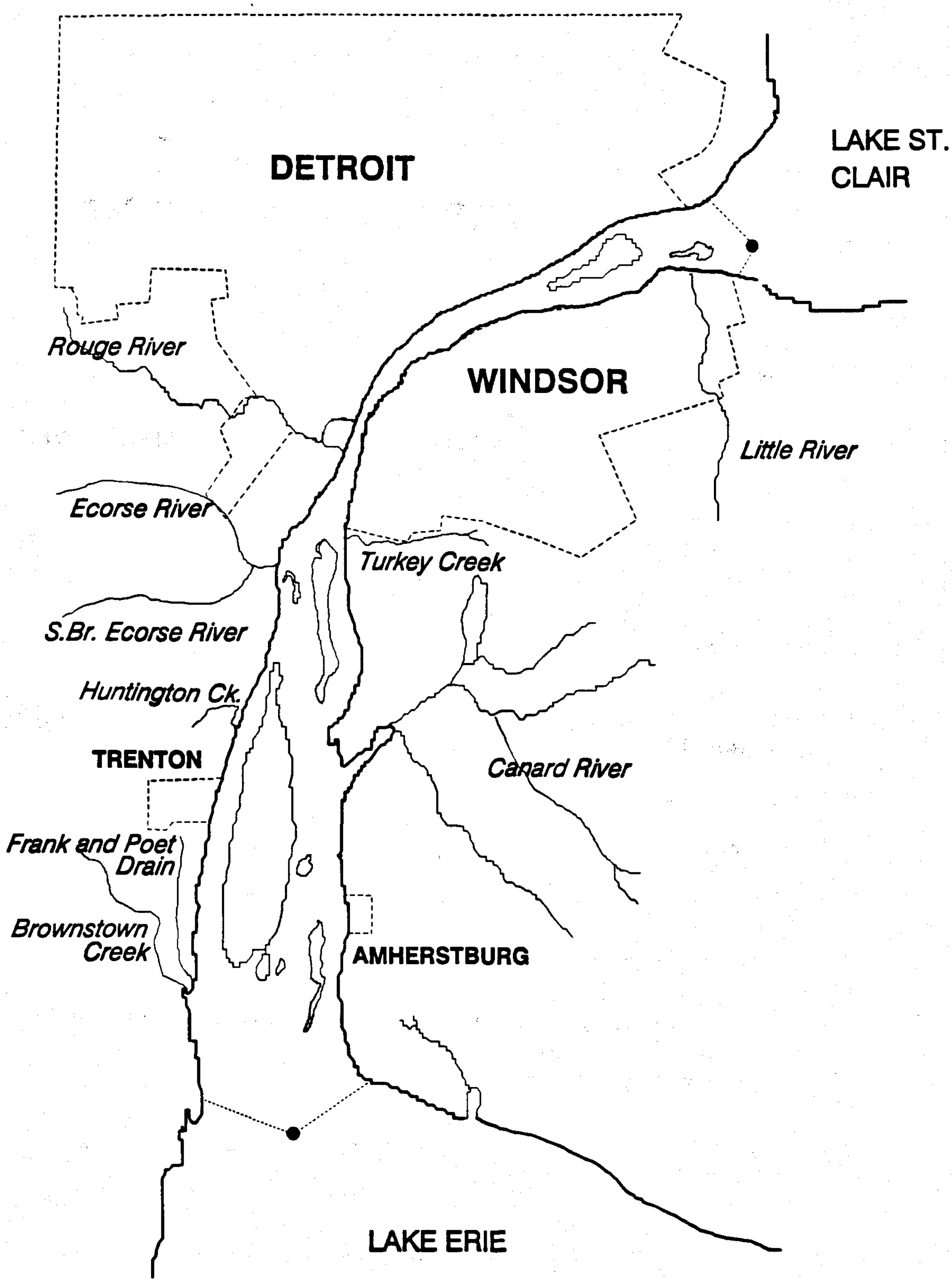


Figure 5-3. Tributaries to the Detroit River.

Table 5-1. Detroit River tributary basin size and flow data.

Drainage Basin (With Data Reference)	Drainage Basin Size $(mi)^2$	Drainage Basin Size $(km)^2$	Mean Discharge (cfs)	100-year Flood Discharge (cfs)
Michigan				
Rouge River	467	1,214	1,090*	19,100
Ecorse River	45	117	29	4,400
Frank and Poet Drain	25	65	16	1,010
Brownstown Creek	35	91	22	1,340
Huntington Creek	2.6	7	1.7	1,060
Direct (including sewers)	33	86	ND	ND
Total Michigan	607.6	1,580	1,158.7	26,910
Ontario				
Little River (MacLaren 1985)	24	62	15	2,002**
Canard River (Procter & Redfern 1982)	131	340	54	6,700**
Turkey Creek (Wall, Pringle & Dickinson 1986)	11	29	12	2,170**
Direct (Estimate)	33	86	ND	ND
Total Ontario	199	517	81	10,872
Total Detroit River From Tributaries	806.6	2,097	1,239.7	37,782

ND - No data available.
* The Rouge River flow includes a large continuous industrial discharge of 790 cfs.
** Flood flow data from Environment Canada, 1985.

NOTE: Average discharge figures for Michigan are based on the Period of Record. Source for Michigan data: D. Hamilton, Personal Communication, 9/89.

On the Ontario side, the three tributaries drain a total of 199 square miles with a total average flow of 81 cfs (2.3 m^3/sec). The Little River drains approximately 24 square miles (62 km^2) and discharges into the upper Detroit River near Peach Island with an average flow of 15 cfs (0.4 m^3/sec) (MacLaren 1985).

Turkey Creek drains 11 square miles (29 km^2) and discharges to the Detroit River just above Fighting Island. The average flow is 54 cfs (1.5 m^3/sec) (Wall, Pringle and Dickinson 1986).

The Canard River, a turbid, slow moving stream with diked wetlands at its mouth, enters the Detroit River south of Fighting Island. The average flow is 54 cfs (1.5 m^3/sec). Its drains 131 square miles (340 km^2), most of which is agricultural land (Procter and Redfern 1982).

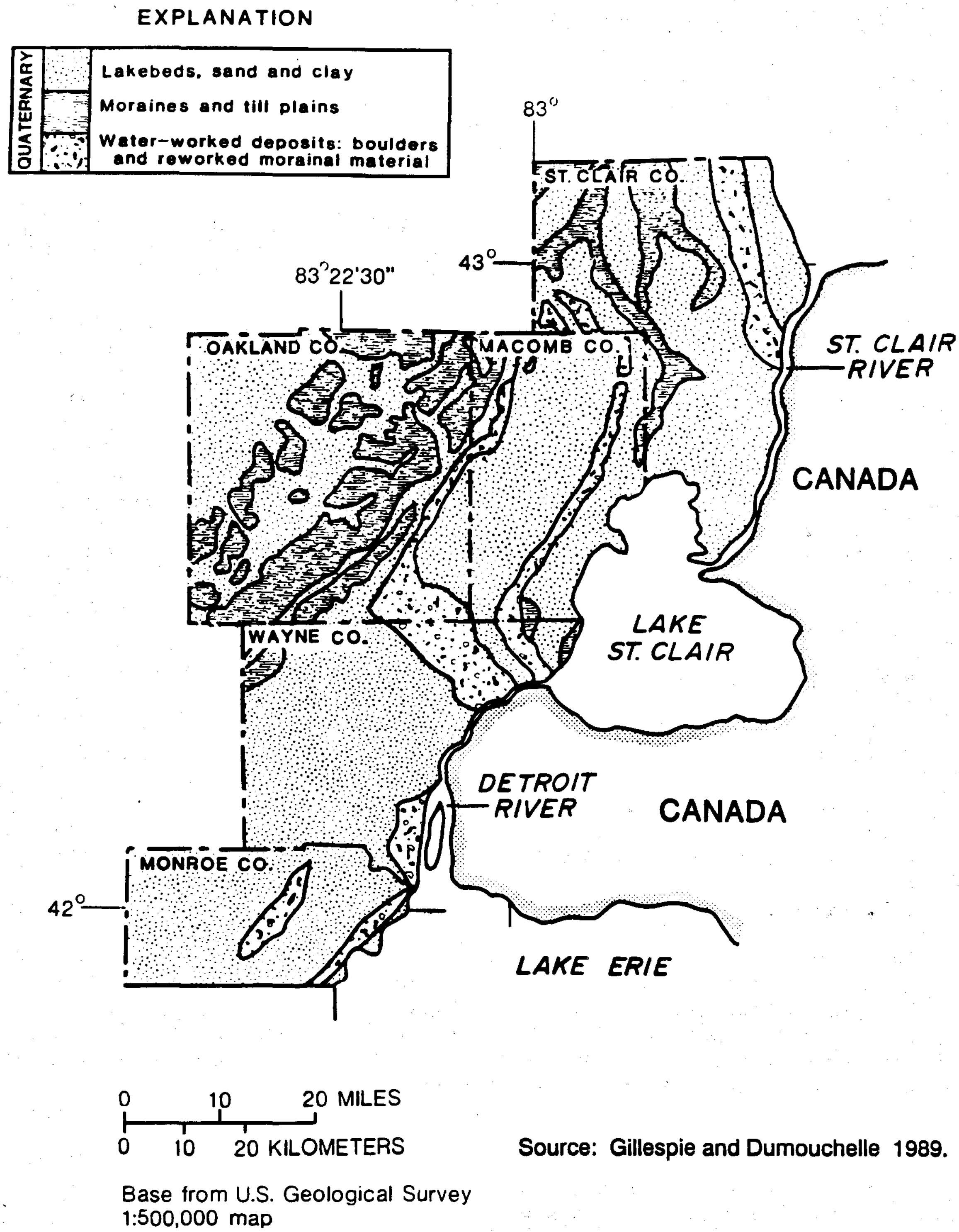
The total average tributary flow is approximately 1240 cfs (35.1 m^3/sec), representing less than one percent of the Detroit River average flow (185,000 cfs or 5,240 m^3/sec). The relatively minute contribution of flow from the tributaries to the total river flow indicates the significance of the water quality originating in the upper Great Lakes and flowing through from Lake St. Clair.

5.2.2 Topography, Soils and Erosion

5.2.2.1 Michigan Topography

Southeast Michigan's surface topography was established during the Wisconsinan glacial period. Glacial deposits and movements shaped the plains and low hills. The Michigan SAOC soils are loose materials including sand, gravel, silt and clay. In some localities, however, bedrock is close to the surface. Figure 5-4 illustrates the surface geology of the southeast Michigan area. Detailed 1:24,000 scale topographical maps are available from the U.S. Geological Survey (LTI Inc. 1988).

Landforms in the southeast Michigan area consist primarily of a sand and gravel rock morainic belt and a glacial plain area. The morainic belt occupies approximately 2200 square miles (5700 square kilometers) in Livingston, Washtenaw and Oakland, and the northwest corners of Wayne and Macomb Counties. Among the morainic hills are gently undulating till plains and relatively flat outwashed channels, pitted with many lakes and swamps, characteristic of glacially-formed landscapes. To the southeast lies a glacial plain veneered by sediments deposited in the forerunners of the present Great Lakes. This low flatland zone varies from 20 to 30 miles (30 to 50 kilometers) wide and lies between the Great Lakes shoreline and the morainic belt. Lowland soils are mainly clay and sand. Intermixed with these lake deposits are small water-laiden glacial moraines, raised beach ridges and raised deltas formed by rivers fed by the melting glaciers. Current stream courses occasionally modify the low relief of this plain. This lowland zone occupies approximately 2300 square miles (6000 square kilometers) extending over most of St. Clair, Macomb, Wayne and Monroe counties.



Source: Gillespie and Dumouchelle 1989.

Figure 5-4. Surface geology of Southeast Michigan.

The regional elevation ranges from 570 feet (174 m) above sea level along Monroe County's Lake Erie shoreline and 574 feet (175 m) above sea level along the Detroit River in Wayne County, to 1240 feet (378 m) above sea level at several points along the hills of Oakland and Livingston Counties. In the lake plains, the relative relief varies from 10 to 50 feet per square mile (1 to 5 m per square kilometer). In the hilly area, the relative relief varies from 100 to 400 feet per square mile (12 to 48 m per square kilometer). Detailed local topographical information is available in the literature (SEMCOG 1976).

In this region, slopes greater than 12% (limiting urban and agricultural land development) occur mainly along the stream banks. In hilly areas, slopes exceeding 12% are extensive, covering about 450 square miles (1170 square kilometers), or about 20% of the hill zone area, and 10% of the region's total area.

5.2.2.2 Michigan Soils

The type of soils in the SAOC are important because they affect the drainage characteristics of the region and hence influence the runoff from storm events and the erosion which accompanies water and wind action. On the Michigan side, the hilly area away from the river is sandy and drains well, but the area near the river, especially in and near Detroit, is primarily clay which is almost impervious so that water runs off immediately.

Soil types in the Detroit River SAOC vary according to the landforms and parent materials from which they have developed. Well-drained sandy and loamy soils are present in Michigan's glacial drift in the northwest hilly area (Figure 5-5). The level uplands and plains are dominated by poorly-drained soils with finer textures. Soils of the lake plains are poorly drained with fine to medium textures.

Michigan's Detroit River SAOC soils are gray-brown, podzolic soils formed under broadleafed deciduous forests of beech, oak, hickory, etc. These trees remove basic minerals from the lower soil levels and return them to the surface through the decaying leaves and branches, yielding slightly acidic and highly productive agricultural soils.

Impervious clay and silts dominate the eastern 80% of the City of Detroit, while pervious soils (sand) are found along the Rouge River and in isolated pockets elsewhere. Pervious soils are much more conducive to groundwater transmission to sewers than impervious soils. The Detroit District U.S. Army Corps of Engineers (1969) has classified soils in Wayne County into pervious and impervious regions, based on soil texture. The ground surface and bedrock contours indicate the depth to bedrock varies from 50 to 200 feet (15-61 m) under Detroit.

5.2.2.3 Michigan Runoff and Erosion

The Great Lakes Basin Frameworks Study (Great Lakes Basin Commission 1975) provided information on erosion and sedimentation characteristics in the Lake Erie basin. The study utilized the universal soil loss equation which incorporates the National Conservation Needs Inventory

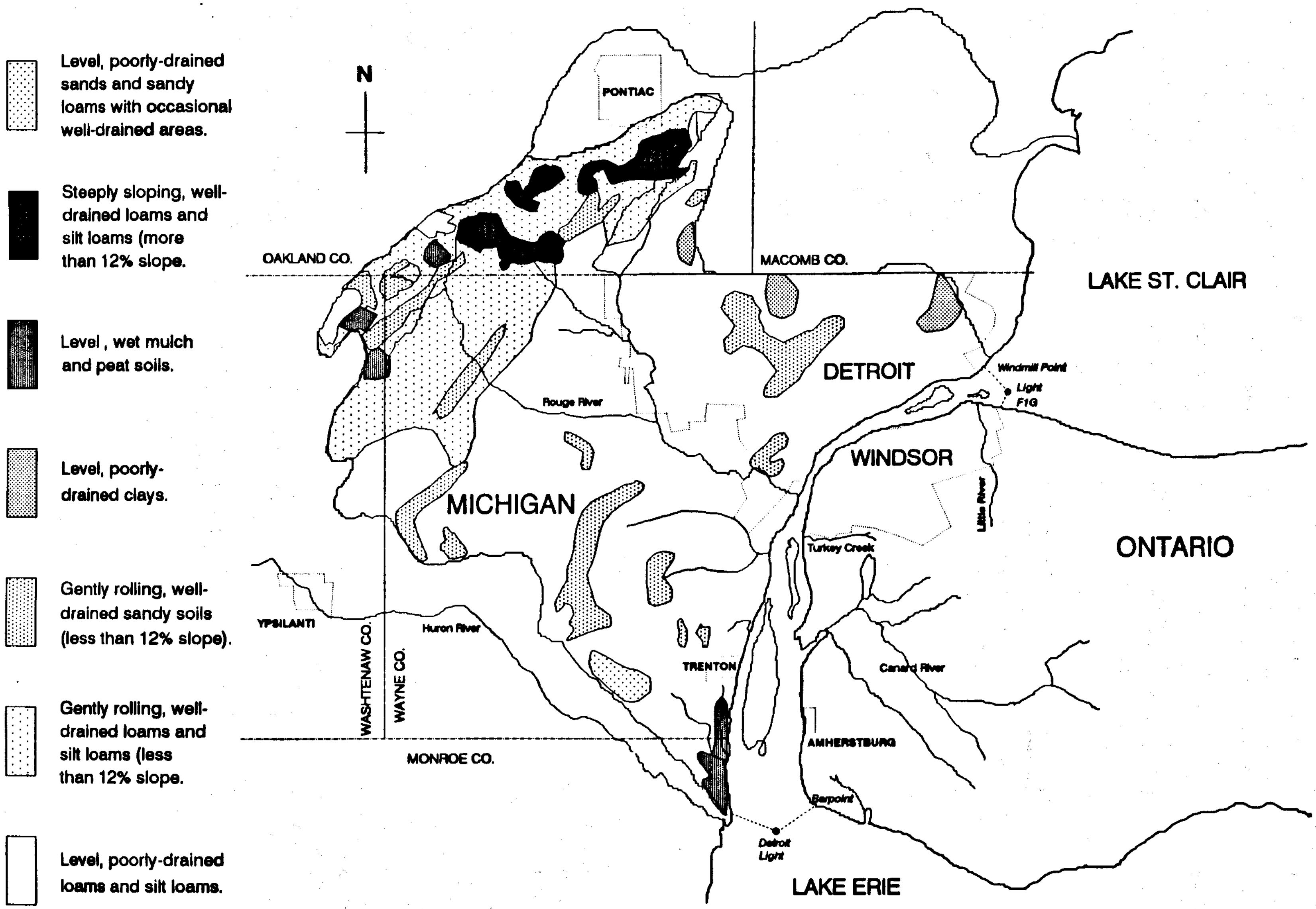


Figure 5-5. Michigan soils near the Detroit River Area of Concern.

updated to 1968). Such data is available by county and by soil group. In Wayne County the weighted average annual sheet erosion is 3.3 tons per acre per year. Sheet erosion is the removal of a uniform layer of soil from land by water. The three components involved in computing sheet erosion rates are: 1) soil and slope characteristics, 2) cropping patterns and land cover conditions, and 3) regional rainfall characteristics. Estimations indicate that this number will remain relatively constant over the years (Great Lakes Basin Commission 1975).

5.2.2.4 Michigan Groundwater Flow

In Michigan, general groundwater flow is east towards the Detroit River. Locally, the direction of groundwater flow is influenced by surface water drainage, dewatering projects (such as in the Sibley Quarry in Wayne County), and glacial landforms. Groundwater discharges to the Detroit River form two hydrogeologic units: a shallow glacial unit and a bedrock unit. The shallow glacial unit consists of mostly silty-clay till and glaciolacustrine deposits with discontinuous stringers of sand and gravel. In the upper river (above Fighting Island), the bedrock unit is comprised of carbonate rocks of the Traverse and Dundee formations, overlain by at least 49 feet (15 m) of glacial deposits. Near the mouth of the river, the Detroit River Group forms the river channel.

The estimated total discharge of groundwater from the Michigan side of the Detroit River from Belle Isle to Point Mouillee is between 53 and 106 cfs (1.5 m^3/sec and 3 m^3/sec) (U.S.G.S. 1987; Mazola 1987). Rates of groundwater seepage are highest in the northern portion of the Detroit River near Belle Isle, and generally decrease downstream, increasing again below the Ecorse River mouth. Groundwater and surface water systems are highly interconnected in the Trenton Channel and the lower Detroit River, due to thin or absent sediments overlying bedrock.

5.2.2.5 Ontario Topography

In the Sarnia-Windsor area, the dominant surficial deposits and features are the result of glacial lakes that once inundated the area. In Essex County surficial deposits are primarily a till overlying a low swell on the bedrock (MacLaren 1976). The underlying bedrock of the Essex area is Devonian Age dolomitic limestone. Other than the limestone outcroppings on Peach Island, the bedrock does not impact the topography which is generally featureless. The bedrock is an important source of salt which is mined on the waterfront.

The limestone bedrock dredged from the shipping channels in the lower river was used to create Crystal Bay Island and the dikes south and west of Bois Blanc Island. Dredged silica sand and loose sandstone were added to the southern dike. Erosion of the sandstone from this dike has resulted in the formation of a sand beach now known as White Sand Beach on Bois Blanc Island.

Other naturally occuring Canadian islands in the Detroit River include Fighting Island, Turkey Island, and Peach Island (also referred to as Peche Island). The southern two-thirds of Fighting Island and some portion of the northern section have been used as a waste disposal site for many years. The northern third of Fighting Island, Turkey Island, and Peach Island have retained many of their natural features. Bois Blanc Island is now an amusement park. Grassy Island, a U.S. island, has also been altered substantially from its natural state as it was once a refuse disposal ground.

The surface geology of Essex County is summarized in Figure 5-6. Except for the beach sand plains of the Ojibway area and the waterfront east of Peach Island, the glacial overburden is dominated by extensive clay plains. Both the clay plains and the beach sand plains exhibit little local relief except for an occasional knoll or beach ridge. From east of Windsor to the St. Clair beach area, the low lying plains are poorly drained. Between La Salle and the Ambassador Bridge, sand and gravel are presently being extracted from the glacial till as a source of mineral aggregate.

The topography of the area is extremely flat. The total fall from the town of Essex to the Detroit River is only 59 feet (18 meters). The Little River basin stream gradient is only 0.06% with flat flood plains and artificial drainage. Turkey Creek has an average slope of 0.08%. The Canard River also has poor natural drainage with man-made drainage ditches and field tile systems. There are no lakes in the Canadian SAOC, but the Canard River has a large marsh at its mouth which attenuates flows.

The extensive marsh areas between the mouth of the Canard River and Turkey Creek are a major natural feature. These marshes are under water most of the growing season and exist because of the low gradients in the streams and natural drainage channels entering the Detroit River. These marshes provide excellent fish and wildlife habitat and help stabilize stream flow.

5.2.2.6 Ontario Soils

Soils along the Ontario shore are dark gray gleysols with intermingled gray-brown podzols (Figure 5-7) (INTRA 1986). The dark gray gleysols have a high soil moisture content and are poorly aerated. These soils are discolored brown or gray and exposure to fluctuating water tables has caused significant leaching. The dark brown podzols were developed under a deciduous or mixed forest vegetation. The textured horizon in this soil group resulted from the translocation of clay in suspension from an upper layer. The Canard River watershed is almost entirely Brookstone clay loam which exhibits poor natural drainage. The area drained by Turkey Creek consists of sand and sandy loams.

5.2.2.7 Ontario Erosion

Soil erosion, especially by wave action, has been studied extensively in Essex County (MacLaren 1977) providing a substantial amount of data concerning:

i) the nature, magnitude, and effects of erosion in the County;

ii) the identification of areas hazardous for development;

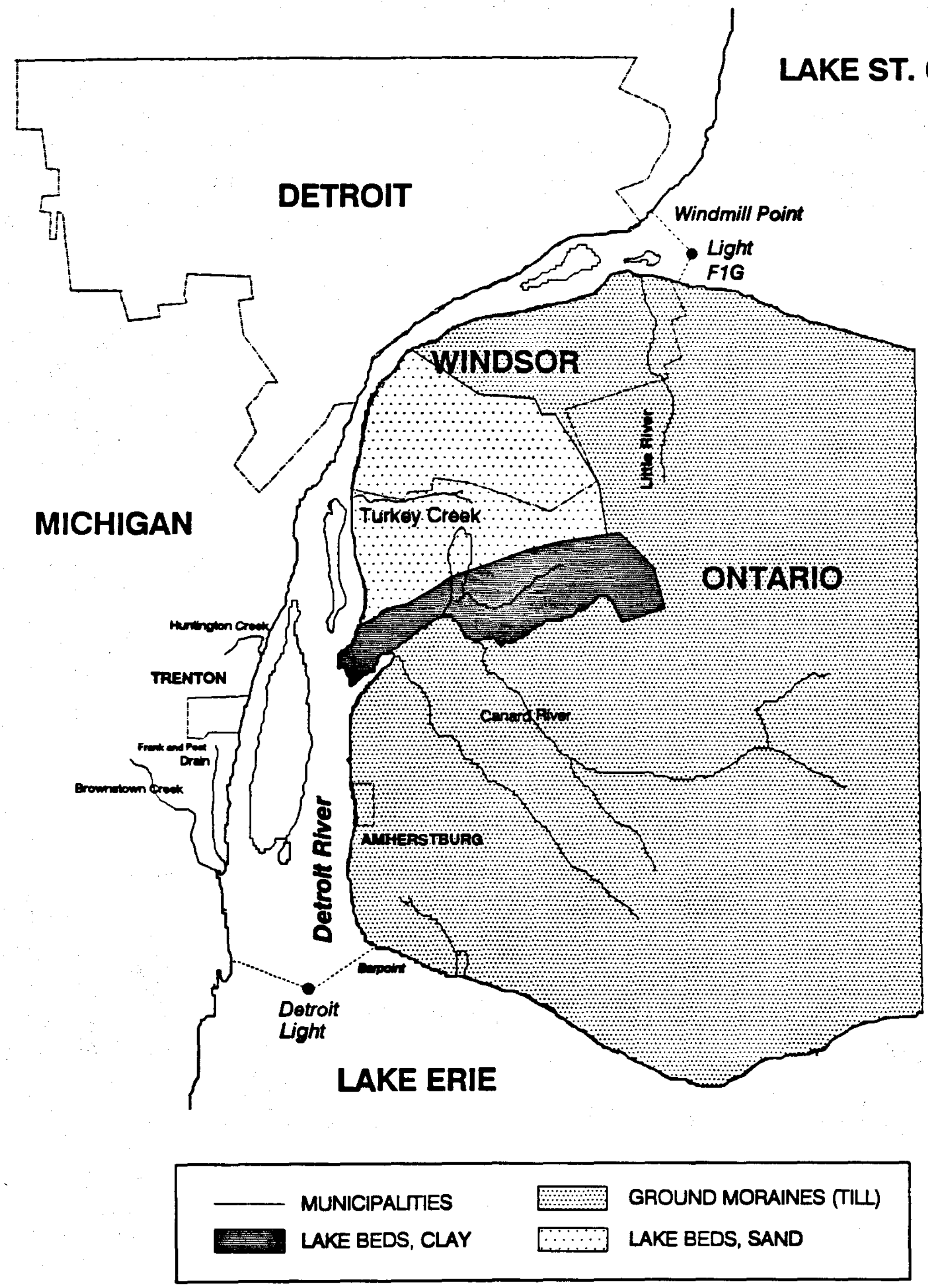


Figure 5-6. Surface geology of Essex County, Ontario.

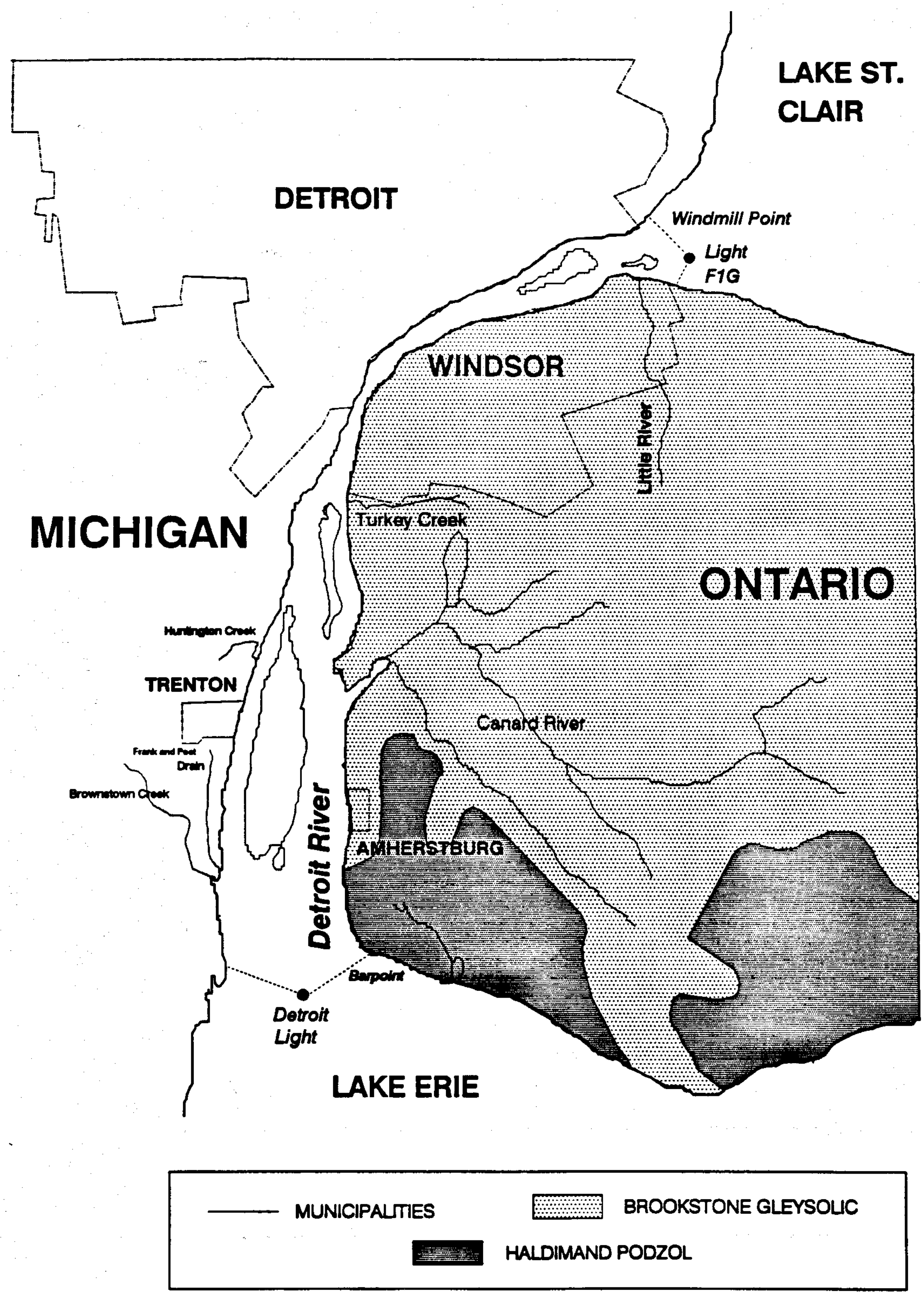


Figure 5-7. Soils of Essex County, Ontario.

iii) preliminary recommendations for corrective and preventive works; and

iv) policies, programs and strategies regarding future development in shoreline areas which are subject to excessive erosion.

These studies show that under normal conditions, erosion along the Detroit River is caused by river currents and by waves generated by shipping and boating activity. Otherwise, wave action is not a major erosion factor on the river where the narrow channel width and the protection provided by a number of islands prevent the sizable build-up of waves. During periods of high lake levels when beaches are narrower and waves can attack the shoreline directly, erosion can be considerable.

5.2.2.8 Ontario Groundwater Flow

In Ontario, the groundwater flow is generally west towards the Detroit River. Three levels of groundwater discharge exist: local, intermediate, and regional (or bedrock). The local unit is contained in surficial sands and gravels, and the weathered and fractured zone of lake clay and clay tills. Similar to the Michigan surficial unit, flow in this system is influenced strongly by local surface conditions. The intermediate unit is comprised of intact lacustrine clay and clay till, ranging from less than 10 feet to 131 feet (3 meters to 40 meters) thick. It is believed most of the groundwater flow from this unit is downward towards the bedrock unit. The bedrock unit is comprised primarily of carbonate rocks of the Hamilton and Dundee Formations and the Detroit River Group. Flow in this unit is towards the Detroit River and Lake Erie.

Flow estimates of groundwater seepage into the Detroit River from the Ontario side were not included in the studies reviewed (Taylor et al. 1987; Lum and Gannon 1985; LTI, Inc. 1985; Wall et al. 1987; U.S.G.S. 1987; and Mazola 1969).

5.2.3 Hydrology

The Detroit River hydrologic characteristics include the transport characteristics of water passing through the watershed (rainfall, runoff, groundwater seepage and tributary flow), and the physical and hydraulic river characteristics (width, slope, volumetric flow rate, flow route, and current velocity). The watershed hydrologic charcteristics influence nonpoint (diffuse) sources of pollutants from the surrounding land such as silt, pesticides, herbicides, and chloride. Hydrologic considerations are important to the water quality since they influence the sources, fate and impact of contaminants in the aquatic system. They also influence navigation, flooding potential, shoreline erosion, and contribute to various factors (e.g. transport and kinetic parameters) that control the river's assimilative capacity for pollutants and the impact of the river on Lake Erie's water quality. Hydraulic information is also used for planning emergency response to oil or chemical spills from shoreline industries or shipping activities. Mathematic models used to simulate the system hydraulic characteristics have been developed for the Detroit River. The river's pertinent physical and hydraulic characteristics, and the available mathematical models are discussed below.

5.2.3.1 Physical Characteristics

The Detroit River slope is relatively uniform for most of its length with a total fall of only 3 ft (0.9 m) from Lake St. Clair to Lake Erie (Table 5-2). The river width varies between 2,000 to 10,000 ft (600 to 3,000 m) with depths generally between 3 and 50 ft (1 to 15 m). There are twelve islands in the river. Bottom channel material consists of silt, clay, sand, gravel, boulders and bedrock.

Additional detailed physical information is available in the literature (Derecki 1984; U.S. Army Corps of Engineers 1973; Roginski and Kummler 1981).

The river can be divided into two distinct river reaches, the upper and lower, with different hydraulic characteristics (Figure 5-8, Table 5-3) (Derecki 1984).

The upper reach of the Detroit River extends approximately 13 miles (21 km) from Lake St. Clair to the head of Fighting Island with a fall of 1 ft (0.3 m). Except at the head of the river where the channel is wider and divided by Peach Island and Belle Isle, the river forms a single well-defined channel approximately 2,000 to 3,000 ft (600 to 900 m) wide. The upper river is generally deep, with mid-channel depths varying from 30 to 50 ft (9 to 15 m) and has steep banks (Derecki 1984). There is also a steep dropoff 10 to 500 ft (3 to 152 m) from the Ontario shore where the edge of the navigation channel is located. The Fleming Channel, the main navigational channel of the upper river, runs north of Peach Island and south of Belle Isle.

The lower reach of the Detroit River is substantially wider (5000 to 10,000 ft (1500 to 3000 m)) and shallower (2 to 30 ft (0.6 to 9 m)) than the upper reach. Ten islands divide the lower river into distinct channels. Between Fighting Island and Bois Blanc Island the main channel natural depths average less than 20 ft (6 m), and the bottom material is mainly bedrock and boulders. Extensive rock excavation and dredging was required to construct the present navigation channels. The Detroit River slope is steepest between Fighting Island and Bois Blanc Island where the river falls approximately 1.5 ft (0.5 m), leaving less than 0.5 ft (0.2 m) fall for the rest of the lower reach (Derecki 1984).

Five navigational channels were dredged in the lower reach (Figure 5-8) (NOAA 1984). A two-directional main navigation route in the upper portion of the lower Detroit River follows the Fighting Island Channel and the Ballards Reef Channel downstream to Stony Island for a distance of 9 miles (14 km). The navigation channel divides into two one-directional routes at the head of Stony Island; namely, the southbound Livingstone Channel, and the northbound Amherstburg Channel. The Trenton Channel splits off from Fighting Island Channel at the head of Grassy Island and continues to the west of Grosse Ile. The navigable portion of the Trenton Channel terminates with a turning basin south of the Grosse Ile Free Bridge at Trenton. Downstream of Grosse Ile, Celeron and Bois Blanc Islands, the river is approximately 20,000 ft (6100 m) wide with depths

Table 5-2. Characteristics of the Detroit River watershed.

Parameter	Measurement
Length	31.7 miles (51 kilometers)
Width	1,900 to 20,000 feet (600 to 6100 meters)
Maximum Depth	50 feet (16 meters)
Average Flow Rate	185,000 ft^3/sec (5,240 m^3/sec)
Fall from Head to Mouth	3 feet (0.9 meter)
Average Retention Time	21 hours
Velocity	1 to 3 feet/sec (0.3 to 1 meter/sec)
Number of Islands	12
Drainage Basin Size*	700 sq. miles (1,800 sq. kilometers)
Population in the AOC	Approximately 4 million

* Drainage Basin Size refers to natural drainage basin of the Detroit River and its tributaries. Areas included in the SAOC due to sewage collection systems outside the boundaries of the natural drainage basin are not included in this calculation.

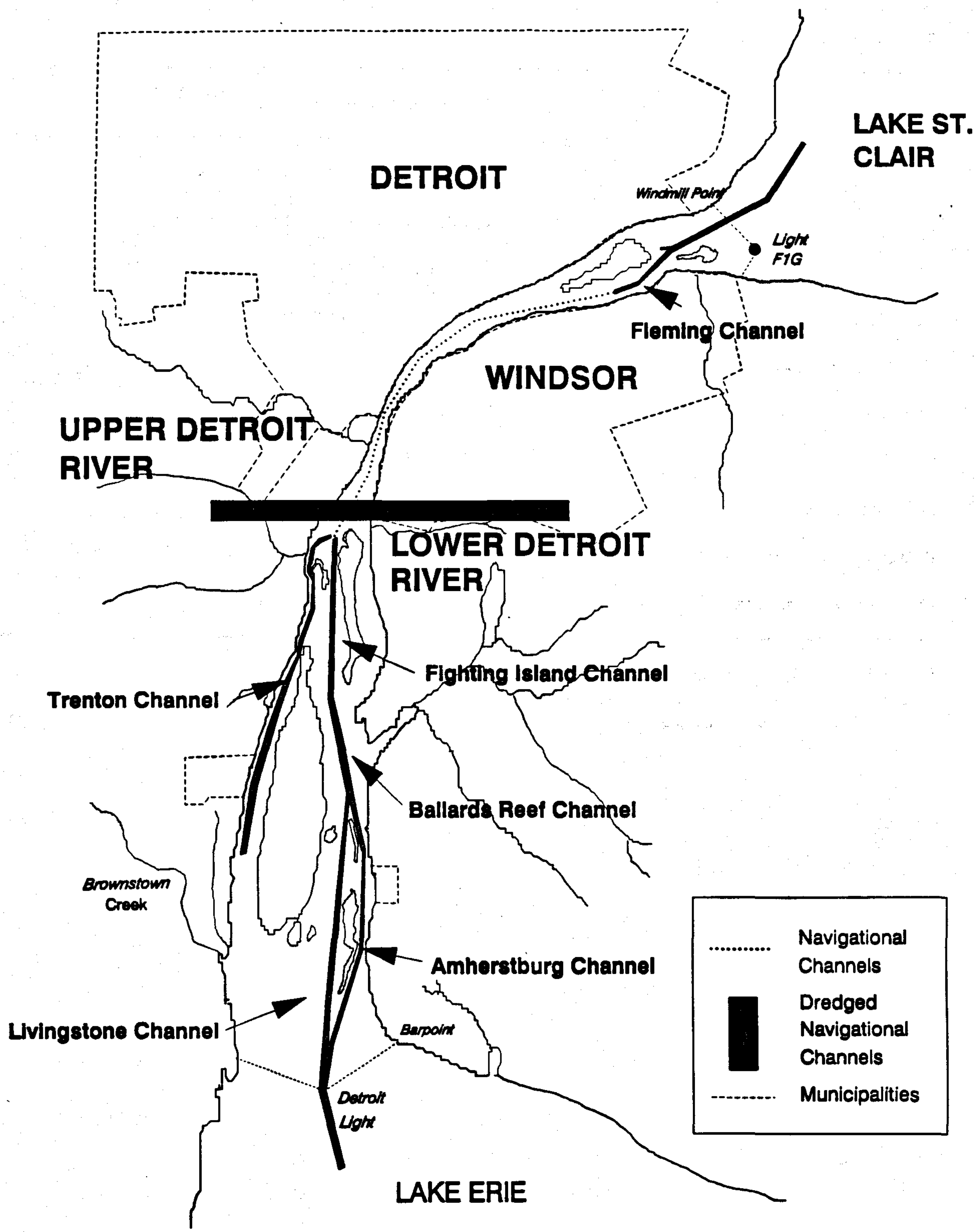


Figure 5-8. Commercial navigation channels and dredged areas in the Detroit River.

Table 5-3. Physical and hydraulic characteristics of the Detroit River.

	Upper River	Lower River
Length	13 mi (21 km)	19 mi (30 km)
Average Depth (not including Navigation Channels)	30 - 50 ft (9 - 15 m)	10 - 30 ft (3 - 9 m)
Drop	1 ft (0.3 m)	2 ft (0.6 m)
Width	2,000 - 5,000 ft. (600 - 1,500 m)	5,000 - 10,000 ft. (1,500 - 3,000 m)
Islands	2	10
Bottom Material	sand, clay	sand, clay, boulders, rock

Source: Derecki 1984.

ranging from 1 to 14 ft (0.3 to 4.3 m) excluding the Livingstone and Amherstburg Channels which are dredged to 27 ft (8.2 m).

5.2.3.2 Hydraulic Characteristics

Flow:

The United States Geological Survey (U.S.G.S), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Army Corps of Engineers and the Canadian Public Works (CPW) measure flow at seven locations (Figure 5-9). The Detroit River flow is relatively constant, typically uni-directional and well-mixed from top to bottom. Lateral mixing of water across the river is such that displacement occurs gradually, as well as progressively, with increased travel time/distance downstream, so that a small fraction of the total river flow downstream is displaced across the river (R. Boone, Personal Communication). The long term average discharge is 184,000 cfs (5,200 m^3/sec) (1900-1978), which varies seasonally from a monthly winter low of about 155,000 cfs (4,400 m^3/sec) to a monthly summer high of 200,000 cfs (5,700 m^3/sec). Seasonal variation in monthly flows range from 30,000 to 45,000 cfs (800 to 1,300 m^3/sec) (Derecki 1984). Recent annual average flows have been higher than the long term average, but have decreased from the record high of 229,000 cfs (6500 m^3/sec) in 1986 (D. Hamilton, Personal Communication).

Water depths and flows in the Detroit River depend on seasonally fluctuating Great Lakes levels and storms. High easterly or westerly winds cause Lake Erie seiches resulting in fluctuations at the river mouth and flooding along the low-lying waterfront areas. Flood control dikes have been constructed but are generally inadequate.

The Detroit River has a complex flow distribution (Figure 5-10) due to the many islands and channels (Derecki 1984a). In the main channel of the upper reach, the Fleming Channel carries 70 to 80 percent of the river flow. At the upstream end of the lower reach, the river flow is divided by Fighting and Grassy Islands. The Fighting Island Channel carries 56 percent of the flow, the Trenton Channel carries 21 percent, and the channel east of Fighting Island carries 23 percent. The flow east of Fighting Island divides at the southern end of the Island, with 12 percent flowing west of Turkey Island and 11 percent east. At the head of Stony Island and Crystal Bay, the Ballards Reef Channel flow of 79 percent is distributed to the channel west of Stony Island (6 percent), the Livingstone Channel (26 percent), and the Amherstburg Channel (47 percent). At the head of Bois Blanc Island the flow is distributed among five channels. The Trenton Channel flow is divided at Celeron Island with 6 percent flowing west and 15 percent flowing east of the island (Derecki 1984).

Velocity:

The velocity, important to the fate and transport of water and sediment borne contaminants, has been measured at several locations (U.S. Army Corps of Engineers 1981, and Derecki 1984a). Average velocities vary from 1 foot per second (ft/sec) to over 2 ft/sec (0.3 to 0.6 m/sec) depending on location and controlling flow conditions. Average velocities shown in Figure 5-11 represent the average velocity in the

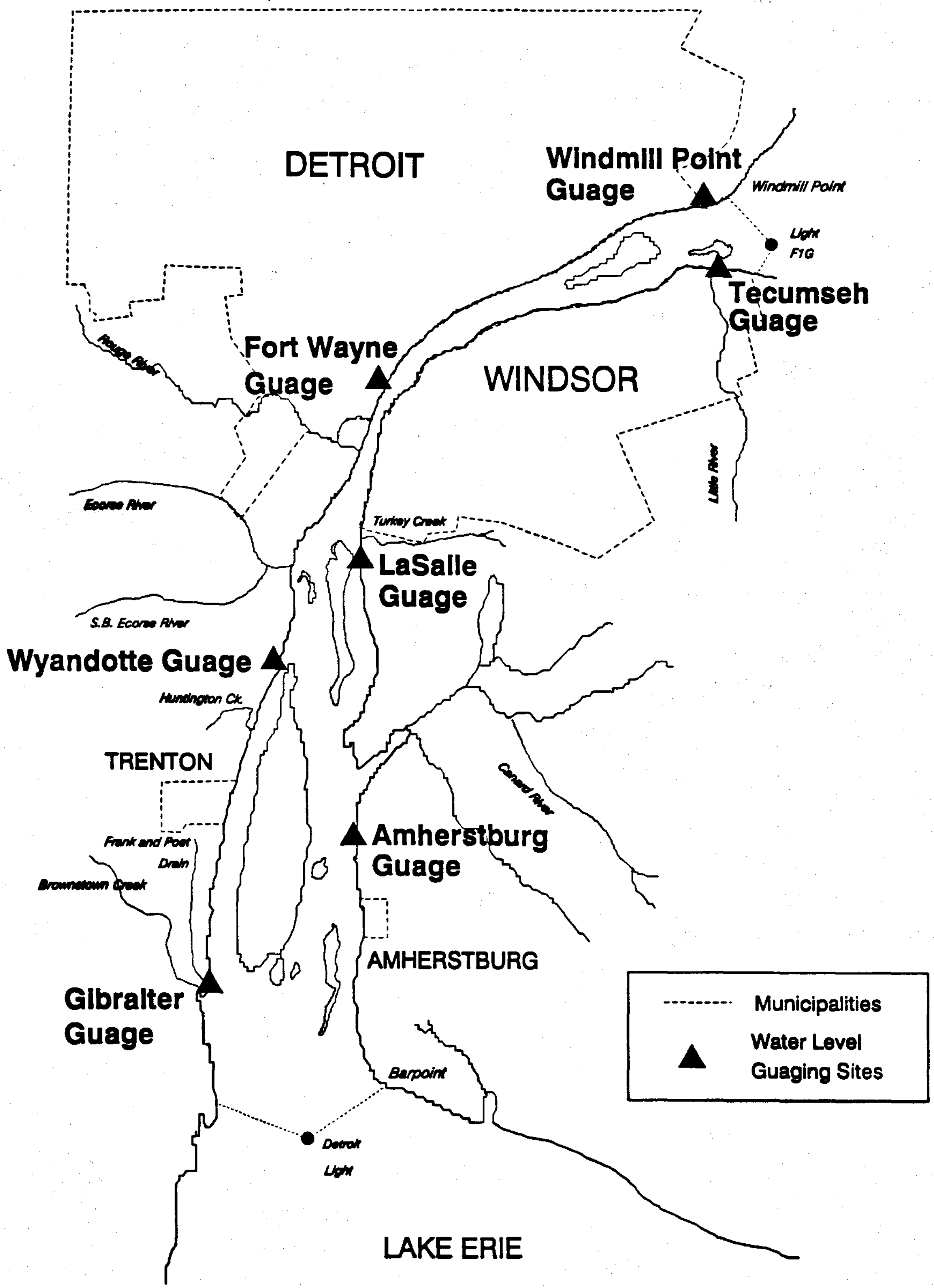
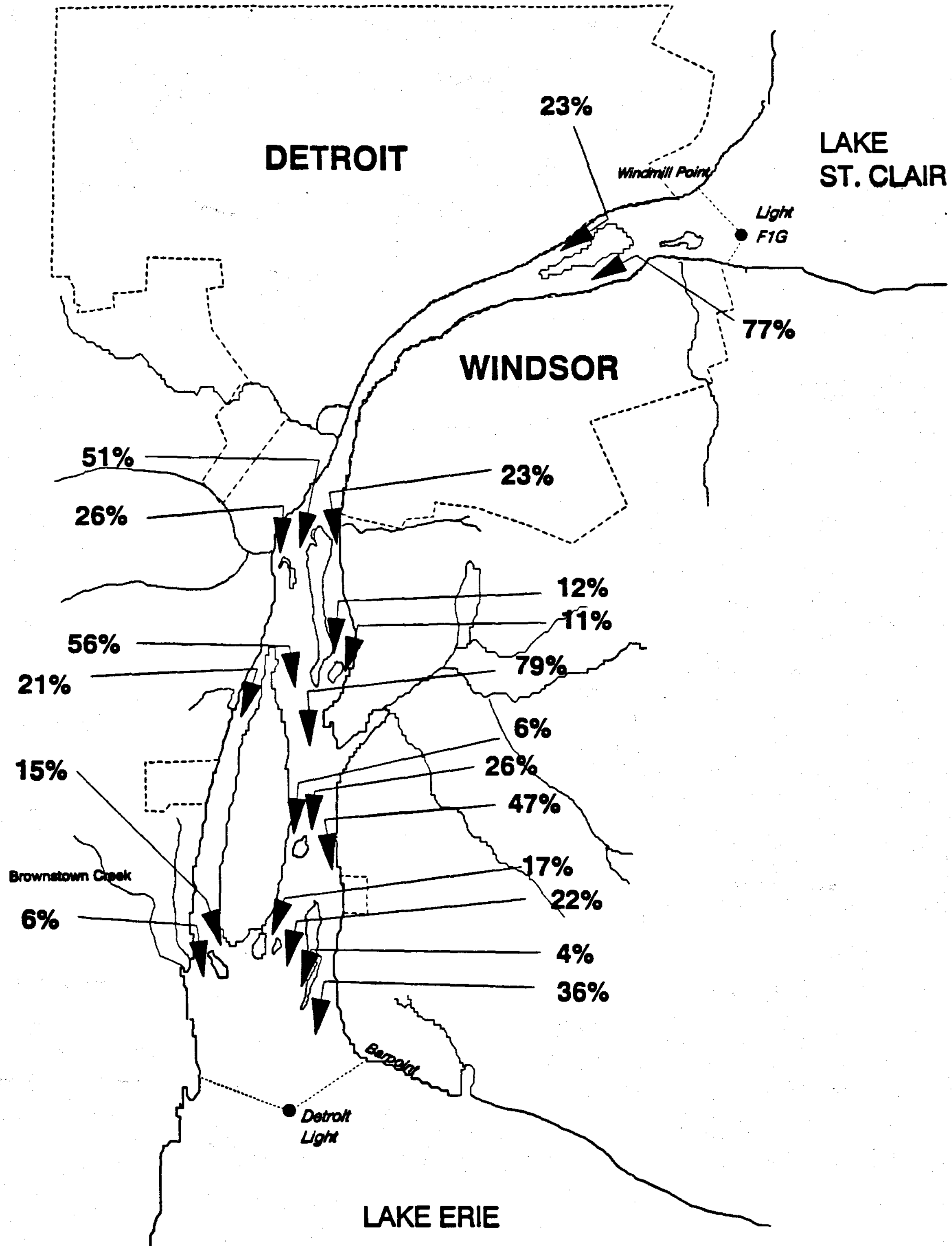


Figure 5-9. Water level guaging sites in the Detroit River.



Source: Derecki 1984.

Figure 5-10. Flow distribution in the Detroit River.

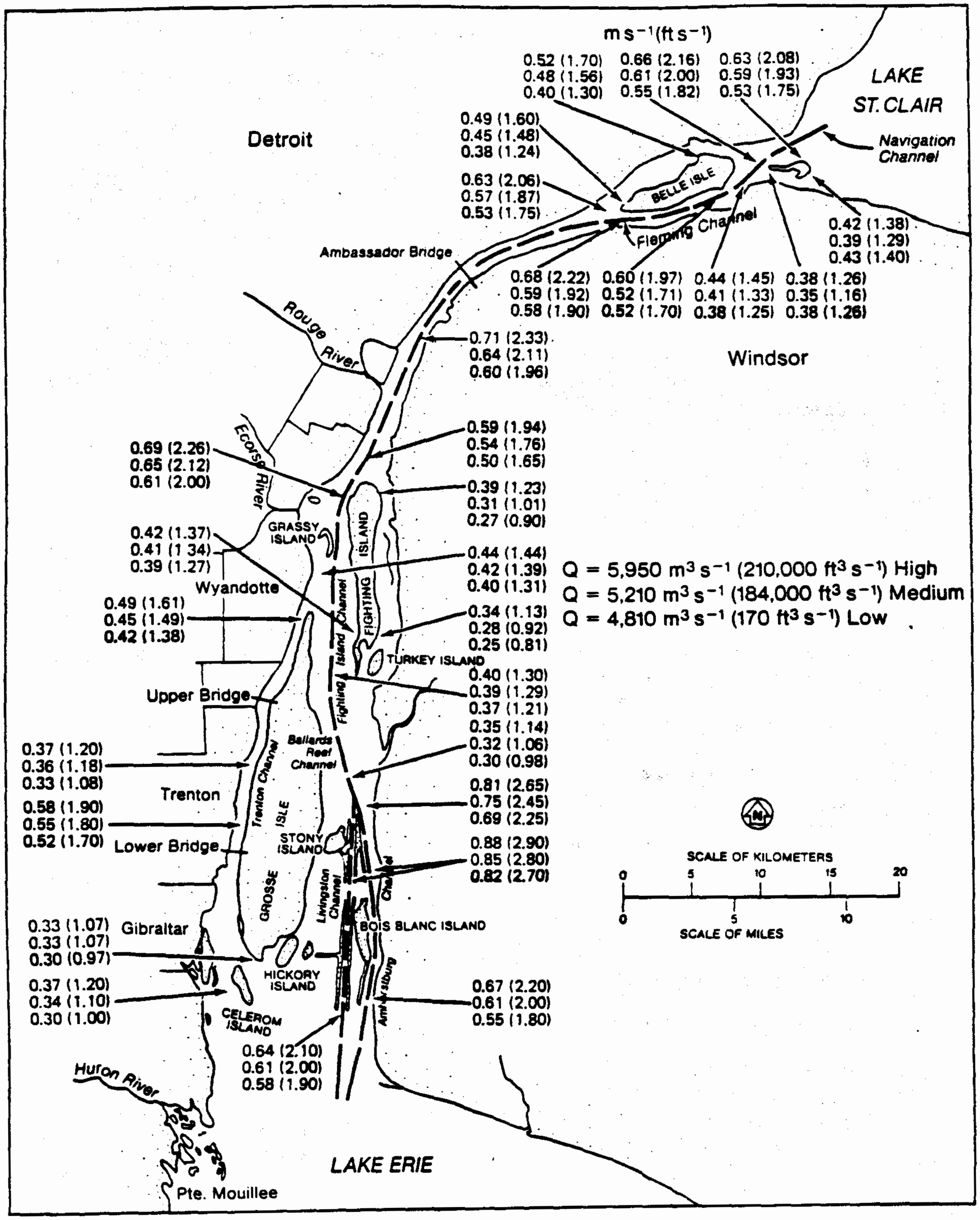


Figure 5-11. Detroit River average velocities. (Source: Derecki 1984).

velocities shown in Figure 5-11 represent the average velocity in the river cross section at a specific location for high, mean and low flows. The maximum mid-channel surface currents for normal flow conditions are approximately 1.3 times higher due to the nonlinear velocity distribution in the channel. The velocity is distributed logarithmically in the vertical direction and parabolicly in the transverse direction across the channel. Upper reach maximum mid-channel surface currents, in the vicinity of the Ambassador Bridge, reach 3 to 4 ft/sec (0.9 to 1.2 m/sec).

Average velocities in the lower river (approximately 1.5 ft/sec) are generally less than in the upper river (approximately 2 ft/sec) due to the larger cross sectional area in the lower river. However, the upper Amherstburg Channel attains a maximum surface velocity of 5 to 6 ft/sec (1.5 to 1.8 m/sec) and in the Trenton Channel velocities can exceed 4 ft/sec (1.2 m/sec).

Associated with river velocity is time of passage or the time required for water to pass through the river. The average time of passage for the entire Detroit River is 19 to 21 hours (Derecki 1984a). The average times of passage for the various Detroit River channels is provided in Appendix 5-1.

Ice Conditions:

Historically, ice formed on the Detroit River from early December to mid-March (Manny et al. 1988). Currently, large volumes of heated wastewater discharges prevent freezing in the upper river except in the broad and shallow area between Belle Isle and the U.S. shoreline. The relatively swift current in the upper channel transports ice from Lake St. Clair downstream without major problems (Derecki 1984a). Ice-induced flooding does not present problems due to the relatively steep river banks of the upper reach. Ice cover develops in expanses adjacent to the many islands in the lower reach. At times, with heavy ice movement from Lake St. Clair and blockage at the river mouth by ice from Lake Erie, the entire river may fill with ice. Flooding hazard in the lower river occurs due to the shallow river banks. Infrequently, ice jams in the lower river have interferred with shipping. Detailed information with respect to ice in the Detroit River is available from NOAA.

Mathematical Models:

Several hydraulic and water quality models have been developed to simulate Detroit River hydraulics and water quality conditions. Models are valuable tools for stimulating contaminant fate and transport and can be used to model expected system response to remedial actions and to develop emergency response actions to oil and contaminant spills. The Great Lakes Environmental Research Laboratory (GLERL) at NOAA has developed a one-dimensional unsteady flow model of the Detroit River above Wyandotte (Quinn 1976). The U.S. Corps. of Engineers also developed a one-dimensional model (Derecki 1984a). Limno-Tech, Inc. (LTI) has developed a two-dimensional finite element model for part of the river influenced by the Detroit Waste Water Treatment Plant plume (ES&E, Inc. 1987). Roginski and Kummler (1981) have developed a two-dimensional finite difference model to assess the water quality impacts from the City of Detroit's combined sewer overflows (CSOs). Several models were developed during the Upper Great Lakes Connecting Channels Study (UGLCCS). The Ontario Ministry of the Environment has developed a model of the Detroit River based on the KETOX model (R. Boone, Personal Communication). The KETOX model simulates the hydrodynamics and far-field pollutant transport for most river system with multiple inputs of contaminants (Yuen and McCorquodale 1988). The model is a two dimensional, steady-state model incorporating river segmentation to analyze complex river systems.

5.2.4 Limnology

Limnology is the study of freshwater rivers, lakes and streams, and their chemical, physical and biological relationships. The physical and chemical conditions determine the type of plant and animal communities that inhabit freshwater systems. Natural waters are limnologically classified according to ambient characteristics such as temperature, nutrient and mineral levels, sediment types and plant and animal communities. The physical characteristics of aquatic systems set the boundaries of potential uses. Biological and chemical characteristics are important to fish, wildlife, and water uses because they define the aquatic community and ecological relationships. A detailed limnological profile for the Detroit River by the U.S. Fish and Wildlife Service is available for further background reading (Manny et al. 1988). Some of the classifications and physical aspects not addressed in other RAP sections are discussed below.

The Detroit River is classified as a mesotrophic ecosystem with moderate primary and secondary productivity based on nutrient levels in the river (Manny et al. 1988). The basic plant nutrients and essential trace compounds, as well as dissolved oxygen, sodium, calcium, magnesium, and manganese are present in sufficient quantities. The serious oversupply in the past of phosphorus, chloride and ammonia has decreased substantially over the last 20 years, yielding much smaller areas having eutrophication problems. The mean annual river temperature is about 10°C (40°F) with monthly average temperatures ranging from 0.6°C to 22.2°C (33°F to 72°F) (Table 5-4) (Manny et al. 1988). These temperatures are suitable for warmwater fish year round and for coldwater fish from September to June.

Table 5-4. Average Monthly Water Temperature (°C) in the Detroit River at Belle Isle, 1973-1984. (Manny et al. 1988)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.7	0.6	1.5	5.7	11.5	17.6	21.7	22.4	19.4	13.0	7.5	2.5

5.2.5 Sediments

Agricultural and urban development in the Detroit River SAOC has historically resulted in extensive sediment loadings to the river. Surficial Detroit River sediments in the main channels are coarse materials due to the selective action of the moderate to high current velocities which carry the fine particles to the depositional zones of the Detroit River and Lake Erie. Much of the upper river sediments are consolidated glacial clay, while the lower river is bedrock, glacial boulders, or unconsolidated material. Fine-grained silts and clays are also deposited adjacent to islands or nearshore areas of the river (Figure 5-12) by various currents (Fallon and Horvath 1985). The depositional zones are important because certain waterborne contaminants absorb to particulate matter and settle in these zones. These areas are generally rich in organic matter and then become a potential, continuing source of pollutants to the water column through diffusion, resuspension, and partitioning. Particle size, an important variable in this process, is illustrated graphically in Figure 5-13 and exhibits a wide variation (Thornley and Hamdy 1984). The sediment contaminant characteristics and their importance as a source of contamination to the water column and biota are further discussed in Chapters 6 and 7.

5.2.6 Climate

Detroit River SAOC has a mid-continental climate with cold winters and relatively short, hot summers (Manny et al. 1988). Precipitation averages 30 inches (76 cm) annually including 16 inches (40 cm) of snow. Prevailing winds are from the southwest and average 10 miles/hr (16 km/hr). The presence of the Great Lakes moderates the regional weather extremes. Cold fronts and convective thunderstorms occur in the summer months. Cyclonic storms, which bring frontal precipitation, are common in winter.

The average date of first frost is October 21, and the average last freezing date is April 23 (Manny et al. 1988). The annual growing season averages 180 days. The mean monthly rainfall ranges from 1 to 3.6 inches (2.7 to 9.2 cm) with the greatest precipitation and storm intensity occurring annually between June and August (period of Record is 1960-1973) (Driscoll and Assoc. 1981). Detailed weather and climate data and statistics are available from NOAA and the U.S. Weather Service.

5.2.7 Air Quality

Air quality is an important consideration in the water quality of the Great Lakes; however, the potential impact on the Detroit River has not been documented. The Great Lakes Water Quality Agreement of 1978 (as amended) directs the U.S. and Canada to develop Lakewide Management Plans (LMPs) for each of the Great Lakes that will address air quality and its impact on water quality. The relatively small surface area of the Detroit River would suggest a negligible impact from direct deposition of air contaminants on water quality. However, water entering the head of the Detroit River has been impacted by airborne contaminants.

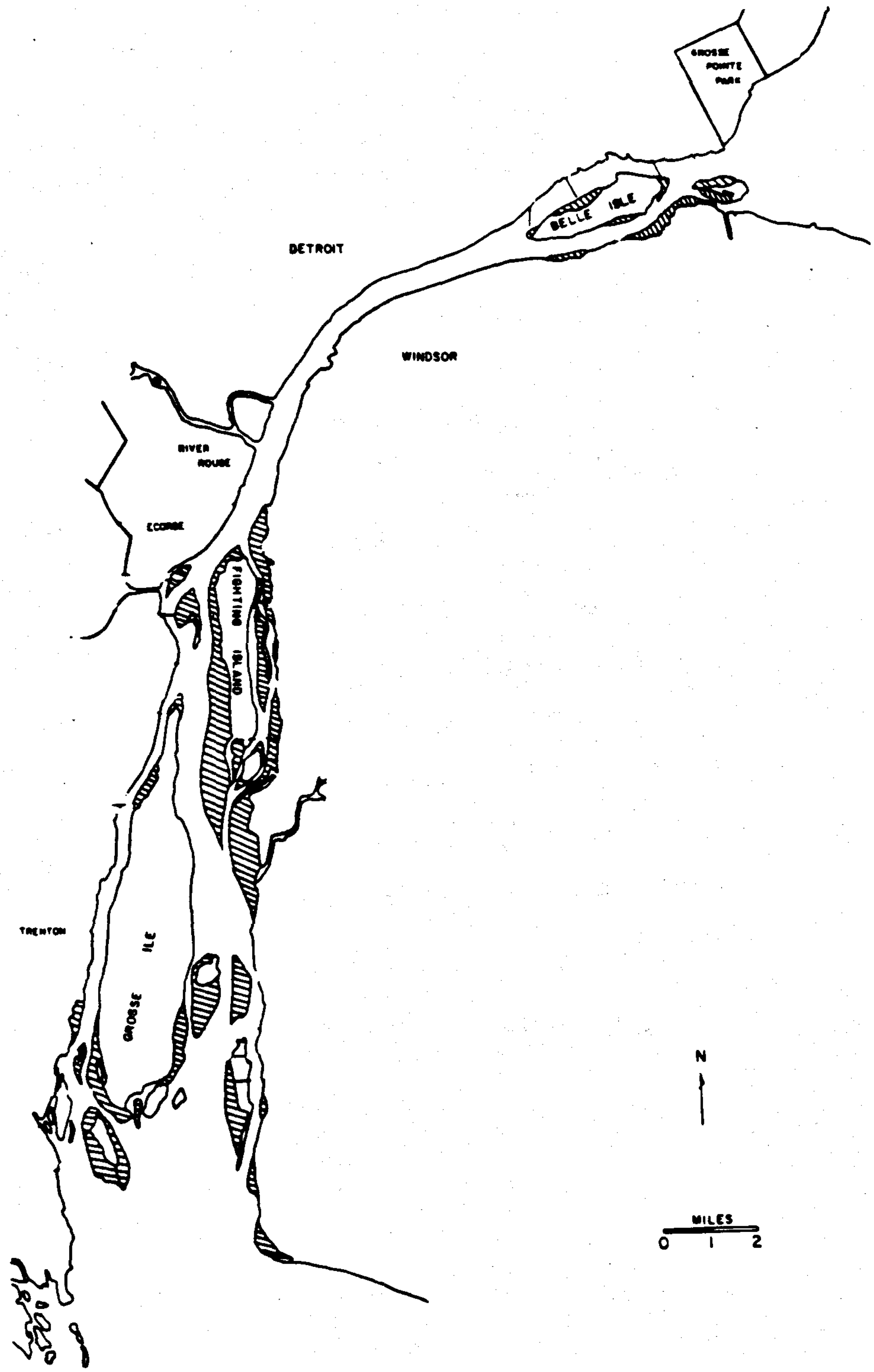


Figure 5-12. Sediment depositional zones in the Detroit River.

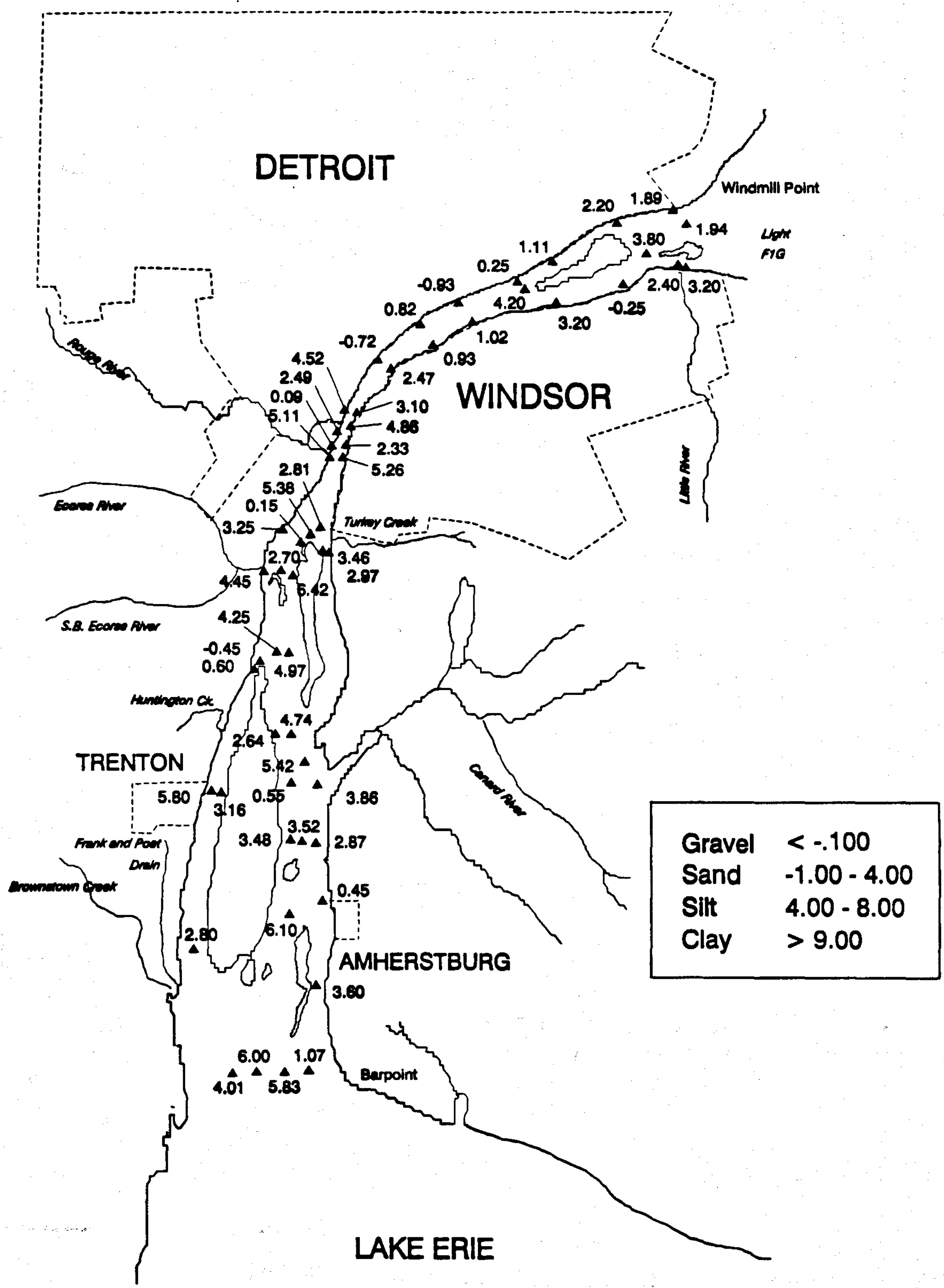


Figure 5-13. Grain size distribution of Detroit River sediments.

5.3 LAND USE

5.3.1 Local Cultural History

Prior to European settlement of the Detroit area, mature oak-hickory forests grew on the lake plains and elm-ash woodlands colonized the "black swamp" soils (Manny et al. 1988). Along the shorelines, a fring of emergent vegetation grew in water one to six feet deep (0.3 - 5.4 m). Inland of this emergent riverine vegetation was a strip of coastal marsh that extended over 1 km in width, especially near the mouth of streams such as the Rouge River. According to the Comstock surveys, the Rouge River was 4 to 6 m deep with sandy bottom sediments (Manny et al. 1988). North American Indians were the first to use the natural resources of the Detroit River ecosystem. Although Woodland Indians from about 400 A.D. to French contact in the early 1600's) had a subsistance economy which included agriculture, the natives who survived European-induced diseases were integrated into the fur trade economy with dependance on European goods and settlements. The wild rice that grew at the mouth of the Canard and Detroit Rivers provided a source of trade for the Huron-Wyandotte Indians, who settled in the Detroit River area in the mid-1600s.

The first European settlement was founded at Detroit by the French as a fur trading and military post in 1726. When the area passed to the British in 1765, the economy was unchanged. However, not long after the present international boundary was established in 1783, European agricultural settlement began in earnest, destroying the fur trade and altering the landscape.

After 1910, the population growth and land use intensity accelerated as industrial development took place in Wayne County. The steel industry, supportive of the expanding auto, chemical and refining industries in Detroit, River Rouge, Ecorse, Trenton and Wyandotte, dominated the metropolitan area by 1930. Stimulated by automobile production and later by military production for World War II, industrial growth spread into the downriver area and population density greatly increased. By 1950, the 10 km stretch between Zug Island and Wyandotte was densely packed with large steel, chemical and other manufacturing plants. In the last decade, portions of this have been raised, but many of the former industrial waste disposal sites, such as those on Grosse Ile and Fighting Island, remain.

5.3.2 Land Use on the Michigan Side

The Great Lakes Basin Framework (Great Lakes Basin Commission 1975) analyzed land use in the Lake Erie Basin in terms of sub-areas. Planning Sub-area 4.1 includes 4,062,100 acres in Sanilac, St. Clair, Macomb, Oakland, Livingston, Washtenaw, Wayne, Monroe and Lenawee Counties which includes the Detroit River SAOC. The land use of Sub-area 4.1 is divided with 19% urban build-up, 56% crop land, 3% pasture-range, 17% forest, and 6% other (Table 5-5).

The Michigan Detroit River shoreline use is dominated by heavy industry, particularly steel and automobile related (Table 5-6). Commercial developments are concentrated along Detroit's waterfront with 29.2 miles of the remaining shoreland privately owned. Approximately 25.4 miles of the U.S. side of the river have been artificially filled and 5.6 miles remain as wetlands.

Fragile resource lands are areas with unusual sensitivity to human activity because their biotic and abiotic components are in a delicately balanced dynamic equilibrium. Detroit River shoreline fragile lands include marshes located in the lowland areas of the lower Detroit River.

5.3.3 Sewered Areas in the Michigan SAOC

Most of the Michigan SAOC is sewered. Figure 5-14 (SEMCOG 1987) indicates existing sewer service in 1987. Maps indicating existing sewer service areas and areas of potential service by the year 2000 are used in the review of projects requesting state and federal funding in Southeast Michigan.

5.3.4 Population Estimates for the Michigan SAOC

The exact population for the area strictly within the Michigan SAOC boundaries has not been determined, but it is approximately 3.5 million. Wayne County comprises the largest portion of the SAOC and has approximately 2,200,000 people (U.S. Census Bureau 1984). The remaining counties partially in the SAOC have populations of approximately 2.3 million. The highest densities are in or immediately surrounding the City of Detroit (Figure 5-15).

5.3.5 Land Use in the Ontario SAOC

Land use information for the area strictly within the Ontario SAOC has not been developed but Essex County is the only Ontario SAOC county, and therefore county information should reflect SAOC land uses. Ninety percent of the 1828 square kilometers in Essex County is agricultural or undeveloped, seven percent is residential and the remaining three percent is commercial, industrial, or recreational (Table 5-7) (Essex Region Conservation Authority 1987). Agricultural methods and soil conservation practices are important in the Ontario SAOC because of the predominance of agriculture. In Essex County 87% of the farm enterprises are engaged in cash crop farming; 12% in corn, 25% in wheat, and 50% in beans (Wall, Vaughn and Marsh 1987). Seventy percent of the farms use conventional tillage and 21% employ some type of conservation tillage.

The commercial, industrial and residential land is mostly in or near the cities along the Detroit River shoreline. Windsor is the largest city in the SAOC and other areas include the towns of Tecumseh, and Amherstburg and the Townships of Anderdon, Malden, and Sandwich West. The shoreline of the Ontario SAOC is estimated to be 31% residential, 33% industrial and commercial, 22% recreational, and 14% agricultural or

Table 5-5. Land use distribution in Wayne County Michigan (LTI, Inc. 1988)

Land Use Type	Area (Acres)		Percent of Total Area	
Agriculture	36,000		9.0	
Active Cultivation		25,000		6.2
Idle Cultivation		5,500		1.4
Woodland		2,100		0.5
Pastureland		700		0.2
Other		2,700		0.7
Undeveloped	83,000		21.0	
Recreation	20,000		5.1	
Residential	129,000		32.4	
Commercial	15,000		3.8	
Industrial	24,000		6.1	
Transportation, Education	91,000		22.6	
TOTAL	398,000		100.0	

Table 5-6. Detroit River shoreline use in the Michigan AOC.

Land Use Type	Miles of Shoreline	Percent
Residential	5.1	16.5
Industrial and Commercial	19.0	61.2
Public Lands and Building	0.0	0.0
Agricultural or Undeveloped	5.1	16.5
Recreation	1.8	5.8
Total Shore Miles	31.0	100.0

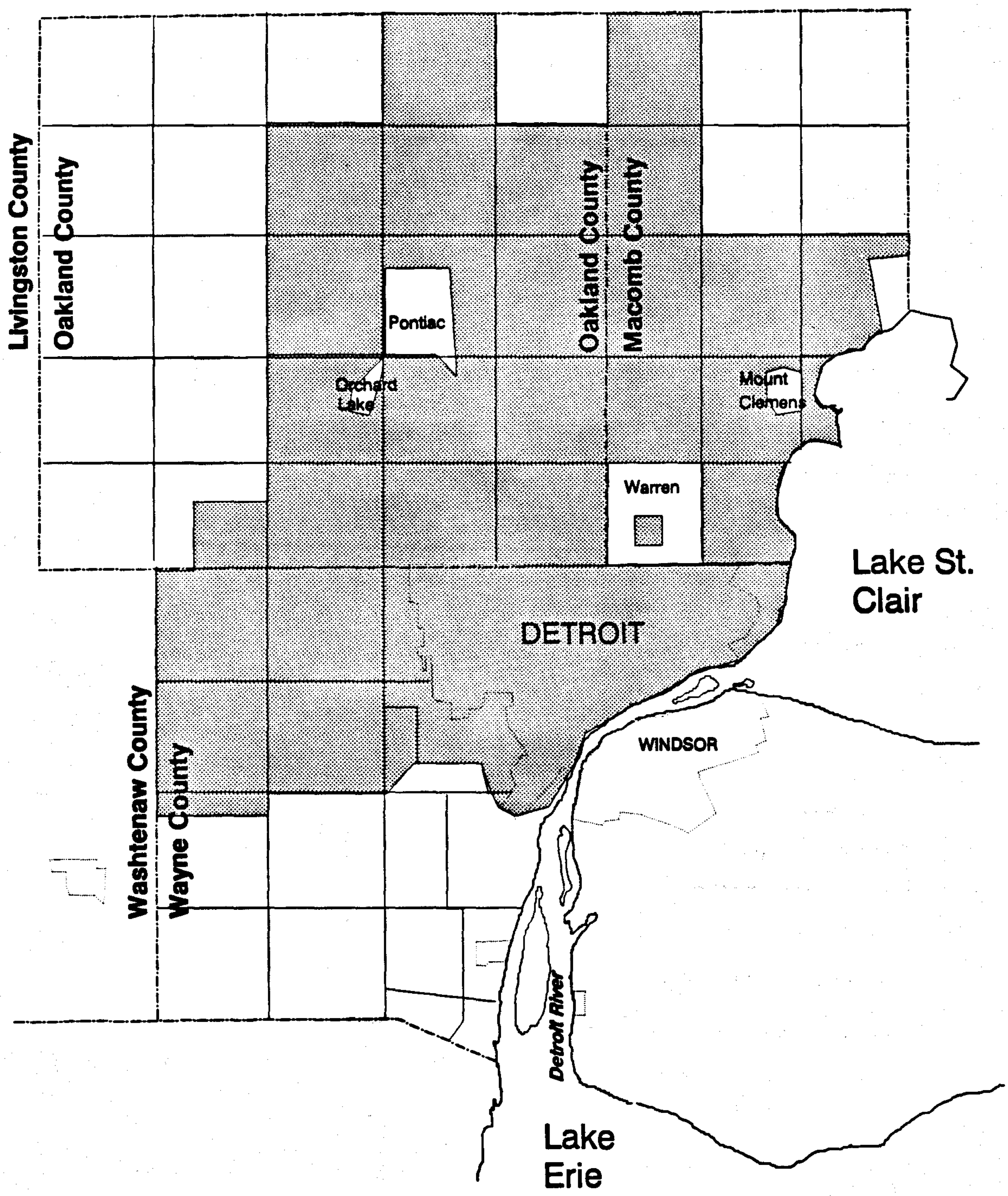


Figure 5-14. Generalized sewer service area map for Southeast Michigan. Source: SEMCOG 1987.

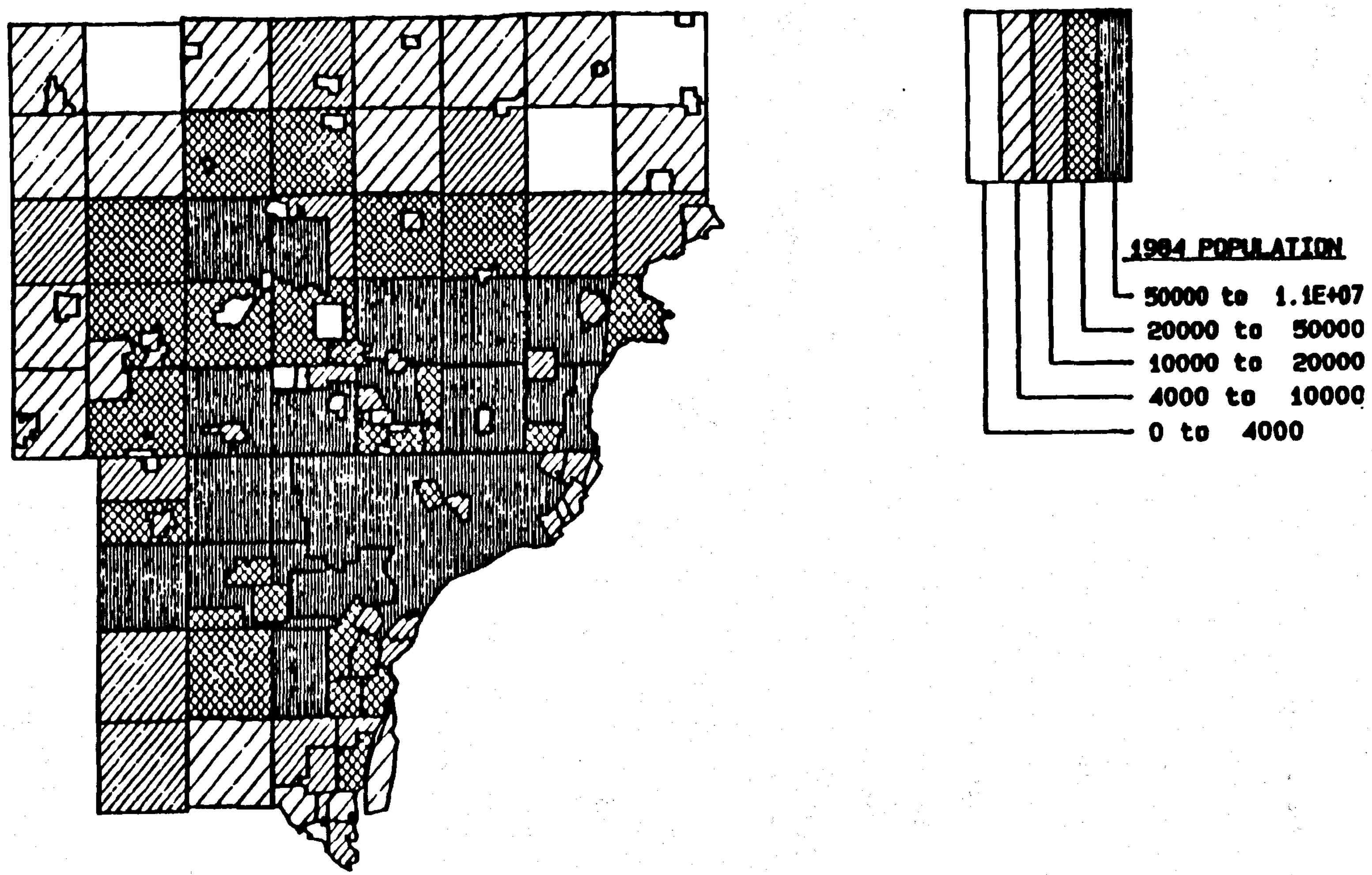


Figure 5-15. Population distribution on the Michigan side of the AOC.

Table 5-7. Land use distribution in Essex County, Ontario. (Essex Region Conservation Authority 1987)

Type of Land	Area (sq. km)	Percent of Total Area
Agricultural and Undeveloped	1647	90
Residential	127	7
Commercial	18	1
Industrial	18	1
Recreation	18	1
Total	1828	100

undeveloped (classified based on 1974 aerial photographs) (MacLaren 1978) (Table 5-8, Figure 5-16). The areas of marsh shoreline are primarily between the mouths of the Canard River and Turkey Creek. Outside this area, the shoreline is largely artificial in nature. Occasional stretches of sand beach or natural shoreline occur, especially near Bell's Corner and in Tecumseh. The islands also consist of largely artificial shorelines.

Single family residential development constitutes the major land use along the Windsor waterfront as is the case in Malden Township, the Town of Amherstburg, the Town of Tecumseh and the Village of St. Clair Beach. Other uses include a few commercial establishments, some government property used for customs, an Indian cemetary and a Royal Canadian Mounted Police detachment. Industry occupied only twenty-eight locations in 1978, mostly between Turkey Creek and the Ambassador Bridge. Waterfront parks, natural areas and open spaces are listed in Table 5-9.

5.3.6 Sewered Areas in the Ontario SAOC

Sewered areas in the Ontario SAOC are confined principally to the city limits of Windsor, Tecumseh, St. Clair Beach, Amherstburg and the northern part of the Township of Sandwich West.

5.3.7 Population Estimates for Essex County, Ontario

The 1976 assessed population of Essex County (including Windsor) was approximately 310,000. The nine municipalities of the Windsor Sub-Region had a 1976 assessed population of 83.7% of the Essex county population. The projected population for Essex County was 400,000 in 1982, yielding 340,000 for the sub-region.

5.4 WATER USES

The Detroit River is used extensively for a variety of activities and need including:

- agriculture;
- interlake commercial navigation route;
- industrial water supply;
- drinking water supply for the Detroit and Windsor Metropolitan areas;
- indigenous aquatic life, including warm- and cold-water fish, and wildlife;
- recreational activities (fishing, hunting, boating, and swimming);
- receiving water for treated industrial and municipal wastewater; and
- receiving water for storm runoff and combined sewer overflows.

Each use is important but may conflict with other uses since some are dependent on a good water quality while others may degrade river water quality. The Michigan Water Quality Standards and Ontario Provincial Water Quality Objectives specifically protect the water for these uses (see Chapter 4, Regulatory Programs). The Great Lakes Water Quality Agreement identifies fourteen beneficial uses to be supported in the Great Lakes Basin (see Chapter 2, Introduction). Because the river can

Table 5-8. Detroit River shoreline uses on the Ontario side. (Estimated from MacLaren 1978)

Type of Use	Kilometers of Shoreline	Percent of Total
Residential	15.6	31
Industrial and Commercial	16.6	33
Recreation	11.3	22
Agriculture or Undeveloped	7.3	14
Total	50.8	100

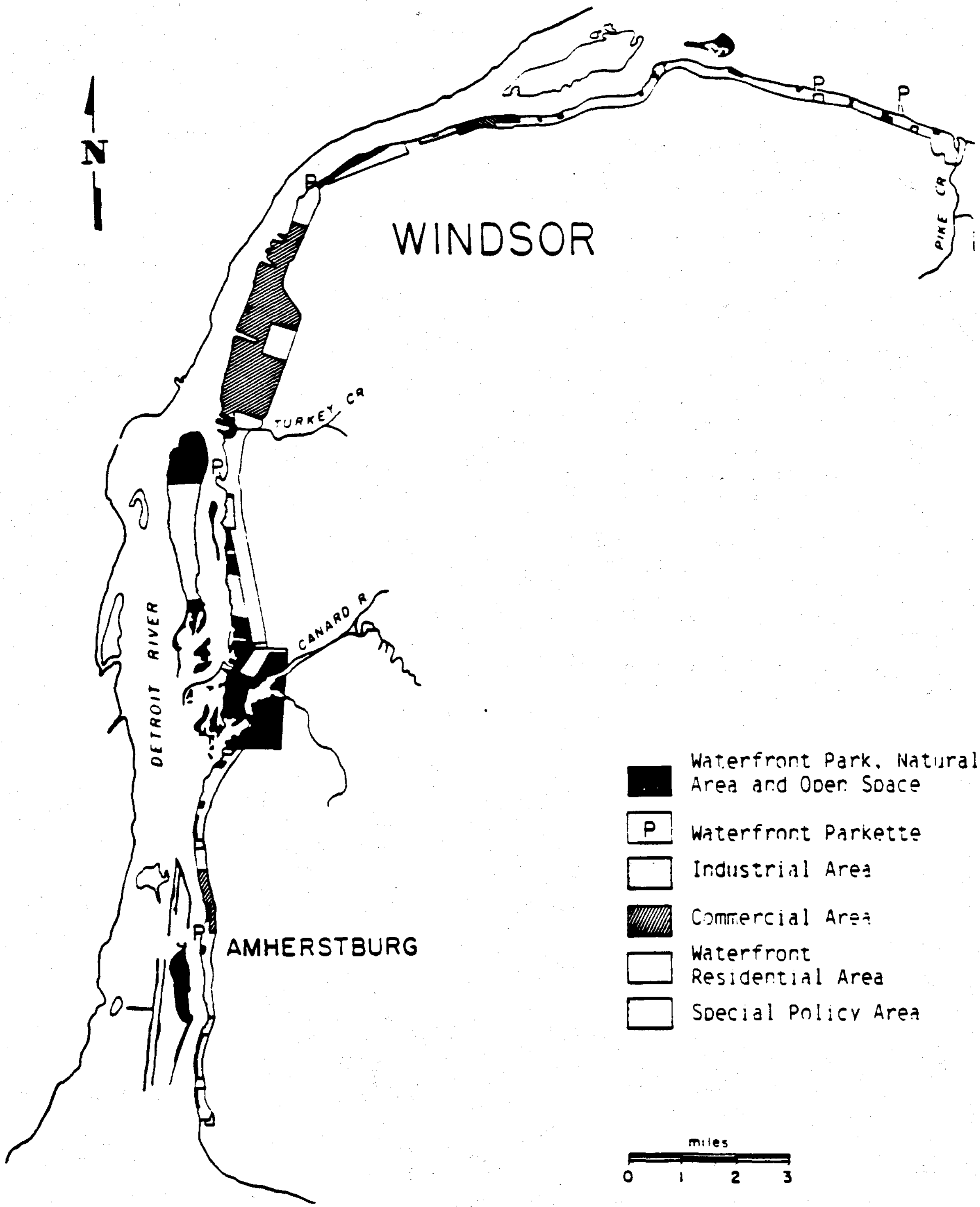


Figure 5-16. Detroit River shoreline use on the Ontario side.

Table 5-9. Waterfront parks, natural areas, and open space on the Ontario shoreline.

Name	Classification	Significance
Walden Waterfront	open space	regional
Bois Blanc Island	waterfront park	regional
King's Naval Yard	waterfront park	regional
Fort Malden	waterfront park	regional
Calvert Park*	waterfront park	regional
Crystal Bay Island	open space	regional
Anderdon Waterfront**	open space	regional
Indian Cemetary	waterfront park	regional
Canard River Park*	natural area	regional
Canard River Marshes**	natural area	local***
La Salle Mariners**	natural area	local
Islandview**	natural area	local
Grassy Island	open space	local
La Salle Arena Park**	waterfront park	local
La Salle Park*	waterfront park	regional
Fighting Island Marsh	natural area	regional
Turkey Creek Mouth**	natural area	regional
Brighton Beach**	waterfront park	regional
Sandwich Waterfront Park**	waterfront park	regional
McKee Park	waterfront park	local
Assumption-Centennial Park	waterfront park	regional
Caron Avenue Park**	waterfront park	local
Dieppe Gardens-DNR Park	waterfront park	regional
Great Western Park	open space	local
Alexander Park	waterfront park	regional
Goose Bay	open space	local
Coventry Gardens-Reaume Park	waterfront park	regional
Lt. Rose Beach	waterfront park	local
Bridges Bay	open space	local
Kiwanis Park	open space	local
Lakeview Park**	waterfront park	regional
Peche Island	natural area	regional
Sand Point-Step 26 Beach	waterfront park	regional
Rendevous Park**	waterfront park	regional
Tecumseh Waterfront Park	waterfront park	regional
Lakewood Park**	waterfront park	regional
Beach Grove	open space	regional
Pike Creek Park**	waterfront park	regional

* Denotes an enlargement to an existing waterfront park, natural area, or area of open space.
** Denotes a new waterfront park, natural area, or area of public open space.
*** Wetland evaluations of Canard River Marshes conducted by Ontario Ministry of Natural Resources indicate the wetlands are of Provincial significance. As well, the Detroit River marsh complex is not noted in this table but is also an important wetland area along the river of Provincial significance. More data concerning these wetland areas is available in Section 6.4.2. Source: J. Brisbane, OMNR 1991.
Source: LTI, Inc. 1988.

accommodate only a finite variety and magnitude of uses, thoughtful land and river management is necessary to maintain or enhance the natural habitat and serve the industrial, municipal and recreational needs of the community.

This section briefly summarizes present Detroit River water uses. A more detailed description of the fish and wildlife habitat is found in Chapter 6. A description of the impaired uses of the aquatic ecosystem is given in Chapter 7, Problem Definition.

5.4.1 Agriculture

As indicated previously, approximately 15% of the Detroit River shoreline is classified as "agricultural or undeveloped". Wayne County and Essex County data indicate that 30% and 90% respectively (a total of 442,974 acres or 1793 km^2) of land use is similarly classified. Quantitative data regarding surface water use for agricultural needs are not available, however existing qualitative information indicates that agricultural use of the Detroit River or its tributaries is minimal. This is primarily due to the low elevation of the agricultural areas, and the relatively high costs associated with irrigation.

5.4.2 Navigation

The Detroit River is an integral part of the Great Lakes-St. Lawrence Seaway and Detroit is the busiest port in the Great Lakes (Manny et al. 1988).

Commercial navigation is an economically vital use of the Detroit River. For example, the economic benefits of the Port of Detroit are well over a billion dollars and account for nearly 50,000 Michigan jobs (LTI, Inc. 1988).

Over the past 15 years (1973 to 1988) commercial navigation in the Great Lakes-St. Lawrence Seaway has declined, largely due to economic conditions and a drop in demand for intra-lake shipments. In 1983, Detroit River freight traffic (9,334 vessel transits or 60.8 million metric tons of freight) was about half that of the traffic recorded in 1972 (18,268 transits or about 119 million metric tons). Two-thirds of the commercial river traffic is not destined for Detroit River ports, using the Detroit River as a passage to other Great Lakes ports. One-third of the freight movement is generated out of Detroit River ports, including the Port of Detroit, which is a major center for handling and distributing cargo and freight. Iron ore, coal, lignite and limestone accounted for 91 percent of all domestic traffic and 77 percent of total port traffic in 1973 (Giffels et al. 1978). Other cargo includes gypsum, wheat, oil, gasoline and asphalt. Ontario ports are used primarily for rail car ferries.

The navigation routes (discussed previously in Section 5.2.3.1, Figure 5-8) consist of main, auxiliary, and side channels. Navigation channels are dredged to a depth of 27 ft (8.23 m) below low water datum. Commercial harbors and turning basins, as well as water level and cross channel current control structures, complete the Detroit River navigation system.

5.4.3 Water Supply

A major use of the Detroit River is as an industrial and drinking water supply. The river supplies approximately 25 industries with process or cooling water. There are five municipal drinking water intakes in the Detroit River serving approximately 4.1 million people in nearly 100 communities in the SAOC (Figure 5-17). Detroit River SAOC drinking water intake and distribution information is summarized in Table 5-10.

The largest water supply is the Detroit Water and Sewerage Department (DWSD) which supplies 3.8 million people in 117 communities with complete or standby service. Detroit operates four water treatment plants (WTPs) for the two Detroit River drinking water intakes at Belle Isle and Fighting Island. Another plant treats water drawn from the Lake Huron intake. Seventy percent of Detroit's average water demand is drawn from the intake near Belle Isle. Thirty percent of Detroit's drinking water is from the other two intakes (15% each). The plants have a combined capacity of approximately 1600 MGD and treat raw water using coagulation, flocculation, sedimentation, sand filtration, disinfection, and occasionally carbon feed for taste and odor control (M. Kovach, Personal Communication).

Other water treatment plants using the standard treatment processes listed above include the Windsor, Ontario, the Wyandotte, Michigan and the Amherstburg and Tecumseh, Ontario WTPs.

5.4.4 Fish

The Detroit River presently supports over sixty species of resident and migratory fish which contributes valuable recreational and social benefits to the area. While the majority of the species found on the river are warmwater species, the river can support a coldwater fishery between September and June.

Manny et al. (1988) and Spitler (Personal Communication, 1991) have documented forty-two species of fish that spawn in the river (Table 5-11). Some specific spawning and nursery areas have been highlighted in Figures 5-18 and 6-42, however, virtually all of the river provides some degree of fish habitat. The most important species presently using the river for spawning are rainbow smelt, yellow perch, gizzard shad and white bass (Muth et al. 1986).

Although the river is known to support a strong sport fishery, no population estimates are available for the various fish species within the AOC.

The Detroit River, besides harboring year-round residents, is a vital migration route for valuable fish populations as well. For example, over 50% of all walleye tag returns from fish tagged near Monroe, Michigan (Lake Erie) were harvested by anglers in the Lake St. Clair and Detroit River system, while many walleyes tagged in Anchor Bay (Lake St. Clair) were recaptured by anglers in Lake Erie. Likewise, numerous smallmouth bass tagged in southern Lake St. Clair showed up in angler creels in the upper Detroit River (Haas et al. 1985).

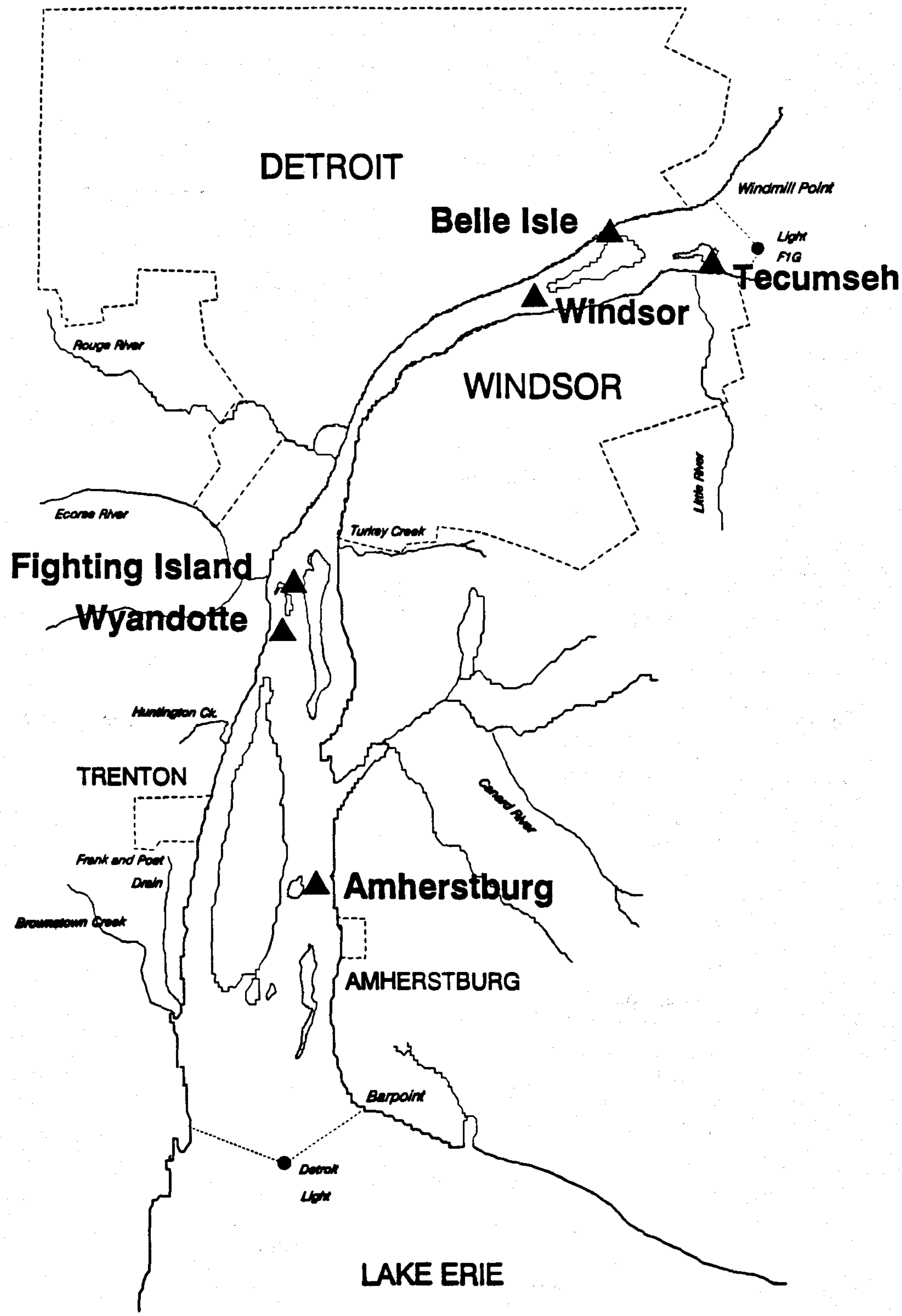


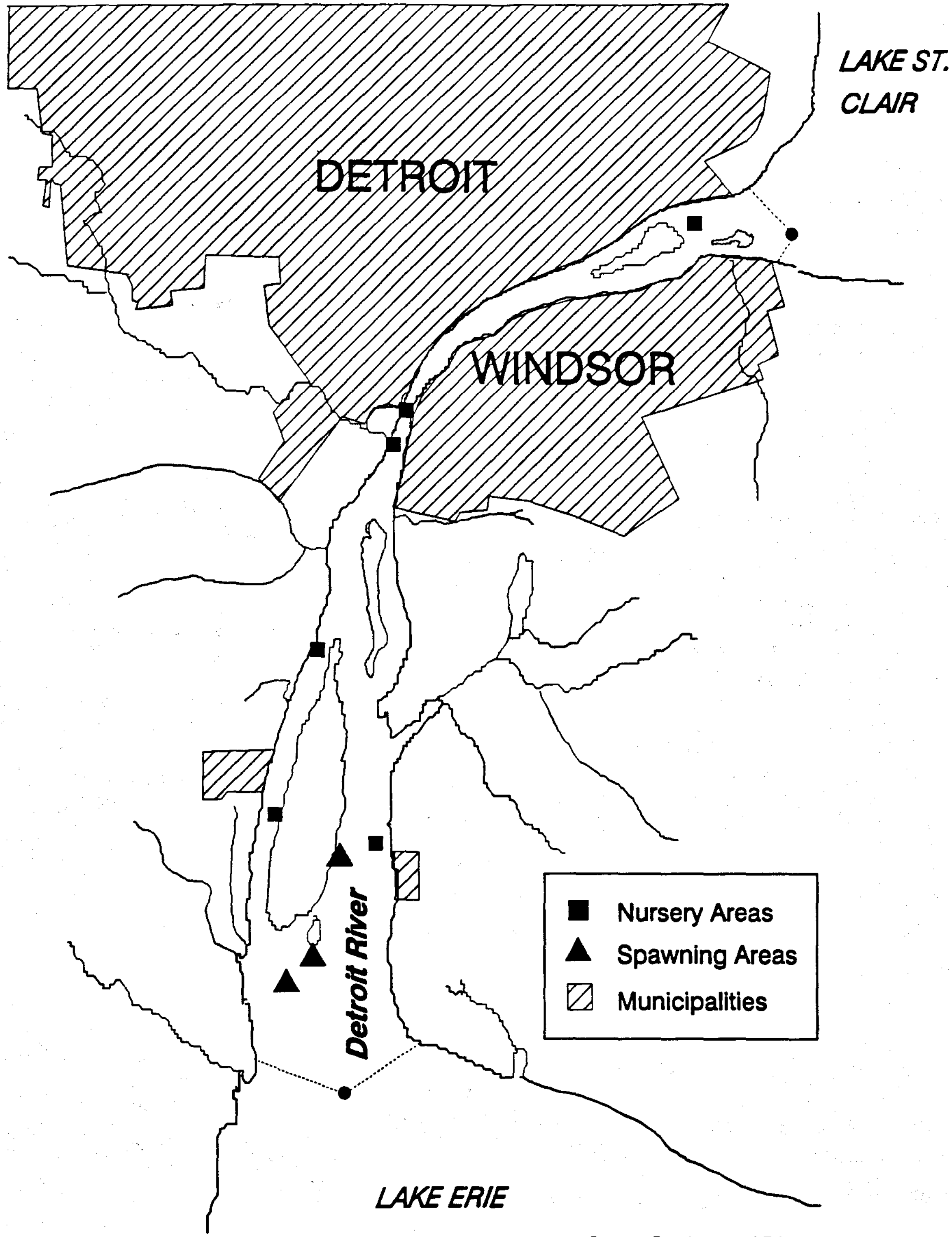
Figure 5-17. Location of drinking water intakes in the Detroit River.

Table 5-10. Summary of the drinking water intakes and distribution for the Detroit River AOC.

Municipality	Intake Location	Population Served	Percent Served by Intake	Number of Plants/ Capacity
Detroit, MI	1) Belle Isle	2.6 million	70	3/1160 MGD
	2) Fighting Island	0.6 million	15	1/210 MGD
	3) Lake Huron	0.6 million	15	1/240 MGD
Windsor, ONT	Belle Isle	0.25 million	100	1/40 MGD
Wyandotte, MI	N. of Grosse Ile, Point Hennepin	34 thousand	100	1/18 MGD
Amherstburg, ONT	Amherstburg Channel	9 thousand	100	1/4 MGD
Tecumseh, ONT	Windsor	10 thousand	100	1/4 MGD

Table 5-11. Fishes that spawn in the Detroit River (Manny et al. 1988, updated by R. Spitler, Personal communication, 1991).

Lake Sturgeon	Trout-perch
Spotted gar	Burbot
Longnose gar	Brook silverside
Bowfin	White bass
Alewife	Rock bass
Gizzard shad	Green sunfish
Sea lamprey	Pumpkinseed
Lake whitefish	Bluegill
Silver lamprey	Smallmouth bass
Rainbow smelt	Largemouth bass
Northern pike	Black crappie
Muskellunge	White crappie
Goldfish	Johnny darter
Carp	Yellow Perch
Emerald shiner	Log perch
Spottail shiner	Silver chub
White sucker	Walleye
Northern hog sucker	Freshwater drum
Channel catfish	Fourhorn sculpin
Stonecat	Mooneye
White perch	Orange spotted sunfish



Source: Goodyear and Edsall et al. 1982.

Figure 5-18. Detroit River nursery and spawning areas.

5.4.5 Wildlife

The river habitat is important to many resident and migratory birds. Stony, Celeron, Grassy, and Mud Islands provide shore-bird habitat. Stony Island has a heron rookery and the southern portion of Grassy Island has a rookery for gulls and terns. The lower Detroit River encompasses the Wyandotte National Wildlife Refuse, and is a gathering site for many migratory birds. According to Detroit Audobon Society surveys, 305 species of birds have been observed and approximately 150 species breed in the Detroit-Windsor area (Giffels et al. 1978).

Birds inhabiting areas near the river include ducks, herring gulls, ring-billed gulls, great blue herons, egrets, killdeer, and spotted sandpipers. Important species of nesting ducks in the Detroit River wetlands include mallards, blue-winged teal, blackducks and, if nesting boxes are provided, wood ducks. Young ducklings are commonly found along the southern shores of Grosse Ile and other Detroit River islands. At least 3 million waterfowl migrate annually through the Great Lakes region, which is at the intersection of the Atlantic and Mississippi flyways. An estimated 700,000 diving ducks, 500,000 dabbling ducks, and 250,000 Canada geese migrate across Michigan each fall (Manny et al. 1988). During autumn migration, an average of 115,000 ducks and as many as 352,000 have been counted on the Detroit River (Giffels et al. 1978). Fourteen percent (18,000) of the total population of whistling swans in eastern North America stop along the river in the spring. The ice-free waters in the upper river encourage large numbers of migratory waterfowl, especially dabbling and diving ducks, to winter in the AOC.

During spring and fall migration seasons thousands of mallards, blackducks, mergansers, redheads, canvasbacks, goldeneyes, scup, and other ducks are attracted by the shoreline wetlands, beds of wild celery, and other aquatic vegetation in the littoral waters around Belle Isle, Celeron, Sugar and Grassy Islands and Grosse Ile. Near the mouth of the river, in the vicinity of Celeron Island, the annual duck-use days average 13,655,000 and swan-use days average 230,000 totaling 13,885,000 waterfowl-use days per year (Giffels et al. 1978).

5.4.6 Recreation

The Detroit River is an important recreational resource used for total body contact and partial body contact recreation. Total body contact include scuba diving, water skiing, and swimming. These activities generally take place at the foot of Grosse Ile between Sugar Island and the Livingstone Channel (D. Tuomari, Personal Communication). Partial contact recreational activities include fishing, boating, wading, waterfowl viewing and duck hunting.

5.4.6.1 Fishing

There is presently no commercial food fishery in the Detroit River, however, a significant bait fishery exists on the Ontario side. Approximately 600,000 bait fish per year are harvested from the rivershed and sold to bait wholesalers and retailers (J. Brisbane, Personal Communication).

Detroit River sport fishing is a very important resource which is presently thriving. In Michigan, the recreational fishery value of the St. Clair-Detroit River system (1975-1977) exceeded 10 million dollars annually (Edsall, Manny and Raphael 1988). Total catch in Canadian waters in 1979 consisted of 18 species totaling 150,000 fish (Sztramko 1980). The most common fish caught by anglers in 1979 were white bass (57% of the total), walleye (15%), freshwater drum (12%), yellow perch (9%), and rock bass (5%). Based on a 1983 survey, it was estimated that 1,055,000 fish were caught in the lower river and 151,000 in the upper river (Haas et al. 1985). In this survey white bass was again the single most abundant fish caught in the Detroit River followed by yellow perch and walleye. Detroit River anglers caught an estimated average of 1.82 fish per hour in the lower river and 0.8 fish per hour in the upper river. Lake St. Clair yielded an estimated 0.5 fish per hour. These numbers indicate that anglers fishing on the Detroit River have a higher success rate than those on the St. Clair River and Lake St. Clair.

A 1983-1985 MDNR survey of the recreational fishery in Michigan waters of the St. Clair-Detroit River system showed an average annual fishing effort of 4,172,000 angler hours and an average combined catch by boat, shore, and ice anglers of 2,811,000 fish. Table 5-12 summarizes the percent recreational fishing effort expended by boat, shore, and ice anglers and the respective percent total catch. Detroit River anglers expended an average 600,000 hours of fishing effort and caught an average of 570,000 fish (Edsall, Manny and Raphael 1988).

5.4.6.2 Duck Hunting

Duck hunting in the AOC occurs primarily near the river mouth. It was estimated that over 61,000 person days are spent annually duck hunting in the vicinity of the Detroit River (U.S. Fish and Wildlife Service 1987).

5.4.6.3 Swimming

Swimming is a total body contact recreational activity. There is only one beach on the Michigan side of the AOC (Belle Isle), but swimming or wading may also occur in the marinas and at some shoreline parks.

There are two beaches within the AOC; Sand Point Beach and Stop 26, both located just upstream from the mouth of the Little River in Ontario. Two offshore river areas used extensively for swimming, windsurfing and waterskiing are Crystal Bay (located between Stony and Bois Blanc Islands) and an area near Boblo Amusement Park on Bois Blanc Island (D. Tumouri, Personal Communication).

5.4.6.4 Boating

The Detroit River is a major recreational boating area supporting approximately 75 facilities allowing river access along the entire length. The boats moored at these facilities include fishing boats, sailboats, yachts, and power cruisers. Sixty-two marinas on the Detroit River are used by Michigan boaters and twelve marinas cater to boaters in Ontario (Appendix 5-2). Approximately 16% of the Detroit River marinas are commercial and 40% are private. The total slip capacity of the Michigan Detroit River marinas exceeds 5500 (Michigan Department of

Table 5-12. Detroit River recreational fishing effort and total catch. (MDNR Survey 1983-1985)

	Angler Hours	Percent Effort Expended	Number Caught	Percent Catch
Boat Anglers	390,000	65	370,000	65
Shore Anglers	120,000	20	114,000	20
Ice Anglers	90,000	15	86,000	15
Total	600,000	100	570,000	100

Commerce 1976). The Ontario marinas have a capacity of 1300 boats (OME 1987 unpublished notes). The Michigan marinas are primarily concentrated at head of the river near Belle Isle, the confluence with the Ecorse river, the lower end of Grosse Ile and near Gibraltar.

5.4.7 Receiving Water

5.4.7.1 Municipal Wastewater Treatment Plants

Municipalities in the SAOC collect and treat industrial and domestic wastewater and discharge the treated wastewater to the Detroit River. There are ten municipal facilities discharging directly to the river, the largest of which is the Detroit Water and Sewerage Department (DWSD). The DWSD treats and discharges up to a billion gallons of wastewater per day with an average discharge of 715 MGD. Other Michigan wastewater treatment plants include Wayne County Wyandotte (76 MGD), Trenton (6 MGD), Grosse Ile (2 MGD) and Wayne County Huron Valley (6.8 MGD). Ontario municipal facilities include Windsor Little River (8 MGD), Windsor Westerly (35 MGD), Essex Southwest (seasonal lagoon), Township of Anderdon (seasonal lagoon), and Amherstburg (1.5 MGD) (A.O. Stephens, Personal Communication).

5.4.7.2 Industrial Wastewater Discharge

There are 30 industries and power plants that discharge cooling water and/or treated process water directly to the river. Over the past ten years, twenty-three Michigan plant closings or diversions of industrial wastes to municipal plants have reduced the number of direct industrial discharges to the river (MDNR 1977 and MDNR 1987). The principle industrial discharge area lies on the U.S. side and extends from Zug Island southeast to Gibraltar in the Trenton Channel. Major industries include steel mills, petroleum refineries, electrical power generating plants, and manufacturers of chemicals, automotive parts, rubber products, salt, and plastics. There are an additional 46 permitted industrial facilities discharging to Michigan tributaries which flow into the Detroit River outside the AOC. Specific details regarding the industrial discharges are provided in Chapter 7 of this document.

5.4.7.3 Runoff and CSOs

The Detroit River also receives runoff through the eight tributaries and the storm sewer system. The sewer systems in Detroit and Windsor convey combined sanitary, industrial and storm sewage. To protect the WWTPs from excessive hydraulic loadings during storms, the excess combined sanitary, industrial and storm water is discharged through combined sewer overflows (CSOs) directly to the Detroit River or its tributaries. There are approximately seventy-six combined sewer overflows that discharge directly to the Detroit River, approximately 56 on the U.S. side and 20 on the Canadian shore. An additional 175 CSOs discharge to the Michigan tributaries of the Detroit River (7 to the Ecorse River and 168 to the Rouge River). Sewage treatment plant overflows also discharge to the Little River. Raw sewage from failed septic tank systems enters the Detroit River from those areas which are presently unsewered. Urban runoff together with CSOs constitute an additional impact on the Detroit River, which is discussed further in Chapter 8.

CHAPTER 6
DESCRIPTION OF THE AQUATIC ECOSYSTEM

The purpose of this chapter is to describe the aquatic ecosystem of the Detroit River Area of Concern (AOC). The following discussion summarizes pertinent data for parameters used to determine the support status of the fourteen beneficial uses. The fourteen beneficial uses are those listed in Annex 2 (Part 1(c)) of the Great Lakes Water Quality Agreement (GLWQA) of 1978 (as amended), described previously in Chapter 2. The chapter is intended to (1) identify areas where beneficial uses are not supported, and (2) identify areas where additional data are needed before a determination can be made regarding the support of beneficial uses.The data presented are also compared to GLWQA objectives and Michigan and Ontario water quality criteria. The purpose of these criteria is to protect the designated uses. Since a Remedial Action Plan is a dynamic document, this chapter will need to be updated as additional data become available.

As a preliminary step in determining the impaired uses in the Detroit River, the Detroit River Binational Public Advisory Council (BPAC) was asked to provide the RAP Team with BPAC's perception and knowledge of problems associated with the River. A BPAC meeting was used as the forum to communicate on an individual basis and as small discussion groups, the BPAC members' concerns for the Detroit River. Ten responses were received from individuals and small groups. The results of this discussion session indicated that the public (as representeed by the participating BPAC members) perceived the Detroit River as not supporting all beneficial uses (Appendix 6-1). Only three of the beneficial uses were identified by the majority as either "not impaired" or "undecided": (1) Tainting of fish and wildlife flavor; (2) Eutrophication, undesirable algae; and (3) Added costs to agriculture/industry. Beneficial uses considered impaired included restrictions on fish consumption, degradation of aquatic life populations, fish tumors, restrictions on dredging activities, beach closings, and loss of fish and wildlife habitat. Some of the perceived impaired uses were confined to specific areas of the river, e.g. the Trenton Channel or the lower river; however in general the responses reflected a serious concern for the status of the entire river.

As a follow-up to these responses, the RAP Team reviewed the data presented within the text of this chapter and discussed their conclusions with the BPAC. Identified impairments of the aquatic ecosystem are summarized in Chapter 7.

6.1 WATER QUALITY

The water quality of the Detroit River has been studied for over thirty years. Early studies in the 1950s dealt almost exclusively with fecal coliform bacteria. Subsequent studies in the 1960's began to address some conventional pollutants including suspended and settleable solids, ammonia, oils, phenol and biochemical oxygen demand (BOD). Reports by EnCoTec (1974), Hamdy and Post (1985), and Thornley and Hamdy (1984) included work on heavy metals, benthic macroinvertebrates and phytoplankton since 1966, MDNR has operated a sampling program which provides water quality data on a monthly basis from stations at upper and lower transects in the Detroit River (Figure 6-1). This program covers conventional parameters and metals but not persistent toxic organic compounds (Table 6-1). The monitoring program was reduced in 1990 from ten to three stations at the upper transect (near Lake St. Clair). In 1979 and 1980, some monitoring for selected organic compounds was conducted at the lower transect of the river. Limited organic contaminant monitoring also occured at Michigan Detroit River drinking water intakes between 1971 and 1976. The Upper Great Lakes Connecting Channels Study (U.S. EPA and EC 1988) provided considerable data for conventional, organic and inorganic compounds (Table 6-2). Additional Detroit River water quality data have been generated since 1986 by the Ontario Ministry of the Environment Drinking Water Surveillance Program (DWSP) (OME 1986). As a part of this program, raw and treated water from selected water treatment plants were analyzed for approximately 160 parameters, including bacteriological indicators, conventional pollutants, and numerous organic and inorganic compounds (Appendix 6-2). The Windsor and Amherstburg water treatment plants are sampled on a monthly and semi-annual basis, respectively.

Table 6-1. Water quality parameters currently monitored monthly by the Michigan Department of Natural Resources at 22 stations in the Detroit River.

Temperature	Cyanide, total
pH	Mercury, total
Alkalinity	Silver, total
Conductivity	Potassium, total
Turbidity	Lead, total
Suspended solids	Arsenic, total
Dissolved solids, total	Cadmium, total
Residue, total	Selenium, total
Nitrate + Nitrite Nitrogen	Lithium, total
Ammonia	Beryllium, total
Nitrogen, organic	Chromium, total
Phosphorus, ortho and total	Nickel, total
Chlorophyll a	Magnesium, total
Chloride	Sodium, total
Silicates	Copper, total
Phenols, total	Cobalt, total
Cyanide	Manganese, total
Total organic carbon	Aluminum, total
Biological oxygen demand, 5-day	Vanadium, total
Sulfate	Titanium, total
Hardness	Zinc, total
	Iron, total

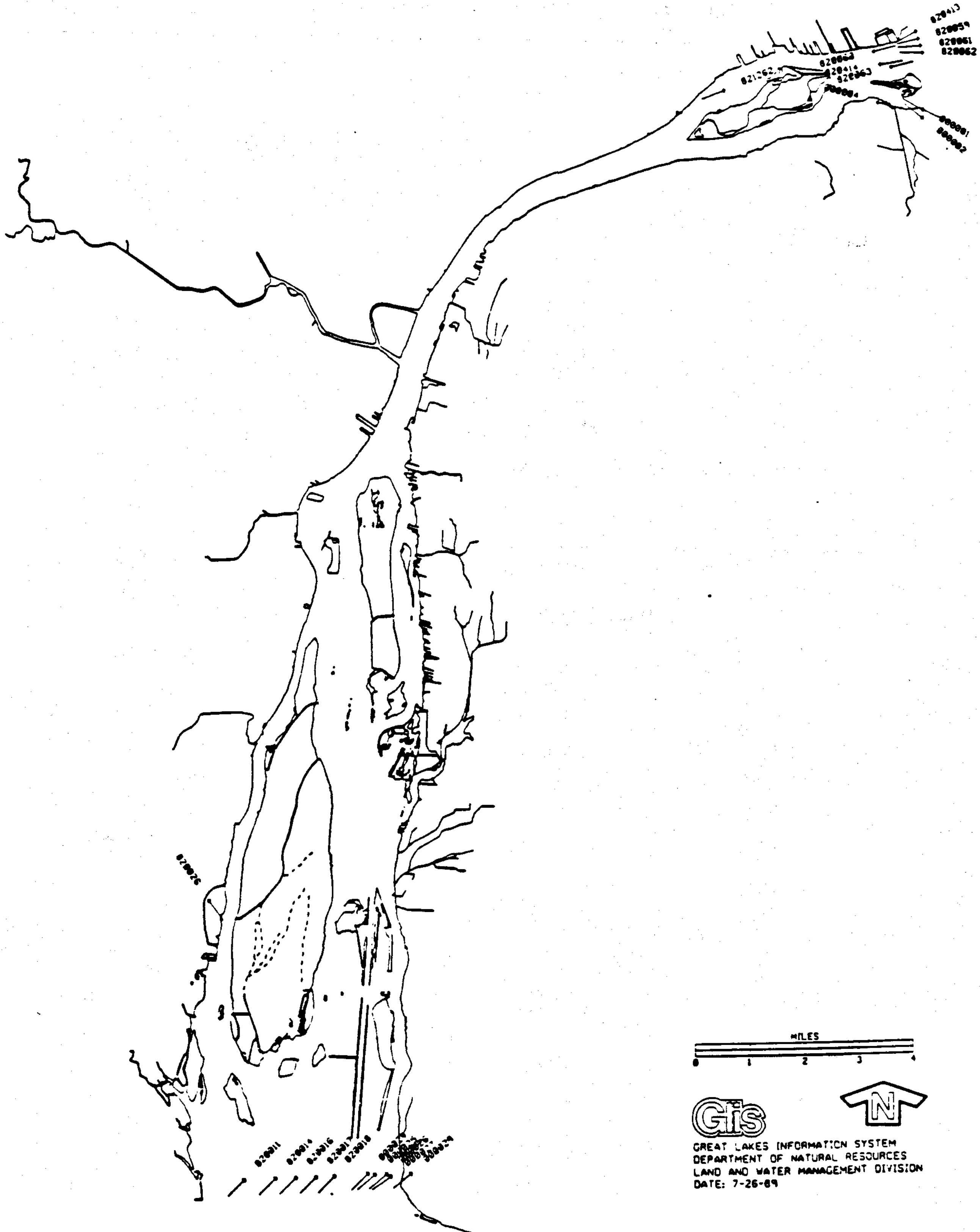


Figure 6-1. Michigan Department of Natural Resources monthly monitoring program Detroit River stations.

Table 6-2. Parameters of Concern in the Upper Great Lakes Connecting Channels Study (U.S. EPA and EC 1988).

Organics:	Polychlorinated biphenyls (PCBs)
	Hexachlorobenzene (HCB)
	Octachlorostyrene
	Polycycyclic aromatic hydrocarbons (PAHs)
	Oil and grease
	Phenols, total
Metals:	Cadmium
	Lead
	Zinc
	Mercury
	Copper
	Nickel
	Cobalt
	Iron
	Chromium
Conventional/other:	Phosphorus
	Ammonia
	Chlorides

6.1.1 Bacteriological Water Quality

The bacteriological quality of water is based on testing for nonpathogenic indicator organisms for the protection of public health. Michigan Water Quality Standards, U.S. EPA Water Quality Criteria and OME Objectives specify the fecal coliform bacteria group as the appropriate test organisms. Fecal coliform bacteria are a group of nonpathogenic bacteria which are normally excreted by humans and other warm-blooded animals. Untreated domestic wastewater generally contains more than 3 million coliforms per 100 ml (Hammer 1975). Pathogenic bacteria and viruses causing enteric diseases in humans originate from the fecal discharges of diseased persons. Consequently, water contaminated by fecal pollution is identified as being potentially dangerous by the presence of fecal coliform bacteria. The Michigan Water Quality Standard for total body contact recreation is currently 200 organisms per 100 milliliters water (200/100 ml) calculated as the geometric mean of any series of 5 or more consecutive samples taken within a 30 day period. The OME objective is 100 per 100 ml based on a geometric mean of a series of 10 or more samples. Waters meeting these standards are considered safe for total body-contact recreational use. The Great Lakes Water Quality Agreement (IJC 1988) does not specify a numeric acceptable level for microbiological organisms, but does give a narrative criteria stating that waters should be substantially free from infectious bacteria, fungi, and viruses.

Total body contact recreation activities in areas of the Detroit River are periodically impaired due to elevated fecal coliform bacteria levels. The following areas have been identified as being impaired due to bacteriological water quality (Figure 6-2):

A. Areas exceeding Michigan Water Quality Standards for fecal coliform concentration:

- Immediately downstream of the Rouge River confluence; and
- All areas immediately downstream of Michigan combined sewer overflows (CSOs), particularly following wet weather events.

B. Areas exceeding the OME objective include the following nearshore areas:

- Stop 26 and Sand Point beaches;
- Downstream of the Little River;
- Downstream of Turkey Creek;
- Downstream of the Amherstburg WPCP; and
- Downstream of the City of Windsor CSOs.

Beach closings due to the bacteriological water quality have occurred at two adjacent beaches on the Ontario side of the Detroit River AOC. Both beaches were continuously posted for "swimming at your own risk" by the Essex County Health Department due to levels of fecal coliform bacteria exceeding criteria (REF). The only beach located on the Michigan side of the Detroit River AOC is on Belle Isle; this beach has not been closed due to bacteriological concerns. Plans for a beach at Lake Erie Metro Park were cancelled due to preliminary study data indicating high fecal coliform levels along the shore (Johnson and Anderson Inc. 1983).

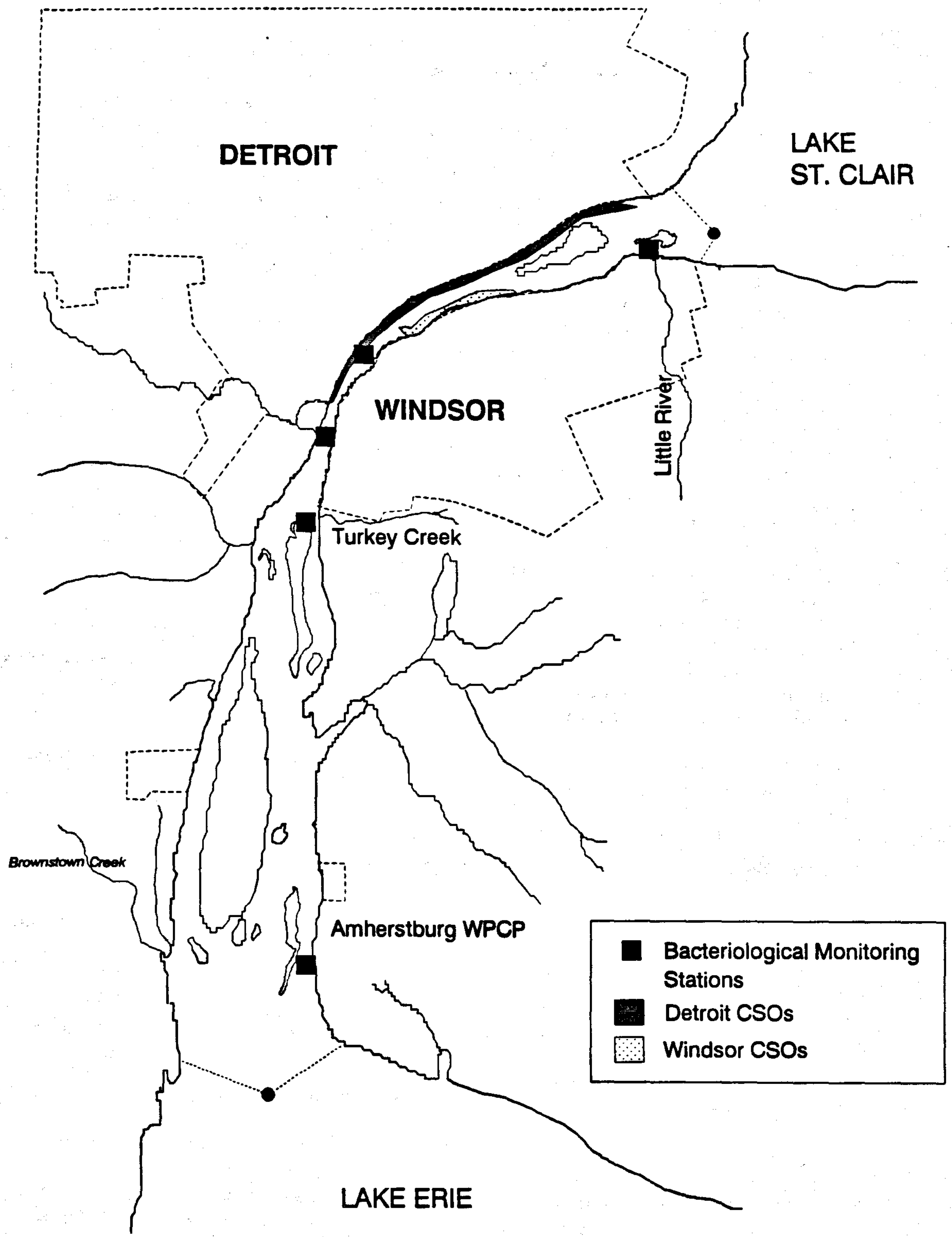


Figure 6-2. Impaired areas of the Detroit River due to bacteriological water quality.

6.1.1.1 Michigan Fecal Coliform Monitoring Data

The most recent study of bacteria levels along the Michigan shore of the Detroit River found only one area of the River to exceed Michigan Water Quality Standards for fecal coliform. Five samples were collected within a 30 day period (August-September, 1989, including two collections within 24 hours of rain events) at fifteen stations in the river (Wayne County Department of Public Health, unpublished data 1989). Geometric means were calculated to determine compliance with Michigan Water Quality Standards. The geometric mean at all stations was less than Michigan's 200/100 ml standard, except at the stations located on the transect immediately downstream of the Rouge River confluence (Figure 6-3). The study also concluded that fecal coliform densities at each transect were highest near the shore, implying that the bacteriological contamination is from shoreline sources including outfalls. The study showed samples taken from Lake St. Clair near the head of the Detroit River had fecal coliform geometric mean values of less than 200/100 ml. In addition, samples collected at seven stations on the river were also analyzed for the bacterium *Escheria coli* (*E. coli*). The proposed Michigan Water Quality Standard for *E. coli* based on 30 day average was not exceeded. However, the proposed daily standard was violated once (at the near shore station at the Ambassador Bridge).

Combined sewer overflows (CSOs) are a source of bacteriologic contamination and raw sewage to the Detroit River, particularly following rainfall events. The Wayne County Health Department sampled ten locations in the Detroit River downstream of the Rouge River to Lake Erie following a heavy rain (Wayne County Department of Public Health 1989). Fecal coliform bacteria densities in single grab samples were highest near the Rouge River confluence (34,200 organisms per 100 ml) and decreased to 280/100 ml near Trenton (Figure 6-4). Densities increased again in Lake Erie to 920/100 ml. Four days later all samples had densities of 80/100 ml or less.

The Wayne County Department of Public Health also sampled a variety of locations on Ecorse Creek (five samples within 30 days) (D. Tuomari, Personal Communication). Based on fecal coliform levels found, the health department issued an advisory for people not to use Ecorse Creek or its tributaries for total body contact.

A study conducted in 1985 also concluded CSOs were a source of bacteriological contamination to the river. Bi-weekly samples taken nearshore upstream of the Rouge River confluence had more than 200 organisms per 100 ml while mid-river samples had relatively low densities of fecal coliforms, again indicating sources from along the shoreline, (ES&E et al. 1987).

The discharge of untreated sewage is illegal under Act 245 in Michigan. As a result, all areas immediately downstream of Michigan CSOs are identified as impaired.

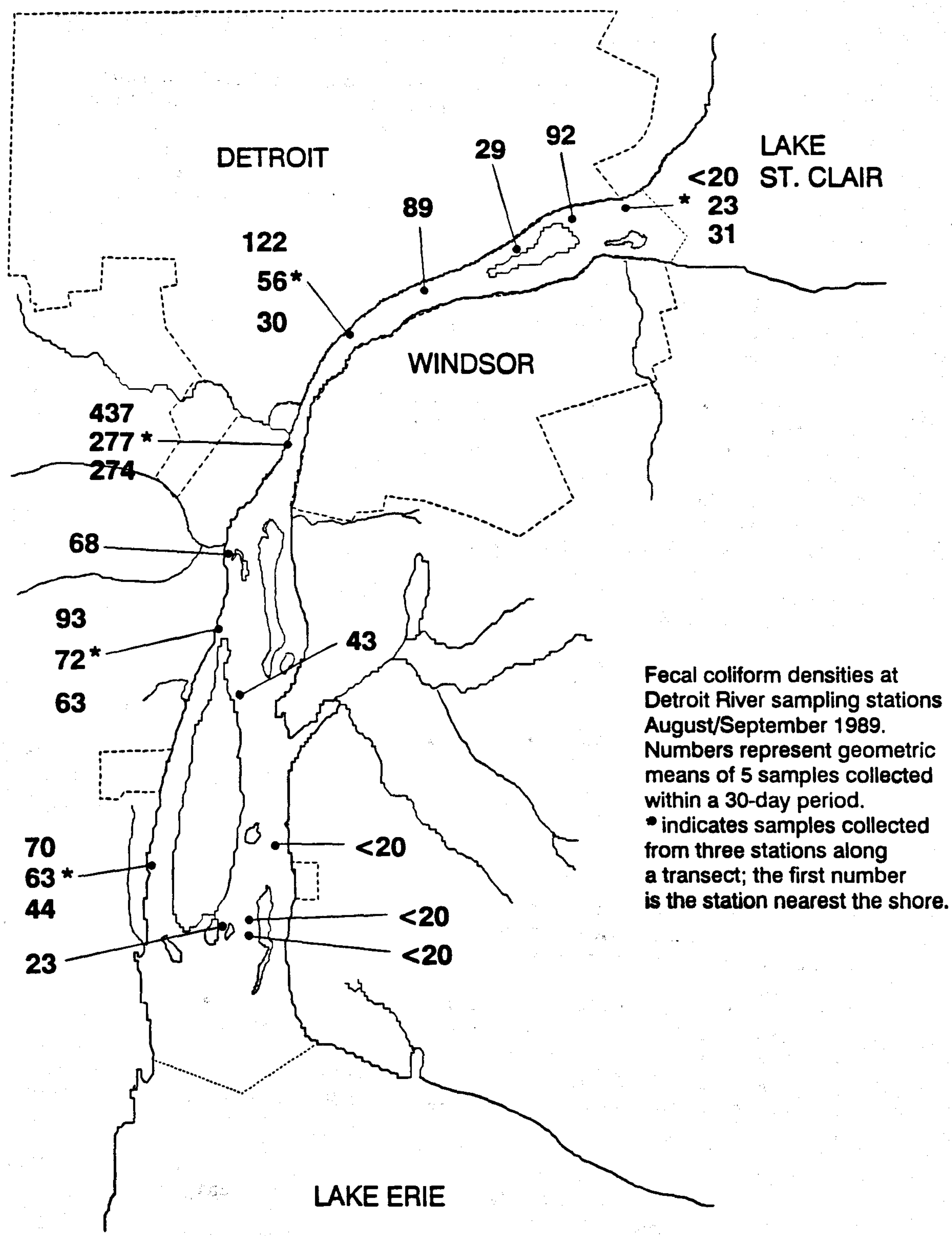


Figure 6-3. Detroit River 1989 bacteriological water quality study results. (Wayne County Department of Public Health 1989).

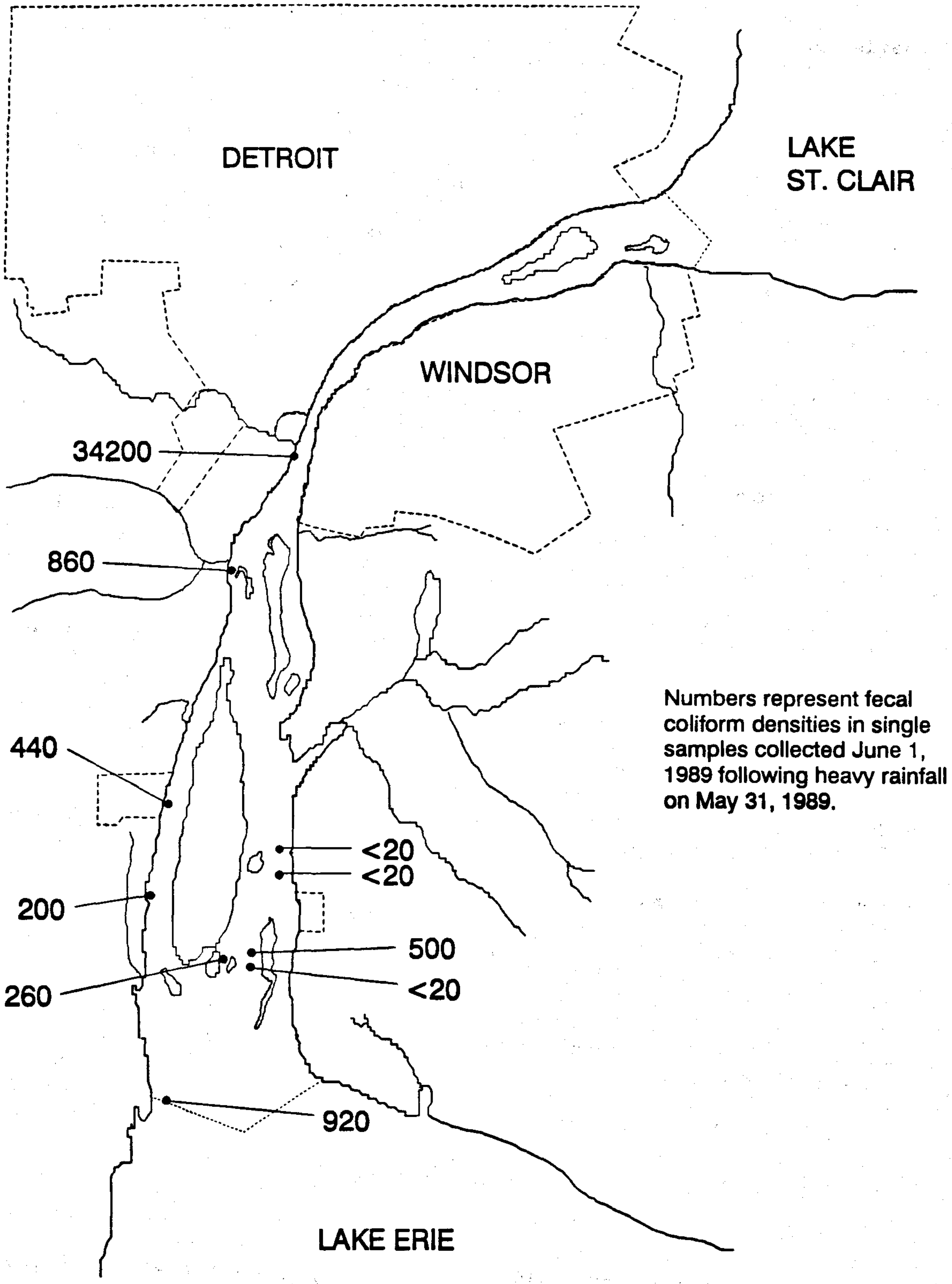


Figure 6-4. Densities of fecal coliform bacteria in the Detroit River following a rain event. (Wayne County Department of Public Health 1989).

Review of the literature indicates that bacterial concentrations in the Detroit River have been a concern since the 1960's, particularly following wet weather events. In 1964 excessively high bacterial densities (geometric mean coliform densities greater than 2,400 organisms per 100 ml) originating from the Detroit River extended two to three miles into Lake Erie, and as far as Stoney Point after heavy rains (maximum densities of 100,000/100 ml) (Vaughan and Harlow 1965). Bacterial densities in combined sewer overflows contained up to 100 million organisms per 100 ml with overflows occurring 33 to 45 days per year. The elevated bacteria levels lasted up to five days following storms. Near Conners Creek, the geometric mean of five consecutive samples collected in a 30 day period was near 7,000 organisms per 100 ml water while concentrations in the lower river exceeded 80,000 organisms per 100 ml. Burm (1967) observed fecal coliform levels following two storm events in 1963 and found concentrations along the shoreline downstream of Conners Creek that significantly exceeded 200/100 ml (Appendix 6-3). There was a strong correlation between the high concentrations and storm events, indicating CSOs as a primary source. Burm also noted that fecal coliform levels were greater than 200/100 ml for several days after the storms. Concentrations were highest in the nearshore areas. Based on coliform data, conditions changed very little from 1962 to 1987 (EnCoTec, 1974; City of Detroit [unpublished data] 1988).

Data collected between 1979 and 1986 at twelve sites along the Michigan shoreline of the upper Detroit River indicated high bacterial concentrations in some areas (Appendix 6-4) (City of Detroit 1988). These data were collected as individual grab samples, and results were not calculated as the geometric mean of five consecutive samples within a 30-day period (pursuant to Michigan Water Quality Standards protocol). There was a trend of increasing bacteria concentrations with distance downstream. Additional samples collected along Belle Isle indicated that the water quality near Belle Isle was significantly better than along the Michigan shoreline.

A study conducted at the Lake Erie Metro Park in 1982 near the mouth of the river (Johnson and Anderson Inc. 1983) revealed high fecal coliform levels along the Michigan shoreline. Results for the three sampling stations indicated that coliform bacteria concentrations frequently exceeded 200/100 ml and often exceeded 1000/100 ml (Appendix 6-5). Five day geometric means ranged from 21 to 2368 organisms per 100 ml. Plans for a beach at Lake Erie Metro Park were cancelled and a wave pool was built instead. New work at this site is underway with the prospect of diking off an area for swimming. Water Quality Standards would be met by chlorinating the enclosed pool if necessary.

6.1.1.2 Ontario Fecal Coliform Monitoring Data.

The Ontario Ministry of Environment has monitored fecal coliform concentrations in the Detroit River since 1969. Bacteriological concentrations and trends along the Ontario shore are similar to those observed along the Michigan shore.

In May, July and August of 1975, the OMOE studied the bacteriological quality of the water after improvements were made at the West Windsor Water Pollution Control Plant (WPCP) and the Little River Sewage Treatment Plant (Kinkead and Hamdy 1976). The 100/100 ml OME objective was exceeded at only a few locations and primarily during storms (Figure 6-5). The May and August surveys were conducted during dry weather and showed only minor exceedances. The July survey, conducted during a storm, showed severe exceedance of the bacterial objective at most stations. The impacts decreased with distance from shore but extended beyond 600 ft. (183 meters) downstream during July (Figure 6-6). The report concluded that significant improvements were achieved between 1969 and 1975 due to treatment plant improvements but recommended further study and control of additional sources.

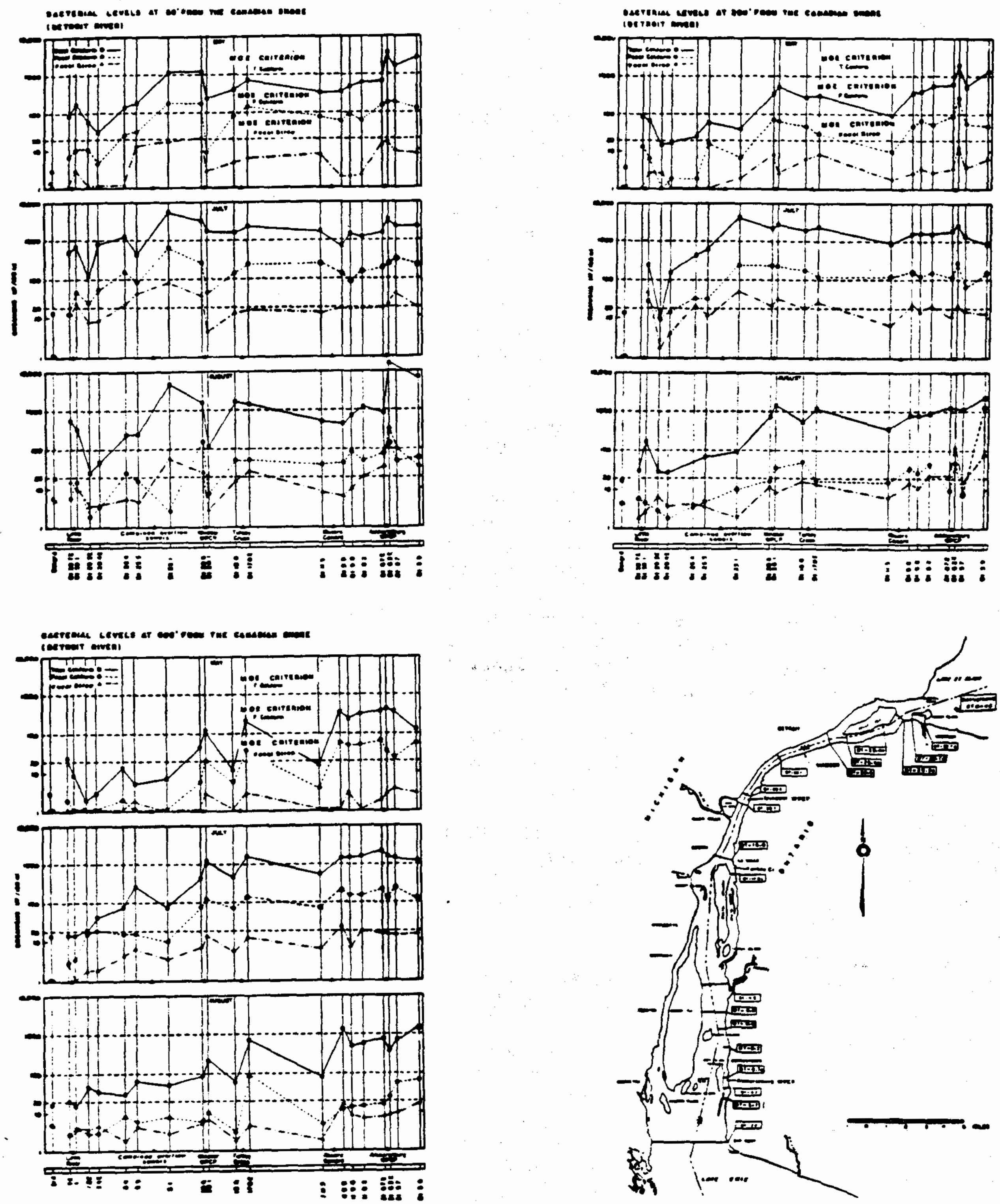
A follow-up study (Hamdy and Johnson 1987) concluded that the bacteriological quality of the Ontario nearshore waters of the Detroit River deteriorated between 1975 and 1984. The frequency with which the OME objective of 100/100 ml was exceeded increased from 66.7% (10 of 15 nearshore stations) in 1975 to 86.7% (13 of 15 stations) in 1981. The number of nearshore stations at which the objective was exceeded remained relatively constant (86-87%) between 1981 and 1984. Similar to study results on the Michigan side, the bacteriological contamination on the Ontario side generally decreased with increasing distance from shore, implying that the sources were along the shoreline. With the exception of the West Windsor WPCP, fecal coliform densities observed downstream from each point source were higher than those measured at corresponding upstream stations (Table 6-3).

Findings concluded that the high level of bacteriological contamination of the river was due to known point sources and tributary nonpoint sources:

- Little River, including Little River WPCP;
- City of Windsor CSO's;
- Turkey Creek; and
- Amherstburg WPCP.

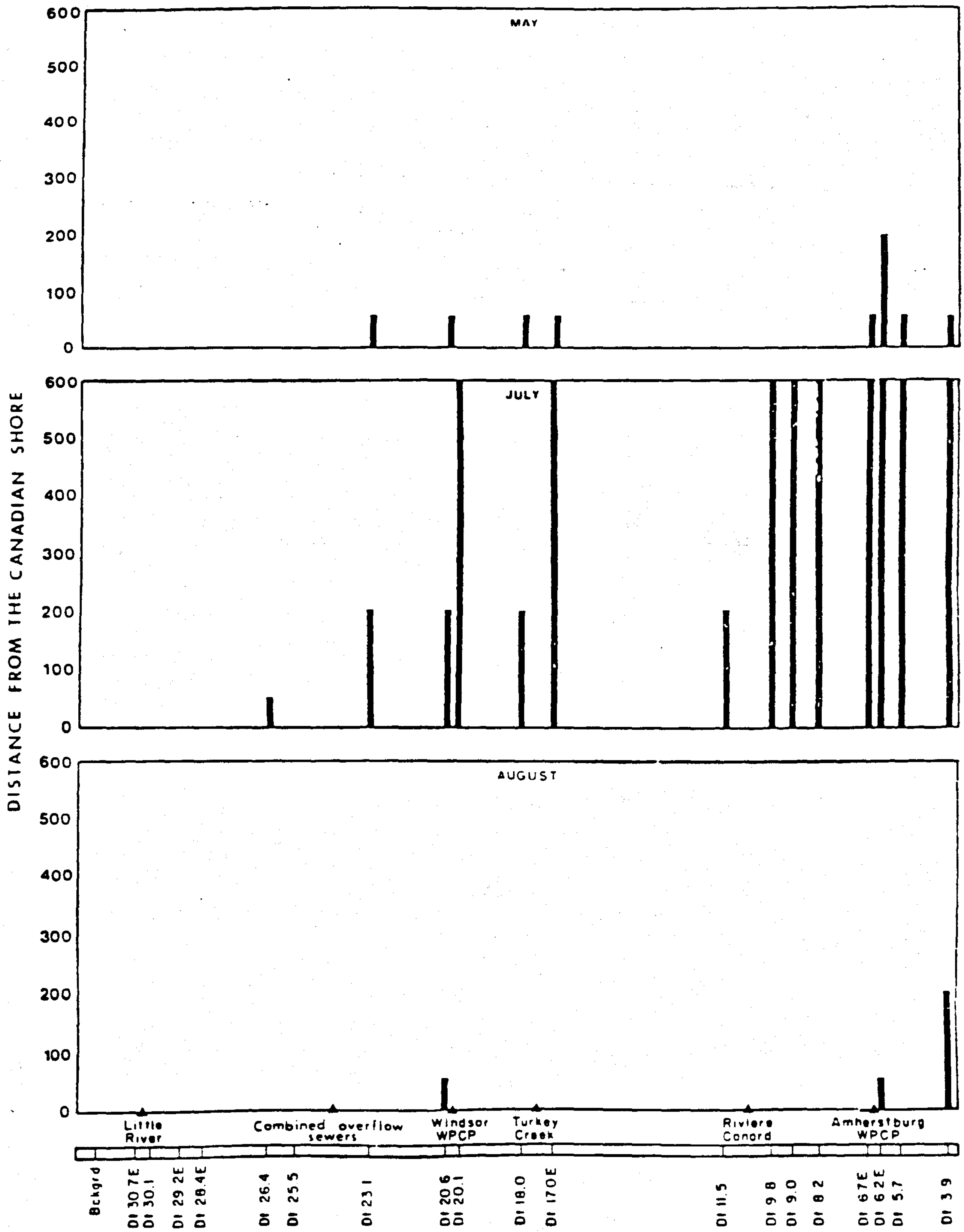
The downstream extent of contamination from each of these sources was not identified, however the data indicated a decrease in bacteriological water quality with increasing distance downstream. The report recommended further study of the bacteriological contamination of the Detroit River, with emphasis on a comprehensive definition of the causes and effects of the bacteriological contamination within the river. The highest priority for research was given to the reach beginning just upstream of Little River to the West Windsor WPCP. The monitoring program consisted of fewer than three surveys per year (1975, 1978, 1981, 1982, and 1984) for three-to-four days each, and may not reflect the bacteriological conditions during the entire year.

Fecal coliform monitoring results during 1977 and 1988, indicate that violations of the PWQO declined from 75% of all stations in 1987, to 61.1% in 1988. In comparing annual violations 15 meters offshore at the 15 stations reported by Hamdy and Johnson (1987), the frequency of violations is 93.3% (14 of 15 stations) in 1987, and 73.3% (11 of 15 stations) in 1988. The 1987 results represent the highest reported



Source: Kinkead and Hamdy 1976.

Figure 6-5. 1975 Detroit River fecal coliform concentrations at stations along the Ontario shore.



Source: Kinkead and Hamdy 1976.

Figure 6-6. Lateral extent of fecal coliform concentrations exceeding Ontario standards in the Detroit River: 1975.

Table 6-3. Geometric mean fecal coliform densities observed at Ontario near shore stations for 1975 and 1984 (Hamdy and Johnson 1987).

Station	Year 1975	1984	Change in Bacteriological Density ($p<0.05$) 1975-1984
Little River			
upstream	12	8	Decrease
downstream	45	50	Increase
Windsor CSO's			
upstream	154	177	Increase
downstream	237	487	Increase
West Windsor WPCP			
upstream	237	487	Increase
downstream	42	530	Increase
Turkey Creek			
upstream	133	343	Increase
downstream	220	389	Increase
Amherstburg WPCP			
upstream	191	261	Increase
downstream	316	861	Increase

frequency of violations since 1975. The 1988 results are the lowest since 1978 (Cowell 1990).

6.1.2 Conventional Parameters

Conventional parameters in the Detroit River were measured during a number of surveys over the past three decades. Included in these surveys was a U.S. Department of Health, Education and Welfare study in the mid-1960s which monitored suspended and settleable solids, chlorides, iron, BOD, dissolved oxygen, COD, nitrogen compounds, phosphorus, pH, hardness, alkalinity, temperature, and conductivity at ten transects across the Detroit River (Vaughan and Harlow 1965). In the mid 1970's, the U.S. Environmental Protection Agency monitored chlorides, BOD, COD, iron, nitrogen compounds, phosphorus, and dissolved solids at 18 stations from the river head to the mouth (EnCoTec 1974). In the mid 1980's, the U.S. and Canada conducted a joint study to monitor suspended solids, filtered chloride, total phosphorus, ammonia, filtered hardness, and silica at two transects at the head and mouth of the river and three transects in the Trenton Channel during the Upper Great Lakes Connecting Channels Study (U.S. EPA and EC 1988). Although these surveys were of short duration and performed for different purposes, they provide data useful in developing a perspective of historical conditions.

Several additional studies were conducted by OME (Johnson and Kauss 1987), U.S. Fish and Wildlife Service, Environment Canada, and numerous other agencies as part of the UGLCC Study.

The Michigan Department of Natural Resources has developed a continuous database, extending from 1966 to the present. The sampling program began with seven transects totaling fifty-four stations stratigically spaced throughout the river in 1966 (MWRC 1970).

Presently it consists of two transects (Figure 6-1). Four stations are sampled at the upper transect (the head of the river) and seven stations are sampled at the lower transect (the mouth of the river) during open water season (April through November). In addition, two bridge stations (Belle Isle Bridge and Grosse Ile bridge) are sampled monthly year round. The parameters monitored at these locations are shown in Table 6-1. Data from these locations were used to prepare a ten year summary of conventional parameters including iron, chlorides, total dissolved solids, phosphorus and nitrogen compound concentrations and loadings in 1976 (MDNR 1977). They were also the basis for a ten year synopsis of total phosphorus, chloride, sulfate, nitrogen compounds, specific conductivity, total solids, total dissolved solids and suspended solids at each station on the Detroit River upper and lower transects from 1973 to 1984 (Holtschlag 1987). Holtschlag's report (1987) does not contain any trend analysis due to the low correlation found to exist between stream flow and concentrations. However, the report did find that concentrations of constituents at the ten stations at the upper transect were not significantly different across the transect. At the lower transect, most constituent concentrations were greater near the U.S. and Canadian shoreline. A forthcoming report from MDNR will summarize an additional 12 years of MDNR monitoring data through 1988 and includes OME water quality monitoring data from the same time period (J. Rossio, MDNR unpublished report).

The MDNR report (1977) noted that the water quality of the Detroit River had improved significantly from 1966 to 1976. A 1962-64 survey of the river by the U.S. Public Health Service found severely degraded conditions, particularly in the lower reaches of the river. Raw sewage, chemical waste oils, garbage, and general debris were being dumped into the river. The Michigan Water Resources Commission set water quality goals in 1966 for the Detroit river. These goals were superceded by the NPDES permits in 1973. The 1966-76 survey found river concentrations of chlorides and total phosphorus to decrease by 46% and 62%, respectively, during this period. Concentrations of total iron, phenols, total dissolved solids and ammonia nitrogen did not change significantly, although loadings of certain parameters to the Detroit River from Michigan point sources decreased (total iron 81%, chlorides 80%, total phosphorus 63% and oil 80%). The 1977 report found CSOs to be a major source of nutrients, bacteria, solids, oil and debris to the Detroit River after heavy rains.

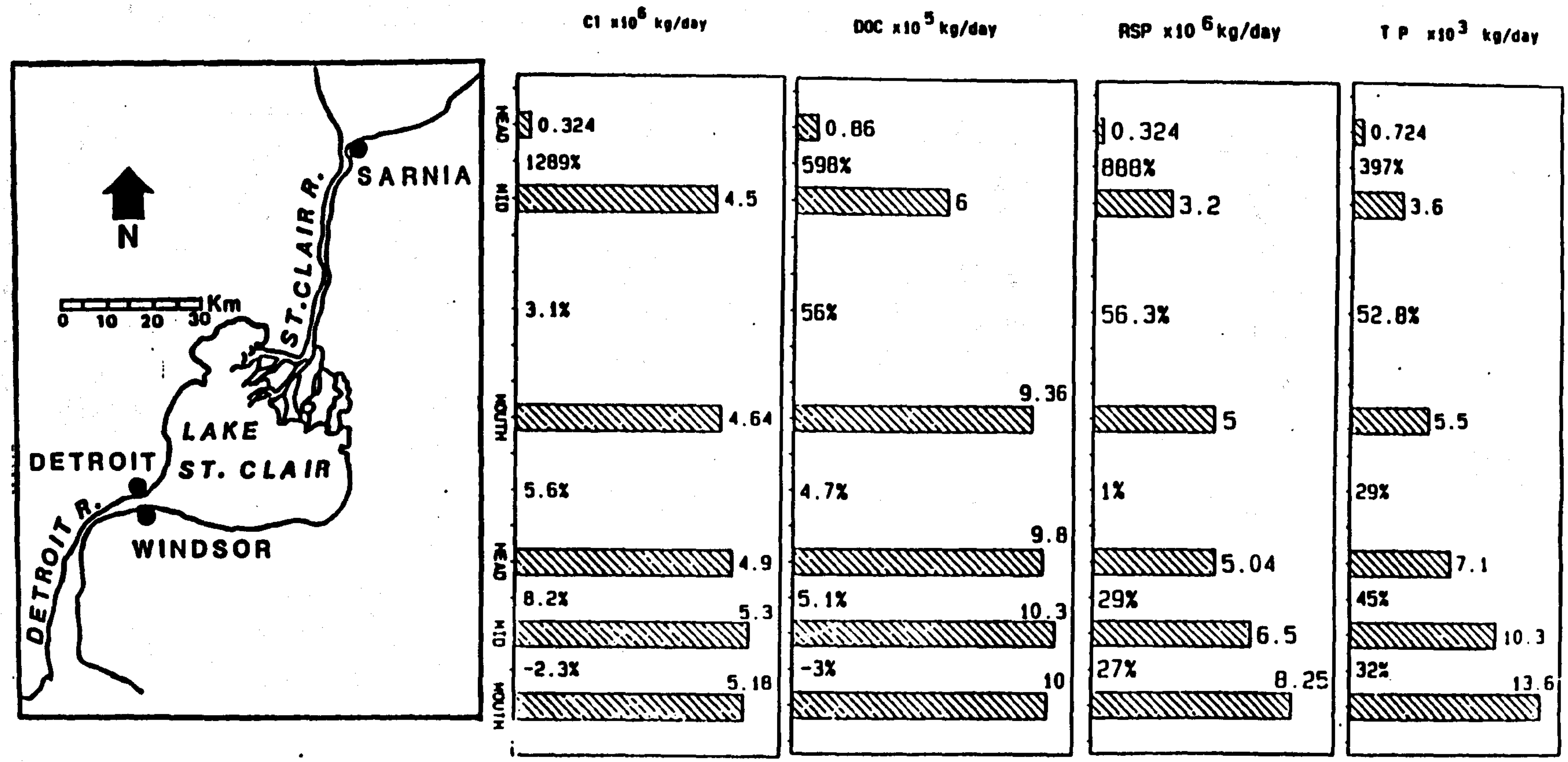
Figure 6-7 presents results of a 1984 investigation by Johnson and Kauss (1987). Loadings estimated from a head and mouth investigation of the Detroit River indicated only moderate net increases in chloride and dissolved organic carbon from the head to the mouth of the Detroit River. Suspended solids and total phosphorous loads increased on the order of 56% and 87% respectively in the same interval. A more recent investigation by the Ministry of the Environment in 1988, reported in Cowell (1990) reported that increases in conventional parameters were observed adjacent to the Ontario shoreline, as outlined in Table 6-4.

The annual average concentrations of selected conventional parameters at the Detroit River lower transect between 1972 and 1988 are shown in Figures 6-8 and 6-9 (MDNR monitoring data). These figures illustrate the general trends during this time period and show generally improving or stabilized water quality in the Detroit River. The annual average concentrations of these conventional parameters are within the state, provincial and federal water quality criteria, as well as meeting the GLWQA objectives. Annual averages are based on data from all ten stations at the lower transect during the ice-free months of the year.

Conventional parameters are discussed individually in the following text. Table 6-5 summarizes the average concentration of selected parameters at the lower transect for April through November of 1988. Data from the upper transect are not presented since acceptable levels of conventional parameters at the lower transect would suggest that there are not significant contributions of specific parameters on the river. Data for loadings from Lake St. Clair are included for selected parameters in Chapter 8. Evaluation of this data concludes that the Detroit River currently has water quality which meets the applicable criteria with regard to conventional parameters.

6.1.2.1 Suspended Solids

Suspended solids concentrations ranged from 8 to 18 mg/l at the Detroit River mouth between 1972 and 1988 (Figure 6-8) (MDNR monitoring data). The considerable variation among years is assumed to be due to varying meteorological conditions, lake levels and river velocities. In 1965,



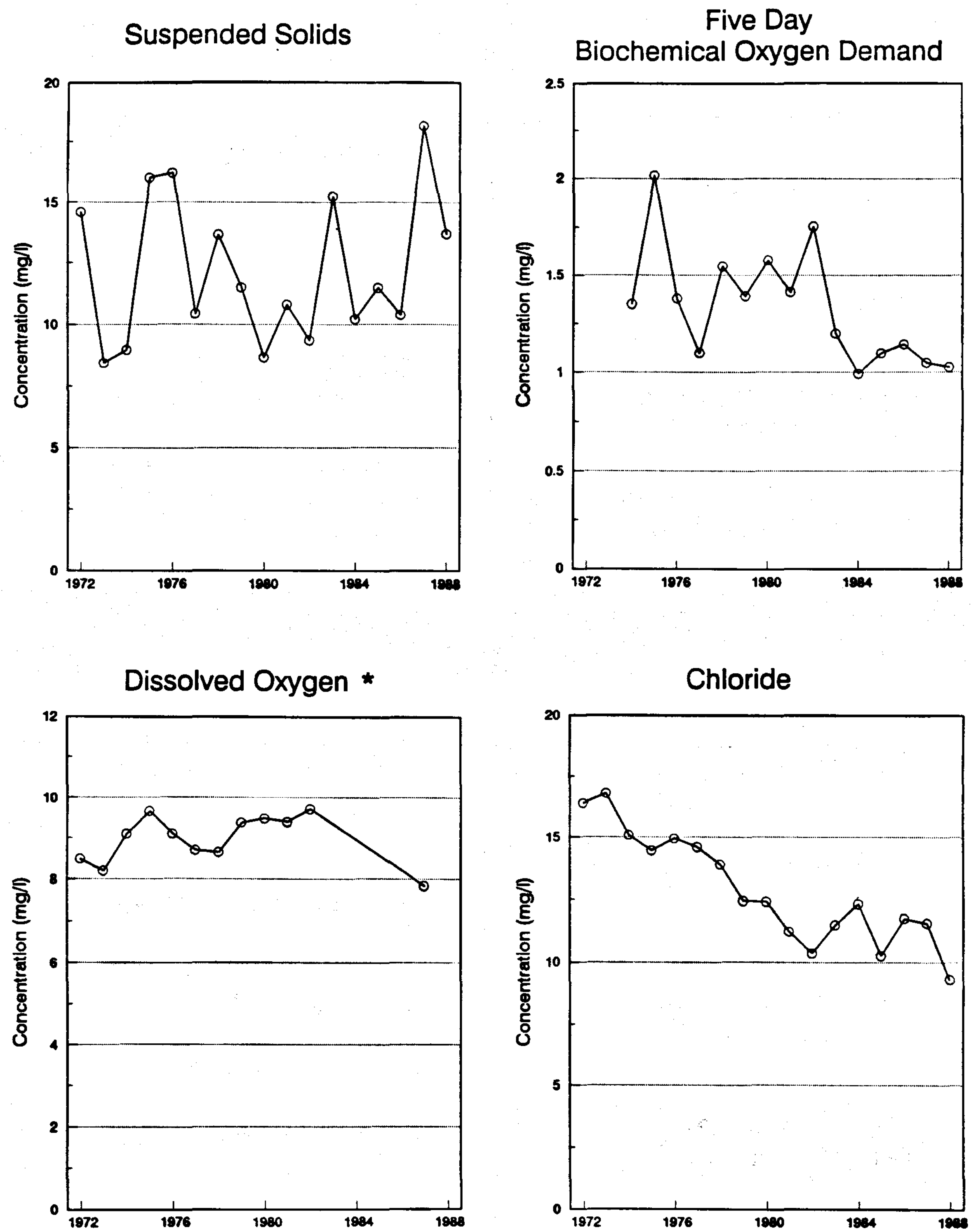
CL = Chloride
DOC = Dissolved Organic Carbon
RSP = Suspended Solids
TP = Total Phosphorus

Figure 6-7. Relative loading differences between segments of the St. Clair and Detroit Rivers. (Source: Johnson and Kauss 1987).

Table 6-4. Increase or decrease in mean concentration of nutrients between head (DT30.7e) and mouth (DT3.9) of Detroit River, 1988 survey (closest to Canadian shore).

STATION	n	CONDUCTIVITY umho/cm (25°C)	HCO3 mg/L (CaCO3)	TOTAL HARDNESS mg/L (CaCO3)	CI mg/L	DIC mg/L (as C)	DOC mg/L (as C)	NH4 mg/L (as N)	NO3 mg/L (as N)	TKN mg/L (as N)	TP mg/L (as P)	PARTICULATE mg/L
Head of River	6	229.7	88.4	109.8	8.3	20.5	1.7	0.030	0.233	0.237	0.042	9.8
Mouth of River	2	243.0	88.0	111.0	12.5	20.1	1.7	0.049	0.245	0.300	0.027	21.1
% Increase (Decrease)		5.8	(0.5)	1.1	50.6	(2.0)	0	63.3	5.2	28.8	(35.7)	115.3

From Cowell (1990)



* Parameter is temperature dependent.

Figure 6-8. Mean annual concentrations of selected conventional parameters at the lower transect of the Detroit River (1972 to 1988).

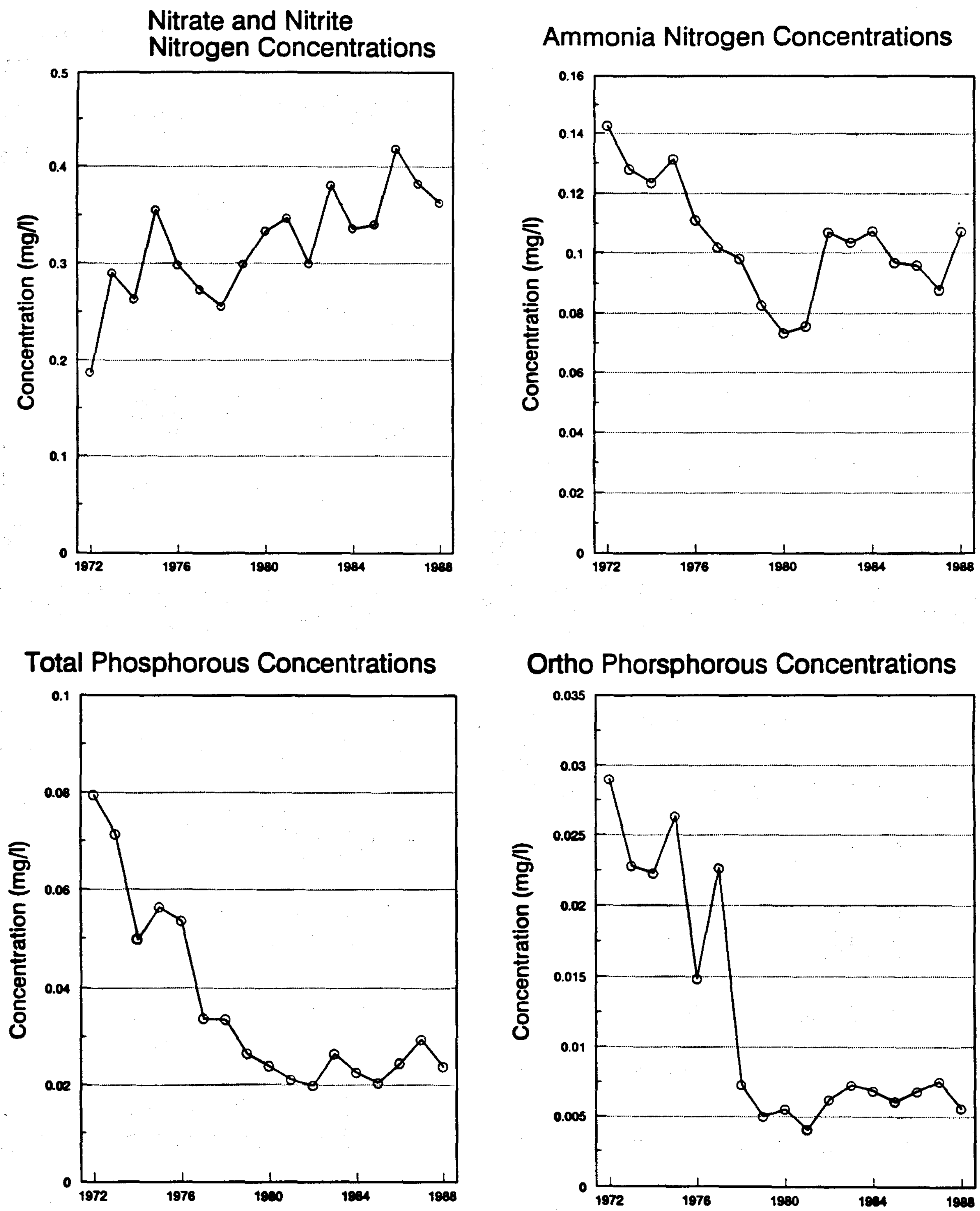


Figure 6-9. Mean annual concentrations of selected conventional parameters at the lower transect of the Detroit River (1972 to 1988).

Table 6-5. Concentration of selected conventional parameters measured at the Detroit River in 1988 (Average of 10 samples from across the lower transect).

	Apr	May	June	July	Aug	Sept	Oct	Nov
Suspended Solids (mg/l)	19.364	13.0	10.546	12.727 (11.25)	9.545 (14.93)	23.0	14.364	7.273
NO_2 and NO_3 as Nitrogen (mg/l)	.813	.544	.262	.220 (0.23)[1]	.306 (0.32)[1]	.235	.234	.287
NH_3 and NH_4 as Nitrogen (mg/l)	.106	.116	.098	.110 (0.126)[2]	.091 (0.087)[2]	.101	.124	.112
Phos. Total (mg/l)	.034	.029	.017	.022 (0.031)	.021 (0.028)	.026	.023	.020
Phos. Total Ortho (mg/l P)	.006	.007	.003	.005	.007	.006	.005	.007
Chloride (mg/l)	12.546	11.091	7.64	8.545	7.545	8.545	8.818	9.909
BOD_5 (mg/l)	1.082	1.782	1.29	.836	.700	1.100	.691	.745

Source: MDNR Monitoring Data at Detroit River Range 3.9.

Bracketed numbers from 1988 MOE Study @ Detroit River Rouge 3.9. Average of 4 samples across transect as reported by (Cowell 1990).
1 - NO_3 as N
2 - NH_4 as N

suspended solids averaged 5 to 10 mg/l near the head of the river (Vaughan and Harlow 1965). Holtschlag's (1987) ten year summary describes some of the variability of suspended solids based on upper and lower transect data collected between 1973 and 1984. Michigan nearshore means were approximately 7 mg/l, the mid-river averaged about 10 mg/l, and the Ontario side averaged approximately 14 mg/l. Maxima along the Michigan shore, mid-river and Ontario shore were 50, 66, and 163 mg/l respectively. At the lower transect the Michigan shore and mid-river means were 8 mg/l and the Ontario shore was 13 mg/l. Maxima at the lower transect along the Michigan shore, mid-river and Ontario shore were 55, 40 and 90 mg/l respectively.

A 1984 study by OME (Johnson and Kauss 1987) indicated suspended solids concentrations on the order of 8.8 to 9.5 mg/l at the upper transect. Concentrations downstream ranged from 18.5 to 21.4 mg/l along the Michigan shoreline and 10.7 to 12.4 mg/l along the Ontario shoreline. Approximately 3,210 metric tonnes per day of suspended solids were estimated to exit the Detroit River in excess of those entering by way of the water column.

MDNR monitoring data indicate concentrations of suspended solids ranged from 7 to 23 mg/l in 1988 at the lower transect (Table 6-5). These concentrations are below levels of concern (25 mg/l) for fish (Alabaster and Lloyd 1982).

6.1.2.2 Biochemical Oxygen Demand and Dissolved Oxygen

The five-day biochemical oxygen demand (BOD) at the lower transect of the Detroit River ranged from 1 to 2 mg/l between 1974 and 1988 (Figure 6-8) (MDNR monitoring data). BOD was highest in 1974 and lowest in 1984. Although variable within this range, BOD was relatively stable, especially between 1984 and 1988. Monthly averages ranged from 0.69 to 1.7 mg/l in 1988 (Table 6-5). In 1965, Vaughan and Harlow (1965) reported that BOD was 2 to 4 mg/l at the head of the river, and that it increased to 8 mg/l near the Rouge/Detroit River confluence before decreasing to the range of 2 to 4 mg/l at the mouth.

The minimum dissolved oxygen (DO) concentration at the head was 8.6 mg/l while at the mouth it was 5.1 mg/l in 1965. Percent DO saturation was 93 to 106% at the head and 60 to 82% near the mouth (Vaughan and Harlow 1965). Annual average Detroit River DO at the lower transect ranged from 7.8 to 9.7 mg/l between 1972 and 1988 (MDNR monitoring data). The highest concentration occurred in 1982 and the lowest occurred in 1987. Rule 64 of Michigan's Water Quality Standards requires that a minimum of 7 mg/l DO be maintained at all times in all Great Lakes and connecting waterways (MWRC 1986). The Great Lakes Water Quality Agreement (Annex 1) identifies a minimum DO value of 6 mg/l (IJC 1988). Dissolved oxygen has been above this level in the Detroit River since the mid-1960s.

6.1.2.3 Chlorides

MDNR monitoring data indicate chloride concentrations for the lower transect of the Detroit River ranged from 9 to 17 mg/l between 1972 and 1980 and show a steady downward trend (Figure 6-8) (MDNR monitoring data). Rule 51 of the Michigan Water Quality Standards requires a level of 50 mg/l or less as a monthly average (MWRC 1986).

Johnson and Kauss (1987) observed chloride concentrations downstream of the Rouge River confluence adjacent to Michigan in the range of 8.4 to 12.1 mg/l. Maximum mean chloride concentrations were 9.3 mg/l along the Ontario shoreline. Chloride loadings increase between the head and mid-range of the Detroit River, with a marginal decrease between the mid- and the mouth of the river (Figure 6-7). Tables 6-4 and 6-5, reveal results from a 1988 investigation (Cowell 1990). Results are reasonably consistent with those reported by Johnson and Kauss (1987) and MDNR.

Historical data indicate chloride concentrations at the lower transect are highest on the Ontario side of the river. In 1965 mean chloride concentrations at the upper transect of the River ranged between 7 and 10 mg/l with mean values of 10 to 58 mg/l at the lower transect (Vaughan and Harlow 1965). In 1974 chloride concentrations at the lower transect averaged 25 to 45 mg/l with concentrations of 10 to 17 mg/l at the upper transect of the River (EnCoTec 1974). Holtschlag's summary revealed little difference in mean chloride concentrations at the upper transect (8 mg/l) during the ten year period but the highest values were 26 mg/l along the Michigan shore (Holtschlag 1987). At the lower transect chlorides were higher at the three Michigan nearshore stations (mean of 10.2, with a maximum of 26 mg/l) than at the four mid-river stations (mean of 7, with a maximum of 13 mg/l), but the highest concentrations were the three stations nearest the Ontario shore (mean of 16, with a maximum of 70 mg/l). The station nearest the Ontario shore had a ten year mean of 29 mg/l total chloride (Holtschlag 1987). The higher concentrations could be a result of the Canadian Salt facility in Ontario (see Chapter 8).

6.1.2.4 Nitrogen Compounds: Nitrate (NO3), Nitrite (NO2) and Ammonia

Concentrations of nitrate plus nitrite have steadily increased from 1972 to 1988 at the lower transect of the Detroit River (Figure 6-9) (MDNR monitoring data). The mean annual concentrations ranged between 0.18 and 0.41 mg/l. Monthly averages ranged from 0.22 to 0.81 mg/l in 1988 (Table 6-5). Nitrogen compounds normally exhibit seasonal fluctuations with higher concentrations occuring during winter and spring flooding when plant populations are minimal (Reid and Wood 1976).

Historical data substantiates this trend and indicates concentrations were lowest near the Michigan shore. In 1965, nitrate (NO3) and nitrite (NO2) concentrations at the upper transect of the river averaged 0.10 to 0.24, and 0.001 to 0.002 mg/l, respectively (Vaughan and Harlow 1965). At the lower transect of the river, nitrite and nitrate concentrations increased slightly (compared to concentrations at the upper transect) to ranges of 0.22 to 0.40 mg/l nitrate, and 0.003 to 0.011 mg/l nitrite. Holtschlag's (1987) data showed the highest nitrite plus nitrate concentrations at the upper transect along the Ontario shore (0.55 mg/l) with lower mean values (0.25 to 0.40 mg/l) in mid-river and near the Michigan shore. At the lower transect, means were lowest near the Michigan shore (0.3 mg/l) and steadily increased across the river to 0.43 mg/l. Although discrete measurements can be made, these forms of nitrogen are dynamic and dependent on a variety of environmental factors.

Nitrate levels measured in 1988 by MOE (Cowell 1990) during July and August were in the range of 0.23 to 0.32 mg/l. These parameters did not approach a level of concern anywhere in the river.

Mean annual concentrations of total ammonia steadily decreased from 0.142 to 0.075 mg/l at the lower transect of the Detroit River between 1972 and 1980 (Figure 6-9) (MDNR monitoring data). In 1981, concentrations increased and fluctuated near 0.1 mg/l from 1982 to 1988. In 1965 total ammonia averaged 0.08 to 0.14 mg/l at the upper transect and 0.16 to 0.41 mg/l at the lower transect (Vaughan and Harlow 1965). Holtschlag's data (1987) showed concentrations of ammonia at the upper transect were consistently 0.01 to 0.02 mg/l, while at the lower transect there was a wide variation from the Michigan to the Ontario shore. The four stations closest to the Michigan shore averaged 0.36, 0.23, 0.16 and 0.08 mg/l respectively. The fifth station (0.04 mg/l) was still elevated (compared to concentrations at the upper transect). The next four stations moving toward Ontario reflected the corresponding stations at the river head (approximately 0.01 mg/l) while the station closest to the Ontario shore had 0.06 mg/l total ammonia.

Although total ammonia is measured, the form considered toxic to aquatic life is un-ionized ammonia. Un-ionized ammonia exists in equilibrium with ionized ammonia, with concentrations dependent on the temperature and pH of the water. Data from the early 1980's suggested that concentrations of un-ionized ammonia along the Michigan shore of the river may have approached levels considered to be chronically toxic to aquatic life (0.02 mg/l). However, there was uncertainty associated with laboratory measured pH during this period, which greatly influences the unionized fraction. Current data indicates concentrations of un-ionized ammonia are below levels, of concern (Creal 1984).

6.1.2.5 Total Phosphorus and Orthophosphorus

Phosphorus concentrations in the Detroit River are an important issue for the protection of Lake Erie with respect to trophic conditons. The Great Lakes Water Quality Agreement has described target phosphorus loading for all the Great Lakes. For Lake Erie, the target load (including input from the Detroit River as well as all other sources) is 11000 metric tons per year. The most recent annual total phosphorus estimated input for Lake Erie (from all sources) for 1983, 1984 and 1985 are described in Appendix B of the Report on Great Lakes Water Quality (IJC 1989) as 9800, 12874, and 11216 metric tons per year, respectively. These data suggest a decrease in total phosphorus loading since 1984, approaching the Agreement goal.

Phosphorus loading to Lake Erie from the Detroit River, with mean flows and mean total phosphorus concentrations are shown in Table 6-6. The total phosphorus concentration in the Detroit River and phosphorus loading to Lake Erie has declined dramatically between 1966 and 1979, and has since become relatively stabilized (Figure 6-9) (MDNR monitoring data). Variations within this "stabilized" concentration are most likely due to rainfall-induced fluctuations in land based runoff and total river flow.

Table 6-6. Loadings, flow and total phosphorus concentrations in the Detroit River between 1966 and 1988.

Year	Loading in Metric tons/yr	Mean flow in cfs x 1000**	Mean Total "P" in mg/l*
1966-1968	30,682	191	0.180
1969-1971	20,713	211	0.110
1972-1974	13,516	233	0.065
1974-1976	10,651	217	0.053
1977-1979	5,456	198	0.031
1980-1982	3,989	203	0.022
1983-1985	4,473	214	0.023
1986-1988	5,032	217	0.026

* MDNR monitoring data at Detroit River Range 3.9.

** U.S. Army Corps of Engineers. 1988. Personal Communication with Coordinating Committee on Great Lakes Basin, Hydraulic and Hydrologic Data to J. Rossio, MDNR, October 1988.

Mean annual total phosphorus concentrations at the lower transect of the Detroit River ranged from 0.02 to 0.08 mg/l between 1972 and 1988 (MDNR monitoring data). There was a decline between 1972 and 1982, with a stabilization between 0.02 and 0.03 mg/l between 1979 and 1988.

Monthly averages ranged from 0.017 to 0.034 mg/l in 1988 (Table 6-5) (MDNR monitoring data). A OME study conducted 1984 found phosphorus in the range of 0.02 to 0.03 mg/l (Johnson and Kauss 1987). Total phosphorus loadings to Lake Erie were estimated at 4,964 metric tonnes (Figure 6-7). This is consistent with the data reported in Table 6-5 for the period 1983-85. OME phosphorus data for 1988 (Table 6-4) are again relatively consistent with MDNR monitoring data.

The reduction in phosphorus concentration since 1966 is further documented by other studies. In 1965, total phosphorus at the upper transect of the Detroit River ranged between 0.03 and 0.30 mg/l (Vaughan and Harlow 1965). At the lower transect concentrations of up to 1.20 mg/l were measured near the Michigan shore with averages of 0.18 to 0.48 mg/l total phosphorus. In 1974, total phosphorus at the upper transect ranged from 0.05 to 0.06 mg/l while concentrations at the lower transect ranged from 0.04 to 0.24 mg/l (EnCoTec 1974). Holtschlag's ten year summary (1973-1984) showed total phosphorus means at the upper transect of the Detroit River from 0.01 to 0.02 mg/l along the Michigan shore and the mid-river, while concentrations at each of the three Ontario stations were 0.02 mg/l (ten year mean concentrations). At the lower transect, the three Ontario stations had mean concentrations of 0.017, 0.018 and 0.025 mg/l, while the four mid-river means were all about 0.012 mg/l and the three Michigan means were 0.055 (nearest the Michigan shore), and 0.018 and 0.017 mg/l (further from shore). These data indicate that both shorelines impact the total phosphorus concentrations in the Detroit River, and that the impact along the Michigan shoreline is greatest. Sources include watershed runoff from rural agricultural land and urban areas as well as industrial, municipal and CSO/stormwater discharges (see Chapter 8).

Current phosphorus concentrations in the Detroit River are acceptable in that aquatic plant growth does not impair the designated uses of the river. However, phosphorus levels must continue to decrease to meet the phosphorus load reduction plan for Lake Erie as outlined in the GLWQA (Annex 3).

Orthophosphorus concentrations at the lower transect also decreased from 1972 to 1981 and then remained relatively stable (Figure 6-9) (MDNR monitoring data). There was a general decline from a high of 0.03 mg/l orthophosphorus in 1972 to a low of 0.004 mg/l in 1981 with stabilization occurring between 1978 and 1988 at 0.004 to 0.007 mg/l (MDNR monitoring data). Monthly averages of total orthophosphorus ranged from 0.003 to 0.007 mg/l (Table 6-5).

6.1.3 Metals

A substantial database for ambient concentrations of metals in the Detroit River exists as a result of the Michigan Department of Natural Resources monthly monitoring program and the Ontario Ministry of Environment Monitoring Program. The MDNR has monitored metals concentrations at the upper and lower transects of the river since 1977. Additional monitoring data was developed under UGLCCS (U.S. EPA and EC 1988) as the Detroit River System and Trenton Channel Mass Balance Studies (U.S. EPA 1988a; U.S. EPA 1988b). Results of this monitoring data and information from the NPDES program (effluent data) indicate ambient concentrations of mercury, cadmium, copper, lead and zinc are a water quality concern in portions of the Detroit River. Concentrations of all other metals measured were below the Michigan Water Quality Standards Rule 57(2) levels, the Ontario Provincial Water Quality Objectives (PWQO), and the Great Lakes Water Quality Agreement Specific Objectives. Table 6-7 compares the various water quality criteria for metals. Monitoring results for the individual metals are discussed in the following text.

For purposes of this report, metals concentrations at the upper transect of the river were assumed to be near uniform across the river (Holtschlag 1987) and are described as a single value for trend analysis and for the presentation of monthly monitoring data for 1988. Table 6-8 contains the average ambient metal concentrations for 1988 as measured by the MDNR at the upper transect of the river.

Data from the ten stations at the lower transect indicate the metals concentrations are not uniform across the river (Holtschlag 1987). Therefore, the monitoring data has been aggregated into three groups. The three western-most stations were averaged and called the Michigan side, the four mid-river stations were averaged to represent the mid-river, and the remaining three stations were averaged and called the Ontario side. Table 6-9 contains the average ambient metal concentrations for 1988 as measured by the MDNR at the lower transect of the river.

Samples obtained from May to November of 1984, were treated similarly by Johnson and Kauss (1987). Data for iron, lead, mercury and zinc concentrations measured along U.S. and Canadian shorelines at the upper, mid and lower transects of the Detroit River, are reported in Table 6-10.

The following text discusses annual mean concentrations from 1977 to 1988 (where MDNR monitoring data are available) at the upper and lower transects of the river. These data are useful for trend analysis and, to some extent, to evaluate contaminant inputs to the river. This discussion also provides some insight into OME monitoring results from 1984 and 1988 studies. To evaluate the ambient concentrations with respect to Michigan Rule 57 levels, Ontario PWQ Objectives, and GLWQA specific objectives, all the data for each sampling station for the period of 1984-88 were compared to the appropriate criteria. Results of this comparison are included in the text when any exceedance occurred. In some instances however, the detection level for some metals was higher than the criteria, and therefore no exceedances could be determined unless other data were available.

Limited data for metals concentrations in the Detroit River were also developed under the Upper Great Lakes Connecting Channels Study (U.S. EPA and EC 1988). Two studies, the Detroit River System Mass Balance survey and the Trenton Channel Mass Balance survey, were conducted to evaluate the dynamics of the Detroit River and the Trenton Channel with

Table 6-7. Summary of ambient water quality criteria (ug/l) for selected metals in the Detroit River (as of October, 1990).

Parameter	Michigan WQS Rule 57(2) Level*	Ontario Provincial Water Quality Objective (PWQO)	IJC GLWQA Specific Objective
Mercury	0.0006	0 to 0.2	0.2
Lead	3	5 to 25+	25
Cadmium	0.4	0.2 0.2	
Copper	11	5.0 5.0	
Nickel	33	25 25	
Zinc	49	30 30	
Total Chromium	48	100 50	

- Under Michigan WQS Rule 57(2), allowable levels of the following metals are dependent on the hardness of the receiving water. Hardness was assumed to be 98.7 mg/l as $CaCO_3$ based on the mean value for 1988. The following equations are used to calculate the Rule 57(2) levels:

  Lead: e(1.75 (ln(H))-7.0)
  Cadmium: e(0.7852 (ln(H))-4.51)
  Copper: e(0.94 (ln(H))-1.957)
  Nickel: e(0.92 (ln(H))-0.73)
  Zinc: e(0.85 (ln(H))-0.011)
  Chromium: e(0.82 (ln(H))+0.097)

+ The PWQO value varies dependent on the alkalinity.

Table 6-8. Mean monthly concentration of metals at the upper transect of the Detroit River in 1988.

Metal	Apr	May	June	July	Aug	Sept	Oct	Nov
Mercury				K 0.5				
Lead	2.2	1.1	K 1.0	1.6	K 1.0	1.5	1.0	1.0
Cadmium	K 0.2	K 0.2	K 0.2	K 0.2	K 0.2	K 0.2	K 0.2	K 0.2
Silver				K 0.5				
Chromium	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0
Nickel	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0
Copper	2.0	1.4	1.3	1.5	K 1.0	1.0	1.4	1.6
Zinc	9.3	57.1	6.4	6.0	9.6	9.9	4.8	5.5
Potassium	1.1	1.1	0.9	1.0	0.9	0.9	0.9	1.0
Selenium				K 1.0				
Lithium				K 8.0				
Berylium				K 1.0				
Magnesium	8.7	8.4	7.2	7.4	7.1	7.1	7.2	8.2
Sodium	7.6	6.7	4.8	5.3	5.3	5.1	4.7	5.7
Titanium				K 15.0				
Calcium	33.2	31.6	25.9	28.4	26.9	29.2	27.4	29.2
Cobalt				K 20.0				
Aluminum				135.2				
Managanese				8.2				
Vanadium				K 10.0				
Iron				280.2				

K indicates not detected at the detection level shown.

Source: MDNR Monitoring Data at Detroit River Range 30.8 (U.S.) and 30.7 (Canada).

Table 6-9. Mean concentration of metals at the lower transect of the Detroit River in 1988.

Metals Measured	Sampling Position at Mouth of River	Metal Concentration (ug/l) APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
.0006	MICH				K 0.5				
Mercury (Hg)	MID				K 0.5				
	ONT				K 0.5				
3	MICH	2.1	2.6	2.0	2.1	1.2	1.7	2.2	1.1
Lead (Pb)	MID	1.5	K 1.0	1.2	K 1.0	K 1.0	1.4	K 1.0	K 1.0
25	ONT	3.1	K 1.0	1.1	2.0	K 1.0	1.3	K 1.0	K 1.0
.4	MICH	K 0.2	0.4	0.3	0.3	K 0.2	0.2	0.3	K 0.2
Cadmium (Cd)	MID	K 0.2	0.2	0.2	K 0.2	K 0.2	K 0.2	0.2	K 0.2
.2	ONT	K 0.2	K 0.2	0.2	K 0.2	K 0.2	K 0.2	K 0.2	K 0.2
	MICH				K 0.5				
Silver (Ag)	MID				K 0.5				
	ONT				K 0.5				
48	MICH	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0
Chromium (Cr)	MID	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0
50	ONT	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0	K 3.0
33	MICH	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0
Nickel (Ni)	MID	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0
25	ONT	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0	K 4.0
11	MICH	1.8	2.3	2.1	1.8	2.1	2.3	2.2	1.8
Copper (Cu)	MID	2.0	1.2	1.4	1.2	1.0	1.6	1.2	1.0
5	ONT	2.5	1.6	1.3	1.3	1.1	1.5	2.1	1.1
49	MICH	9.0	35.3	20.0	18.4	21.0	19.2	24.5	17.8
Zinc (Zn)	MID	7.9	9.7	8.7	8.0	8.1	8.0	6.8	5.0
30	ONT	10.5	11.7	10.3	11.0	10.9	10.9	8.9	7.3

K indicates not detected at the level shown.

NOTE: Values represent the mean of samples collected for each month in each portion of the river. The Michigan value represents the three sampling stations nearest the Michigan shore; Mid represents the four mid-river sampling stations, and the Ontario value is the mean of the three sampling stations nearest the Ontario shoreline.

Source: MDNR monitoring data

Table 6-10. Comparison of contaminant levels by shoreline (mean concentrations, units as indicated)

PARAMETER	DETROIT RIVER - HEAD		DETROIT RIVER - MID		DETROIT RIVER - LOWER	
	U.S. SHORE DT 30.8W	CDN. SHORE DT 30.7E	U.S. SHORE DT 17.4W	CDN. SHORE DT 17.0E	U.S. SHORE DT 8.7W	CDN. SHORE DT 9.3-5000
Whole Water						
Iron (mg/L)	0.17	0.33	0.46	0.25	0.52	0.44
Lead (mg/L)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Mercury (ug/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc (mg/L)	0.002	0.002	0.008	0.003	0.007	0.002
Suspended Solids						
Iron (mg/g)	25	26	30	27	30	27
Lead (mg/g)	52	38	123	54	73	40
Mercury (ug/g)	0.13	0.32	1.45	0.44	0.48	0.43
Zinc (ug/g)	120	111	317	147	213	115

(Johnson and Kauss 1987)

respect to specific contaminants and the relative importance of known or unknown contaminant sources. These data, where available, are also included in the text.

6.1.3.1 Mercury

Analysis of the MDNR monitoring data from 1977 to 1988 does not reveal any trend in mercury concentrations in the Detroit River. Concentrations in almost all samples were less than the method detection level for mercury (level of detection (LOD) ranged from 0.2 to 1.0 ug/l). Mercury was detected during this period in only eight samples from the upper transect. Five of these samples were collected in August of 1979, from the five stations nearest the Ontario shore. Concentrations at these stations ranged from 0.7 to 1.0 ug/l.

Michigan's WQS Rule 57 value of 0.0006 ug/l mercury is well below the detection level, as are the Ontario PWQO and the GLWQA Objective of 0.2 ug/l total mercury. Therefore, exceedances of these criteria cannot be determined for these data.

Mercury levels on suspended solids collected during 1984 (Johnson and Kauss 1987) were typically on the order of 0.43 to 0.48 ug/g at stations along both shores. A peak mercury concentration on suspended solids, of 1.45 ug/g (ppm) was detected at DT17.4W, adjacent to the Michigan shoreline, downstream of the Rouge River confluence with the Detroit River (Table 6-10). Estimated mercury loadings based on the suspended solids values, ranged from 1.09 kg/d at the head of the Detroit River, to 7.1 kg/d at the mouth of the river. Analysis of variance conducted on mercury levels on suspended solids indicate a significant (p 0.05) difference between mercury levels at the head of the Detroit River with stations in the mid to lower reaches. Mercury was not detected in water samples at a detection level of 0.01 ug/l.

Samples obtained during 1988 (Cowell 1990), indicated a range of mercury concentrations in water from non-detectable at a method detection limit of 0.01 ug/l to 0.037 ug/l located upstream of the West Windsor Water Pollution Control Plant. This level was higher than those observed at the head transect; however, these increases are not significant (p 0.05) reflecting large standard deviations due to a high percentage of non-detected concentrations.

Analysis of water samples collected as a part of the UGLCC Study employing methodology with a lower detection level found levels of mercury throughout the river which exceeded Michigan's Rule 57(2) level. Concentrations of total mercury at both the upper and lower transects of the Detroit River were 0.008 ug/l (based on a composite of ten samples collected across the river). Total mercury concentrations in the Trenton Channel ranged from 0.024 ug/l to 0.449 ug/l.

In summary, these data indicate that mercury concentrations exceed Michigan's Rule 57 criteria throughout the length of the river, and exceed Ontario PWQ and GLWQA Objectives in the Trenton Channel. Additional monitoring for mercury employing methodology with detection levels less than Michigan's Rule 57 value (0.0006 ug/l) is needed to provide better, more current data for evaluation.

6.1.3.2 Lead

Lead measured on suspended solids during 1984 by OME along the Ontario shoreline ranged from 38 to 53 ug/g while concentrations along the U.S. shore ranged from 44 to 122 ug/g (Johnson and Kauss 1987) No samples obtained during the study were above the method detection level of 0.003 mg/l. Lead measured on suspended solids in 1984 indicated significant differences ($p \leq 0.01$) between stations situated along the Michigan shoreline versus Ontario shoreline (Table 6-10, Figure 6-10). Samples obtained during 1988 (Cowell 1990) were also less than the method detection level.

Analysis of individual lead concentrations in ambient water for each monitoring station at the lower transect for 1984-88 indicated exceedances of Michigan's Rule 57(2) level of 3.0 ug/l in 4% of the samples (19 of 419 samples), but concentrations did not exceed the PWQO or GLWQA Objective of 25 ug/l (Table 6-11). Forty-seven percent of these exceedances occured at the station nearest the Michigan shoreline. Four of forty-eight samples collected at the three stations closest to the Ontario shore in 1987-88 had concentrations of lead exceeding 3.0 ug/l. These data suggest that the Michigan and Ontario shorelines are sources of lead to the Detroit River.

The UGLCC Study reported concentrations of total lead below the method detection level of 0.1 ug/l at both upper and lower transects (U.S. EPA 1988a). However several locations in the Trenton Channel contained total lead concentrations ranging from 3.24 ug/l to 10.61 ug/l, which exceeded the Michigan Rule 57(2) level, but were below the Ontario PWQO and GLWQA Objective of 25 ug/l.

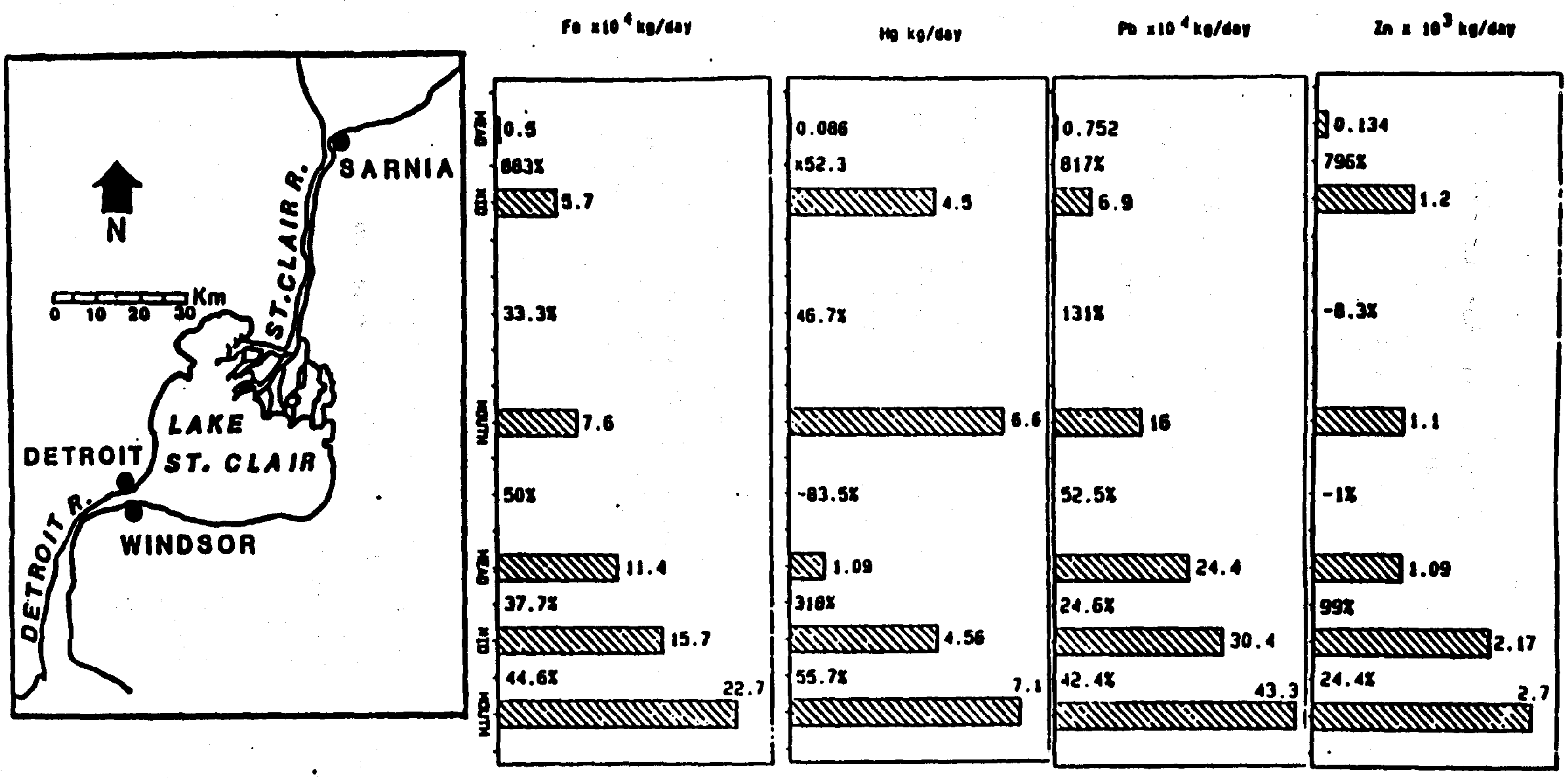
A review of NPDES effluent and monitoring data for 1988-89 indicate concentrations of lead at Zug Island (downstream of the DWSD discharge) theoretically exceeded Michigan WQS Rule 57(2) level based on modeling and mass balance calculations (Benzie 1989).

In summary, these data indicate that lead concentrations are well below Ontario and GLWQA Objectives. Occasional exceedances of Michigan Rule 57 criteria have occured in the Trenton Channel and near the Michigan and Ontario shorelines.

6.1.3.3 Cadmium

Analysis of 419 individual sample results from the lower Detroit River between 1984 and 1988 showed that cadmium exceeded Michigan's Rule 57(2) levels of 0.4 ug/l in 9% of the samples and the PWQO and GLWQA Objective in 15% of the samples (Tables 6-12 and 6-13). The station nearest the Michigan shoreline had cadmium levels which exceeded the Rule 57(2) level in 39% of the samples and the PWQO and GLWQA Objective in 69% of the samples. These data indicate that cadmium is entering the river from shoreline sources along the Michigan side of the Detroit River.

The UGLCC Study found concentrations of cadmium in the Trenton Channel ranging from 0.7 to 0.77 ug/l which exceeded Michigan's Rule 57(2) level and the Ontario PWQO and GLWQA Objective (U.S. EPA and EC 1988). Three of the four samples taken in the vicinity of the Grosse Ile free



Fe = Iron
Hg = Mercury
Pb = Lead
Zn = Zinc

Figure 6-10. Relative loading differences between segments of the St. Clair and Detroit Rivers. (Source: Johnson and Kauss 1987).

Table 6-11. Lead exceedances of Michigan's Rule 57(2) Level at the lower transect of the Detroit River, 1984 - 1988. The Rule 57(2) Level is 3.0 ug/l.

Storet Station Number[a]	Distance from the Michigan Shoreline (miles)	Number of Samples Collected	Number of Exceedances	Percent Exceedance	Mean Concentration of Samples Exceeding the Michigan Water Quality Standards (ug/l)				
					1984	1985	1986	1987	1988
820011	0.47	67	9	13%	4.00	5.80	3.10		3.70
820014	1.04	40	3	8%		5.40	3.80		
820016	1.42	39	1	3%		3.90			
820017	1.80	39	0	0%					
820018	2.18	39	2	5%	4.00	4.60			
000024	2.75	39	0	0%					
000025	2.84	39	0	0%					
000026	3.07	39	2	5%				3.30	3.20
000027	3.12	39	1	3%				3.40	
000029	3.50	39	1	3%					4.00
TOTAL		419	19	4%					

[a] Location of STORET station is shown in Figure 6-1.

Source: MDNR Monitoring data.

Table 6-12. Cadmium exceedances of Michigan's Rule 57(2) Level at the lower transect of the Detroit River, 1984 - 1988. The Rule 57(2) Level is 4.0 ug/l.

Storet Station Number[a]	Distance from the Michigan Shoreline (miles)	Number of Samples Collected	Number of Exceedances	Percent Exceedance	Mean Concentration of Samples Exceeding the Michigan Water Quality Standards (ug/l)				
					1984	1985	1986	1987	1988
820011	0.47	67	26	39%	0.74	0.70	0.58	0.82	0.65
820014	1.04	40	2	5%		0.70	0.60		
820016	1.42	39	1	3%		0.90			
820017	1.80	39	1	3%		0.50			
820018	2.18	39	0	0%					
000024	2.75	39	2	5%		0.60	0.60		
000025	2.84	39	0	0%					
000026	3.07	39	3	8%	0.80	0.90	0.50		
000027	3.12	39	1	3%		0.70			
000029	3.50	39	0	0%					
TOTAL		419	36	9%					

[a] Location of STORET station is shown in Figure 6-1.

Source: MDNR Monitoring data.

Table 6-13. Cadmium exceedances of the Ontario PWQO and GLWQA Specific Objective at the lower transect of the Detroit River, 1984 - 1988. The Ontario PWQO and GLWQA objective Level is 0.2 ug/l.

Storet Station Number[a]	Distance from the Michigan Shoreline (miles)	Number of Samples Collected	Number of Exceedances	Percent Exceedance	Mean Concentration of Samples Exceeding the Ontario PWQO and GLWQA Objective (ug/l).				
					1984	1985	1986	1987	1988
820011	0.47	67	46	69%	0.67	0.56	0.44	0.72	0.40
820014	1.04	40	4	10%		0.50	0.60	0.30	
820016	1.42	39	4	10%		0.53			0.30
820017	1.80	39	3	8%		0.40			0.30
820018	2.18	39	0	0%					
000024	2.75	39	2	5%		0.60	0.60		
000025	2.84	39	0	0%					
000026	3.07	39	3	8%	0.80	0.90	0.50		
000027	3.12	39	2	5%		0.70			0.30
000029	3.50	39	0	0%					
TOTAL		419	64	15%					

[a] Location of STORET station is shown in Figure 6-1.

Source: MDNR Monitoring data.

bridge along the western shore at the Trenton channel had concentrations which exceeded Michigan's Rule 57(2) level of 0.4 ug/l. Total cadmium concentrations increased from the upper transect to the lower transect of the Detroit River from a mean of 0.023 ug/l to a mean of 0.035 ug/l. In general, Detroit River water concentrations were below relevant ambient water quality guidelines.

The Provincial Water Quality Objective (0.0002 mg/l) is the same as the method detection level used in the 1988 OME investigation (Cowell 1990); thus, any detectable samples will be in violation of this water quality objective. The findings of the study indicated 5.1% of samples exceeded this criteria at stations adjacent to the Canadian shoreline.

NPDES monitoring and effluent data for 1988-89 indicate Michigan's Rule 57(2) level for cadmium is theoretically exceeded at Zug Island downstream of the Detroit Water and Sewerage Department (DWSD) discharge (MDNR 1989). The Detroit River Plume Monitoring and Modeling Program (ES&E Inc. et al. 1987) was used to estimate an impact area of five miles downstream from the DWSD discharge.

In summary, these data indicate occasional exceedances of Michigan Rule 57 criteria in the lower river for cadmium, particulary along the Michigan shoreline in 1987-88. More frequent exceedances of the more restrictive Ontario and GLWQA Objectives occurs in the lower river.

6.1.3.4 Copper

Analysis of all individual sample results from the lower transect of the Detroit River between 1984 and 1988 (MDNR monitoring data) showed that none of the samples exceeded Michigan's Rule 57(2) level (11.0 mg/l), but that three of the 419 samples collected during these five years exceeded the PWQO and GLWQA Objective of 5.0 ug/l total copper (Table 6-14). There was one exceedance in mid-river in 1985 (7.5 ug/l) and two exceedances in 1986 (mean concentration of samples exceeding criteria was 6.2 ug/l) at the station nearest the Michigan shoreline.

These data indicate that copper is not currently a water quality concern at the lower transect of the Detroit River. Mean monthly concentrations at the lower transect for 1988 were well below Michigan, Ontario and GLWQA water quality criteria (Table 6-9).

The Provincial Water Quality Objectives for copper was exceeded at 2 of 27 stations samples during the 1988 OME investigation (Cowell 1990, Figure 6-11); however, neither of these samples exceeded the Michigan WQS Rule 57(2).

The UGLCC Study found total copper concentrations were slightly higher at the lower transect of the Detroit River than at the upper transect (1.64 ug/l vs. 1.29 ug/l) (U.S. EPA and EC 1988). These values are well below the applicable criteria.

In the Trenton Channel Mass Balance study, individual copper concentrations ranged from 0.77 to 6.0 ug/l (U.S. EPA 1988b). None of these exceeded Michigan's Rule 57(2) level (11 ug/l) but one sample (out of 148) contained copper concentrations which exceeded the PWQO and GLWQA Objective of 5.0 ug/l.

Table 6-14. Copper exceedances of the Great Lakes Water Quality Agreement (GLWQA) Specific Objective and the Ontario Provincial Water Quality Objective at the lower transect of the Detroit River, 1984 - 1988. The GLWQA Objective and Ontario Provincial Water Quality Objective is 5.0 ug/l.

Storet Station Number[a]	Distance from the Michigan Shoreline (miles)	Number of Samples Collected	Number of Exceedances	Percent Exceedance	Mean Concentration of Samples Exceeding the GLWQA Objective (ug/l).				
					1984	1985	1986	1987	1988
820011	0.47	67	2	3%			6.2		
820014	1.04	40	0	0%					
820016	1.42	39	0	0%					
820017	1.80	39	1	3%		7.5			
820018	2.18	39	0	0%					
000024	2.75	39	0	0%					
000025	2.84	39	0	0%					
000026	3.07	39	0	0%					
000027	3.12	39	0	0%					
000029	3.50	39	0	0%					
TOTAL		419	3	1%					

[a] Location of STORET station is shown in Figure 6-1.

Source: MDNR Monitoring data.

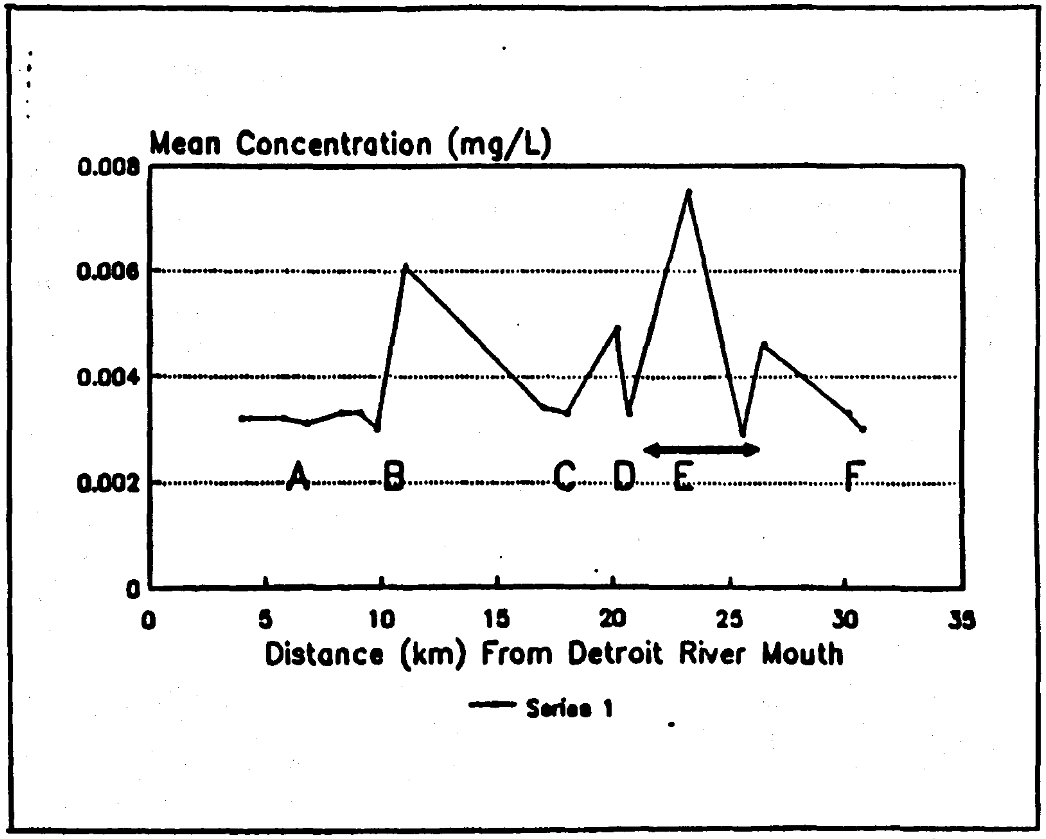


Figure 6-11. Total copper measured in water samples obtained adjacent to the Ontario shoreline. (Source: Cowell 1990).

In summary, concentrations of copper at the lower transect of the Detroit River are currently within water quality criteria. Some exceedances may be occurring in the Trenton Channel.

6.1.3.5 Nickel

Analysis of all 419 individual samples from the lower transect of the Detroit River for the period of 1984-88 (MDNR monitoring data) showed that none exceeded Michigan's Rule 57(2) level of 33 ug/l, or the PWQO and GLWQA Objective of 25 ug/l.

During the 1988 MOE investigation (Cowell 1990), nickel remained at non-detectable levels throughout the river, although sources of nickel were detected along the Canadian shore. Most of these sources were below the Provincial Water Quality Objective; however, one exception was noted for the West Windsor Water Pollution Control Plant (mean of five samples - 0.1218 mg/l).

Data from UGLCCS also found nickel concentrations below applicable water quality criteria (utilizing a lower level of detection) (U.S. EPA and EC 1988). Total nickel concentrations in the Detroit River showed little change between upper (0.97 ug/l) and lower (1.1 ug/l) Detroit River transects. In the Trenton Channel, individual sample nickel concentrations ranged from 1.1 to 8.11 ug/l (U.S. EPA 1988b).

These data indicates that nickel is not a water quality concern in the Detroit River.

6.1.3.6 Zinc

Analysis of all 419 individual samples collected at the lower transect of the Detroit River between 1984 and 1988 (MDNR monitoring data) showed that nine of the samples (2%) exceeded Michigan's Rule 57(2) level of 49 ug/l (Table 6-15), and 36 of the samples (8%) exceeded the PWQO and GLWQA Objective of 30 ug/l (Table 6-16). The station nearest the Michigan shore had the greatest number of exceedances over these years with 10% of the samples exceeding Michigan's Rule 57(2) level (the annual mean concentrations of samples exceeding criteria ranged from 55 to 77 ug/l) and 31% of the samples exceeding the PWQO/GLWQA Objective (the annual mean concentrations of samples exceeding the criteria ranged from 37.5 to 77 ug/l). The stations along the Ontario shore also had some exceedances of both water quality criteria, while the mid-river had very few exceedances of either criteria. These data indicate that the concentrations exceeding these levels have generally decreased between 1984 and 1988. Table 6-9 shows that the monthly mean concentrations of zinc at the lower transect did not exceed Rule 57 criteria in 1988 and exceeded Ontario PWQO/GLWQA Objective only once (May 1988, Michigan side) at 35 ug/l.

The 1984 study by Johnson and Kauss (1987) indicated zinc concentrations in water ranged from 2 to 8 ug/l along the Michigan shore and from 2 to 3 ug/l along the Ontario shore. Loadings data from this study (Figure 6-10) indicate that zinc loadings at the head of the Detroit River were 1.09×10^3 kg/d, while loadings near the bottom of the river amounted to 2.7×10^3 kg/d. Concentrations measured as part of the 1988

Table 6-15. Zinc exceedances of Michigan's Rule 57(2) Level at the lower transect of the Detroit River, 1984 - 1988. The Rule 57(2) Level is 49 ug/l.

Storet Station Number[a]	Distance from the Michigan Shoreline (miles)	Number of Samples Collected	Number of Exceedances	Percent Exceedance	Mean Concentration of Samples Exceeding the Michigan Water Quality Standards (ug/l)				
					1984	1985	1986	1987	1988
820011	0.47	67	7	10%	76.7	59.3			55.0
820014	1.04	40	0	0%					
820016	1.42	39	0	0%					
820017	1.80	39	0	0%					
820018	2.18	39	0	0%					
000024	2.75	39	0	0%					
000025	2.84	39	0	0%					
000026	3.07	39	0	0%					
000027	3.12	39	1	3%		53.8			
000029	3.50	39	1	3%		52.8			
TOTAL		419	9	2%					

[a] Location of STORET station is shown in Figure 6-1.

Source: MDNR Monitoring data.

Table 6-16. Zinc exceedances of the Great Lakes Water Quality Agreement (GLWQA) Specific Objective and the Ontario Provincial Water Quality Objective at the lower transect of the Detroit River, 1984 - 1988. The GLWQA Objective and Ontario Provincial Water Quality Objective is 30.0 ug/l.

Storet Station Number[a]	Distance from the Michigan Shoreline (miles)	Number of Samples Collected	Number of Exceedances	Percent Exceedance	Mean Concentration of Samples Exceeding the GLWQA Objective and the Ontario Provincial Water Quality Objective (ug/l).				
					1984	1985	1986	1987	1988
820011	0.47	67	21	31%	76.7	48.6	37.5	37.7	40.9
820014	1.04	40	4	10%	33.9	30.8		36.2	
820016	1.42	39	3	8%	32.4	35.4			
820017	1.80	39	0	0%					
820018	2.18	39	1	3%				34.0	
000024	2.75	39	0	0%					
000025	2.84	39	0	0%					
000026	3.07	38	2	5%		33.6		34.2	
000027	3.12	39	3	8%	34.8	45.4			
000029	3.50	39	2	5%		46.0			
TOTAL		419	36	9%					

[a] Location of STORET station is shown in Figure 6-1.

Source: MDNR Monitoring data.

MOE investigation (Cowell 1990) reflect similar values in that, the range from head to mouth concentrations vary from 1 ug/l to 4 ug/l along the Ontario nearshore. The highest zinc concentration measured was noticed at DT3.9 at the station furthest from the Ontario shore (12 ug/l), possibly reflecting upstream inputs associated with the Michigan shoreline.

Data from the Detroit River System Mass Balance study indicated total zinc concentrations increased between the upper (1.2 ug/l) and lower (3.3 ug/l) Detroit River transects (U.S. EPA 1988a). In the Trenton Channel, individual samples had zinc concentrations in the range of 1.8 to 45.85 ug/l (U.S. EPA 1988b). In these two studies, concentrations of zinc exceeded the PWQO and GLWQA Objective of 30 ug/l in two of the 148 samples analyzed. Both water samples were collected from the station in the Trenton Channel nearest the mainland Michigan shoreline.

These data indicate that exceedances of Rule 57 criteria for zinc at the lower transect have occured infrequently since 1986, however exceedances of the more restrictive Ontario and GLWQA criteria are more frequent. For these reasons, concentrations of zinc in the lower river are a water concern quality.

6.1.3.7 Chromium

Analysis of all 419 individual samples collected between 1984 and 1988 at the lower Detroit River transect (MDNR monitoring data) revealed no exceedances of Michigan, Ontario or Great Lakes Water Quality Agreement criteria for total chromium.

Cowell (1990) indicated that chromium concentrations increased by 21% between the head and the mouth of the Detroit River adjacent to the Ontario shoreline. The highest mean concentration of chromium for all Detroit River stations measured during the 1988 MOE investigation (Cowell 1990), was 7.8 ug/l. Figure 6-12 suggests potential inputs of chromium in a portion of the Detroit River along the Windsor waterfront; however, ambient concentrations are well below the Ontario Provincial Water Quality Objective of 100 ug/l.

The UGLCC Study did not evaluate ambient levels of chromium in the Detroit River.

These data indicate that chromium is not a water quality concern in the Detroit River.

6.1.4 Organics

Information on ambient levels of organic contaminants in the Detroit River is very limited. As previously mentioned, the MDNR monthly monitoring program does not currently include organic compounds although limited data from 1979 and 1980 are available. Organic compounds are not routinely included in monitoring analysis unless a specific problem is suspected. Most laboratories do not have sensitive enough analytical methods to detect the levels present in the water, and as a consequence,

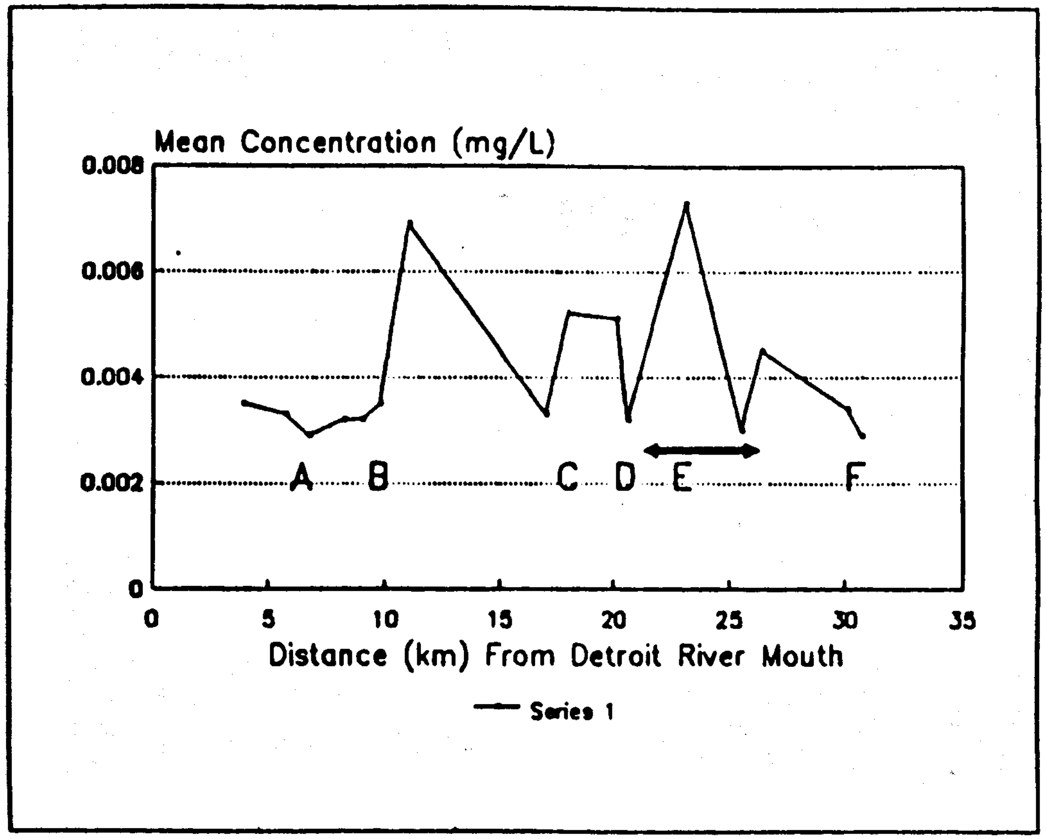


Figure 6-12. Total chromium measured in water samples obtained adjacent to the Ontario shoreline. (Source: Cowell 1990).

the results are usually "nondetectable". The cost for analytical work is much higher for organics than for conventional parameters. Additional data has resulted from samples taken at the Detroit River municipal water supply intakes. The Detroit River System Mass Balance Study and the Trenton Channel Mass Balance Study (conducted as a part of UGLCCS, (U.S. EPA and EC 1988)) provide data from a limited time period for selected organic parameters. In addition, Comba and Kaiser (1985) conducted a survey in 1982-83 to evaluate levels of volatile halocarbons in the Detroit River. A survey was conducted by OME in 1988 as a followup to UGLCCS to determine the significance of loading from Ontario sources (Cowell 1990). Contaminants of interest included PCBs, organochlorine pesticides, chlorinated aromatic compounds, volatiles and polynuclear aromatic hydrocarbons (PAHs). The Ontario Drinking Water Sampling Program (DWSP) program also yields some data for organic levels in raw and treated water (OME 1986). Further, Johnson and Kauss (1987) investigated the presence of PCBs, HCB and OCS in water and suspended solids samples obtained in 1984. Table 6-17 is a comparison of the Michigan's 57(2) levels, the Ontario PWQO and the GLWQA Specific Objectives where developed for selected organic compounds.

Organic contaminants in water were monitored at the lower transect of the Detroit River in 1979 and 1980 for PCB, PBB, diethylhexyl phthalate, di-N-butyl phthalate, and selected persistent chlorinated pesticides (Table 6-18) (MDNR monitoring data). Results indicated no detectable levels of PCB, PBB or pesticides were found. Low levels of diethylhexyl phthalate (DEHP) were detected in samples from May and June of 1979 and May of 1980 (Table 6-19). The MDNR does not have water quality criteria for phthalates. The GLWQA Specific Objective and the Ontario PWQO for DEHP is 0.6 ug/l. The Michigan DNR is currently developing Rule 57 criteria for DEHP, however interpretation of laboratory results is difficult due to the ubiquitous nature of phthalates and the potential for laboratory contamination, (Atlas and Giam 1981, Sullivan et al. 1981).

Organic contaminant analyses were performed on raw water at three Michigan municipal water intakes in the Detroit River between 1971 and 1976 (Table 6-20) (MDNR monitoring data). Analysis was conducted for total PCB, phthalates, DDD, DDE, DDT and eleven other chlorinated pesticides at the Detroit Belle Isle, Detroit Wyandotte, and City of Wyandotte water supply intakes. All but three samples contained levels less than the method detection level for the sixteen organic compounds. A low concentration of Bis-2-ethylhexyl phthalate (5.70 ug/l) was found in one sample which was collected from the area near the Belle Isle intake in 1976. In addition, one sample from the City of Wyandotte intake in 1971 contained DDD at 0.003 ug/l, DDE at 0.001 ug/l, and DDT at 0.016 ug/l. These levels exceeded Michigan's Rule 57(2) level for DDT plus metabolites of 0.00023 ug/l and the Ontario PWQO and GLWQA Objective of 0.003 ug/l (for DDT plus metabolites). Subsequent samples had DDT, DDD and DDE concentrations less than detection.

The OME Drinking Water Surveillance Program (OME 1986, 1987, 1988, 1990) analyzed raw Detroit River Water taken for treatment for drinking water, at Windsor and Amherstburg. Approximately 110 organic parameters were tested for on a monthly basis (Appendix 6-6). This program has found

Table 6-17. Summary of water quality criteria (ug/l) for selected organic compounds (as of October, 1990).

Parameter	Michigan's Rule 57(2) Level	Ontario Provincial Water Quality Objective (PWQO)	IJC GLWQA Specific Objective
PCB	0.00002	0.001*	(no value for water)
Hexachlorobenzene	0.0018	0.0065	-
DDT	0.00023 (sum of DDT, DDE, DDD)	0-0.003*	0.003 (sum of DDT and metabolites)
DDE	"	"	"
DDD	"	"	"
Heptachlor/ Heptachlor Epoxide	0.002	0.001	0.001 (sum of heptachlor and heptachlor epoxide)
Dieldrin	0.0000315	0.001	0.001 (as sum of aldrin and dieldrin)
Lindane	0.097	-	0.01
Endrin	-	0.002	0.002
Methoxychlor	-	0.040	0.040
Octachlorostyrene	-	0.1[a]	-
alpha-Chlordane	0.00053 (as Chlordane)	0.060	0.060 (as Chlordane)
gamma-Chlordane	"	"	"
Chloroform	43	-	-
1,1,1-trichloroethane	117	-	-
Trichloroethylene	94	-	-
Carbon tetrachloride	20	-	-
Methylene chloride	59	-	-
Dibutylphthalate	-	4	-
Diethylhexylphthalate	-	0.6	-
Other phthalates	-	0.2	-
Mirex	-	0-1.0*	Substant. absent
PBB	-	0*	-

@ Advisory - Conservative value based on limited toxicological information (Subject to revision as data becomes available - margin of safety is modified to reflect increased confidence in database).

* See narrative in MOE 1984 Water Management Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment.

Table 6-18. Organic compounds monitored in 1979-80 at Detroit River lower transect (R3.9).

Parameter	Level of Detection (ug/l)
Aroclor 1242	0.1
Aroclor 1254	0.1
Aroclor 1260	0.1
Total PCB	0.3
Total PBB	0.1
Chlordane	0.1
Heptachlor	0.02
Heptachlor epoxide	0.02
Lindane (g-BHC)	0.1
Endrin	0.1
Methoxychlor	0.1
Di-N-butyl phthalate	1.0
Diethylhexyl phthalate	1.0
o',p-DDT	0.05
p',p'-DDT	0.01
Dieldrin	0.02

Table 6-19. Concentrations of diethylhexylphthalate at the lower transect of the Detroit River, 1979-80 (ug/l) (MDNR monitoring data).

Monitoring Station @	May 1, 1979	June 13, 1979	May 20, 1980	June 17, 1980
10 station composite (820011-820029)	4.5			
820011, 820014		6.3	11	K2
820016, 820017, 820018		K1	21	K2
820024, 820025, 820026		K1	45	K2
820027, 820029		2.1	15	K2.1

K Indicates not detected at the level shown.

@ Locations of monitoring stations as shown in Figure 6-1.

GLWQA objective = 0.6 ug/l

Table 6-20. Organic contaminant monitoring at three Michigan municipal water supply intakes in the Detroit River, 1971-76. (MDNR Monitoring Data)

Parameter	Level of Detection (ug/l)	Years Sampled
Bis-2-ethylhexylphthalate	1.0	1975-76
Di-N-Bis-phthalate	1.0	1975-76
Chlordane	0.05	1975-76
DDD	0.001	1971-72
DDE	0.001	1971-72
DDT	0.001	1971-72
Dieldrin	0.001	1974-72
Endrin	0.01	1975-76
Toxaphene	1.0	1975-76
Heptachlor	0.005	1975-76
Heptachlor Epoxide	0.005	1975-76
Methoxychlor	0.05	1975-76
Total PCB	0.01	1971-76
2,4-D	0.05	1975-76
Silvex	0.5	1975-76
Lindane	0.05	1975-76

some organic contaminants at concentrations greater than their detection limits (Table 6-21). Of the large number of organic contaminants tested for, none exceed PWQOs (where developed) with the possible exception of the pesticide Heptachlor. Heptachlor may have exceeded the PWQO on one occasion at the Windsor intake, but the concentration found was so low it could not be quantified with confidence. Most organic compounds were below detection levels, even though highly sensitive equipment was utilized in the chemical analysis. Treated drinking water was also analyzed in this program. No organic contaminants exceeded the Ontario Drinking Water Objectives (ODWO) (where developed) in the Windsor or Amherstburg water supplies.

Beginning in June 1985, the MOE tested for dioxins at Windsor and Amherstburg Water Treatment Plants, as well as others in the Lake Huron-Erie Corridor (OME 1986).

In November 1985, an agreement was entered into by Health and Welfare Canada (HWC), Carleton University and the OME to allow this program to be expanded to include additional area water treatment plants.

Arising from this joint study on dioxin testing, several technical decisions relating to data interpretation required resolution. HWC uses high resolution mass spectrometry while the MOE routinely uses low resolution mass spectrometry, with high resolution mass spectrometry reserved for corroborating positive findings.

Results to May 1986 indicated that no dioxins or furans have been found in treated waters subsequent to February 26, 1986. At about that time, the MOE Laboratory and HWC revised the criteria for interpreting chlorinated dibenzodioxin and dibenzofuran analytical data at the part per quadrillion (ppq) levels in drinking water supplies. This protocol is required to formalize the rigorous data interpretation rules necessary to handle ultra-trace organic compound analysis near the method detection limit. This change in reporting procedures could account for the non-detection of dioxins and furans subsequent to February 26, 1986.

The protocol ensures that:

- A high degree of reliability can be attached to the analytical data,
- The methods of data treatment are clearly specified, and
- Data reported by different laboratory can be compared on a common basis.

A summary of the results of the dioxin survey from the Windsor and Amherstburg plants follows, with dates shown by month/day/year:

- Octadibenzofurans were found in treated water at trace levels at Windsor on 12/03/85.
- No 2,3,7,8-tetradibenzodioxin was found in any sample of raw or treated water.
- Tetradibenzodioxins were found in raw water at Windsor on 07/15/85, none were found in treated water.

Table 6-21. Summary results of approximately 110 organic parameters tested for in raw Detroit River water taken for treatment at Windsor and Amherstburg Water Treatment Plants on a monthly basis from 1986 to 1989 (parameters below detection limits are not shown).

Windsor

Test Parameter	Detection Limit	# Detected (# Samples)	Maximum Value	PWQO	ODWO
Alpha BHC	0.001 ug/l	46 (58)	0.005 <T		
Lindane	0.001 ug/l	8 (58)	0.003 <T	0.010 ug/l	4 ug/l
Atrazine	0.050 ug/l	6 (49)	0.540 <T		60 ug/l
Heptachlor	0.001 ug/l	1 (60)	0.005 <T	0.001 ug/l	3 ug/l
Atratone	0.050 ug/l	1 (50)	0.290 <T		
Prometone	0.050 ug/l	1 (50)	0.150 <T		
Simazine	0.050 ug/l	1 (50)	0.140 <T	10 ug/l	10 ug/l
2,4-D	0.100 ug/l	1 (50)	0.210 <T	4 ug/l	100 ug/l
Hexachlorobutadiene	0.001 ug/l	5 (58)	0.005 <T		
Hexachlorobenzene	0.001 ug/l	4 (58)	0.002 <T	0.0065 ug/l	
1,2,4-Trichlorobenzene	0.005 ug/l	1 (58)	0.006 <T	0.500 ug/l	
Benzene	0.050 ug/l	5 (59)	3.000 <T		5 ug/l
Toluene	0.050 ug/l	8 (59)	0.200 <T		24 ug/l
Ethylbenzene	0.050 ug/l	5 (59)	0.500 <T		2.4 ug/l
M-Xylene	0.100 ug/l	2 (59)	0.200 <T		300 ug/l
O-Xylene	0.050 ug/l	2 (59)	0.100 <T		300 ug/l
Chloroform	0.100 ug/l	11 (59)	19.600		
1,1,1-Trichloroethane	0.020 ug/l	2 (59)	2.000		
Dichlorobromomethane	0.050 ug/l	6 (59)	9.200		
Chlorodibromomethane	0.100 ug/l	3 (59)	3.700		
Bromoform	0.200 ug/l	1 (59)	0.200 <T		
Styrene	0.050 ug/l	8 (15)	0.250 <T		
Total Trihalomethanes (TMH)	0.500 ug/l	9 (59)	57.000		350 ug/l
Tetrachloroethylene	0.050 ug/l	2 (59)	0.400 <T		
1,1-Dichloroethylene	0.100 ug/l	1 (59)	2.000		

Amherstburg

Test Parameter	Detection Limit	# Detected (# Samples)	Maximum Value	PWQO	ODWO
Alpha BHC	0.001 ug/l	24 (35)	0.004 <T		
Beta BHC	0.001 ug/l	1 (35)	0.001 <T		
Lindane	0.001 ug/l	3 (35)	0.002 <T	0.010 ug/l	4 ug/l
Atrazine	0.050 ug/l	1 (23)	0.100 <T		60 ug/l
Pentachlorobenzene	0.001 ug/l	1 (35)	0.003 <T	0.030 ug/l	
Flouranthene	0.020 ug/l	1 (22)	0.010 <T		
Benzo(k) Flouranthene	0.001 ug/l	1 (22)	0.001 <T		
Benzene	0.050 ug/l	5 (35)	2.000		5 ug/l
Toluene	0.050 ug/l	2 (34)	0.100 <T		24 ug/l
P-Xylene	0.100 ug/l	2 (34)	0.100 <T		300 ug/l
M-Xylene	0.100 ug/l	4 (34)	0.200 <T		300 ug/l
O-Xylene	0.050 ug/l	5 (34)	0.050 <T		300 ug/l
Chloroform	0.100 ug/l	4 (44)	0.300 <T		
Styrene	0.050 ug/l	2 (15)	0.200 <T		
Tetrachloroethylene	0.050 ug/l	11 (22)	0.250 <T		

<T Indicates a trace level which is at or only slightly above the detection limit of the analytical method and can not be quantified with confidence.

- Heptadibenzodioxins were found only once in raw water at Amherstburg on 12/02/85; they were not found in treated water.
- Octadibenzodioxins were found in raw water at Windsor on 07/15/85, 09/25/85, 11/20/85, 12/03/85, 12/10/85, 12/17/85, 02/12/86, 02/19/86 and 02/26/86; and at Amherstburg on 07/02/85, 11/19/85, 12/02/85, 01/21/86, 02/17/86 and 02/26/86.
- Octadibenzodioxins were found at trace levels in raw water at Windsor on 01/14/86.
- Octadibenzofurans were found in raw water at Windsor on 12/03/85.

To put the results of the octadibenzodioxins and the octadibenzofurans in perspective, the following information is offered:

- An interim "maximum acceptable concentration" of 15 ppq (as 2,3,7,8-dibenzodioxin) for drinking water was derived by an expert group with members from HWC, Ontario Ministry of the Health, Ontario Ministry of Labour, and OME. Dibenzodioxins and dibenzofurans, other than 2,3,7,8-tetradibenzodioxin, are far less toxic, some of these by as much as a factor of ten thousand.

- Therefore, the levels found in treated water, even for a maximum value of 46 ppq octadibenzodioxin at Windsor (01/21/86), should be compared to a much larger number to reflect the lower toxicity of this compound. This number is 150000 ppq, derived by multiplying the health-based level of 15 ppq by the lower toxicity factor of 10000. A similar comparison can made for the situation of trace levels of octadibenzodioxins plus octadibenzofurans found in Windsor assuming the maximum values for the two traces (at $T \leq 10$ ppq), i.e. $T \leq 20$ ppq total, by again comparing with the 150000 ppq number to reflect the lower toxicity of the two compounds.

  Note: $T \leq$ (number) means below or equal to the reporting limit, that is, dioxin or furan is present, but at a level too low to quantify.

A summary of OME dioxin sampling results subsequent to 1986, along with a reassessment of earlier findings based on refined analytical and reporting procedures, is currently under review by the OME.

The OME conducted a study in 1988 (Cowell 1990) to document organic contamination along the Ontario shoreline. Twenty-eight stations in the river were sampled in July and again in August of 1988. In addition, the following point sources were also sampled: Amherstburg WPCP, West Windsor WPCP, and Windsor CSOs and the mouths of Little River, Turkey Creek and the Canard River. Analytical constraints precluded intensive analysis at all stations. The sampling program was designed to economically screen for the presence of organic contaminants where they would most likely be expected to occur.

Preliminary findings indicate that several pesticides are ubiquitous (lindane and its breakdown products), while trace levels of organic contaminants were occasionally detected at the Windsor and Amherstburg WPCPs, the Little River and Turkey Creek.

Table 6-22 provides a brief summary of organic compounds detected, their location and concentrations.

These findings indicate that low concentrations of PAHs are entering the Detroit River from Turkey Creek. Additional sources may exist in the vicinity of Amherstburg. However, the Amherstburg WPCP does not appear to be a source. The significance of these findings is not well understood. However, levels do not appear to pose serious concerns in the context of the EPA Human Health Ambient Water Quality Criterion of 42 ug/l for fluoranthene.

6.1.4.1 Polychlorinated Biphenyls (PCBs)

PCB concentrations are a concern in the Detroit River due to the persistance and high bioaccumulation potential of this compound. Various studies have found ambient levels of PCBs to exceed Michigan's Rule 57(2) value of 0.02 ng/l and the Ontario PWQO of 1.0 ng/l. In the Detroit River Systems Mass Balance Study (U.S. EPA 1988b), total PCB concentrations in ambient water averaged 1.4 ng/l at the upstream transect (Table 6-23) and 3.3 ng/l at the downstream transect, based on composite samples across the river for each transect (means of two 7-day sampling periods). Concentrations in the Trenton Channel ranged from 1 to 385 ng/l with the highest concentrations found along the western shore of the channel (U.S. EPA and EC 1988).

A study of 9 PCB congeners in the Detroit River showed a decrease in the lower chlorinated congeners (one to four chlorines per biphenyl molecule) and an increase in the higher chlorinated congeners (6 to 10 chlorines per molecule) with increased distance downstream. The authors concluded that given the stability of PCBs, this shift indicated an input of higher chlorinated PCBs along the river (Williams 1988).

An earlier survey conducted in 1983 also found elevated levels of PCBs in the Detroit River (Kaiser et al. 1985). PCB concentrations in water averaged 0.6 ng/l at four stations near the head of the river and increased downstream to 1.0 ng/l on the Ontario side and to levels as high as 3.4 ng/l in and downstream of the Trenton Channel.

PCBs were not detected in whole water during a 1984 study (detection level of 20 ng/l) (Johnson and Kauss 1987); however, levels of PCBs in suspended solids ranged from 65 to 499 ng/g along the Michigan shoreline and 14 to 32 ng/g along the Ontario shoreline. Oliver (1986) illustrated a significant correlation between octanol/water (k_{OW}) and organic carbon corrected partition coefficients (K_{OC}) utilizing total organic carbon (TOC) values for particulates, contaminant levels measured on suspended particulates and organic carbon corrected partition coefficients, estimates of dissolved (aqueous) contaminant levels and whole water concentrations were obtained. Predicted whole water concentrations based on expected partitioning behavior estimate PCB levels up to 15.6 ng/l downstream from the Rouge River. Predicted concentrations were generally below the PWQO of 1 ng/l in samples collected along the Ontario shoreline. PCB loadings at the head of the Detroit River, estimated from levels measured on suspended solids were on the order of 3.7 kg/d. This would suggest that sources in the upper

Table 6-22. Summary of selected organic parameters detected along the Ontario shoreline of the Detroit River in July and August, 1988 (Cowell 1990).

Sampling Site	Parameter Detected	Concentration Range
Amherstburg STP	bis-2-ethylhexylphthalate	10*-30 ng/L
	di-n-butylphthalate	2*-11 ng/L
	2,4,6-trichlorophenol	300 ng/L
	hexachlorobenzene	12 ng/L
	solvent extractables	370 ng/L
	indole	3*-31 ng/L
West Windsor STP	bis-2-ethylhexylphthalate	3* ng/L
	butylbenzylphthalate	1* ng/L
	di-n-butylphthalate	3 ng/L
	di-n-octylphthalate	3 ng/L
	2,4,6-trichlorophenol	110 ng/L
	hexachlorobenzene	10 ng/L
	solvent extractables	13 ng/L
Turkey Creek	anthracene	2* ng/L
	benzo (x) fluoranthene	7* ng/L
	benzo (a) pyrene	10* ng/L
	fluoranthene	40* ng/L
	phananthrene	170-180 ng/L
	pyrene	1*-60 ng/L
Little River	benzo (h) fluoranthene	1* ng/L
Detroit River mouth	hexachloroethane	4-7 ng/L
downstream of Amherstburg	benzo (b) fluoranthene	10* ng/L
	benzo (x) fluoranthene	2* ng/L
	benzo (b) chyrsene	2* ng/L
downstream of Turkey Creek	anthracene	2* ng/L
	benzo (k) fluoranthane	2* ng/L
	phenanthrene	30* ng/L
	pyrene	20* ng/L

* Approaching the detection limit of the analytical method; can not be quantified with confidence.

Table 6-23. Mean concentrations of organic contaminants at Detroit River upper and lower transects.

LOCATION	TOTAL PCB (ng/l)	HEXACHLOROBENZENE (ng/l)	PAH** (ng/l)
Detroit-upper transect	1.4*	0.31*	100 to 350
Detroit-lower transect	3.3*	0.33*	380 to 3,900
Trenton Channel	1 to 385 ***	0.38***	3,000

* Data from Detroit River Systems Mass Balance Study. Values are based on composite samples across the river for each transect, means of two 7-day sampling periods, one during high flow and one during low flow periods, 1986 (U.S. EPA 1988a).

** Data from a 1983 survey (Kaiser et al. 1985).

*** Data from Trenton Channel Mass Balance Study conducted in 1986 (U.S. EPA 1988b).

Detroit River, particularly adjacent to the Michigan shore, are contributing substantial inputs of PCBs (Figure 6-13). These loadings were marginally increased at the Detroit River mid-area downstream of the Rouge River, before decreasing to 1.6 kg/d load at the mouth of the Detroit River.

A review of the existing data from the above sources indicates polychlorinated biphenyls (PCBs) are present throughout the Detroit River at concentrations above the applicable criteria. The Trenton Channel has PCB concentrations higher than the main river, indicating sources upstream along the Michigan shoreline. The Michigan 304(1) list (Benzie 1989) also identifies two portions of the Detroit River as exceeding Michigan's Rule 57(2) level for PCB. The Great Lakes Water Quality Agreement (IJC 1988) does not identify a Specific Objective for PCB in water.

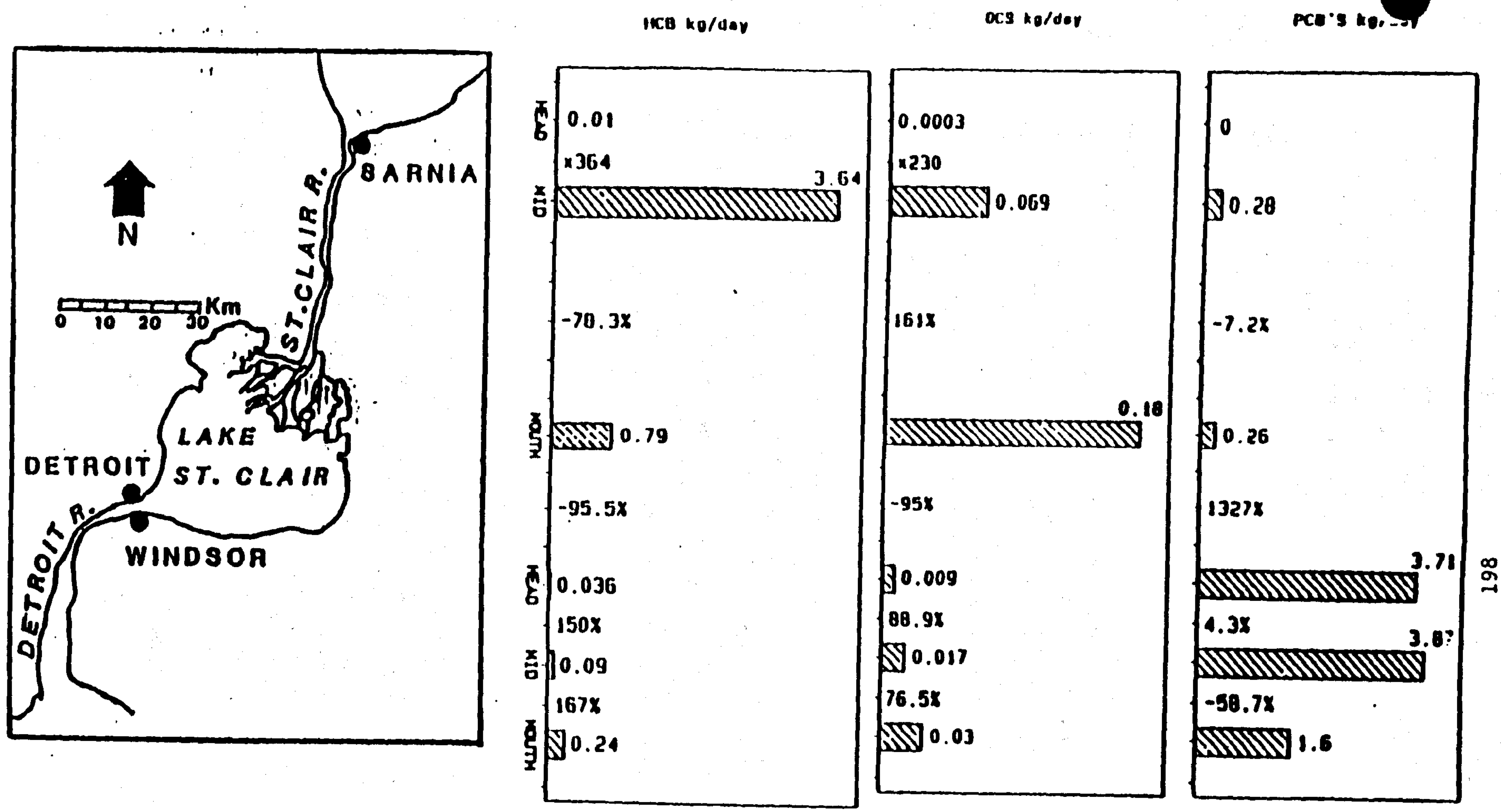
6.1.4.2 Chlorobenzenes

Several surveys have indicated the presence of hexachlorobenzene and other chlorinated benzenes in the Detroit River. The Detroit River System Mass Balance Study (U.S. EPA 1988a) revealed no significant change in total hexachlorobenzene (HCB) concentrations from the upstream to the downstream transects (0.33 ng/l), indicating no significant sources along the river. This concentration of HCB did not exceed the Ontario PWQO of 6.5 ng/l or the Michigan's Rule 57(2) level of 1.8 ng/l. There is not a GLWQA Specific Objective for HCB.

Hexachlorobenzene concentrations were found to be slightly elevated (0.38 ng/l) in the Trenton Channel during the Trenton Channel Mass Balance Study (U.S. EPA 1988b). Concentrations ranged from 0.02 to 2.84 ng/l with an average of 0.38 ng/l (± 0.49 ng/l S.D.). Stations nearest the Michigan shore had higher mean concentrations (0.695 ng/l) than those closer to Grosse Ile (0.24 ng/l). Four individual samples from the station nearest the Michigan shoreline contained levels of HCB which exceeded Michigan's Rule 57(2) level but not the Ontario PWQO. These data suggest there may be some sources of HCB on the Michigan shoreline in or upstream of the Trenton Channel.

Hexachlorobenzene measured on suspended solids ranged from 2.8 to 11.5 ng/g and 4.5 to 19 ng/g along the Michigan and Ontario shorelines, respectively (Johnson and Kauss 1987). These values were used to predict HCB concentrations in whole water (based on expected partioning behavior) of less than 0.6 ng/l. Minor sources of HCB appear to occur along the length of the Detroit River, as estimated loadings increased from 36 g/d to 240 g/d in the head to mouth interval (Figure 6-13). Estimated whole water concentrations on the Ontario shoreline appear to be somewhat higher than along the Michigan shoreline; however, there was no statistical difference at a probability level of 0.05.

In a survey conducted prior to the Mass Balance Study, unspecified chlorinated benzenes in the upper Detroit River ranged from 0.3 to 2 ng/l (Kaiser et al. 1985). Higher levels were noted on the Michigan side, especially in the Rouge River where chlorobenzene levels reached 25.9 ng/l. Further analysis of this sample showed a concentration of only 0.28 ng/l HCB, indicating HCB was a minor component of the chlorobenzenes.



HCB = Hexachlorobenzene
OCS = Octachlorostyrene
PCBs = Polychlorinated biphenyls (total)

Figure 6-13. Relative loading differences between segments of the St. Clair and Detroit Rivers. (Source: Johnson and Kauss 1987).

6.1.4.3 Other Organochlorine Compounds

A variety of additional organochlorine contaminants have been observed in the Detroit River water. Among these are DDT (and its environmental metabolites DDD and DDE), hexachlorocyclohexane (3 isomers), chlordane (2 isomers), heptachlor epoxide, endosulfan (2 isomers), dieldrin, endrin, methoxychlor, and octachlorostyrene. These compounds were found along both shores at concentrations ranging from 0.3 to 0.5 ng/l in the upper Detroit River (U.S. EPA and EC 1988). Significantly higher organochlorine concentrations with the exception of octachlorostyrene were observed at many downstream stations on the Michigan side with values as high as 20 ng/l at the mouth of the Rouge River. Octachlorostyrene levels, however, were virtually constant throughout the river at 0.005 to 0.008 ng/l in water. The Ontario Ministry of the environment has developed a water quality advisory for octachlorostyrene of 0.1 mg/l. This is an extremely conservative number based on limited toxicological information and will be amended as new toxicity information emerges. There is not a Michigan Rule 57(2) value or a GLWQA Objective for this compound. Octachlorostyrene concentrations on suspended solids were generally low, ranging from 0.8 to 3.2 ng/g; however, minor inputs may have been associated with both Michigan and Ontario shores as concentrations on suspended solids increased from 0.8 to 3.0 ng/g and 2.5 to 3.2 ng/g, respectively (Johnson and Kauss 1987). These data indicate upstream sources of octachlorostyrene and significant loadings of other organochlorine compounds along the Michigan side of the Detroit River (U.S. EPA and EC 1988). Estimated loadings (Figure 6-13) suggest minor additional inputs of octachlorostyrene along the length of the Detroit River. Estimated whole water concentrations from measurements on suspended solids (Johnson and Kauss 1987), suggest that levels of octachlorostyrene in the Detroit River are below the Ministry of the Environment water quality advisory.

Volatile halocarbons have also been observed in the Detroit River (Comba and Kaiser 1985), at levels below applicable criteria (where developed). Chlorinated hydrocarbons such as chloroform, bromo-dichloro-methane, and chloro-dibromo-methane are common in chlorinated wastewater effluent and were observed at levels exceeding 1.0 ug/l in the Detroit River downstream of wastewater treatment plant outfalls and combined sewer overflows. Other volatile halocarbons such as 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, carbon tetrachloride, methylene chloride, Freon II (CCl_3F) and Freon 12 (CCl_2F_2), were also found at levels below water quality concern. These compounds most likely originate from industrial facilities since they are either produced or used by industrial processes.

6.1.4.4 Polynuclear Aromatic Hydrocarbons

Polynuclear aromatic hydrocarbons (PAHs) are byproducts of incomplete combustion of fossil fuels, petroleum refining and coking for steel making operations. Concentrations in the upper Detroit River ranged from 100 to 350 ng/l for total PAH (Kaiser et al. 1985). Concentrations increased downstream along the Ontario and particularly the Michigan shoreline with values as high as 6,100 ng/l at Fighting Island. Concentrations at four sampling stations in the lower Detroit River ranged from 380 to 3,900 ng/l (mean was 1600 ng/l). Individual PAH compounds were not measured in this study.

Table 6-22 outlines concentrations of some PAHs measured during 1988 (Cowell 1990). Most PAHs were measured at or near detection levels; however, phenanthrene was measured at 0.18 ug/l at the mouth of Turkey Creek.

There are no water quality criteria for total PAH in water, but Michigan has developed Rule 57(2) levels for some individual PAH compounds. U.S. EPA has established a Human Health Ambient Water Quality Criteria of 42 ug/l for fluoranthene.

6.1.5 Water Quality Summary

Conventional parameters (e.g. temperature, pH, dissolved oxygen) measured in the Detroit River were in a range sufficient to protect and maintain aquatic life, pursuant to Michigan Water Quality Standards, Ontario Provincial Water Quality Objectives, and GLWQA Objectives. Some nonconventional parameters (e.g. metals and PCBs) however, have been found to exceed either Michigan WQS Rule 57(2) levels, Ontario PWQ Objectives, or GLWQA Specific Objectives and potentially impair one or more of the designated beneficial uses of the river. These parameters and specific locations are summarized in Table 6-24, along with an identification of the description of the exceedance. Levels of other organic compounds detected in the river are below applicable water quality criteria, where these criteria have been developed.

6.1.6 Tributaries

6.1.6.1 Michigan Tributaries

The Rouge River is also a designated Area of Concern and a RAP has been developed to address water quality concerns in that drainage basin (MDNR 1989b, 1990). Water quality in each of the eleven subbasins of the Rouge River suffers a level of degradation to impair some, if not all, of the designated uses for that stream segment as established by the Michigan Water Resources Commission. Frequent and severe impairment of each designated use is common throughout the basin and is not limited to the downstream reaches.

The extent and severity of the use impairments in the Rouge River indicate that the sources of pollution responsible are common throughout the basin. Pollutants affecting the Rouge River originate from a number of diverse sources throughout the basin. This is a result of the large size of the basin and the variety of human activities and uses within its boundaries. The sources of impairment include: municipal and industrial discharges, combined sewer overflows, storm runoffs, sediments, upstream subbasin influences and stream flow. The causes of impairment include: conventional pollutants, nutrients, toxic pollutants, bacterial contamination, and general aesthetic concerns.

The most recent MDNR studies of the Ecorse River were conducted on the Sexton and Kilfoil Drain in the vicinity of Detroit Metro Airport. The Sexton and Kilfoil Drain at this location is a headwater area of the South Branch of the Ecorse River. Sampling of drain waters by Hendges (1990) showed extremely high BOD and ammonia levels to be present.

Table 6-24. Summary of Detroit River Water Quality Impairments.

Contaminant	Specific Location	Impaired Use
Bacteria	1. Michigan near shore waters immediately downstream of: Rouge River Confluence, and all Michigan CSOs.	Swimming (Fecal coliform levels exceed Michigan WQS).
	2. Ontario nearshore waters downstream of: Little River, Turkey Creek, Amherstburg WPCP, and the City of Windsor CSOs.	Swimming (Fecal coliform levels exceed PWQO).
Mercury	Michigan WQS: Entire river. Ontario PWQO/GLWQA: Trenton Channel.	Restrictions on fish consumption; potential toxicity to aquatic life.
Cadmium	Michigan WQS: Michigan shore of lower river. Ontario PWQO/GLWQA: Lower river, entire width.	Potential toxicity to aquatic life.
Copper	Ontario PWQO/GLWQA: Lower river, Michigan side.	Potential toxicity to aquatic life.
Lead	Michigan WQS: Lower river, Michigan and Ontario sides.	Potential toxicity to aquatic life.
Zinc	All criteria: Lower river, entire width.	Potential toxicity to aquatic life.
PCBs	All criteria: Entire river.	Restrictions on fish consumption.

This degraded water quality was attributed to the likely presence of plane de-icing fluids within stormwater that is periodically discharged to the drain from the airport. Jones (1990) found degraded aquatic macroinvertebrate communities in the same general area of the Sexton and Kilfoil Drain and attributed these conditions primarily to unstable flood regimes. He also concluded that discharges of de-icing fluids could have impacted the biological communities that were evaluated. Studies of the main branch of the Ecorse River near the mouth showed the presence of sediments contaminated with heavy metals, cyanide, volatile organic compounds, nutrients, and oil and grease (U.S. EPA 1985). Earlier studies of the Ecorse River documented severe sediment contamination problems in the upper reaches of the north branch of the river (Evans 1978) and in the main branch of the river (Rydquist and Willson 1969). The problems noted in the upper north branch of the river were determined to be caused by a hazardous waste treatment facility. Problems noted in the main branch of the river were mainly related to combined sewer overflows (CSOs).

Degraded aquatic macroinvertebrate communities were noted in the upper (Jones 1990) and lower (Evans 1988) reaches of the Frank and Poet Drain. The primary causes of those findings was determined to be unstable flow regimes. However, it was noted that the aquatic macroinvertebrate communities in the upper reaches of the drain may also have been impacted by periodic discharges of stormwater contaminated with plane de-icing fluid from the Detroit Metro Airport.

Sediments contaminated with heavy metals, numerous organic compounds, and oil and grease are present in the lower reaches of Huntington Creek (a.k.a. Monguagon Creek) (Schrameck 1991). It was concluded that the most likely cause of this contamination was due to past discharges from Atochem North America, Inc. (formerly Pennwalt Chemical Corporation). Studies conducted in the vicinity of the mouth of Huntington Creek in 1988 (Hites 1989) demonstrated that sediment transport impacts from Huntington Creek could clearly be traced into the western basin of Lake Erie.

Further basin wide biological and chemical surveys will be conducted by MDNR staff during the summer of 1991 on the Ecorse River, Frank and Poet Drain, and Huntington Creek to supplement existing information.

6.1.6.2 Ontario Tributaries

Thirteen tributaries which discharge to the St. Clair and Detroit Rivers and Lake St. Clair from Ontario watersheds were sampled over an 18 month period beginning in April 1984 (Johnson and Kauss 1991). Water, suspended solids and bottom sediments were collected on an approximately quarterly basis for a wide range on environmental contaminants. These included: nutrients, phenols, inorganics including heavy metals, total PCBs, chlorinated organic compounds, several classes of pesticides, as well as oils and greases. A tabular summary (Table 6-25) of findings for selected general categories of industrial organic compounds and trace metals follows. For a more complete description of these tributaries and their respective contributions as non-point sources to the Detroit River, the reader is referred to Section 8.3.1.2.

Table 6-25: Occurrence of trace metals and industrial organic compounds in whole water samples of Ontario tributaries (1984-1985).

Tributary	Aluminum		Cadmium		Chromium		Copper		Iron		Lead		Mercury		Nickel		Zinc	
	%>PWQO	n	%>PWQO	n	%>PWQO	n	%>PWQO	n	%>PWQO	n	%>PWQO	n	%>PWQO	n	%>PWQO	n	%>PWQO	n
Little River	100	5	25	8	0	8	75	8	100	8	0	8	0	8	62.5	8	37.5	8
Turkey Creek	100	5	75	8	0	8	75	8	62.5	8	12.5	8	0	8	12.5	8	50	8
Canard River	100	5	50	8	0	8	62.5	8	100	8	0	8	0	8	0	8	12.5	8
Big Creek	0	0	0	1	0	1	0	1	100	1	0	1	0	1	0	1	0	1
PWQO	100 ug/L		0.2 ug/L		100 ug/L		5 ug/L		300 ug/L		25 ug/L		0.2 ug/L		25 ug/L		30 ug/L	
MDL	1 ug/L		0.2 ug/L		1 ug/L		1 ug/L		1 ug/L		3 ug/L		0.01 ug/L		1 ug/L		1 ug/L	

Tributary	Hexachlorobenzene			Hexachlorobutadiene			Hexachloroethane			Total PCBs			Total Phenols			Octachlorostyrene		
	%>MDL	%>PWQO	n	%>MDL	%>PWQO	n	%>MDL	%>PWQO	n	%>MDL	>PWQO	n	%>MDL	%>PWQ	n	%>MDL	%>PWQO	n
Little River	28.6	0	7	12.5	0	8	12.5	-	8	0	NAP	8	71.4	71.4	7	0	-	8
Turkey Creek	25	0	8	0	0	8	0	-	8	0	NAP	8	100	85.7	7	0	-	8
Canard River	12.5	0	8	12.5	0	8	12.5	-	8	0	NAP	8	71.4	71.4	7	0	-	8
Big Creek	0	0	1	0	0	1	0	-	1	0	NAP	1	0	0	1	0	-	1
PWQO	6.5 ng/L			100 ug/L*			N.A.			1 ng/L			1 ug/L			N.A.		
MDL	1 ug/L			1 ng/L			1 ng/L			20 ng/L			0.2 ug/L			1 ng/L		

Source: Johnson and Kauss (1991).

MDL - Method Detection Limit
N.A. - Not Available
* - Manitoba guideline
PWQO - Provincial Water Quality Objective
NAP - Not applicable since MDL is >PWQO
n - Number of samples analyzed
d/s - Downstream station (at mouth)
u/s - Upstream station

6.1.7 Drinking Water

During the summer of 1990, taste and odor problems were encountered in drinking water supplied to the Michigan downriver communities and City of Windsor. Windsor water treatment plant officials postulated that aquatic plants were responsible for this phenomenon. During July of 1990, as the first indications of this taste and odor problem was encountered, the Windsor water intake increased chlorine residual from 1 mg/l to 1.2 mg/l. However, the taste and odor problem worsened as water temperatures increased. During this time approximately 250 kg/day of aquatic plants began to collect at the bar screen of the water intake. In an attempt to confirm whether this problem was associated with this accumulation of plants, plant material was sent to several laboratories for analysis. Results from two of the laboratories identified the plant as traditional pond weeds, while a third laboratory concluded that "geosmin", a naturally occuring chemical secretion from blue green algae, may have been the responsible agent. Raw and treated water samples have been submitted for chemical analysis to determine if in fact, geosmin is the causative agent (J. Fraser, City of Windsor, Pers. Comm.).

Initially Detroit Water and Sewerage Department (DWSD) officials believed the taste and odor problem may have been associated with cleaning operations carried out on the pretreatment basins at their southwest water treatment plant at Allen Park. The water intake serving this plant is located at Fighting Island (see Chapter 5). Areas affected included Ash Township, Brownstown Township, Belleville, Ypsilanti Township, Allen Park, Grosse Ile, Huron Township, Melvindale, Romulus, VanBuren Township, Ecorse, Southgate, Taylor, Trenton, Riverview and Flat Rock. In response to the problem, DWSD officials reduced the demand for this plant as much as possible, and used carbon treatment at the facility to minimize taste and odor complaints. DWSD plans to do numerical modeling and hydrologic studies on the Detroit River to see if the intake is being adversely influenced.

The cause of the taste and odor problem for DWSD was also postulated to be due to geosmin. Geosmin was found at concentrations of 38 parts per trillion (ppt) and 30 ppt in water samples from this treatment facility (DWSD correspondence, 9/12/90). DWSD indicated geosmin appears to affect taste when the concentration in water is greater than 50 ppt. The borderline region is in the range of 30-50 ppt (DWSD correspondence, 9/12/90).

The City of Windsor plans to establish its own testing facilities in anticipation of a similar problem next summer. Treatment methods to alleviate this problem include the use of potassium permanganate or activated carbon. It has been suggested that this apparently sudden abundance of weeds may be the result of increased water clarity associated with the proliferation of zebra mussels in the area.

Taste and odor problems in Detroit drinking water were also noted in December, 1990, requiring DWSD to use carbon treatment. The cause in this situation was attributed to the seasonal turnover in Lake St. Clair, compounded by a recent snowstorm.

6.1.8 Aesthetics

Large volumes of combined sewer overflows frequently discharging to the river following wet weather events contribute discolored water (e.g. from slaughter houses), oil and grease, and other types of objectionable deposits and debris (Roy Schrameck, Personal Communication). Due to the high flow of the river, these effects are usually not persistant, with the exception of remaining debris along the shorelines.

Numerous spills of various materials have been noted in the river (see Chapter 8). A total of 12 oil related spills were reported to the U.S. Coast Guard Marine Safety Office in 1989.

Industrial and urban development along the Detroit River have detracted from the natural beauty of the area, however these are not water quality impacts.

6.2 SEDIMENT QUALITY

The bottom of the Detroit River is composed of materials ranging from very fine silty clay to bedrock. Most of the river bottom is covered with varying thickness of silt, clay, sand, or gravel, but some sections along the Canadian shore are limestone bedrock. The deep mid-river section between Belle Isle and Fighting Island is consolidated glacial clay. The velocity of the currents dictate the bottom constituents in other areas. For instance, backwater and protected areas near the shoreline are dominated by silty clay ooze, while the majority of the mid-section of the Trenton Channel, which has a moderate velocity, is fine gravel or medium sand. River sediments continuously shift and change in areas where velocities are moderate to high, resulting in shoaling in the dredged navigational channels and considerable downstream sediment transport.

Sediment quality is important to the shipping industry since dredging is periodically required to maintain shipping channels, boat slips and berths. Dredging activities in the Detroit River were estimated to product 420,000 cubic meters of dredged materials (average annual quantity, 1975) (IJC 1982). Disposal of the dredged sediments is regulated dependent on contaminant levels in the dredged materials. Navigational dredge material is currently disposed of by the U.S. Corps of Engineers at Pointe Mouillee, a confined disposal facility. The Pointe Mouillee facility is an interagency cooperative project located at the mouth of the Huron River in Lake Erie. The project includes the construction of a 400 ft. diked containmant system for the disposal of polluted spoil from the Detroit and Rouge Rivers. When the site (called Barrier Island) is filled, it will be developed and managed by MDNR to (1) restore a functional wetland system to the west shore of Lake Erie, (2) develop waterfowl, wetlands wildlife and fisheries programs, and (3) develop public use and education programs. Pointe Mouillee is also a State Game Area.

The majority of navigational dredge material on the Canadian side is also confined. Navigational dredging on the Canadian side of the International Border is conducted by the Canadian Department of Public Works under the auspicious of the Department of Transport. The most recent example of navigational dredging involved the removal of 75,000 cu.m. of material which was disposed of at the Michigan Pointe Mouillee facility.

Sediment quality also impacts aquatic organisms which live in or near the sediments, and other aquatic life which consume plants or benthic aquatic organisms. Sediments with high levels of contaminants or low oxygen concentrations can be toxic to aquatic life. Contaminant levels in sediments and sediment toxicity to benthic organisms is described in detail in the following text.

Contaminated sediments per se are not an impaired use. Contaminated sediments could potentially cause impaired uses in the river if they can be related to:

(1) toxicity to plants, benthic organisms, near-bottom zooplankton or fish larvae or eggs; or

(2) bio-uptake of contaminants resulting in:

   (a) toxicity to aquatic organisms via the food chain; or

   (b) bioaccumulation of contaminants in fish resulting in fish tumors or restrictions on fish (and wildlife) consumption; or

(3) movement of contaminants into the water column such that contaminant levels exceed appropriate standards/objectives; or

(4) restrictions on the disposal of dredged sediments.

Evaluating sediment contaminant levels in terms of identifying impaired uses is a difficult and perhaps impossible task at the time of the RAP preparation, primarily because defensible chemical-specific sediment quality criteria have not yet been developed.

The concept of utilizing sediment toxicity bioassays to determine the capability of sediments to support aquatic life, has been embodied in the OME Provincial Sediment Quality Guidelines, a draft discussion paper on their development and application produced in February, 1991 (Persaud et al. 1991). The draft Provincial Sediment Quality Guidelines are a set of numerical guidelines developed for the protection of aquatic biological resources. They have been derived to protect those organisms that are directly impacted by contaminated sediment, namely the sediment dwelling or benthic species. These guidelines are currently under review by the OME and will provide a much needed biological effects based method for evaluating sediments to determine what levels of contamination are acceptable in the short-term, and when contamination is severe enough to warrant significant remedial action.

In addition, the state-of-the-art of sediment toxicity testing has not progressed to the point where the results of these methods can be used as the sole support for regulatory decisions involving the management of contaminated bottom sediments. Additional research is needed to evaluate the intra- and interlaboratory precision of these methods and their ability to accurately predict in-field conditions.

The U.S. EPA Region V Guidelines for the Classification of Great Lakes Harbor Sediments (Table 6-26) are currently used as a preliminary indicator of sediment quality; the Guidelines are used with other methods to determine appropriate disposal options for dredged materials. The Guidelines are not intended to identify acceptable levels of contaminants in sediments such that aquatic life will be protected (U.S. EPA 1977). OME dredging guidelines have also been established to determine the quality of sediment necessary to enable open-water disposal of dredged material (Table 6-26) (Persaud and Wilkins 1976).

The following text and figures use the U.S. EPA Region V Classification Guidelines and OME Dredging Guidelines for comparison purposes due to the lack of any criteria for levels of concern for contaminants in sediments. The U.S. EPA is currently developing sediment quality criteria for the protection of aquatic life, as is OME. When these sediment quality criteria become available, this section of the RAP will need to be updated and revised.

6.2.1 Metals

Metals data are available from nine studies since 1980 (ERG 1983; ES&E et al. 1987; Kreis 1987; LTI 1985; Mudroch 1985; Kizlauskas and Pranckevicius 1987; Bertram et al. 1989; Lum and Gammon 1985; and Thornley and Hamdy 1984). These studies were performed for a variety of reasons with varying equipment but the data were all analyzed for total metals using the bulk sediment analysis procedure. The toxicity of Detroit River sediments is discussed in section 6.2.3 of this chapter.

For purposes of this report, the river was divided longitudinally into ten, three mile sections to account for the fact that the chemical quality of the Detroit River bottom sediment varies greatly with downstream distance. In addition, because there is considerable variation in sediment type across the river, the river was additionally divided laterally into an Ontario shoreline, a Michigan shoreline and a mid-river segment. Data from all of the above studies were plotted on maps for each of the commonly analyzed metals. The low, median and high value within each section were determined and plotted.

Figure 6-14 depicts a visual representation of the relative cumulative magnitude of metals contamination in the Detroit River sediments. This figure was developed by comparing the median concentration for each metal in each of the 30 river sections with the OME and U.S. EPA's classified guidelines. Sediment contaminant concentrations were obtained from the nine previously listed studies. Sediment metal concentrations in the nonpolluted range were assigned a value of zero, moderately polluted were assigned a value of two, and contaminants in the heavily

Table 6-26. U.S. EPA Region V Guidelines for the classification of Great Lakes harbor sediments, and Ontario Ministry of the Environment dredging guidelines. Values in mg/kg dry weight, values otherwise noted. (U.S. EPA 1977 and Persaud and Wilkins 1976)

Parameter	Background Concen-trations***	EPA Guidelines			OME Dredging Guideline
		Non Polluted	Moderately Polluted	Heavily Polluted	
Volatile solids (%)	1.52	<5	5-8	>8	
COD		<40,000	40-80,000	>80,000	
TKN		<1,000	1,000-2,000	>2,000	2,000
Oil and Grease (Hexane Solubles)			<1,000	1,000-2,000	>2,0001,500
Lead	17	<40	40-60	>60	50
Zinc	46	<90	90-200	>200	100
Ammonia		<75	75-200	>200	0.1
Cyanide		<0.10	0.10-0.25	>0.25	
Phosphorus	654	<420	420-650	>650	1,000
Iron		<17,000	17,000-25,000	>25,000	10,000
Nickel	18	<20	20-50	>50	25
Manganese		<300	300-500	>500	--
Arsenic	6.1	<3	3-8	>8	8
Cadmium	1.3	*	*	>6	1
Chromium	38	<25	25-75	>75	25
Barium		<20	20-60	>60	
Copper	15	<25	25-50	>50	25
Mercury	0.20			>1	0.3
Total PCB's	0.0	**	**	>10	0.05

@ OME dredging guidelines define acceptable levels for the open water disposal of dredged material.

* Lower limits not established.

** The pollutional status of sediments with total PCB concentrations between 1 and 10 mg/kg dry weight will be determined on a case-by-case basis.

*** Lake St. Clair/Lake Erie background levels (IJC 1982).

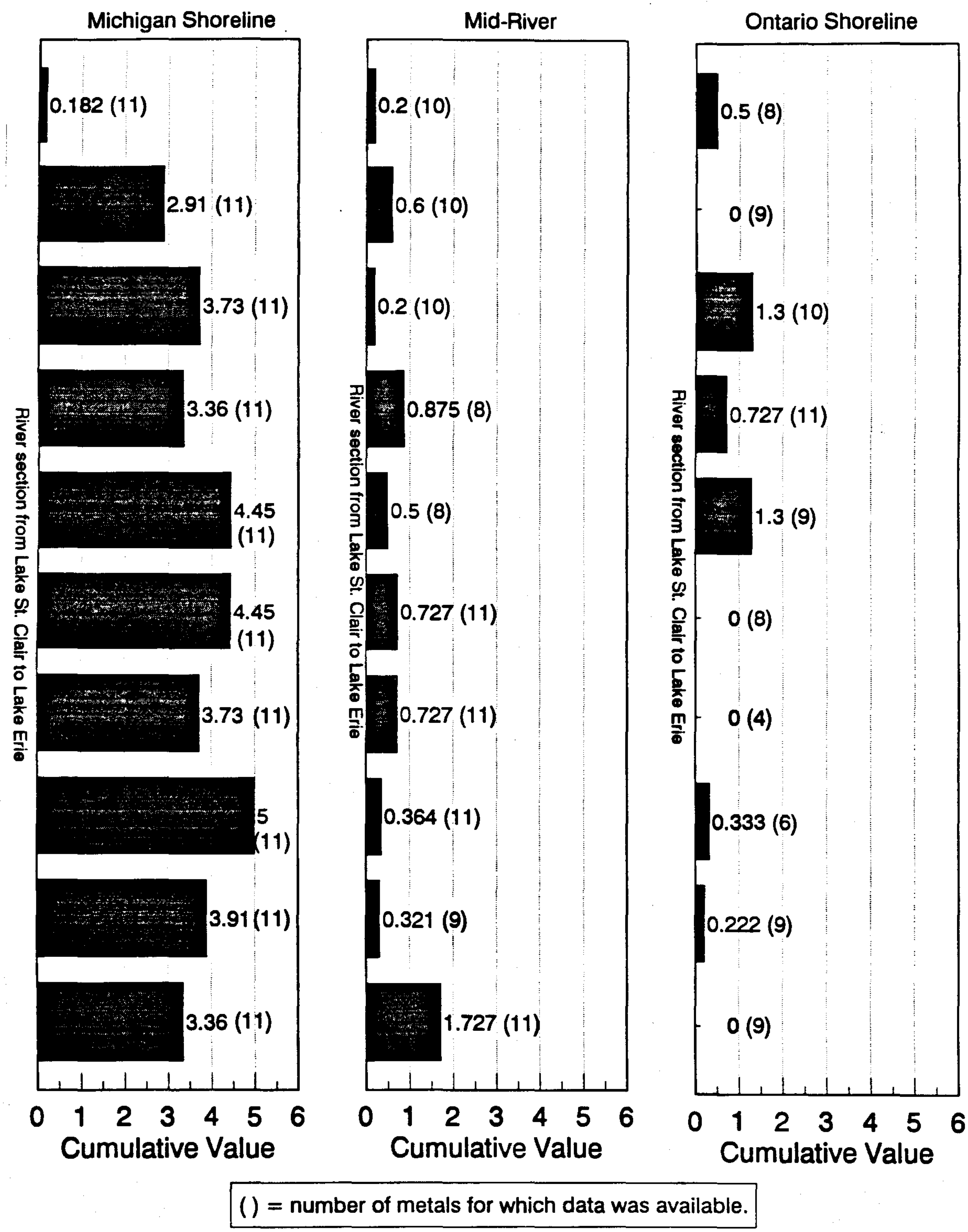


Figure 6-14. Relative cumulative magnitude of Detroit River sediment contamination by river section from head to mouth based on eleven metals assigned a value of 0, 2 or 5 respectively for each metal in the non-, moderately-, or heavily polluted category.

polluted range were assigned a value of five. This was repeated for each of the metals (and cyanide) except barium for which U.S. EPA guidelines exist. The total was then divided by the number of metals for which data was available. Figure 6-14 demonstrates that the Michigan shoreline sediments downstream of Conners Creek to the mouth (sections 2 through 10) are heavily contaminated. The mid-river had a few places where some sediments were moderately contaminated, but the most severely contaminated mid-river sediments were near the mouth (sections 9 and 10). Contaminant levels in sediments along the Ontario shoreline were moderately polluted along and immediately downstream of Windsor (sections 3, 4 and 5).

Although the Windsor shoreline data are sparse, sediments from this area generally fell in the "non-polluted" range.

6.2.1.1 Arsenic

Individual arsenic sediment concentrations in the Detroit River ranged from 0.86 to 36 mg/kg while median arsenic concentrations of the 3-mile sections ranged from 0.98 to 18 mg/kg (Figure 6-15a,b). Background concentrations of arsenic in Lake St. Clair/Lake Erie sediments are estimated to be 6.1 mg/kg (Table 6-26) (IJC 1982). The only sediment arsenic data along the Ontario shore were classified as moderately polluted according to the U.S. EPA guideline and exceeded OME guideline. Mid-river sediments were in the non-polluted range at the head and mouth, with other mid-river sediments in the moderately polluted range (where data were available). From the head of the Detroit River to Belle Isle along the Michigan shoreline, sediments were classified as moderately polluted by U.S. EPA guideline and exceeded the OME guideline as well. Michigan shoreline sediments downstream of Belle Isle to the mouth exceeded the U.S. EPA arsenic guideline for heavily polluted sediments and the OME guideline for polluted sediments. Median arsenic concentrations for sections were highest between the confluence of the Rouge River through the mid-Trenton Channel. The highest individual values were in the Trenton Channel near Trenton.

6.2.1.2 Cadmium

Individual cadmium concentrations in Detroit River sediments ranged from 0.1 to 41 mg/kg while median concentrations of the ten sections ranged from 0.2 to 14.5 mg/kg (Figure 6-16a,b). Background concentrations of cadmium in Lake St. Clair/Lake Erie sediments are estimated to be 1.3 mg/kg (Table 6-26) (IJC 1982). The highest individual and median concentrations were in the Trenton Channel where concentrations exceeded the U.S. EPA guideline for heavily polluted sediments (6 mg/kg) as well as the OME guideline. Median concentrations for sections in the entire Michigan shoreline downstream of Conners Creek were elevated over the mid-river and Ontario shoreline sediment median concentrations. All median sediment cadmium levels were less than the OME guideline of 1.0 mg/kg along the Ontario shoreline and throughout the mid-river with the exception of two lower sections, which had median values of 1.0 and 1.6 mg/kg total cadmium, respectively.

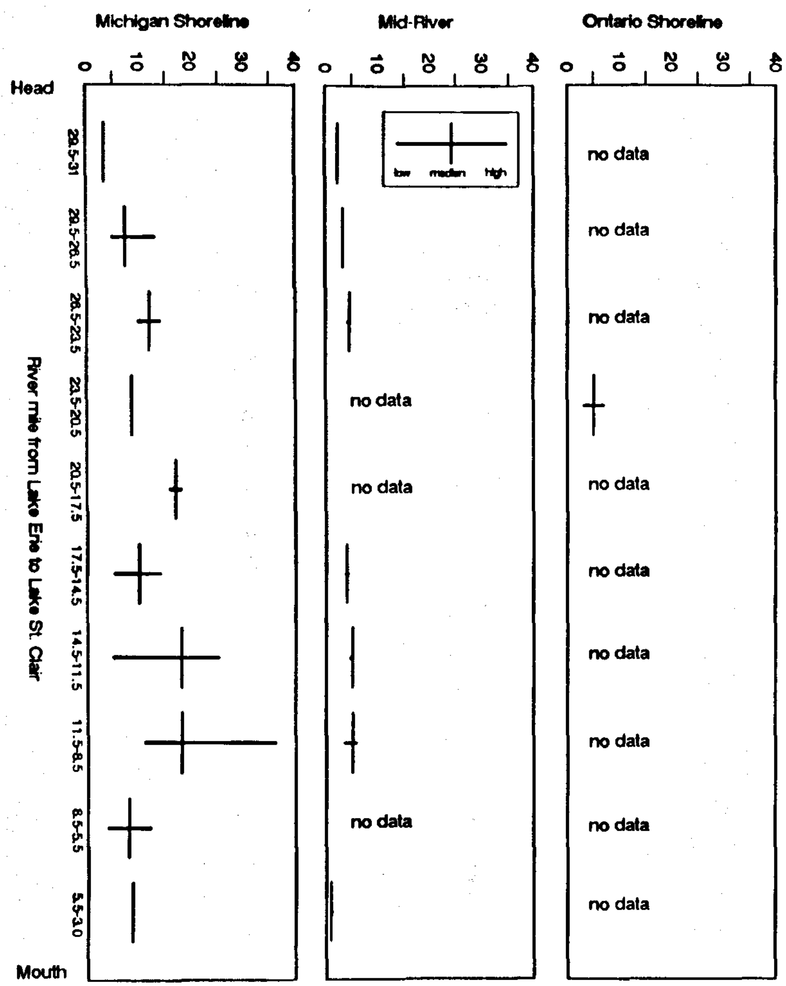


Figure 6-15a. Arsenic concentrations in Detroit River sediments. Results in mg/kg.

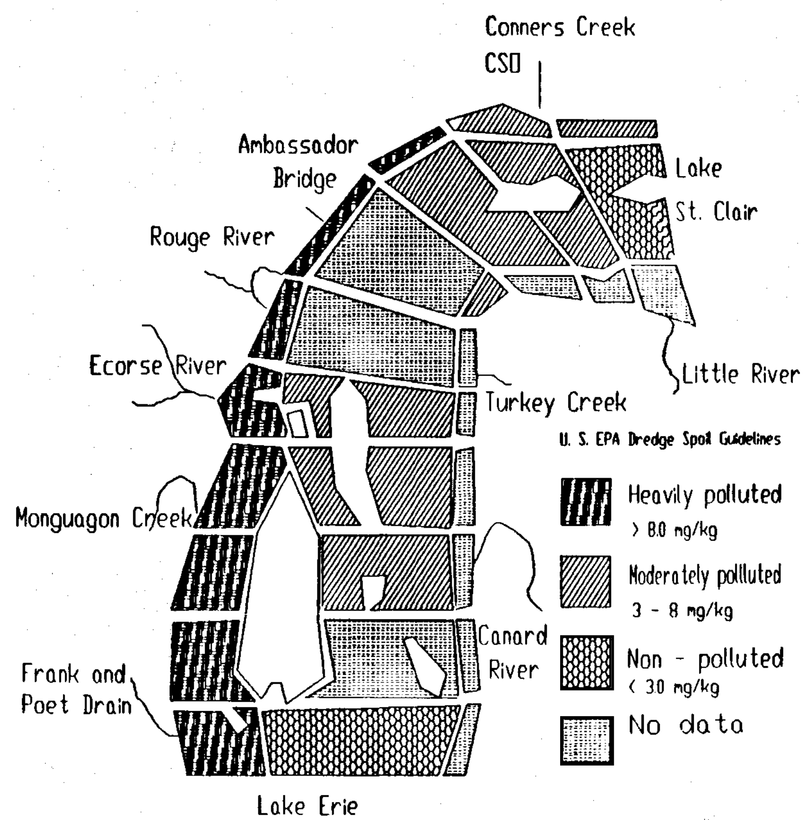


Figure 6-15b. Categorization of median arsenic concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

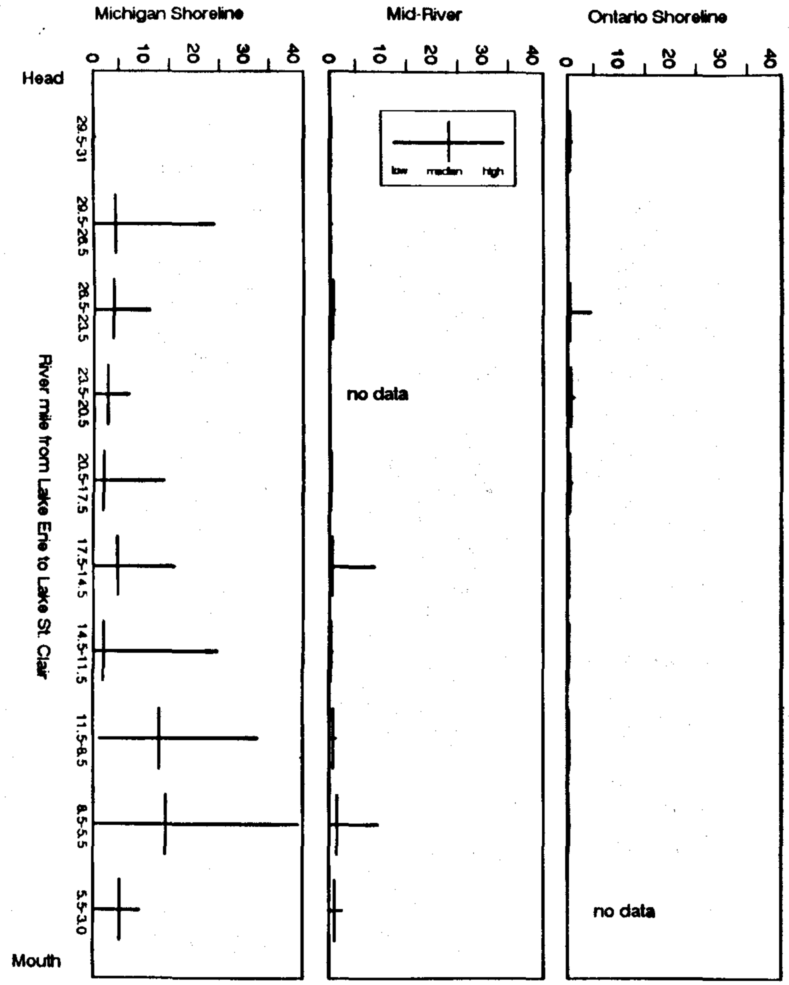


Figure 6-16a. Cadmium concentrations in Detroit River sediments. Results in mg/kg.

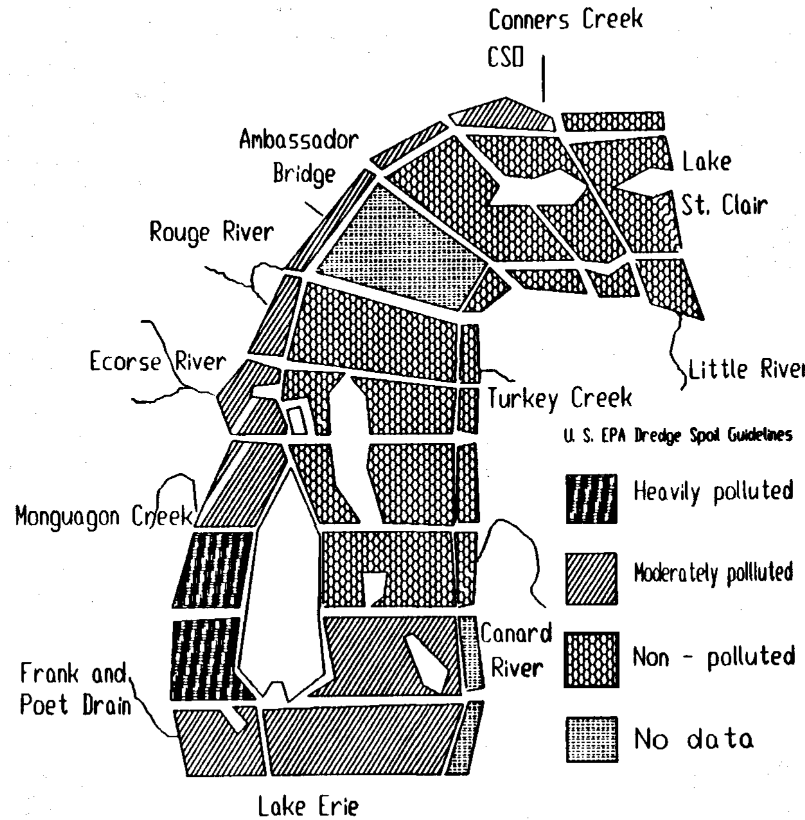


Figure 6-16b. Categorization of cadmium concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

6.2.1.3 Chromium

Individual total chromium concentrations ranged from 4 to 680 mg/kg while median total chromium concentrations in the ten sections ranged from 4.8 to 280 mg/kg (Figure 6-17a,b). Background concentrations of chromium in Lake St. Clair/Lake Erie are estimated to be 38 mg/kg (Table 6-26) (IJC 1982). The Ontario shoreline and mid-river sediment chromium median concentrations were similar in that they were higher and more variable in the upper three-fifths of the river than downstream. Only eleven and fourteen percent of the sediment samples from the mid-river and Ontario shoreline, respectively, had chromium concentrations which exceeded the U.S. EPA guideline for heavily polluted sediments (>75 mg/kg). Fifty-seven percent of the samples from the Michigan shoreline exceeded this value. The highest individual chromium sediment concentration was found in the Trenton Channel, while the highest median concentration for sections was along the Michigan shoreline in the section at the confluence of the Ecorse River. The OME dredging guideline for chromium of 25 mg/kg was exceeded in 90% of the samples collected from the Michigan shoreline, 30% of mid-river samples, and in 50% of samples from along the Ontario shore (where data were available).

Data from 1970 and 1980 studies indicate chromium concentrations in sediment downstream of the Ecorse river mouth and at the mouth of the Detroit River have decreased (Thornley and Hamdy 1984). Concentrations of the mouth of the Rouge River increased during this period.

6.2.1.4 Copper

Individual copper concentrations in Detroit River sediments ranged from 0.5 to 280 mg/kg, while median values in the sections ranged from 3.3 to 130 mg/kg (Figure 6-18a,b). Background concentrations of copper in Lake St. Clair/Lake Erie are estimated to be 15 mg/kg (Table 6-26) (IJC 1982). All but one section along the Ontario shoreline for which data were available had median values less than the OME dredge spoil guideline of 25 mg/kg total copper. Median total copper concentrations in mid-river sediments were all less than 25 mg/kg except the two sections nearest the mouth (median values of 45 and 31 mg/kg).

The Michigan shoreline had the lowest median concentration at the head, but downstream of Conners Creek to Elizabeth Park median levels increased to the range of 68 to 140 mg/kg. Maximum median values along the Michigan shoreline were found in the section just downstream of Belle Isle (140 mg/kg), followed by the section just downstream of Ecorse River (130 mg/kg). Concentrations remained high downstream to Elizabeth Park in the Trenton Channel, but were reduced to 28 to 37 mg/kg near the mouth. Fifty-six percent of the individual samples collected along the Michigan shoreline exceeded the U.S. EPA's guideline for heavily polluted sediments of >50 mg/kg total copper. Only seven percent of the individual sediment samples from along the Ontario shoreline and the mid-river, respectively, exceeded 50 mg/kg total copper. The OME guideline was exceeded in 90%, 20% and 12% of the Michigan shoreline, mid-river, and Ontario shoreline, respectively, based on the median sediment concentration for total copper.

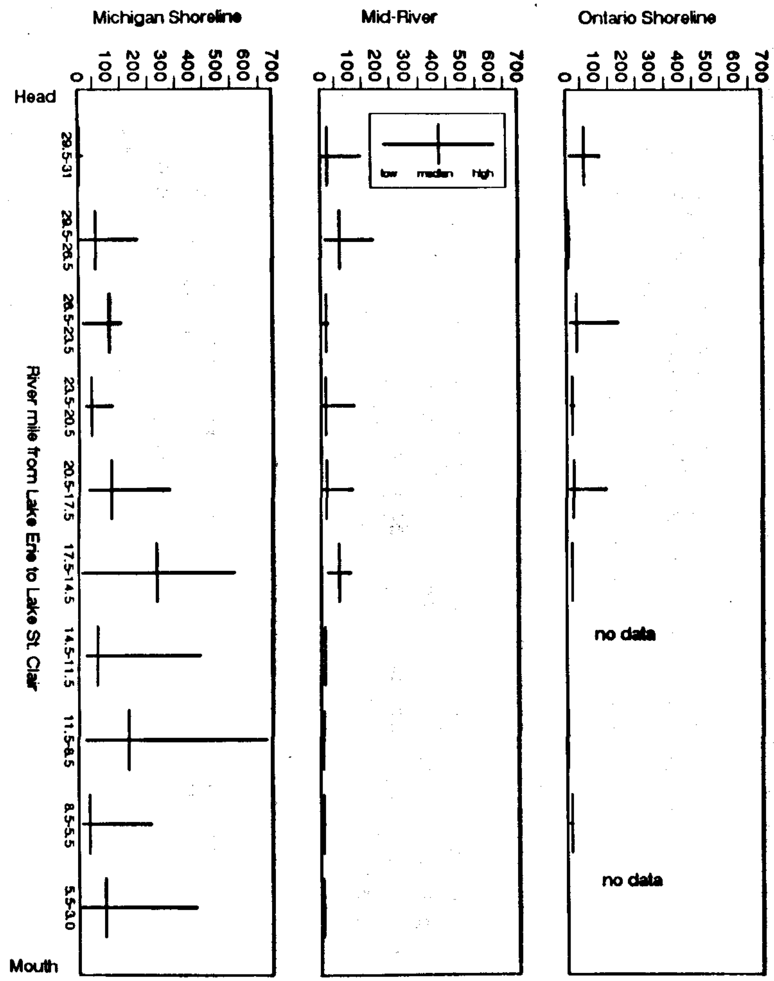


Figure 6-17a. Chromium concentrations in Detroit River sediments. Results in mg/kg.

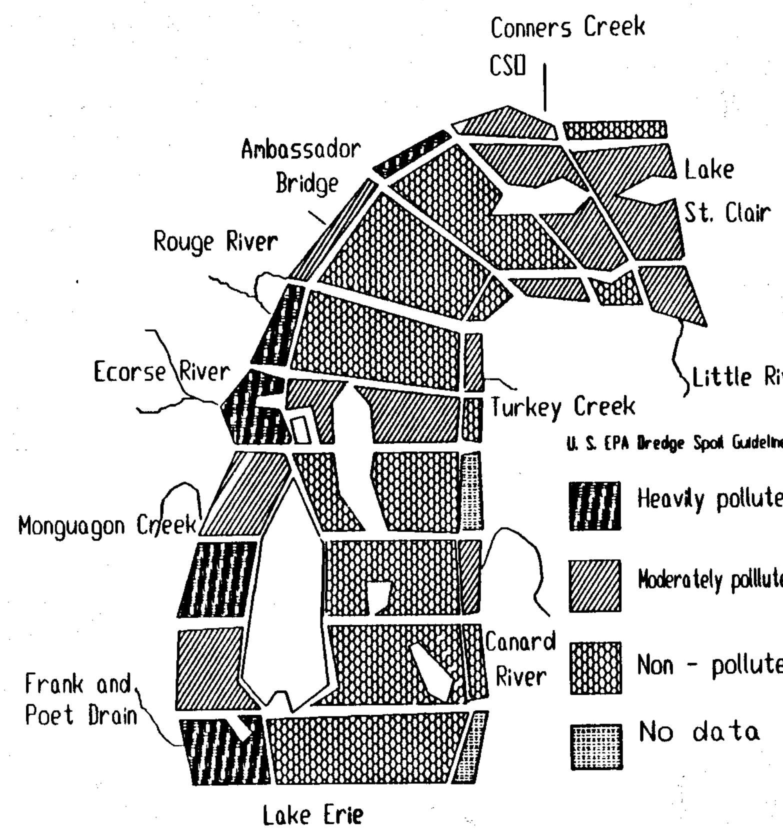


Figure 6-17b. Categorization of chromium concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

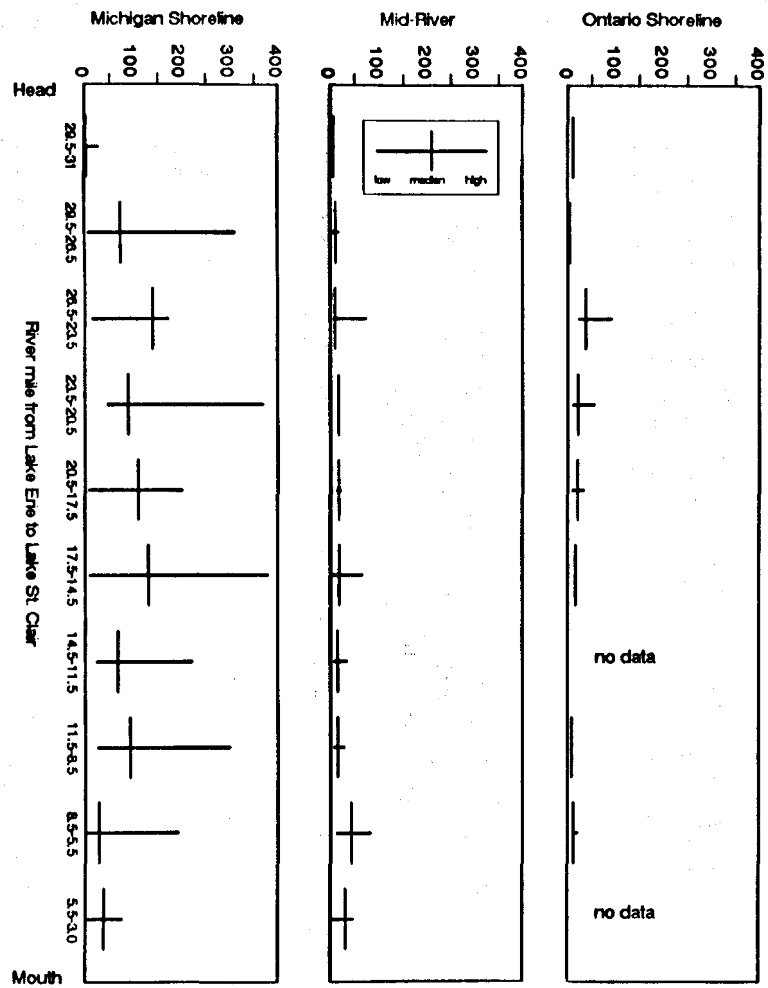


Figure 6-18a. Copper concentrations in Detroit River sediments. Results in mg/kg.

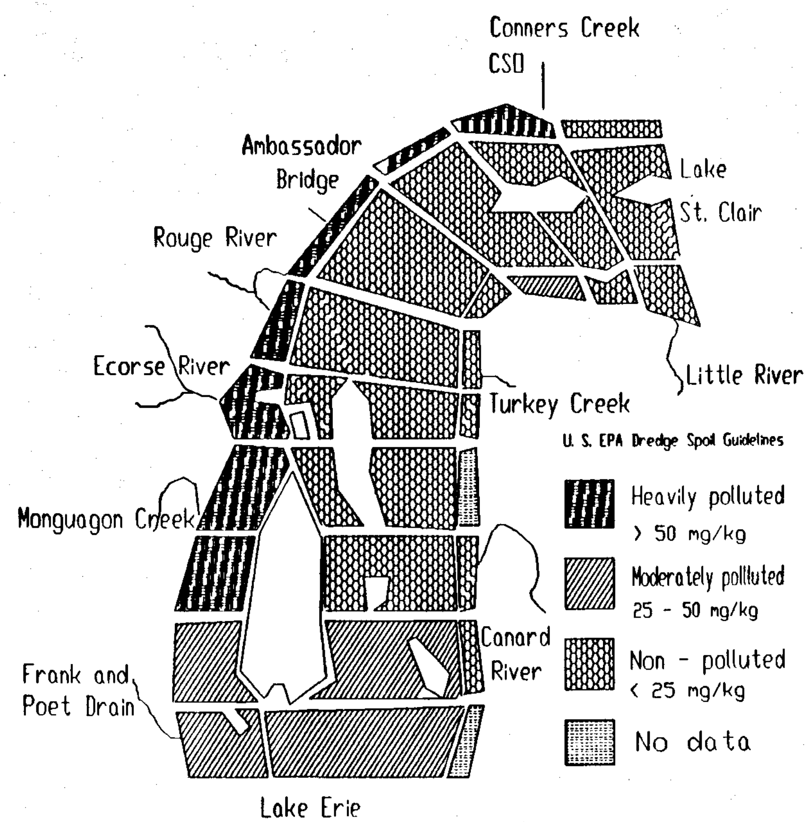


Figure 6-18b. Categorization of median copper concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

Data from 1970 and 1980 studies indicate copper concentrations have decreased in sediments at the mouth of the Detroit River and downstream of the Ecorse River (Thornley and Hamdy 1984). Concentrations increased in sediments near the mouth of the Rouge River.

6.2.1.5 Cyanide

Individual total cyanide concentrations in Detroit River sediments ranged from less than detection (LOD varied from 0.1 to 0.4 mg/kg) to 15.7 mg/kg, while median cyanide sediment concentrations for these sections ranged from <0.1 to 0.4 mg/kg total cyanide (Figure 6-19a,b). Because the detection level was above the OME guideline and the U.S. EPA's guideline for moderately or heavily polluted sediments, no comparison could be made in the sections where cyanide concentrations were not detected. There were also several sections where no sediment analysis had been performed for cyanide. However, the Ontario shoreline sediments contained 0.1 mg/kg equivalent to the OME guideline or <0.1 mg/kg where data were available. The mid-river sediments had several non-detectable results. In the lower half of the mid-river, where data were available, sediments were either moderately (0.1 to 0.25 mg/kg) or heavily (>0.25 mg/kg) polluted according to U.S. EPA guideline. Along the Michigan shoreline, sediments exceeded 0.1 mg/kg at the head and mouth of the river and 0.25 mg/kg in all other river sections. The highest levels were located between Conners Creek and Gibralter along the Michigan shoreline.

6.2.1.6 Iron

Individual Detroit River sediment iron concentrations ranged from 2,600 to 180,000 mg/kg. Median sediment iron concentrations for the sections were less than 17,000 mg/kg (the U.S. EPA guidelines for nonpolluted sediments) in all but three sections of the Ontario shoreline and the mid-river (Figure 6-20a,b). These areas were downstream of Windsor, near the tip of Fighting Island and the southeast side of Grosse Ile. The Michigan shoreline sediment median concentrations above the Ambassador Bridge were less than 17,000 mg/kg. Downstream, all but one section exceeded the U.S. EPA guideline for heavily polluted sediments of greater than 25,000 mg/kg. The highest section median value was downstream of the Rouge River, but the highest individual sediment iron concentration was found in the Trenton Channel. Michigan shoreline sediment median concentrations were generally two to six times higher than the mid-river or Ontario shoreline sediment values, reflecting past of present significant sources of iron along the Michigan shoreline. The OME dredging guideline for iron of 10,000 mg/kg was exceeded in 86% of samples along the Ontario shoreline. The median iron concentration exceeded 10,000 mg/kg in sections 1, 3, 4, 5 and 9 along the Ontario shoreline.

Studies from 1970 and 1980 indicate iron concentrations have decreased in sediments near the mouth of the Ecorse River (Thornley and Hamdy 1984).

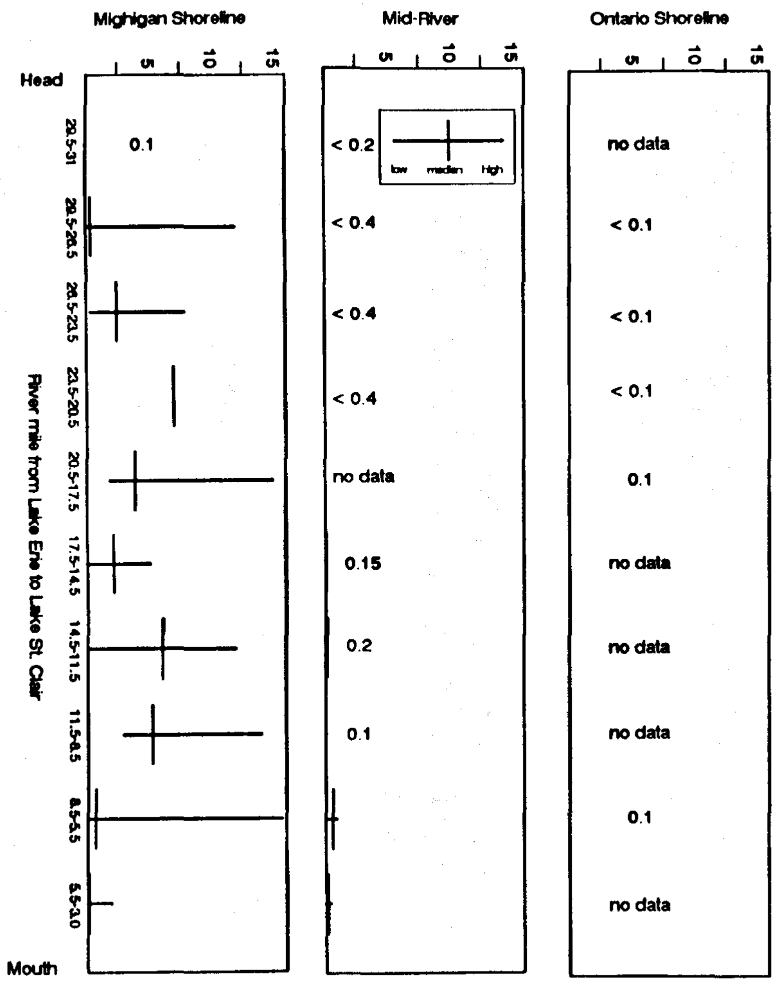


Figure 6-19a. Cyanide concentrations in Detroit River sediments. Results in mg/kg.

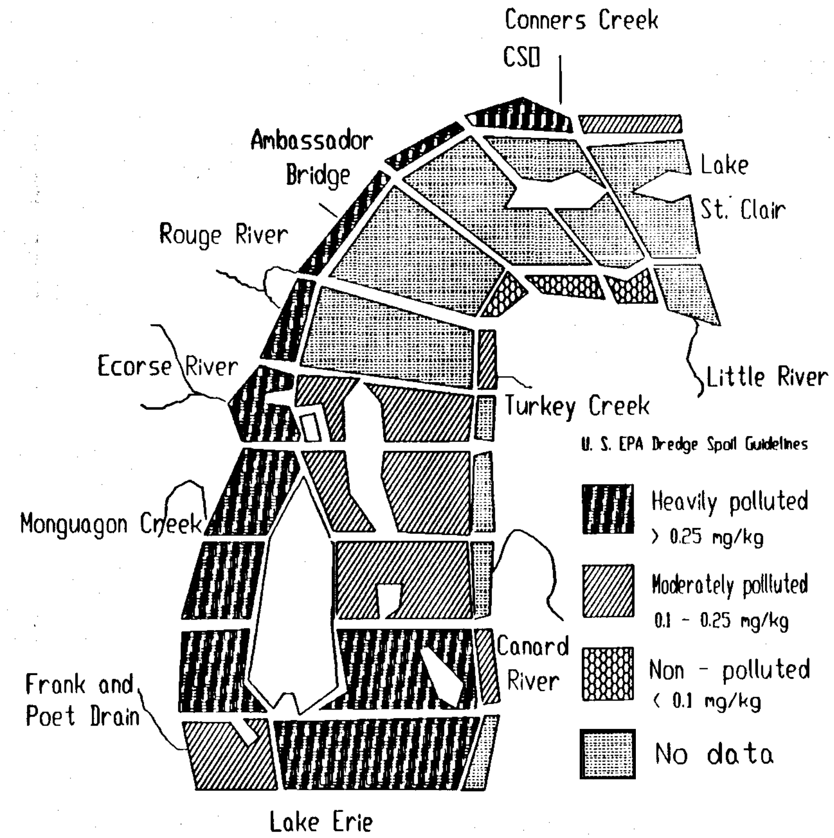


Figure 6-19b. Categorization of median cyanide concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

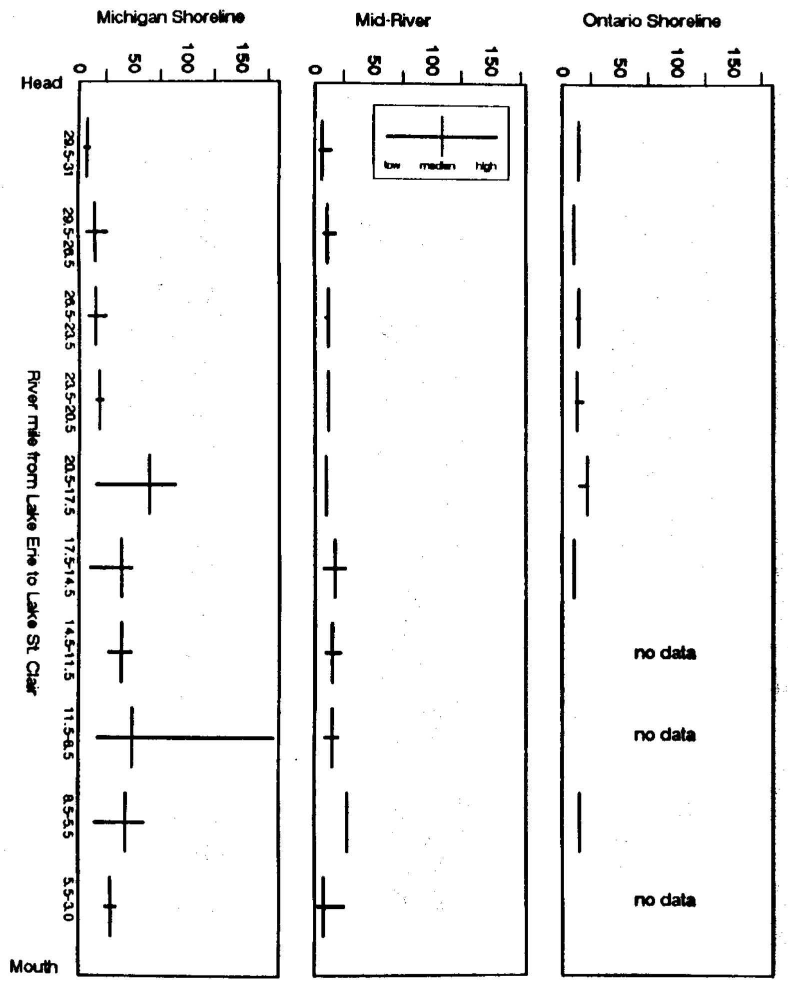


Figure 6-20a. Iron concentrations in Detroit River sediments. Results in mg/kg x 1000.

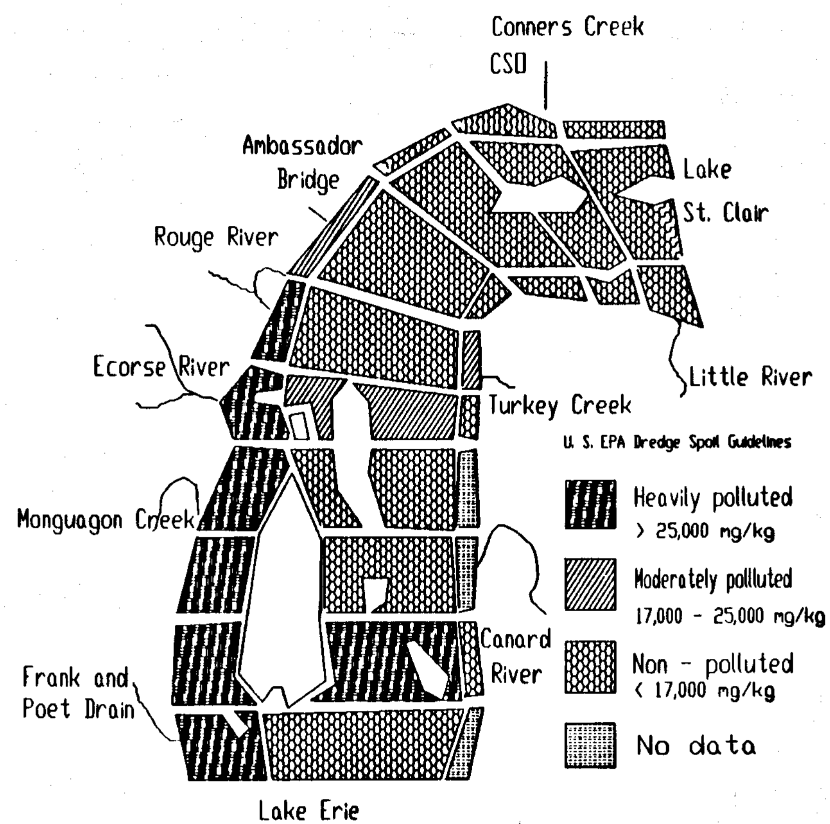


Figure 6-20b. Categorization of median iron concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

6.2.1.7 Total Lead

Individual Detroit River lead concentrations ranged from non-detectable (<1.0 mg/kg) to 810 mg/kg. Background concentrations of lead in Lake St. Clair/Lake Erie are estimated to be 17 mg/kg (Table 6-26) (IJC 1982). Mid-river and Ontario shoreline lead concentrations were similar except higher concentrations (median value of 100 mg/kg) were evidenced along and immediately downstream of Windsor along the Ontario shoreline (Figure 6-21a,b). Median lead levels gradually decreased to the range of 10 to 20 mg/kg near the mouth along the Ontario shoreline and to the range of 20 to 60 mg/kg in mid-river sediments. Michigan shoreline sediment median lead values were 7 mg/kg at the head, and ranged from 100 to 330 mg/kg downstream of Conners Creek to Trenton, and from 50 to 70 mg/kg at the mouth. These data show very high levels of lead contamination along the Michigan shoreline immediately downstream of combined sewer overflows and industrial and municipal outfalls. Seventy-one percent (n = 95) of the sediment samples analyzed for lead along the Michigan shore exceeded the U.S. EPA guideline for heavily polluted sediments (60 mg/kg). Only 13 percent (n = 71) and twenty-six percent (n = 31) of the samples exceeded this guideline in the mid-river and Ontario shoreline respectively. The OME dredging guideline of 50 mg/kg was exceeded in 90% of the samples from the Michigan shoreline, and in 20% and 10% of the samples from the mid-river and Ontario shoreline, respectively. The median lead concentration exceeded this value in the third segment (mile 23.5 to 26.5) along the Ontario shoreline.

Studies from 1970 and 1980 indicate lead concentrations have decreased in sediments near the mouth of the river and downstream of the confluence with the Ecorse river (Thornley and Hamdy 1984). Concentrations near the mouth of the Rouge River increase during this period.

6.2.1.8 Manganese

Individual concentrations of manganese ranged from 71 to 2,800 mg/kg. The only manganese datum along the Ontario shore was in the moderately polluted range (300-500 mg/kg) according to the U.S. EPA guideline. Median values in all mid-river sections (where data were available) were less than 300 mg/kg (in the nonpolluted range), except in the most downstream section, where the median value was 430 mg/kg. Michigan shoreline median values for manganese in sediments increased from 160 mg/kg in the upper river to between 330 and 450 mg/kg from Conners Creek to the Rouge River (Figure 6-22a,b). Downstream of the Rouge to Gibralter, manganese sediment median concentrations ranged between 580 and 990 mg/kg, exceeding the U.S. EPA guideline for heavily polluted sediments of >500 mg/kg. Downstream of Gibralter, the median concentration was 430 mg/kg along the Michigan shoreline. The highest individual manganese concentrations were in the Trenton Channel. There is no OME dredging guideline for manganese.

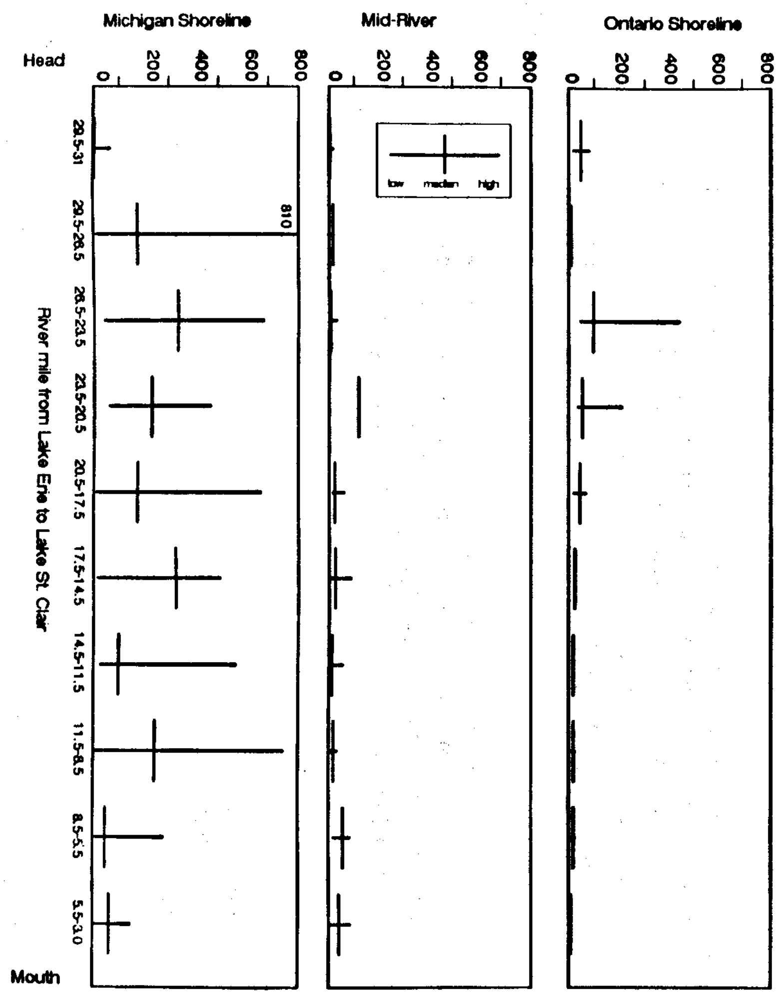


Figure 6-21a. Lead concentrations in Detroit River sediments. Results in mg/kg.

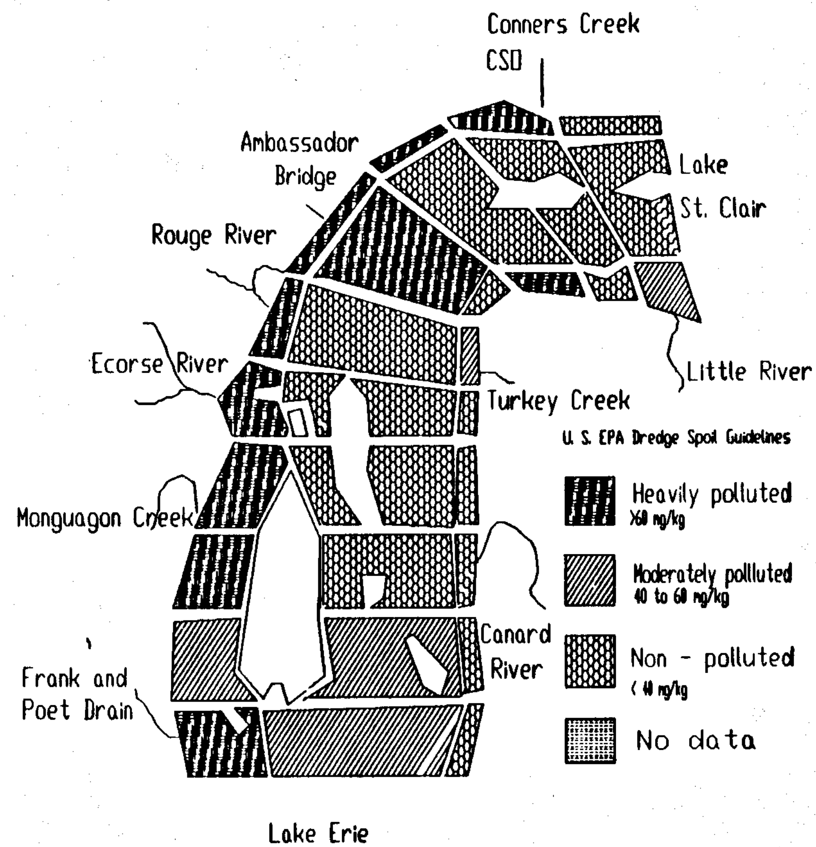


Figure 6-21b. Categorization of median lead concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

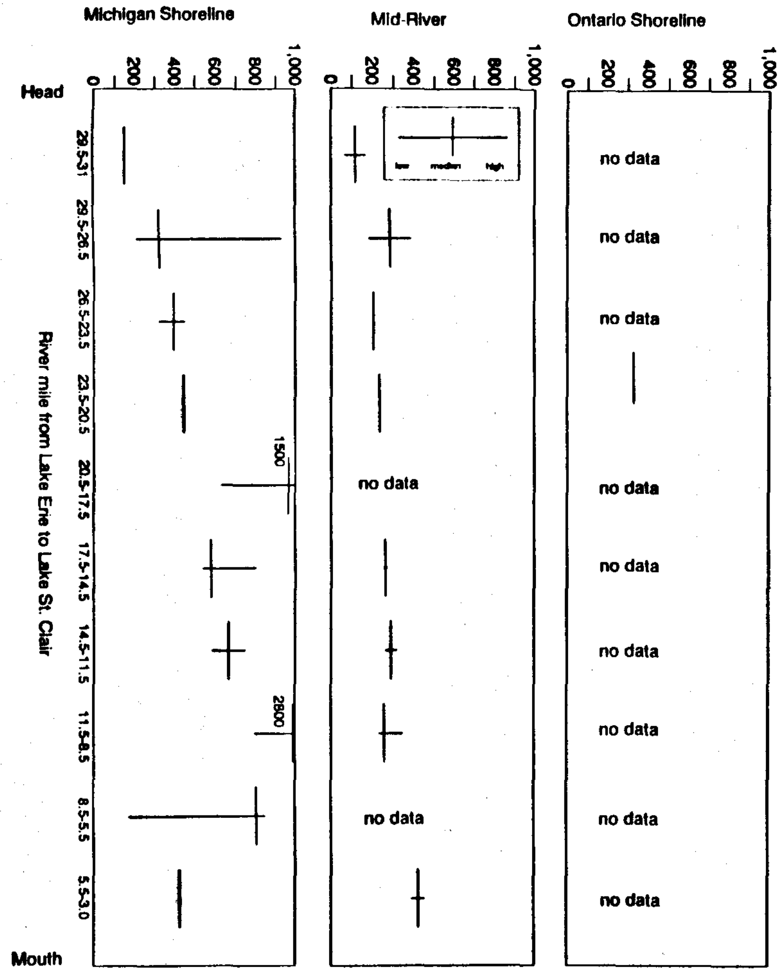


Figure 6-22a. Manganese concentrations in Detroit River sediments. Results in mg/kg.

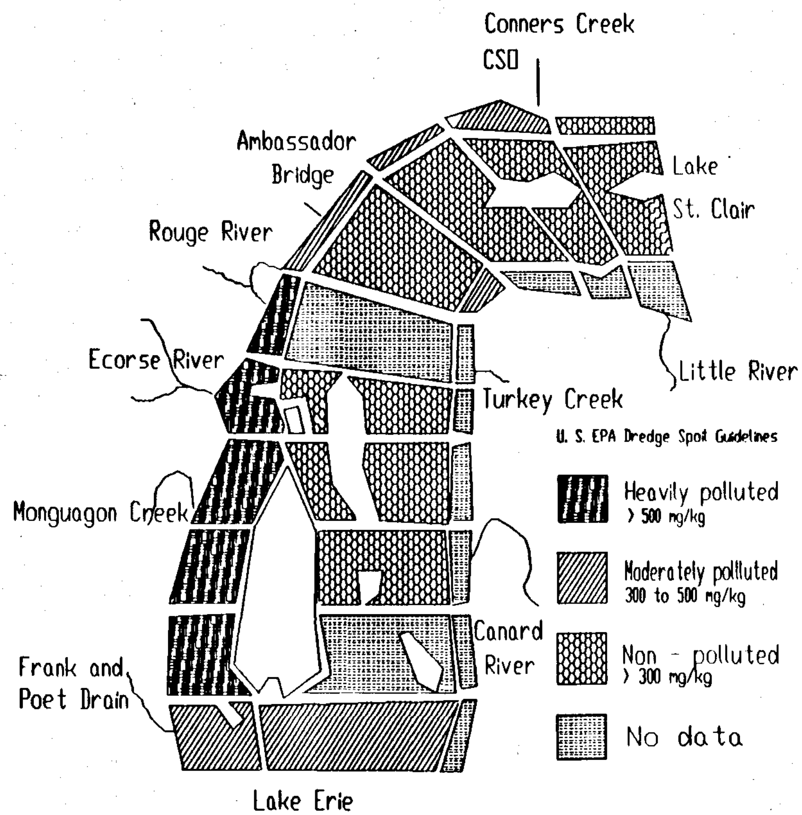


Figure 6-22b. Categorization of median manganese concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

6.2.1.9. Mercury

Individual mercury concentrations ranged from less than detection (detection levels ranged from 0.01 to 1.0 mg/kg) to 55.8 mg/kg. Background concentrations in Lake St. Clair/Lake Erie are estimated to be 0.2 mg/kg (Table 6-26) (IJC 1982). All sections had median concentrations of total mercury less than detection (1.0 mg/kg) with the exception of the Michigan shoreline between Monguagon Creek and Elizabeth Park (river mile 8.5 to 11.5) (Figure 6-23a,b). Only nine percent of samples from all individual stations (n = 153) exceeded 1.0 mg/kg total mercury (U.S. EPA guideline for heavily polluted sediments). All of these stations were located along the Michigan shoreline, and almost half were located in river mile section 8.5 to 11.5. The majority of the Ontario and mid-river sediments contained less than 0.2 mg/kg total mercury and therefore were below the OME dredging guideline of 0.3 mg/kg. Although there are certain areas along the Michigan shore where sediment mercury concentrations continue to be elevated, there has been a tremendous decrease in Detroit River sediment mercury concentrations since 1970 (Thornley and Hamdy 1984). A tenfold decrease in mercury concentrations in sediments was noted at the river mouth.

6.2.1.10 Nickel

Individual nickel concentrations in Detroit River sediments ranged from 3 to 300 mg/kg, while section median values ranged from 8 to 90 mg/kg (Figure 6-24a,b). Background concentrations in Lake St. Clair/Lake Erie are estimated to be 18 mg/kg (Table 6-26) (IJC 1982) All Ontario shoreline median values (where data were available) were less than the OME dredging guideline of 25 mg/kg. Mid-river sediment median values ranged from 10 to 35 mg/kg with the higher concentrations generally occurring in the lower one-third of the river. Sediments along the Michigan shore at the head of the river contained a mean concentration of 7 mg/kg total nickel. Downstream of Conners Creek, section median sediment concentrations for nickel alternately increased and decreased ranging from 26 to 90 mg/kg. The highest median concentrations were from the Rouge River confluence through the Trenton Channel on the Michigan shore. Fifty-eight percent (n = 91) of the samples on the Michigan shore exceeded the U.S. EPA guideline for heavily polluted sediments ($>$50 mg/kg total nickel), whereas only four percent of the mid-river and Ontario shoreline samples exceeded this guideline. Eighty-one percent of the section median values for total nickel exceeded the MOE dredge spoil guideline along the Michigan shoreline; twenty-two and twenty-seven percent of the section median values in the mid-river and Ontario shoreline, respectively, exceeded this value.

Studies conducted in 1970 and 1980 indicate concentrations of nickel have decreased in sediments, at the mouth of the Detroit River, and in the river near the confluence with the Ecorse River (Thornley and Hamdy 1984). Concentrations near the mouth of the Rouge River increased during this period.

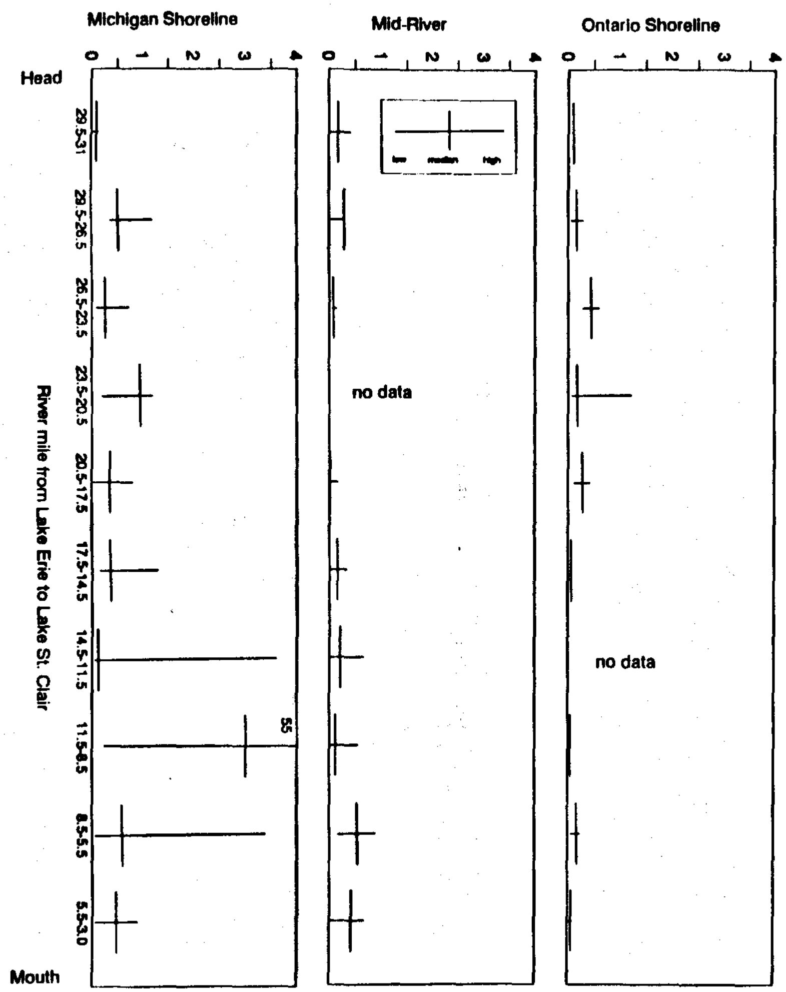


Figure 6-23a. Mercury concentrations in Detroit River sediment. Results in mg/kg.

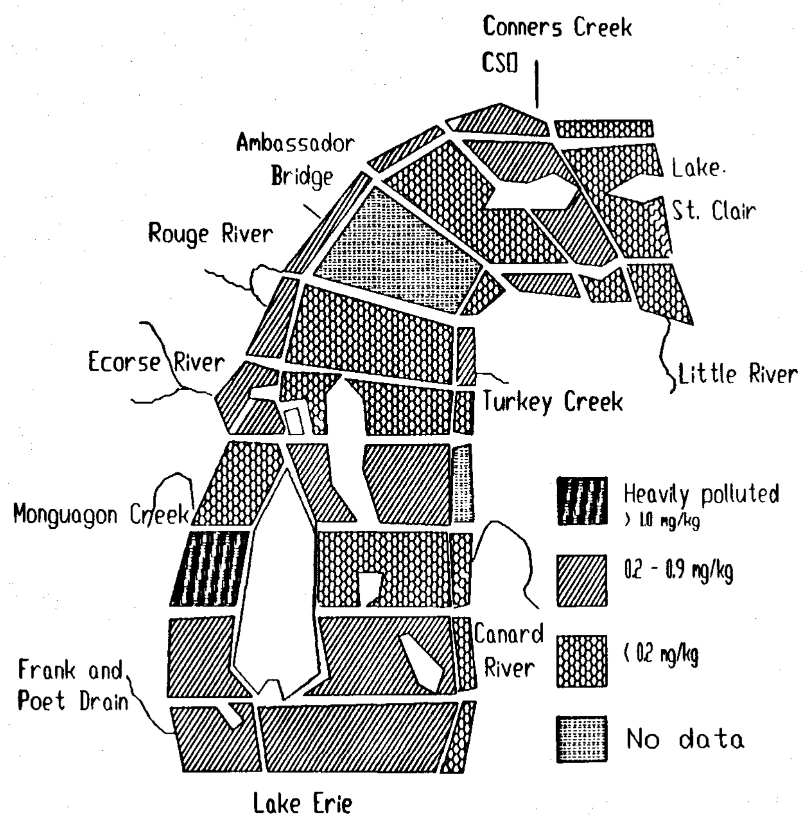


Figure 6-23b. Categorization of median mercury concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

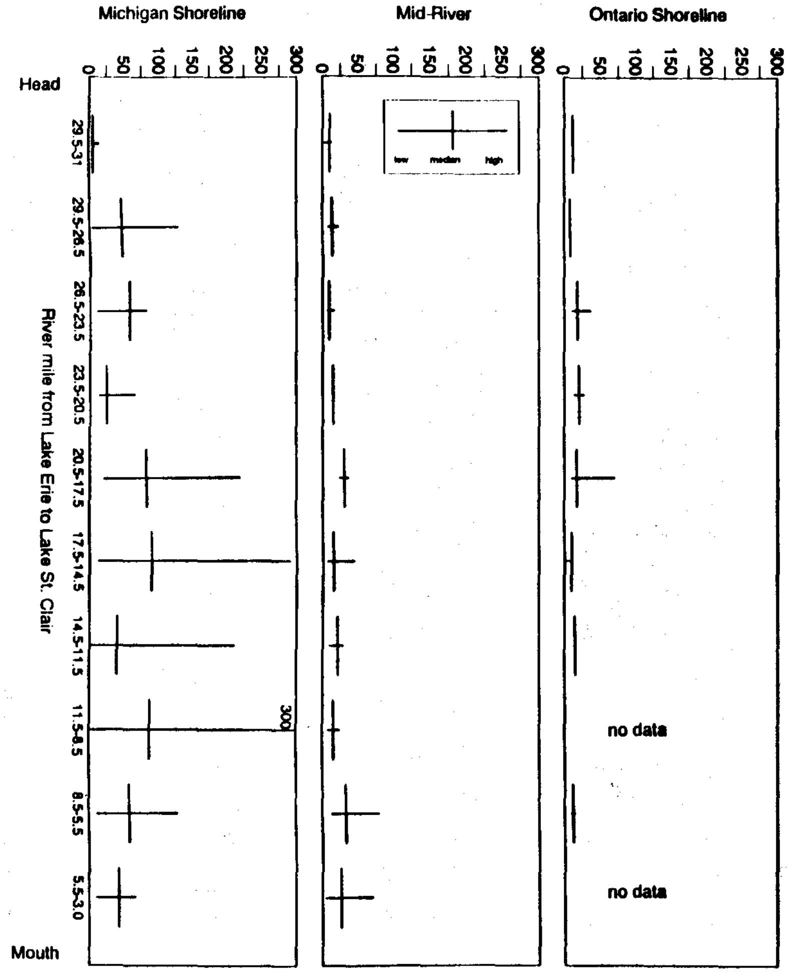


Figure 6-24a. Nickel concentrations in Detroit River sediments. Results in mg/kg.

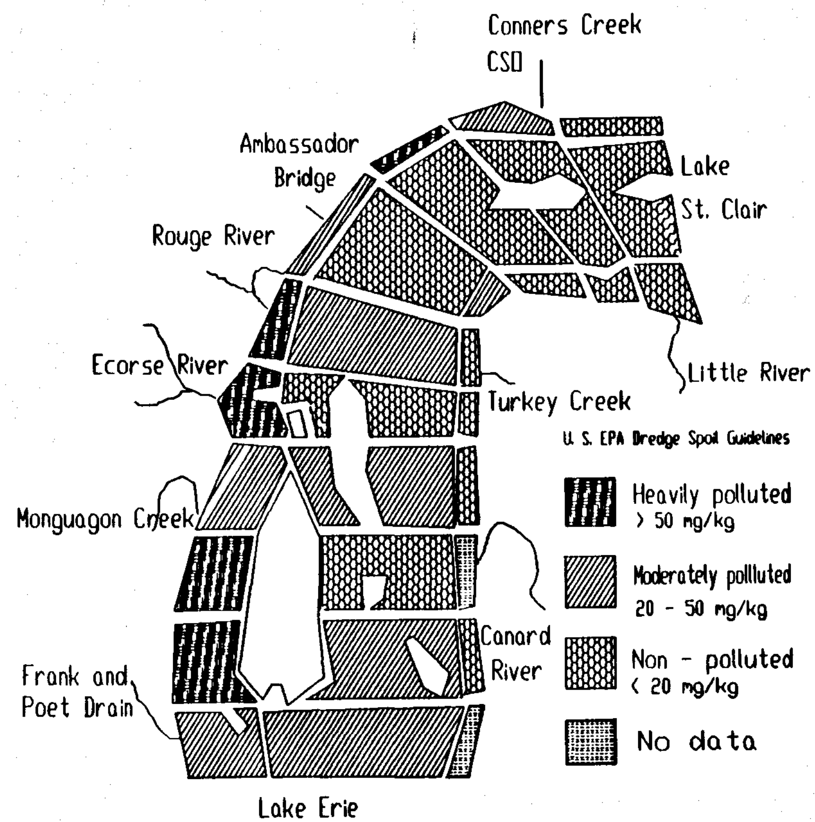


Figure 6-24b. Categorization of median nickel concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

6.2.1.11 Zinc

Individual concentrations of zinc in Detroit River sediments ranged from 6 to 53,000 mg/kg, while median levels ranged from 23 to 960 mg/kg (Figure 6-25a,b). Background concentrations in Lake St. Clair/Lake Erie are estimated to be 46 mg/kg (Table 6-26) (IJC 1982). Median zinc concentrations along the majority of the Ontario shoreline were less than the OME dredge guideline of 100 mg/kg. Exceptions were along and immediately downstream of Windsor where median concentration values were 110, 120, and 150 mg/kg. Mid-river median sediment zinc levels were low (< 47 mg/kg) in the upper reach, moderately polluted (120-140 mg/kg) for two sections, followed by three sections of non-polluted sediments (< 90 mg/kg). In the lower mid-river sections, sediments exceeded the U.S. EPA guideline for heavily polluted sediments (> 200 mg/kg) in one section and for moderately polluted sediments in the lowest section. Along the Michigan shoreline, sediment samples from the uppermost section of the Detroit River had zinc concentrations in the non-polluted range (< 33 mg/kg), but from downstream of Conners Creek to Lake Erie, Michigan shoreline sediments exceeded the guideline for heavily polluted sediments with respect to zinc. The highest individual and highest median values were in the Trenton Channel downstream of Monguagon Creek.

Studies conducted in 1970 and 1980 indicate concentrations of zinc have decreased in sediments at the mouth of the Detroit River and in the river near the confluence with the Ecorse River (Thornley and Hamdy 1982). Concentrations near the mouth of the Rouge River increased during this period.

6.2.2 PCBs and Oil and Grease

PCBs and oil and grease have been studied by numerous authors between 1980 and 1988. The following references were used as data sources for this section: ERG Inc. 1983; ES&E et al. 1987; Kreis 1987; LTI 1985; Kislauskas and Pranckevicuis 1987; Bertram et al. unpublished; Thornley and Hamdy 1984; Kenaga and Crum 1987; Kaiser et al. 1985; Pugsley et al. 1985; and Smith et al. 1985.

6.2.2.1 PCBs

Concentrations of PCBs in Detroit River sediments ranged from below detection (< 0.001 mg/kg) to 40.00 mg/kg (Figure 6-26). Background concentrations of PCBs in Lake St. Clair/Lake Erie sediments are estimated to be zero by the IJC Dredging Subcommittee (Table 6-26) (IJC 1982). Median PCB concentrations in sediment ranged from 0.028 to 8.05 mg/kg. All individual and median PCB concentrations in mid-river and Ontario shoreline sediments were less than 1.0 mg/kg. Approximately half of the sediment samples from these river sections exceeded the Ontario Ministry of the Environment's dredging guideline of 0.05 mg/kg total PCB in sediments. All of the Michigan shoreline sediment median concentrations exceeded 0.05 mg/kg total PCB, and four of the ten section median sediment concentrations exceeded 1.0 mg/kg. PCB concentrations in six of the ten Michigan shoreline sections exceeded the U.S. EPA guideline for heavily polluted sediments of 10.0 mg/kg total PCB. The highest total PCB concentrations in Detroit River sediments were found along the Michigan shore just upstream from the Ambassador Bridge.

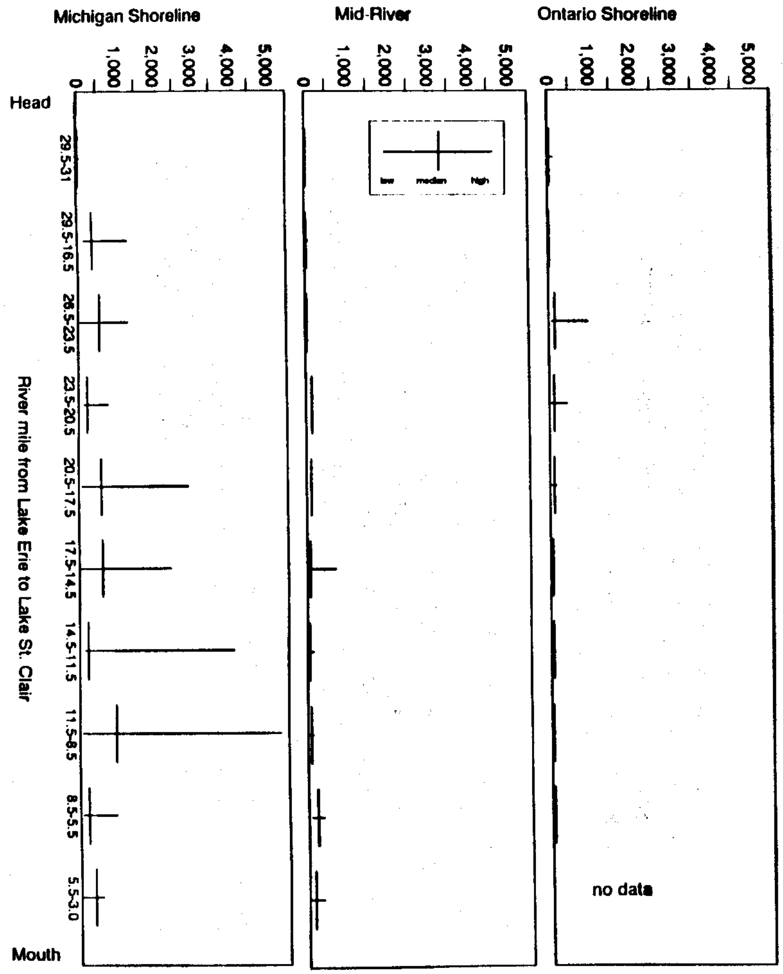


Figure 6-25a. Zinc concentrations in Detroit River sediments. Results in mg/kg.

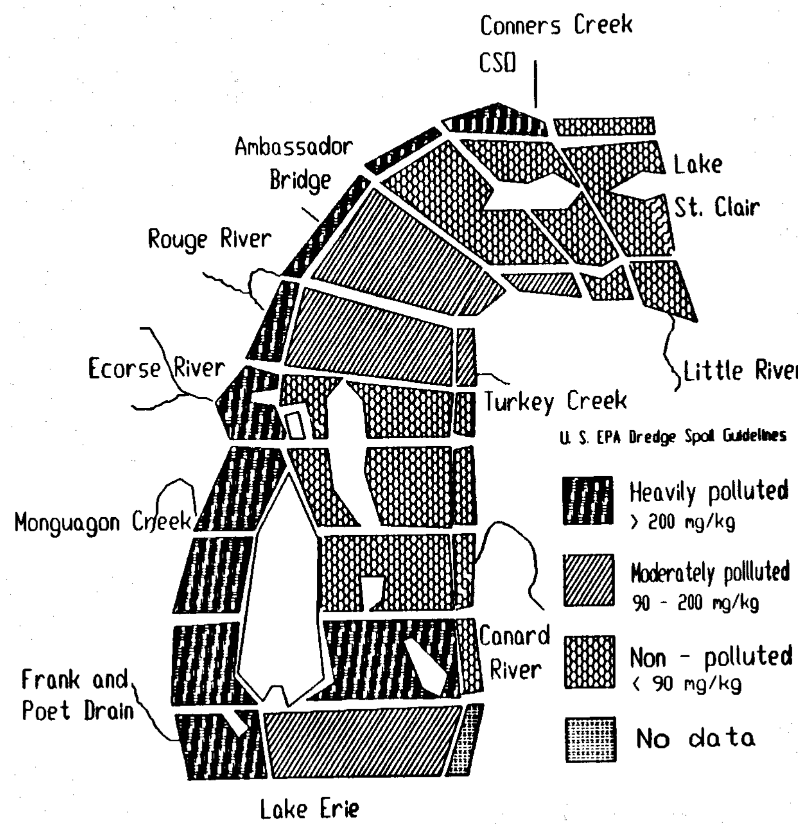


Figure 6-25b. Categorization of median zinc concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

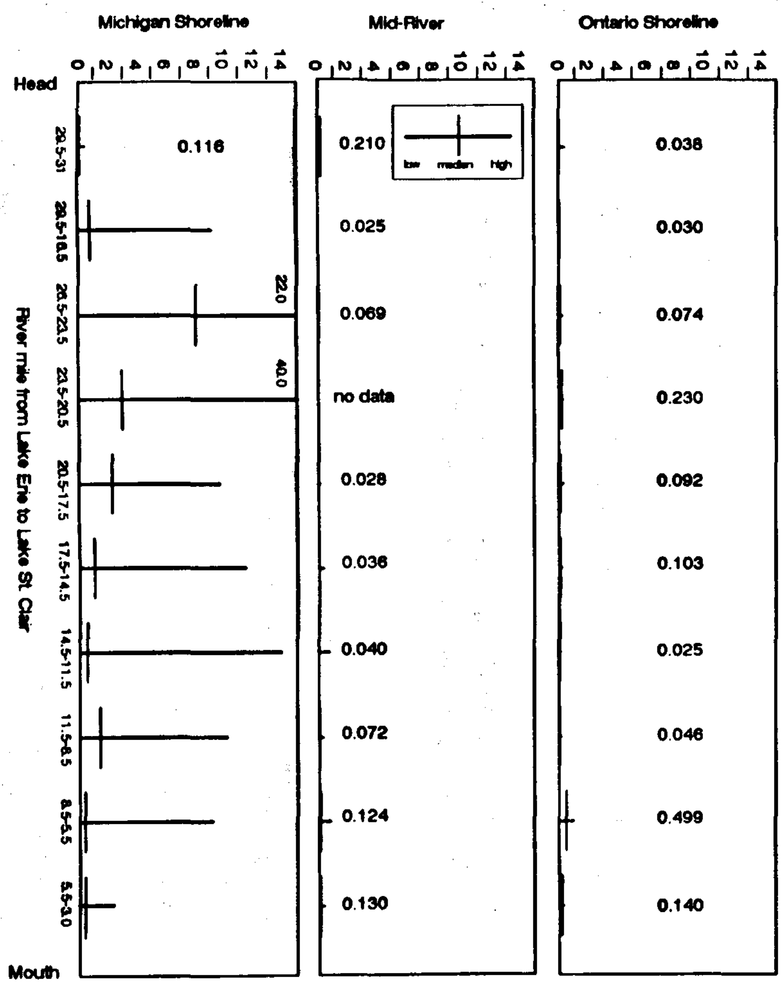


Figure 6-26a. PCB concentrations in Detroit River sediments. Results in mg/kg.

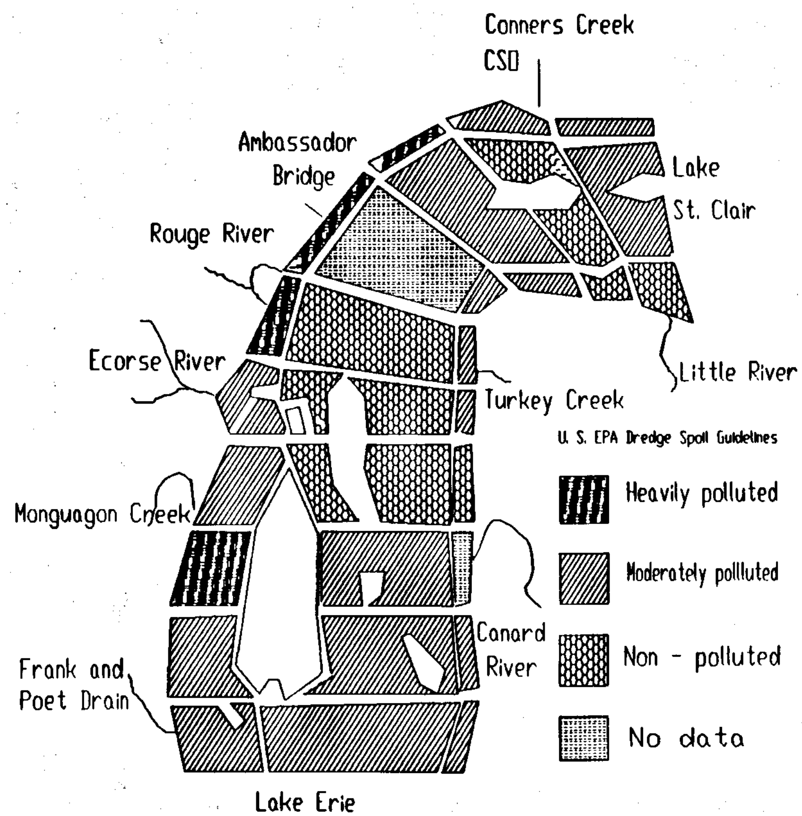


Figure 6-26b. Categorization of PCB concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

6.2.2.2 Oil and Grease

Oil and grease concentrations in the Detroit River ranged from 20 to 47,226 mg/kg. Median values for river sections ranged from 50 to 18,715 mg/kg (Figure 6-27a,b). The Ontario shoreline sediment oil and grease median concentrations and most individual sample concentrations were all below OME and U.S. EPA guidelines of 1,500 and 4,000 mg/kg, respectively, for open lake disposal (where data were available). Mid-river sections were also in the non-polluted range except for one section near the mouth (1,210 mg/kg) which was in the moderately polluted range (1,000 to 2,000 mg/kg) according to U.S. EPA guideline, and less than the OME dredge spoil guideline. Median concentrations along the Michigan shoreline exceeded the U.S. EPA guideline for heavily polluted sediments (>2,000 mg/kg) in all sections except at the very head and at the mouth. Median and individual concentrations were significantly higher than the guidelines. The highest individual concentrations were in depositional sediments along the Michigan shoreline just downstream of Belle Isle. The highest median concentration was in the Trenton Channel section downstream of Monguagon Creek.

6.2.3 Summary of Sediment Contaminants

Table 6-27 summarizes the available data on levels of contaminants in Detroit River sediments when examined using U.S. EPA, Region V guidelines for heavily polluted sediments. Certain sections of the Michigan shoreline appear to exhibit higher concentrations of particular contaminants than others, however, many of the contaminant distributions overlap considerably. Generally, contaminant concentrations are substantially greater along the Michigan shoreline, compared to the mid-river and Ontario shoreline sectors. Additionally, the Michigan shoreline from the Rouge River southward through the Trenton Channel appears to have the greatest overall contaminant levels (U.S. EPA and EC 1988).

Great variability in contaminant levels exist within the segmentation scheme employed in this study. For example, substantially lower contaminant concentrations exist on the Grosse Ile portion of the Trenton Channel compared to the Michigan mainland portion: this factor is not apparent from the representation of the segmentation scheme. Similarly, contaminant distributions in sediment are reflective of the combination of discharge and hydrological effects. Because there is little lateral mixing in the Detroit River, and distinctly for the Trenton Channel in particular, contaminants have been deposited in sediment according to long-shore water flow following a longitudinal vector. Although, contaminant levels are elevated in many instances, in particular zones, large areas of the Detroit River exhibit low or moderate levels of sediment contamination.

6.2.4 Sediment Toxicity

Sediment toxicity tests have been conducted on Detroit River sediments using several biota (bacteria, phytoplankton, zooplankton, benthic macroinvertebrates). The results of these tests are reported in Kreis

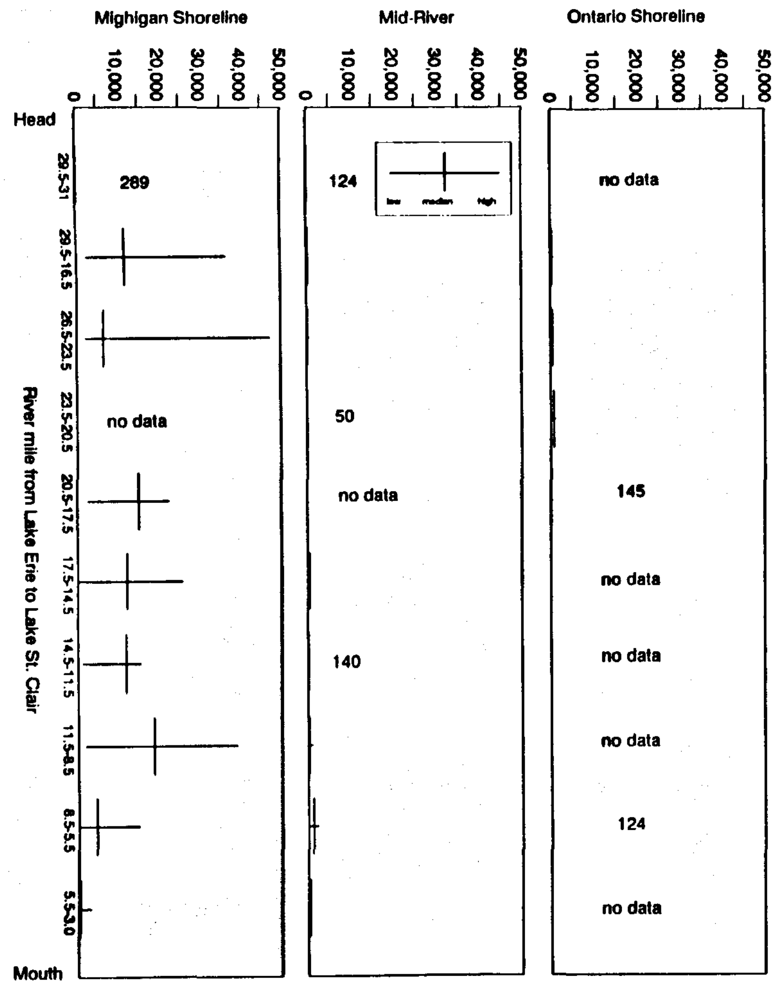


Figure 6-27a. Oil and grease concentrations in Detroit River sediments. Results in mg/kg.

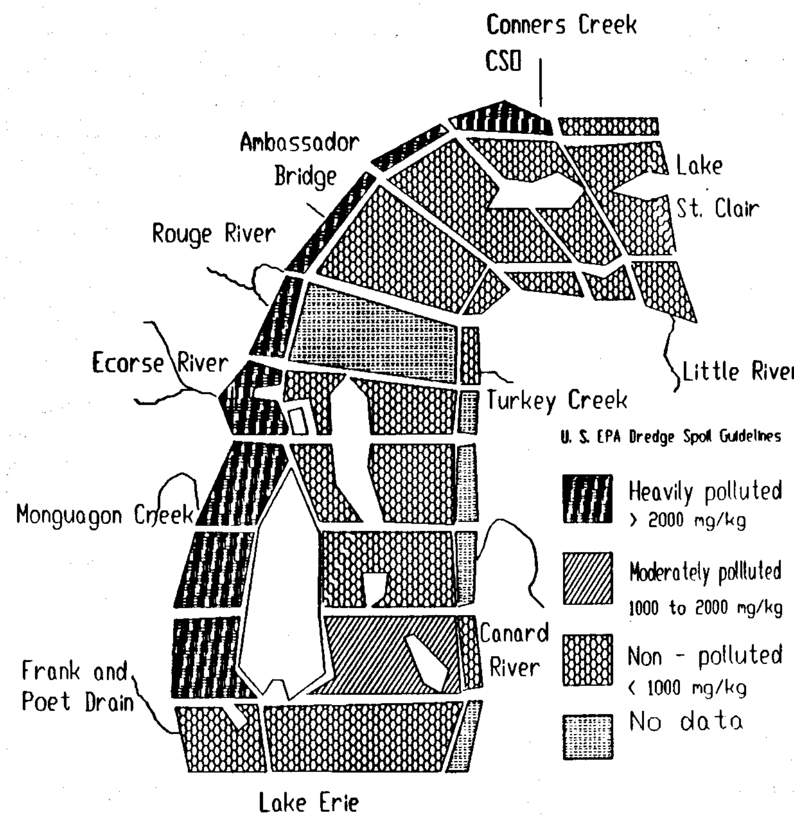


Figure 6-27b. Categorization of oil and grease concentrations in Detroit River sediments collected between 1980 and 1987 according to U.S. EPA dredge spoil guidelines.

Table 6-27. Summary of Detroit River heavily polluted sediments (using U.S. EPA Region V Guidelines for the classification of Great Lakes harbor sediments).

Contaminant	Michigan Shoreline	Mid-River	Ontario Shoreline
Arsenic	Belle Isle to mouth		(sparse data)
Cadmium	Trenton Channel (Monguagon Cr. to Gibraltar)		
Chromium	Belle Isle to mouth		
Copper	Conners Cr. to Elizabeth Pk.		
Cyanide	Conners Cr. to Gibraltar	Stony I. to mouth	(sparse data)
Iron	Rouge R. to mouth	Stony I. to Boblo I.	
Lead	Connors Cr. to mouth	Ambassador Br.	Windsor area
Manganese	Rouge R. to Gibraltar		(sparse data)
Mercury	Trenton Channel (Monguagon Cr. to Elizabeth Park)		
Nickel	Belle Isle to Gibraltar		
Zinc	Connors Cr. to mouth	Stony I. to Boblo I.	
PCBs	Belle Isle to Ecorse Trenton Channel (Monguagon Cr. to Elizabeth Park)		
Oil & Grease	Connors Cr. to Gibraltar		(sparse data)

(1987; 1988). However, the precision and ability of these tests to predict field conditions has not been adequately studied. Although sediment toxicity can be demonstrated for the Detroit River and these patterns resemble contaminant distributions and resident benthos distributions, field validation and direct cause linkages have not been established. Recognizing that additional research and development is needed and sediment toxicity tests have not been standardized for regulatory and remedial decision making, sediment toxicity results have been included in the Detroit River RAP primarily for informational purposes.

6.2.4.1 Bacteria

The toxicity of sediment interstitial water from 136 select locations in the Detroit River were assessed using the marine bacterium, Photobacterium phosphoreum, in the Microtox assay (Giesy et al. 1988b). The sampling program for this study included stations as far north as the Rouge River and extended southward to Lake Erie on both sides of Grosse Ile. Based on luminescence inhibition of P. phosphoreum by sediment interstitial water, Microtox results indicated that the western, nearshore zone of the Trenton Channel had the greatest number of highly toxic sites (Figure 6-28). Of the 136 stations assayed, 25 were highly toxic, 60 moderately toxic, 10 slightly toxic and 41 non-toxic. All 85 locations in the lower Detroit River, which were classified as highly or moderately toxic based on the Microtox assay, were too toxic to support benthic insects, snails or clams. Large expanses of the lower Detroit River, primarily north and to the east of Grosse Ile were non-toxic or slightly toxic.

White et al. (1987a) studied the inhibitory effects of sediment interstitial water and solid-phase sediments from the Detroit River on the H-3 glucose and H-03 adenine uptake rates of native bacteria. These investigators reported that solid-phase sediments from the Trenton Channel of the Detroit River inhibited H-3 glucose and/or H-03 adenine bacterial uptake rates 25% more than the inhibitory levels observed with the control sediment. Results indicate that uptake is greatly suppressed solely from sediment concentration in the control test medium and that the toxic effects observed are a smaller proportion of uptake inhibition, relative to particle densities. The environmental significance of this inhibitory effect is unclear.

The mutagenic potential of sediment extracts to bacteria was measured using the bacterial Salmonella/microsome assay (Ames test). The Ames test is typically used as a screening tool for potential carcinogenicity. Various degrees of mutagenic potential were noted at 28 of 30 Detroit River stations, with the most strongly mutagenic sediments being from the Trenton Channel (Figure 6-29) (Maccubbin 1987); several stations exhibited mutagenicity without metabolic activation. Moderately mutagenic sediments were primarily concentrated in the lower river near Lake Erie. This study did not include the Canadian shore.

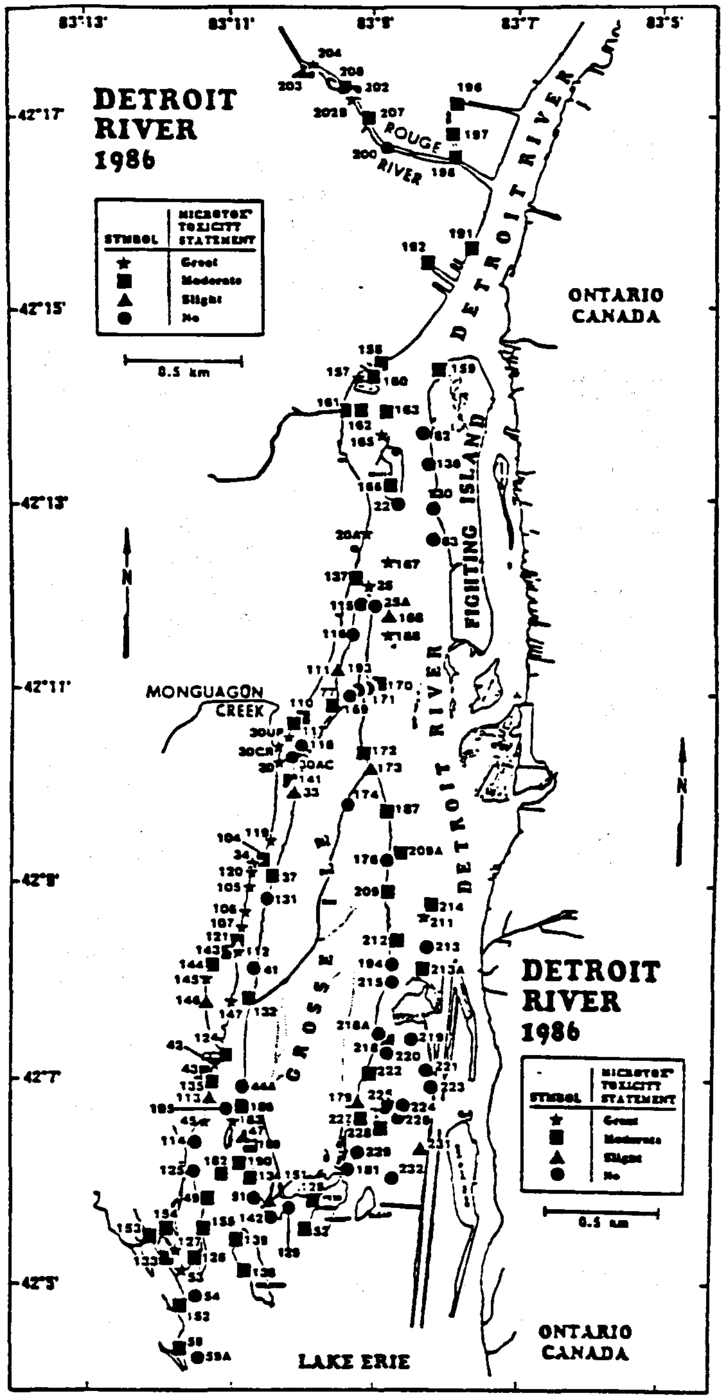


Figure 6-28. Sediment toxicity as determined from the Microtox Assay, lower Detroit River, 1986.

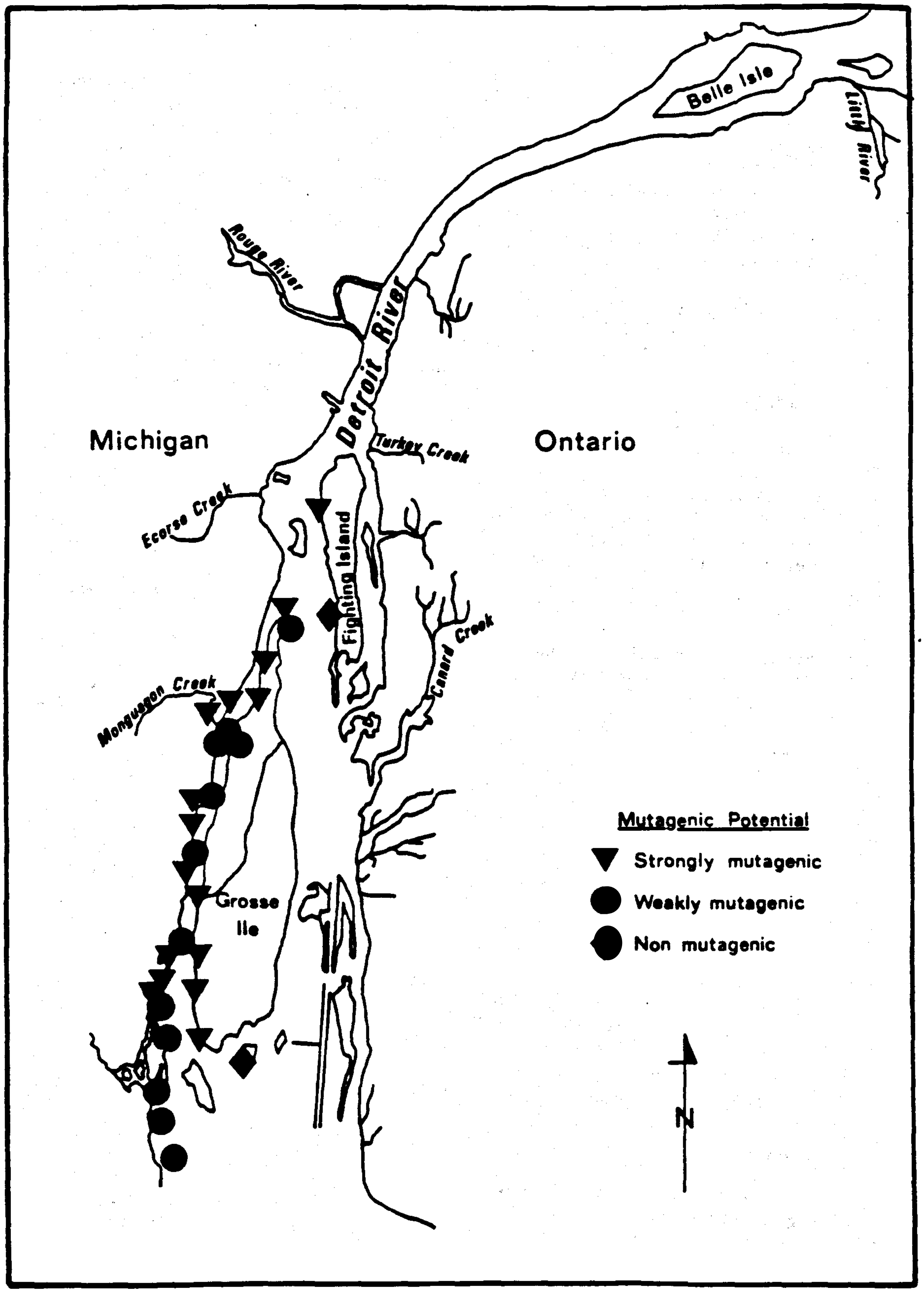


Figure 6-29. Distribution of mutagenic potential of Detroit River sediments as determined from the Ames Test. 1986. (Source: U.S. EPA and EC 1988).

6.2.4.2 Phytoplankton

Munawar et al. (1985) investigated the toxicological effect of Detroit River sediment elutriate water on ultra-phytoplankton (less than 2 um in length). Toxicological analysis of sediment elutriates is usually performed to assess the potential environmental impacts of dredging activities. Munawar et al. (1985) found sediment elutriates collected near Windsor, Ontario to be toxic to ultra-phytoplankton and the level of toxicity was directly correlated with the water soluble metal fraction.

6.2.4.3 Zooplankton

Giesy et al. (1988a) measured the acute toxicities of sediment interstitial water from 30 stations in the Detroit River using the cladoceran, _Daphnia magna_. The acute toxicity data from this study are summarized in Table 6-28 and clearly demonstrate that sediment interstitial waters from the Monguagon Creek vicinity of the Trenton Channel was more toxic than the other areas sampled. Twenty of the 30 sediment interstial waters tested were not acutely toxic to _D. magna_. White et al. (1987) investigated zooplankton-phytoplankton interactions upon exposure to contaminated Detroit River sediment elutriate water by determining _Daphnia pulicaria_ ingestion rates on _Cryptomonas_. Of the four sites investigated, sediment elutriate from Monguagon Creek elicited the greatest reduction in ingestion rate (Figure 6-30).

Seven-day chronic bioassays were used to measure the impacts of Detroit River near-bottom water in the Trenton Channel on Ceriodaphnia, another sensitive zooplankton test organism (White et al. 1987a). Percent female survival and number of young and broods produced per female compared to controls were the criteria for determining toxicity. Reproductive success (mean number of young produced/female) was substantially reduced relative to Lake Michigan controls at all four Detroit River test sites (Figures 6-31 and 6-32). These reductions were seasonal but most severe from July to September.

6.2.4.4 Benthic Macroinvertebrates

Oligochaetes:

The oligochaete, _Stylodridus heringianus_, exhibited higher sediment avoidance responses when exposed to sediments from the Trenton Channel compared to other areas in the Detroit River (Kreis 1988). Results of these avoidance response experiments are shown in Figures 6-33 and 6-34. Results indicated that Station 34 (Levy site) exhibited the greatest toxicity and the other stations lesser degrees of toxic responses.

Chironomids:

Giesy et al. (1987) assessed the chronic toxicity of solid phase sediments from 30 stations in the Detroit River by measuring this effect on the survival and growth of _Chironomus tentans_. These researchers found that all stations along the western shore of the Trenton Channel dramatically reduced the growth (60-96% growth reduction) of _C. tentans_ compared to controls.

Table 6-28. Lethality of Detroit River pore water to *Daphnia magna* during a 96 hour exposure (Giesy et al. 1987).

Station@	LC-10 (% Pore Water)	CI LC10	LC-50 (% Pore Water)	CI LC50
83	NT		NT	
54	NT		NT	
47	NT		NT	
44A	NT		NT	
113	NT		NT	
52	NT		NT	
51	NT		NT	
45	NT		NT	
114	NT		NT	
111	NT		NT	
59A	NT		NT	
53	NT		NT	
49	5.1	0-10.6	79.6	56.1-141.1
43	NT		NT	
30AC	NT		NT	
25A	NT		NT	
41	NT		NT	
77	NT		NT	
25	NT		NT	
110	10.1	1-20	41.3	10.1-100
30UP	7.6	0.92-14.4	19.0	14.2-37.7
112	23.6	5.1-63	34.6	31.7-37.2
30CR	8.4	3.7-13.6	38.3	32.5-47.6
30	7.4	2.2-12.6	27.8	21.6-40.1
42	8.7	1.5-15.8	47.2	38.9-56.4
104	NT		NT	
105	10.2	2.8-17.6	59.5	51.7-71.6
107	17.0	3.2-30.8	39.5	34.7-43.9
34	16.1	2.4-30	37.5	32-42
82	NT		NT	

@ Station location is shown in Figure 6-28.

CI = 95% confidence interval.

NT = Not toxic; slope of probit line not significantly different from zero.

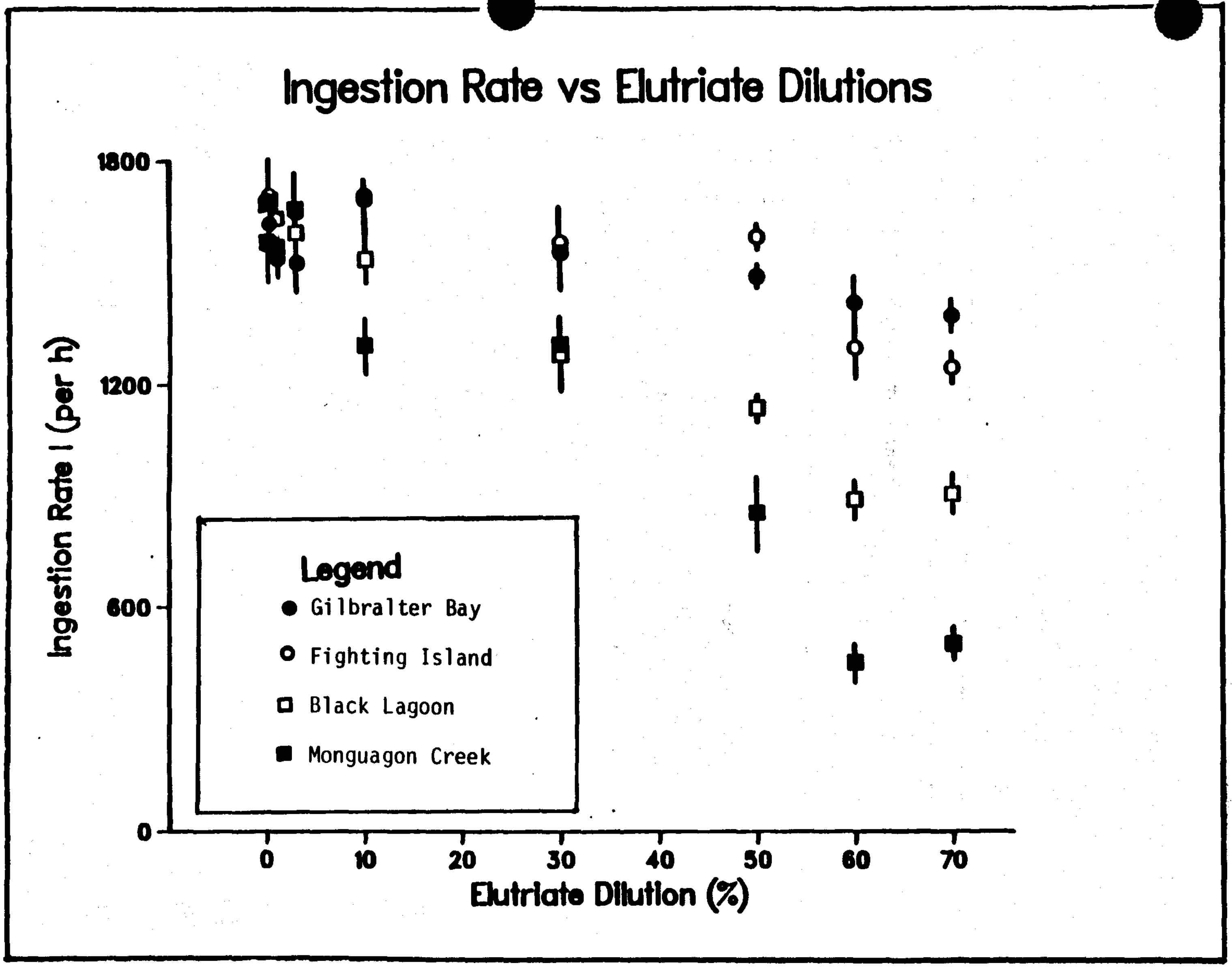
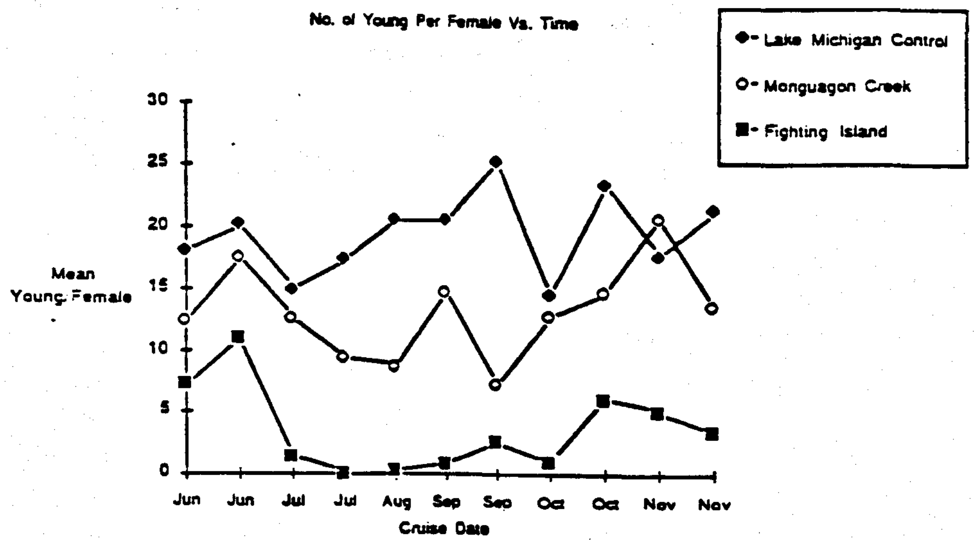


Figure 6-30. Daphnia ingestion rate versus sediment elutriate concentration from four sites in the lower Detroit River. (Source: White et al. 1987a).



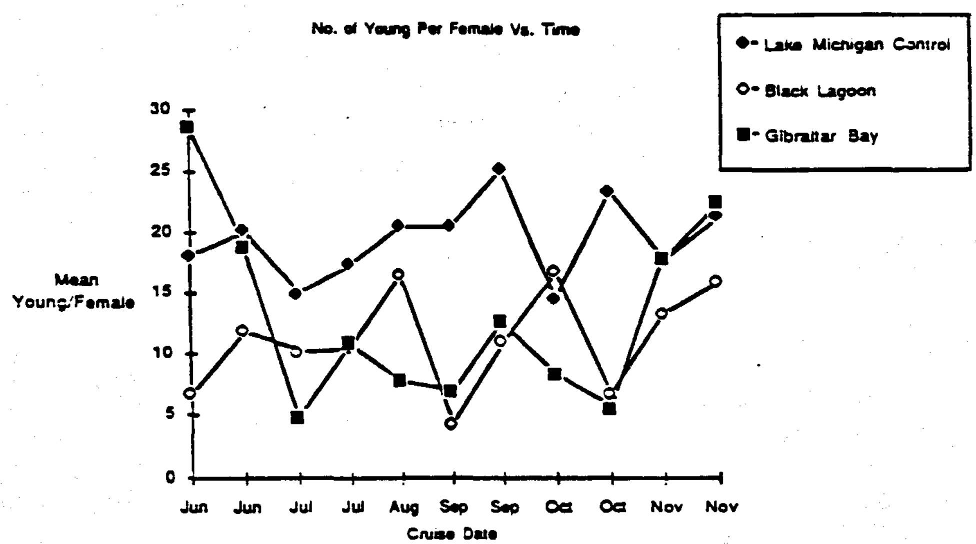
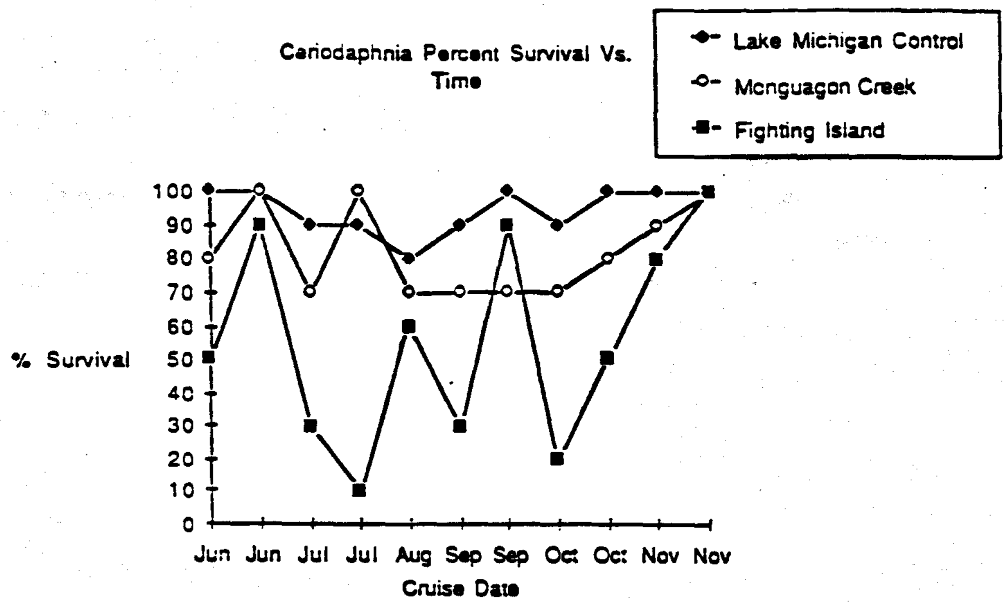


Figure 6-31. Seasonal Ceriodaphnia production of young in water samples from the four master stations and the Lake Michigan Control.



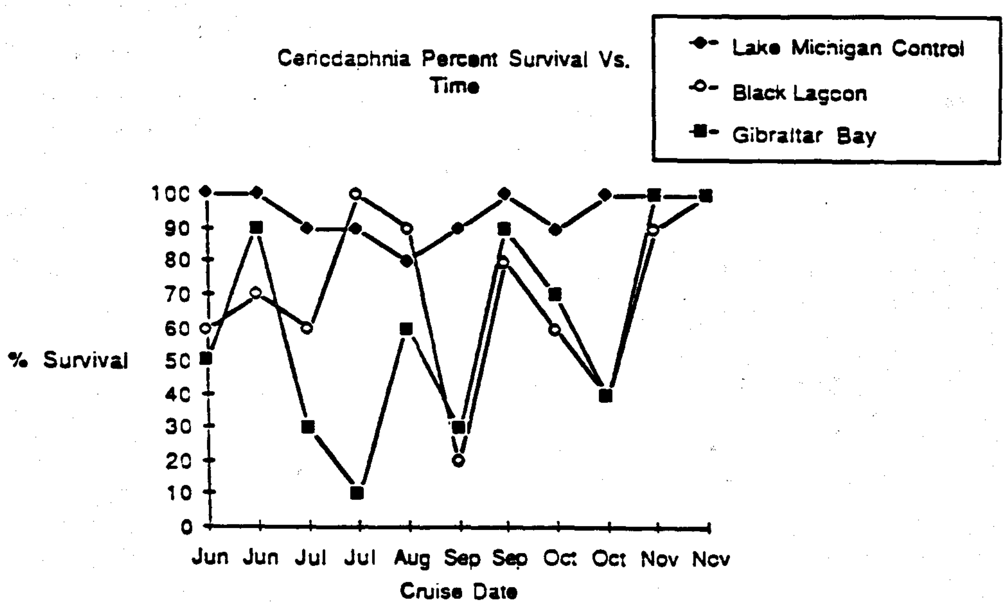


Figure 6-32. Seasonal Ceriodaphnia survival in water samples from the four master stations and the Lake Michigan Control.

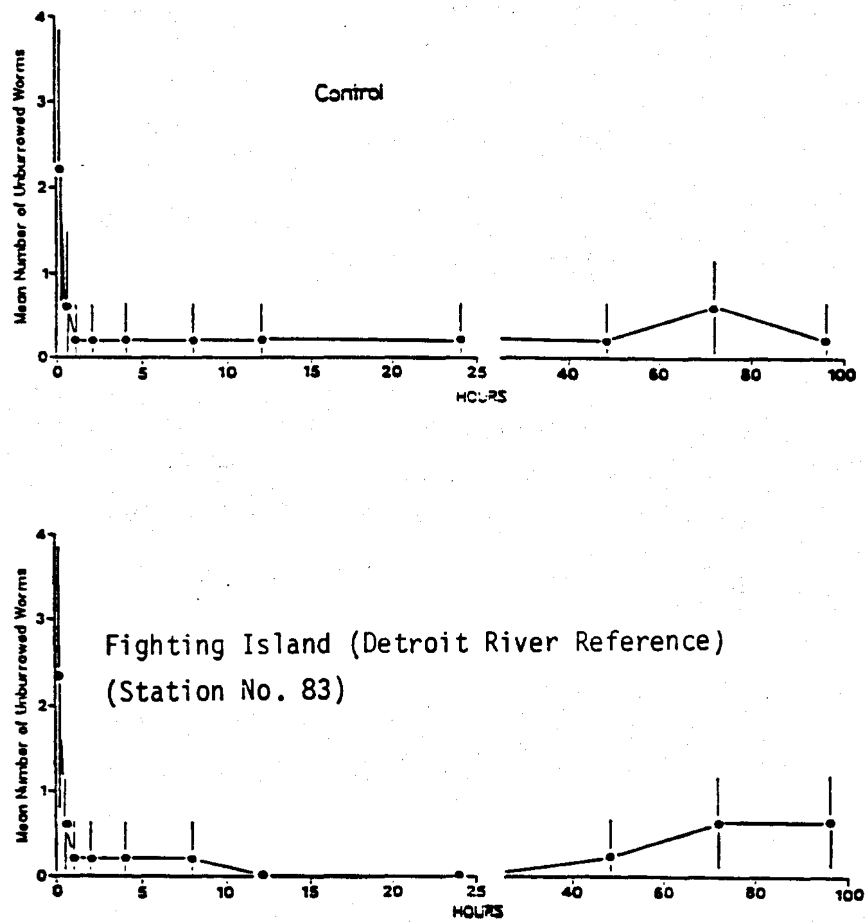


Figure 6-33. Mean number and standard error of unburrowed Stylodrilus over time for Lake Michigan (Control) sediment and Station 83 (Fighting Island, Detroit River-Reference) sediment. Five replicates, 10 worms per replicate. (Source: Kreis 1988).

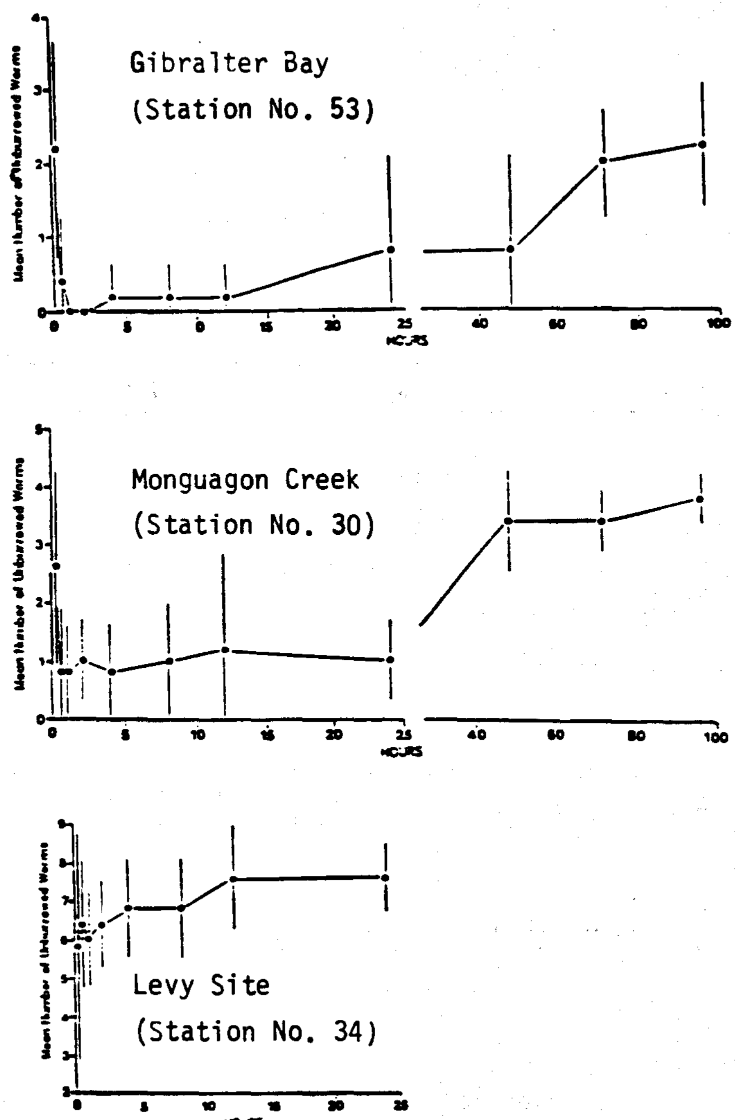


Figure 6-34. Mean number and standard error of unburrowed Stylodrilus over time for three lower Detroit River sediments. Five replicates, 10 worms per replicate. (Source: Kreis 1988).

The Chironomus tentans assay was also applied to intervals of short, sediment cores collected from the Trenton Channel and surrounding area (Rosiu et al. 1989). Results indicated that some locations possessed sediments which were as toxic or more toxic deeper in the core than at the core surface. These stations were typically located on the western shore of the channel. Several stations, however, exhibited little or no toxicity for the length of the sediment core.

White et al. (1987a) also reported that sediments from the Trenton Channel produced significantly higher avoidance responses in C. tentans compared to sediments from other locations in the Detroit River (Table 6-29).

6.2.5 Summary of Sediment Toxicity

A complete assessment of sediment toxicity has not been conducted for the entire Detroit River. Munawar et al. (1985) demonstrated that sediment elutriates in the headwater zones of the Detroit River were toxic to phytoplankton. In an intensive study of the Trenton Channel and adjacent areas (Kreis 1988), bulk sediment, sediment porewater, and sediment elutriate from certain locations were toxic to various test organisms which represented various levels of the trophic spectrum. Additionally, sediment extracts exhibited mutagenic potential. Although large expanses of the study area exhibited no or little toxicity, results suggest that the western nearshore zone of the Trenton Channel exhibited severe toxic responses. Although a general pattern of agreement was shown by most assays, the degree of toxicity varied from assay to assay for a given site. This may indicate that the test organisms are sensitive to different contaminants found in the complex mixtures of sediments. Munawar et al. (1985) demonstrated that phytoplankton toxicity in sediment elutriates were, in part, due to heavy metals. Undoubtedly, heavy metal toxicity is involved in Detroit River sediment toxicity, however, exact cause-effect relationships for different trophic levels have not been established because of the number of contaminants present. Although sediment toxicity can be demonstrated for the Detroit River and these patterns decidedly resemble contaminant distributions and resident benthos distributions (discussed in Section 6.3), field validation and direct cause linkages have not been established.

6.3 BENTHIC ORGANISMS

6.3.1 Macroinvertebrates

Benthic macroinvertebrates consume primarily plant and detrital material, although some forms are carnivorous. Since many of these organisms live in direct contact with the sediments, they have the potential to accumulate contaminants present in the sediments. Macroinvertebrates, as a part of the food chain, are a food source for fish, waterfowl, and predators. These predators, comprising a higher trophic level, may bioaccumulate some persistent chemicals to concentrations many times that found in the sediment, water, or the benthic organisms which they consume.

Table 6-29. Behavioral responses of Chironomus tentans to near-bottom water from the lower Detroit River (Kreis 1988). Asterisk (*) indicates a statistically significant difference ($p < 0.05$) from the control.

		RESPONSE		
DATE	STATION[a]	ESCAPE	RESPIRATION	REST
6-23	30	6-20*	1.40*	2.33*
	34	7.13*	0.97*	1.90*
	53	4.20*	1.83*	3.97*
	83	5.10*	2.23	2.33*
	Control	2.60	2.30	5.10
7-8	30CR	4.73*	2.03	3.23*
	34	6.77*	1.00*	2.23*
	53	4.07*	1.93	4.00
	83	5.63*	1.57*	2.80*
	Control	2.53	2.27	5.20
8-22	30CR	4.93*	1.93	3.13*
	34	5.37*	2.10	2.53*
	53	3.53*	2.07	4.47
	83	3.63*	2.37	4.00*
	Control	2.50	2.37	5.13
10-15	30CR	5.20*	1.50*	3.27*
	34	5.27*	1.47*	3.27*
	53	4.10*	1.83*	4.07*
	83	4.10*	2.43	3.47*
	Control	2.47	2.60	4.93
11-13	30CR	5.33*	1.37*	3.30
	34	6.60*	0.90*	2.50*
	53	4.87*	1.60*	3.53*
	83	4.57*	1.67*	3.73*
	Control	2.53	2.67	4.80
11-21	30CR	4.53*	1.93	3.53*
	34	6.03*	1.40*	2.57*
	53	3.93*	2.07	4.00*
	83	4.23*	1.97	3.80*
	Control	2.27	2.43	5.27

[a] Station location is shown in Figure 6-28.

Several Detroit River benthic macroinvertebrate community studies have been conducted over the years and can be used to document, and to some extent, track the water and sediment quality of the Detroit River. Population numbers and species diversity of macroinvertebrates may be correlated with changes in water and sediment quality. These changes often reflect improvements in effluent qualities. However, residual sediment contaminants in localized areas may preclude a rapid response to decreased concentrations of contaminants in the water column. In these areas the benthic macroinvertebrate community may not recover until the sediment toxicity is reduced through remedial actions or natural processes such as burial or flushing. For these reasons, the current benthic community may not reflect the improvements in water quality as a result of pollution control measures already implemented.

More than 300 species of benthic invertebrates have been documented in the Detroit River system (Edsall et al. 1988a). The most signifcant taxa in terms of biomass are oligochaeta, chironomidae, Gastropoda, Ephemeroptera, Trichoptera, and Amphipoda. Oligochaetes are most common in the lower Detroit River (downstream of the Rouge River) while chironomids are abundant throughout the river system. Taxa diversity and abundance are generally greater in the shallow depositional zones as opposed to the deeper high velocity portions of the river (Edsall et al. 1988a).

The historical degradation of the Detroit River is evidenced by qualitative accounts of mayfly (Ephemeroptera) population densities. These organisms are typically pollution intolerant and play a key role in the food chain as some fish feed exclusively on them in midsummer. Mayflies were seen in great abundance in the early part of the century (EnCoTec 1974). As the Detroit and Windsor metropolitan areas developed, municipal and industrial waste quantities discharged to the river increased. Dissolved oxygen levels decreased and levels of toxicants and oil and grease increased resulting in a drastic reduction of the mayfly population in the Detroit River. Early macroinvertebrate surveys of the Detroit River conducted in 1929-1930 found snails, fingernail clams, and tubificid worms (Wright and Tidd 1933). The absence of mayfly nymphs suggested a reduced level of water quality. Presently, mayfly populations are increasing (Schloesser et al. 1988) although they have not yet attained appropriate levels.

The Trenton Channel also showed water quality impacts in the 1930's as evidenced by the sparsity of live fingernail clams in the area. Surveys conducted between 1949 and 1956 found the lower Detroit River and the western Trenton Channel was dominated by pollution tolerant forms of macroinvertebrates (Hunt 1962), indicating a decrease in water quality from the 1930's.

Subsequent studies have found benthic populations in the river upstream of Belle Isle were dominated by organisms characteristic of high water quality (Vaughn and Harlow 1965; EnCoTec 1974).

Similarly, the organisms found along the Canadian shore for the length of the river represented a diverse population including facultative and clean water macroinvertebrate forms such as mayflies and caddisflies (Trichoptera) (Surber 1955; Thornley and Hamdy 1984). Thornley and

Hamdy (1984) identified a balanced community structure indicative of satisfactory water quality conditions along the entire Canadian shoreline, both in 1968 and 1980. Canadian pollution sources impacting on the biology did not seriously disrupt the macrozoobenthos.

The benthic community near the Michigan shoreline from Belle Isle to Zug Island consisted only of pollution tolerant sludge worms and leaches. In this same reach, the mid-stream of the river had a community similar to that found upstream of Belle Isle (1963 survey, Vaughn and Harlow 1965). Benthic macroinvertebrates found just upstream of the Rouge River included sparse numbers of mayflies and caddisflies, indicating fair water quality (Surber 1955).

Downstream of the Rouge River, the benthic community along the Michigan shoreline was severely degraded and largely dominated by pollution tolerant organisms with a bottom habitat largely unsuitable for most aquatic life (Surber 1955; Vaughan and Harlow 1965; EnCoTec 1974). Scuds, mayflies, and midges were the dominant insect taxa found (EnCoTec 1974). Pollution tolerant aquatic worms exceeded one million per square meter, indicative of severe organic enrichment (Thornley and Hamdy 1984). More recent work in this area substantiates this conclusion (1985-86 survey, ES&E et al. 1987; Kenaga, unpublished).

Limited improvement in the benthic community was noted in an area below the Trenton Channel by one survey (EnCoTec 1974) although a second survey conducted in 1977 of eleven Detroit River stations concluded that little change had occurred in the river over the last 20 years (Hiltunen and Manny 1982). Thornley and Hamdy (1984) determined that the high numbers of worms representing a lessor degree of organic enrichment persisted along the Michigan shoreline to the mouth of the Detroit River.

More recent data indicates improvements in the benthic communities in all areas of the Detroit River and substantial improvements in the upper river and along the entire Canadian shoreline. This improvement is illustrated by the increase in the mayfly densities and distribution between 1968 and 1980 (Figure 6-35) (Thornley and Hamdy 1984). The burrowing mayfly, Hexagenia limbata was found at 70% of Canadian stations in 1980 compared to 26% in 1968. In 1980, these mayflies were present in the lower 10 km of the river where they were absent in 1968. Densities of Hexagenia limbata were greatly increased along the Ontario shore from the 1968 observations. Hexagenia limbata mayflies were found on the Michigan side in very low densities, but their presence was an indication of partial recovery over the 12 year period. Recent benthic sampling data from 1982 and 1984 showed the mayfly genera Hexagenia, Caenis, and Baetisca have recolonized several portions of the lower Detroit River as a result of water quality improvement (Edsall et al. 1988b).

Macroinvertebrates in the Trenton Channel in 1985-86 were present in densities less than earlier studies indicated (Kenaga, unpublished). Some locations were devoid of benthic life. Oligocheates remained the dominant taxa, with pollution tolerant forms comprising 95 percent of the organisms collected. Macroinvertebrate habitat in the Trenton Channel was severely degraded as evidenced by the presence of oils and chemical odors.

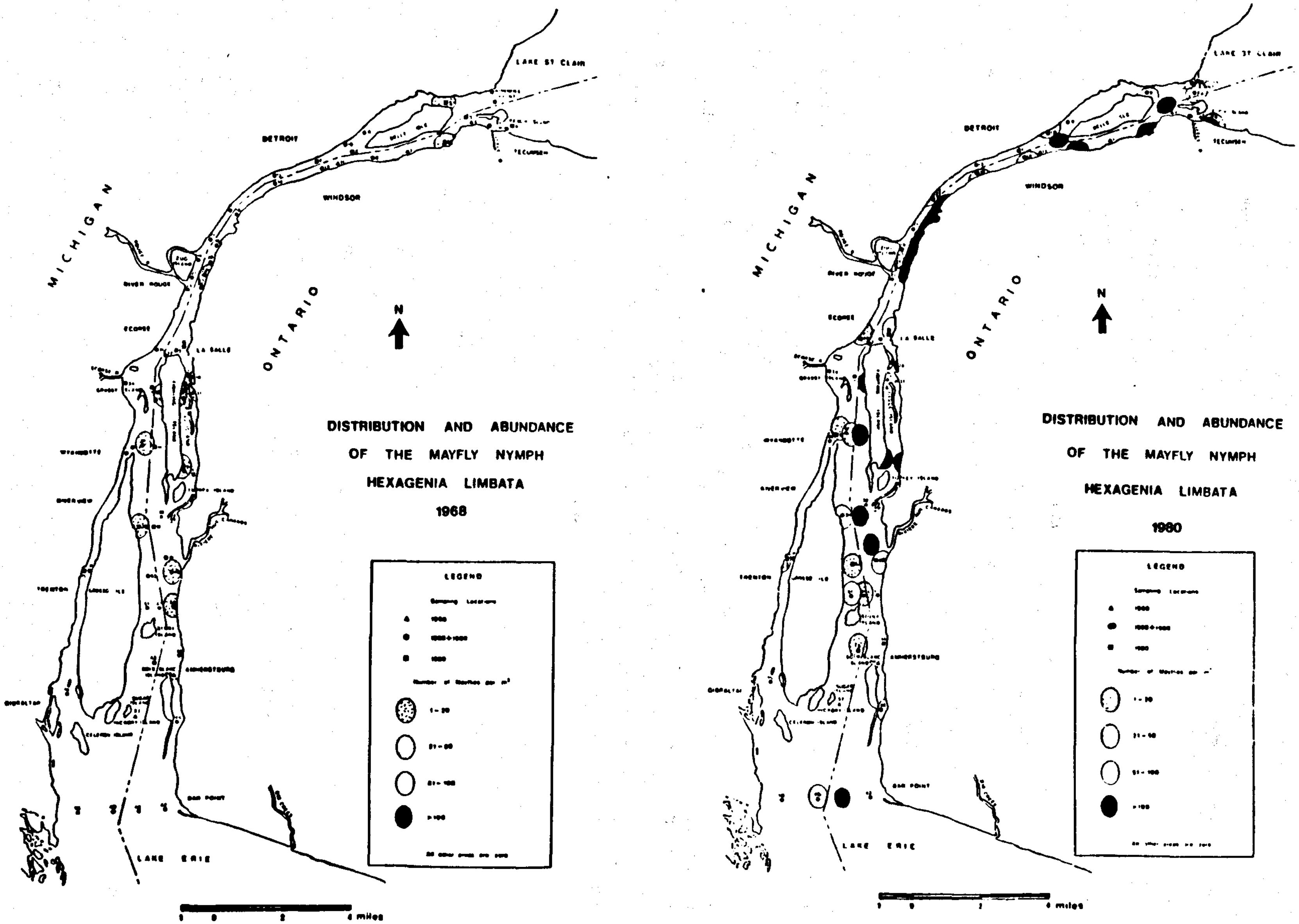


Figure 6-35. Mayfly distribution in the Detroit River, 1968 and 1980.

Samples collected along the west side of Fighting Island yielded burrowing mayflies indicating fair water quality, however this area has not historically shown impacts of wastewater discharges (Kenaga, unpublished report).

In summary, macroinvertebrate communities in the Detroit River have improved since 1968, however several areas remain degraded. Impaired areas include the Michigan shoreline from the confluence with the Rouge River to the mouth, including the Trenton Channel. The west shore of Fighting Island was not impaired. Macroinvertebrate communities along the Canadian shoreline were not impaired.

6.3.2 Mussels

6.3.2.1 Species

Mussels and clams filter large amount of water for food and can bioaccumulate contaminants at concentrations greater than those found in water or sediments. Unionid mussel populations (or niads) in the Detroit River include 13 species classified as Endangered, Threatened or Rare in the Michigan Natural Resources Inventory. Freitag (1987) reported five species listed as endangered or threatened by the State of Michigan. No other area in Michigan has been reported to support this number of listed species (Table 6-30). Evaluation of recent and museum specimens of mussels indicates that the original fauna of the Detroit River consisted of 36 species. The recent species composition of the Detroit River is apparently little changed from the historic fauna with approximately 80% remaining. Live mussels were absent from the Trenton Channel, but were present in low numbers (both density and diversity) on the east side of Grosse Ile. On the Canadian side of the channel below Fighting Island, mussel populations were reduced from those found upstream (Kovalak, personal communication with Freitag). Several factors could have affected species composition including changes in abundances of resident fish species, degraded water quality, or changes in other physical factors. There is some evidence to show that some clams are recently reappearing in the river. Unionid clams, not found in the Detroit River in a 1968 survey, were found in 1980 (Thornley and Hamdy 1984). Of 70 stations sampled during the two surveys, 43 stations were common to both 1968 and 1980 surveys.

6.3.2.2 Bioaccumulation of Toxicants in Clams

Clams have been used to monitor contaminants in the connecting channels because they quickly accumulate organic compounds and metals through feeding and direct absorption (Coker et al. 1921; Pugsley et al. 1985). Pugsley reported PCBs and octachlorostyrene in native mussels *Lampsilis radiata siliquoidea* in the Detroit River obtained from stations situated adjacent to the Canadian shore. PCB and octachlorostyrene concentrations in clams were similar to concentrations in sediments, more so for octachlorostyrene than for PCB (Figures 6-36 and 6-37).

Kauss and Hamdy (1985) used caged clams to monitor the uptake of PCB, octachlorostyrene and hexachlorobenzene. The clams *Elliptio camplanata* Dillwyn were used at ten stations during 1982 and at 17 stations in 1983 in an attempt to better define the distribution of

Table 6-30. Recent and historical records of mussels from the Detroit River (Freitag 1987).

Species	Historical		Recent	
	Museum[1]	Literature	Gibralter	Belle Isle
Actiponsies carinata	DR		X	X
Alasmidonta marginata	BI, L, BB	X		
Alasmidonta viridis (=*calceola*)	BI, BB	X		
Amblema plicata	BI, S	X	X	X
Anodonta grandis grandis	S, DM	X	X	X
Anodonta imbecillis		X		
Anodontoides ferussacianus	DR, L	X		X
Carunculina parva		X		
Cyclonaias tuberculata	DR, BI, G, S, L	X	X	X
Dysnomia torulosa rangiana[3]	BI, S, BB	X	X	X
**Dysnomia sulcata delicata*	DR, BI, F	X		
Dysnomia triquetra[4]	BI	X	X	X
Elliptio dilatata	DM, S, BI	X	X	X
Fusconaia flava	DM	X	X	X
**Fusconaia subrotunda*		X		
Lampsilis fasciola	L BB	X		
Lampsilis ventricosa	**BI	X	X	X
Lampsilis radiata siliquoidea	**DR, BI	X	X	X
Lasmigona compressa	DR	X		
Lasmigona complanata				X
Lasmigona costata	F, L	X	X	X
Leptodea fragilis	**F	X	X	X
**Leptodea leptodoa*		X		
Ligumia oasuta	BI, S	X	X	X
Ligumia recta	BI, F, L, S	X	X	X
Obliquaria reflexa		X	X	X
Obovaria olivaria	BI, F, G, S, L	X		X
Obovaria subrotunda[3]	BI, F, S, BB	X	X	X
Pleurobema coccineum	F, L, S, BB	X	X	X
Proptera slats	DI, L, S,	X	X	X
Quadrula pustulosa		X		
Quadrula quadrula	BI	X		
Simpsoniconcha ambigua[3]	BI, BB	X		X
Strophitus undulata	BI, S, BB	X	X	X
Truncilla dopaciformis		X	X	X
Truncilla truncata	BI	X	X	X
Villosa fabalis[3]	BI	X	X	X
Villoss iris	DR, BI, L, S, RB	X	X	X

1. UMMZ Location records:
   DM = Detroit, Michigan
   DR = Detroit River
   BI = Belle Isle
   F = Fighting Island
   G = Grassy Island
   S = Stoney Island
   L = Livingston Channel
   BB = Bois Blanc Island

2. Some site locations could not be determined:
   X = present
   * = not considered part of the fauna
   ** = not all records searched

3. Michigan endangered species

4. Michigan threatened species

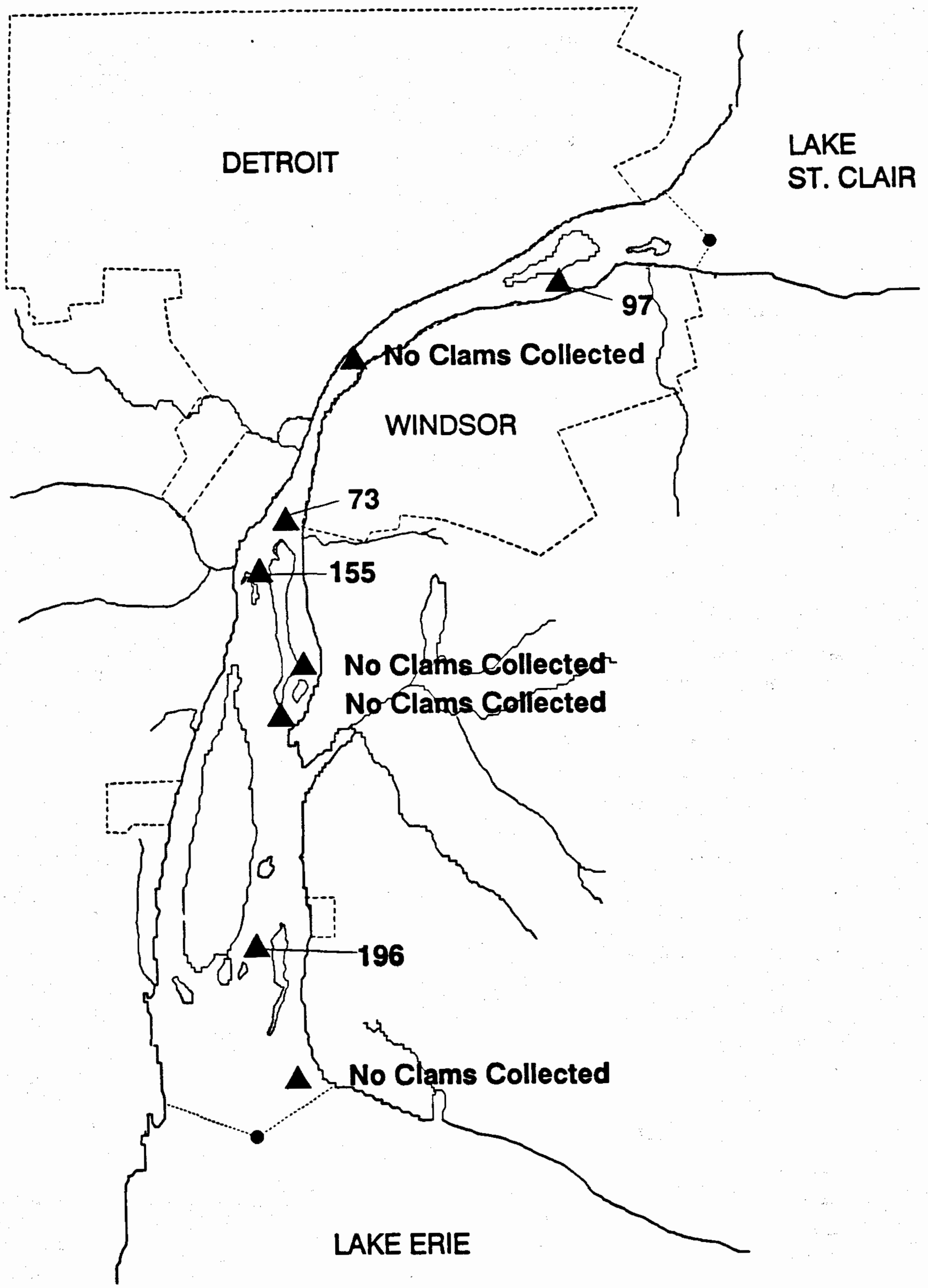


Figure 6-36. PCB levels for 1983 samples of Lampsilis radiata siliquoidea whole tissue extract expressed as Aroclor 1254 on a dry weight basis (wet/dry weight = 6.667). Results are in ug/kg. (Pugsley et al. 1985).

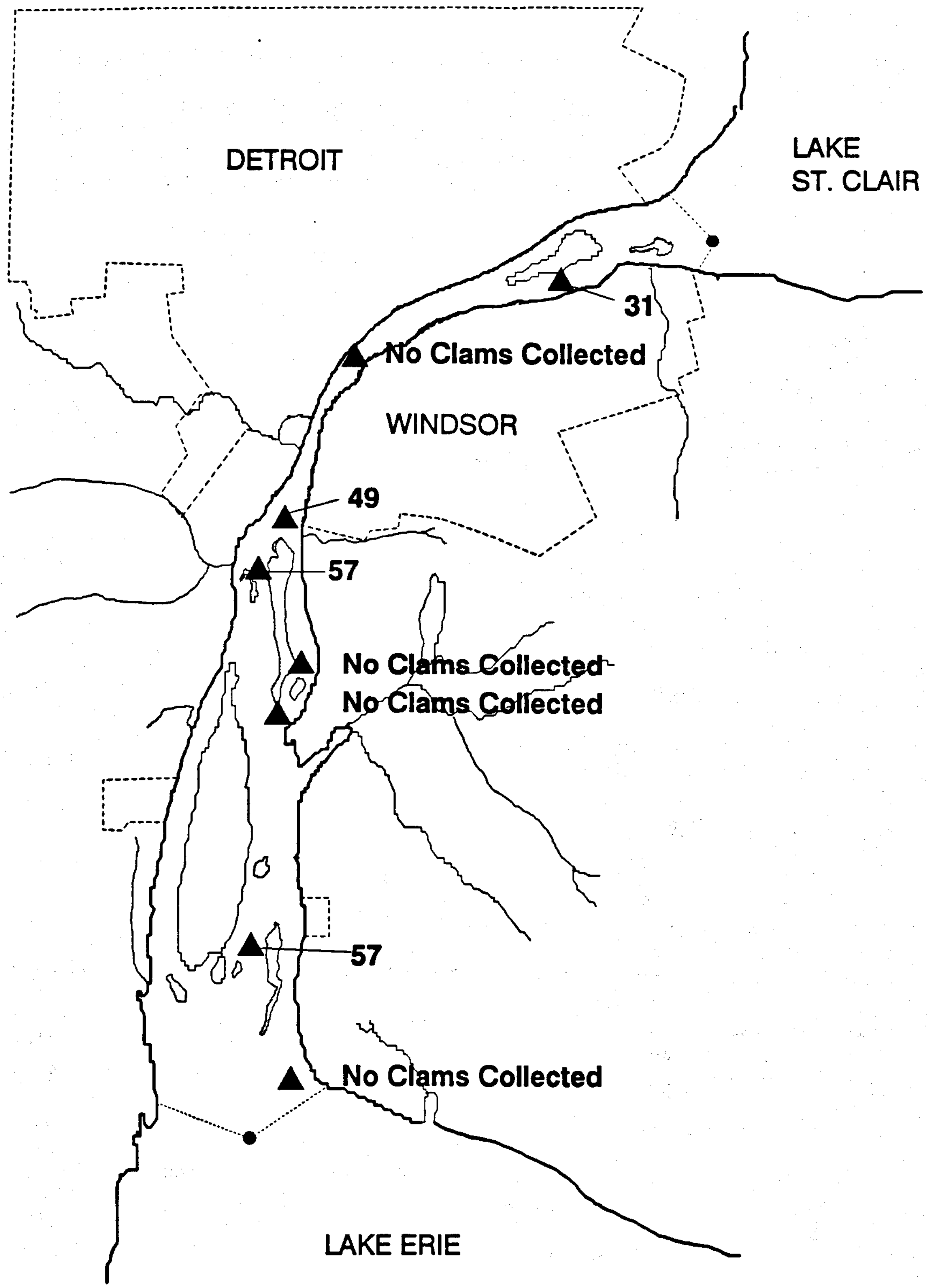


Figure 6-37. Octachlorostyrene levels for 1983 samples of Lampsilis radiata siliquoidea whole tissue extract expressed as Aroclor 1254 on a dry weight basis (wet/dry weight = 6.667). Results are in ug/kg. (Source: Pugsley et al. 1985).

biologically available organochlorine contaminants and aid in the identification of sources of these materials. The highest levels were found along the western Detroit River shore near Conners Creek, the lower Trenton Channel, and the Rouge River. PCBs were the major organochlorine clam contaminant, ranging from 20 to 293 ug/kg along the Michigan shore. Clams from the Ontario shore had much lower concentrations (Figure 6-38).

An additional caged clam study was undertaken by Kauss and Hamdy in 1984 to further delineate sources of organochlorine compounds (Edsall et al. 1988a). After 18 weeks of exposure, 14 out of 25 organochlorine compounds analyzed for were found in clams at one or more of the 26 stations. The most frequently detected organochlorine compounds found were PCBs, OCS, p,p'-DDE and HCB. The PCBs were the primary organochlorine compound found in terms of frequency and magnitude. The highest concentrations of PCBs were found in clams along the Michigan shoreline. These findings in addition to others indicate the Detroit River is a major source of PCBs to Lake Erie (Edsall 1988a).

Polynuclear aromatic hydrocarbons (PAHs) were also reported in caged clams at elevated levels along the Michigan shoreline and downstream in the Trenton Channel ranging from 136 to 772 ug/kg (Pugsley et al. 1985). Along the Ontario shoreline PAHs in clams ranged from 52 to 274 ug/kg.

Native Detroit River mussels (Lampsilis radiata siliquoidea) at four stations along the Ontario shore contained lead ranging from 3 to 9 mg/kg and cadmium ranging from 3.5 to 6.2 mg/kg (Figure 6-39) (University of Windsor 1986). PCBs ranged from 73 to 196 ug/kg at these same locations. Octachlorostyrene in clams ranged from 31 to 57 ug/kg, a factor of 70 to 285 times higher than sediment concentrations (Pugsley et al. 1985).

6.3.3 Zebra Mussels

The zebra mussel (Dreissena polymorpha) is a mollusk that gets its name from its striped shell. Populations were only found in Europe and Asia until zebra mussels were collected from the waters of Lake St. Clair in June 1988. Scientists believe the mussel was introduced into the lake by a ship discharging ballast water picked up in a European port.

The mollusk has spread quickly. Populations have been found in Lake St. Clair, throughout Lake Erie, and the Detroit and St. Clair Rivers and in harbors in the upper Great Lakes. Zebra mussels have been found as far east as Cornwall in the St. Lawrence River, and as far west as Duluth, Minnesota.

For the first few years after the initial invasion, there is usually a build up of numbers and biomass. Reproduction of the zebra mussel occurs between June and October as water temperatures exceed 54°F (12°C). Planktonic veliger larvae are produced which attain maximum densities in July-August between 10 and 2 feet (3 and 7 m) depths in a belt around the perimeter of the lake. Maximum growth rates are expected to exceed 0.6 inches (1.5 cm) per year to a maximum shell length greater than 1.7 inches (4 cm). The maximum life span approaches five years in Europe (Mackie et al. 1989).

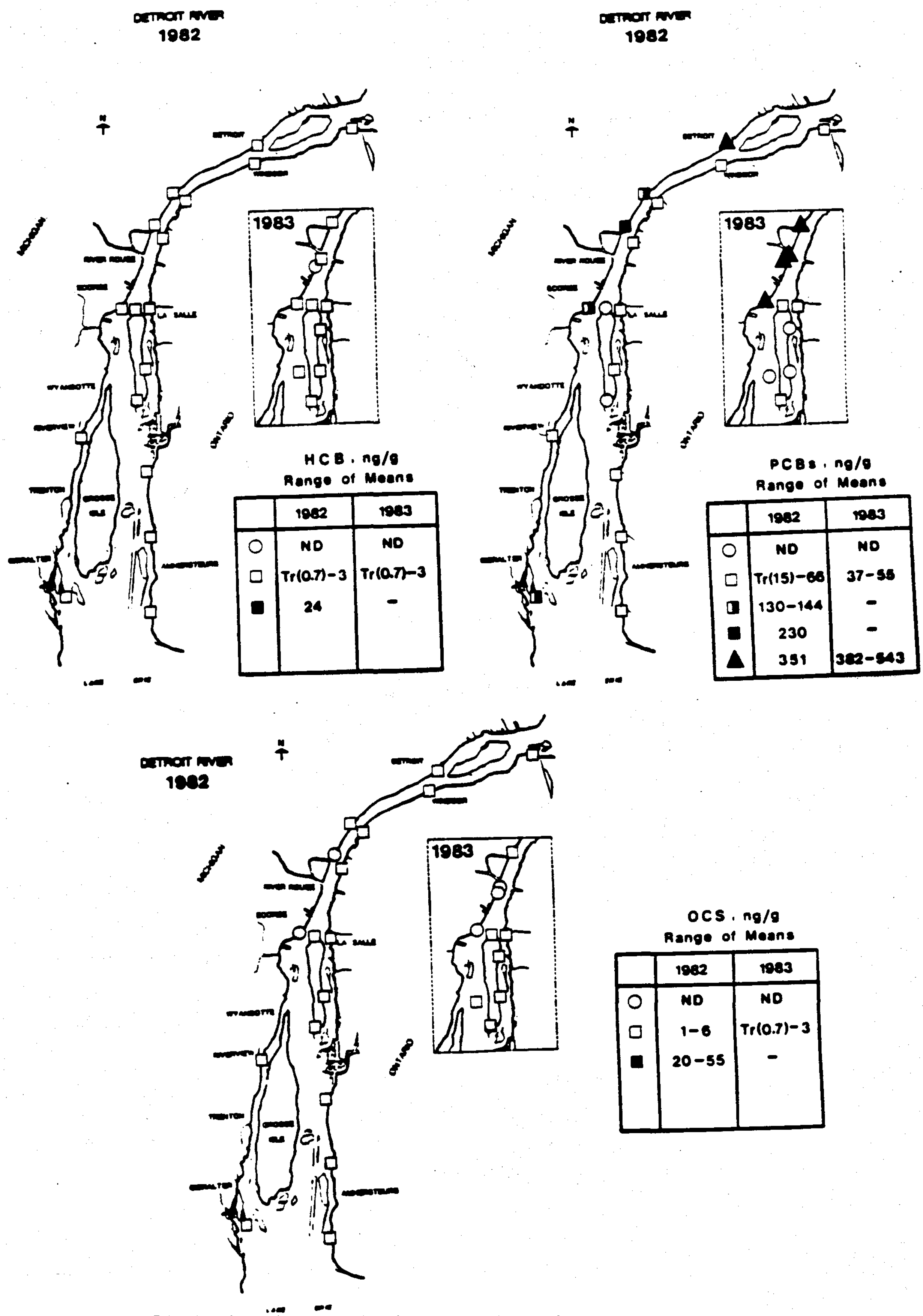


Figure 6-38. Distribution of organochlorine contaminants in clams exposed in the Detroit River (1982 and 1983). (Source: Kauss and Hamdy 1985).

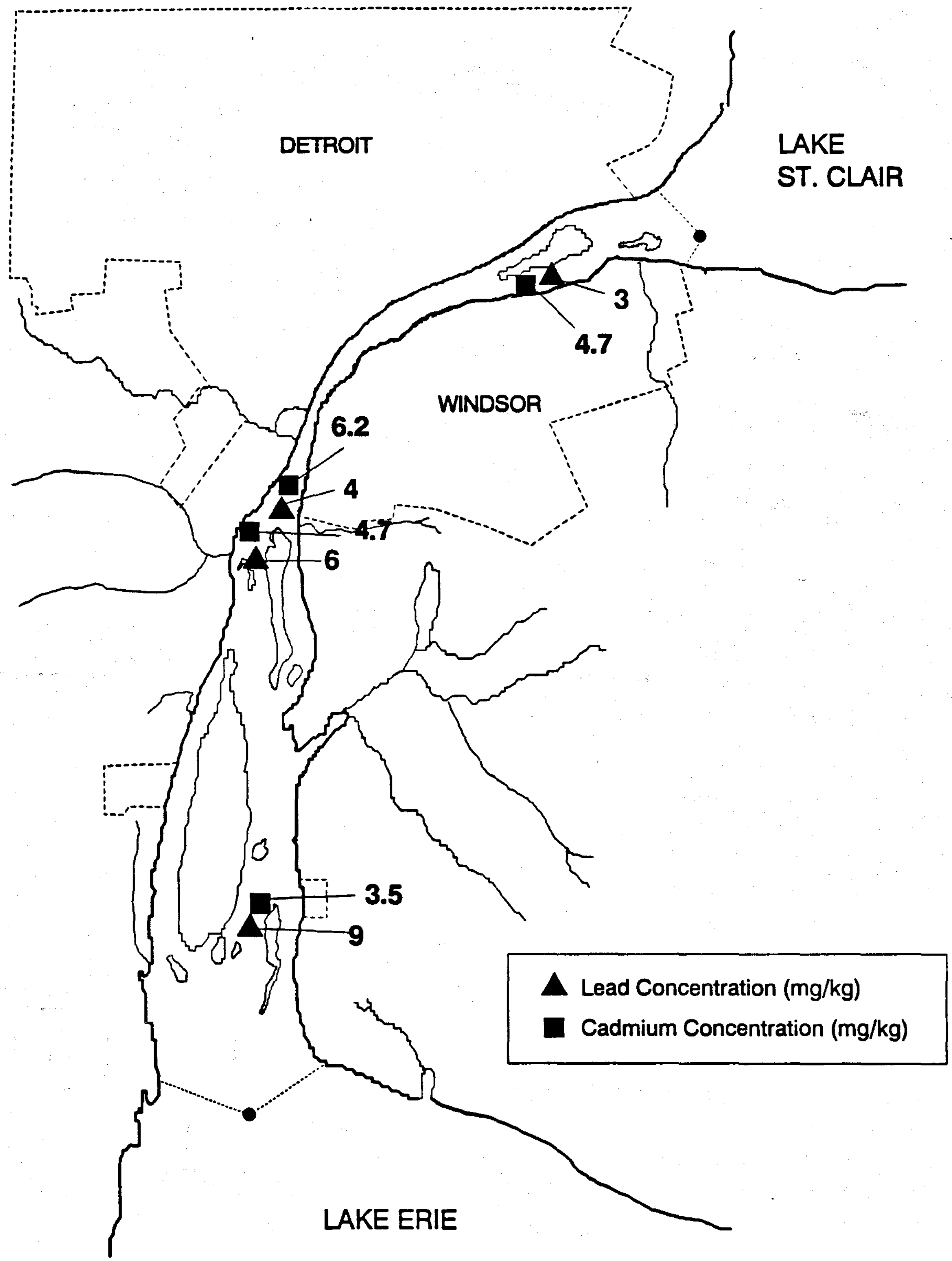


Figure 6-39. Lead and cadmium levels for 1983 samples of <u>Lampsilis radiata siliquoidea</u> whole tissue extract expressed as Aroclor 1254 on a dry weight basis (wet/dry weight = 6.667). Results are in mg/kg. (University of Windsor 1986).

Zebra mussels breed prolifically, building up colonies several layers thick. Large concentrations of zebra mussels have been found on municipal and industrial water intake pipes causing serious reduction in water flow. It is estimated that removing mussels and preventing further buildup could cost water users in Lake Erie alone hundreds of millions of dollars. Several facilities on both sides of the Detroit River have reported zebra mussel infestation. The mussel can also foul navigation buoys to the point of submergence, encrust hulls of boats and encrust and clog fishing nets that remain in the water over the summer and/or fall. In addition, the mussels may become a significant vector of parasites that are lethal to game species of waterfowl and fish.

Large numbers of zebra mussels attached to Lake Erie spawning reefs could adversely impact the aquatic ecosystem and specifically the fishery. For example, by consuming plankton, zebra mussels could reduce the amount of food available for the young of some fish species. By colonizing shoals they could decrease the survival rate of fish eggs.

Numerous control programs have been attempted. Unfortunately, there is no universally accepted method of zebra mussel control. While the preferred abiotic control method is heat treatment, cooling water systems must be designed specifically for this ability. Flushing is a viable alternative if the intake is not too far from the plant, but complete prevention/removal of Dreissena is difficult. The most popular and effective control method is chlorination, but the formation of toxic organochlorines in the environment is possible. Although biological controls are preferred because they would probably have the least environmental impact, an effective predator remains to be found.

Adult zebra mussels may face a number of predators in the Great Lakes basin including:

Fish	Birds	Other
Carp	Mallards	Muskrats
Freshwater Drum	Scaup	Crayfish
"Suckers"	Other diving ducks	
Sturgeon		
Whitefish		
Yellow perch		
White perch		
American eel		

None of these predators appears to have the ability to control population densities. However, scaup densities at Point Pelee have increased from approximately 20 in 1987 to roughly 700 in 1988 to over 13,000 in 1989. These birds were actively feeding on zebra mussels.

Physical and biological impacts have also been documented. In the Western Basin on Lake Erie secchi disk transparency doubled, chlorophyll a decreased by 43% and particulate organic carbon also decreased from 1988 to 1989. Native unionids have been killed when zebra mussels attach to the shells in large numbers and laboratory studies indicate that live unionid shells are a preferred substrate for zebra mussels.

Numerous studies associated with zebra mussels are currently underway, however, it may be some time before the true extent of the problem is known.

6.4 AQUATIC PLANTS

6.4.1 Phytoplankton

In aquatic systems, the phytoplankton form the basis of the food chain along with submersed and emergent plants. These microscopic floating plants are consumed primarily by fish, zooplankton and other aquatic life. Manny, et al. (1988) reported that 82 species of phytoplankton were found in the Detroit River at low densities (about 500 cells/ml). These communities were dominated by diatoms (*Fragilaria crotonesis* and *Tabellaria fenestrata*) most of the year, similar to the communities found in Lake Huron. Due to the relatively short retention time of the Detroit River, the phytoplankton population is largely dependent on the populations found in Lake St. Clair. In July and August, *Oscillatoria* sp., a blue-green algae common to nutrient enriched waters, comprises a significant portion of the phytoplankton of the Detroit River and Lake St. Clair. Relative to other waters, the mean number of diatom species in the Detroit River (29.8) is third highest in the Great Lakes. Although a few localized areas of excessive algal growth have been noted by researchers, this is generally not a problem in the Detroit River.

6.4.2 Macrophytes and Wetlands

Epiphytic algae and rooted plants provide food and cover for many aquatic animals. They not only produce large quantities of organic matter, but are the principle remaining physical structure in parts of the river, since debris is removed during channel maintenance (Edwards et al. 1989). At least 20 species of submersed macrophytes occur in the Detroit River (Manny et al. 1988). Most commonly found were *Vallisneria americana* (wild celery), *Heteranthera dubia* (water stargrass), and *Myriophyllum spicatum* (Eurasian watermilfoil) (Table 6-31). *Myriophyllum spicatum* was first found in Lake St. Clair in 1974. By 1978, it was the third most common submersed macrophyte in the Detroit River. Eurasian milfoil is native to European waters and is considered a nuisance aquatic plant since it forms dense mats at the surface of the water. Macrophytes provide important spawning, nursery and feeding habitat for many fish species, and food and cover for waterfowl.

Heteranthera and *Chara* (Stonewart or muskgrass) were found in the Detroit River in relatively higher and lower abundance, respectively, than in the St. Clair River and Lake St. Clair (Manny et al. 1988). The reason for this has not been determined. *Chara* is considered highly beneficial vegetation in that it filters nutrients out of the water.

In the Detroit River, most macrophyte beds occur in less than 7 m of water. Manny, et al. (1988) noted that approximately 72 percent of the area between the shoreline and a 3.7 m depth contour is occupied by submersed plants. This association with relatively shallow water makes macrophytes and wetlands susceptable to water level fluctuations. As with other waters associated with the Great Lakes, water levels in the

Table 6-31. Distribution and relative abundance of submersed macrophytes (expressed as the percentage frequency of occurrence) in the Detroit River in 1978 (Manny et al. 1988).

Taxon	Distribution
Vallisneria americana Michx. (Wild celery)	49
Characeae (Muskgrass)	9
Potamogeton richardsonii (Benn.) Rydb. (Redhead grass)	4
Myriophyllum spicatum L. (Eurasian watermilfoil)	13
Elodea candensis Michx. (Waterweed)	7
Heteranthera dubia (Jacq.) Mac M. (Water stargrass)	31
Potamogeton spp. (Narrow-leaf forms)	3
Najas flexilis (Willd.) Rostk. & Schmidt (Bushy pondweed)	5
Potamogeton gramineus L. (Variable pondweed)	3
Ceratophyllum demersum L. (Coontail)	< 1
Nymphaea sp. (Water-lily)	< 1
Potamogeton illinoensis Morong. (Illinois pondweed)	< 1
Potamogeton nodosus Poiret (Long-leaf pondweed)	1
Total number macrophyte taxa 13	

Note: Nitellopsis obtusa, Nitella hyalina, Potamogeton crispus, Potamogeton zosteriformis, Ranunculus longirostris, Butomus umbellatus and Sagittaria sp. (in the submersed stage) were also found in the Detroit River by Schloesser et al. (1986) and Hudson et al. (1986).

Detroit River can change dramatically from year to year, making absolute definition of the size and distribution of macrophyte and wetland areas difficult. Manny et al. (1988) estimated the total area covered by emergent macrophytes to be 860 ha with over 95% found in the lower section of the river.

Few studies have been done on emergent vegetation type and distribution in the Detroit River system. A 1983-84 study of emergent macrophytes at Stony Island in the Detroit River found 11 species, the dominant in terms of biomass being Typha angustiola, sparganium eurycarpum, Scirpus americanus, and Sagitiaria rigida (Edsall et al. 1988a).

The wetlands and submersed macrophyte beds constitute critical habitat for primary and secondary production for plants, fish and birds (McCullough 1985). Based on 1982 data, Manny et al. (1988) estimated the Detroit River contained 31 coastal wetlands and submersed macrophyte beds, covering a total of 1,382 ha with approximately half of that area being in Michigan and half in Ontario (Figure 6-40, Table 6-32).

Wetland data for the Ontario portion of the river have recently been compiled by the Chatham District of the Ministry of Natural Resources using a Province wide wetland evaluation and classification system. Based on 1984 and 1985 field studies, there were 1136 hectares of Provincially and Regionally significant wetland along the Ontario portion of the Detroit River, with approximately half (539 hectares) being emergent (Tables 6-33, 6-34, Figure 6-41). (OMNR Chatham District, unpublished data 1989)

A number of factors such as poor substrate quality, diking, dredging and filling have resulted in the loss of some wetlands and in others becoming partly or entirely nonfunctional. Records from 1967 (Manny et al. 1988) indicate 1,458 ha of emergent vegetation grew in wetlands in Michigan waters, compared to Manny's estimate of 634 ha in 1982. The majority of emergent vegetation habitat is now limited to small isolated locations in the lower Detroit River (Edsall et al. 1988a).

6.5 ZOOPLANKTON

Zooplankton, an important link in the trophic food chain, have not been studied to a great extent in the Detroit River. However, because of the river's short retention time, zooplankton species composition should be largely reflective of Lake St. Clair populations. In Lake St. Clair, 14 taxa of planktonic copepods and 18 taxa of cladocerans were reported (Manny et al. 1988). A recent study (1986) of the Detroit River found that 85 percent of the zooplankton collected were copepods, and cladocerans and rotifers comprised the remaining 12.8 percent and 2.5 percent, respectively (White et al. 1987b). Two specimens of the large European cladoceran Bythotrephes cederstroemi were noted in the Trenton Channel during this study. More than 90 percent of the zooplankton collected were calanoid and cyclopoid copepods and Bosmina, which are known food sources for larval fish. Zooplankton distribution was patchy throughout the River, providing an inconsistent level of food source for larval fish.

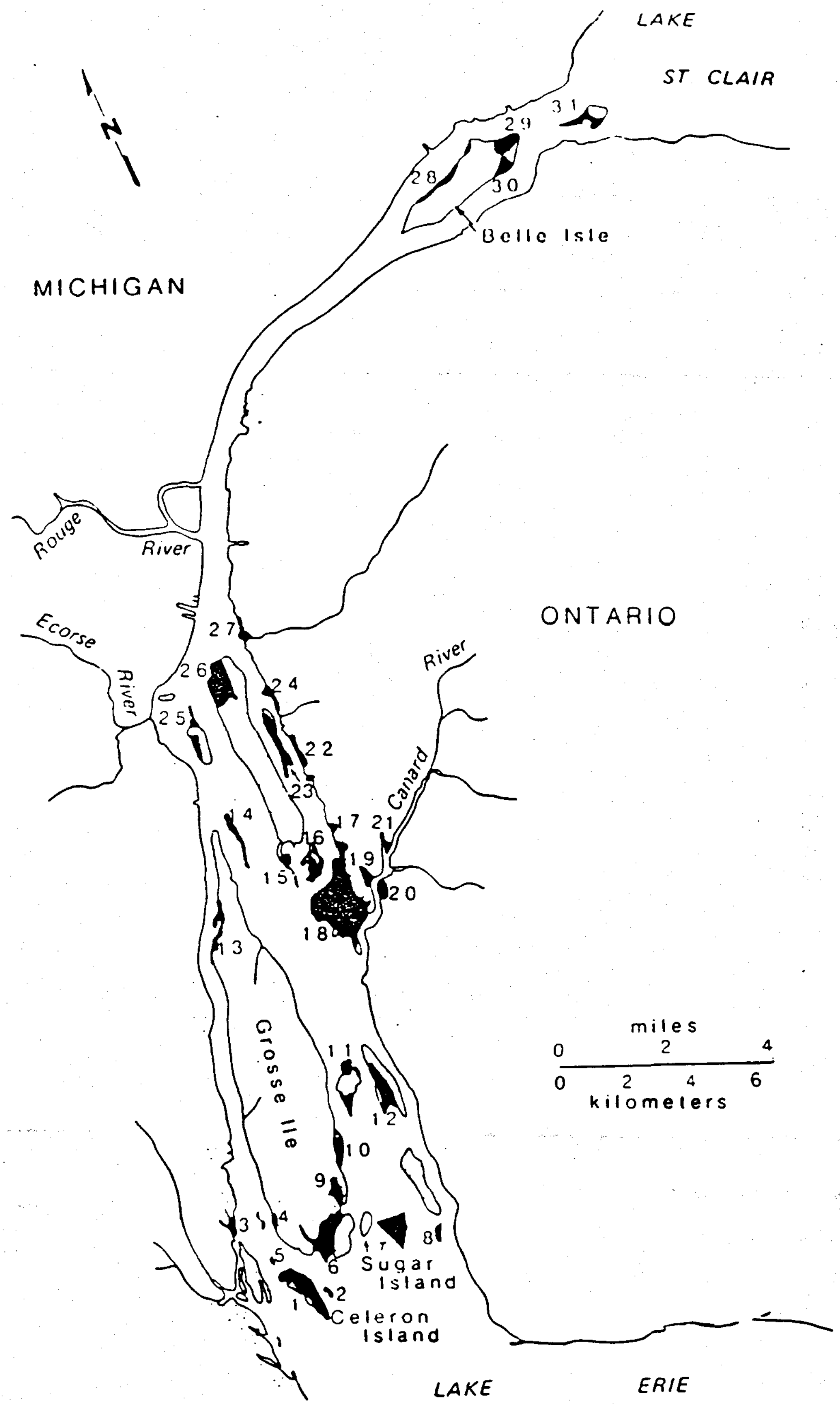


Figure 6-40. Distribution of wetlands and large submersed macrophyte beds in the Detroit River (from Landsat 4 image dated July 25, 1982; scale 1:130,000). (Source: Manny et al. 1988).

Table 6-32. Areas of wetlands and large submersed macrophyte beds in the Detroit River on July 25, 1982 (Planimetered by E. Jaworski from Manny et al. 1988).

Reference No.*	Wetland type[a]	Area (ha)
1	EM/AQ	87.28
2	AQ	7.27
3	EM/AQ	25.46
4	EM/AQ	14.55
5	EM/AQ	7.27
6	EM/AQ	87.28
7	AQ	72.73
8	AQ	25.46
9	AQ	21.82
10	EM/AQ	36.37
11	EM/AQ	43.64
12	AQ	50.91
13	EM/AQ	43.64
14	AQ	29.09
15	AQ	14.55
16	EM/AQ	43.64
17	EM/AQ	14.55
18	EM	247.30
19	EM	18.04
20	SS/EM	25.46
21	SS/EM	14.55
22	EM	29.09
23	EM/AQ	58.19
24	EM	29.09
25	SS/EM/AQ	43.64
26	FO/SS	101.83
27	EM	29.09
28	EM/AQ	43.64
29	AQ	43.64
30	EM/AQ	29.04
31	FO/SS/EM	43.64
	Total	1,381.80

* Reference number refers to Figure 6-45.

[a] Wetland type: EM = Emergent Marsh
AQ = Submersed Macrophyte
FO = Forested
SS = Shrub-Scrub

Table 6-33. Macrophyte summary of wetlands on Ontario portion of the Detroit River based on wetland evaluation and classification surveys - Summer 1984, 1985 (Ontario Ministry of Natural Resources - Chatham District - 1989).

Vegetation Type	Common Name	Scientific Name	Hectares of vegetation type (% of wetland area)
Submergents	milfoil	*Myriophyllum* spp.	505.44 ha (44.5%)
	pondweed	*Potamogeton* spp.	
	coontail	*Ceratophyllum demersum*	
	muskgrass	*Chara* spp.	
	water star grass	*Heteranthera dubia*	
Emergents (robust)	cattails	*Typha* spp.	539.11 ha (47.4%)
	reed grass	*Phragmites communis*	
	bulrush	*Scirpus* spp.	
	elephant grass	*Phragmites* spp.	
(narrow-leaved)	grasses	*Leersia* spp.	
		Phalaris spp.	
	cutgrass	*Leersia oryzoida*	
	spirea	*Spirea* spp.	
	sedge	*Carex* spp.	
(broad-leaved)	smartweed (water)	*Polygonum* spp.	

Table 6-34. Wetland complexes on Ontario portion of Detroit River based on wetland evaluation and classification surveys conducted during summers of 1984 and 1985 (Ontario Ministry of Natural Resources-Chatham District - 1989).

Westland Complex Name	Class Designation	Area of Wetlands (ha)
Detroit River Complex	2	575.0
Turkey Creek Marsh	3	32.0
Fighting Island Marsh	3	113.0
Canard River Complex	1	416.0

Note: Class 1 and 2 Wetlands are Provincially Significant and Class 3 Wetlands are Regionally Significant.

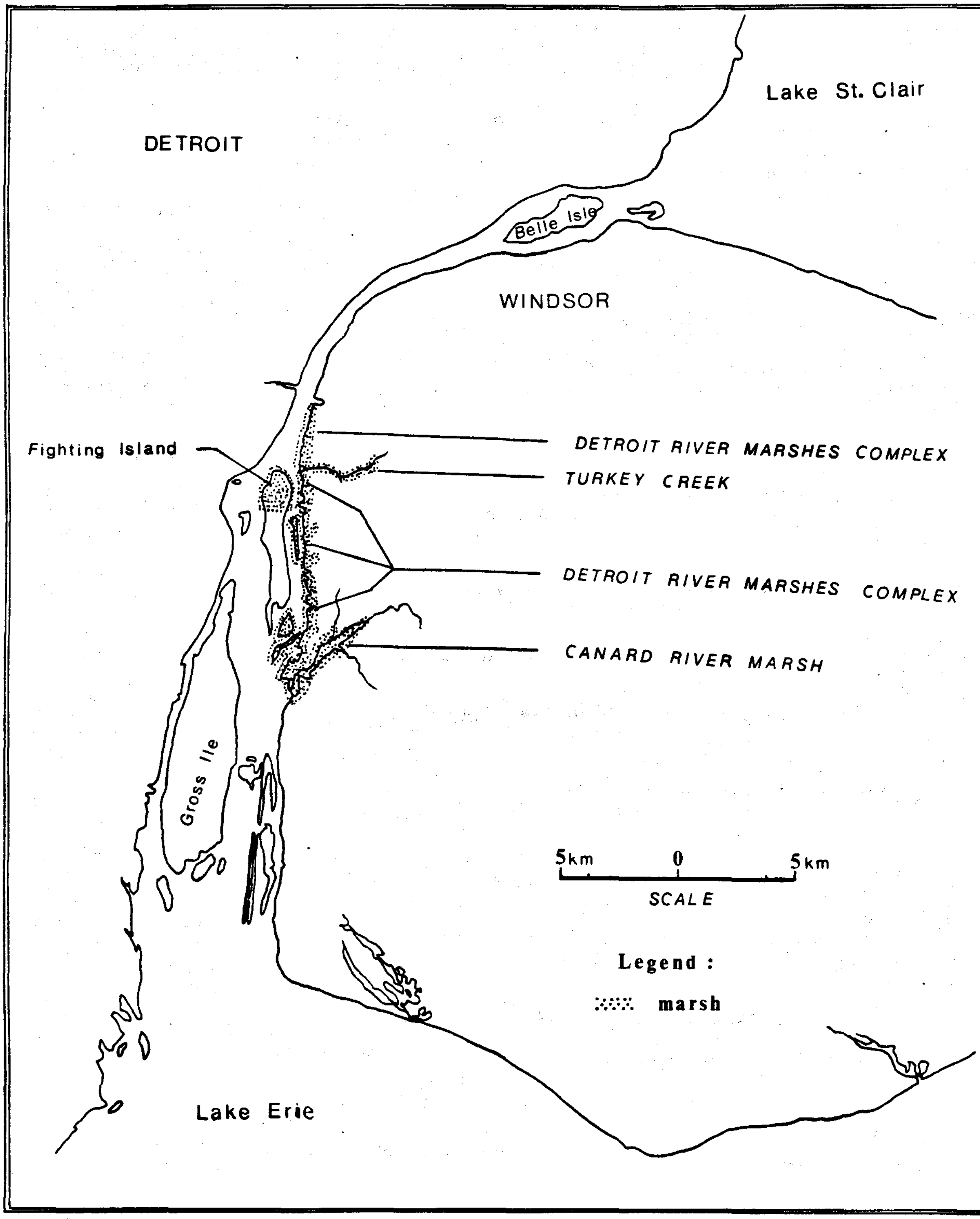


Figure 6-41. Location of wetlands on Ontario portion of Detroit River based on wetland evaluation and classification surveys conducted during summers of 1984 and 1985 (Ontario Ministry of Natural Resources - Chatham District 1989).

6.6 FISH

The Detroit River provides habitat for a diverse variety of fish species. Currently, there are at least 65 species of fish commonly found in the river (Table 6-35) (Manny et al. 1988). These fish represent a valuable natural resource which can contribute important recreational and social benefits. Historically, some 40 or more additional species lived in or migrated through the river (Bailey and Smith 1981; Manny et al. 1988).

Draft fish community goals and objectives for Lake St. Clair and connecting waters were developed by OMNR and MDNR for presentation at the Great Lakes Fish Commission meeting in early 1990 (OMNR/MDNR 1990). These draft guidelines have recommended the following overall fish community goals for the Lake St. Clair, St. Clair/Detroit River System: "To ensure a percid community with walleye as the top predator based on a foundation of stable self-sustaining stocks and provide from that community an optimum contribution of fish, fishing opportunities and associated benefits to meet societal needs". A number of general objective and species specific objectives for the system are also presented in the Draft Fish Community Goals and Objectives. Some that are most relevant to the Detroit River RAP are presented below:

- Achieve no net loss of the productive capacity of habitats supporting Lake St. Clair and St. Clair/Detroit River Fisheries;

- Restore the productive capacity of habitats that have suffered damage; and

- Reduce contaminants in all fish species to levels below consumption advisory levels.

The draft document also identifies the loss of habitat and productivity due to marsh conversion, water level fluctuations, dredging and deposition of dredged materials and the impacts of contaminants as future issues that may have a negative impact upon attainment of fish community goals and objectives.

6.6.1 Spawning and Juvenile Habitat

In 1982, Goodyear et al. outlined the fish spawning and nursery areas of the St. Clair-Detroit River system. The study indicated the importance of the Detroit River and tributaries as spawning and nursery areas for many species that support major fisheries in the system (Figure 6-42, Table 6-36). Current documentation indicates the river is used for spawning by white bass, yellow perch, rainbow smelt and gizzard shad (Muth et al. 1986). Goodyear et al. (1982) also noted that walleye, yellow perch and white bass are important recreational species that spawn in the river. Largemouth bass, smallmouth bass, northern pike, muskellunge and walleye also spawn in portions of the river. Lake sturgeon may spawn at the head of the river near Peach Island, but their numbers remain sharply reduced from historical levels.

Table 6-35. List of 65 fishes commonly found in the Detroit River (Manny et al. 1988).

Common name	Scientific name
Sea lamprey	Petromyzon marinus
Lake sturgeon	Acipenser fulvescens
Spotted gar	Lepisosteus oculatus
Longnose gar	Lepisosteus osseus
Bowfin	Amia calva
American eel	Anguilla rostrata
Mooneye	Hiodon tergisus
Alewife	Alosa pseudoharengus
Gizzard shad	Dorosoma cepedianum
Chinook salmon	Oncorhynchus tshawytscha
Coho salmon	Oncorhynchus kisutch
Pink salmon	Oncorhynchus gorbuscha
Rainbow trout	Salmo gairdneri
Brown trout	Salmo trutta
Lake trout	Salvelinus namaycush
Lake whitefish	Coregonus clupeaformis
Rainbow smelt	Osmerus mordax
Northern pike	Esox lucius
Muskellunge	Esox masquinongy
Goldfish	Carassius auratus
Common carp	Cyprinus carpio
Silver chub	Hybopsis storeriana
Golden shiner	Notemigonus crysoleucas
Emerald shiner	Notropis atherinoides
Pugnose minnow	Notropis emiliae
Blacknose shiner	Notropis heterodon
Spottail shiner	Notropis hudsonius
Sand shiner	Notropis stramineus
Mimic shiner	Notropis volucellus
Quillback	Carpiodes cyprinus
Longnose sucker	Catostomus catostomus
White sucker	Catostomus commersoni
Northern hogsucker	Hypentelium nigricans
Bigmouth buffalo	Ictiobus cyprinellus
Smallmouth buffalo	Ictiobus bubalus
Spotted sucker	Minytrema melanops
Redhorse, unidentified	Moxostoma spp.
Silver redhorse	Moxostoma anisurum
Golden redhorse	Moxostoma erythrurum
Shorthead redhorse	Moxostoma macrolepidotum
River redhorse	Moxostoma carinatum
Black bullhead	Ictalurus melas
Yellow bullhead	Ictalurus natalis
Brown bullhead	Ictalurus nebulosus
Channel catfish	Ictalurus punctatus
Stonecat	Noturus flavus
Trout-perch	Percopsis omiscomaycus
Burbot	Lota lota
Brook silversides	Labidesthes sicculus
White perch	Morone americana
White bass	Morone chrysops
Rock bass	Ambloplites rupestris
Green sunfish	Lepomis cyanellus
Pumpkinseed	Lepomis gibbosus
Bluegill	Lepomis macrochirus
Smallmouth bass	Micropterus dolomieui
Largemouth bass	Micropterus salmoides
White crappie	Pomoxis annularis
Black crappie	Pomoxis nigromaculatus
Logperch	Percina ceprodes
Yellow perch	Perca flavescens
Sauger	Stizostedion canadense
Walleye	Stizostedion vitreum vitreum
Freshwater drum	Aplodinotus grunniens
Four horn sculpin	Myoxocephalus quadricornis

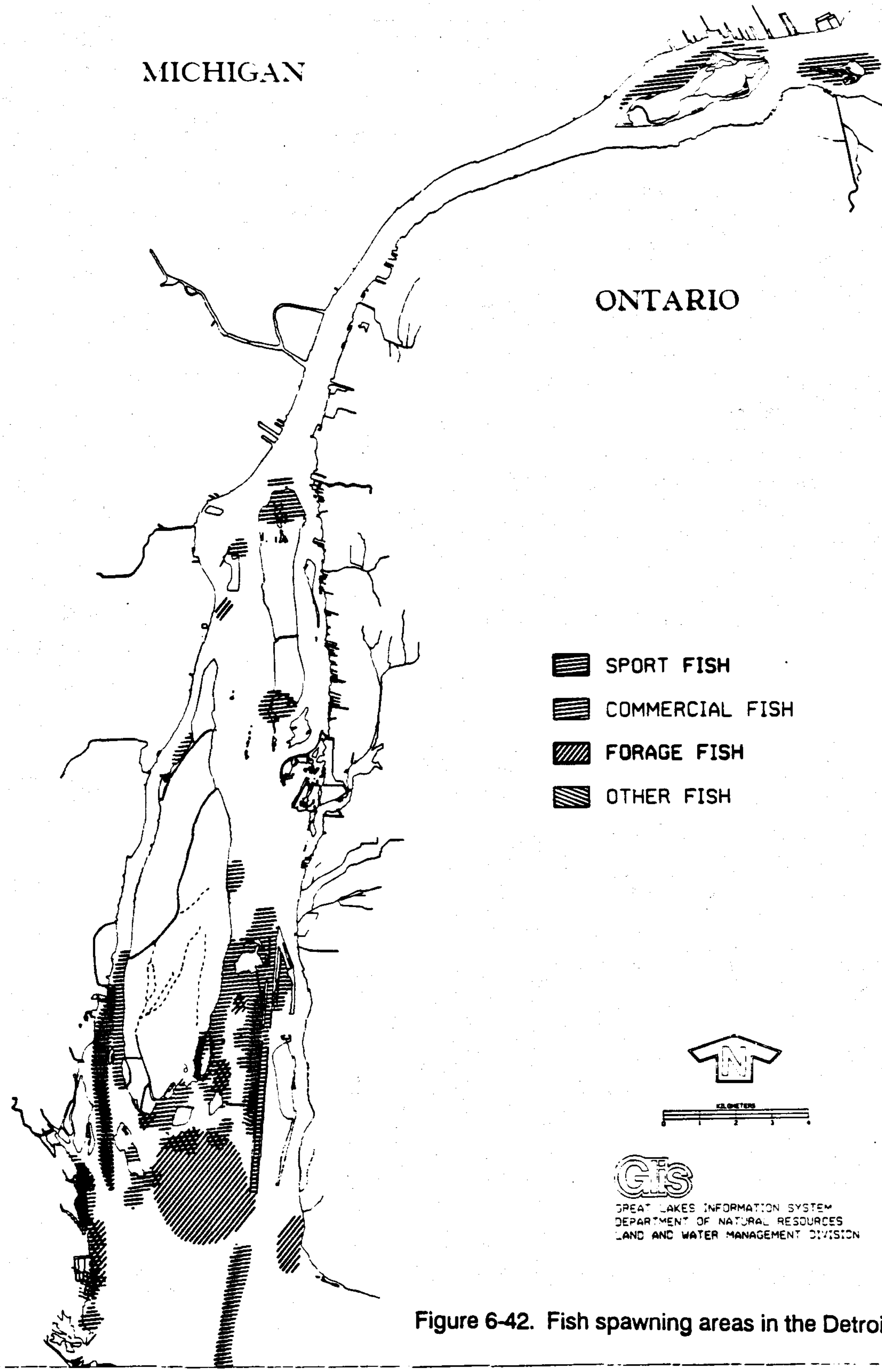


Figure 6-42. Fish spawning areas in the Detroit River.

Table 6-36. Fishes that spawn in the Detroit River (Manny et al. 1988, updated by R. Spitler, Personal Communication, 1991).

Common Name	
Lake sturgeon	Trout-perch
Spotted gar	Burbot
Longnose gar	Brook silverside
Bowfin	White bass
Alewife	Rock bass
Gizzard shad	Green sunfish
Sea lamprey	Pumpkinseed
Lake whitefish	Bluegill
Silver lamprey	Smallmouth bass
Rainbow smelt	Largemouth bass
Northern pike	Black crappie
Muskellunge	White crappie
Goldfish	Johnny darter
Carp	Yellow perch
Emerald shiner	Logperch
Spottail shiner	Mooneye
White sucker	Walleye
Northern hog sucker	Freshwater drum
Channel catfish	Fourhorn sculpin
Stonecat	White perch
Orange spotted sunfish	
Suspected (but not verified)	
Lake trout	Sauger
Chinook salmon	Deepwater sculpin
Spotted sucker	River carpsucker
Slimy sculpin	

Tow-net catches of fish larvae in 1977-78 and 1983-84 (Hatcher and Nester 1983; Muth et al. 1986) indicated that the river is a nursery ground for 25 species of fish (Table 6-37). Most abundant larvae were alewives, rainbow smelt and gizzard shad. The average density of all larvae combined was 275 per 1000 m^3 (Muth et al. 1986). Yellow perch juveniles were also abundant. Other (unpublished) data from OMNR has suggested that several other species such as smallmouth bass, largemouth bass, and northern pike also use the river as nursery habitat. Field work conducted in the wetlands along the river during the summer of 1990 documented the presence of 46 species of fish indicating the importance of wetland habitat to the river's fish community (J. Brisbane, Personal Communication 1989).

From September 19 to 21, 1988, MDNR fisheries workers performed a netting survey of the Gibraltar marsh area. Some 835 fish comprising 30 species were captured. Young-of-the-year smallmouth and largemouth bass, bluegill, pumpkinseed sunfish and rock bass made up 85% of the total catch. Small gizzard shad, white perch, alewife and several minnow species constituted 12% of the catch. The capture of several orange spotted sunfish might be a "first" for the river (R. Spitler, Personal Communication 1989).

Dredging, bulkheading and/or backfilling of wetlands, littoral zones, bayous and small embayments in the Detroit River, especially in the Trenton Channel area, have resulted in extensive losses of spawning grounds and nursery areas for desirable fish. Retaining walls or rip-rap and harbor structures currently form over 60% of the Detroit River shoreline structure (Table 6-38) (Environmental Protection Service, Canada, 1985).

The demise of the commercial fishery for lake herring and lake whitefish in the late 1800's may have been partially caused by loss of spawning habitat due to the destruction of rock outcroppings in the process of creating the shipping channels (Manny and Edsall 1988), as well as by overfishing. Whitefish reproduction seems to be reappearing in the Detroit River-Lake St. Clair area as evidenced by whitefish larvae caught in 1977 and later (Hatcher and Nester 1983, Muth et al. 1986; R. Spitler, Personal Communication, 1989).

Hamilton (1987) electrofished 16 sites in the Detroit River in the fall of 1986 to survey the fish populations. Beds of aquatic vegetation yielded numerous young of the year of 16 fish species as well as a variety of older fish. Hamilton concluded that while the fishes could tolerate poor water conditions, their distribution was limited chiefly by the lack of suitable habitat. For example, he observed that breakwalls that were dented and consequently afforded cover, yielded several more walleye than solid concrete breakwalls which afforded no cover. The need for habitat protection, improvement and restoration in the river was noted.

6.6.2 Adult Fish Populations

A trap net survey of the river was undertaken by MDNR in 1983-84 (Haas et al. 1985). The lower Detroit River survey station ranked first in mean

Table 6-37. Fishes that use the Detroit River as a nursery area (Manny et al. 1988).

Common Name	
Alewife	Trout-perch
Gizzard shad	Walleye
Emerald shiner	Burbot
White perch	Lake herring
Rainbow smelt	Lake whitefish
Logperch	Johnny darter
Spottail shiner	White sucker
White bass	Spotted sucker
Yellow perch	River carpsucker
Deepwater sculpin	Slimy sculpin
Common carp	Freshwater drum
Brook silverside	Lake whitefish
	White crappie

Table 6-38. Shoreline structure of the Detroit River and its islands in 1985, as determined from a coastal resource atlas (Environmental Protection Service, Canada 1985).

Structure	Percentage of Shoreline Canada	U.S.A
Bluffs	3%	19%
Beaches -sand	6%	2%
-sand/gravel	4%	0%
-gravel	1%	0%
Banks -low vegetation	6%	1%
Wetlands	15%	18%
Structures -riprap	46%	52%
-walls/harbor	19%	8%

catch per unit of effort for the entire study and was second in total number of species. White perch, white bass and goldfish were dominant in the lower portion of the river and probably reflected the influence of Lake Erie where these fish are abundant (Edwards et al. 1989). The lower river contained an abundant and diverse fish population despite nearby inputs of pollutants (Thornley and Hamdy 1984). In all, some 41 species of fish were identified in the Detroit River.

Fish tagging studies in the St. Clair and Detroit rivers during 1983-85 included 43 species of fish (Haas et al. 1985); of these, 13 were recovered in sufficient quantities to enable rough estimates of movement through the St. Clair/Detroit River System (SCDRS) and even into Lakes Huron and Erie. Average distances moved and rates of travel were highest for walleyes and white bass. Tagged walleyes have shown substantial movement from Lake Erie into the SCDRS in spring and back to Lake Erie in fall or winter (Wolfert 1963; Ferguson and Derksen 1971; Michigan Department of Natural Resources, Mt. Clemens, MI, unpubl. data). Yellow perch, channel catfish, freshwater drum, and white sucker also showed a strong tendency to move between the St. Clair and Detroit rivers and the adjacent Great Lakes (Edwards et al. 1989).

6.6.3 Non-Native Species

Exotic and invading species had been in the river as early as 1883 when common carp which had reportedly been introduced into western Lake Erie made their way into the river. As with many introductions, they displaced some native fishes. Other non-native fish inadvertantly introduced have included rainbow smelt and alewife introduced in 1932, sea lamprey in 1940's, and white perch in the late 1970's. Occasional mouth brooding cichlid (*Tilapia* sp.) are captured in survey nets, perhaps shortly after release from aquariums. Their overwinter survival is doubtful.

In the 1960s and 70s, Michigan and Ontario's stocking programs introduced coho, chinook and kokanee salmon to the Great Lakes system. Michigan stocked coho and chinook salmon directly into the Detroit River at Belle Isle. The program was cancelled in 1990 due to lack of success. Annual plants of brown and rainbow trout continue at Belle Isle, under study.

6.6.4 Sportfishing

Sportfishing has enjoyed great popularity in the Detroit River. A concensus of fisheries managers indicates that the fishery is one of the best in this part of the continent. Edwards et al. 1989, reviewed relevant creel data for the river and indicated the average catch per hour was 1.01 fish, the estimated harvest per hectare was 241 fish and 74 kg. and the estimated annual angler effort for all species was 239 hours per hectare. This compared favorably with the average annual sport fishing effort on inland lakes of 94.1 hr/hectare (as noted by Colby et al. 1979). Although sport fishing dates back to at least the 1800's, detailed angler data is scarce. General creel data from Ontario (Sztramko and Paine 1984) suggest that perch were the dominant species harvested in the 1920's and 30's while walleye was the species most harvested in the 1940's. Walleye and white bass shared dominance throughout the 1950's, 1960's, and 1970's, but in the 1980's, white bass became the single most harvested species.

Prior to the mid-1960's, the Michigan Conservation Department (now MDNR) law enforcement officers carried out a statewide creel census. From 1945 to 1963, officers conducted over 3,000 interviews on the lower Detroit River (but kept no records for seven of those years). The data are sparse, but are nonetheless revealing. According to Cooper (1964), the officers interviewed 3,057 anglers who fished for 10,878 hours, harvesting 15,441 fish. The catch included 10,877 yellow perch (66% of the total), 2,106 rock bass (12.8%), 1,209 white bass (7.4%), 788 northern pike (4.8%), 694 walleye (4.2%), 457 freshwater drum (2.3%) and several other species in small quantities. At that time, the average catch rate of 1.5 fish per hour was somewhat below the 2.4 average for all Great Lakes waters in Michigan, but better than the 1.3 average for inland waters. Cooper concluded that sportfishing in the Detroit River around Grosse Ile was of good quality, by average Michigan standards. In 1943 Krumholz and Carbine estimated that a total of 197,759 hours were exerted by boat anglers in the river. A winter creel census on the Ontario portion of the river in 1961 indicated 1,660 Ontario residents and 1,200 U.S. residents fished for 9,280 person hours and harvested 1,900 walleye and 131,800 yellow perch.

Most of the harvest by anglers in Ontario waters of the lower Detroit River has been composed of white bass and walleye in the summer boat fishery. These species were usually taken in temporally discrete fisheries - white bass being in May and June and walleye in July and August. Although the catch per unit effort (CPUE) for walleye has varied over the years, it remained stable in 1975-83, ranging from 0.135 to 0.175 fish angler h^{-1}, or from 26,000 to 30,000 fish (Sztramko and Paine 1984). During 1956-80, the variation in CPUE for white bass was more pronounced (0.170 - 1.540 fish angler h^{-1}). Total estimated effort remained stable after 1976, ranging from 120,169 to 159,465 angler hours. Other species harvested included yellow perch, freshwater drum, rock bass, and smallmouth bass (Edwards et al. 1989).

Bryant (1984) reported a combined total of 1,994,420 hours of activity in 1980-81. Since the 1980-81 season, it is estimated that boat effort has increased by over 62%. MDNR records indicate that there are over 200,000 registered boats in the southeast Michigan area, within a short drive of the Detroit River.

In a comprehensive study of the U.S. and Canadian portions of the river, Haas et al. (1985) found that boat and shore anglers fished for a combined total of 2,802,640 hours during the two year period 1984-85. Boat and shore angling was evenly split. Boat anglers spent one-half of their time in the southern end of the river, below Grosse Ile, while shore anglers concentrated along the City of Detroit waterfront.

In 1984-85, the upper river boat and shorefishing efforts combined for a total of 879,566 fish. Over the same two years, the combined lower river fishery yielded 1,956,100 fish, over twice the success of the upper river anglers. Nearly 70% of the total catch came from the area downstream of Grosse Ile. The catch rate in the entire Detroit River fishery was very good at one fish per hour during this study. Bryant

(1984) indicated the 1980-81 harvest included white bass as first in total catch, followed by yellow perch, freshwater drum, and finally walleye. Haas et al. (1985) reported that anglers harvested more white bass (62.6%) than any other species, followed by walleye (11.5%), yellow perch (9.7%) and freshwater drum (6.8%).

Other species of fish available to anglers included smallmouth bass, redhorse sucker, white perch, northern pike, muskellunge, channel catfish, largemouth bass, bluegill, sunfish, white and black crappies, carp, brown bullhead, rock bass, white sucker, brown trout, rainbow trout, coho and chinook salmon (Haas et al. 1985).

Chinook salmon introduced at Belle Isle in the early 1970's failed to produce a viable fishery. Michigan's coho salmon planting program in the Detroit River (200,000 smolts per year since 1974) ended in 1990 due to poor returns. Occasionally three-to-six pound rainbow and brown trout are caught by shore and boat anglers around Belle Isle each spring and fall (50,000 yearlings of each are planted annually).

6.6.5 Commercial Fishing

In the early 1800's, a commercial fishery developed in the river for lake whitefish, lake herring, walleye and yellow perch (Haas and Bryant 1978). By the early 1870's, commercial catches of ten major native species were recorded annually. By 1900, carp were added, a species introduced to Lake Erie in the 1800's. Catches of lake sturgeon, lake herring, lake whitefish, smallmouth bass, yellow perch and walleye were highest in the late 1800's and decreased substantially later. Smallmouth bass, lake herring, and lake whitefish disappeared from the catch by 1910, 1930 and 1950, respectively, while lake sturgeon, yellow perch and walleye continued to be fished through the 1960's. Other species sometimes harvested included northern pike, channel catfish, bullheads and suckers.

There is no longer a commercial food fishery in the Detroit River. The Michigan commercial fishery in the river closed in 1909 in favor of sport angling. The commercial fishery on the Ontario side of the river was closed in 1970 due to high levels of mercury discovered in fish. Since then, mercury levels have declined; however, no commercial food fishing licenses have been reissued for the river.

An active commercial bait fishery is in place on the Ontario portion of the Detroit River with an average of 600,000 dozen bait fish, with an approximate retail value of one million dollars (Canadian) being harvested annually. Most of them are sold to bait wholesalers and retailers in Southwestern Ontario and portions of Michigan, providing an important source of revenue to a number of local small businesses.

6.6.6 Fish Consumption Advisories

6.6.6.1 Contaminants in Fish

Any discussion of the trends of contaminants in fish collected from the Detroit River area must relate to the contiguous water bodies of Lake Erie, Lake St. Clair and the St. Clair River and their pollution sources. Individual fish of many sport species, especially walleye, are highly migratory.

For 20 years, the prime sport fish contaminant in this areas has been mercury. Discharges from 1949 until 1970 from the Dow Chlor-alkali plant on the St. Clair River at Sarnia, occurred on a daily maximum basis of up to 200 lb. of mercury, resulting in extreme contamination of fish which was first discovered in 1970. Closures of commercial fisheries in Lake St. Clair and Lake Erie resulted. Since that time, as seen in Figure 6-43, there have been long-term declines in the level of mercury in sport fish in Lake St. Clair as typified by the walleye. Even so, there are still substantial numbers of large predatory fish, as shown in Figure 6-44, for 1988 and 1989 actual Lake St. Clair walleye data, which exceed the OME unrestricted consumption criterion of 0.5 ppm mercury. With time, the mercury levels in fish from this area, such as walleye, should continue to decline slowly.

In Lake Erie, where fish were not so severely impacted by the Dow discharges, the recovery from pollution, as measured by mercury levels in walleye (Figure 6-45), is more complete. Mercury levels in walleye taken from Lake Erie in 1988 and shown in Figure 6-45, are all well below the OME 0.5 ppm criterion. A comparison with analyses of mercury in museum specimens of walleye collected as long ago as 1874, indicate that current mercury levels in walleye are at least as low, if not possibly lower, than at any recorded time in the last 100 years (Johnson 1990).

In regard to organic contaminants such as PCB, recent levels of that chemical in walleye from the Detroit River are given for 1986, 1987 and 1988 in Figure 6-46. All analyses were considerably below the OME fish consumption criterion of 2000 ppb. It is evidence that there has been a considerable fall in the level of PCB in the edible portion of walleye from this area between 1986 and 1988. These three sets of data are from the Ontario sport fish data base. Comparing two of these sets, those for 1986 and 1988 with the 1986 data collected by the State of Michigan (Figure 6-47) it can be clearly seen that the skin-on Michigan portion gives somewhat higher results than the skinless portion used by Ontario for some of the speciments in the sample. The differences were not sufficient to cause the State of Michigan to issue any advice to restrict consumption of the walleye in the Detroit River area.

The major species advised for restriction of consumption because of PCB in the Detroit River area is the carp. Figure 6-48 plots the 1986 Michigan and 1987 Ontario data for the Fighting Island area. All measurements were of skinless fillets. Apart from one specimen in the Michigan collection, both samples were comparable, with most of the specimens exceeding the 2 ppm consumption criterion. Small carp (under 50 cm in length) in Ontario did contain less than 2 ppm PCB.

Carp taken from American waters of the Detroit River in 1985 and 1986 had very high and extremely variable levels of PCB (Figure 6-49) depending apparently on the individual specimen and location of collection. This variability suggests that inputs of PCB at that time, in the habitat of these carp, were also variable, with the likely existence of smaller localized sources which were affecting only those carp in close proximity to them at some time in their life history.

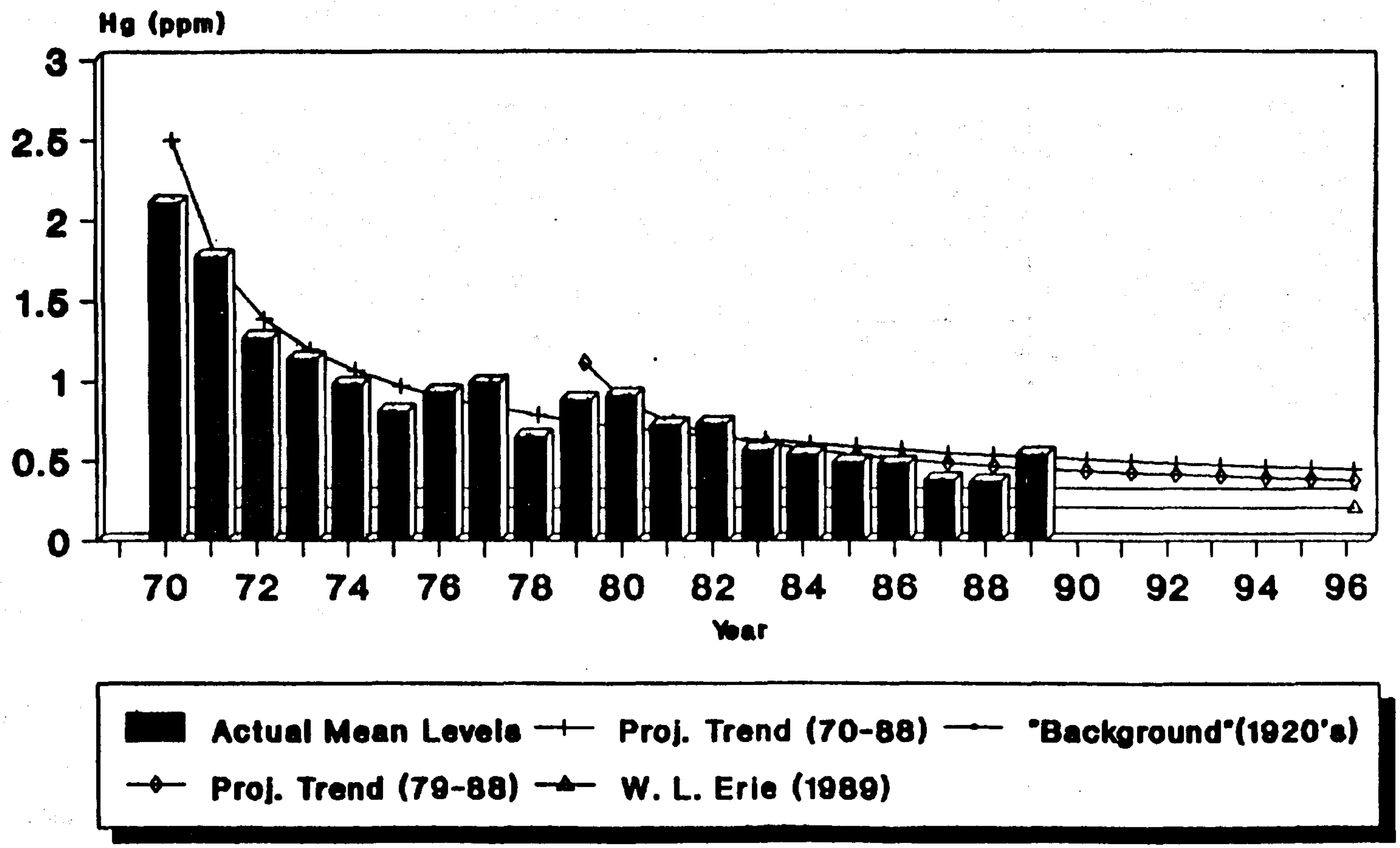
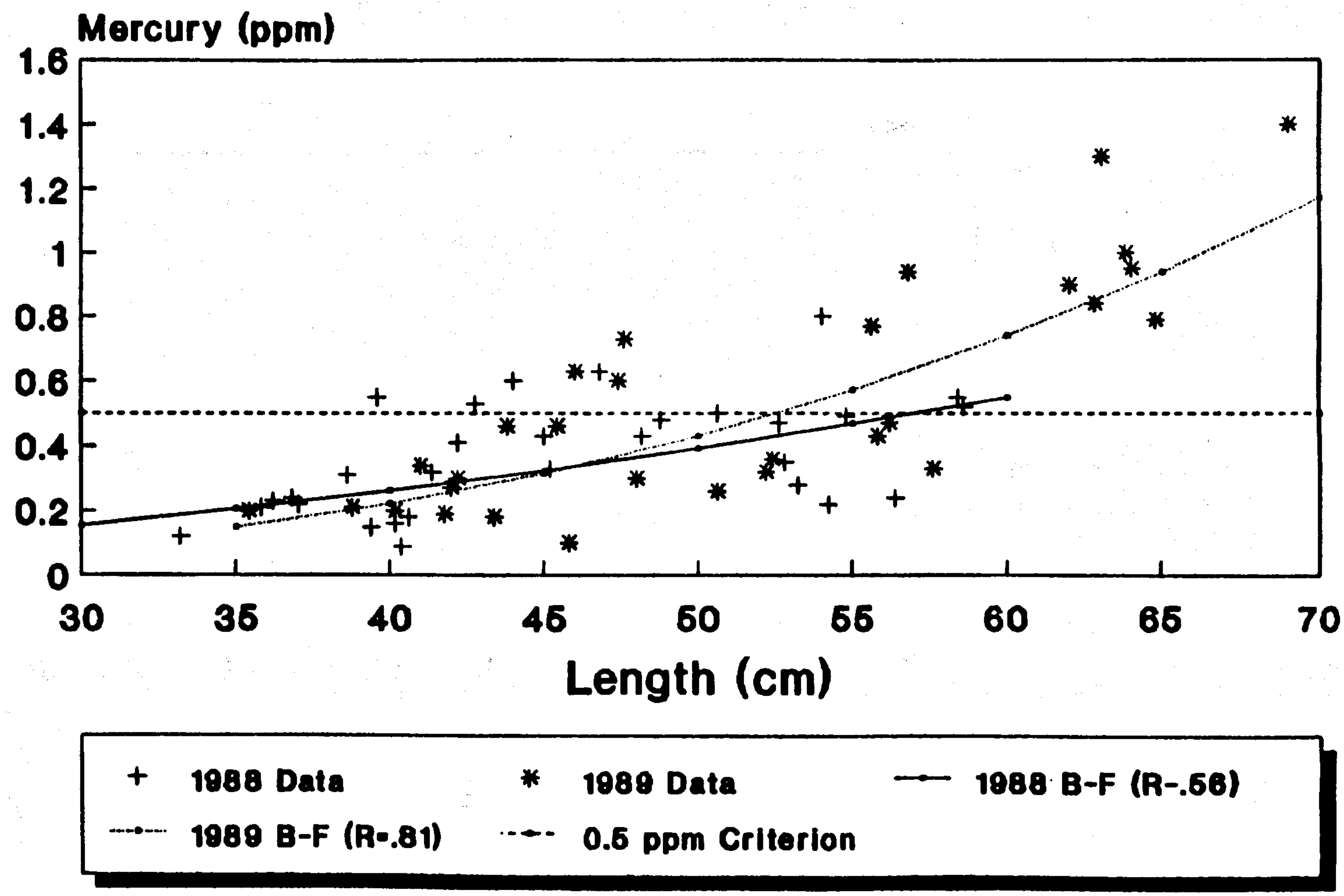


Figure 6-43. Mercury declines and projections in Lake St. Clair walleye 1970-1989.



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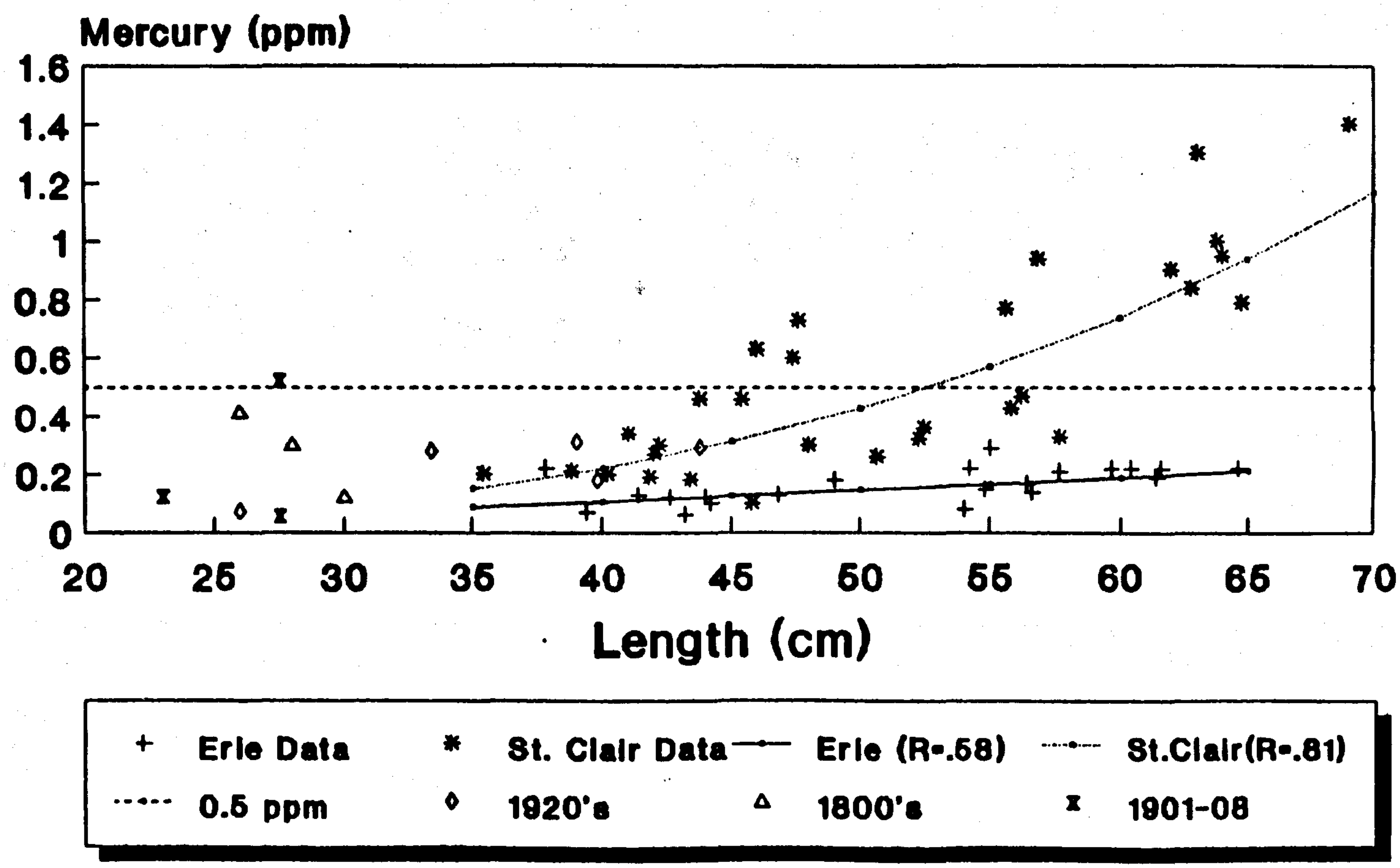
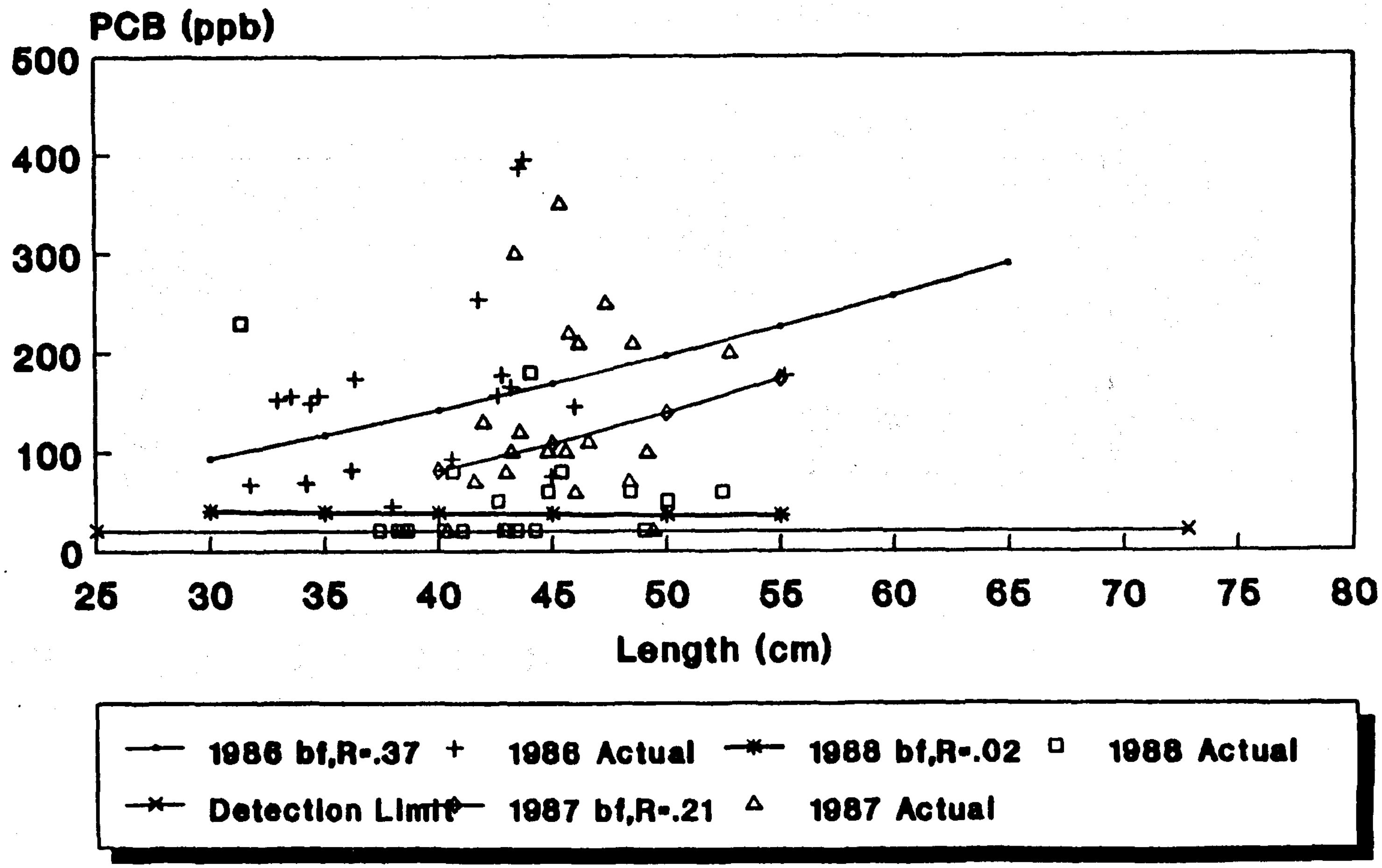
Ont MOE skinless fillet data

Figure 6-44. Mercury in Lake St. Clair walleye 1988-1989.



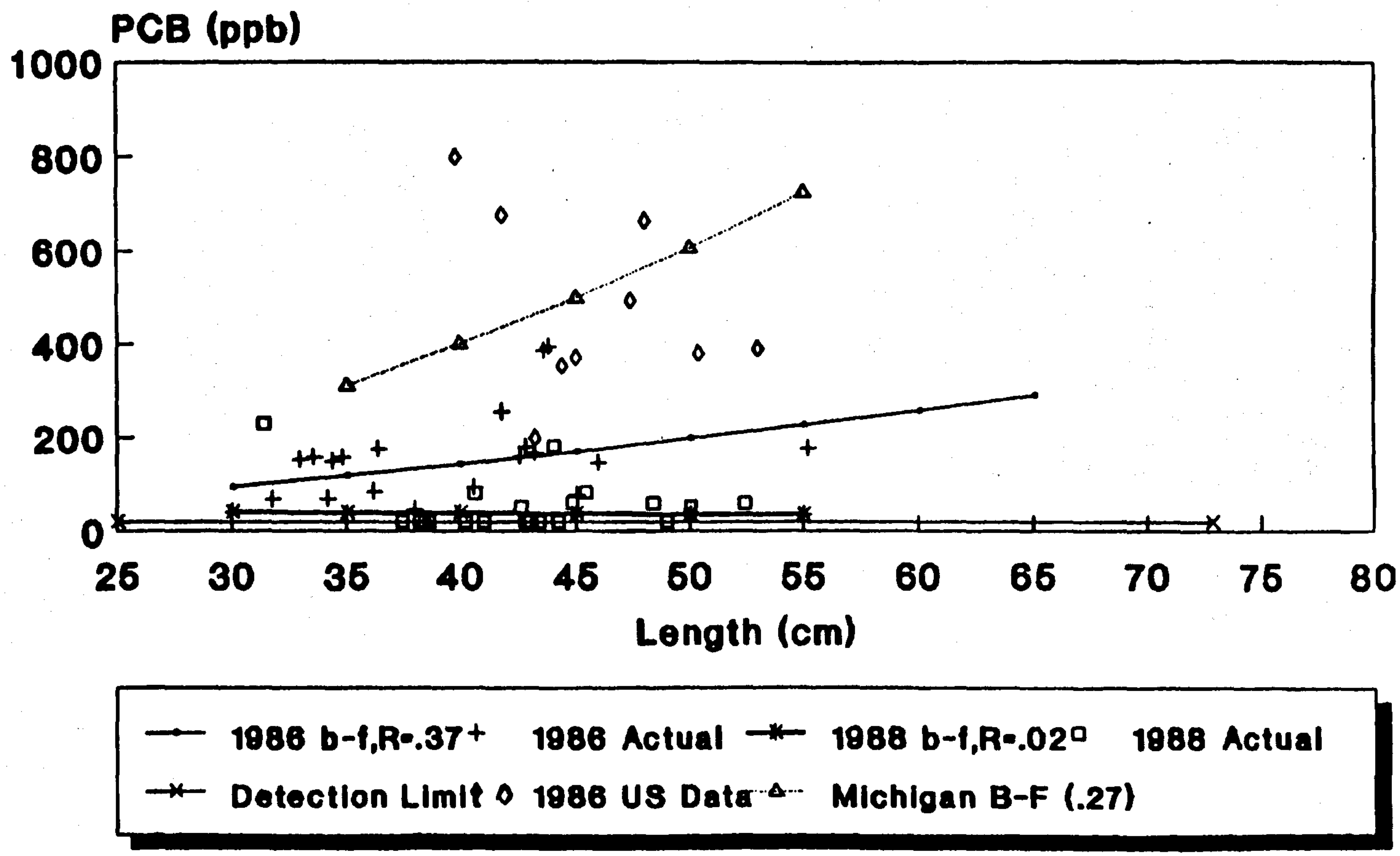
Ont MOE skinless fillet data

Figure 6-45. Mercury in Lake St. Clair and Lake Erie walleye 1989 with historical data 1872-1927.



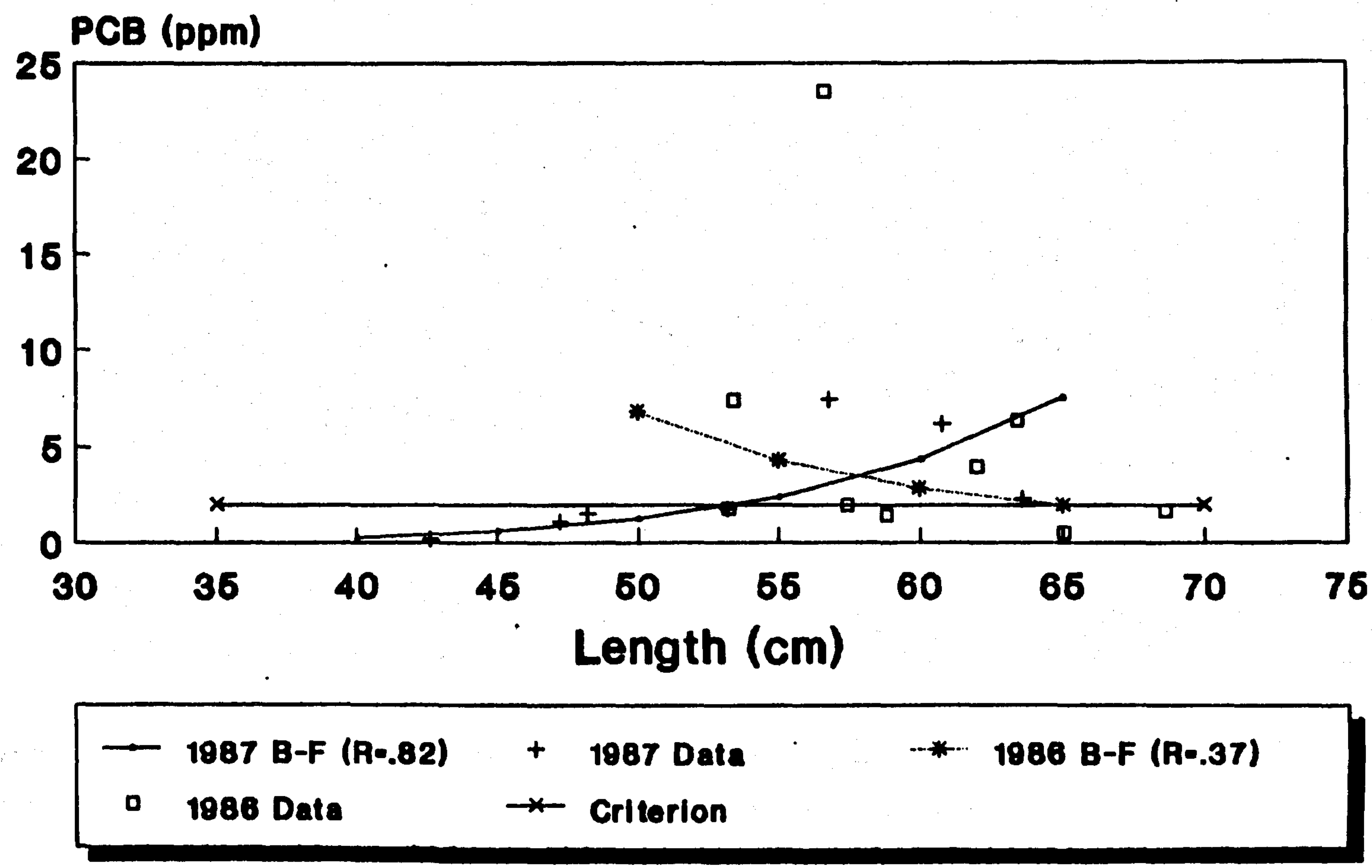
Ont MOE Data - skinless fillets
bf = Best-fit Geometric Regression

Figure 6-46. Detroit River walleye - 1986, 1987 and 1988 best fit curves and actual PCB data.



Ont MOE Data - skinless fillets
Michgan DNR - skin-on fillets
(1 additional value 2,567 ppb)

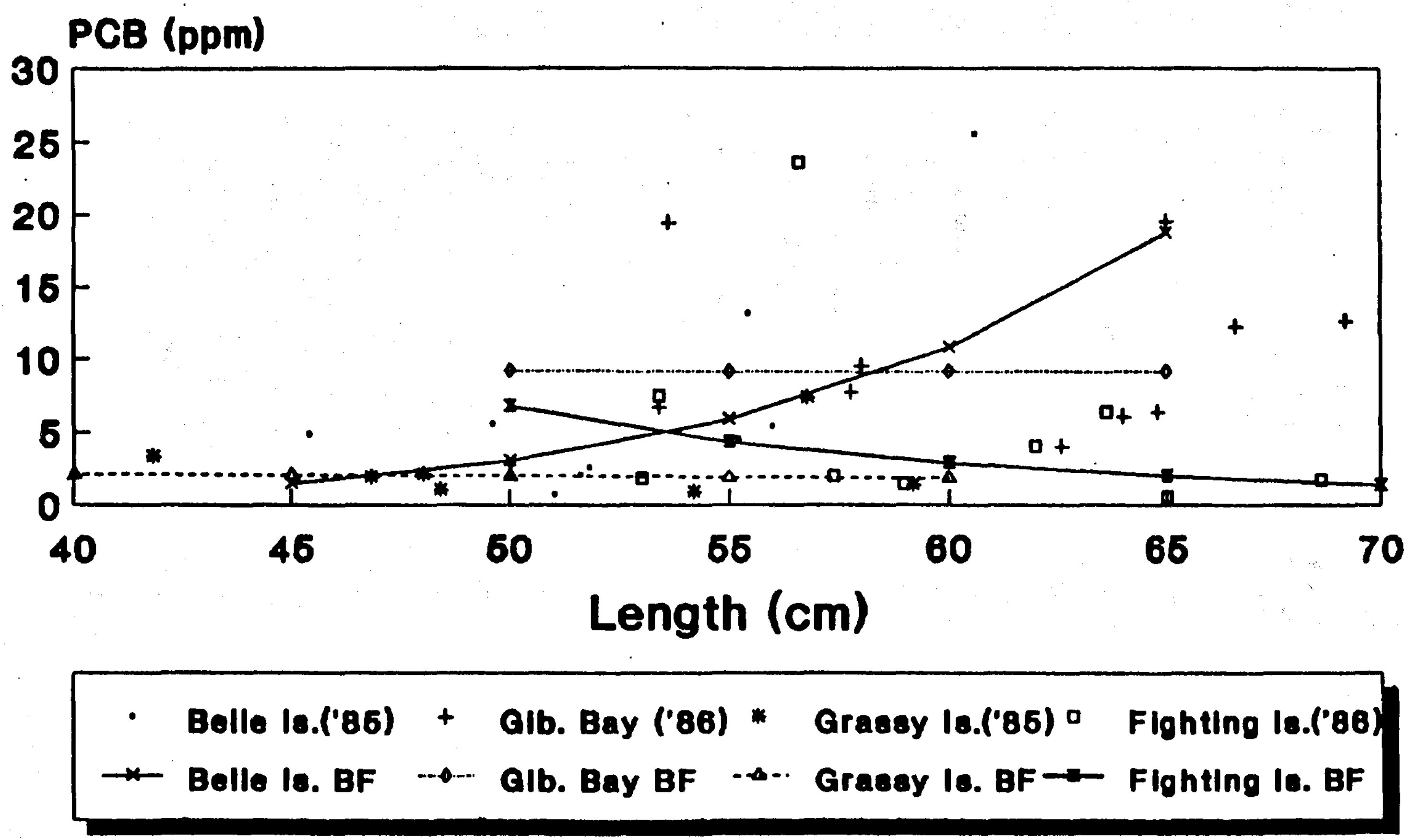
Figure 6-47. Detroit River walleye - 1986 and 1988 best fit curves and actual PCB data.



1986 Michigan data
1987 Ontario data

Skinless fillet data

Figure 6-48. PCBs in Fighting Island carp - 1986 and 1987.



State of Michigan Data, skinless fillet.
B-F (BI=.55, GB=.001, GI=.05, FI=.37)

Figure 6-49. PCBs in carp from the Detroit River in American waters 1985 and 1986.

Ontario data on PCB in white bass in 1987 and 1988 indicated that all specimens in both years contained less than 1 ppm PCB. The specimens in the 1988 collection were of a smaller average size and while therefore lower in PCB level than the 1987 collection, indicated the same modelled PCB trend with size (Figure 6-50).

PCB levels in channel catfish in 1988 collected by Ontario were all below 2 ppm (Figure 6-51).

6.6.6.2 Michigan Fish Consumption Advisories

The Michigan Department of Public Health annually issues an advisory apprising anglers of contamination found in Michigan fish. The 1990 advisory recommends no consumption of Detroit River carp due to elevated levels of total PCBs (MDNR 1990a). Elevated total PCB levels have been defined by the U.S. Food and Drug Administration and the Michigan Department of Public Health as concentrations exceeding 2.0 mg/kg total PCBs in the edible flesh tissue. The MDPH advisory is based on carp (skinless fillet) collected near Grassy Island and Belle Isle in 1985, and carp collected near Fighting Island and Gibraltar Bay in 1986 (Appendix 6-7).

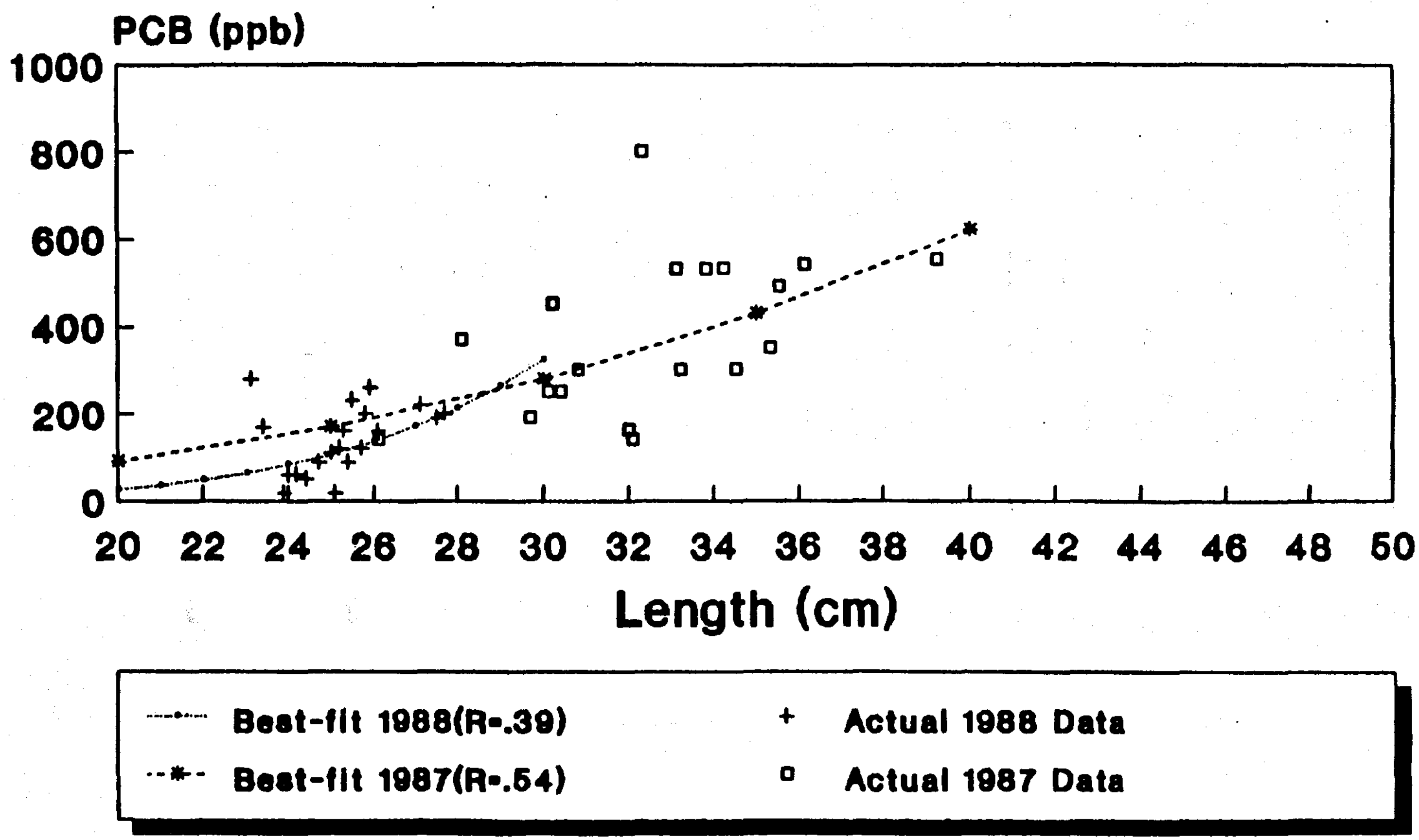
Approximately seventy percent of the Detroit River carp collected exceeded the trigger level (2.0 mg/kg). Concentrations of total PCBs ranged from 0.52 to 25.6 mg/kg in carp from the four collections.

Walleye were collected by MDNR near Grassy Island in 1986. Results from analysis of these walleye (skin-on fillet) did not warrant a consumption advisory, according to MDPH criteria. One walleye of the ten collected exceeded the trigger level of 2.0 mg/kg total PCBs. Concentrations of PCBs in walleye ranged from 0.197 to 2.567 mg/kg. Mercury in the walleye ranged from 0.13 to 0.79 mg/kg (mean = 0.238 mg/kg).

The 1990 fish consumption advisory also contains a "restricted consumption" advisory for freshwater drum over 14 inches due to elevated concentrations of mercury. This advisory is based on data from the Ontario fish contaminant monitoring program. The advisory for freshwater drum recommends consumption of no more than one meal per week by the general population and includes special caution for pregnant women, nursing mothers, women who intend to have children, and children age 15 and under because these groups are more vulnerable to contaminants than the general population.

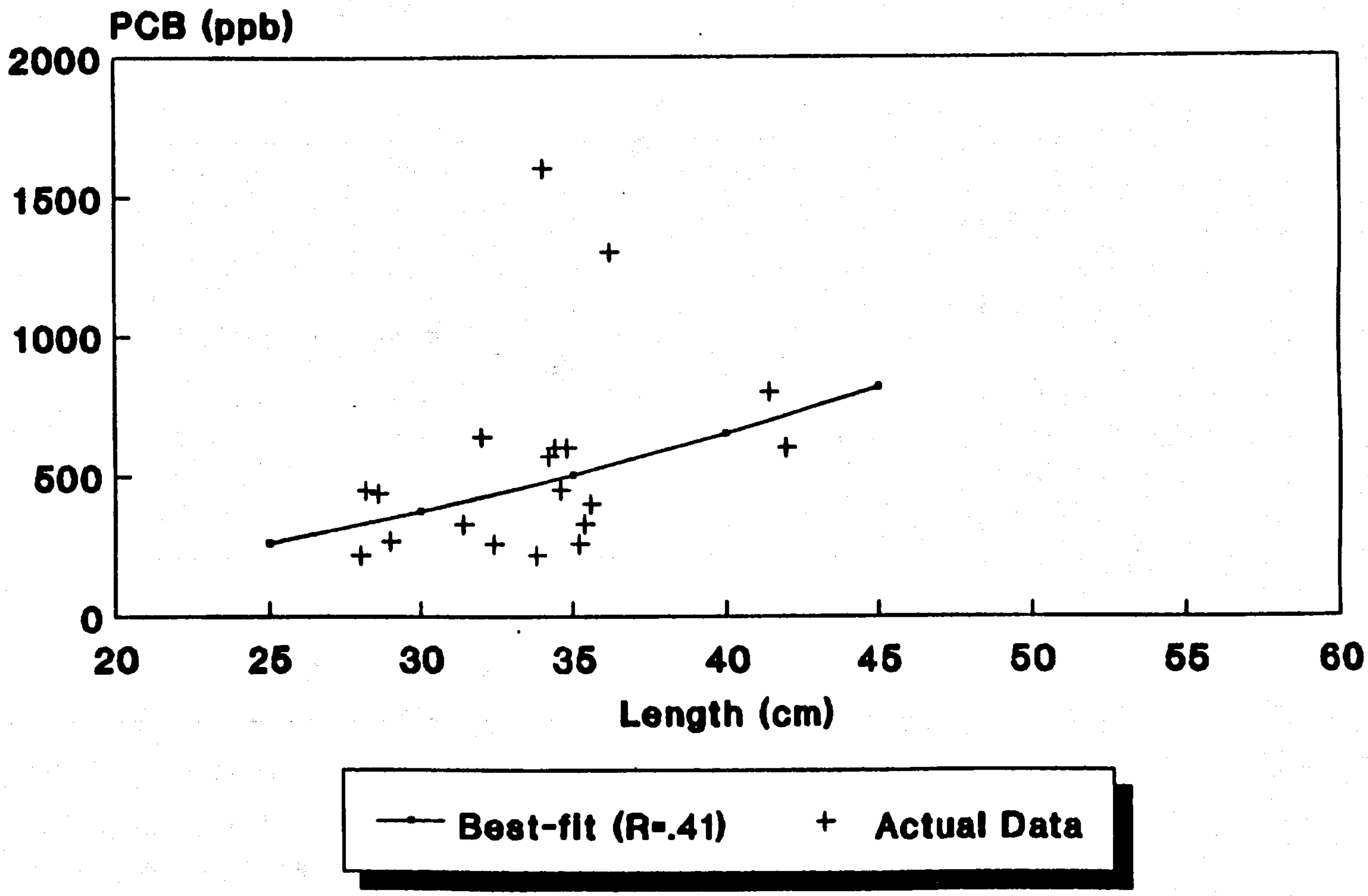
6.6.6.3 Ontario Fish Consumption Advisories

The Ontario Ministry of the Environment and the Ontario Ministry of Natural Resources also jointly issue an annual advisory for anglers apprising them of contaminants in Ontario fish (OME and OMNR 1990). The 1990 Guide to Eating Ontario's Sport Fish provides consumption advice with respect to a number of species obtained from the Fighting Island, Boblo Island and Malden Township areas of the Detroit River. For several species and sizes within these species, it is noted that women of child-bearing age and children under the age of 15, may not be able to eat all sizes of all species. Ontario's most recent Detroit River



Ont. MOE data - skinless fillets

Figure 6-50. PCBs in Detroit River white bass 1987 and 1988.



Ont. MOE Data - skinless fillets

Figure 6-51. PCBs in channel catfish from the Detroit River - 1988.

fish collections for contaminant analysis were obtained during 1988 (Appendix 6-8) (OME and OMNR 1990). Dorsal muscle from all fish was analyzed for mercury, PCB, mirex and a standard scan of pesticides and chlorinated organics. At Fighting Island, yellow perch were also analyzed for 2,3,7,8-TCDD. Walleye and white bass at Boblo Island and walleye at Malden Township, were also analyzed for toxaphene.

An important part of the Ontario Sport Fish Contaminant Monitoring Program, is the fact that a wide range of sizes of individual fish are analyzed to establish the suitability of eating fish from different size classes. While it may not be appropriate to eat a larger, older fish due to a higher potential for bioaccumulation, consumption of smaller individuals which have not accumulated contaminants, may be acceptable.

At Fighting Island, rock bass between 25 and 30 centimeters (10-12 inches), and freshwater drum between 35 and 45 centimeters (14-18 inches), are listed for restricted consumption due to elevated concentrations of mercury. Freshwater drum 45 to 55 centimeters (18-22 inches) at this site are listed for no consumption due to elevated levels of mercury (greater than 0.5 mg/kg). Concentrations of mercury in the edible portion of rock bass, freshwater drum and walleye of these sizes were above the Ontario fish consumption advisory of 0.5 ppm (OME 1990). At Malden Township, rock bass between 15 and 20 centimeters (6-8 inches) and walleye between 45 and 65 centimeters (18-26 inches) were listed for restricted consumption due to elevated mercury concentrations.

Near Fighting Island, carp greater than 35 centimeters (18 inches) are listed for restricted consumption by the general public, and for no consumption by women of childbearing age and children under 15 years due to elevated levels of PCBs (3.3 mg/kg). Canadian medical authorities suggest that fish containing an excess of 2.0 mg/kg total PCB should be eaten by adults (except women of child-bearing age) only on an occasional basis.

No restrictions were placed for consumption of walleye or white bass collected near Boblo Island.

6.6.7 Contamination in Young-of-the-Year Fish

PCBs in young-of-the-year spottail shiners collected between 1978 and 1983 were found at significantly ($p < 0.01$) higher concentrations at Sturgeon Bar and Celeron Island along the Michigan shoreline than along the Ontario shoreline (Table 6-39) , suggesting Michigan inputs of PCBs (Suns et al. 1985). Octachlorostyrene, chlordane, and DDT metabolites were more uniformly distributed in spottail shiners from different locations in the river, suggesting uniquitous sources of these chemicals. BHC, heptachlor, aldrin, and chlorinated benzenes were near detection limits. Mirex and chlorinated phenols were not detected. An update of sampling investigations subsequent to 1983 is currently in preparation by the Water Resources Branch of the OME. This will provide additional insight into temporal and spatial trends of contaminants in young-of-the-year fish from the Detroit River.

Table 6-39. **Regional means of PCB residues in Young-of-the-Year Spottail Shiners from 1982/83 collections.**

	ONTARIO WATERS			U.S. WATERS		
	NO. OF SITES SAMPLED	MEAN PCB RESIDUES ng/g	NO. OF SITES EXCEEDING IJC GUIDELINE	NO. OF SITES SAMPLES	MEAN PCB RESIDUES ng/g	NO. OF SITES EXCEEDING IJC GUIDELINES
Lake St. Clair	4	38	0			
Detroit River	3	253	3	3	1873	3
Lake Erie West	3	227	3			
Lake Erie East	4	40	0			

IJC guideline for protection of aquatic life - 100 ng/g

Source: Suns et al. 1985

6.6.8 Fish Tumors

6.6.8.1 Oral/dermal Tumors

Although the precise etiology of oral and dermal papillomas in fish is currently debated, some researchers believe a virus may be the causitive agent (Harshbarger and Clark 1990). The widespread distribution and high incidence of this neoplasm shown in studies of the Great Lakes is consistent with this theory. A recent study (Smith et al., 1989) in Hamilton Harbour (another AOC) showed incidences of 55.0% (combined oral and dermal papillomas) for bullhead, while a control site at Long Point Bay showed 15.0% of the bullhead affected. White suckers had similarily high values (58%) from creeks in the Hamilton area, while control sites from non-polluted creeks had incidents of 30%. Black, et al. (1982) felt that chemicals in polluted areas might activate or indirectly increase viral virulance and several studies have shown increased tumor incidence correlated with the degree of pollution (Baumann et al. 1982; Black 1984; Malins et al. 1984; Sonstegard 1977; and Smith et al. 1989). Smith et al. (1989) reported that high incidences of oral and dermal lesions with accompanying liver neoplasms in bullheads and white suckers, further suggested chemicals might somehow be involved in the etiology of those neoplasms.

Five species of fish were collected from six Michigan sites in the lower Detroit River and examined for external lesions, necropsied for internal abnormalities and tissues removed for histological examination (Figure 6-52) (Kreis 1987). Oral and dermal tumors cited in this study did not include lesions due to lymphocystis. Bullhead and walleye were the only two species exhibiting dermal and/or oral neoplasms at 10.2% and 4.5% respectively (Table 6-39). Of the six sites examined, bullheads at Point Hennepin and Celeron Island exhibited the greater incidence of oral/dermal tumors at 17.2% and 13.6% respectively (Table 6-41). Detroit River data suggest a low incidence of lip papillomas in white suckers, however the sample size was small.

A 1987 study of bullhead and walleye collected from the same locations found dermal/oral tumor incidence rates to be 10% and 12%, respectively (Kreis et al. 1989). As indicated previously, studies in other areas of the Great Lakes have shown similar and often higher incidences of oral and/or dermal tumors.

A study by Johnson, MacLennan, and Smith (1990) assessed contaminants in Lake St. Clair walleye, with and without viral skin diseases present. Contaminant residues in male walleye taken from the spring spawning migration into the Thames River (from Lake St. Clair) with grossly visible skin lesions, were compared with those in unaffected fish of similar sizes from the same location. The skin lesions were diagnosed histologically to be lymphocystis, dermal sarcoma, and a single calcereous nodule. Levels of polychlorinated biphenyls, organochlorine pesticides, mercury, heavy metals, chlorinated phenols and chlorinated benzenes were measured in the edible muscle of both groups.

Contaminant levels in fish with epidermal lesions were lower and more uniform than non-affected fish. Lower chemical levels correlate with

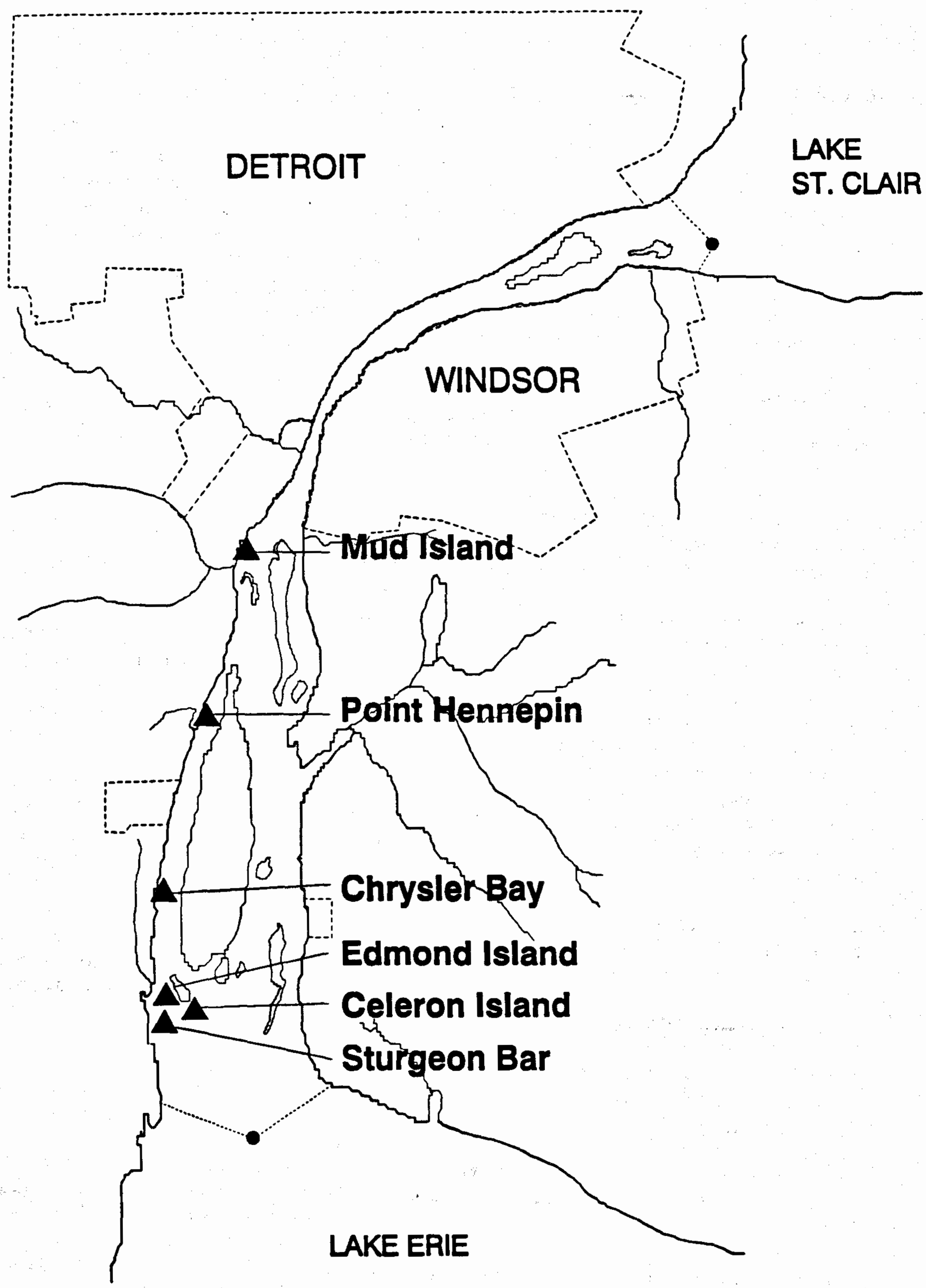


Figure 6-52. Fish sampling locations in the Detroit River (Kreis et al. 1989).

Table 6-40. Incidence of neoplasms in fish species from the Detroit River 1986-1987 (Kreis et al. 1989).

SPECIES	TUMOR TYPE			
	Dermal/Oral[a]		Liver[b]	
Bullhead	46/449	(10.2)	27/306	(8.8)
Walleye	3/ 66	(4.5)	5/ 60	(8.3)
Redhorse Sucker	0/ 46	(0.0)	5/ 37	(13.5)
White Sucker	0/ 13	(0.0)	2/ 11	(18.2)
Bowfin	0/ 22	(0.0)	4/ 22	(18.2)

[a] Dermal/oral tumors included epidermal papilloma an neuroepithelioma in bullhead and fibroma in walleye.

[b] Liver tumors included foci of altered hepatocytes, hepatocellular carcinoma and cholangioma.

Table 6-41. Incidence of neoplasms in bullhead from selected sites in the Detroit River 1986-1987 (Kreis et al. 1989).

	Incidence* (%)			
Site	Dermal/Oral		Liver	
Mud Island	0/ 14	(0.0)	0/12	(0.0)
Hennepin Point	16/ 93	(17.2)	9/79	(11.4)
Station 43	4/ 61	(6.6)	1/50	(2.0)
Celeron Island	3/ 22	(13.6)	1/16	(6.3)
Upper Gibraltar Bay	5/ 86	(5.8)	3/62	(4.8)
Lower Gibraltar Bay	15/172	(8.7)	11/86	(12.8)

* Incidence = number of fish with neoplams/number examined.

slightly lower muscle lipid in affected fish, though the reduced lipid may indicate stress imposed by the viral diseases.

There appears to be no relationship between epidermal lesions and the levels of persistent contaminants measured in the study. Guidelines for the consumption of normal walleye apply also to those with these skin disorders.

While this study is not area specific to the Detroit River, Lake St. Clair being a contiguous waterbody, and walleye having an extensive habitat, these findings are of interest to the Detroit River AOC.

The occurance of oral and dermal lesions in brown bullhead and other species seems to be common in the Great Lakes. Although we are uncertain of the chemical/biological agents responsible for these lesions, it seems clear that the occurance of these tumors is some indication of poor fish health. Research on tumor incidence and etiology should continue in this area.

6.6.8.2 Liver Tumors

A number of fish species sampled in the Great Lakes in non-polluted areas (South Baymouth, Lake Huron) have no liver tumors (Cairns and Fitzsimons 1988). Several fish species collected in the Detroit River in 1986-1987 exhibited liver neoplasms (combined hepatocellular (liver) and cholangiolar (bileduct)) with observed incidences for bullhead, walleye, redhorse sucker white sucker and bowfin of 8.8%, 8.3%, 13.5%, 18.2% and 18.2% respectively (Kreis et al. 1989). The highest incidence of liver tumors in bullhead were observed at Sturgeon Bay (12.8%) and Point Hennepin (11.4%). Liver and oral/dermal tumor incidence was found to be age/size related based on the number of tumors present in bullheads older than three years and in walleye greater than 50 centimeters in length. No liver or oral/dermal tumors were found in bullheads collected from Mud Island. No relationships were found between oral, dermal or liver tumors in bullheads.

Fish from the Detroit River have a liver tumor incidence that is comparable with other highly industrialized areas within the Great Lakes as shown by other fish tumor studies completed over the past few years. Cairns and Fitzsimons (1988) showed that white suckers from western Lake Ontario had a combined heptaocellular and cholangiolar tumor incidence of 0 to 7% depending on location. Black, et al. (1980) were the first to show liver tumors in bullhead from the Buffalo River with an incidence of 10%. Baumann, et al. (1982) in a study of the Black River near Lake Erie, showed an age correlation with tumors. Bullhead three years or older had a tumor incidence of 33%. Black, et al. (1982) reported a 30-35% incidence of liver neoplasia in older walleye as compared to the Detroit River study of 8.3% (incidence rates increased by approximately 3% when adjusted for age/size).

The development of carcinomas is a very complicated subject, further complicated by the time that lapses before they are noticed. Maccubbin (1987), in the Detroit River study previously mentioned, found that all species examined had benzo(a)pyrene or its metabolites in their bile indicating recent exposure to the presence of PAHs in the environment.

Concentrations varied widely from site-to-site and species-to-species. The highest concentrations were found at Mud Island, Point Hennipen and Gibraltar Bay, with walleye usually having the highest concentration among species tested.

Kreis et al. (1989) also examined the relationship between PAH concentrations in sediment and stomach contents, and tumors in walleye and bullhead from the Detroit River. Stomach contents of walleye and bullhead with and without tumors were analyzed and assumed to be representative of short term exposure and potentially, long term exposure, depending on mobility. Total PAH concentrations in stomach content samples from tumorous and non-tumorous bullhead did not correspond to the spatial distribution of total PAH concentrations in sediments. Stomach PAH concentrations were significantly greater in bullhead with tumors (than in those without tumors) at only one of the four sites studied. There were no significant differences in stomach PAH concentrations in walleye with and without tumors at either of the two sites studied. The authors concluded that no distinct relationships between the incidence of tumors and PAH and PCB concentrations in sediments, food or tissues were observed.

6.6.9 Fish Flavor Impairment

No fish flavor impairment studies have been performed on the Detroit River since no complaints of fish flesh flavor tainting have been reported. The Michigan Department of Natural Resources has a program to determine if fish flavor is impaired when complaints of poor tasting fish are received (MDNR/SWQD/GLEAS Procedure No. 55).

6.6.10 Lake Erie/Lake St. Clair Fishery

Adverse impacts on the Lake Erie Fishery specifically from the Detroit River are not well documented. There are, however, data that indicate that elements within the Detroit River system that negatively impact the river also enter Lake Erie. Burns (1985) summarized the loadings of toxic and nontoxic materials in Lake Erie and noted distribution patterns of lead, cadmium, DDT plus metabolites and PCBs which show accumulations of these elements at the western end of Lake Erie.

The Detroit Remedial Action Plan is limited in scope to the Detroit River Area of Concern with boundaries as defined in Chapter 5, Description of the Area. Impacts to Lake Erie as a result of the Detroit River and any other significant sources should be considered in the development of the Lake Erie Lakewide Management Plan, as mandated by the Great Lakes Water Quality agreement. However, recognizing that the Detroit River is part of a connecting link between two to the Great Lakes, and that the river accounts for approximately 80% of the inflow into Lake Erie, it may be beneficial to point out some facts concerning Lake Erie that may be relevant. Elements within the Detroit River system that negatively impact the river may also enter Lake Erie.

Currently, Lake Erie supports the largest freshwater commercial fishery in the world. In 1989, the commercial catch from the Canadian waters of Lake Erie was 42.2 million pounds. Yellow perch, walleye, white bass, white perch and rainbow smelt comprised the majority of the harvest

(Ontario Ministry of Natural Resources, unpublished report 1990). During 1989, the commercial harvest in Ohio keyed on the same species as the Ontario commercial fishery, excluding walleye and totalled 4.7 million pounds (Ohio Department of Natural Resources 1990). The sport fishery on Lake Erie is measured in excess of 18 million angler hours effort annually and is valued around 654 million dollars (Lake Erie State of the Lake Committee 1990). Walleye and yellow perch are the main stay of the fishery, however, a broad range of other species also contribute to the harvest.

The Michigan Department of Public Health has issued a "No Consumption" advisory for carp and catfish from Lake Erie due to elevated concentrations of PCBs in the fish tissue. The Ontario Ministry of the Environment currently does not have any fish consumption advisories in effect for the Western Basin of Lake Erie. Carp in excess of 55 cm from the Pelee Island vicinity, however, are recommended to be consumed at no more than two meals per week for brief periods, and no more than two meals per month for extended periods of consumption, due to PCB levels in fish flesh (OME and OMNR 1990).

Levels of mercury in Western Lake Erie walleye are well below the 0.5 ppm Ontario sport fish consumption criterion, while some Lake St. Clair walleye exceed this value measured on skinless fillets. PCBs in Lake St. Clair fish do not pose any consumption risks, with the exception of large channel catfish (55 to 65 cm; 22-26 in.) which exceed the 2.0 ppm criteria (OME and OMNR 1990). This data suggests that the Detroit River is having a negligible impact with respect to mercury contamination of Lake Erie fish, but may be having some impact in terms of PCB contamination.

Caution must be exercised in making this type of inference and a more detailed assessment of the western Lake Erie fishery considering all sources including the Detroit River would be required to substantiate any impacts.

6.7 WILDLIFE

6.7.1 History of the Wildlife Community

In precolonial conditions, the Detroit River ecosystem was a tremendous wildlife resource. The couriers du bois reported sighting large flocks of swans, geese and ducks, plus plentiful beaver and muskrat according to LaVoy (1971). Waterfowl used the emergent riverine wetland during the breeding season as well as during migration. The extensive wild celery (Vallisneria americana) beds in the lower Detroit River were a major migration stopover point for canvasback (Aythya valisneria), redhead (Aythya americana) and other ducks as well as tundra swans (Cygnus columbianus). In fact, the largest migration corridor for the canvasback from the breeding grounds in the Canadian prairie provinces southeasterly to Chesapeake Bay centered on the Detroit and St. Clair Rivers (Bellrose 1976). Herons and egrets (Ardeidae) were also abundant in the area. The Detroit River froze over virtually every year until approximately 1930 according to Hunt (1957).

The river wildlife community changed dramatically following settlement and industrialization. As wetlands along the riverfront were filled and converted into industrial sites, nesting and spawning habitat was lost. By 1949 Hunt (1957) stated, "The extensive marshes which once existed adjacent to the west side of the Trenton Channel have nearly all been filled." Waterfowl, wading birds, and other species that had previously nested in those marshes had for the most part disappeared from the area. Muskrats persisted locally in the remaining small marshes and in bank dens where they could feed on submersed plant beds.

The same industries that filled in the wetlands dumped untreated waste materials of many kinds into the river. This, in turn, changed the submersed plant communities. Hunt (1957) stated, "The former lush growths of wild celery, wild rice and pondweeds have almost totally disappeared." He went on to state that waste oils were, "mixed with bottom materials in nearly all of the channel." He concluded, that, "pollution (in the broad sense) is probably responsible for the absence of wild celery, indeed the general paucity of all plant life, in the upper west part of the study area (the lower Detroit River)." During the 1940's and 50's thousands of ducks were found dead on the lower Detroit River. Among the causes of mortality were oiling (up to 33 percent of losses), acute phosphorus poisoning (specifically in 1948), and starvation (Hunt 1957). Nevertheless, during the study the same investigator reported an average of 39,000 ducks wintering on the lower Detroit River during the period 1949-1955. Another large die-off occurred during the spring of 1960 when between 10,000 and 12,000 ducks died on the lower Detroit River near Gibralter and Grosse Ile. Hunt and Cowan (1963), felt that the majority of the mortalities were a result of oil fouling these birds feathers.

Bellrose (1976) reported that the northern corridor of canvasback migration (including Lake St. Clair, the Detroit River and western Lake Erie) was used by 260,000 canvasback ducks in the 1950's. During the 1960's, the numbers of canvasbacks following the Mississippi River corridor increased, while the number of canvasbacks using the northern corridor (Detroit River) dropped precipitously.

More recently, water pollution control has eliminated much of the oil and other contamination in the river water, however the sediments remain contaminated. Although wild celery remains one of the most common submersed aquatic plants in the river, it has not returned to its former abundance. During 1988, the Michigan Duck Hunters Association and MDNR planted wild celery tubers in two locations around Celeron Island in an attempt to hasten the expansion of wild celery beds. Tubers in one of the areas did very well, but a dense bed of mud plantain (Heteranthera dubia), an introduced species, appears to have out-competed the native wild celery at the other location. Whether wild celery will ever be restored to its former abundance in the river remains questionable.

Historical data concerning bald eagles in the immediate vicinity of the Detroit River is scarce. Some unpublished data does exist for the north shore of Lake Erie and this is thought to be somewhat reflective of the Detroit river area. It indicates that historic densities of bald eagles along the north shore of Lake Erie included one active nest site per mile of shoreline (Pud Hunter, Personal Communication). During the 1940s and 1950s workers observed a decline in the number of active nesting sites which had reached a low point of only two known active nests along the north shore of Lake Erie by 1980. A ban on the use of DDT in the late 1970s and on PBCs in the early 1980s is thought to have contributed to a resurgence of the eagle population. In 1989, nine active nesting pairs were observed along the north shore of Lake Erie (Pud Hunter, Personal Communication).

It is anticipated that as eagle populations continue to rebuild they will once again begin to frequent areas of the Detroit River, albeit the dense human population along the upper portion of the river may discourage nesting in that area.

6.7.2 Current Status of Waterfowl and Other Water-Related Birds

Although the waterfowl carrying capacity of the Detroit River is much reduced from its former condition, the river remains a major resource to migrant waterfowl. Bellrose (1976) reported that 5,400 canvasback and 2,000 redheads winter on the Michigan waters of Lake St. Clair and the Detroit River. During migration, thousands of canvasback, redhead and lesser scaup (*Aythya affinia*) use the Detroit River. Up to 500 tundra swans also use the river. Recently common and red-breasted mergansers (*Mergus merganser*, *M. serrator*) have also become abundant on the lower river during late fall through early spring. Over 5,000 mergansers were observed in the vicinity of Celeron Island and Grosse Ile during the 1988-89 winter.

The Detroit River is not an important waterfowl production area. A few hundred mallards, wood ducks, blue-winged teal and, in recent years, Canada geese are produced in the marsh areas that remain, notably those of Fighting Island and the areas near the mouth of the Canard River. Some mallards are also produced in the vicinity of Windsor and Amherstburg as well as on adjacent marina areas.

The Detroit River supports a fairly substantial and diverse population of colonial waterbirds. Species that nest on islands in the river include: great blue heron (*Ardea herodias*,) great egret (*Casserodium albus*), ring-billed gull (*Larus delwarensis*), herring gull (*L. argentatus*) and common tern (*Sterna hirundo*) (Scharf et al. 1978; Blokpoel and Tessier 1986; McNicholl 1989a, 1989b).

A survey done of the U.S. portion of the River in 1976/1977 revealed five species of colonial waterbirds nesting on three islands: 11 pairs of great blue herons and 23 pairs of great egrets on Stoney Island; 20 pairs of common terns and over 1600 pairs of ring-billed gulls on Grassy Island; and 2 pairs of herring gulls and nearly 5300 pairs of ring-billed gulls on Mud Island (Scharf et al. 1978). A 1979 survey (Weseloh et al. 1990) determined that approximately 101 herring gull nests comprised a colony on Fighting Island. Two herring gull nests were reported on Mud Island in a 1977 survey (Weseloh et al. 1990).

What little written history there is on nesting by waterbirds on these islands has been summarized by Scharf et al. (1978). Mud Island is a dredge spoil island constructed in 1959/1960. Large numbers of common terns nested there during the early years and ring-billed gulls moved in at some later date. Grassy Island is also a dredge spoil island and it was not yet completed in 1977 when both common terns and ring-billed gulls started nesting there.

The only update of the status of colonial waterbirds on the U.S. side of the River is for ring-billed gulls in 1984 when 3,000 pairs nested at Mud Island and none at Grassy Island (Blokpoel and Tessier 1986).

The major importance of the Detroit River marshes are as staging areas during both autumn and spring. Again the marshes near the mouth of the Canard River and to a much lesser extent those of Fighting Island are important. Canadian Wildlife Service (CWS) aerial surveys conducted during the 1970's and 1980's indicate that waterfowl numbers begin to increase in August from the few hundred local blue-winged teal, mallards and wood ducks to approximately 3,000 birds immediately prior to the hunting season. Mallards form the greatest portion, followed by American widgeon, blue-winged teal and black ducks. Numbers decrease for a period after opening of the hunting season, but by early November birds often number between 10,000 and 15,000 birds with canvasbacks being the most abundant followed by scaup, redheads and mallards. By early December, numbers decline and in severe winters are limited to a few goldeneye and common mergansers in the open water of the river as well as a few hundred mallards feeding on waste grain in the vicinity of the Hiram Walker distillery. In addition, some Canada geese remain most winters especially in the vicinity of Windsor. In late February, waterfowl begin to increase and peak in mid to late-March. Numbers of birds seldom approach the autumn peaks and are usually less than 10,000. Again, canvasbacks are the most abundant bird. Waterfowl numbers rapidly decline after the 1st of April to the few birds that use the area for nesting.

In an updated assessment of migrant waterfowl use of the Ontario shorelines of the Southern Great Lakes, Dennis, et al. (1984) indicated the lower Detroit River and associated marshes ranked 6th out of 17 areas surveyed in terms of total waterfowl days of usage during migration periods.

Peak numbers recorded by Canadian Wildlife Service (CWS) aerial surveys during autumn by species group are as follows: mallard 4,690; black duck 2,941; American widgeon 1,103; canvasback 10,800; redheads 6,000; scaup (both greater and lesser) 3,000; gadwall 305; American coot 471. Peak numbers in spring were mallard 126; black duck 70; canvasback 5,782; redhead 1,227; scaup 238; common merganser 427; American goldeneye 139; and whistling swans 10.

These peak numbers are considered conservative, first, because migration peaks seldom coincide with waterfowl surveys due to inclement weather, and second, because aerial surveys usually under-estimate bird numbers by at least 30 percent.

Osprey (*Pandoin haliaetus*) also hunt the waters of the lower Detroit River regularly during migration. At least three different osprey were observed in the Gibralter/Grosse Ile/Celeron Island area during September 1988 (Doug Reeves, Personal Communication).

Bald eagles (Haliaetus leusocephalus) also use the lower portion of the river during the fall, winter and early spring. An immature bald eagle injured by a shotgun blast was found on Celeron Island on December 26, 1988. On one occasion during the winter of 1988 four different eagles were observed in the vicinity of the lower Detroit River (Doug Reeves, Personal Communication). So long as open water remains and fish and waterfowl are available, eagles can be expected to continue using the river during the colder months. One pair of eagles has nested just a few miles south of the lowermost boundary of the Detroit River for at least the past three years. This pair has been observed foraging on the extreme lower portion of the river.

Today the lower Detroit River marshes and the marshes associated with the Province of Ontario's Lake Erie shore to the Holiday Beach park have high numbers of mallards, black ducks and Canada geese, respectively, in spring and autumn. The favorable climate and the river currents enable birds to use the area later in autumn than in most other areas. The funneling effect of the Great Lakes shoreline, baited sanctuaries, and nearby grain fields result in heavy use by waterfowl. Several of the shoreline marshes are managed primarily for waterfowl hunting. In the 1981 surveys, Dennis, et al. (1984) found that, although the annual waterfowl use had not changed when compared to data reported by Dennis and Chandler (1974), autumn numbers of mergansers and black ducks had declined dramatically and canvasbacks and redheads had dramatically increased. They postulated that decreased use by dabbling ducks was the result of the loss of emergent aquatics due to higher water levels in the Great Lakes (Bookhout et al. 1988).

In summary, the wildlife carrying capacity of the Detroit River is much reduced from its precolonial condition. Industrial and urban development has resulted in decreased populations, primarily through the loss of habitat. Management goals for wildlife have not been established for the Detroit River AOC and would be useful in evaluating the status of this beneficial use.

6.7.3 Contaminants in Waterfowl, Other Water-Related Birds and Eggs

There are presently no regular programs for collection and testing of waterfowl for persistent bioaccumulative contaminants in Michigan or Ontario. In Ontario, the Ministry of Natural Resources (OMNR) collected mallards from the Detroit River during the summers of 1988 and 1989. During 1988, nine mallards were shot at two sites in the River. Two adults and two juveniles were collected at Peach Island and five adult mallards were shot at Canard River. Liver and muscle samples were analyzed for a variety of organic contaminants. Mean total PCB levels (wet weight) were greatest in juvenile mallards frm the Canard River site (liver = 600.5 ug/kg; muscle = 322.5 ug/kg) followed by adults from Peach Island (liver = 184.5 ug/kg; muscle = 50.9 ug/kg) and adults from Canard River (liver = 96.5 ug/kg; muscle = 36.1 ug/kg). Mean lipid levels were approximately 3.6% in liver and 1.2% in muscle tissue. Normalized for lipid content, total PCB levels in liver tissue ranged from 2.6-16.3 mg/kg and in muscle tissue ranged from 1.8-75.0 mg/kg. In 1989 waterfowl were collected by OMNR with the assistance of the U.S. Fish and Wildlife Service, from the lower Detroit River near Grosse Ile. Results from these analyses are not yet available (OMNR 1990).

The only other available analysis of adult waterfowl in the Detroit River was performed on 13 diving ducks, including seven lesser scaups, three greater scaups and three goldeneyes, collected in 1981 near Mud Island in the Detroit River near Ecorse (Smith et al. 1985). Mean total PCB concentrations were 10, 11 and 7.6 mg/km, respectively, in the carcasses of the lesser and greater scaups and goldeneyes. The goldeneyes also contained 1.7 mg/kg hexachlorobenzene and 0.33 mg/kg trans-nonachlor and 1.3 mg/kg DDE in greater scaups. PCB ranged from 2.7 to 20 mg/kg in these birds. PCB lipid fractions ranged from 38 to 89 mg/kg total PCB. Fifteen young-of-the-year diving ducks were also collected at Mud Island during 1981. Male and female dressed carcasses of goldeneye, greater scaup, and lesser scaup contained total PCB concentrations ranging from 0.73 to 22.39 mg/kg. The highest concentrations were in males for all species, e.g., the mean PCB concentration for lesser scaup males was 10.73 mg/kg, for females 3.98 mg/kg (Kreis 1988). Variance between species was considerable with the highest mean concentration in goldeneye (12.96 mg/kg) followed by lesser scaup (8.03 mg/kg) and greater scaup (4.45 mg/kg). These levels are relatively high compared to wing pools of mallards and black ducks in the Atlantic flyway collected in 1979 (Cain, 1981). These are also high compared to total PCB found in dabbling and diving ducks from New York State (Kim et al. 1984) (Smith et al. 1985).

Comparisons between Smith et al. (1985) and Cain (1981) or Kim et al. (1984) must be made with caution as different tissues were analyzed in each study and these tissues differed greatly in their lipid content. The carcasses analyzed by Smith et al. had a mean percent lipid level of 18%, much greater than the individual tissue lipid levels analyzed in Kim et al. (1984) or the wings analyzed in Cain (1981). Data from different studies must be normalized to draw valid comparisons between contaminant levels (OMNR 1990).

In 1988, the U.S. Fish and Wildlife Service collected adult and juvenile Canada geese, mallard ducks and adult blue-winged teal from ponds located on Grassy Island in the Detroit River (a confined disposal facility). Samples were collected to determine if sediment contaminants were impacting waterfowl using the ponds on Grassy Island. Analysis will be performed on the livers as a first priority, and muscle tissue, if possible. Results from these studies are not yet available (T. Kubiak, Personal Communication, 1989).

The Michigan Department of Natural Resources Wildlife Division collected 29 ducks (ten species) from Harsons Island in northern Lake St. Clair and 24 ducks (nine species) from Pointe Mouillee in Western Lake Erie in 1988. Samples are slated for analysis by the U.S. Fish and Wildlife Service and the Michigan Department of Public Health (MDPH) of one or more combinations of the following tissues: breast meat, skin, and liver. As of October 1990, the MDPH has analyzed six waterfowl samples from the Pte. Mouillee area. These adult mallards showed no detectable levels of PCBs and only trace levels of DDT and HCB. Three flightless young-of-the-year mallards collected in 1989 from Pte. Mouillee had total PCB concentrations ranging from 1.5 to 2.5 mg/kg (J. Hesse, Personal Communication).

Populations of Great Lakes colonial nesting birds decreased from the 1950s to the 1970s, in part due to environmental contaminants. Although they have different sensitivities to contaminants, tern, gull and cormorant populations suffered severe fluctuations during the 1950's (Fox and Weseloh 1987). The eggs were being laid but the shells were too thin to survive the brooding process. Cormorant populations within the Great Lakes basin suffered an overall decline of approximately 80% by the early 1970s. A variety of other problems including mortality, gonad dysfunction, thymic atrophy, edema, weight loss, hyperkeratization, hepatotoxicity, reproductive impairment, congenital malformations and other adult behavior modifications were noted (Kubiak et al. 1989).

Significant reductions in environmental contaminants have occurred since the early 1970's with corresponding improvements in colonial bird populations. The current annual growth rate of cormorant breeding populations in the Great Lakes is estimated at 50 percent, suggesting that breeding populations can recover rapidly once contaminant concentrations in the food chain fall below toxic levels (Fox and Weseloh 1987).

In 1974 the Canadian Wildlife Service established a monitoring program to measure organochlorine contamination in herring gull eggs in the Great Lakes. Data collected annually show that levels of persistent toxic contaminants decreased substantially from the high values reported in the 1970s. Since the early 1980s, contaminant levels in herring gull eggs have remained essentially constant (Environment Canada 1991). Reproductive success has improved and visual abnormalities in birds are seldom seen (Gilbertson 1988).

Researchers currently disagree on the utility of herring gulls as an indicator species. Gilbertson (1988) points out that herring gulls should be used for long-term monitoring in trend levels, but are extraordinarily insensitive, even though they accumulate high levels of chemicals. Herring gulls are able to tolerate elevated contaminant levels, yet reproduce successfully. Gilbertson further suggests that the herring gull is useful for demonstrating toxicological injury under conditions of substantial contamination, as occurred in the early 1970's, but it is not the species to use as an indicator of the level of restoration needs. Struger et al. (1985) selected herring gulls as an indicator species for environmental contamination because it is a top predator, feeding at the highest trophic level in the Great Lakes. The species nests colonially and eggs are easy to secure for analysis. The herring gull readily accumulates organochlorine compounds. Based on discriminant function analysis of levels of organochlorines in eggs, Struget et al. found a statstical correlation between contaminant levels and colony location. This research suggests the herring gull has value as an indicator of regional contamination in the Great Lakes. Weseloh et al. (1990) also suggest that the herring gull, under some circumstances, may function as an indicator of regional contamination. The variation in contaminants in herring gull eggs on a Basin basis paralleled those known for sediments, water and fish.

Gilbertson (1988) suggests that use of four other indigenous species, the bald eagle, osprey, mink and otter, which have been shown to be highly sensitive to pollution by persistant chemicals, would be more appropriate as indicators of ecosystem health.

The herring gulls on Fighting Island have been the object of several studies dealing with toxic chemicals in wildlife. Egg samples were first collected and analyzed in 1972 (Gilbertson and Reynolds 1974). Since 1978, herring gull eggs from Fighting Island have been sampled annually for toxic chemical analysis as part of a Great Lakes wide program conducted by the Canadian Wildlife Service (IJC 1988; Struger et al. 1985). The results of those analyses are given in Table 6-42. Levels of DDE, hexachlorobenzene, PCBs, alpha-chlordane and TCDD have decreased noticeably over the study period (1978-88). Levels of other contaminants have held relatively steady (dieldrin, oxychlordane) or increased (mirex). Studies in 1978 and 1979 reported in Weseloh et al. (1990), indicate that herring gull eggs from Fighting Island have significantly higher levels of DDE, HCB and PCBs, than found in eggs from other colonies in Lake Erie and the Niagara River. The report further indicates; however, that productivity levels of herring gulls from the Fighting Island colony are consistent with normal productivity levels associated throughout the Great Lakes. The author suggests that, even though significant decreases of contaminants have occurred in the period up to 1979, particularly for DDE, there was no corresponding change in eggshell thickness, as they remained approximately 6.7% thinner than pre-1947 thickness levels.

Given the herring gulls insensitivity to environmental contaminants, as referred to earlier, it would appear that reductions in some contaminant levels such as DDE since 1972 (from 14 to 3 ppm), may not be large enough to result in thickened shells.

Struger et al. (1985), indicated that herring gull eggs obtained from Fighting Island during 1981, contained significnatly higher levels of hexachlorobenzene and PCBs than eggs obtained from colonies in other areas throughout the Great Lakes (Table 6-43). These contaminant levels, although declining, indicate that the gulls are exposed to chlorinated contaminants in the Detroit River from which they primarily feed. Struger et al. (1985) related to the findings of Suns et al. (1985), in which young-of-the-year spottail shiners from the Detroit River contain significantly higher PCB levels than in those found in Lake St. Clair and Western Lake Erie, suggesting that the Detroit River system contributes a large portion of active PCBs to Lake Erie. A significant body of published information exists with respect to contaminants in herring gulls and other species from Western Lake Erie Island, including the Sister Islands, Middle Big chichen and Pelee Island (Weseloh et al. 1988 1990). While contaminant levels in eggs are on the decline for numerous contaminants, others are not declining as rapidly, or not at all. The Detroit River appears to be exerting a significant effect on birds from Western Lake Erie; however, other effects such as migration of birds to distance areas for feeding purposes may play an important role (D.V. Weseloh, Personal Communication 1990).

Levels of PCBs, HCB and DDE decreased in herring gull eggs from the Detroit River along the length of Lake Erie to the Niagara River, suggesting the Detroit river as the primary source of these compounds on Lake Erie (Struger et al. 1985).

Table 6-42
Contaminant concentration (mg/kg wet weight except where indicated) in herring gull eggs from Fighting Island.
Values in parentheses are standard deviation.

YEAR	#	DDE	DIELDRIN	MIREX	HEXACHLORO-BENZENE	PCB* (AROCLOR)	ALPHA-CHLORDANE	OXYCHLORDANE	TCDD (ng/kg
1978	11	9.4382	0.1818	0.1273	0.2809	115.0909		0.1964	
		(+/-2.5129)	(+/-0.0649)	(+/-0.1076)	(+/-0.0574)	(+/-33.4500)		(+/-0.1082)	
1979	10	5.9310	0.1320	0.1150	0.3310	138.7200	0.1050	0.1650	
		(+/-0.0410)	(+/-0.0410)	(+/-0.0606)	(+/-0.1046)	(+/-44.9456)	(+/-0.0299)	(+/-0.0005)	
1981	10	5.4220	0.2000	0.1200	0.2480	111.0200	0.2800	0.1230	49
		(+/-1.5728)	(+/-0.1224)	(+/-0.1043)	(+/-0.0683)	(+/-33.3659)	(+/-0.1743)	(+/-0.0313)	
1982	10	3.9900	0.2410	0.1390	0.1729	75.8600	0.0270	0.1680	35
		(+/-1.3323)	(+/-0.1429)	(+/-0.0965)	(+/-0.0621)	(+/-25.7601)	(+/-0.10496)	(+/-0.0767)	
1983	11	3.1618	0.2018	0.2173	0.1251	65.3636	0.0145	0.1773	26
		(+/-0.8937)	(+/-0.0904)	(+/-0.3062)	(+/-0.0362)	(+/-17.9976)	(+/-0.0069)	(+/-0.0694)	
1984	10	3.4530	0.2310	0.2330	0.2097	84.7900	0.0170	0.2090	33
		(+/-1.2004)	(+/-0.0540)	(+/-0.4339)	(+/-0.0379)	(+/-21.1982)	(+/-0.0048)	(+/-0.0667005)	
1985	10	3.4700	0.1530	0.3730	0.0972	48.1700	0.0105	0.1240	23
		(+/-2.2288	(+/-0.0067)	(+/-0.5495)	(+/-0.0313)	(+/-17.7601)	(+/-0.0072)	(+/-0.0695)	
1986	1	2.3700	0.0650	0.1100	0.0590	41.3000	0.0080	0.0900	16
1987**		2.2	0.9	0.04	0.06	54.65			14
1988**		2.2	0.15	0.04	0.09	60.43			20
1989**		2.2	0.06	0.04	0.05	58.57			13

*PCB data through 1986 are for aroclor are not congener specific. Data for 1987 through 1989 are congener specific and have been converted back to aroclor for comparison purposes.

** Data for 1987-89 for six organochlorines are based on a single analysis from a 10-egg pool. Therefore there are no standard deviations for these years.

Source: Environment Canada, 1991.

Table 6-43. Comparison of residue levels (parts per million Lipid wt. ± S.D.) in herring gulls eggs from Niagara River, Channel/Shelter Island and Fighting Island (N=10/site) with lake-wide[1] means (N=20/lake), 1981.

DDE			DIELDRIN			DDT		
12×10^1	L.Ontario	A[2]	5.1	L.Superior	A	0.99	L.Ontario	A
10×10^1	Channel/Shelter I.	A	2.9	L.Ontario	B	0.79	Fighting I.	AB
67	Fighting I.	B	2.6	L.Huron	B	0.68	Channel/Shelter I.	BC
67	L.Superior	B	2.6	Fighting I.	B	0.57	Niagara R.	C
59	Niagara R.	B	2.5	Niagara	B	0.49	L.Erie	C
42	L.Erie	B	2.4	L.Erie	B	0.45	L.Superior	C
42	L.Huron	B	2.4	Channel/Shelter I.	B	0.37	L.Huron	C

MIREX			HCB			PCBs		
29	L.Ontario	A	3.1	Fighting I.	A	14×10^2	Fighting I.	A
11	Niagara R.	B	2.6	L.Ontario	AB	90×10^1	Channel/Shelter I.	B
3.0	L.Huron	C	1.9	Channel/Shelter I.	B	85×10^1	L.Ontario	B
2.6	L.Erie	C	1.4	Niagara R.	B	63×10^1	L.Erie	C
1.7	L.Superior	C	1.4	L.Superior	BC	52×10^1	Niagara R.	CD
1.5	Fighting I.	C	1.0	L.Erie	C	39×10^1	L.Superior	DE
0.85	Channel/Shelter I.	C	0.77	L.Huron	C	28×10^1	L.Huron	E

1 Lake-wide means were calculated for residue determinations of herring gull eggs for the following colonies: Lake Ontario-Snake & Mugg's Islands, Lake Erie-Port Colborne Lighthouse & Middle Island, Lake Huron-Chantry & Double Islands, Lake Superior-Granite Island & Agawa Rocks (IJC 1983).

2 Residue levels for the same compound showing similar letters are not significantly different from one another (SNK test, P 0.05).

Source: Struger <u>et. al</u> (1985).

On the Canadian side of the river, colonial waterbirds are only known to nest on Fighting Island (Cadman et al. 1987). In 1988 there were 118 herring gull nests and an undetermined number (less than 50) of common terns nests on the south end of the Island (McNicholl 1989a, 1989b; D.V. Weseloh, pers. obs.). A large ring-billed gull colony (approximately 20,000 pairs) nested on the central part of the island in 1984 (Blokpoel and Tessier 1986; D.V. Weseloh pers. obs.). Local residents noted that ring-billed gulls started nesting on Fighting Island the same year that they left Grassy Island, a short distance to the west of Fighting Island. The only historical data available on this site shows that herring gulls nested there in 1972 (Gilbertson and Reynolds 1974).

6.7.4 Wildlife Consumption

There are no wildlife consumption advisories or programs for collection and testing of fur bearing aquatic mammals in the State of Michigan or the Province of Ontario. Occasionally, the Wildlife Division of the MDNR may analyze fur bearers for various contaminants. Consequently, there are few or no data available to determine concentrations of metals or organic contaminants in these animals in the Detroit River SAOC.

Potential fur bearers would include mink, otter, muskrat, racoon and opposum. Contaminant body burdens are assumed to be very low for most species due to the low percentage of food arising from the aquatic ecosystem which these animals might eat. Mink and otter, however, would be expected to consume significant quantities of fish and other aquatic organisms. Plants, the primary food of muskrats would not be expected to contain or bioaccumulate persistent organic contaminants such as PCBs. The mink and otter would have the highest percentage of potential contaminated food but populations of these animals are very low in the source AOC since it is largely urban. Opossums, which are occasionally consumed by humans, would likely have lower contaminant levels since they are omnivores and do not spend much time near the aquatic ecosystem. For these reasons the Michigan Departments of Public Health and Natural Resources have determined that fur bearers do not warrant contaminant monitoring given other priorities.

The Ontario Ministry of Natural Resources is currently analyzing mink from four southwestern Ontario townships including Mersea, Dover, Chatham and Camden. This data will be used to examine the relationship between levels of individual PCB congeners, particularly co-planar congeners, and the health of mink populations in the Great Lakes; previous work has documented the sensitivity of mink to PCBs and their importance as an indicator species should be recognized.

The OMNR has documented the commercial harvest of snapping turtles for human consumption. In April, 1990 this commercial harvest was prohibited due to concern for the decreasing populations of snapping turtles. However, snapping turtles may still be captured for personal consumption. In September, 1989 OMNR issued a newsrelease announcing the discovery of organic contaminants in snapping turtles collected from five sites in southern Ontario during 1988. This release advised against the regular consumption of snapping turtles from industrialized areas. In 1989, OMNR expanded the snapping turtle study to examine contaminant levels in turtles from 16 sites in Ontario including the Detroit River.

Muscle and liver tissue from four adult snapping turtles from the Turkey Creek areas in the Detroit River were analyzed. Mean total PCB levels (wet weight) of 0.4 mg/kg and 4.4 mg/kg were found in muscle and liver tissue respectively. Total PCB levels (wet weight) in muscle ranged from 0.15-0.67 mg/kg and in liver tissue ranged from 2.8-6.6 mg/kg. Levels of other compounds in muscle and liver tissue were as follows: mean total DDT levels were 6.7 ug/kg and 102.9 ug/kg; mean mirex levels were 1.7 ug/kg and 11.8 ug/kg and mean octachlorostyrene (OCS) levels were 0.6 ug/kg and 7.8 ug/kg. Muscle levels of total PCBs, total DDT and mirex were below Health and Welfare Canada guidelines for fish consumption. Levels of OCS did exceed a New York Department of Environmental Conservation OCS guideline of 0.2 ug/kg for consumption of fish. This study also indicated that older turtles had greater contaminant burdens than young turtles and that contaminant levels in older turtles might exceed established contaminant guidelines for fish (OMNR 1990).

CHAPTER 7
PROBLEM DEFINITION

The objective of this chapter is to summarize the impairments and water quality problems described in Chapter 6, the Aquatic Ecosystem. It compares the information presented in the previous chapter with: (1) the beneficial uses described in the Great Lakes Water Quality Agreement (GLWQA) (Annex 2); (2) other provisions of the GLWQA, e.g. the Specific Objectives (Annex 1) and the Phosphorus Load Reduction Agreement (Annex 3); (3) Michigan's Water Quality Standards (WQS) including protection for designated uses; and (4) Ontario's Provincial Water Quality Objectives (PWQO). The status of beneficial uses is summarized in Table 7-1.

7.1 WATER QUALITY CRITERIA (MICHIGAN, ONTARIO, GLWQA)

Michigan Water Quality Standards prescribe minimally acceptable water quality conditions to be met at drought flows and after mixing of effluents with receiving waters. Water quality is to be better than specified by the WQS at flows greater than drought flows. Rule 57 is Michigan's narrative water quality standard for toxic substances. The process outlined in Rule 57(2) and associated guidelines is used to derive Rule 57(2) Guideline Levels which are utilized to develop surface water discharge permit limitations for point source discharges. Even though the Rule 57(2) levels are not ambient standards, they are useful as general indicators in the evaluation of ambient data.

The Ontario Provincial Water Quality Objectives and the GLWQA Specific Objectives (Annex 1) also identify acceptable levels in ambient water for some conventional parameters and toxic substances.

Annex 3 of the GLWQA addresses control of nutrient input through Phosphorus Load Reduction Plans. Phosphorus input to Lake Erie from the Detroit River appears to be consistent with this plan to date, although continued efforts are necessary to meet future objectives.

Levels of conventional parameters currently meet the applicable criteria. However some metals and organic contaminants in water were found to exceed these criteria.

Mercury. Ambient levels of mercury measured during the UGLCC Study exceeded the Michigan Rule 57(2) level throughout the river, and also exceeded the GLWQA Objective and the Ontario PWQO in the Trenton Channel.

Cadmium. Cadmium concentrations exceeded Michigan Rule 57(2) levels in 36 of 419 samples (9%) taken at the lower transect between 1984 and 1988. The Ontario PWQO and the GLWQA Objective were exceeded in 64 of 419 samples (15%). Most of these exceedances occurred at the station nearest the Michigan shoreline, although exceedances of all criteria for cadmium occurred at seven of the ten monitoring stations during this period. Cadmium theoretically exceeded Michigan Rule 57(2) levels downstream of the Detroit Water and Sewerage Department (DWSD) discharge (near Zug Island) based on the Detroit River Plume Monitoring and Modeling Program (ES&E et al. 1987) and modeling and mass-balance calculations.

Table 7-1. Summary of potential water quality impairments in the Detroit River AOC and their significance to the Detroit River RAP.

GLWQA Beneficial Use	Significance to the Detroit River RAP
1. Restrictions on fish and wildlife consumption;	This use is impaired. The following fish consumption advisories apply to the AOC: Michigan: Carp (PCB) and Freshwater Drum (Mercury) Ontario: Carp (PCB); Freshwater drum, Rock bass, Walleye (Mercury)
2. Tainting of fish and wildlife flavour;	No reports of tainting.
3. Degradation of fish and wildlife populations;	Fish: This use is not impaired. The fish community is now structured more towards benthivores than it was originally, however over 60 species have been found in the river, with fish occupying all niches. Wildlife: Wildlife populations in the AOC have decreased due to urbanization. Some loss of reproductive capacity has occured (bald eagles), however, this appears to be a problem associated with conditions in the Great Lakes Basin rather than specific to the Detroit River.
4. Fish tumors or other deformities;	This use is impaired. Liver tumors at levels exceeding background incidence rates have been found in five species.
5. Bird or animal deformities or reproductive problems;	No documented bird or animal deformities associated with the Detroit River AOC have been reported. Levels of contaminants in herring gull eggs from Fighting Island have decreased notably since 1974 but have not declined appreciably since the mid-1980's.
6. Degradation of benthos;	This use is impaired. Degraded benthic communities have been noted: Michigan: Shoreline from Rouge R. to the mouth.
7. Restrictions on dredging activities;	This use is impaired: Michigan: Dredge spoils from shoreline downstream of Conners Creek are not suitable for open water disposal based on levels of metals and, in some areas, PCBs in sediments. Midriver: Dredge spoils from the lower river not suitable for open water disposal based on levels of cyanide, copper, lead and zinc. Ontario: Concentrations of arsenic, chromium, copper, iron, lead, zinc, cyanide, mercury, and PCB sediment concentrations in some areas exceed OME Guidelines.
8. Eutrophication or undesirable algae;	This condition has not been documented in the river and is unlikely to occur due to the short retention time of the river.
9. Restrictions on drinking water consumption, or taste and odor problems;	This use is impaired. No restrictions on drinking water have occured, however taste and odor problems were reported in July/August 1990 and in December 1990.
10. Beach closings;	This use is impaired. Total body contact activities in areas of the river are periodically impaired due to elevated bacteria levels (See

Table 7-1 (continued). Summary of water quality impairments in the Detroit River AOC.

GLWQA Beneficial Use	Significance to the Detroit River RAP
	below: Mich. WQS and Ontario PWQO). Beach closings have occurred in the Ontario AOC. The only beach in the Michigan AOC is on Belle Isle and it has not been closed.
11. Degradation of aesthetics;	This use is impaired. Debris and persistant objectionable deposits from CSOs exist along areas of shorelines. In addition, numerous spills of various materials have been noted to occur in the river (Chapter 8). Industrial development and urbanization have detracted from the natural beauty of the area, although these are not water quality impacts.
12. Added costs to agriculture or industry;	Not impaired, although the treatment of water intakes due to the presence of zebra mussels is required in some instances. This is a Great Lakes Basin wide issue.
13. Degradation of phytoplankton and zooplankton populations; and	Phytoplankton: Impairment has not been documented in the river and is unlikely to occur due to the short retention time of the river. Zooplankton: No documented impairment. Further assessment of more permanent nearshore populations is recommended.
14. Loss of fish and wildlife habitat.	This use is impaired as a result of significant loss of wetlands and habitat which has occurred due to industrial development and urbanization. It is recognized that existing wetlands in the AOC should be protected. Draft fish community goals also emphasize the achievement of no net loss of the productive capacity of fish habitats and the restoration of habitats wherever possible. Fish and wildlife management goals are needed to help further determine the extent of impairment and guide future rehabilitation strategies. Impairment due to water quality concerns has not been adequately documented. This area of study needs further evaluation.

GLWQA / Michigan Water Quality Standard / Ontario Provincial Water Quality Objective	Significance to the Detroit River RAP
1. GLWQA Annex 1 Specific Objectives/ and Ontario PWQO for contaminants in water	Exceedences have occurred as follows: PCBs (entire river); Mercury (Trenton Channel); Zinc, Copper, Cadmium (Mi and Ont waters -lower river)
2. Mi. WQS Rule 57(2) Allowable Levels	Exceedences have occurred as follows: Mercury, PCBs (entire river); Zinc, Cadmium, Lead (Mi and Ont waters- lower river)
3. Mi. WQS Rule 62 (Total Body Contact)	Michigan: Not met in nearshore waters downstream of confluence with Rouge R. Areas immediately downstream of CSOs are also impaired.
4. Ontario PWQO for fecal coliform	Ontario: Not met in nearshore waters downstream of Little R., Turkey Cr., Amherstburg WPCP, and the City of Windsor CSOs.

Copper. Concentrations of copper did not exceed Michigan Rule 57(2) levels between 1984 and 1988 in samples taken from the lower transect, however GLWQA and Ontario PWQ Objectives were exceeded in 3 of the 419 samples (1%). Two of these samples were from the station nearest the Michigan shoreline. Copper concentrations measured in ambient water during the UGLCCS Study did not exceed MDNR, OME or GLWQA criteria.

Lead. Concentrations of lead exceeded Michigan Rule 57(2) levels in 19 of 419 samples (4%) collected at the lower transect between 1984 and 1988, primarily at the station closest to the Michigan shore. GLWQA and Ontario PWQ Objectives were not exceeded. Michigan criteria were also exceeded in the Trenton Channel as measured in the Trenton Channel Mass Balance study (UGLCCS). Lead theoretically exceeded Michigan Rule 57(2) levels downstream of the Detroit Water and Sewerage Department (DWSD) discharge (near Zug Island) based on modeling and mass-balance calculations.

Zinc. MDNR monthly monitoring data (1984-1988) indicate levels of zinc exceeded Michigan Rule 57(2) levels in 9 of 419 samples (2%) collected at the lower transect, and exceeded GLWQA and Ontario PWQ Objectives in 9% of the samples. Approximately half of these exceedances occurred at the sampling station nearest the Michigan shoreline. Exceedences also occurred at the three stations closest to the Ontario shore.

PCBs. Based on the UGLCCS data, ambient levels of PCBs exceeded Michigan Rule 57(2) levels and the GLWQA and Ontario PWQ Objectives throughout the river.

Data for ambient concentrations of organic compounds are scarce, however analysis indicates levels of hexachlorobenzenes and other organochlorines and polynuclear aromatic hydrocarbons are below water quality criteria (where criteria have been developed).

7.2 GLWQA BENEFICIAL USE: "Beach closings."

This use is impaired. Beach closings due to bacteriological water quality have occurred at two adjacent beaches on the Ontario side of the Detroit River AOC. Both beaches, Stop 26 and Sand Point, are located just upstream of the mouth of the Little River, and were continuously posted as unsafe for swimming due to periodic exceedances of Ontario's PWQO for fecal coliform bacteria. The only beach located on the Michigan side of the Detroit River AOC is on Belle Isle near the head of the river. This beach has not been closed due to bacteriological concerns. Plans for a beach at Lake Erie Metro Park (near Sturgeon Bar Island in the lower river) were cancelled due to preliminary study data indicating high fecal coliform levels along the shore (Johnson and Anderson Inc. 1983).

Although there have been no additional beach closings, total body contact activities in several areas of the river are periodically impaired due to elevated bacteria levels. Documentation exists indicating the area immediately downstream of the confluence with the Rouge River exceeds Michigan's Water Quality Standards (Rule 62) for elevated levels of fecal coliforms. In addition, the discharge of inadequately treated sewage is illegal in Michigan, and as a result, all areas immediately downstream of Michigan CSOs are identified as impaired areas. Exceedences of Ontario's Provincial Water Quality Objectives have been identified downstream of: (1) the Little River; (2) Windsor CSOs; (3) Turkey Creek; and (4) the Amherstburg WPCP.

7.3 GLWQA BENEFICIAL USE: "Restrictions on drinking water consumption, or taste and odor problems."

This use is impaired. Although restrictions on drinking water have not occurred, taste and odor problems have been documented in the Detroit River in July and August, 1990. The cause of the problem has not been confirmed, however the Detroit Water and Sewerage Department and City of Windsor water treatment plant officials theorize that geosmin, a chemical naturally secreted by blue-green algae, may be the causitive agent. Additional treatment of the drinking water was required at both facilities, and officials anticipate a similar problem to occur in subsequent summers. Taste and odor problems were also noted in December, 1990 in water taken from the Belle Isle intake. Turn over in Lake St. Clair compounded by a recent snowstorm was thought to be the cause.

7.4 GLWQA BENEFICIAL USE: "Eutrophication or undesirable algae."

This use is not impaired. This condition has not been documented in the Detroit River.

7.5 GLWQA BENEFICIAL USE: "Added costs to agriculture or industry."

This use is not impaired. There are no known added costs to agriculture or industry due to the water quality of the river, however the treatment of water intakes due to the presence of zebra mussels is required in some instances. This is a basin-wide problem in the Great Lakes.

7.6 GLWQA BENEFICIAL USE: "Degradation of aesthetics."

This use is impaired. The IJC listing/delisting criteria includes the presence of persistent objectionable deposits, unnatural color, turbidity, oil slicks, surface scums, or odor as aesthetically degrading. There is no quantitative method for determining aesthetic degradation, and supporting documentation is scarce. However large volumes of combined sewer overflows frequently discharging to the river following wet weather events contribute discolored water (e.g. from slaughter houses), oil and grease, and other types of objectionable deposits and debris (see Chapter 8, Pollutant Inputs to the Detroit River). Due to the high flow of the river, these effects are not persistant, with the exception of remaining debris along the shorelines.

Spills of various materials have been noted in the river (Chapter 8). A total of 12 oil related spills were reported to the U.S. Coast Guard Marine Safety Office in 1989. Industrial development and urbanization have detracted from the natural beauty of the area, however these are not water quality impacts.

7.7 GLWQA BENEFICIAL USE: "Restrictions on dredging activities."

This use is impaired. There are no criteria in the GLWQA for acceptable levels of contaminants in sediments, nor does Michigan or Ontario have any legally enforceable criteria. In the absence of these, U.S. EPA and Ontario MOE guidelines for the disposal of dredged materials were used in part to judge sediment quality. Using these guidelines as a basis for comparison would indicate that dredging activities in the Detroit River are impaired. On a site specific basis, sediments removed may be subject to disposal restrictions dependent upon quality and may not be suitable for open water disposal (e.g., may require confined disposal).

7.7.1 Metals in Sediments

Michigan shoreline sediments. Sediments near Lake St. Clair were non-polluted with metals, but in areas downstream of Conners Creek, the median concentrations of nearly all heavy metals exceeded the U.S. EPA Region V Guidelines for the classification of heavily polluted sediments and Ontario Ministry of the Environment's dredge spoil guidelines. The data indicate that dredge spoils from the entire Michigan shoreline except at the head may not be suitable for open water disposal based on the concentrations of metals in the sediments.

Mid-river sediments. Eight of the ten mid-river sections had sediments with one to four metals that were in the moderately polluted range of the U.S. EPA guidelines. The two most downstream sections had several metals in the moderately polluted range and one to four metals in the heavily polluted range.

Ontario shoreline sediments. The median concentrations of metals in sediments did not exceed the U.S. EPA guidelines for the classification of heavily polluted metals except for lead in the Windsor area. Median concentrations of arsenic, chromium, copper, iron, lead, zinc, cyanide, or mercury exceeded OME guidelines in six areas along the Ontario shoreline.

7.7.2 PCBs and Oil and Grease in Sediments

Michigan Shoreline Sediments. Median PCB concentrations in sediments were highest between the tip of Belle Isle and Ecorse where sediments exceeded the U.S. EPA guidelines for PCB (10 mg/kg) in localized areas. Sediments along the entire Michigan shoreline exceed the OME's dredge spoil guidelines of 0.05 mg/kg for PCBs.

Median oil and grease concentrations exceeded the OME dredge spoil guidelines and the U.S. EPA's guidelines for heavily polluted sediments at all stations from Conners Creek downstream to Gibraltar.

Mid-River Sediments. Concentrations of PCBs in mid-river sediments were variable. Three sections had concentrations of PCBs exceeding OME's dredge spoil guidelines of 0.05 mg/kg PCBs: upstream and downstream of Belle Isle and downstream of Fighting Island to the mouth. Other areas where data were available were less than 0.05 mg/kg total PCB.

Sediments were classified as non-polluted with oil and grease (using U.S. EPA criteria) at all mid-river sections except for one section near the mouth.

Ontario Shoreline Sediments. Sediment concentrations of PCBs from downstream of Belle Isle to Fighting Island, and from Stoney Island to the mouth exceeded OME guidelines (0.05 mg/kg), but did not exceed U.S. EPA guidelines for heavily polluted sediments (10 mg/kg); U.S. EPA guidelines do not exist for light or moderate PCB sediment contamination.

Where data were available, sediments were classified as non-polluted with oil and grease using U.S. EPA and OMOE criteria.

7.8 GLWQA BENEFICIAL USE: "Degraded benthos."

This use in impaired in various locations in the river.

Michigan Shoreline. The benthic community was judged as degraded along the Michigan shoreline from the Rouge River to the Detroit River mouth. The communities were composed of pollution tolerant oligochaetes and chironomids. Near the Rouge River confluence, there were extremely high populations of oligochaetes, indicating severe enrichment. Some locations in the Trenton Channel were devoid of benthic life, indicating toxicity. The lack of pollution intolerant organisms such as the burrowing mayfly *Hexagenia* sp. in these areas also indicated degraded conditions. In addition, some sediments, sediment elutriate and sediment porewaters were toxic to benthic organisms in sediment bioassays. The most toxic sediments in these bioassays were located along the Michigan mainland shore of the Trenton Channel. Although sediment toxicity can be demonstrated for the Detroit River, field validation and direct cause linkages have not been established.

Mid-river. Mid-river benthic communities were considerably better than the Michigan shoreline and included mayfly larvae, scuds, midge larvae, aquatic worms, and leeches. The communities were depressed in the navigation channels, but were relatively diverse near the channels away from the depositional zones.

Ontario Shoreline. The Ontario shoreline benthic communities consisted of a balanced community structure indicative of satisfactory water quality conditions was noted along the entire shoreline. Most areas had pollution sensitive benthic organisms, such as the burrowing mayfly *Hexagenia* sp.

7.9 GLWQA BENEFICIAL USE: Degradation of phytoplankton and zooplankton populations."

No impairment has been documented. However, further assessment of the nearshore zooplankton communities is recommended.

7.9.1 Phytoplankton

The phytoplankton community largely reflects the condition of the upper Great Lakes and Lake St. Clair. The community was judged as not impaired based on density, diversity and species composition.

7.9.2 Zooplankton

The zooplankton community of the Detroit River was similar to that present in Lake St. Clair and composed of a normal balance of copepods, cladocerans and rotifers. The composition and health of more permanent nearshore populations have not been examined. It is recommended that these nearshore communities be further assessed.

7.10 GLWQA BENEFICIAL USE: "Loss of fish and wildlife habitat."

This use is impaired as a result of the significant physical loss of wetlands and habitat which has occured due to industrial growth and urban development. The maintenance and protection of existing wetlands is critical to the fish and wildlife populations in the AOC. Impairment due to water quality concerns has not been adequately documented, and evaluation of this area of study is needed.

The Detroit Metropolitan/Windsor area has changed considerably over the last century due to industrialization and urban development. The majority of the extensive marshland along the Michigan and Ontario shores have been filled and bulkheaded, eliminating the emergent plants and reducing the littoral zone (Manny et al. 1988). The result of this extensive urban development has been a major loss of fish and wildlife habitat. Dredging activities in the lower river have also resulted in habitat loss. Present development pressures continued to threaten fish and wildlife habitat.

The loss of, or impact to specific habitats, such as wetlands, as a consequence of water quality issues has not been well documented. Sediment toxicity tests have been conducted on Detroit River sediments, however the precision and ability of these tests to predict field conditions has not been adequately studied. Although sediment toxicity can be demonstrated for the Detroit River and these patterns resemble contaminant distributions and resident benthos distributions, field validation and direct cause linkages have not been established. It is recognized that additional research and development is needed and sediment toxicity tests must be standardized for regulatory and remedial decision making purposes. Recent work by Nichols et al. (1989), indicates aquatic macrophytes contain elevated levels of heavy metals, however, the relationship between elevated levels of heavy metals and wetland habitat impacts or losses is not clear. Further assessment may eventually provide more insight into this situation, however, it is clear that wetlands in the AOC provide important fish and wildlife habitat and should be protected. Draft fish community goals and objectives for Lake St. Clair and connecting waters have been developed jointly by MDNR and OMNR. Among other things, they emphasize the achievement of no net loss of the productive capacity of fish habitats and the restoration of habitats wherever possible.

7.11 GLWQA BENEFICIAL USE: "Bird or animal deformities or reproduction problems."

This use is not impaired. Currently, the Detroit River supports a fairly substantial and diverse population of fish-eating waterbirds including great blue herons, great egrets, ring-billed gulls, herring gulls, common terns and double crested cormorants. In the Great Lakes Basin, significant reductions in environmental contaminants have occurred since the early 1970's with corresponding improvements in colonial bird populations. The return of successfully breeding pairs of bald eagles to the northern shoreline of Lake Erie and the reappearance of bald eagle pairs in the lower Detroit River, further suggests that reproductive success of fish eating birds may be improving. Levels of contaminants in herring gull eggs from Fighting Island have decreased noticeably since 1974 but have not declined appreciably since the mid-1980's.

No documented bird or animal deformities associated with the Detroit River AOC have been reported. Based on this data, this use is judged as not impaired.

7.12 GLWQA BENEFICIAL USE: "Degradation of fish and wildlife populations."

7.12.1 Fish

This beneficial use is not impaired.

Over sixty species of fish are presently found in the Detroit River (Lee et al. 1980, Goodyear et al. 1982 and Haas et al. 1985 in Manny et al. 1988), with fish occupying all niches, including forage, planktivores, piscivores, omnivores and detritivores. Forty species have been lost from the river (Bailey and Smith 1981 and Edsall et al. 1988 in Manny et al. 1988). The community is now structured more towards benthivores than it was originally. The causes of the changes are due to several factors including invasion of new species, planting of new species, habitat changes and losses, losses due to dredging of the navigation channel in the lower river, and overfishing.

There were 32 fish species spawning in the Detroit River and abundant larval fish collected during a study conducted in 1986, suggesting that reproduction is occurring. The river has nursery areas for at least 25 species of fish. Based on the existing data, fish reproduction appears to be successful. Specific studies which would provide data on the relative reproductive capacity, e.g. sperm counts, egg production, or fertility measurements, of fish species in the Detroit River have not been undertaken.

Sport fishing is of high quality, the return per hour of fishing is good, and numerous economic, social and recreational benefits are provided by the current fish populations that occur in the river.

Due to the changes in the fish community structure that have taken place over time, it has been suggested that some degradation of fish populations has occurred. However, a return to a historic fish community structure is not possible or realistic. Improved or increased fish habitat may result in increased biomass and community diversity and thus an even further enhanced fishery. Draft fish community goals and objectives for Lake St. Clair and connecting waters have been developed jointly by MDNR and OMNR. They support the current fish community structure with walleye as the top predator species based on a foundation of stable, self-sustaining stocks.

7.12.2 Wildlife

The wildlife carrying capacity of the Detroit River is much reduced from its precolonial condition. Industrial and urban development has resulted in decreased populations, primarily through the loss of habitat. Improved or increased wetland habitat would result in enhanced wildlife populations and would have a positive impact on the health of the river. Management goals for wildlife have not been established for the Detroit River AOC and would be useful in evaluating the status of this beneficial use. The Detroit River has been identified as an important resting and staging area for migratory waterfowl, even though it is is not a major waterfowl production area. A 1984 assessment of migrant waterfowl use of the Ontario shorelines of the Southern Great Lakes indicated the lower Detroit River and associated marshes ranked 6th out of 17 areas surveyed in terms of total waterfowl days of usage during migration periods.

There has been some loss of reproductive capacity among some species such as bald eagles in Southwestern Ontario. These losses, however, have not been documented as being specific to the Area of Concern, but rather appear to be reflective of conditions within the Great Lakes Basin.

7.13 GLWQA BENEFICIAL USE: "Tainting of fish or wildlife flavor."

This use is not impaired.

7.13.1 Fish

There have been no reports of fish tainting in the Detroit River.

7.13.2 Wildlife

No waterfowl or wildlife tainting problems have been reported.

7.14 GLWQA BENEFICIAL USE: "Restrictions on fish and wildlife consumption."

7.14.1 Fish

This use is impaired in the Detroit River AOC.

Michigan. There is presently a fish consumption advisory (no consumption) throughout the river on carp due to elevated levels of PCBs. A restricted consumption advisory has been issued for freshwater drum due to elevated levels of mercury.

Ontario. There is presently a fish consumption advisory (restricted consumption) on carp greater than 35 centimeters due to elevated levels of PCB. There is also a restricted consumption advisory for the larger sizes of rock bass and freshwater drum near Fighting Island, and for rock bass and walleye near Malden township due to elevated levels of mercury concentrations in the fish flesh. Freshwater drum 45-55 cm (18-22 inches) near Fighting Island are listed for "no consumption" due to elevated levels of mercury.

7.14.2 Wildlife

There are presently no waterfowl or wildlife consumption advisories for the Detroit River AOC.

7.15 GLWQA BENEFICIAL USE: "Fish tumors or other deformities."

This use is impaired.

Brown bullhead, bowfin, redhorse sucker, white sucker and walleye surveyed in the Detroit River along the Michigan shore had neoplasms or preneoplastic lesions. The incidence rate for oral and/or dermal tumors in bullhead was 10.2% and walleye was 4.5%. Bullhead, walleye, bowfin, redhorse sucker, and white sucker had 8.8%, 8.3%, 18.2%, 13.5%, and 18.2% liver neoplasms, respectively. Tumor incidence rates were observed to vary greatly from site to site and from species to species within the river. These incidence rates are comparable to that found in other highly industrialized areas in the Great Lakes, and exceed documented background levels.

CHAPTER 8
POLLUTANT INPUTS TO THE DETROIT RIVER

8.1 INTRODUCTION

8.1.1 Sources of Data

Pollutants may enter the Detroit River from a variety of sources including industrial or municipal point source discharges (including combined sewer overflows) and nonpoint sources, such as tributaries, landfills, atmospheric deposition, groundwater, agricultural runoff, urban runoff and storm sewers. Historically, there has been a considerable amount of data collected documenting pollutant volumes, concentrations and/or loadings for conventional parameters like BOD, total phosphorus and fecal coliform bacteria. As these issues began to be addressed, problems with toxicants have become more evident. This section describes the sources of data used to gain insight into the magnitude and significance of the environmental toxicant problem in the Detroit River.

The intent of this Chapter is to document sources of contaminants causing impaired uses. No attempt has been made to critique regulatory programs or recommend remedial actions. As previously noted in Chapter 4, the Stage II RAP may include new programs or changes in existing regulatory programs if existing programs have been shown to be ineffective in protecting beneficial uses.

8.1.2 The Upper Great Lakes Connecting Channels Study

The Upper Great Lakes Connecting Channels Study (UGLCCS) was conducted on the St. Marys, St. Clair and Detroit Rivers and Lake St. Clair. The study objectives included the determination of the existing environmental conditions, identification and quantification (where possible) of contaminant impacts on the ecosystem, determination of the adequacy of the existing or proposed regulatory programs, and recommendations for control and surveillance programs to protect and monitor the connecting channels and downstream lakes.

This study was guided by a management committee co-chaired by the U.S. EPA and Environment Canada. An Activities Integration Committee oversaw the eight workgroups who developed and coordinated work plans, completed the field work and developed the reports for each geographical area. Roughly 170 individual project reports were summarized by workgroups and further synthesized into the UGLCCS report (USEPA and EC 1988). The four year project yielded much new data concerning contaminant sources, loadings and yet to be addressed problems in the aquatic ecosystem.

A target list of contaminants (Table 8-1) to evaluate was determined with input from nearly one hundred and sixty scientists, researchers, municipal officials and the regulatory personnel from U.S. and Canadian agencies. After the list was developed, most of the laboratories performing contaminant analyses during UGLCCS participated in "round-robins" to ensure that the data would be compatible.

Table 8-1. The list of parameters analyzed during the Upper Great Lakes Connecting Channels Study.

PARAMETERS	COMMON ABBREVIATIONS
Organics	
Polychlorinated biphenyls	PCBs
Hexachlorobenzene	HCB
Octachlorostyrene	OCS
Polycyclic aromatic hydrocarbons	PAHs
Oil and Grease	
Phenols (total phenolics)	
Chlorinated phenols	
Metals	
Cadmium	Cd
Lead	Pb
Zinc	Zn
Mercury	Hg
Copper	Cu
Nickel	Ni
Cobalt	Co
Iron	Fe
Chromium	Cr
Conventional/Other	
Phosphorus	P
Ammonia	NH3
Chlorides	Cl
Total residual chlorine	TRC
Cyanide	CN

Several analytical difficulties were encountered. One of the main concerns is the detection level difference among laboratories. This is important since loading data were a major focus in determining the mass balance of selected chemical contaminants into and out of the Detroit River system. If the laboratory reported the contaminant concentration as below their level of detection, no loading could be calculated. The same effluent taken to another laboratory with more sensitive detection limits might yield a contaminant concentration from which a loading could be calculated. These differences in detection limits hindered the loading/mass balance effort. Michigan laboratories generally had lower detection limits than Ontario, allowing loads to be calculated from Michigan facilities with no corresponding loads from Ontario facilities for some parameters (e.g., PCBs, OCS and HCB) (Table 8-2). Limited laboratory capabilities prevented all samples going to one laboratory. At present, it is likely that additional efforts would be hindered in a similar manner.

The study was successful in evaluating the Detroit River and the Trenton Channel as sinks for selected contaminants or sources of contaminants to downstream waters. During the study, tributaries, CSO's, point source discharges and the river itself were monitored for selected contaminants to determine loadings and changes in contaminant concentrations occuring in the system.

The Detroit River System Mass Balance studies were cooperatively conducted by U.S. and Canadian agencies between April 21 and 29, 1986, and July 25 and August 5, 1986, respectively (U.S. EPA, 1987). The Trenton Channel Mass Balance studies were conducted between May 6 and 7, 1986, and August 26 and 27, 1986 (U.S. EPA, 1987a). Sampling transects for the Detroit River System Mass Balance and for the Trenton Channel Mass Balance are shown in Figure 8-1.

Tributaries monitored during UGLCCS included the Rouge and Ecorse Rivers in Michigan, and the Little and Canard Rivers and Turkey Creek along the Ontario Shore. CSOs plus stormwater were monitored during UGLCCS in Windsor. No new CSO or stormwater data were available from Detroit, so older (1979) data were used in the mass balance effort.

The Michigan Department of Natural Resources (MDNR), Ontario Ministry of the Environment (OMOE), U.S. Environmental Protection Agency (EPA) and Environment Canada collectively monitored flow and effluent quality of major direct and indirect point source dischargers to the Detroit River. Direct sources were those discharging directly to the Detroit River and indirect sources were those discharging to the Detroit River via tributaries or drains.

Nine municipal treatment plants and 20 industrial facilities were sampled over a 24 hour period (Michigan sources) or 3 to 6 days (Ontario sources) during 1985 and 1986. Composite samples were analyzed for conventional pollutants, metals and trace organics, including the list of contaminants chosen for the UGLCC Study, (Table 8-1).

Table 8-2. Difference in laboratory method detection level (MDL) between Michigan and Ontario during the Upper Great Lakes Connecting Channels Study, 1985-1988.

Parameter	Michigan MDL (ug/l)	Ontario MDL (ug/l)	Factor Difference
Total PCBs	0.0001	0.1	1,000
HCB	0.00001	0.02	2,000
OCS	0.000001	0.02	20,000
Total Phenols	10	1	0.1
Oil and Grease	2,000	100	0.05
Total Cadmium	0.2	5	25
Total Mercury	0.0001	0.025	250
Total Cobalt	0.0001	5	5,000
Phosphorus	10	100	10
Ammonia	10	100	10
TOC	10	100	10
TDS	20,000	500	0.025

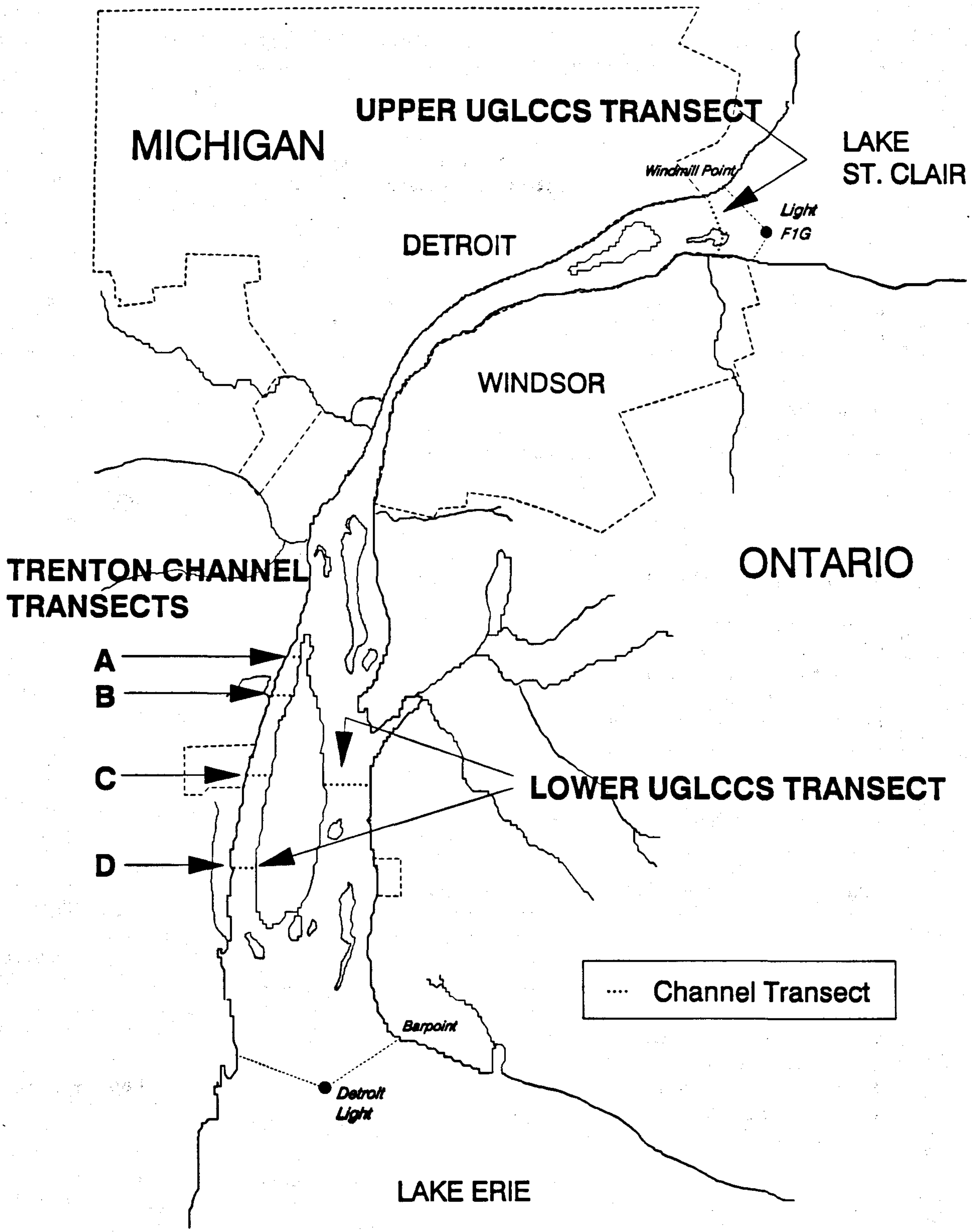


Figure 8-1. Sampling transects for the Detroit River and Trenton Channel mass balance surveys, 1986.

The conclusions that can be drawn from UGLCCS are limited by a small data base, differences in survey timing, differences in sampling and analytical methods and differences in analytical detection levels. The Michigan surveys were performed in May, and July through September, 1986, while the Ontario data were collected between October and December, 1985. Michigan composited four grab samples (1 every 6 hours), while Ontario samples were collected by automatic composite samplers (1 portion every 15 minutes).

8.1.3 Post UGLCCS Data Sources for Michigan

Additional Michigan point source data were potentially available from five other sources: 1) Discharge Monitoring Reports (DMRs) submitted by the facilities as required by NPDES permits; 2) Compliance Evaluation Inspections (CEIs or point source studies) performed by the MDNR; 3) short term waste characterization studies performed on the effluent by the permitted dischargers as part of their permit compliance; 4) NPDES permit applications which characterize the effluent to be permitted.

Discharge monitoring reports show the results of compliance monitoring required by the NPDES permit. The DMRs were used primarily to update conventional pollutant loadings. DMR data used in this report included the years 1987 through 1990.

Compliance Survey Inspections (CSIs) are performed periodically by the MDNR to determine if the facilities are in complaince with their NPDES permits. These inspections include analyses of many additional parameters not reported on their DMRs. All facilities are inspected in a uniform manner and generally the same (MDNR) laboratory is used. However, as part of the UGLCCS data gathering effort, the EPA Large Lakes Research Station (LLRS) conducted the analysis for some parameters (e.g. total PCBs, hexachlorobenzene, octachlorostyrene and mercury). The LLRS has a research grade laboratory with considerably lower levels of detection available.

Additional sources of data are the short and long term waste characterizations required in some Detroit River industrial and municipal NPDES permits. These data are generally 24 hour composite effluent samples taken over a period of four to six weeks during normal facility operations. These studies were required when existing data were insufficient to characterize a facility's effluent. Short term waste characterizations were performed primarily for metals. Long-term self monitoring was required under the terms of their NPDES permit at the Detroit WWTP. Monitoring was conducted 4 times a month for 21 metals, 20 organic contaminants and 3 PCB Aroclors.

In addition, applicants for NPDES permits are required to perform various chemical analyses as part of their permit application. The type of analyses is determined by the industrial or municipal category in which the facility is placed. The most recent permit application data were used in describing the contents of each major discharge in section 8.2.1.

There are no post UGLCCS nonpoint source data for Michigan.

8.1.4 Post UGLCCS Data Sources for Ontario

The Ontario point source data used in this report were obtained from one of the following sources: 1) Ontario Ministry of the Environment Report on Industrial Direct and Sewage Treatment Plant Discharges, 2) Certificates of Approval, 3) Municipal/Industrial Strategy for Abatement (MISA) Monitoring Studies and Regulations.

The Ontario Ministry of the Environment Reports on Discharges are annual updates of the status of all industrial direct discharges and municipal sewage treatment plants in Ontario. These reports contain self-monitoring data for conventional pollutants and trace contaminants measured during 1988.

Certificates of Approval (C of A) are legal documents issued by the Ontario Ministry of the Environment which stipulate legally enforceable effluent requirements.

Four Detroit River dischargers were required under the MISA program to monitor their final effluents. A five day premonitoring Pilot Study occurred during 1987 at 37 Municipal Water Pollution Control Plants throughout Ontario. Results of this study are reported in Section 8.2.

The MISA Effluent Monitoring Regulations have been developed for the Inorganic Chemical and Metal Casting Sectors contain the regulations for monitoring two of seven designated industrial sectors. This program is currently under development. Effluent limit regulations based on best available technology economically achievable for each industrial sector and the municipal sector (BATEA) will follow monitoring regulation period. The MISA program is detailed more thoroughly in Chapter 4 of the RAP.

8.2 POINT SOURCE DISCHARGES

8.2.1 Summary of Michigan Point Source Discharges

All permitted dischargers to the surface waters of the State of Michigan are required to have an NPDES permit to ensure that Michigan's Water Quality Standards are met in the receiving waters. Rule 57 of the standards establishes maximum allowable levels of toxic substances. Maximum allowable levels are set to protect designated uses including aquatic life, terrestrial life and human health from toxic substances. An application characterizing the effluent must be submitted to the Surface Water Quality Division. This triggers a review of the facility, processes used, and materials which may be in the effluent. The NPDES permit requirements may include 1) limits for specific parameters that are presently in the discharge which have a reasonable potential of being acutely toxic at the point of discharge or exceeding Michigan's Water Quality Standards after mixing with the receiving stream, 2) whole effluent toxicity limits, 3) monitoring of parameters limited in the permit to evaluate compliance, 4) monitoring (biological or chemical) for a specific period of time to further characterize the effluent, 5) special conditions such as minimization plans for highly bioaccumulative materials or biouptake studies and 6) limits for other parameters as needed to assure that WQS are met (e.g. phosphorus). In addition to these water quality based effluent limits, treatment technology standards for each industrial catagory must be met. A more complete description of this process is found in Chapter IV.

All of the NPDES permits issued to facilities discussed in Chapter 8 contain effluent limits, monitoring requirements and other special conditions. Each permit states that effluent discharges shall not physically or chemically alter instream characteristics. Should degradation occur, immediate steps to remedy the noncompliance shall be taken by the permittee and the permittee must notify MDNR. Any changes in facility operations or sewerage system users that result in increased levels of any chemical must be reported to MDNR. Also, these NPDES permits do not authorize discharges of any type to the groundwater.

A summary of direct and indirect discharges and the permit requirements are shown in Tables 8-3 and 8-4. Figure 8-2 shows the location of each Michigan discharger by watershed including the Rouge River, Ecorse Creek, Frank and Poet Drain and Monguagon Creek, Brownstown and Marsh Creeks as well as those discharging directly to the Detroit River. Although the Rouge River is within the SAOC it is also an area of concern and has its own RAP. As discussed in Chapter 5, Description of the Area, the Rouge River and its watershed will be considered a point source for purposes of this RAP.

The following section details the major municipal and industrial facilities discharging directly or indirectly to the Detroit River from the Michigan SAOC. These facilities were identified in UGLCCS as the major Michigan dischargers to the Detroit River. For each point source, a description of their surface water discharge is given with information regarding NPDES permit monitoring requirements and effluent limitations.

8.2.1.1 Summary of the Effluent Quality at Michigan Facilities

The results of monthly self-monitoring, waste characterization studies and Compliance Survey Inspections are used to assess each facilities compliance with its NPDES permit and to set additional permit limits and monitoring requirements. The results of the heavy metals and cyanide analyses are presented in Table 8-5 and the results of the organic analysis are presented in Table 8-6. The results of these analyses are discussed for each facility in the appropriate Sections (see Sections 8.2.1.2 to 8.2.1.17).

Chemical concentrations in the final effluent were evaluated by MDNR staff and were generally either below levels of detection or below levels of concern. However, some discharges of total PCBs and mercury, detected in effluent collected in 1986, were of concern. In most cases additional PCB and mercury monitoring or permit limits were required. In the case of National Steel-80" Mill, McLouth Steel-Gibraltar and BASF-Wyandotte, MDNR staff determined that the most likely source of total PCBs or mercury was ambient Detroit River water used by the facility for noncontact cooling water. Total PCB concentrations in the Trenton

Table 8-3. Michigan facilities with NPDES permits directly discharging to the Detroit River, their type of operation and the parameters requiring effluent limits, monitoring or observation.*

Facility Name	Operation Type	Parameters Requiring Effluent Limits, Monitoring or Observation	Special Effluent Characterizations
BASF Corporation	chemical production	flow, TSS, TOC, alkalinity, ammonia-N, temperature, 1,2-dichloroethane, 1,2-dichloropropane, bis (2-chloroisopropyl) ether, toluene, BOD_5, pH, total organics**	short term waste characterization for organics & metals
Chrysler-Trenton Engine	auto engine manufacture	flow, pH	
Detroit Edison Connors Creek	electric generating plant	flow, TSS, oil & grease, temperature, Total Reactive Chlorine (TRC), total iron, total copper	
Detroit Edison River Rouge	electric generating plant	flow, TSS, oil & grease, temperature, TRC	
Detroit Edison Trenton Channel	electric generating plant	flow, TSS, oil & grease, temperature, TRC, total iron, total copper	
Detroit Mistersky	electric generating plant	flow, TSS, temperature, TRC, oil & grease, pH, total phosphorus, total iron, total copper	
Detroit WWTP	municipal/industrial wastewater	Conventionals flow, BOD_5, TSS, pH, FC, DO, oil & grease, total phosphorus, temperature, TRC, NH_3 Regular Heavy Metals total cadmium, total chromium, hexavalent chromium, total copper, total iron, total lead, total nickel, total mercury and total zinc	follow-up aquatic life effluent toxicity studies

Table 8-3. (continued)

Facility Name	Operation Type	Parameters Requiring Effluent Limits Monitoring or Observation	Special Effluent Characterizations
		Special Metals total aluminum, total antimony, total arsenic, total barium, total cobalt, total magnesium, total manganese, total selenium, total silver, total sodium, and total tin	
		Organics chloroform, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethylene, dichloromethane, chlorodibromomethane, 1,2-dichloroethane, 1,1,2,2-tetrachloroethane, tetrachloroethylene, benzene, ethyl benzene, toluene, hexachlorobenzene, hexachlorobutadiene, Di-n-butyl phthalate, Bis(2-ethylhexyl)phthalate, Di-n-octyl phthalate, pentachlorophenol, aniline, total xylenes, aroclor 1242 (PCB), aroclor 1254 (PCB), and aroclor 1260 (PCB)	
Federal Marine Terminal, Inc.	landfill	flow, TSS, oil & grease, NH_3, total cyanide, phenols, total mercury, PCBs, pH	
Grosse Ile Twp WWTP	municipal/industrial wastewater	flow, $CBOD_5$, TSS pH, FC, DO, TRC total phosphorus, ammonia-N, PCB, cadmium, chromium, silver, lead, nickel, zinc, copper, amenable cyanide	

Table 8-3. (continued)

Facility Name	Operation Type	Parameters Requiring Effluent Limits Monitoring or Observation	Special Effluent Characterizations
McLouth Steel-Trenton	steel & pig iron production	flow, pH, TSS, oil & grease, temperature, free cyanide, total phenol, filterable iron	short term waste characterization for metals and PNAs
Michigan Foundation	limestone quarry	flow, TSS, H_2S, pH	
Monsanto Chemical Co.	food-grade specification products manufacture	flow, TSS, phosphorus, arsenic, ammonia-N, temperature, unionized ammonia	short term waste characterization for metals
National Steel Corp. Great Lakes Division Ecorse Plant	steel mfg & processing	flow, TSS, oil & grease, temperature pH, dissolved iron	short term waste characterization for metals follow-up aquatic life effluent toxicity tests
National Steel Corp. Great Lakes Division 80" Mill	steel mfg & processing	flow, TSS, oil & grease, pH	short term waste characterization for metals
National Steel Corp. Great Lakes Division Zug Island Plant	pig iron, coke and coke by-products production	flow, pH, oil & grease, ammonia-N, amenable cyanide, total cyanide, total phenols, total lead, total zinc, TRC, TSS	short term waste characterization for metals
Pennwalt	chemical production	flow, TSS, BOD_5, total zinc, TRC, total phenols, chloride, ammonia-N, pH, temperature, DO	short term waste characterization for metals & organics

Table 8-3. (continued)

Facility Name	Operation Type	Parameters Requiring Effluent Limits Monitoring or Observation	Special Effluent Characterizations
PVS Chemicals, Inc. (Michigan)	chemical production	flow, temperature, pH	short term waste characterization for metals follow-up aquatic life effluent toxicity studies
Renaissance Center	hotel/shops/offices	flow, temperature, pH	
Trenton WWTP	municipal/industrial wastewater	flow, $CBOD_5$, TSS, pH, FC, DO, TRC, total phosphorus, ammonia-N, cadmium, chromium, copper, cyanide, lead, nickel, silver, zinc, PCBs, hexachlorobenzene,	short term waste characterization for metals
Wayne County - Huron Valley WWTP	municipal/industrial wastewater	flow, BOD_5, TSS, total phosphorus, FC, TRC, pH, DO	short term waste characterization for metals
Wayne County-Wyandotte WWTP	municipal/industrial wastewater	flow, BOD_5, TSS, pH, FC, DO, TRC, total phosphorus, ammonia-N, phenol, oil & grease, methylene chloride	short term waste characterization for metals
Mobil Oil	oil terminal	flow, temperature, oil & grease, pH	
Wyandotte Electric Plant	electric generating plant	flow, temperature, TRC	
Wyandotte Water Filtration Plant	water filtration	flow, TSS, pH	

* All facilities monitor flow and observe outfall.
** Total Organics includes more than 50 organic compounds listed in the NPDES permit (Appendix 8-1).

Table 8-4. Michigan facilities with NPDES permits discharging via tributaries (except Rouge River) to the Detroit River, their types of operation, and the parameters requiring effluent limits, monitoring or observation.*

Ecorse Creek Facility Name	Operation Type	Parameters Requiring Effluent Limits Monitoring or Observation*
Amoco Oil Co	oil terminal	flow, oil & grease
Ashland Petroleum	oil terminal	flow, oil & grease
B.P. Oil Company	oil terminal	flow, oil & grease, pH
Detroit Metro Airport	air terminal	flow, BOD_5, CBOD, NH_3, total phosphorus, oil & grease, DO pH
National Steel Corp. Great Lakes Division Michigan Plant	steel processor	flow TSS, oil & grease, pH
Southwest Water Treatment Plant	water filtration plant	flow, TSS, pH
Union Oil Company	oil terminal	flow, oil & grease, pH
Frank & Poet Drain Facility Name		
Detroit Metro Airport	air terminal	flow, $CBOD_5$, NH_3, total phosphorus, oil & grease, DO, pH
McLouth Steel, Gibralter	steel processor	flow, TSS, oil & grease, total iron, $CBOD_5$, NH_3, DO, pH, total lead, total zinc, total iron, temperature
Brownstown/Marsh Creek Facility Name		
Ford Woodhaven	auto parts manufacturer	flow, TSS, total chromium, pH
Lang Feed	grain elevator	flow, oil & grease

*All facilities monitor flow and observe outfalls.

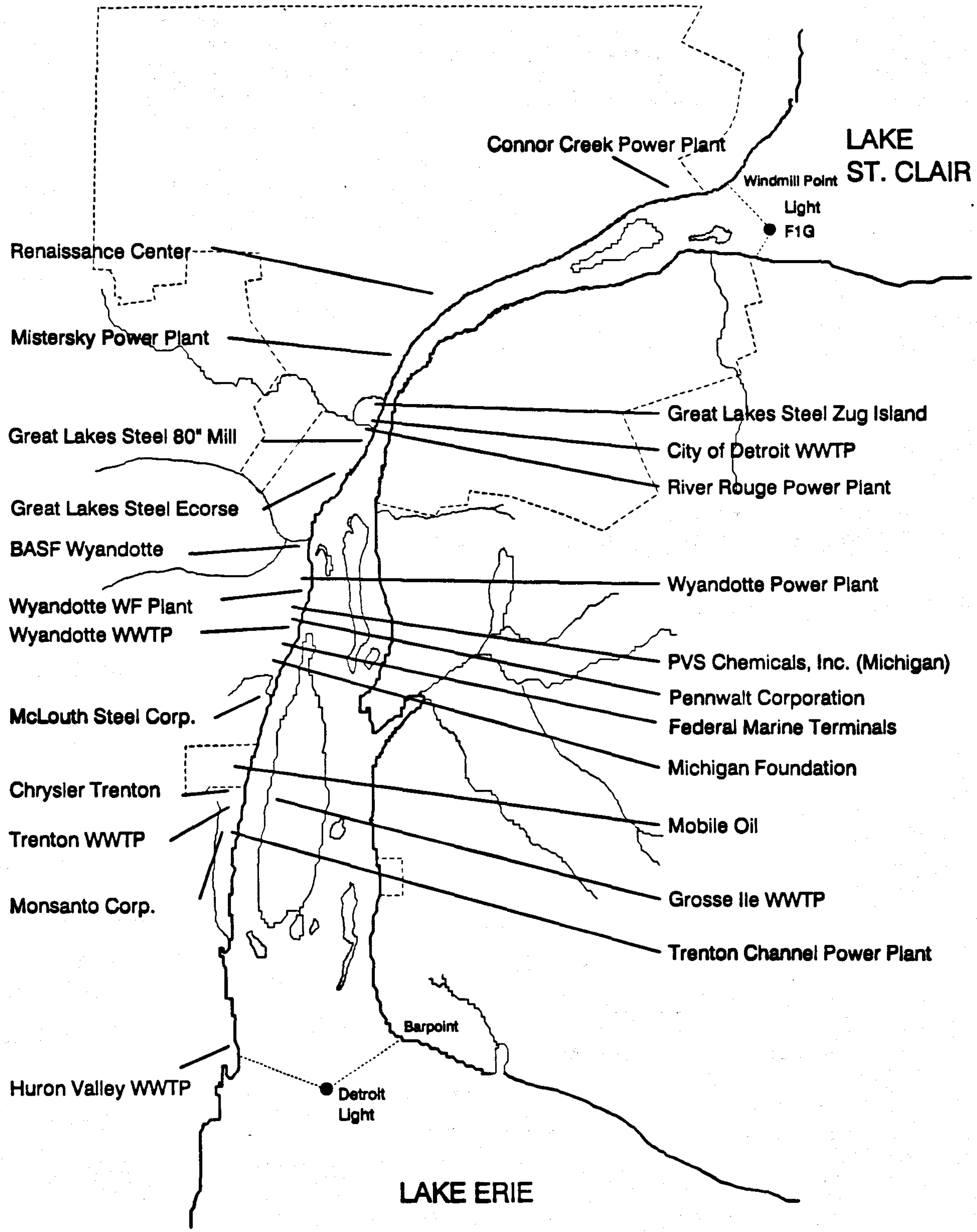


Figure 8-2. Location of Michigan point source discharges to the surface water in the Michigan Detroit River Source Area of Concern (Direct dischargers, 1990).

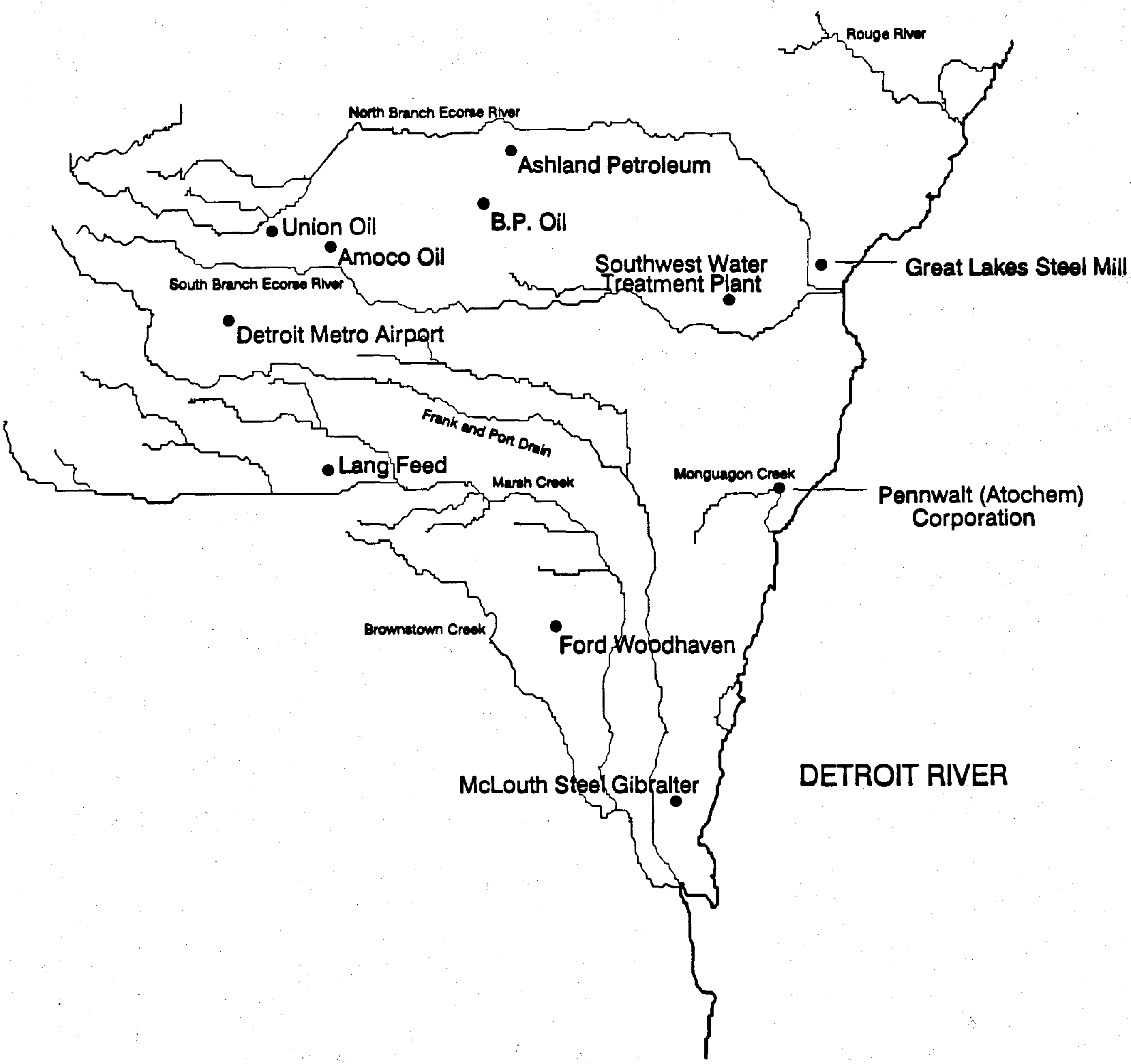


Figure 8-2. (Continued) Indirect dischargers, 1990.

Table 8-5. Concentrations of heavy metals and cyanide in the effluent from Michigan facilities. Results in ug/l.

Facility	Outfall Number	Design Flow (MGD)	Total Cadmium	Hexavalent Chromium	Total Chromium	Total Copper	Total Cyanide	Total Lead	Total Mercury	Total Nickel	Total Zinc	Total Silver
Major Michigan Sources												
Detroit WWTP	049	920	1.5	<5	3.6	7.3	9	1.1	0.0294*	62	35.8	<0.5
Wayne Co. Wyandotte WWTP	001	150	22.8	NA	4.9	18.4	21	11.9	0.05*	11.2*	120	<0.5
Trenton WWTP	001	6.5	0.05	<5	6.7	3.7	9	2.3	0.129*	5.5	26	<0.5
Grosse Ile WWTP	001	2.25	0.073*	<5	6.2	10	<5	1.1	<0.0275*	3.2*	9	<0.5
Wayne County Huron Valley WWTP	001	12	0.3	<5	<3	11.4	<5	2.3	<0.5	6.2	32	NA
McLouth Steel Trenton	001B	16	0.7	NA	7.3	4.9	170	31.8	0.0125*	4.3	9.3*	NA
	002	57	0.7	NA	<3	6.3	<5	2.3	0.0271*	1.83*	27*	NA
	004	48	0.5	NA	<3	3.9	NA	<1	0.0248*	2.96*	524*	NA
McLouth Steel Gibraltar	001A	2	0.17*	<5	<3	4.2	<5	4.8	0.0113*	2.8*	16.6	<0.5
	001	10	0.18*	<5	<3	17.1*	<5	0.34*	0.0075*	7.7*	7.3	<3
National Steel 80" Mill	009	192	0.088*	<5	5.5*	3.7	<5	1.7	0.0115*	4.0*	14.8	<0.5
National Steel Ecorse	011	4.9**	<0.2	NA	8.3*	20.5	6	12	0.0063*	4.7	76.7	<5
	018	2.8**	0.088*	NA	9*	11.9	16	1.6	0.005*	8.0	534	<5
National Steel Zug Island	008A	4	1.7#	NA	<3#	3.5#	NA	76.6#	<0.5#	<4#	2870#	<0.5#
	008	52	0.7	8	5.3*	5.8	9	13.3	0.019*	2.9*	94.8	<0.5
Pennwalt	006	14.72	0.7	NA	3.51*	3.5	<2	9.6	0.34*	7.2	58	<0.5
PVS	003	3	1.1	NA	2.09*	10.4	<4	7.5	0.07*	11.1	13.2	<0.5
BASF Wyandotte	001	2.9**	0.2	<5	1.9*	2.8	6	0.73*	0.245*	4.1*	11.8	<0.5
	002	0.6**	0.4	<5	3.6*	11.9	18	1.38*	0.21*	5.4*	104	<0.5
Monsanto	001	16.1	0.4	NA	3.68*	1.7	<1	3.8	0.042*	3.0*	38	<0.5
Detroit Coke	001	4.6**	0.6	NA	3.5*	24	<5	19	0.0076*	1.9*	22.9*	NA

* 1986 point source survey. Sample analyzed by EPA-LLRS.
** Flow rate at the time the samples were collected.

# Concentration of one grab sample.
NA = Not Analyzed.

Table 8-6. Concentrations of organic parameters in the final effluent of major dichargers on the Michigan side of the AOC. Analysis was conducted on 24 hour composite and grab samples. All units are micrograms per liter. (See Appendix 8-2 for a list of parameters analyzed but not detected).

	Composite Samples		Grab Samples	
	Parameter	Concentration	Parameter	Concentration
Detroit WWTP (1989)	Bis (2-ethylhexyl) phthalate	9.7	Methylene chloride	14.5
outfall 049	Total PCBs	0.0951*	Trichloroethane	2.6
	Hexachlorobenzene	0.00049*	Chloroform	5.6
	Octachlorostyrene	0.0000134*	Tetrachloroethene	7.6
			Ethylbenzene	4.85
			Xylene isomers (o, m and p)	19
			1,1,1-Trichloroethane	2.95
Wayne County	Bis (2-ethylhexyl) phthalate	1.6	Methylene chloride	NQ**
Wyandotte WWTP (1986)	Total PCBs	0.0875*	Tetrachloroethene	3.1
outfall 001	Hexachlorobenzene	0.00097*	1,1,1-Trichloroethane	NQ
	Octachlorostyrene	0.000212*		
Trenton WWTP (1988)	g-BHC (lindane)	0.12		
outfall 001	1,2,3,4-Tetrachlorobenzene	0.011		
	Total PCBs	0.0124		
	Hexachlorobenzene	0.00034		
	Octachlorostyrene	0.00001		
Grosse Ile WWTP (1989)	Bis (2-ethylhexyl) phthalate	3.1		
outfall 001	Total PCBs	0.040*		
	Hexachlorobenzene	0.0013*		
Wayne County				
Huron Valley WWTP (1989)				
outfall 001	2,4-Dimethylphenol	NQ	Chloroform	5.45
			1,1,1-Trichloroethane	NQ
McLouth Steel (1989)				
Trenton				
intake	Bis (2-ethylhexyl) phthalate	4.6		
outfall 001B	Bis (2-ethylhexyl) phthalate	2.5	Bromoform	1.25
	Hexachlorobenzene	0.00095*		
outfall 002	Total PCBs	0.0634*		
	Hexachlorobenzene	0.0017*		
outfall 004	Total PCBs	0.2564*		
	Hexachlorobenzene	0.004*		
	Octachlorostyrene	0.000837*		
McLouth Steel (1986)				
Gibraltar				
outfall 001A	Hexachlorobenzene	0.00033*	Chloroform	NQ
	Total PCBs	0.0197*		
outfall 001	Hexachlorobenzene	0.0000057*		
	2,4-Dimethylphenol	NQ		
	Phenol	NQ		
National Steel (1986)				
80" Mill				
outfall 009	Total PCBs	0.0164*		
	Hexachlorobenzene	0.00026*		

* 1986 point source survey. Sample analyzed by EPA-LLRS.
**NQ Concentrations not quantified by Laboratory (see Appendix 8-2 for specific explanations).

Table 8-6. Continued.

	Composite Samples Parameter	Concentration	Grab Samples Parameter	Concentration
National Steel (1986) Ecorse				
outfall 011	Total PCBs	0.0455*	Carbon tetrachloride	NQ
	Hexachlorobenzene	0.001*		
	Octachlorostyrene	0.000055*		
outfall 018	Total PCBs	0.026*		
	Hexachlorobenzene	0.00041*		
	Octachlorostyrene	0.000127*		
National Steel (1986) Zug Island				
outfall 008	Total PCBs	0.0951*	Carbon tetrachloride	NQ
	Hexachlorobenzene	0.00042*	Methyl chloride	NQ
	Octachlorostyrene	0.00001*		
Pennwalt (1986)				
outfall 006	Total PCBs	0.0583*	Bromoform	NQ
	Hexachlorobenzene	0.0026*	Carbon tetrachloride	NQ
			Chloroform	NQ
PVS (1987)				
outfall 003	Total PCBs	0.0614*	1,1-Dichloroethane	1.5
	Hexachlorobenzene	0.021*	1,2-Dichlorobenzene	0.19
	Pentachlorobenzene	0.032	Hexachlorobutadiene	0.012
			4,4'-DDE	0.018
BASF Wyandotte (1986)				
outfall 001	Total PCBs	0.0536*	1,2-Dichloropropane	NQ
	Hexachlorobenzene	0.0034*	Toluene	34
	Diethylphthalate	3.5		
outfall 002	Total PCBs	0.0261*	1,2-Dichloropropane	280
	Hexachlorobenzene	0.00066*	Bis (2-chloro-isopropyl) ether	110
	Octochlorostyrene	0.000003*	Bis (2-chloroethyl) ether	2.8
	Diethylphthalate	3.9		
Monsanto (1986)				
outfall 001	Total PCBs	0.0711*	Trichloroethane	1.2
	Hexachlorobenzene	0.00016*		
	Bis (2-ethylhexyl) phthalate	5.0		
Detroit Coke (1988)				
outfall 001	Bis (2-ethylhexyl) phthalate	NQ		
	Total PCBs	0.0123		
	Hexachlorobenzene	0.00011		

* 1986 point source survey. Sample analyzed by EPA-LLRS.
**NQ Concentrations not quantified by Laboratory (see Appendix 8-2 for specific explanations).

Channel ranged from 1 ng/l to 385 ng/l (see Section 6.1.4.1) while ambient mercury concentrations in the Trenton Channel ranged from 0.024 ug/l to 0.449 ug/l (Section 6.1.3.1). Therefore, no additional total PCB limits or monitoring requirements were added to the permits of National Steel-80" or BASF-Wyandotte and no additional mercury limits or monitoring requirements were added to the McLouth Steel-Gibraltar permit.

Routine biomonitoring studies are conducted by MDNR and the results are used to develop any permit requirements for biomonitoring programs. Under Rule 82 of the WQS, facilities are not allowed to discharge effluent that would cause acute toxicity in the mixing zone while Rule 57 prevents facilities from discharging effluent that would be chronically toxic to organisms in the receiving water. Facilities discharging effluent that is acutely or chronically toxic, or is close to being toxic, are required (by NPDES permit) to develop biomonitoring programs. If the biomonitoring program documents exceedances of Rule 57 or Rule 82 then the facility is required to develop and implement a Toxicity Identification/Reduction Evaluation (TI/RE) plan.

The biomonitoring results are presented in Table 8-7. The results of each study are discussed in Sections 8.2.1.2 - 8.2.1.17. The effluent from all of the facilities met the requirements of Rule 82 or Rule 57 except for National Steel-Ecorse and PVS Chemicals, Inc. (Michigan). National Steel Ecorse was required to develop and implement a biomonitoring plan. The cause of the effluent toxicity at PVS Chemicals, Inc. (Michigan) was not determined and recent tests (November 1990) indicate that the effluent from PVS Chemicals, Inc. (Michigan) is meeting the requirements of Rule 82 and Rule 57.

Table 8-7. Results of biomonitoring at major Michigan Detroit River facilities.

Facility	Test Date	Outfall Tested	Test Organism	Test Type	Toxicity Results	Toxicity Units	Exceedence Rule 82 Requirements	Exceedence Rule 57 Requirements
Detroit WWTP	November 1987	(049B)	_D. magna_	A (2 tests)	No I	1.0 TU_A	No	No
			fathead minnow	A (flow through)	No M	1.0 TU_A	No	No
				C	MATC = 39E	2.56 TU_C	--	No
		(049)	_D. magna_	A	47I/100E	1.0 TU_A	No	No
Wyandotte WWTP	July 1989	(001)	_D. magna_	A	No I	1.0 TU_A	No	No
Trenton WWTP	March 1988	(001)	_D. magna_	A	No I	1.0 TU_A	No	No
Grosse Ile WWTP	March 1988	(001)	_D. magna_	A	No I	1.0 TU_A	No	No
Huron Valley WWTP	May 1990	(001)	_D. magna_	A (2 tests)	No I	1.0 TU_A	No	No
			fathead minnow	A (flow through)	No M	1.0 TU_A	No	No
McLouth Steel Trenton	March 1988	(001)	_D. magna_	A	No I	1.0 TU_A	No	No
McLouth Steel Gibralter	March 1988	(001)	_D. magna_	A	No I	1.0 TU_A	No	No
National Steel 80" Mill	March 1988	(009)	_D. magna_	A	25I/100E	1.0 TU_A	No	No
National Steel Ecorse	March 1988	(011)	_D. magna_	A	No I	1.0 TU_A	No	No
		(018)	_D. magna_	A	48 hr EC50 = 54E	1.85 TU_A	Yes	--
National Steel Zug	March 1988	(008)	_D. magna_	A	No I	1.0 TU_A	No	No
Pennwalt	November 1987	(006)	_D. magna_	A	No I	1.0 TU_A	No	No

Table 8-7. (continued)

Facility	Test Date	Outfall Tested	Test Organism	Test Type	Toxicity Results	Toxicity Units	Exceedence Rule 82 Requirements	Exceedence Rule 57 Requirements
PVS Chemical	November 1987	003	D. magna	A	48 hr EC50 = 71E	1.41 TU_A	Yes	--
			fathead minnow	A	No M	1.0 TU_A	No	No
	November 1990	003	D. magna	A	No I	1.0 TU_A	No	No
BASF Wyandotte	July 1988	001	D. magna	A	48 hr EC50 = 39E	2.56 TU_A	No	No
Monsanto	March, 1988	(001)	D. magna	A	No I	1.0 TU_A	No	No
			fathead minnow	A (flow through)	No M	1.0 TU_A	No	No

A = Acute
C = Chronic
MATC = Maximum Acceptable Toxicant Concentration. Obtained by calculating the geometric mean of the lower and upper chronic limits from a chronic test. A lower chronic limit is the highest tested concentration which did not cause the occurrence of a specific adverse effect. An upper chronic limit is the lowest tested convention which did cause the occurrence of a specific adverse effect and above which all tested concentrations caused such an occurrence.
EC50 = Effluent concentration at which 50% of the test organisms are immobilized.
TU_A = Acute toxic unit. Defined as the reciprocal of the test concentration that causes the acute effect by the end of the acute exposure period.
TU_c = Chronic toxic unit. Defined as the reciprocal of the effluents's MATC.
I = Immobilization (D. magna stop swimming)
M = Mortality
E = Percent Effluent (i.e. 100E = 100% effluent, 54E = 54% effluent).

8.2.1.2 The City of Detroit Wastewater Treatment Plant (MI0022802)

The facility is a publicly owned, secondary wastewater treatment plant with phosphorus removal. The plant treats wastewater from residential, commercial and industrial sources from the City of Detroit and 75 suburban communities. It serves a population of approximately 3.5 million and nearly 500 industries use this facility.

The average flow of treated wastewater from the plant is 700,000,000 gallons per day and the maximum wet weather flow is 1,200,000,000 gallons per day. Much of the sewer system is combined (carries sanitary and storm waters), and during wet weather the flow into the system exceeds the capacity of the plant and the sewers. To prevent flooding of residential basements or damage to the plant and sewer system, the diluted wastewater (sanitary sewage and stormwater) in excess of system capacity is bypassed untreated to the Rouge and Detroit Rivers through a number of combined sewer overflows. Approximately 98% of the system is combined and there are 78 known combined sewer outfalls. The location of each outfall is described in the NPDES permit (Appendix 8-1) and loads of pollutants from CSOs are discussed in Section 8.4.2.1.

The plant receives raw wastes from two influent sewer sources, the Oakwood Interceptor and the Jefferson Interceptor. The treatment process consists of: the addition of ferrous chloride in the influent wet well to aid phosphorus removal, rough screening by 8 mechanically cleaned bar racks, grit removal in 16 V-Bucket grit collectors, polymer addition, primary settling and oil skimming in 12 rectangular sedimentation tanks each having a capacity of 50,000,000 gallons per day and 4 circular sedimentation tanks each having a capacity of 150,000,000 gallons per day, aeration in 4 rectangular basins each with a capacity of 300,000,000 gallons per day (3 aeration systems are pure oxygen), polymer addition, secondary clarification in 25 clarifiers each having a diameter of 200 feet and finally, disinfection by 11 chlorinators. The waste solids are thickened in 12 gravity thickeners each having a diameter of 15 feet and mean depth of 20 feet, stored in 6 - 200,000 gallon tanks, filtered in 28 vacuum filter units and then incinerated in 14 multiple hearth incinerators. The incinerator ash is landfilled.

The plant has a split flow system which can provide full primary and secondary treatment for 805,000,000 gallons per day (Figure 8-3). The flows that received secondary treatment are monitored at sampling location 049B for compliance with effluent limits. Flows in excess of 805 MGD that reach the plant receive only primary treatment. This primary effluent enters a splitter chamber where flow in excess of the secondary capacity is diverted around the secondary plant. This diverted flow is monitored at location 049A for compliance with permit limitations. The diverted primary effluent and the secondary effluent are combined, chlorinated and monitored prior to discharge to the Detroit River via outfall 049.

When the combined flows to outfall 049 exceed the hydraulic capacity of the outfall structure, secondary effluent can be diverted to the Rouge River through an emergency outfall, 050. Effluent limitations for 050 are identical to those for 049 with the exception of Fecal coliform and total residual chlorine which only require monitoring.

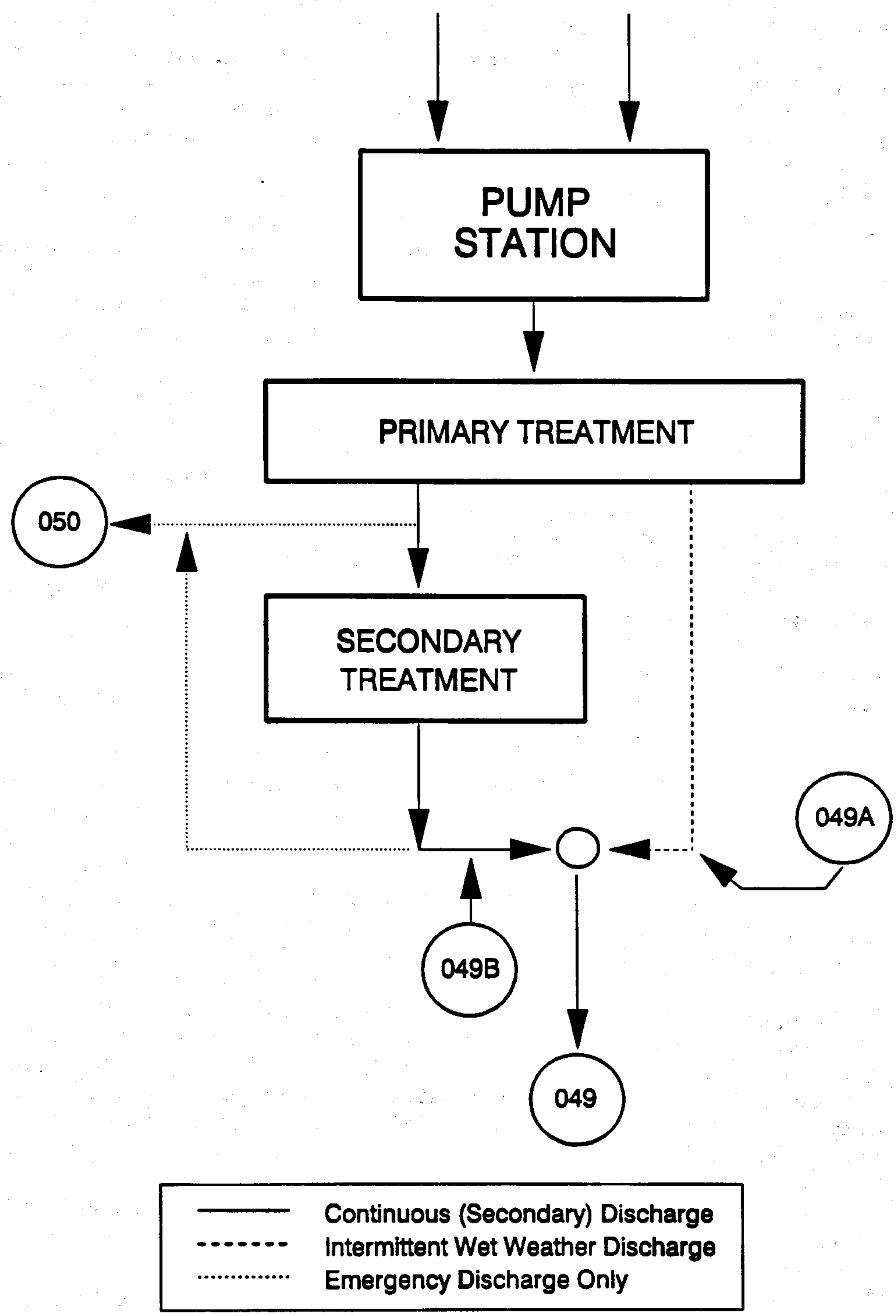


Figure 8-3. A schematic illustration of flow direction and outfalls from the Detroit Wastewater Treatment Plant.

On October 19, 1989, the Michigan Water Resources Commission reissued the NPDES Permit MI0022802 to the Detroit Water and Sewerage Department (DWSD). The permit included among other things, new final effluent limitations for toxics, secondary treatment for all dry and wet weather flows up to and including 920 MGD and a requirement for the DWSD to develop and implement a combined sewer overflow control program. On December 15, 1989, the DWSD filed a petition for a contested case hearing on the reissued permit and contested the new final 30 day average effluent limitations for PCBs, mercury and cadmium, the combined sewer overflow control program requirements, and the Industrial Waste Pretreatment program (described in the Detroit WWTP permit, Appendix 8-1). Several other parties also filed petitions for contested case hearing on various requirements specified in the reissued permit. They are the National Wildlife Federation/Michigan United Conservation Clubs, Greater Detroit Chamber of Commerce, Eugene Perrin/Rick Coronado and Great Lakes United. As a result of these petitions for contested case hearing, many of the new requirements in the reissued permit were stayed and the DWSD is currently operating under the previous permit which was issued on August 23, 1983, and the Final Order of Abatement which was entered on October 4, 1988. Also, following reissuance of the permit, the City of Detroit asked the U.S. District Court to take jurisdiction over the reissued NPDES permit. Legal and administrative action regarding this issue are proceeding.

Total PCBs and mercury effluent limitations were included in the October 19, 1989 permit. The effluent limits are water quality based. The permit would require development of a PCB and Mercury Minimization Program designed to reduce all sources of PCBs and mercury entering the sewer system. The plan would include a description of all potential sources of PCBs and mercury entering the sewer system, assessment of concentrations and mass loadings of PCBs and Mercury, and influent and sludge monitoring. The plan would also include a strategy to eliminate all detectable sources of PCBs and mercury entering the system and appropriate control measures to be implemented when detectable discharges are discovered.

The proposed permit also requires the City of Detroit WWTP to complete a plan for complying with effluent limitations for copper, lead and cadmium, which become effective on June 1, 1992. The plan shall be an overall attempt to find the constituent sources, monitor and reduce their output and upgrade pretreatment facilities to ensure an overall reduction copper, lead and cadmium in the sewage system and effluent.

The permit would also require that Detroit WWTP submit and implement a biomonitoring plan. The plan outlines four chronic toxicity tests to be conducted once every two months using the effluent from outfall 049. Test species include fathead minnows and *Daphnia magna* or *Ceriodaphnia*. If toxicity requirements for Rule 57 were not being met, then a toxicity control plan would be implemented within 90 days. If toxicity requirements of Rule 57 are close to being exceeded, the permittee would be required to conduct quarterly chronic toxicity tests for the life of the permit.

The final effluent from the City of Detroit WWTP is sampled periodically by the DNR during routine Compliance Survey Inspections (CSI). Samples are analyzed for a number of conventional pollutants, metals and organics.

The most recent CSI data available is from a study conducted on July 11 and 12, 1989. Twenty-four hour composite samples were analyzed for some metals and cyanide and the results are presented in Table 8-5. The total mercury concentration found during this CSI was below detection at 0.5 ug/l. Table 8-5 indicates the mercury concentration from a 1986 point source survey conducted by EPA's Large Lakes Research Station (LLRS) which used a lower level of detection. These results of the metals and cyanide analysis have been considered in the development of the Detroit WWTP permit limits. As previously noted, the October 19, 1989 permit would require the facility to develop and implement a mercury minimization plan. Also, the permit containts limits and monitoring requirements for several metals and cyanide (Table 8-8).

The twenty-four hour composite sample and a single grab sample were analyzed for a number of organic parameters as part of the 1989 CSI. All of the parameters analyzed in the composite samples were below the level of detection except for Bis (2-ethylhexyl) phthalate (found at 9.7 ug/l) (Table 8-6). However, total PCBs, HCB, and OCS were analyzed by EPA-LLRS in 1986, using lower detection levels, and the concentrations detected were 95.1 ng/l and 0.49 ng/l, and 0.0134 ng/l respectively. Also, all of the parameters analyzed in the 1989 CSI grab sample were below levels of detection except for methylene chloride (14.5 ug/l), trichloroethene (2.6 ug/l), chloroform (5.6 ug/l), tetrachoroethene (7.6 ug/l), ethylbenzene (4.85 ug/l) and xylene isomers (ortho, meta, and para) (19 ug/l). A brief description of sampling methods and a list of parameters analyzed are presented in Appendix 8-2. As previously noted, the permit would require the facility to develop and implement a PCB minimization plan. The contested permit also contains monitoring requirements for several organic parameters (Table 8-8).

The most recent biomonitoring test conducted at Detroit WWTP was performed in November, 1987. The bioassay tests were conducted using Daphnia magna and fathead minnows (Table 8-7). Secondary effluent, collected at outfall 049B, was not acutely toxic to D. magna during the two 48-hour static toxicity tests or to fathead minnows during a 96-hour flow through toxicity test. However, secondary effluent was chronically toxic to fathead minnow larvae during the 7-day larval survival and growth test. The calculated maximum allowable toxicant concentration (MATC) value, based on growth, was 39% effluent corresponding to 2.56 chronic toxic units. Rule 82 was not violated because the permit allows 12.4 chronic toxic units.

The final effluent, sampled at outfall 049 and dechlorinated with sodium thiosulfate, was acutely toxic to D. magna (47% immobilization in 100% effluent) but was less than 1 acute toxic unit (Dimond 1988). The effluent did not exceed Rule 82 requirements but additional testing was recommended in the permit.

The Discharge Monitoring Reports (DMRs) for October, 1987 through December, 1990 indicate one exceedance of oil and grease effluent requirements and one exceedance of total phosphorus effluent requirements in 1990.

Table 8-8. NPDES permit discharge limits and monitoring requirements for the City of Detroit Wastewater Treatment Plant (MI0022802). The permit was issued October 19, 1989 and contested.

		Discharge Limitations			
Effluent Characteristic	Dates In Effect	Daily Minimum	Daily Maximum	30-Day Average	7-Day Average
OUTFALL 049A, Primary effluent conduit, for all flows discharged to Outfall 049A:					
Flow (in MGD)	All Year	--	Monitoring Only		--
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	All Year	--	--	100 mg/l	--
Total Suspended Solids	All Year	--	--	100 mg/l	--
Total Phosphorus (as P)	All Year	--	--	2.5 mg/l	--
Ammonia Nitrogen (as N)(mg/l)	All Year	--	Monitoring Only		--
OUTFALL 049B, The combined secondary effluent conduit, for all dry weather flows and all wet weather flows up to and including 805 MGD as a daily average and effective February 1, 1992, 920 MGD as a daily average:					
Flow (in MGD)	All Year	--	Monitoring Only		--
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	All Year	--	--	25 mg/l 168,000 lb/d	40 mg/l 269,000 lb/d
	All Year beginning 2/1/92	--	--	25 mg/l 192,000 lb/d	40 mg/l 307,000 lb/d
Total Suspended Solids	All Year	--	--	30 mg/l 210,000 lb/d	45 mg/l 302,000 lb/d
	All Year beginning 2/1/92	--	--	30 mg/l 230,000 lb/d	45 mg/l 345,000 lb/d
Total Phosphorus (as P)	All Year	--	--	1.0 mg/l	--
Ammonia Nitrogen (as N)	All Year	--	Monitoring Only		--

Table 8-8. (continued)

Effluent Characteristic	Dates In Effect	Discharge Limitations Daily Minimum	Daily Maximum	30-Day Average	7-Day Average
OUTFALL 049, Effluent conduit for all flows:					
Flow (in MGD)	All Year	--	Monitoring	Only	--
Dissolved Oxygen	All Year	--	Monitoring	Only	--
Fecal Coliform Bacteria	All Year	--	--	200/100ml	400/100ml
Oil & Grease	All Year	--	--	--	15 mg/l
Total Residual Chlorine	All Year	--	Monitoring	Daily	--
	All Year beginning 12/1/92	--	0.11 mg/l	--	--
pH (standard units)	All Year	6.5	9.0	--	--
Cadmium	All Year	--	63 ug/l	25 ug/l	--
	All Year beginning 6/1/92	--	--	4.5 ug/l 35 lb/d	--
Copper	All Year	--	Monitoring	Weekly	--
	All Year beginning 6/1/92		72 ug/l		
Lead	All Year	--	Monitoring	Weekly	--
	All Year beginning 6/1/92	--	236 ug/l	36 ug/l 264 lb/d	--
Total PCBs	All Year	--	Monitoring	Weekly	--
	All Year beginning 6/1/92	--	0.00002 ug/l		--
Mercury	All Year	--	Monitoring	Weekly	--
	All Year beginning 6/1/92	--	0.0006 ug/l		--
1,1,2,2-Tetrachloroethane	All Year		4.5 ug/l		--
Nickel (ug/l)	All Year	--	Monitoring	Monthly	--
Zinc (ug/l)	All Year	--	Monitoring	Monthly	--

Table 8-8. (continued)

Effluent Characteristic	Dates In Effect	Discharge Limitations Daily Minimum	Daily Maximum	30-Day Average	7-Day Average
Silver (ug/l)	All Year	--	Monitoring	Monthly	--
Hexavalent Chromium (ug/l)	All Year	--	Monitoring	Monthly	--
Total Chromium (ug/l)	All Year	--	Monitoring	Monthly	--
Cobalt (ug/l	All Year	--	Monitoring	Monthly	--
Chlorides (mg/l)	All Year	--	Monitoring	Monthly	--
Iron (mg/l)	All Year	--	Monitoring	Monthly	--
Alkalinity (mg/l)	All Year	--	Monitoring	Monthly	--
Ammonia Nitrogen (as N)(mg/l)	All Year	--	Monitoring	Monthly	--
Cyanide Amenable (ug/l)	All Year	--	Monitoring	Monthly	--
Hexachlorobenzene (ug/l)	All Year	--	Monitoring	Monthly	--
Octachlorostyrene (ug/l)	All Year	--	Monitoring	Monthly	--
Phenolic Scan (ug/l)	All Year	--	Monitoring	Monthly	--
Purgeable Halocarbon Scan (ug/l)	All Year	--	Monitoring	Monthly	--
Purgeable Aromatic Scan (including xylene)(ug/l)	All Year	--	Monitoring	Monthly	--
Acrylonitrile (ug/l)	All Year	--	Monitoring	Quarterly	--
Styrene (ug/l)	All Year	--	Monitoring	Quarterly	--
Tris (2,3-dibromopropyl) phosphate (ug/l)	All Year	--	Monitoring	Quarterly	--

8.2.1.3 Wayne County Wyandotte Wastewater Treatment Plant (MI0021156)

The wastewater treatment plant serves a population of 500,000, has a design capacity of 150,000,000 gallons per day and an average flow of 60,000,000 gallons per day. This facility is a pure oxygen, activated sludge sewage treatment plant with phosphorus removal. Ferric chloride and an anionic polymer are used to improve phosphorus removal. The final effluent is chlorinated (May 15 - October 15) and discharged to the Trenton Channel of the Detroit River. There are four sewer system overflows in the Detroit River, two to Ecorse Creek and one to Zink Drain.

In 1985 a six week waste characterization study was conducted and the results were used along with self monitoring data, the application and compliance survey data to set permit limits and monitoring requirements for the current permit. The monitoring requirements and limits in the NPDES permit are presented in Table 8-9. Additional requirements are in the permit (Appendix 8-1).

The final effluent from the Wayne County Wyandotte WWTP outfall 001 was sampled on May 6, 1986 during a Compliance Survey Inspection. Twenty-four hour composite samples and grab samples were analysed, by MDNR and EPA-LLRS labs, for a number of different organics, conventional pollutants and heavy metals. The results of the inspection indicate that the final effluent was within NPDES permit limits. Analyses conducted and levels of detection are presented in the CSI (Appendix 8-2).

Some results of the metals and cyanide analysis are presented in Table 8-5. The twenty-four hour composite samples were also analyzed for a number of organic contaminants by MDNR labs. All parameters were below levels of detection except for Bis (2-ethylhexyl)-phthalate (1.6 ug/l) (Table 8-6).

In addition, a single grab sample was analyzed by the MDNR lab for organic contaminants. All parameters were below levels of detection except for tetrachloroethane, methylene chloride and 1,1,1, trichloroethane. Tetrachloroethene was detected at 3.1 ug/l but the other two compounds could not be quantified due to equipment or sample problems (Table 8-6).

As part of the same study, twenty-four hour composite samples were analyzed for total PCBs, hexachlorobenzene and octachlorostyrene by EPA-LLRS. The concentrations were 87.5 ng/l, 0.97 ng/l and 0.212 ng/l, respectively.

Except for total PCBs and mercury, all concentrations were below levels requiring permit limits based on environmental or public health concerns. A new permit has not been issued at this facility due to ongoing litigation with Wayne County. However, the next permit will require the facility to limit discharges of mercury and total PCBs.

The most recent biomonitoring tests at Wayne Co. Wyandotte WWTP were performed in July 1989 using Daphnia magna. A composite sample from the effluent collected prior to chlorination was not toxic to Daphnia magna in 48 hour static acute tests and the effluent met the requirements of Rule 82 and Rule 57 (Table 8-7) (Saalfeld 1989).

Table 8-9. Discharge limits and monitoring requirements (1990) for the Wayne County Wyandotte WWTP (MI0021156).

EFFLUENT CHARACTERISTICS	DATES IN EFFECT	LOAD LIMITATIONS		CONCENTRATION LIMITATIONS		MONITORING REQUIREMENTS
		30 Day Average	7 Day Average	30 Day Average	7 Day Average	Testing Frequency
5-Day 20°C Biochemical Oxygen Demand	All Year	37530 lb/day 17060 kg/day	56300 lb/day 25590 kg/day	30 mg/1	45 mg/1	7 x weekly
Suspended Solids	All Year	37530 lb/day 17060 kg/day	56300 lb/day 25590 kg/day	30 mg/1	45 mg/1	7 x weekly
Total Phos-phorus (as P)	All Year	---	---	1.0 mg/1	---	7 x weekly
Fecal Coliform Bacteria	May 15 to Oct. 15	---	---	200/100 ml	400/100 ml	7 x weekly
Ammonia Nitrogen (as N)	All Year	---	---	---	---	7 x weekly
Oil and Grease	All Year	---	---	10 mg/1 Daily Min.	--- Daily Max.	7 x weekly
Total Residual Chlorine	All Year beginning 7-1-88	---	---	---	0.5 mg/1	Daily during periods of disinfection
pH	All Year	---	---	6.0	9.0	7 x weekly
Dissolved Oxygen	All Year	---	---	4.0 mg/1	---	7 x weekly
Phenol	All Year	---	10 lb/day 4.5 kg/day	---	---	7 x weekly
Methylene Chloride	All Year	EPA Method 601		---	---	Quarterly

The Discharge Monitoring Reports for Wayne Co. Wyandotte WWTP (October, 1987, through December, 1990) indicate exceedances for the following parameters:

1987	1988	1989	1990
D.O. - 1	D.O. - 34	BOD_5 - 1	D.O. - 2
Phosphorus - 1	TSS - 5	TSS - 3	BOD_5 - 1
	Phosphorus - 5	Phosphorus - 2	BOD_5 (% removal) - 6
	Fecal Coliform - 2	Fecal Coliform - 2	TSS - 1
	BOD_5 - 1	TRC - 6	TSS (% removal) - 6
	TRC - 4		Ammonia - 3
			Phosphorus - 1
			TRC -

This facility exceeded its total suspended solids limits for five months in 1987. It also failed to commence its new construction as required by the NPDES permit resulting in a federal/state law suit filed in September 1988.

On March 18, 1987 MDNR, the Attorney General of Michigan, and the U.S. EPA filed suit against Wayne County in Federal District Court for these violations. In 1989 the complaint was amended to include each of the thirteen communities that contribute wastewater to the system. This was necessary to develop a regional solution to the problem. The judge has appointed a monitor to participate in the resolution of these issues.

As previously noted, the Wayne County Wyandotte permit has not reissued since it was due to expire on September 19, 1986 and the facility has been operating under the terms of the last permit. The next permit will require the County to develop a program to control sewer system overflows and revised the Industrial Pretreatment Program in addition to discharge limits on mercury and total PCBs.

8.2.1.4 City of Trenton Wastewater Treatment Plant (MI0021164)

The facility is a publicly owned, secondary wastewater treatment plant with phosphorus removal. The plant treats wastewater from residential, commercial and industrial sources and serves a population of approximately 23,000.

The average flow of treated wastewater is about 5,000,000 gallons per day and the design capacity is about 6,500,000 gallons per day. The wastewater passes through an aerated grit chamber, then undergoes primary sedimentation, aerations, secondary clarification and chlorination. Alum is added prior to clarification to aid phoshporus removal. Discharge is to the Trenton Channel of the Detroit River. There are currently two CSO outfalls in City of Trenton's sewer system discharging to the Trenton Channel.

The application, compliance survey data, waste characterization studies and monthly monitoring reports were used to set permit limits and monitoring requirements for the current permit (issued 3/31/89, expires 10/1/92). Some monitoring requirements and limits are presented in Table 8-10. In addition, the permittee is required to limit discharges of mercury, develop a plan to control CSO discharges, and implement the Industrial Pretreatment Program that was approved on September 27, 1985.

Table 8-10. Permit limits and monitoring requirements (1990) for Trenton WWTP (MI002164).

Effluent Characteristic	Dates In Effect	Discharge Limitations: Daily Minimum	Daily Maximum	30-Day Average	7-Day Average
Flow (in MGD)	All Year	--	--	--	--
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	All Year	--	--	25 mg/l 1355 lb/day	40 mg/l 2168 lb/day
Total Suspended Solids	All Year	--	--	30 mg/l 1630 lb/day	45 mg/l 2440 lb/day
Ammonia Nitrogen (as N)	All Year	--	monitoring	--	--
Total Phosphorus (as P)	All Year	--	--	1.0 mg/l	--
Dissolved Oxygen	All Year	3.0 mg/l	--	--	--
	All Year beginning 6/1/89	4.0 mg/l	--	--	--
Fecal Coliform Bacteria	5/1-10/31	--	--	200/100ml	400/100ml
	All Year beginning 1/1/91	--	--	200/100ml	400/100ml
	All Year during periods of chlorination	--	monitoring	--	--
Total Residual Chlorine	All Year beginning 1/1/91 during periods of chlorination	--	0.036 mg/l	--	--
pH (standard units)	All Year	6.5	9.0	--	--
Cadmium	All Year	--	monitoring	--	--
Total Chromium	All Year	--	monitoring	--	--
Hexavalent Chromium	All Year	--	monitoring	--	--

Table 8-10. (continued)

Effluent Characteristic	Discharge Limitations				
	Dates In Effect	Daily Minimum	Daily Maximum	30-Day Average	7-Day Average
Copper	All Year	--	monitoring	--	--
Amenable Cyanide	All Year	--	monitoring	--	--
Lead	All Year	--	monitoring	--	--
Nickel	All Year	--	monitoring	--	--
Silver	All Year	--	monitoring	--	--
Zinc	All Year	--	monitoring	--	--
PCB's	All Year	--	monitoring	--	--
Hexachlorobenzene	All Year	--	monitoring	--	--

The plan to limit discharges of mercury includes the following: A review of potential industrial or commercial sources of mercury, regular testing of WWTP influent, effluent and sludges to determine internal mass balances and removal rates, detection and removal of unknown mercury sources and investigation of suspect reaches of the collection system for possible contaminated sediments.

The permittee was required to develop an Interim Combined Sewer Overflow program to limit CSO discharges and insure that they only occur in response to wet weather events. The permittee was also required to develop a Final Combined Sewer Overflow Control Program which will result in the elimination or adequate treatment of combined sewage discharges to comply with the Water Quality Standards during times of discharge.

Also, the permittee was required implement an industrial waste control program. The program must assure that pollutant discharges from nondomestic sources to the WWTP are controlled to prevent operational problems at the plant and insure that the permittee meets effluent limits.

The City of Trenton WWTP permit contains more detailed information on programs and plans discussed above (Appendix 8-1). The permit also contains additional requirements and definitions.

The final effluent from the City of Trenton WWTP was monitored during a routine CSI conducted during a twenty-four hour period on November 1 and 2, 1988. A brief description of sampling methods and a list of parameters analyzed are presented in Appendix 8-2. The composite samples were analyzed for metals, cyanide, and organic contaminants (Tables 8-5 and 8-6). All organic parameters were below levels of detection except for g-BHC (lindane) at 0.12 ug/l and 1,2,3,4-tetrachlorobenzene at 0.11 ug/l. All metals, organics and conventional pollutants were below levels of detection or below levels of concern. However, the results of a 1986 Compliance Survey Inspection indicate that mercury and total PCBs were detected (by the EPA-LLRS lab) at levels of concern. As previously noted, the city was required to develop and implement a plan to limit discharges of mercury. Also the city is required by their permit to conduct PCB monitoring.

The most recent biomonitoring tests at this facility were conducted by MDNR in March of 1988 using *Daphnia magna*. A composite sample of the effluent was collected prior to chlorination was not toxic to *Daphnia magna* in 48 hour acute static tests (Table 8-7) (Hering and Saalfeld 1988a). The final effluent did not exceed Rule 82 or Rule 57 requirements.

The Discharge Monitoring Reports for the Trenton WWTP (October, 1987 through December, 1990) indicate exceedances for the following parameters:

1987	1988	1989	1990
D.O. - 3	D.O. - 3	TSS - 3	TSS (% removal) - 3
Phosphorus - 2	TSS - 2	Phosphorus - 2	TSS - 2
Fecal Coliform - 1	Phosphorus - 1	$CBOD_5$ - 2	$CBOD_5$ - 1
		TSS (% removal) - 2	

Past enforcement actions against this facility include a letter from EPA (under Section 308 of the CWA) (July 13, 1987) requesting information on the industrial pretreatment program. An Administration Order was issued November 11, 1988 and these issues have been reconciled. This facility was issued a Notice of Noncompliance in November of 1990 for failing to comply with NPDES permit requirements regarding construction of corrective facilities to prevent combined sewer discharges from two outfalls (003 and 006). The facility has presented a plan to prevent discharges from outfall 003 and a consultant is working to address discharges from outfall 006.

8.2.1.5. Grosse Ile Wastewater Treatment Plant (MI0026191)

The Grosse Ile Township Wastewater Treatment Plant is a rotating biological contactor (RBC) secondary treatment plant with phosphorus removal. The plant treats effluent from primarily residential sources and has an average flow and design capacity of 1,100,000 gallons per day and 2,250,000 gallons per day, respectively.

Waste treatment consists of large solids removal by a bar screen or comminator, primary settling, secondary treatment in two trains of rotating biological contactors (5 each), final clarification and chlorination. Ferric chloride and a polymer are used to aid in phosphorus removal. Treated wastewater is discharged to the Trenton Channel of the Detroit River. Grosse Ile Township's sewer system is separated and there are no CSO outfalls to the Trenton Channel.

Waste characterization studies, the application, compliance survey inspections and monthly operating reports were used to determine permit limits and monitoring requirements for the current permit (issued 10/20/88, expires 10/1/92). The monitoring requirements and limits are presented in Table 8-11. Additional permit requirements and definitions are presented in Appendix 8-1.

The final effluent from the Grosse Ile WWTP was monitored during a routine Compliance Survey Inspection conducted on March 7-8, 1989. All of the pollutant analyzed were either below levels of detection or below levels of concern.

Twenty-four hour composite samples were collected and results of the metals and cyanide analysis are presented in Table 8-5. Where metals concentrations were below the level of detection, Table 8-5 presents data from twenty-four hour composite samples collected in May, 1986 and analyzed by EPA-LLRS.

The twenty-four hour composite samples collected in 1989 were also analyzed for organic contaminants and all parameters were below levels of detection except for Bis (2-ethylhexyl) phthalate (3.1 ug/l) which was below levels of concern. Two grab samples were also collected on March 7-8, 1989 and analyzed for organic contaminants. All parameters were below levels of detection. A brief description of sampling methods and a list of parameters analyzed are presented in Appendix 8-2. All parameters analyzed for the 1989 Compliance Survey Inspection were either below detection or below levels of concern. However, total PCBs detected by EPA-LLRS in effluent collected during a 1986 CSI were at a level of concern and PCB monitoring requirements are included in the current permit.

Table 8-11. Discharge limits and monitoring requirements (1990) for Grosse Ile Township Wastewater Treatment Plant (MI0026191).

Effluent Characteristic	Dates In Effect	Discharge Limitations Daily Minimum	Daily Maximum	30-Day Average	7-day Average
Flow (in MGD)	All Year	--	--	--	--
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	All Year	--	--	25 mg/l 469 lb/day	40 mg/l 751 lb/day
Total Suspended Solids	All Year	--	--	30 mg/l 563 lb/day	45 mg/l 844 lb/day
Ammonia Nitrogen (as N)	All Year	Monitoring Only			
Total Phosphorus (as P)	All Year	--	--	1 mg/l --	--
Dissolved Oxygen	All Year	3 mg/l	--	--	--
Fecal Coliform Bacteria	5/1-10/31	--	--	200/100ml	400/100ml
Total Residual Chlorine	All Year		0.5 mg/l	--	--
Total Cadmium	All Year	Monitoring Only			
Hexavalent Chromium	All Year	Monitoring Only			
Total Chromium	All Year	Monitoring Only			
Total Silver	All Year	Monitoring Only			
Total Lead	All Year	Monitoring Only			
Total Nickel	All Year	Monitoring Only			
Total Zinc	All Year	Monitoring Only			
Total Copper	All Year	Monitoring Only			
Amenable Cyanide	All Year	Monitoring Only			
PCB's	All Year	Monitoring Only			
pH (standard units)	All Year	6.5	9.0	--	--

Routine biomonitoring tests were conducted at Grosse Ile WWTP on March 23-25, 1988. A composite sample of unchlorinated final effluent was not acutely toxic to *D. magna* in a 48-hour, static test (Table 8-7) (Hering and Saalfeld 1988b). Rule 82 and Rule 57 requirements were being met.

The Discharge Monitoring Reports for the Grosse Ile WWTP (for October 1987 through December, 1990) indicate exceedances for the following parameters:

1989	1990
TSS - 3	BOD_5 (% removal) - 2
Fecal Coliform - 3	TSS (% removal) - 2
TSS (% removal) - 2	

The above exceedances relate to infiltration/inflow problems. The facility was issued a Notice of Noncompliance in July of 1990 for exceedances of effluent requirements. The facility has submitted a report providing a specific schedule for the inspection and correction of inflow and infiltration problems.

8.2.1.6 Wayne County Huron Valley Wastewater Treatment Plant MI0043800

This facility is a publicly owned, secondary wastewater treatment plant and serves a population of 35,000. The plant has a design flow and average flow of 12,000,000 gallons per day and 5,500,000 gallons per day, respectively. Wastewater is discharged to the Detroit River through outfall 001.

Raw wastewater enters the plant pump station via an 84" diameter interceptor where it is screened prior to entering the wet well. It is then pumped up to and flows through the grit chambers, primary tanks, biological treatment tanks, final tanks and chlorine contact tanks.

This facility was completed in 1988 and replaced the Wayne County-Flat Rock and Wayne County-Trenton wastewater treatment plants as well as several wastewater treatment lagoons in small communities. The application and waste characterization studies of these two plants were used to develop permit limits and monitoring requirements for Wayne County Huron Valley WWTP (Table 8-12). The current permit was issued on August 17, 1989 and expires on October 1, 1993. All definitions and additional permit requirements are presented in Appendix 8-1.

The permittee is also required to develop and implement an Industrial Waste Control Program. The program was required to insure that pollutant discharges from nondomestic sources are controlled and do not cause operational problems at the treatment facility or cause the permittee to exceed effluent limitations.

The final effluent from the Wayne County Huron Valley WWTP was monitored during a routine Compliance Survey Inspection conducted on May 15 and 16, 1989. The effluent was analyzed for a number of pollutants including nutrients, metals and organic compounds. The pollutants were either below levels of detection or below levels of concern.

Table 8-12. Wayne County-Huron Valley WWTP effluent limits (1990) and monitoring requirements (MI0043800).

Effluent Characteristic	Dates In Effect	Discharge Limitations: Daily Minimum	Daily Maximum	30-Day Average	7-day Average
Flow (in MGD)	All Year	--	--	--	--
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	All Year	--	--	25 mg/l 2500 lb/day	40 mg/l 4000 lb/day
Total Suspended Solids	All Year	--	--	30 mg/l 3000 lb/day	45 mg/l 4500 lb/day
Ammonia Nitrogen (as N)	All Year	--	--	Monitoring only	--
Total Phosphorus (as P)	All Year	--	--	1.0 mg/l	--
Dissolved Oxygen	All Year	4.0 mg/l	--	--	--
Fecal Coliform Bacteria	All Year	--	--	200/100 ml	400/100 ml
Total Residual Chlorine	All Year All Year beginning 1/1/91	-- --	0.5 mg/l 0.036 mg/l	-- --	-- --
pH (standard units)	All Year	6.5	9.0	--	--
Total Lead	All Year	--	--	Monitoring only	--
Hexavalent Chromium	All Year	--	--	Monitoring only	--
Total Chromium	All Year	--	--	Monitoring only	--
Total Cadmium	All Year	--	--	Monitoring only	--
Total Zinc	All Year	--	--	Monitoring only	--
Total Copper	All Year	--	--	Monitoring only	--
Total Nickel	All Year	--	--	Monitoring only	--
Total Silver	All Year	--	--	Monitoring only	--
Total Mercury	All Year	--	--	Monitoring only	--
Amenable Cyanide	All Year	--	--	Monitoring only	--
Methylene Chloride	All Year	--	--	Monitoring only	--
PCB	All Year	--	--	Monitoring only	--

Some metals and cyanide concentrations in twenty-four hour composite samples are presented in Table 8-5. All of the organic compounds analyzed in twenty-four hour composite samples were below levels of detection except for 2,4-Dimethylphenol which was detected but not quantified due to sample interference. Chloroform was detected in three grab samples at an average and maximum of 5.45 ug/l and 5.7 ug/l, respectively (Table 8-6). All other organics were less than detection except for 1,1,1, trichloroethane which was detected but not quantified due to sample interference. A brief description of sampling methods and a list of parameters analyzed are presented in Appendix 8-2.

Routine biomonitoring tests were conducted at the WWTP on May 14-18, 1990. A fathead minnow 96-hour flow-through acute toxicity test and two D. magna 48-hour static acute toxicity tests were conducted on the final effluent. The effluent was not acutely toxic to fathead minnows or D. magna and the effluent did not exceed Rule 82 or Rule 57 requirements (Table 8-7) (Dimond 1990).

The Discharge Monitoring Reports for the Wayne County Huron Valley WWTP indicate exceedances of the following requirements (1988 to December 1990):

1988	1989	1990
D.O. - 2	pH - 2	$CBOD_5$ - 1
Phosphorus - 8	Phosphorus - 2	D.O. - 5
Fecal coliform - 4	BOD_5 (% removal) - 4	TRC - 3
BOD_5 (% removal) - 6	Chlorine - 7	Fecal coliform - 7
Chlorine - 6		
TSS (% removal) - 3		

Exceedances of effluent requirements in 1988 and 1989 were related to difficulties getting the biological treatment tanks running properly. The facility was required to use chemical treatment until the biological treatment tanks were running efficiently. The facility was issued a Notice of Noncompliance in November of 1990 for exceedances of fecal coliform effluent limits. The facility has submitted a plan to address exceedances of effluent limits and is presently working to implement the plan.

8.2.1.7 McLouth Steel Corporation Trenton Plant (MI0002399)

This facility is an integrated steel mill that produces both pig iron and steel. There are no coking facilities at the plant. The process and cooling water used at this facility is taken from the Detroit River and spot chlorinated (2 times daily for 15 minutes) for slime control. Noncontact cooling water used in the induction furnaces is demineralized for removal of scale forming deposits. Detroit's municipal water system furnishes domestic water. Sanitary wastewater is discharged to the City of Trenton's sewage system.

Process wastewaters and contact cooling waters are discharged to the company's wastewater treatment plant. Grit and oil removal is provided by the wastewater treatment plant and the pH of the effluent is adjusted by lime addition in a mixing chamber. The water flows into one of three clarifiers where a polymer and spent pickle liquor (ferrous chloride or ferric chloride) are added. All three clarifiers discharge to a closed drain that contains storm runoff and noncontact cooling waters from the hot rolling mill. The effluent is discharged into a pipeline carrying combined storm and noncontact cooling waters and the total flow is discharged to the Detroit River via outfall 001. Noncontact cooling water is discharged to the Detroit River through outfalls 002 and 004.

Waste characterization studies, the application, compliance survey inspections and monthly operating reports were used to determine permit limits and monitoring requirements. The monitoring requirements and limits for outfalls OBF, 01A, 001, 002 and 004 are presented in Table 8-13. This facility is presently operating under NPDES permit No. MI0002399, issued on September 20, 1990.

The most recent permit also requires the facility to develop and implement a biomonitoring plan. The plan shall include four acute toxicity tests on two test species using effluent from outfall 001. The toxicity tests shall be conducted once every two months using fathead minnows and D. magna. The results of these tests will be used to develop additional permit requirements (if necessary).

The final effluent from outfalls 001B, 002 and 004 was monitored on March 7 and 8, 1989 during a routine Compliance Survey Inspection. Twenty-four hour composite samples were collected and results of the metals and cyanide analysis are presented in Table 8-5. Concentrations of zinc and silver were not analyzed during the 1989 CSI so concentrations from the 1986 CSI were reported in Table 8-5. Also, mercury concentrations were below the level of detection in 1989 so concentrations from samples analyzed by EPA-LLRS in 1986 are reported in the table.

Twenty-four hour composite samples from outfalls 001B, 002 and 004 were also analyzed for organic contaminants. All concentrations were below levels of detection except for Bis (2-ethylhexyl) phthalate which was detected at 2.5 ug/l in effluent from outfall 001B and at 4.6 ug/l in a sample of intake water. All organic parameters were below levels of detection in grab samples from outfalls 001B, 002 and 004 except for bromoform (1.25 ug/l) in outfall 001B. A brief description of sampling methods and a list of parameters analyzed are presented in Appendix 8-2.

In addition, EPA-LLRS detected Hexachlorobenzene in outfalls 001B, 002 and 004 at concentrations of 0.95 ng/l, 1.7 ng.1 and 4.0 ng/l, respectively. Total PCBs were detected in outfalls 002 and 004 (noncontact cooling water) at concentrations of 63.4 ng/l and 256.4 ng/l.

All organics and metals analyzed by MDNR or EPA-LLRS were either below levels of detection or below levels of concern except for total PCBs and mercury. However, it is likely that the total PCBs in the noncontact cooling water being discharged through outfalls 002 and 004 are present in the intake. The facility is conducting intake and outfall monitoring to determine if ambient water is also the source of mercury.

Table 8-13. Discharge limits and monitoring requirements (1990) for McLouth Steel Corporation-Trenton Plant (MI0002399).

		Discharge Limitations				Monitoring Requirements	
		kg/day (lbs/day)		Other Limitations			
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
OBF (blast furnace blowdown)	Flow [MGD]		[0.7]			Daily	Report Total Daily Flow
	Ironmaking Production Level (tons/day)			(report)		Monthly	Calculation
FOR IRONMAKING MONTHLY AVERAGE PRODUCTION LESS THAN 3370 TONS PER DAY, THE FOLLOWING LIMITATIONS APPLY:							
	Total Cyanide	5.9	12			Daily	24-Hr Composite
	Total Residual Chlorine		0.98			Daily	Grab
FOR IRONMAKING MONTHLY AVERAGE PRODUCTION GREATER THAN OR EQUAL TO 3370 TONS PER DAY AND LESS THAN 4200 TONS PER DAY, THE FOLLOWING LIMITATIONS APPLY:							
	Total Cyanide	7.4	15			Daily	24-Hr Composite
	Total Residual Chlorine		1.2			Daily	Grab
FOR IRONMAKING MONTHLY AVERAGE PRODUCTION GREATER THAN OR EQUAL TO 4200 TONS PER DAY AND LESS THAN 5220 TONS PER DAY, THE FOLLOWING LIMITATIONS APPLY:							
	Total Cyanide	9.2	18			Daily	24-Hr Composite
	Total Residual Chlorine		1.5			Daily	Grab
FOR IRONMAKING MONTHLY AVERAGE PRODUCTION GREATER THAN OR EQUAL TO 5220 TONS PER DAY, THE FOLLOWING LIMITATIONS APPLY:							
	Total Cyanide	11	23			Daily	24-Hr Composite
	Total Residual Chlorine		1.9			Daily	Grab

Table 8-13. (continued)

		Discharge Limitations				Monitoring Requirements	
		kg/day (lbs/day)		Other Limitations			
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
01A (treated process wastewater)	Flow [MGD]		[17.3]			Daily	Report Total Daily Flow
PH ADJUSTED INFLUENT TO CENTRAL TREATMENT SYSTEM							
	Total Suspended Solids (mg/l)			(report)	(report)	3X Weekly	24-Hr Composite
	Total Lead (ug/l)			(report)	(report)	3X Weekly	24-Hr Comp.
	Total Zinc (ug/l)			(report)	(report)	3X Weekly	24-Hr Comp.
	pH (Standard Units)					Continuous	Report Daily Max. and Min.
EFFLUENT FROM CENTRAL TREATMENT SYSTEM							
	Total Suspended Solids	1650	4940	*	*	Daily	24-Hr Composite
	Ammonia-Nitrogen	200	400			Weekly	24-Hr Composite
	Total Phenols (4AAP)	5	25			Weekly	24-Hr Composite
				Daily Minimum	Daily Maximum		
	pH (Standard Units) (see footnote d., below)			7.0	10.0	Continuous	Report Daily Max. and Min.
	Hot Forming Production Level (Tons/day)			(report)		Monthly	Calculation
FOR HOT FORMING MONTHLY AVERAGE PRODUCTION LESS THAN 4100 TONS PER DAY, THE FOLLOWING LIMITATIONS APPLY:							
	Total Lead	4.0	12	*	*	3X Weekly	24-Hr Comp.
	Total Zinc	6.0	18	*	*	3X Weekly	24-Hr Comp.
	Oil and Grease	1025	1600			Daily	Grab

Table 8-13. (continued)

		Discharge Limitations					
		kg/day (lbs/day)		Other Limitations		Monitoring Requirements	
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
FOR HOT FORMING MONTHLY AVERAGE PRODUCTION GREATER THAN OR EQUAL TO 4100 TONS PER DAY AND LESS THAN 4920 TONS PER DAY, THE FOLLOWING LIMITATIONS APPLY:							
	Total Lead	4.7	14	*	*	3X Weekly	24-Hr Comp.
	Total Zinc	7.0	21	*	*	3X Weekly	24-Hr Comp.
	Oil and Grease	1025	1900			Daily	Grab
FOR HOT FORMING MONTHLY AVERAGE PRODUCTION GREATER THAN OR EQUAL TO 4920 TONS PER DAY AND LESS THAN 5910 TONS PER DAY, THE FOLLOWING LIMITATIONS APPLY:							
	Total Lead	5.5	16	*	*	3X Weekly	24-Hr Comp.
	Total Zinc	8.2	24	*	*	3X Weekly	24-Hr Comp.
	Oil and Grease	1025	2300			Daily	Grab
FOR HOT FORMING MONTHLY AVERAGE PRODUCTION GREATER THAN OR EQUAL TO 5910 TONS PER DAY, THE FOLLOWING LIMITATIONS APPLY:							
	Total Lead	6.5	19	*	*	3X Weekly	24-Hr Comp.
	Total Zinc	9.6	29	*	*	3X Weekly	24-Hr Comp.
	Oil and Grease	1025	2700			Daily	Grab
001 (treated process waste-water and non-contact cooling water)	Flow [MGD]		[27.5]			Daily	Report Total Daily Flow
	Oil and Grease				10 mg/l	Daily	Grab
	Ammonia-Nitrogen (mg/l)			(report)	(report)	2X Weekly	Grab
	Temperature (°C)			(report)	(report)	2X Weekly	Grab
	Unionized Ammonia (ug/l)			(report)	(report)	2X Weekly	Calculation
	Total Phenols (4AAP) (ug/l)			(report)	(report)	2X Weekly	Grab
	Total Zinc				506 ug/l	Weekly	24-Hr Comp.
	Amenable Cyanide				47 ug/l	Weekly	24-Hr Comp.
	Total Lead (ug/l)				(report)	Weekly	24-Hr Comp.

Table 8-13. (continued)

Outfall	Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Monthly Average	Daily Maximum	Other Limitations Monthly Average	Daily Maximum	Monitoring Requirements Measurement Frequency	Sample Type
	Total Copper (ug/l) (outfall 001 and intake)				(report)	Monthly	24-Hr Comp.
	Total Hardness (mg/l) (as $CaCO_3$)			(report)	(report)	Weekly	24-Hr Comp.
	Total Residual Chlorine (see Part I.A.3.f. below)				36 ug/l	Daily	Grab
	Outfall Observation					Daily	Visual
				Daily Minimum	Daily Maximum		
	pH (Standard Units)			6.0	10.5	Daily	Grab
002 (non-contact cooling water and storm-water runoff)	Flow [MGD]		20.1			Daily	
	Oil and Grease				10 mg/l	2X Weekly	Grab
	Amenable Cyanide			(report)	(report)	2X Weekly	Grab
	Temperature			(report)	(report)	2X Weekly	Grab
				Daily Minimum	Daily Maximum		
	pH			6.5	9.0	2X Weekly	Grab
004 (non-contact cooling water and storm-water runoff)	Flow [MGD]		32			Daily	
	Oil and Grease				10 mg/l	2X Weekly	Grab
	Temperature			(report)	(report)	2X Weekly	Grab
	Outfall Observation					Daily	Visual
				Daily Minimum	Daily Maximum		
	pH			6.5	9.0	2X Weekly	Grab

Table 8-13. (continued)

		Discharge Limitations					
		kg/day (lbs/day)		Other Limitations		Monitoring Requirements	
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
005 (intake filter screen backwash)	Flow [MGD]	(report)	(report)			Weekly	Report Total Daily Flow

The most recent biomonitoring tests at McLouth Steel-Trenton were conducted by MDNR in March of 1988. A composite sample of effluent from outfall 001 was not acutely toxic to D. magna after 48-hours of exposure (Table 8-7) (Hering and Saalfeld 1988c). The final effluent met Rule 57 and Rule 82 requirements.

The Discharge Monitoring Reports for McLouth Steel-Trenton (for October, 1987 through December, 1990) indicate exceedances for the following parameters:

1987	1988	1989	1990
Iron (total - 2)	pH - 2	pH - 4	Cyanide (total) - 1
	TSS - 3	TSS - 8	Iron (total) - 11
	Oil/Grease - 1	Oil/Grease - 9	Cyanide (as CnA) - 1
	Iron (total) - 12	Cyanide (total) - 2	TSS - 5
	Cyanide (as CnA) - 2	Iron (total) - 12	
		Phenol - 1	
		Cyanide (as CnA) - 3	

Prior to this monitoring period, McLouth Steel (Trenton) and the State of Michigan entered into a consent decree on November 17, 1986. Pursuant to the Consent Decree, McLouth Steel was required to pay the State $100,000 for violations of their NPDES permit effluent requirements. In addition, the corporation was required to conduct an engineering study to determine additional waste treatment and/or control needs to assure continued compliance with the facility's NPDES Permit. The Consent Decree required a report of this study with recommendations and an implementation schedule to be submitted to MDNR by May 1, 1987.

This facility is in noncompliance with its NPDES Permit due to chronic effluent limit violations. The facility must also install additional treatment systems to comply with the Clean Water Act. In April, 1990 MDNR and the Michigan Attorney General's office notified this company of their intent to file a lawsuit against McLouth Steel (Trenton) for the permit violations. The Attorney General's Office, MDNR and the company are involved in negotiations to resolve these issues.

8.2.1.8 McLouth Steel Products Gibraltar (MI0004227)

This facility is a steel coil pickling and cold rolling operation. Coil steel from the Trenton plant is fed through a continuous pickling tower system where it is sprayed with hydrochloric acid for the removal of scale and surface oxides. The pickled steel is rinsed with water, dried and oiled. The oil serves as protection against corrosion and as a lubricant during cold rolling. The steel is then fed through a three stand tandem mill, where it is rolled unheated through three two-roll stands. The first two stands utilize a recirculation oil/water emulsion for lubrication, while the third stand has direct continuous application of fresh rolling solution.

The plant obtains its process and cooling water supplies from an intake on the Trenton Channel of the Detroit River. Domestic water is purchased from the City of Detroit. The sanitary wastewater is discharged to the Wayne County - Huron Valley WWTP.

Noncontact cooling water is discharged to a company storm drain through outfall 0B1 (001A) to the Frank and Poet Drain. Waste pickle liquor is distilled and condensed for reuse of the acid while other process wastewater is discharged to a series of three lagoons. The effluent from the third lagoon is discharged to outfall 001 and then mixes with effluent from outfall 01B (001A) where the combined effluent discharges to the Frank and Poet Drain.

Waste characterization studies, the application, compliance survey inspections and self monitoring data were used to develop permit limits and monitoring requirements. The current effluent limits and monitoring requirements are presented in Table 8-14. The current permit was issued in August of 1988, modified in January of 1990 and expires in October of 1992.

The permittee was also required to conduct a Short Term Waste Characterization Study. The permittee was required to monitor copper, chromium, Hexavalent chromium, nickel and silver from outfalls 01B and 001 weekly for six weeks. Also, the permittee was required to monitor landfill leachate and stormwater runoff for total flow, lead, zinc, total phenols, total cyanide and ammonia once every other week for a period of three months. The results of this study will be used to develop any new permit requirements. Additional permit requirements and definitions are presented in Appendix 8-1.

The final effluent from outfalls 01B (001A) and 001 were sampled on September 2-3, 1986 during a Compliance Survey Inspection. Twenty-four hour composite samples were collected and analyzed for a number of conventional parameters, heavy metals and organics. Results of the metals and cyanide analysis are presented in Table 8-5. Several of the metals were analyzed by EPA-LLRS. None of the metals or cyanide concentrations were detected at levels of concern except for mercury. The most likely source of mercury was ambient Trenton Channel water used by the facility so no additional monitoring or permit limits were required.

The results of the organic analysis are presented in Table 8-6. Hexachlorobenzene was detected at concentrations of 0.33 ng/l and 0.0057 ng/l in outfalls 01B (001A) and 001, respectively, in samples analyzed by EPA-LLRS. Also, total PCBs were estimated to be 19.7 ng/l in a sample collected in outfall 01B (001A) and analyzed by EPA-LLRS. Phenols and 2,4-demethylphenol were detected but not quantified in composite samples analyzed by the MDNR lab. All other organics were below levels of detection. In addition, grab samples were analyzed for organic contaminants (MDNR lab), and none were detected except for chloroform

Table 8-14. Discharge limits and monitoring requirements (1990) for McLouth Steel Products-Gibraltar (MI0004227).

		Discharge Limitations (lbs/day)		Other Limitations		Monitoring Requirements	
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
001	Flow [MGD]*		[10]**			Daily	Report Total Daily Flow
	Total Lead				74 ug/l	Weekly	24-Hr Composite
	Oil and Grease (mg/l)				640 ug/l	Weekly	Grab
	Temperature (°F)					Daily	Grab
	Outfall Observation					Daily	Visual
				Daily Minimum	Daily Maximum		
	pH (Standard Units)			6.5	9.0	Daily	Grab
Outfall				Monthly Average	Daily Maximum		
01B	Flow [MGD]		[2]			Daily	Report Total
	Total Suspended Solids			26 mg/l	70 mg/l	3X Weekly	24-Hr Composite
	Oil and Grease				10 mg/l	3X Weekly	Grab
	Total Iron (mg/l)					Weekly	24-Hr Composite
	$CBOD_5$ (mg/l) May 1 - Sept. 30					3X Weekly	24-Hr Composite
	Oct. 1 - April 30					Weekly	24-Hr Composite
	Ammonia-Nitrogen (mg/l) May 1 - Sept. 30				5.0 mg/l	3X Weekly	24-Hr Composite
	Oct. 1 - April 30					Weekly	24-Hr Composite

Table 8-14. (continued)

Outfall	Effluent Characteristic	Discharge Limitations (lbs/day) Monthly Average	Discharge Limitations (lbs/day) Daily Maximum	Other Limitations Monthly Average	Other Limitations Daily Maximum	Monitoring Requirements Measurement Frequency	Monitoring Requirements Sample Type
01B	Oxygen Demand						
	May 1 - Sept. 30				38.6 mg/l	3X Weekly	Calculation
	Oct. 1 - April 30: reporting not required						
	(Oxygen Demand = $[CBOD_5]$ = $5.22[NH_3\text{-}N]$, concentrations in mg/l)						
	Cold Forming Production Level (tons/day)			(Report)		Monthly	Calculation
				Daily Minimum	Daily Maximum		
	Dissolved Oxygen (mg/l)						
	May 1 - Nov. 30			5.0 mg/l		3X Weekly	Grab
	Dec. 1 - April 30					Weekly	Grab
	pH (Standard Units)			7.2	9.5	Continuous	Report Daily Min. & Max.

For Cold Forming Monthly Average Production Less than 2020 Tons Per Day, The Following Limitations Apply:

Outfall	Effluent Characteristic	Monthly Average (lbs/day)	Daily Maximum (lbs/day)	Other Monthly Average	Other Daily Maximum	Measurement Frequency	Sample Type
01B	Total Suspended Solids	150	340			3X Weekly	24-Hr Composite
	Oil and Grease	49	140			3X Weekly	Grab
	Total Lead	0.73	2.2			3X Weekly	24-Hr Composite
	Total Zinc	0.93	2.8			3X Weekly	24-Hr Composite

For Cold Forming Monthly Average Production Greater Than or Equal to 2020 Tons Per Day and Less Than 2450 Tons Per Day, The Following Limitations Apply:

Outfall	Effluent Characteristic	Monthly Average (lbs/day)	Daily Maximum (lbs/day)	Other Monthly Average	Other Daily Maximum	Measurement Frequency	Sample Type
01B	Total Suspended Solids	170	390			3X Weekly	24-Hr Composite
	Oil and Grease	57	170			3X Weekly	Grab
	Total Lead	0.85	2.5			3X Weekly	24-Hr Composite
	Total Zinc	1.1	3.3			3X Weekly	24-Hr Composite

Table 8-14. (continued)

For Cold Forming Monthly Average Production Greater Than or Equal to 2450 Tons Per Day and Less Than 2980 Per Day, the Following Limitations Apply:						
01B	Total Suspended Solids	200	460		3X Weekly	24-Hr Composite
	Oil and Grease	67	170		3X Weekly	Grab
	Total Lead	1.0	3.0		3X Weekly	24-Hr Composite
	Total Zinc	1.3	3.8		3X Weekly	24-Hr Composite
For Cold Forming Monthly Average Production Greater Than or Equal to 2980 Tons Per Day, the Following Limitations Apply:						
01B	Total Suspended Solids	240	550		3X Weekly	24-Hr Composite
	Oil and Grease	79	170		3X Weekly	Grab
	Total Lead	1.2	3.5		3X Weekly	24-Hr Composite
	Total Zinc	1.5	4.5		3X Weekly	24-Hr Composite

*Flow in million gallons per day (MGD).
**Includes 2 MGD of treated process water and 8 MGD of noncontact cooling water.

which was detected but not quantified. All of the organic compounds analyzed as part of the Compliance Survey Inspection were either below levels of detection or below levels of concern except for total PCBs detected in noncontact cooling water discharged through outfall 01B (001A). The most likely source of PCBs was ambient Trenton Channel water used by the facility and no additional monitoring or permit limits were required. A brief description of sampling methods and a list of parameters analyzed are presented in Appendix 8-2.

The most recent biomonitoring tests at McLouth Steel-Gibralter were conducted by MDNR in March of 1988. A composite sample of effluent from outfall 001 was not acutely toxic to D. magna during a 48-hour static test (Table 8-7) (Hering and Saalfeld 1988d). The final effluent met the requirements of Rule 82 and Rule 57.

The Discharge Monitoring Reports from McLouth Steel-Gibralter (for October, 1987 through December, 1990) indicate exceedances of the following parameters:

1987	1988	1989	1990
pH - 1	pH - 1	Oil/Grease - 5	pH - 2
TSS - 1	Oil/Grease - 1		$CBOD_5$ - 1
Oil/Grease - 2	Zinc - 1		D.O. - 2
	TSS - 1		Oil/Grease - 1

A Notice of Noncompliance was issued to this facility in March, 1989, for submitting incomplete DMRs in September through December of 1988. These DMRs did not include the Cold Forming Production Level (tons/day). A Notice of Noncompliance was sent to the facility in January, 1990, for exceedances of the oil and grease effluent requirements in 1989. A corrective action plan to bring the facility into compliance with oil and grease effluent limits was submitted by the company in February of 1990. A Notice of Noncompliance was sent to the facility on November 28, 1990, for exceedances of effluent limits. The Notice of Noncompliance directed the facility to comply immediately (November 20, 1990) with all NPDES permit requirements.

8.2.1.9 National Steel Corporation, Great Lakes Steel Division, 80" Mill (MI0026778)

This facility hot rolls steel slabs into coils, mainly for the automobile industry. Steel slabs, obtained from adjacent plants are hot rolled on a line consisting of reheating furnaces, a scale breaker, roughing mills, finishing mills and down coiler machines. The coiled steel is either sold as is or transferred to finishing mills.

Process and cooling water is obtained from the Detroit River and is spot chlorinated prior to use. Domestic water is obtained from the City of Detroit and sanitary wastes are discharged to the City of Rouge River sewage system.

Water is used to cool and lubricate the hot steel during the rolling operation. This contact cooling water is treated in two scale pits and in four lagoons which are operated in parallel. Effluent is discharged

Table 8-15. Discharge limits and monitoring requirements (1990) for the National Steel Corporation, Great Lakes Steel Division 80" Mill (MI0026778).

		Discharge Limitations (lbs/day)		Other Limitations		Monitoring Requirements	
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
009	Flow [MGD]		[192]			2X Weekly	Report Total Daily Flow (by Calculation)
	Outfall Observation					5X Weekly	Visual
021	Flow [MGD]		[70]			5X Weekly	Report Total Daily Flow
	Oil and Grease		3226		15 mg/l	5X Weekly	Grab
	Total Suspended Solids Intake (mg/l)					Weekly	24-hr Composite
	Discharge	6514	12874	25 mg/l	75 mg/l	5X Weekly	24-hr Composite
				Daily Minimum	Daily Maximum		
	pH (Standard Units)			6.5	9.0	5X Weekly	Grab

*Flow in million gallons per day.

from the four lagoons into two channels (021A and 021B). The two channels connect underground and combine with stormwater and noncontact cooling water from the mills and furnaces. The combined effluent discharge to the Detroit River through outfall 009.

Waste characterization studies, the application, Compliance Survey Inspections and self monitoring data were used to develop permit limits and monitoring requirements. The monitoring requirements and limits for outfall 021 and 009 are presented in Table 8-15. Also, the permittee is required to conduct a Short Term Waste Characterization study. The intake and discharge from outfall 021 was monitored for amenable cyanide, cadmium, total chromium, Hexavalent chromium, copper, lead, mercury, nickel, silver and zinc. Samples were collected once weekly for six weeks and the results are used to develop any additional permit requirements.

Permit No. MI0026778 was issued to this facility on July 26, 1988 and expires on October 1, 1992. Additional requirements and defintions are found in Appendix 8-1.

Effluent from outfall 009 was monitored as part of a routine Compliance Survey Inspection on September 16-17, 1986. Twenty-four hour composite samples were analyzed for a number of conventional pollutants, heavy metals and organic compounds. Results of the metals and cyanide analysis are presented in Table 8-5. Some of the metals concentrations were from composite samples collected at the same time and analyzed by EPA-LLRS.

Composite samples were analyzed for total PCBs and hexachlorobenzene by EPA-LLRS and for a variety of organics by the MDNR lab. Concentrations of total PCBs and hexachlorobenzene and 16.4 ng/l and 0.26 ng/l, respectively. Organic concentrations in composite samples analyzed by the MDNR lab were all below levels of detection. Also, concentrations of organics in grab samples were below levels of detection. A brief description of sampling methods and a list of parameters analyzed are presented in Appendix 8-2.

The effluent sampled during the 1986 Inspection met permit limitations. All organic compounds and metals analyzed were below levels of detection or below levels of concern except for total PCBs and mercury. The source of the total PCBs in the effluent was determined to be intake water from the Detroit River and no permit limits or monitoring requirements were added. As previously noted the facility is required to monitor the intake and outfall for mercury and the results will be used to develop any additional permit requirements (if necessary).

The most recent biomonitoring tests for this facility were conducted by MDNR in March of 1988. A composite sample collected at outfall 009 caused immobilization of 25% of the D. magna in 100% effluent during 48-hour static tests (Table 8-7). However, this level of toxicity satisfies the aquatic toxicity-related requirements of Rule 82 and Rule 57 of the Michigan Water Quality Standards (Hering and Saalfeld 1988e).

The Discharge Monitoring Reports for National Steel Corporation-GLS-80" Mill (for October, 1987 through December, 1990) indicate exceedances for the following parameters:

1987	1988	1989	1990
TSS - 1	TSS - 3 Oil and Grease - 1	Oil and Grease - 1	Oil and Grease - 1

A Notice of Noncompliance was issued to this facility in May, 1990 as a result of a compliance inspection conducted by MDNR. The facility was discharging effluent with a visible oil sheen. The facility was required to develop and implement a plan to correct the problem.

8.2.1.10 National Steel, Great Lakes Steel Division, Ecorse Plant (MI0002313)

The Ecorse plant is a rolling mill that produces strip steel from molten pig iron. The operation includes two basic oxygen furnaces, two electric arc furnaces, a continuous pickling line and various finishing mills. Process and cooling water used at the mill is obtained from the Detroit River and is spot chlorinated each hour prior to use. Domestic water is obtained from the City of Ecorse and sanitary waste is discharged to the City of Ecorse.

The facility has eleven surface water discharge points all of which are along the Detroit River. Outfalls 010 and 014 discharge yard, road and area drainage through an oil skimming basin to the river. Outfalls 029 and 030 discharge untreated yard and road drainage. Outfalls 012, 013, 015, 016 and 017 discharge noncontact cooling water to the Detroit River.

Outfall 011 receives floor drainage from the service shops and process water. The combined wastewater is settled with the aid of a polymer in two basins operated in parallel. Floating oils are removed by two mechanical flight scrapper units and four belt skimmers before the effluent is discharged to the river.

Process water and contact cooling water are treated in four oil-water separators with surface skimmers, two flash mix tanks where ferrous and waste pickle liquor is added, two aeration tanks where the ferrous ion is oxidized, and four reaction clarifiers. The final effluent is discharged through outfall 018 to the Detroit River.

Waste characterization studies, the application, Compliance Survey Inspections and self monitoring data were used to set permit limits and monitoring requirements. Outfalls 012, 013, 015, 016 and 017 are monitored twice weekly and no visible film of oil and grease is allowed. The monitoring requirements and limits for 011 and 018 are presented in Table 8-16. The current permit was issued in May of 1989 and expires in October of 1992 and a copy is available in Appendix 8-1.

The permittee was also required to conduct a Short Term Waste Characterization study. The facility was required to monitor cadmium, copper, total chromium, hexavalent chromium, lead, nickel, silver, zinc, amenable cyanide, mercury and $CBOD_5$ once weekly for six weeks. These

Table 8-16. Detroit River discharge and monitoring requirements (1990) for National Steel, Great Lakes Steel Ecorse Plant (MI0002313).

		Discharge Limitations				Monitoring Requirements	
		(lbs/day)		Other Limitations			
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
011	FLow (MGD)		[.8]			2X Weekly	Report Total Daily Flow
	Total Suspended Solids	170	500			2X Weekly	24-Hr Composite
	Oil and Grease		100			2X Weekly	Grab
	Acrolen (ug/l)		8			Semi-annually	Grab
	Outfall Observation					5X Weekly	Visual
				Daily Minimum	Daily Maximum		
	pH (Standard Units)			6.5	9.0	2X Weekly	Grab
	Temperature					Monthly	Reading
00A (continuous casting)	Flow (MGD)		[1.2]			2X Weekly	Report Total Daily Flow
	Total Suspended Solids	480	1400			2X Weekly	24-Hr Composite
	Oil and Grease	150	440			2X Weekly	Grab
	Total Lead	0.90	2.7			2X Weekly	24-Hr Composite
	Total Zinc	1.3	4.0			2X Weekly	24-Hr Composite
	Acrolein (ug/l)					Semi-annually	Grab
00A (continuous casting & vaccum degassing)	Flow (MGD)		[1.3]			2X Weekly	Report Total Daily Flow
	Total Suspended Solids	510	1500			2X Weekly	24-Hr Composite
	Oil and Grease	150	440			2X Weekly	Grab
	Total Lead	1.3	3.8			2X Weekly	24-Hr Composite

Table 8-16. (continued)

		Discharge Limitations (lbs/day)		Other Limitations		Monitoring Requirements	
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
	Total Zinc	1.9	5.7			2X Weekly	24-Hr Composite
	Acrolein (ug/l)		8			Semi-annually	Grab
				Daily Minimum	Daily Maximum		
	pH (Standard Units)			6.0	9.0	2X Weekly	Grab
00B/ 018 (combined)	Flow (MGD)		[4.8]			2X Weekly	Report Total Daily Flow
	Total Suspended Solids	1100	2400	25 mg/l	75 mg/l	2X Weekly	24-Hr Composite
	Oil and Grease	520	1200		15 mg/l	2X Weekly	Grab
	Total Lead	8.0	19			2X Weekly	24-Hr Composite
	Total Zinc	17	36			2X Weekly	24-Hr Composite
	Total Hardness (as $CaCo_3$) (mg/l)					Monthly	24-Hr
				Daily Minimum	Daily Maximum		
	pH (Standard Units)			6.0	10.0	2X Weekly	Grab
	Total Toxic Organics (TTO)**				0.48 mg/l***		

** The term TTO means total toxic organics which is the sum of all quantifiable values greater than 0.01 mg/l for a list of over 100 organic compounds. The compounds are listed in the permit (Appendix 8-1).

*** This is a guideline based limitation and is not an authorization to discharge toxic organic compounds at levels which cause or may cause water quality violations. The discharge of toxic organic compounds at levels which cause or may cause water quality violations is prohibited.

parameters are to be monitored at the intake and at outfalls 00A, 00B and 011. The results of the study are used to develop any additional permit limits or monitoring requirements.

Effluent from outfalls 011 and 018 were monitored as part of a routine Compliance Survey Inspection. Twenty-four hour composite and grab samples were collected on September 16-19, 1986 and analyzed (by an MDNR lab) for conventional pollutants, heavy metals and organic contaminants. The final effluent met all permit requirements. In addition, composite samples were sent to EPA-LLRS for analysis of some heavy metals, total PCBs, octachlorostyrene and hexachlorobenzene. The results of the metals and cyanide analysis are presented in Table 8-5.

Total PCBs, octachlorostyrene and hexachlorobenzene were detected by EPA-LLRS at concentrations of 45.5 ng/l, 0.055 ng/l and 1.00 ng/l, respectively, in effluent from outfall 011 and at concentrations of 26 ng/l, 0.127 ng/l and 0.41 ng/l, respectively, in effluent from outfall 018 (Table 8-6).

Organic parameters in composite and grab samples analyzed by the MDNR lab were below levels of detection except for carbon tetrachloride in a grab sample taken from outfall 001. The lab was unable to quantify the concentrations present. A brief description of sampling methods and a list of parameters analyzed are presented in Appendix 8-2.

All organics and metals were below levels of detection or below levels of concern except for total PCBs and mercury. The most recent permit includes PCBs in the regulation of Total Toxic Organics (Table 8-16). Also, mercury is included in the short term waste characterization study and the results of intake and outfall monitoring will be used to develop any additional permit requirements (if necessary).

Biomonitoring tests were conducted at National Steel-GLS-Ecorse plant in March of 1988. A composite sample of the final effluent from outfall 011 was not acutely toxic to D. magna in a 48-hour static test (Table 8-7) (Hering and Saalfeld 1988f). However, a composite sample of the final effluent from outfall 018 was acutely toxic to D. magna. Hering and Saalfeld (1988f) estimated that the 48-hour EC50 (effective concentration at which 50% of the test organisms are immobilized) was 54% effluent and did not meet the requirements of Rule 82. The facility was required to develop and implement a biomonitoring plan. If the results of the toxicity tests indicate that final effluent is not meeting the requirements of Rule 82 then the facility will be required to develop and implement a plant to comply with the toxicity requirements of Rule 82.

The Discharge Monitoring Reports for National Steel Corporation-GLS-Ecorse Plant (for October, 1987 through December, 1990) indicated the following exceedances:

1988
pH - 4
TSS - 2
Oil and Grease - 3
Zinc - 5

A Notice of Noncompliance was issued in August, 1988, to National Steel Corporation-Ecorse for exceedances of zinc in January and February of 1988. The facility achieved compliance with the effluent limits and met the requirements of the Notice by September, 1989. This facility was issued another Notice of Noncompliance in March, 1990 as a result of a Compliance Sampling Inspection conducted by MDNR. During the inspection, oil sheens and/or discolorations were observed in the effluent of six outfalls, and a seventh outfall discharged effluent covered with white foam.

National Steel Corporation-GLS-Ecorse facility is currently in noncompliance with its NPDES Permit. In April, 1990 MDNR with the Michigan Attorney General's office notified the company of their intent to file a lawsuit against this facility for this violation of its NPDES permit. The Attorney General's office, MDNR and the company are involved in negotiations to resolve these issues.

8.2.1.11 National Steel Corporation, Great Lakes Steel Division, Zug Island Plant (MI0026786)

This facility produces pig iron in four blast furnaces. Coke, coke by-products and sinter plants are also operated at the facility. Coking operations involve the destructive distillation of coal, producing a non-volatile carbon residue suitable for metallurgical use. The sinter plant produces an agglomerate from fine particles (collected from the coke oven exhaust gases and clarifier sludges), iron oxides (from the scale pits), coke and limestone. The agglomerate is used as feed stock in the blast furnaces.

Pelletized iron ore, along with limestone and coke is reduced to molten iron utilizing the carbon in coke as the reducing agent and the lime as a flux to carry impurities found in the ore. Molten pig iron is drawn off and transferred to the steelmaking operation at the adjacent Ecorse Mill.

This facility obtains its process and cooling water supplies from two intakes on the Detroit River. Both intakes are spot chlorinated on a two-hour cycle for slime control. Domestic waste and some miscellaneous process wastes from the plant are discharged to the Detroit WWTP.

Noncontact cooling water and yard drainage is discharged to the Rouge River through outfall 001 (3.06 MGD) and to the Detroit River through outfalls 002 (14.9 MGD), 003 (10.4 MGD), 005 (2.16 MGD) and 007 (0.5 MGD).

The facility operates a recycle system to supply water for the gas cookers and wet scrubbers throughout the plant. This system recycles about 8.64 MGD through three clarifiers operated in parallel. Any excess treated effluent is discharged to outfall 008 via outfalls 08A, 08B and 08D.

Waste characterization studies, the application, compliance survey inspections and self monitoring data were used to set permit limits and monitoring requirements. Flow and oil and grease are monitored at outfalls 001, 002, 003, 005 and 007. Also, the permit requires that the effluent from these outfalls be visually inspected daily for oil films or floating solids. The pH at each of these outfalls must be between 6.5 and 9.0 SU.

The facility is also permitted to discharge an unspecified amount of stormwater through outfalls 004, 021, 022 and 027. The permittee is required to visually inspect discharges from these outfalls.

In addition, this facility is authorized to discharge from outfalls 08A, 08B and 08D (4,000,000 gallons each) through outfall 008 to the Detroit River. The monitoring requirements and permit limits are listed in Table 8-17.

The permittee was also required to plan and implement a Short Term Waste Characterization Study. This facility was required to monitor an intake and discharges from outfalls 08A and 08B for the following parameters: cadmium, copper, total chromium, hexavalent chromium, lead, nickel, silver, zinc, amenable cyanide, total mercury, PCBs and hexachlorobenzene (monitoring for lead and zinc is not required at outfall 08A). The samples were collected once weekly for six weeks. The results of this study will be used to develop any additional permit requirements.

The permit was issued on July 26, 1988 and expires October 1, 1992. See appendix 8-1 for permit definitions and complete descriptions of permit requirements.

Effluent from outfalls 008A and 008 were monitored as part of routine Compliance Survey Inspections on September 16-19, 1986. Twenty-four hour composite and grab samples were analyzed by the MDNR lab for conventional pollutants, heavy metals and organic contaminants. Also, composite samples were sent to EPA-LLRS for analysis of some heavy metals, total PCBs, hexachlorobenzene and octachlorostyrene. The results of the metals and cyanide analyses are presented in Table 8-5. Total PCBs, octachlorostyrene and hexachlorobenzene were detected at 95.1 ng/l, 0.01 ng/l and 0.42 ng/l, respectively, in effluent from outfall 008. Organic parameters in composite and grab samples analyzed by the MDNR lab were below levels of detection except for carbon tetrachloride in a grab sample taken from outfall 008. However, the lab was unable to quantify the concentration (Table 8-6). None of the samples from outfall 008A were analyzed for organic contaminants. A brief description of sampling methods and a list of parameters analyzed are presented in Appendix 8-2.

The Compliance Survey Inspection results met the final permit limitations. Also, all metals and organics were either below levels of detections or below levels of concern except for total PCBs and mercury. As previously noted, PCBs and mercury will be monitored in the intake and outfalls. Additional monitoring or limits will be required if necessary.

Table 8-17. Detroit River discharge and monitoring requirements (1990) for National Steel, Great Lakes Zug Island Plant (MI0026786).

		Discharge Limitations				Monitoring Requirements	
		(lbs/day)		Other Limitations			
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
008	Flow (MGD)	[52]				2X Weekly	Report Total Daily Flow
	Temperature (°F)					Weekly	Grab
	Ammonia (as N) (mg/l)					2X Weekly	24-Hr Composite
	Total Phenols (4AAP) (mg/l)					2X Weekly	24-Hr Composite
	Outfall Observation					Daily	Visual
				Daily Minimum	Daily Maximum		
	pH (Standard Units)			6.0	9.0	2X Weekly	Grab
08A	Flow (MGD)		[4]			Daily	Report Total Daily Flow
	Ammonia (as N)	44	130			2X Weekly	Composite
	Amenable Cyanide		12			2X Weekly	Composite
	Total Cyanide	13	26			2X Weekly	Composite
	Total Phenols (4AAP)	0.44	1.76			2X Weekly	Composite
	Total Lead	1.3	3.9			2X Weekly	Composite
	Total Zinc	2.0	5.9			2X Weekly	Composite
	Total Residual Chlorine		2.2			2X Weekly	Grab
	Total Suspended Solids	390	1200			2X Weekly	Composite
	Oil and Grease (mg/l)					2X Weekly	Grab
				Daily Minimum	Daily Maximum		
	pH (Standard Units)			6.0	9.0	2X Weekly	Grab

Table 8-17. (continued)

Outfall	Effluent Characteristic	Discharge Limitations (lbs/day) Monthly Average	Daily Maximum	Other Limitations Monthly Average	Daily Maximum	Monitoring Requirements Measurement Frequency	Sample Type
08B	Flow (MGD)		[1.2]			2X Weekly	Report Total Daily Flow
	Ammonia (as N) (lbs/day)					2X Weekly	24-Hr Composite
	Total Phenols (4AAP) (lbs/day)					2X Weekly	24-Hr Composite
	Total Suspended Solids	280	930	30 mg/l	100 mg/l	2X Weekly	24-Hr Composite
	Oil and Grease				15 mg/l	2X Weekly	Grab
				Daily Minimum	Daily Maximum		
	pH (Standard Units)			6.0	9.0	2X Weekly	Grab
08D	Flow (MGD)		[4]			Daily	Report Total Daily Flow
	Ammonia (as N)	650	1850			2X Weekly	Composite
	Amenable Cyanide		12			2X Weekly	Composite
	Total Cyanide	13	26			2X Weekly	Composite
	Total Phenols (4AAP)	6.3	12.6			2X Weekly	Composite
	Total Lead	1.3	3.9			2X Weekly	Composite
	Total Zinc	2.0	5.9			2X Weekly	Composite
	Total Residual Chlorine		2.2			2X Weekly	Grab
	Total Suspended Solids	390	1200			2X Weekly	Composite
	Oil and Grease (mg/l)					2X Weekly	Grab
				Daily Minimum	Daily Maximum		
	pH (Standard Units)			6.0	9.0	2X Weekly	Grab

The most recent biomonitoring tests at National Steel Corporation-GLS-Zug Island were conducted by MDNR in March of 1988. A composite sample of the final effluent from outfall 008 was not acutely toxic to D. magna in 48 hour, static tests (Table 8-7) (Hering and Saalfeld 1988g). The final effluent met the requirements of Rule 57 and Rule 82.

The Discharge Monitoring Reports for National Steel Corporation-GLS-Zug Island (for October, 1987 through December, 1990) indicate exceedances for the following parameters:

1988	1989
Phenol - 2	Nitrogen, ammonia - 2

A Notice of Noncompliance was issued to this facility in March, 1990. This facility is in noncompliance with its NPDES permit as a result of the chronic discharge of effluent from the treatment bypass outfall. On April 8, 1990, MDNR and the Attorney General's office notified the company of their intent to file a lawsuit against National Steel Corporation-Zug Island for violation of its NPDES permit. The Attorney General's Office, MDNR and the company are involved in negotiations to resolve these issues.

8.2.1.12 Pennwalt Corporation (MI0002381)

Prior to 1986, the Pennwalt Corporation in Wyandotte manufactured organic and inorganic chemicals in two separate but adjacent plants. The inorganic plant (East) produced ferric chloride from brine, waste pickle liquor and scrap iron, and about 100 different organic compounds were produced at the organic plant (West). Major products were alkylamines and rubber compounds which were made from ammonia and alcohols.

All process and cooling water used in both plants was obtained through intakes on the Trenton Channel of the Detroit River. The raw water was chlorinated continuously during the summer, beginning in early May. Domestic water was purchased from the City of Detroit and sanitary wastes were discharged to the Detroit sanitary sewer system.

The East Plant discharged cooling water from the ammonia chloride process was discharged to the Detroit River via outfall 003, after the pH was adjusted with acid or base. Combined waste streams were treated in a settling lagoon and received continuous pH adjustment by addition of carbon dioxide, sulfuric acid or base. This lagoon was also monitored before discharge to the Detroit River via outfall 005.

All process and cooling waters at the West Plant were treated in a series of lagoons. Phenolic wastes were discharged to Pond 2 for skimming and load equalizations. These wastes were combined with other waste streams in Pond 3. The pH was adjusted with acid or base prior to discharge into pond 4, where oils were removed and final settling occured. The effluent from Pond 4 was mixed with the cooling water (55% of total flow). Discharge of the combined effluent was through outfall 006 to Monguagon Creek, a small tributary of the Detroit River.

PVS Chemicals, Inc. (Michigan) (see Section 8.2.1.13) bought the operation rights to the ferric chloride production plant (a portion of the Pennwalt Inorganic Plant (East)) in 1986, and title to the NPDES permit for outfalls 003 and 005 were transferred from Pennwalt to PVS Chemicals, Inc. (Michigan) at that time. The land at the site is owned by Pennwalt (Atochem) and leased to PVS Chemicals, Inc. (Michigan). Pennwalt retains the organic plant (West) and discharges from outfall 006. Waste characterization and self monitoring data were used to set permit limits and monitoring requirements. The monitoring requirements are presented in Table 8-18.

The permittee is also required to monitor a number of parameters in the intake and at outfall 001 (formerly 006). The facility is required to monitor more than fifty organic compounds listed in the permit (Appendix 8-1). The monitoring is required twice a year, for the life of the permit. Also the facility is required to monitor BOD_5, total suspended solids and chlorides at the intake, three times per week, for the life of the permit. The results of this monitoring will be used to develop any additional permit requirements.

The permittee was required to do a Short Term Intake-Discharge Study and a Short Term Waste Characterization Study of wastewater before it mixed with noncontact cooling water. The intake-discharge study included weekly monitoring, for two weeks, at both the intake and discharge, for the following parameters: cadmium, total chromium, hexavalent chromium, copper, amenable cyanide, lead, mercury, nickel, zinc, silver, PCBs and ammonia. The Short Term Waste Characterization Study included weekly and twice per week sampling, for one or two weeks, for pH, ammonia, flow and ten organic compounds listed in Appendix 8-1. The results of both short term studies will be used to develop additional permit requirements (if any).

The permit was issued on September 15, 1988 and expires on October 1, 1992. Additional permit requirements are presented in Appendix 8-1. Effluent from outfalls 003, 005 and 006 were monitored as part of a routine Compliance Survey Inspection on May 6, 1986. Twenty-four hour composite and grab samples were analyzed for a number of conventional pollutants, heavy metals and organic compounds. Some results of the metals and cyanide analysis are presented in Table 8-5.

The results of the organic analysis are presented in Table 8-6. All parameters in the composite samples were below levels of detection. Chloroform and carbon tetrachloride were detected but not quantified in grab samples from outfall 006. In addition EPA-LLRS detected total PCBs (0.0641 ug/l) and Hexachlorobenzene (0.021 ug/l) in samples collected during the Compliance Survey Inspection.

The results of the Compliance Survey Inspection were within permit limits. All of the parameters analyzed were either below levels of detection or below levels of concern except for total PCBs and mercury. Monitoring requirements were added to the current permit and as previously noted, PCBs and mercury were monitored in the intake and outfall. The monitoring results will be used to determine the necessity of new permit requirements.

Table 8-18. Discharge limits and monitoring requirements (1990) for the Pennwalt Corporation (MI0002381).

		Discharge Limitations (lbs/day)		Other Limitations		Monitoring Requirements	
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
001 (formerly 006)	Flow (MGD)		[14.7]			Daily	Report Total Daily Flow
	Total Suspended Solids	1568	4525			3X Weekly	24-hr Composite
	BOD_5	1039	2773			3X Weekly	24-hr Composite
	Total Zinc	12.9	23.3	105 ug/l	190 ug/l	2X Monthly	24-hr Composite
	Total Residual Chlorine				0.036 mg/l	3X Weekly	Grab
	Phenol	0.45	1.1	4 ug/l	9 ug/l	Weekly	24-hr Composite
	Ammonia as Nitrogen (mg/l)			Monitor		Weekly	24-hr Composite
	Chlorides (mg/l)			Monitor		3X Weekly	24-hr Composite
	Temperature (°F)			Monitor		3X Weekly	Reading
	Outfall Observation					Daily	Visual
					Minimum		
	Dissolved Oxygen				4.0 mg/l	3X Weekly	Grab

*Flow in million gallons per day.

The most recent biomonitoring tests at the Pennwalt facility were conducted by MDNR in November of 1987. A composite sample of effluent from outfall 006 was not acutely toxic to D. magna during a 48-hour static test (Table 8-7) (Masterson 1988a). The final effluent met the requirements of Rule 82 and Rule 57.

The Discharge Monitoring Reports for Pennwalt Corporation (Atochem North America, Inc.) for October, 1987 through December, 1990, indicate the following exceedances:

1987	1988	1989	1990
BOD_5 - 1	BOD_5 - 1	BOD_5 - 1	pH - 2
pH - 3	pH - 11	pH - 8	phenol - 2
TSS - 1	TSS - 3	phenol - 1	
phenolics - 3	phenolics - 1		
TRC - 1	TRC - 4		

MDNR has issued two Notices of Noncompliance to this facility since 1988 (December 1988) regarding pH exceedances and December 1989 for BOD5 exceedances and visual observations of oil films at outfall 001. In both cases corrective action plans were developed and are being implemented by the facility.

8.2.1.13 PVS Chemicals, Inc. (Michigan) (MI0045098)

As previously noted, PVS Chemicals, Inc. (Michigan) bought a portion of the inorganic plant operations from Pennwalt Corporation (ATOCHEM) in 1988 (see Section 8.2.1.12) and continues to lease the site property from ATOCHEM. Title to the NPDES permit for outfalls 003 and 005 were transferred to PVS from Pennwalt in 1986. PVS Chemicals, Inc. (Michigan) manufactures liquid and anhydrous ferric chloride. The liquid ferric chloride process uses ferrous chloride, iron and chlorine gas as raw materials. Heavy gauge iron and chlorine gas are used to create anhydrous ferric chloride which is sold primarily as a catalyst.

Noncontact cooling water is obtained from the Detroit River through a common intake supplying both PVS and the Pennwalt (West) plant. The noncontact cooling water is pH adjusted prior to being discharged to the Detroit River through outfall 003. Outfall 005 is no longer in use.

Waste characterization data, the application, compliance survey inspection data and self monitoring data were used to set permit limits and monitoring requirements (Table 8-19). The permittee is authorized to discharge a maximum of 3,000,000 gallons per day of noncontact cooling water and stormwater runoff through outfall 003. The flow and temperature of the effluent is monitored.

As part of a routine compliance inspection survey at PVS Chemicals, Inc., the MDNR conducted acute toxicity bioassays using D. magna and fathead minnows and collected composite and grab samples for analysis of conventional pollutants, heavy metals and organics. The samples were collected in November of 1987 and results of the metals and cyanide analysis are presented in Table 8-5. All organics in the composite sample were below levels of detection except for pentachlorobenzene

Table 8-19. Discharge limits and monitoring requirements (1990) for PVS Chemicals, Inc. (Michigan) (MI0045098).

		Discharge Limitations (lbs/day)		Other Limitations		Monitoring Requirements	
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
	Flow, M^3/Day [MGD]*		[3]			Daily	Report Total Daily Flow
	Temperature (°F)					3X Weekly	Reading
	Outfall Observation*					Daily	Visual

*Flow in million gallons per day.

Short-Term Waste Characterization Study Requirements:

Constitutent	Sample Type	Sample Frequency	Sample Duration
Total Zinc	24-Hr. Composite	Weekly	Four Weeks
Hexavalent Chromium	24-Hr. Composite	Weekly	Four Weeks
Total Lead	24-Hr. Composite	Weekly	Four Weeks
Total Nickel	24-Hr. Composite	Weekly	Four Weeks
Total Chromium	24-Hr. Composite	Weekly	Four Weeks
Total Cadmium	24-Hr. Composite	Weekly	Four Weeks

(0.032 ug/l). All organics concentrations in the grab sample were below levels of detection except 1,1-dichloroethane (1.53 ug/l), 1,2-dichlorobenzene (0.19 ug/l), hexachlorobutadiene (0.012 ug/l) and 4,4'-DDE (0.018 ug/l) (Table 8-6). All detectable parameters analyzed in 1987 were below levels of concern. A brief summary of sampling methods and a list of parameters analyzed is presented in Appendix 8-2.

The acute aquatic toxicity bioassay determined that effluent from outfall 003 of PVS Chemicals, Inc. was not acutely toxic to fathead minnows. However, the effluent was acutely toxic to D. magna in a 48 hour static test. The 48 hour EC50 was calculated to be 71% effluent, indicating that the effluent was not satisfying the toxicity requirements of Rule 82 of the Michigan Water Quality Standards (Table 8-7) (Masterson 1988b). The cause of the toxicity was not determined and recent testing (November 1990) indicated that the effluent satisfied toxicity requirements of Rule 82 and Rule 57.

The Discharge Monitoring Reports for PVS Chemicals, Inc. (for January, 1988 through December, 1990) indicate exceedances for the following parameters:

1988	1990
pH - 1	pH - 2

8.2.1.14 Monsanto Inorganic Chemical Company (MI0000558)

The Monsanto Plant produces food grade specification products with inorganic sodium, ammonium, and calcium phosphates. Plant processes make use of phosphoric acid, ammonia, soda ash and caustic. The facility obtains its cooling water from the Detroit River, process and domestic water is acquired from the City of Detroit. Sanitary wastes are discharged to the City of Trenton sanitary sewer system.

Process wastewater and surface runoff are pumped through four lagoons. Treatment includes a settling tank, quick lime addition and clarification, pH adjustment with CO_2, a polishing filter and a rock media filter. The cooling water (from heat exchangers, compressors, rotary coolers, etc.) combines with the treated wastewater and is discharged through outfall 001 to the Elizabeth Park Canal, which drains to the Detroit River.

Waste characterization data, the application, compliance data and self monitoring data were used to set effluent monitoring requirements and permit limits for two outfalls (00A and 001) to the Trenton Channel of the Detroit River. The permittee is authorized to discharge a maximum of 450,000 gallons per day of treated contaminated nonprocess wastewater from outfall 00A to the Trenton Channel (Table 8-20). Also, the permittee is authorized to discharge 16,100,000 gallons per day of treated contaminated nonprocess wastewater and noncontact cooling water through outfall 001 to the Trenton Channel.

Table 8-20. Discharge limits and monitoring requirements (1990) for Monsanto Chemical Company (MI0000558).

		Discharge Limitations (lbs/day)		Other Limitations		Monitoring Requirements	
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
00A	Flow [MGD]*		[.45]			Daily	Report Total Daily Flow
	Total Suspended Solids (May 15-Oct. 15)	23 (net)	59 (net)	20 mg/l (net)	50 mg/l (net)	Daily	24-Hr Composite
	Total Suspended Solids (Oct. 16-May 14)	23 (net)	41 (net)	20 mg/l (net)	35 mg/l (net)	Daily	24-Hr Composite
	Phosphorus, Ortho plus Hydrolyzable	200	600	(7-day average) 10% of raw waste		Daily	24-Hr Composite
	Total Arsenic		0.19		0.05 mg/l	Weekly	24-Hr Composite
	Total Ammonia (as N)(mg/l)					Weekly	Grab
				Daily Minimum	Daily Maximum		
	pH (Standard Units)					Continuous	Reading
	INTAKE RIVER WATER:						
	Flow, (MGD)					Daily	Report Total Daily Flow
	Total Suspended Solids (mg/l)					Daily	24-Hr Composite
	RAW WASTE:						
	Flow, (MGD)					Daily	Report Total Daily Flow
	Phosphours, Ortho plus Hydrolyzable (mg/l)					Daily	24-Hr Composite
001	Flow [MGD)]		[16.1]			Daily	Report Total Daily Flow
	Temperature (°F) Intake Discharge					Daily	Instantaneous Reading

Table 8-20. (continued)

Outfall	Effluent Characteristic	Discharge Limitations (lbs/day) Monthly Average	Daily Maximum	Other Limitations Monthly Average	Daily Maximum	Monitoring Requirements Measurement Frequency	Sample Type
	Heat Load (BTU/hr)			278×10^6	480×10^6	Daily	Calculation
	Total Ammonia (as N)	671	1343	5 mg/1	10 mg/1	Weekly	Grab
	Unionized Ammonia (as N)(mg/1)					Weekly	Calculation
				Daily Minimum	Daily Maximum		
	pH (Standard Units)			6.0	9.5	Continuous	Reading
	Outfall Observation					Daily	Visual

*Flow in million gallons per day (MGD).

The current permit (issued August 18, 1990, expires October 1, 1992) also required the facility to develop and conduct a Short Term Waste Characterization Study. The permittee was required to monitor the intake and outfall 00A, weekly for six weeks, for the following parameters: cadmium, copper, total chromium, hexavalent chromium, lead, nickel, silver, zinc, amenable cyanide and mercury. The results of this study will be used to develop any additional permit requirements.

A routine Compliance Survey Inspection at Monsanto was conducted on May 6, 1986. Composite and grab samples were collected and analyzed by MDNR and EPA-LLRS. The survey results indicated that effluent limits were within permit requirements.

The results of some metals and cyanide analysis are presented in Table 8-5. A brief description of sampling methods and a list of parameters analyzed is presented in Appendix 8-2. Total PCBs were detected at 71.1 ng/l and hexachlorobenzene was detected at 0.16 ng/l in samples analyzed by EPA-LLRS (Table 8-6). All organics in both the composite and grab samples analyzed by MDNR were below levels of detection except for Bis-(2-ethylhexyl)-phthalate (5.0 ug/l) and trichloroethene (1.2 ug/l). All of the parameters analyzed were either below levels of detection or below levels of concern except for total PCBs and mercury. As previously noted, mercury will be monitored at the intake and outfall. The results will be used to determine the necessity of additional permit requirements. The most likely source of PCBs was ambient Trenton Channel water used by the facility and no additional monitoring or permit limits were required.

In March of 1988, MDNR conducted a routine 48 hour, static *D. magna* toxicity screening test on effluent from outfall 001. The effluent was not acutely toxic to *D. magna* (Table 8-7) (Hering and Saalfeld 1988h). The final effluent met the requirements of Rule 82 and Rule 57.

The Discharge Monitoring Reports for Monsanto Chemical (for October, 1987 through December 1990) indicate exceedances for the following parameters:

1987	1988	1989	1990
pH - 1	TSS - 2	TSS - 5	Arsenic - 1
	pH - 4	pH - 4	pH - 2
		Ammonia nitrogen - 1	Ammonia nitrogen - 1

Exceedances have been followed by informal requests for explanations and plans to insure compliance.

8.2.1.15 BASF Corporation, Wyandotte (MI0000540)

This facility produces polyols, iron oxides and vitamin E oil, and develops new chemicals (mainly polyols). Conventional and graft polyols are produced at the polyol complex, while transparent iron oxide pigments and vitamin E oil are produced in separate complexes at the plant.

Water for production and cooling is obtained from the Detroit River and is periodically treated with an algacide during the summer. Domestic water, equipment washwater and water for steam production is obtained from the City of Wyandotte. Wastewater from the vitamin operation facility is discharged to the Wayne County Wyandotte WWTP while process, cooling and storm waters from other sources are discharged to the Detroit River via two outfalls

Waste streams from the polyol plant include: steam vacuum jet condensate from the barometric condensors, equipment and floor wash water, deionizer backflush, production and transfer spillage and some stormwater from building roofs and parking lots. This wastewater is neutralized with sulfuric acid and discharged to a treatment basin. In the basin, solids and floating polyol foams are removed. The treated wastewater is combined with noncontact cooling water (about 90% of total flow) and any additional stormwater flows, and discharged through outfall 001 to the Detroit River. The process and cooling wastewater from the research and development laboratory and effluents from the iron oxide settling basin are neutralized with sulfuric acid in a quick mix tank and discharged to the Detroit River via outfall 002.

A routine Compliance Survey Inspection was conducted on July 15, 1986. Composite and grab samples were collected and analyzed by MDNR and EPA-LLRS. The results of metals and cyanide analyses are presented in Table 8-5. The survey results were compared to permit limits and the effluent met the requirements of the permit.

The results of EPA's analysis indicate that concentrations of total PCBs 53.6 ng/l and 26.1 ng/l in outfalls 001 and 002, respectively (Table 8-6). Concentrations of hexachlorobenzene in outfalls 001 and 002 were 3.4 ng/l and 0.66 ng/l, respectively. Also, octachlorostyrene was detected in outfall 002 at 0.003 ng/l. All organic compounds in composite samples analyzed by MDNR were below levels of detection except for dielhyl-phthalate which was found at 3.5 ug/l in outfall 001 and 3.9 ug/l in outfall 002. Analysis of the grab samples indicate that all organic compounds were below levels of detection except for toluene (34.0 ug/l) in outfall 001 and 1,2-dichloropropane (detected but not quanitified) in outfall 001 and found at 280 ug/l in outfall 002. Also, Bis (2-chloro-isopropyl) ether and Bis (2-chloroethyl) ether were found in outfall 002 at 110 ug/l and 2.0 ug/l, respectively. A brief discussion of methods and organic compounds analyzed are presented in Appendix 8-2.

All of the parameters analyzed during the Compliance Survey Inspection were either below levels of detection or below levels of concern except for total PCBs and mercury in the effluent from outfalls 001 and 002. However, the most likely source of total PCBs and mercury was intake water from the Detroit River and no permit requirements were developed.

The most recent permit monitoring requirements and limits are presented in Table 8-21. Outfall 002 was renamed outfall 003 and a new outfall 002 was incorporated in the permit. The permittee is authorized to discharge up to 750,000 gallons per day of noncontact cooling water and stormwater runoff through outfall 002 to the Trenton Channel of the Detroit River.

The current permit (issued September 15, 1988, expires October 1, 1992) also requires the permittee to monitor 54 organics and six metals, once per year for the life of the permit. Parameters to be monitored are listed in the permit (Appendix 8-1). The monitoring results will be used to develop any additional permit requirements.

In July of 1986, MDNR conducted a routine acute toxicity test on a grab sample from outfall 001 using D. magna. The EC50 was 39% effluent. This level of toxicity is within the requirements of Rule 82 of the Michigan Water Quality Standards due to the initial dilution caused by BASF's high velocity diffuser (Table 8-8).

The Discharge Monitoring Reports for BASF-Wyandotte (for October, 1987 through December 1990) indicated exceedances for the following parameters:

1988	1989	1990
TSS - 1	TSS - 1	pH - 1
TOC - 1	pH - 1	Toluene - 2
Toluene - 2	BOD_5 - 5	
	Toluene - 2	

This facility received a Notice of Noncompliance in March, 1989, for failing to submit DMR data for TSS for May-July of 1988. A second notice was issued in December, 1989, for effluent violations. Exceedances included BOD_5, total suspended solids, and pH. The notice included a schedule of requirements to achieve compliance by January, 1990. In addition, a Notice of Noncompliance was issued to this facility in May of 1990 for exceedances of Toluene limits. The facility was ordered to comply with their NPDES permit by May 15, 1990 and submit a report containing an explanation of steps to be taken to prevent future violations. The report was submitted on 5/30/91 and no Toluene exceedances have been reported since 5/15/90.

8.2.1.16 Detroit Coke Corporation (MI0004430)

The Detroit Coke facility is a coal coking plant with one coke oven battery containing 70 ovens. The coke oven gas generated by the coking process is cooled and stripped of ammonia using water sprays. This contact water then passes through settling tanks and filters before being pumped to an injection well (4000 ft. below grade). Both contact and noncontact cooling water are obtained from the Detroit River. The noncontact cooling water makes one pass through the ammonia wash water spiral coolers and is discharged to the Rouge River via outfall 001.

Domestic water and some process water is purchased from the City of Detroit. Some process water and sanitary water is discharged to the City of Detroit Sanitary Sewer System.

This facility is authorized to discharge noncontact cooling water and stormwater runoff through outfall 001 and is required to monitor flow and visually inspect the outfall for oil films, foams, floating solids and unnatural turibidity or color. Also, the pH of the effluent must be between 6.0 and 9.0 SU. The current permit was issued on October 15, 1987 and expires on October 1, 1992.

Table 8-21. Detroit River discharge and monitoring requirements (1990) for the BASF Corporation Wyandotte (MI0000540).

		Discharge Limitations (lbs/day)		Other Limitations		Monitoring Requirements	
Outfall	Effluent Characteristic	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type
001	Flow [MGD)]*		[7.6]			Daily	Report Total Daily Flow
	Toluene	0.49	1.30			Weekly*	Grab
	Total Suspended Solids						
	Influent					5X/Week	24 Hr. Comp.
	Effluent					5X/Week	24 Hr. Comp.
	Total Suspended Solids, (Net)	500	2626	20 mg/1	60 mg/1	5X/Week	24 Hr. Composite
	BOD_5 See Part I.A.1.a.)	523	1410			Weekly	24 Hr. Composite
	Total Organic Carbon (See Part I.A.1.b., BASF permit, Appendix 8-1)	2500	15800	100 mg/1	250 mg/1	Daily	24 Hr. Composite
	Outfall Observation					Daily	Visual
				Daily Minimum	Daily Maximum		
	pH (Standard Units, (See Part I.A.1.c., BASF permit, Appendix 8-1)			6.0	9.0	Daily	Continuous
002	Flow [MGD]		[7.5]			5X/Week	Report Total Daily Flow
	Outfall Observation					5X/Week	Visual
003	Flow (MGD)		Unspecified			Weekly	Report Total Daily Flow
	1,2-dichloroethane (ug/1)*					2X/Year	Grab
	1,2-dichloropropane (ug/1)*					Monthly	Grab
	Bis(2-chloroisopropyl) ether (ug/1)*					Monthly	Grab
	Outfall Observation					Weekly	Visual

*Flow in million gallons per day (MGD).

A routine Compliance Survey Inspection was conducted on September 7-8, 1988. Composite and grab samples were collected and analyzed by MDNR (Table 8-5) and the effluent quality was within permit requirements. All organic concentrations were below levels of detection except for bis-(2-ethylhexyl)phthalate which was detected but not quantified in both the intake and outfall 001 (Table 8-6). A brief description of sampling methods and parameters analyzed are presented in Appendix 8-2.

The Discharge Monitoring Reports for Detroit Coke (for October, 1987 through January, 1990) indicate no exceedances. This facility is in compliance with its NPDES Permit.

8.2.1.17 Michigan Point Source Discharge Summary

This concludes the description of the major Michigan direct and indirect point source dischargers. All other Michigan Detroit SAOC facilities (excluding facilities discharging to the Rouge River) were in compliance with their NPDES permit requirements. Estimated loads of various parameters are presented in Section 8.3.

8.2.2 Summary of Ontario Point Source Discharges

The Ontario Ministry of the Environment employs a variety of measures to achieve compliance with its requirements, ranging from voluntary measures, formal programs, Control Orders, Requirements and Direction, Certificates of Approval to prosecution. This will change as MISA will set minimum legal requirements across the province.

The implementation of pollution control is a cooperative Federal/Provincial endeavour. Under the federal Fisheries Act, national legally binding regulations and voluntary guidelines set effluent limits for specific industrial sectors. Federal Guidelines set minimum acceptable national standards for existing plants, while regulations prescribe national effluent limitations for new and expanded plants for various industrial sectors. The only exception is the Federal Regulation for chlor-alkali plants which apply to both existing and new facilities.

Ontario has agreed, under the Federal-Provincial Accord for Environmental Protection, to adopt pollution control requirements which are at least as stringent as the national requirements. Since most Ontario plants are in the "existing" category, federal Guidelines apply to the vast majority of the plants. Currently these federal effluent Guidelines and Regulations (year of promulgation) apply to: Pulp and Paper (1971), Petroleum Refineries (1973), Metal Mining (1977), Mercury Cell Chloralkali Plants (1977), Metal Finishing (1977) and Meat and Poultry Processing Plants (1977) (Appendix 8-3). Under the Fisheries Act Regulations and Guidelines, it is an offense to violate a regulation limit. Although it is not an offense to exceed a guideline limit, meeting such a limit is considered compliance with the spirit of the law (Fisheries Act), which prohibits the deposit (discharge) of deleterious substances into waters frequented by fish. Federal Guidelines are, in fact, statements that indicate which practices will be considered necessary by the Federal Government to meet the intent of the Fishieres Act.

Legal Requirements:

Legally enforceable Control Orders (which are negotiated) under Section 113 of the Environmental Protection Act may be issued to any existing plant. Control Orders define tasks and compliance dates by which specific tasks must be completed. Legally enforceable Requirements and Directions may also be issued under Section 51 of the Ontario Water Resources Act. The requirements for issuance of these documents are different in the two Acts. For some sources, there are Federal Regulation limits.

Certificates of Approval (C of A) for sewage works are issued under the Ontario Water Resources Act. In the past, the C of A was an approval to install pollution control equipment with the design numbers shown in the C of A. Recently, some sewage work approvals have begun to include legally enforceable effluent limits.

Effluent Guideline Limits:

Historically, for most sources, Ontario has taken an effluent guidelines approach in setting provincial requirements. This approach, which was incorporated into the "Industrial Guidelines", was based initially on experience with municipal sewage treatment systems. It was presumed that treated industrial effluents should have the same pollutant concentrations as tested municipal effluent. However, since industrial effluents are quite different from municipal effluents in regard to specific pollutants, pollutant concentration and volume flow, application of the same treatment technology did not result in similar treated effluent concentrations. Industrial wastewater effluents in many cases would require dilution by cooling water, etc., to meet the effluent concentrations. Guidelines allow for this difference where similar treatment technology has been installed.

New plants recycle and reuse water in-plant to a much greater extent that do older plants. As a result, even when such plants use a highly effective treatment system, the effluent may exceed concentration limits. In these situations, the Ministry sets loading limits on a kilograms per day basis rather than on an effluent concentrations basis.

Ontario also uses a "water quality approach" in setting effluent limits*. In the case of biodegradable pollutants, every river or lake has a definable dilution, dispersion or assimilation (self-purification) capacity for non-persistent waste discharges. Water quality considerations take precedence when biodegradable discharges exceed the assimilative capacity of the receiving waters, but are within the limits set by Federal Guidelines or Regulations. In these cases more stringent requirements, based on the assimilative capacity, are used to set effluent loading limits. Some of these biodegradable compounds are defined as toxic organics. The degree of biodegradation varies for specific compounds.

* Water Management: Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment. November 1978, Revised May 1984.

Best Professional Judgement Limit:

Where there are no legal limits, the MOE District Officer may set a requirement based on his best professional judgement. This incorporated a review of the manufacturing technology, effluent treatment technology and past performance. The source will have demonstrated that its effluent quality can be controlled at lower limits than those in any Guidelines.

Where innovative technology is being tried, the limits and/or conditions may be set out in a Certificate of Approval. Best professional judgement would also be used in this case.

Thus, limits to the various discharges are set in several forms: pollutant concentrations (milligrams per litre), pollutant loadings (kilograms per day), load per unit of production (kilograms related to production rate), and radioactive loadings (becquerels per litre per day). These limits may be based on any of the above rationales.

All dischargers to the surface waters of the Province of Ontario are are as a minimum, required to follow the Ontario Industrial Effluent Objectives established under the Ontario Water Resources Act. Municipal facilities are subject to limitations as per the 1983 Canada/U.S. Agreement on Great Lakes Water Quality and Policy 08-01 "Levels of treatment for municipal and private sewage treatment works discharge to surface waters".

A summary of the major Ontario direct and indirect dischargers to the Detroit River and their monitoring requirements are shown in Tables 8-22 and 8-23. Their locations are shown in Figure 8-4.

There are four industries which discharge into the Detroit River from the Ontario side on the border. Their discharges may be classified as direct or indirect. The direct dischargers are: Ford Motor Company of Canada, Ltd., The Canadian Salt Company Ltd. and General Chemical Canada Ltd. The indirect discharger is Wickes Manufacturing Company Ltd. which discharges into the Little River, tributary to the Detroit River.

MISA (Municipal-Industrial Strategy for Abatement) regulations for the industrial sector will effect all the above industries except for Wickes Manufacturing Company Ltd., which will be regulated under the municipal sector starting in the summer of 1990.

There are six Ontario municipal sources which discharge into the Detroit River. Four sources are direct and two are indirect. The direct dischargers are: Edgewater Beach Lagoon; Boblo Island Lagoon; Amherstburg Pollution Control Plant; and the West Windsor Pollution Control Plant. The indirect dischargers are: Little River Pollution Control Plant, which discharges into the Little River, and the Essex Lagoon S.W. which discharges into the Canard River. Both rivers are tributaries of the Detroit River.

Table 8-22. Ontario facilities directly discharging to the Detroit River, their type of operation and the parameters requiring effluent limits, monitoring or observation.

Facility Name	Operation Type	Parameters Requiring Effluent Limits Monitoring or Observation*
Amherstburg WPCP	Primary industrial/ municipal wastewater treatment	Flow, BOD, TSS, total phosphorus
Ford Motor Co. of Canada Ltd.	Auto parts manufacture	Flow, TSS, COD, pH, oil and grease, total iron, total fluoride, total phenols, organic carbon, total metals, phenolics, nitrogen compounds, total phosphorus, halogenated volatiles, non-halogenated volatiles, water soluble volatiles, base neutral extractables, fatty and resin acids, PCBs.
General Chemical	Chemical manufacture	Flow, TSS, ammonia-N, chloride, total phosphorus, total fluoride, pH, total cyanide, ogranic carbon, total metals, hydrides, hexavalent chromium, mercury, phenolics, sulphide, halogenated volatiles, sulphate.
West Windsor WPCP	Primary chemical treatment facility treatment	Flow, BOD, TSS, total phosphorus
The Canadian Salt Company, Ltd.	Salt mining	Flow, alkalinity, chloride, pH, residue (filtered, particulate, total)
Hiram Walker and Sons	Distillery	No C of A issued since facility discharges only cooling water to Detroit River.

*Industrial facilities will be required to monitor for parameter identified on sector specific schedules from the Effluent Monitoring Priority Pollutants List (EMPPL) containing 266 parameters (Appendix 8-3).

Table 8-23. Ontario facilities discharging indirectly via the Little River to the Detroit River, their type of operation, and the parameters requiring effluent limits, monitoring or observation.

Facility Name	Operation Type	Parameters Requiring Effluent Limits Monitoring or Observation*
Wickes Mfg.	Auto/truck bumper manufacture	Flow, TSS, dissolved solids, pH, total chromium, total copper, total iron, total nickel, total zinc
Windsor Little River WPCP	Conventional activated sludge	Flow, BOD, TSS, total phosphorus, pH, dissolved oxygen, ammonia, total Kjeldahl nitrogen, alkalinity, temperature, total chlorine residual, fecal coliform

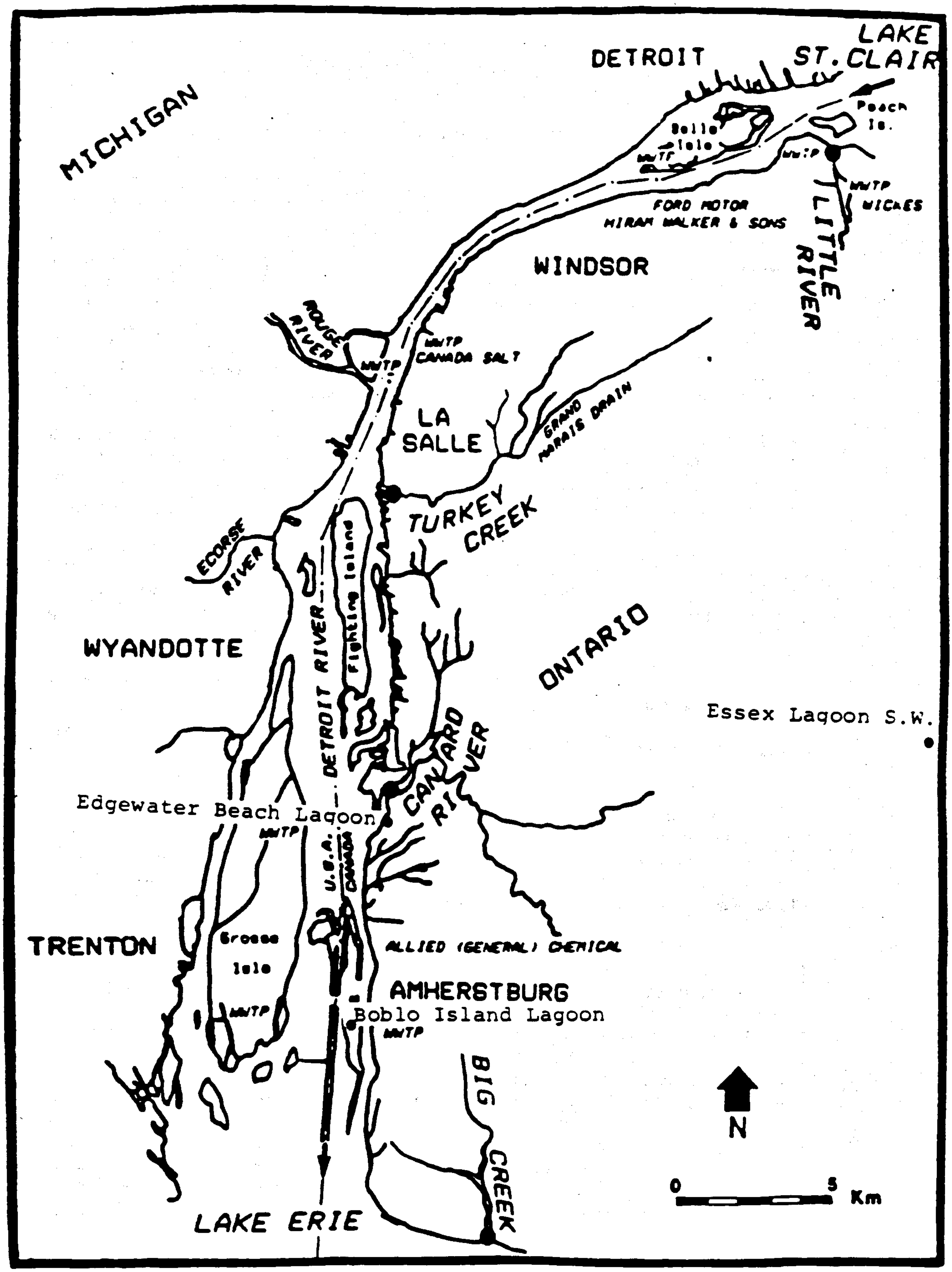


Figure 8-4. Location of Ontario direct and indirect point source discharges to the Detroit River.

The MISA program for the municipal sector is undergoing development and monitoring dates have not been set. Once in effect, the program will establish monitoring and compliance limits for a wide range of contaminants discharged from Ontario municipal sources.

There are 21 Combined Sewer Overflows (CSOs) along the City of Windsor Waterfront (Figure 8-5). While combined sewer overflows are not subject to C's of A, a significant body of work was conducted in 1985 as part of the UGLCCS investigation to document the occurrence of overflows and the extent of organic contaminants entering the Detroit River by way of CSOs. Additional work to document the impact of bacteriological contamination due to combined sewer overflow into the Detroit River is being conducted as part of a 1990 investigation.

Facilities which use non-contact cooling water are: Hiram Walker & Sons Ltd., ADM Agri Industries Ltd. and the University of Windsor. This water is taken from the Detroit River, used for condensing or cooling, than is discharged back into the river.

The sources of back-flush are from the water treatment plants located along the Detroit River. There are four such plants: The City of Windsor, The Town of Amherstburg, the Island of Boblo, and General Chemical Ltd. which serves the General Chemical-Allied Chemicals Complex.

The following section details all municipal and industrial facilities discharging directly or indirectly to the Detroit River within the Source Area of Concern.

8.2.2.1 Amherstburg Water Pollution Control Plant (110002407)

The Town of Amherstburg, Township of Anderdon and Township of Malden Pollution Control Plant was built in 1967 as a primary treatment plant with a rated capacity of 4545 cubic metres (1. MGD). The plant receives separate and combined flows from the Town of Amherstburg and Township of Anderdon and from separated sewers in the Township of Malden. Sewage flows are pumped to the plant from a pumping station located approximately a half a kilometre north of the plant.

The plant facilitates the removal of phosphorous by the addition of ferric chloride were installed in 1975.

The plant was upgraded and expanded to treat a volume of 7770 cubic metres per day in 1985. The upgrading included expansion of the pumping station, installation of two Hydrasieve screens to reduce the loading on the primary clarifiers, construction of a 20 metre diameter by 3.3 M SWD clarifier and a 61.4 cubic metre sludge holding/thickening tank. The ferric chloride and polymer metering pumps were replaced by new equipment. The chlorine disinfection was replaced and upgraded with the installation of a 181.8 cubic metre chlorine contact tank and an adjustable feed rate chlorinator.

The initial plant was designed in 1967 to serve a population of 5500 and was upgraded in 1985 to serve the population of 8500 people with an ultimate design capacity of 14,000 people.

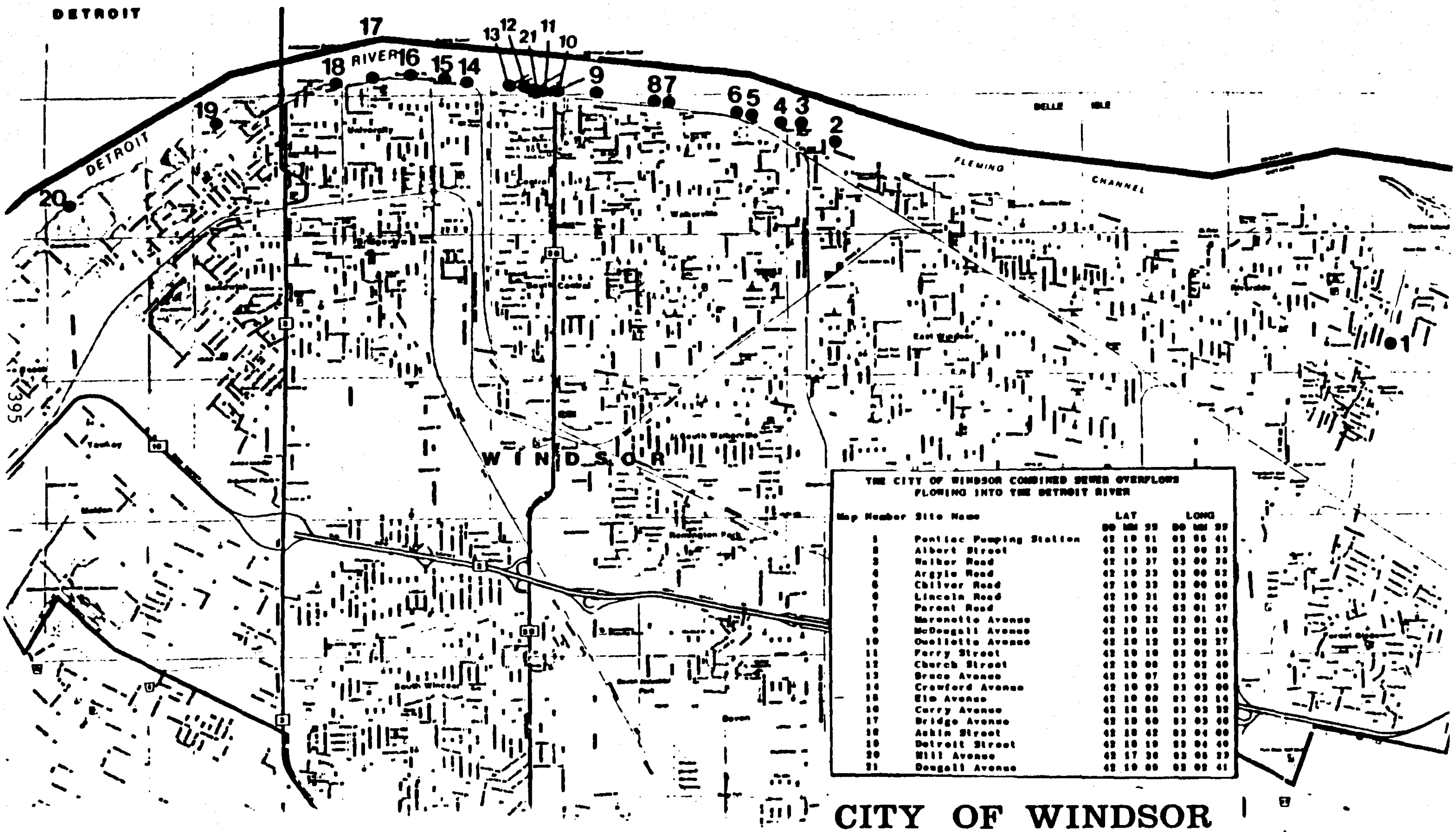


Figure 8-5. Ontario combined sewer overflows to the Detroit River.

The raw sewage from the pumping station is directed to the hydrasieve screens for removal of fine solid material. Ferric chloride and polymer are added ahead of three primary clarifiers. Chlorine is added and then the effluent is then sent to the chlorine contact chamber from where it is then discharged to the Detroit River. The solids from the primary screening is taken to landfill. The sludge from the primary clarifiers is pumped to a sludge holding tank. The sludge is dewatered with a belt press with the filtrate being returned to the plant inlet. The dewatered sludge is taken to a landfill for disposal.

The facility is authorized to discharge treated municipal industrial wastewater to the Detroit River. Such discharge shall be limited and monitored as follows:

	Discharge Limitations			
Effluent Characteristic	Annual Average	Monthly Average	Sample Type	Measurement Frequency
Flow				Daily
Biochemical Oxygen Demand (BOD_5)	50% removal		24-hr Comp	Monthly
Suspended Solids	70% removal		24-hr Comp	Monthly
Total Phosphorus		1.0 mg/l	24-hr Comp	Monthly

The facility was in compliance with the Ontario effluent objectives in 1988, as outlined in Figure 8-6.

Total phosphorus and ammonia nitrogen loadings are presented in Figure 8-7 and Appendix 8-3. Phosphorus loads have declined steadily since 1986 to their present level of 5.1 kg/day.

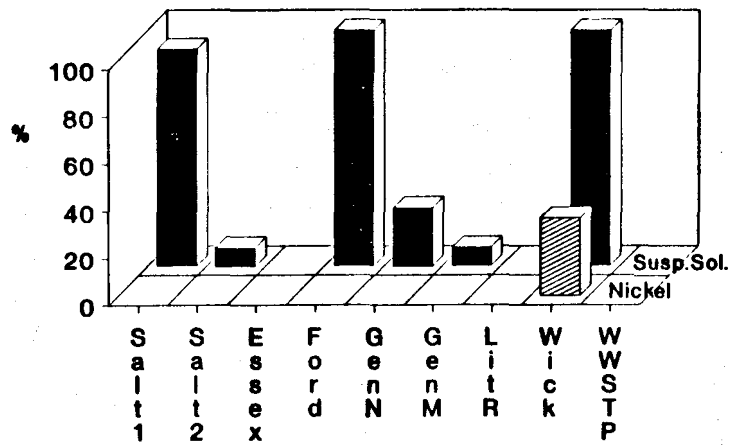
8.2.2.2 Ford Motor Company of Canada Ltd. (0000020107)

The Ford Motor Company Windsor Casting Plant manufactures engine blocks and transmission parts for passenger motor vehicles. Parts are machined and assembled into engines and transmissions.

The facility is authorized to discharge treated wastewater to the Detroit River. Such discharges are limited and monitored by the facility as specified below:

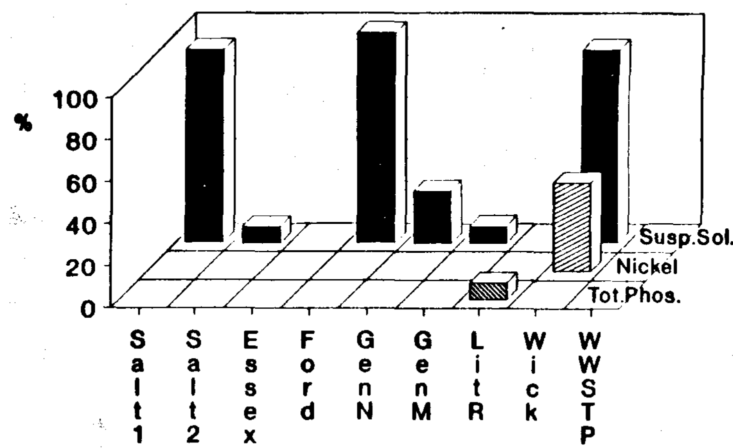
	Discharge Limitations (kg/day)			
Effluent Characteristic	Monthly Average	Annual Average	Sample Type	Measurement Frequency
Flow				Daily

1985



1985

1986

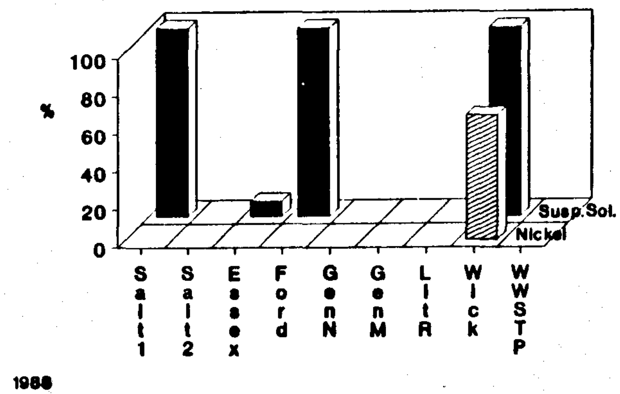


1986

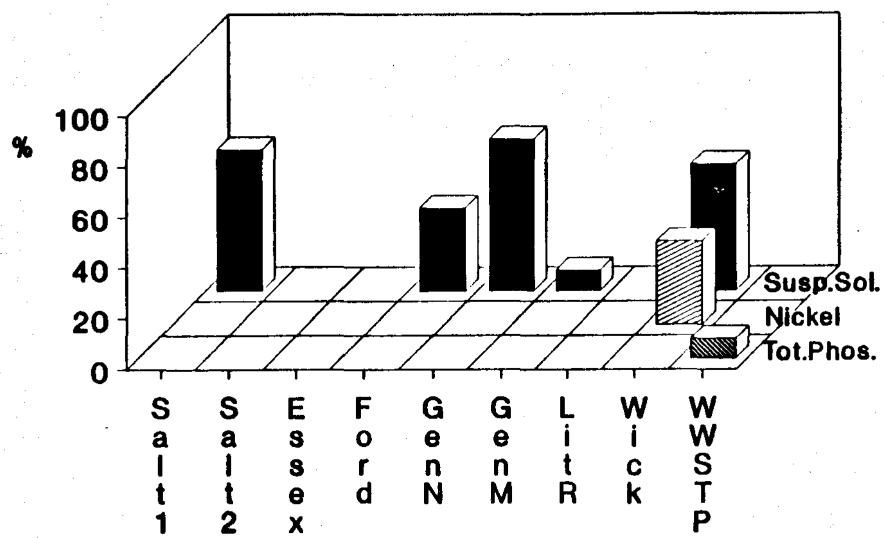
Salt1:	Canada Salt (Control Pt. 1)	Ford:	Ford Motor Co.	LitR:	Little River WPCP
Salt2:	Canada Salt (Control Pt. 2)	GenN:	General Chemical (North Drain)	Wick:	Wickes Mfg.
Essex:	Essex Lagoon S.W.	GenM:	General Chemical (Main Drain)	WWSTP:	West Windsor WPCP

Figure 8-6. Levels of non-compliance with Certificate of Approval requirements for Ontario dischargers (%).

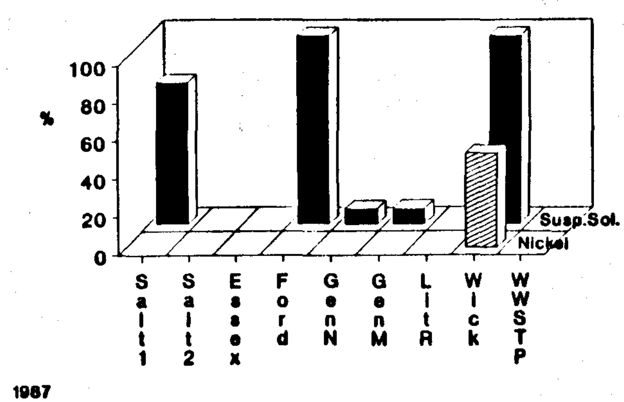
1988



1989



1987



Salt1:	Canada Salt (Control Pt. 1)	Ford:	Ford Motor Co.	LitR:	Little River WPCP
Salt2:	Canada Salt (Control Pt. 2)	GenN:	General Chemical (North Drain)	Wick:	Wickes Mfg.
Essex:	Essex Lagoon S.W.	GenM:	General Chemical (Main Drain)	WWSTP:	West Windsor WPCP

Figure 8-6. (Continued) Levels of non-compliance with Certificate of Approval requirements for Ontario dischargers (%).

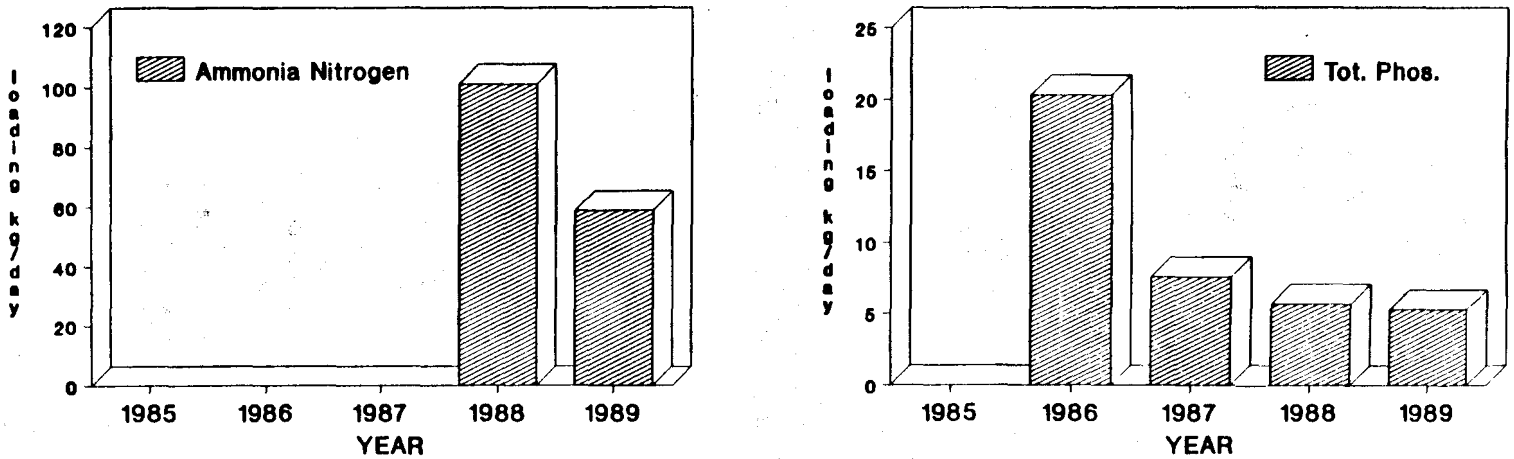


Figure 8-7. Total phosphorus and ammonia-nitrogen loads from the Amherstburg WPCP.

Suspended Solids (R)	15 mg/l	1084	24-hr Comp	Daily
Chemical Oxygen Demand (COD)				Daily
Oil and Grease (G)	15 mg/l	1084	24-hr Comp	Daily
Total Fluoride				Daily
Total Iron (G)	17 mg/l	1218	24-hr Comp	Daily
Phenols	0.02 mg/l	1.45	24-hr Comp	Daily
	Daily Maximum	Daily Minimum		
pH	5.5	9.5		

(G) - Guideline
(R) - Requirement

The Ford Motor Company record of Compliance with effluent guidelines and requirements is illustrated in Figure 8-6.

Special Condition - MISA Monitoring Regulations

The Ford Motor Co. was selected by MISA as one of a number of facilities in the Industrial Metal Casting Sector to monitor and analyze specific parameters.

The monitoring program under MISA regulations, to determine effluent limits commenced May 1, 1990. This program was designed to reduce discharges of toxic contaminants to the Detroit River by implementing new effluent limit regulations which are expected to be in place by 1992. The final effluent will be monitored on a daily, thrice weekly, weekly or monthly basis for an extensive lists of parameters (Appendix 8-3).

Open characterization samples are those which are analyzed by Gas Chromatograph (GC). These samples are identified but not quantified in order to provide an initial screening to determine if some effluent constituents have not been accounted for. Open characterization samples will be taken once per quarter from all process effluent and combined effluent streams to determine the presence of additional compounds which may need to be added to the monitoring list.

This facility is also required to perform monthly biomonitoring using rainbow trout and *Daphnia magna*. Toxicity testing will be conducted in accordance with MOE standard procedures including: "Protocol to Determine the Acute Lethality of Liquid Effluents to Fish, July 1983," and "*Daphnia magna* Acute Lethality Toxicity Test Protocol, April 1988."

Biomonitoring during 1988 indicated that final effluent was acutely toxic to rainbow trout in 11.1% effluent (Table 8-24).

In 1988 the Ford Motor Company of Canada exceeded its suspended solids requirements during the entire year. Since remedial actions were taken, the monthly average suspended solids concentrations were reduced from over 50 mg/l early in 1988 to less than 20 mg/l by the end of 1988. Improved operations may bring the effluent into compliance with the suspended solids requirement of 15 mg/l.

The phenols effluent guidelines of 0.020 mg/l (not a legal requirement) was also exceeded throughout 1988. In-plant modifications resulted in the reduction of average monthly concentrations of phenols from about 0.600 mg/l in January to less than 0.100 mg/l in August. Phenols concentrations increased to approximately 0.300 mg/l by the end of 1988. An appropriate phenol effluent requirements for this facility's discharge is currently under review.

The Ford casting plant makes use of a lagoon to treat their effluent. The wastewater first passes through clarifiers to remove solids, through alum addition and sedimentation, before entering the oil polishing lagoon. Their lagooning process involves skimming for the removal of oil before the wastewater is discharged into the Detroit River.

A general decline in loadings has been observed in the period from 1985 to 1989 for several parameters including iron, suspended solids and oils and greases (solvent etc.) as demonstrated in Figure 8-8.

Monthly monitoring and loading results are presented in Appendix 8-3. The facility had a total compliance record of 60% for meeting its effluent limitations in 1988. Enforcement actions were taken against the Ford Motor Company resulting in a July 1987 fine of $7,500 for infractions under the Ontario Water Resources Act.

8.2.2.3 General Chemical Canada Ltd. Amherstburg (00000100009)

General Chemical Canada Ltd. is located beside the Detroit River just outside the town of Amherstburg. It employes approximately 500 people and manufactures soda ash and calcium chloride. Allied Chemicals Canada, Inc. manufactures Genetrons* (chlorofluorocarbons) and hydrogen fluoride at the same complex. General Chemical Canada has two outfalls which discharge into the Detroit River, the North Drain and the Main Drain.

Soda ash is produced by the Solvay process. Brine solution is pumped from wells where it is carbonated and reacted with slaked lime to form sodium carbonate product, and calcium chloride a co-product. The calcium chloride solution also contains sodium chloride, lime, inert solids and ammonia. This solution is pumped to the calcium chloride plant where it is clarified and concentrated to product a final product. Excess liquid is sent to the soda ash settling basin.

* Genetron is a registered trade mark of Allied Chemicals Canada, Inc. for its chlorofluorocarbon product.

Table 8-24. Results of biomonitoring at Ontario Detroit River facilities.

Facility Tested	Test Date	Outfall Tested	Organism Used	Test Type	Toxicity Results
Ford Motor Co. of Canada	1988	Process Effluent	Rainbow Trout	A	Toxic at 11.1% Effluent
Wickes Mfg.	1988	Final	Rainbow Trout	A	Toxic at 80.6% Effluent

A = Acute

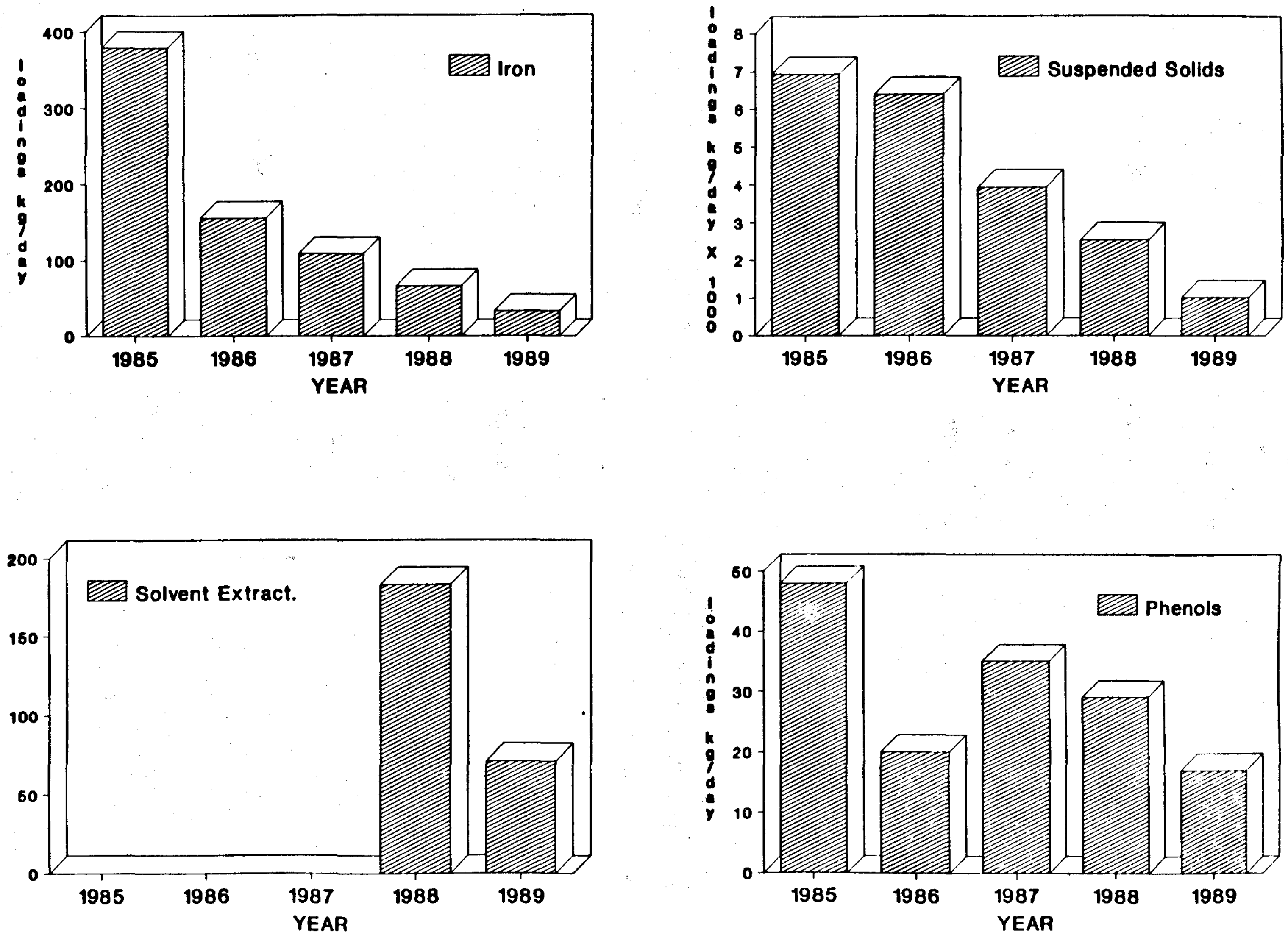


Figure 8-8. Iron, suspended solids, solvent extractables and phenols loadings from the Ford Motor Company, Ltd.

Soda ash is used as a major raw material in the manufacture of sodium salts, glass, detergents, as a reagent in ore processing and for pH control. Principal uses of calcium chloride include dust control and maintenance of secondary roads, freeze conditioning for coal and ores, as a conditioner for concrete and as a dehydrating agent.

Intake water is pumped from the Detroit River at a rate of 100,000 cubic metres per day.

Wastewater generated from within the plant is sent for processing to the calcium chloride plant. Calcium chloride is recovered from this wastewater after which it is pumped to a large lagoon for settling of solid material. A bleed stream from Allied Chemicals hydrogen fluoride facility is also pumped to the large lagoon for removal of suspended solids. The clarified water from this lagoon is sent to the Detroit River via the North Drain. Waste streams from the lime kilns, boiler blowdowns and barometric condensers are sent to the Main Drain. Allied Chemicals chlorofluorocarbons plant also discharges a process waste stream into the General Chemical's North Drain.

The UGLCC Study identified General Chemical Canada as being a source of copper, arsenic, cobalt, chlorides, ammonia, total organic carbon, fluoride and chromium in its effluent. The site monitors chloride, fluoride and ammonia under the IMIS program (MOE 1989).

All effluent streams from Allied Chemicals discharge enter into General Chemical's effluent drains. The effluent is characterized by inorganic salts, chlorides and carbonates. Effluent treatment occurs through by-product recovery and sedimentation. Their discharge is continuous. The monitoring program under MISA regulations started December 1, 1989; however, results are not available at this time.

The facility is permited to discharge treated wastewater via the Main Drain. Such discharge shall be limited and monitored by the facility as specified below:

	Discharge Limitations kg/day			
Effluent Characteristic	Monthly Average	Yearly Average	Sample Type	Measurement Frequency
Flow				Daily
Chloride				Daily
Suspended Solids (R)	15 mg/l	1774	24-hr Comp.	Daily

The facility is permitted to discharge treated wastewater via North Drain. Such discharge shall be limited and monitored by the facility as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Monthly Maximum	Yearly Average	Sample Type	Measurement Frequency
Flow				Dailv
Chloride				Daily
Total Fluoride (R)	200*		Automatic	Dailv
Total Ammonia Nitrogen				
Suspended Solids (G)	15 mg/l			Daily
	Daily Minimum			
pH	5.5			

(G) - guideline
(R) - requirement
*24 Hour maximum of 300 kg/day

The facility is allowed to discharge chloride at a total of 2.36×10^8 kilograms per year (519,000,000 lbs/year) with a daily maximum of 1.36×10^6 kilograms per day (2,990,000 lbs/day).

Special Condition - MISA Effluent Monitoring Regulations

MISA Effluent Monitoring Regulations for the Inorganic Chemical Sector requires monitoring of the effluent for numerous organic and inorganic parameters at frequencies ranging from daily to monthly (Appendix 8-3). This one year monitoring program, implemented in December 1989, was designed to determine the level of these constitutents in the discharge.

Characterization samples for all the required parameters must be collected semi-annually, at intervals of 6 to 8 months.

This facility shall conduct monthly acute biomonitoring of the effluent under the MISA effluents monitoring program for both the North and Main Drains, using rainbow trout and *Daphnia magna* (MOE 1988a, 1988b).

Fish kills in this vicinity occur infrequently (generally less than 1/year) and normally affect 10-20 fish. There is no information to suggest that General or Allied Chemical are responsible for these fish kills, and they may in fact be due to natural causes. Data from 1988 monthly monitoring indicates ammonia nitrogen loadings ranging from 64 to 332 kg/day, with an annual average of 174 kg/day.

The facility was in compliance with its discharge limitations in 1988, as indicated in Appendix 8-3. Loadings from the North Drain and Main Outfall for selected parameters from 1985 to 1989, appear in Figure 8-9 and Figure 8-6. No observable decreases or trends are apparent with the exception of reduced Ammonia Nitrogen from the North Drain.

8.2.2.4 Allied Chemicals Canada, Inc. - Amherstburg

The Allied Chemicals plant which employs approximately 100 people is located just outside the town of Amherstburg along the Detroit River. The Allied Chemicals facility originally included the General Chemical Canada complex where soda ash and calcium chloride are produced. However, due to a corporate spin-off, Allied Chemicals Canada and General Chemical Canada are now separate, independent companies operating at the same location.

Allied Chemicals operates the hydrofluoric acid plant, the Genetron* facility (which produces chlorofluorocarbons) and is responsible for effluent discharges from an on-site quarry.

Hydrogen fluoride is produced from the reaction of sulphuric acid and fluorspar (calcium fluoride), with gypsum (calcium sulphate) being formed as a byproduct. The Genetron* facility produces chlorofluorocarbons by the reaction of carbon tetrachloride or chloroform with hydrogen fluoride.

Hydrogen fluoride is used as a catalyst in the petroleum industry, as an additive for dyes and in the manufacture of certain plastics. Chlorofluorocarbons are used as refrigerants and as blowing agents in the manufacture of plastic foams.

Intake water is supplied by General Chemical Canada from the Detroit River. Wastewater from the hydrogen fluoride plant consists of a neutralized gypsum residue stream which is pumped to a settling basin. The supernatant liquid is recycled back into the process while excess liquid is bled to the General Chemical soda ash waste settling basin which discharges to the Detroit River.

Waste streams from the Genetron* plant include a drain from a collection sump for process effluent, spills and washdowns which discharge into General Chemical's North Drain. A waste hydrochloric acid stream is pumped to General Chemical's soda ash waste settling basin. A small caustic stream is sent to General Chemical for addition to its brine mud. The stream is treated to reduce chlorides before it is returned to the hydrogen fluoride plant for neutralization of the gypsum byproduct stream. A once-through cooling water stream from the compressors is discharged into General Chemical's Main Drain.

Allied Chemicals also discharges effluent from an on-site quarry. This old mined-out quarry collects stormwater and chloride contaminated groundwater. The Ministry has required the plant to keep the level of quarry water below the ground water level to reduce the extent of

* Genetron is a registered trade mark of Allied Chemicals Canada, Inc. for its chlorofluorocarbon product.

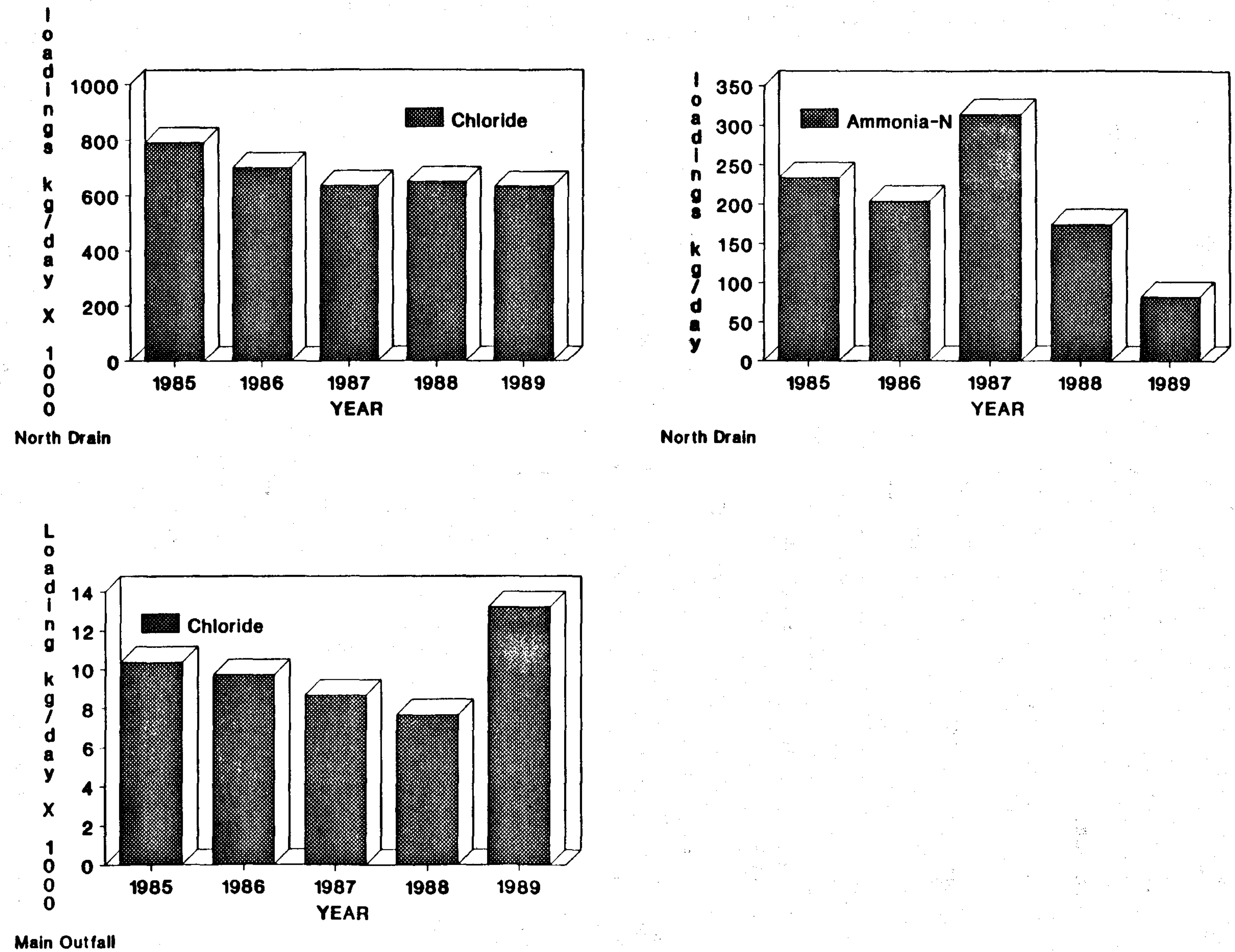


Figure 8-9. Chloride and ammonia-nitrogen loads from General Chemical Canada, Ltd.

ground water contamination. The quarry is periodically pumped to the South Drain which discharges to the Detroit River.

As all effluent streams from Allied Chemicals (except the on-site quarry) discharge into General Chemical's effluent drains, there is no historical data on pollutants in waste streams from Allied Chemicals Canada.

There are no IMIS monitoring requirements for Allied Chemicals Canada (MOE 1989).

8.2.2.5 Little River Water Pollution Control Plant (120001096)

The Little River Pollution Control Plant (LRPCP) is located on the east side of Windsor and discharges to the Little River about 1 kilometer upstream from the Detroit River. The sewershed for the plant covers an area of approximately 4,000 hectares and includes the part of Windsor generally east of Pillette Road, the Town of Tecumseh, the Village of St. Clair Beach and a portion of the eastern portion of the Township of Sandwich South.

The original plant, conventional activated sludge with a design capacity of 18,200 m^3/d, was constructed in 1965 by the former Town of Riverside and the Township of Sandwich East. In 1966 the City of Windsor annexed Riverside and Sandwich East and took over operation of the LRPCP. In 1974, the plant's rated capacity was expanded to 36,300 m^3/d to accommodate growth in the eastern part of the city and accept sewage from the adjacent municipalities. The expansion included the addition of two primary and two secondary clarifiers and facilities for chemical additional for phosphorus removal.

In 1986 the LRPCP was further expanded with the start of construction of Plant 2, activated sludge with a design capacity of 27,300 m^3/d. Plant 1 and Plant 2 give the LRPCP a total design capacity of 63,600 m^3/d average flow and 127,200 m^3/d peak flow. The LRPCP is operated to provide full treatment up to 2.2 times dry weather flow. Flows in excess of this are bypassed, after grit removal, and treated with sodium hypochlorite for disinfection prior to discharge to the Little River. At the present time, the average daily sewage flow to the LRPCP is about 40,000 m^3/d and the inplant bypass is set at 88,000 m^3/d.

The plant also has an emergency inlet bypass which is set to bypass flows in excess of 204,600 m^3/d. Any bypassed flow goes to the Pontiac stormwater pumping station which discharges into the Little River just north of the LRPCP. This plant bypass has not been required to be used in the last four year.

Plant 1 is a conventional activated sludge treatment plant, which was converted from mechanical to fine-bubble diffused aeration during the recent expansion. Plant 2 is also a conventional activated sludge plant which can be operated in various modes, including conventional, step aeration, or utilizing an anoxic zone prior to aeration.

The facility shall not exceed the following final effluent limitations:

Effluent Characteristic	Design Objective	Monthly Average	Single Sample
Biochemical Oxygen Demand (BOD_5)		15 mg/1	25 mg/1
Suspended Solids		15 mg/1	25 mg/1
Total Ammonium Nitrogen		6 mg/1	8 mg/1
Total Chlorine Residual		0.5 mg/1	0.7 mg/1
Total Phosphorus		1 mg/1	1.5 mg/1
Dissolved Oxygen	4 mg/1		

Samples of the final effluent shall be analyzed for at least the following effluent characteristics:

Effluent Characteristic	Sample Type	Measurement Frequency
Biochemical Oxygen Demand (BOD_5)	24-hr Composite	Weekly
Suspended Solids	24-hr Composite	Weekly
Total Ammonium Nitrogen	24-hr Composite	Weekly
Total Kjeldahl Nitrogen	24-Hr Composite	Weekly
Total Phosphorus	24-Hr Composite	Weekly
Alkalinity	24-Hr Composite	Weekly
pH	Grab Sample	Daily
Temperature	Grab Sample	Daily
Dissolved Oxygen	Grab Sample	Daily
Total Chlorine Residual	Grab Sample	Daily

The treated effluent from both plants is disinfected by ultraviolet radiation rather than chlorination and aerated prior to discharge to the Little River. The Certificate of Approval requires the LRPCP to be operated to produce an effluent with less than 200 fecal coliform organisms per 100 mL during the period when disinfection is required (May 1 - November 1) and a dissolved oxygen content greater than 4 mg/1.

The above noted effluent limits may be modified based on recommendations arising from a Little River Comprehensive Stream Study which is being carried out in accordance with the Certificate of Approval. The study is to establish environmental quality of the river, identify all pollutant sources affecting the river, and develop a comprehensive pollution control plan for the Little River basin.

The LRPCP was one of the thirty-seven water pollution control plants included in the OME's MISA Pilot Monitoring Study. The results of the testing for an extensive list or organic and inorganic parameters in final effluent samples collected over a five-day sampling period (February 16 to February 20, 1987) are shown in Appendix 8-3. These results, along with others from the MISA Pilot Study, will be used to establish a list of parameters requiring monitoring and limitation under future MISA regulations for the municipal sector.

The LRPCP was in compliance with the OME guidelines for municipal discharges for BOD, SS, and TP in 1988 (Appendix 8-3). Figure 8-10 and Figure 8-6 present loadings for selected parameters in the period 1986 to 1989. A number of these parameters, while not currently regulated, likely will be subject to limits under MISA regulations.

8.2.2.6 West Windsor Water Pollution Control Plant (120001096)

The West Windsor Pollution Control Plant drains a sewer shed of 28,300 acres which includes all of the City of Windsor west of Pillette Road and the northern portion of the Township of Sandwich West. The population served by West Windsor is about 138,000 persons with an additional 11,950 people in Sandwich West.

The plant was constructed in 1970 as a 109,090 cubic metre primary treatment plant. In 1974, the City of Windsor added nutrient (phosphorous) removal facilities which essentially converted the plant from a primary treatment facility to a physical-chemical process. The addition of these facilities not only satisfied the requirement with respect to effluent phosphorous level of 1 mg/l or less but substantially improved the quality of the effluent with respect to BOD (biochemical oxygen demand) and suspended solids concentrations. In 1981 the plant was expanded to a capacity of 163,636 cubic metres/day to accommodate additional flows from the South Windsor area and to accept sanitary sewage from the adjacent Township of Sandwich West which was constructing a system of sanitary sewers through the Ministry of the Environment's Provincial Sewage Works Program. In addition in 1987 the Ministry of the Environment gave Windsor a $20 million grant to aid in connecting 4000 homes in South Windsor previously on septic tanks which drained directly into Turkey Creek. The construction program was spread over a six year period.

The plant is presently designed for a population of 300,000 persons at 163,400 cubic metres per day. The design removal rates are BOD at 114 mg/l at a rate of 40-75%, suspended solids at 180 mg/l at a rate of 80-90% and effluent total phosphorous content of 1 mg/l. The plant is hydraulically designed for 2.5 DWF (dry weather flow).

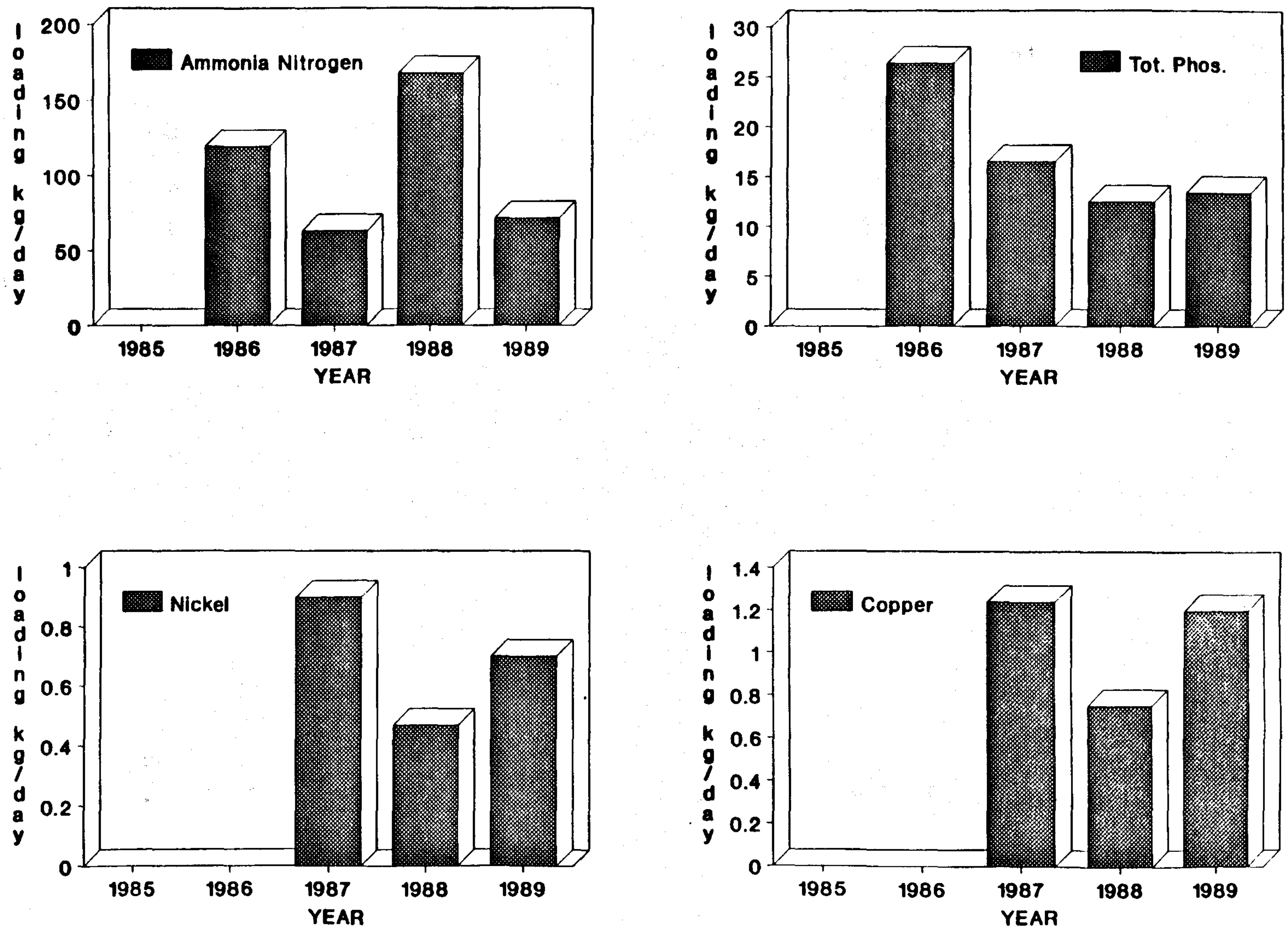


Figure 8-10. Loads of some heavy metals and conventional pollutants from the Little River WPCP.

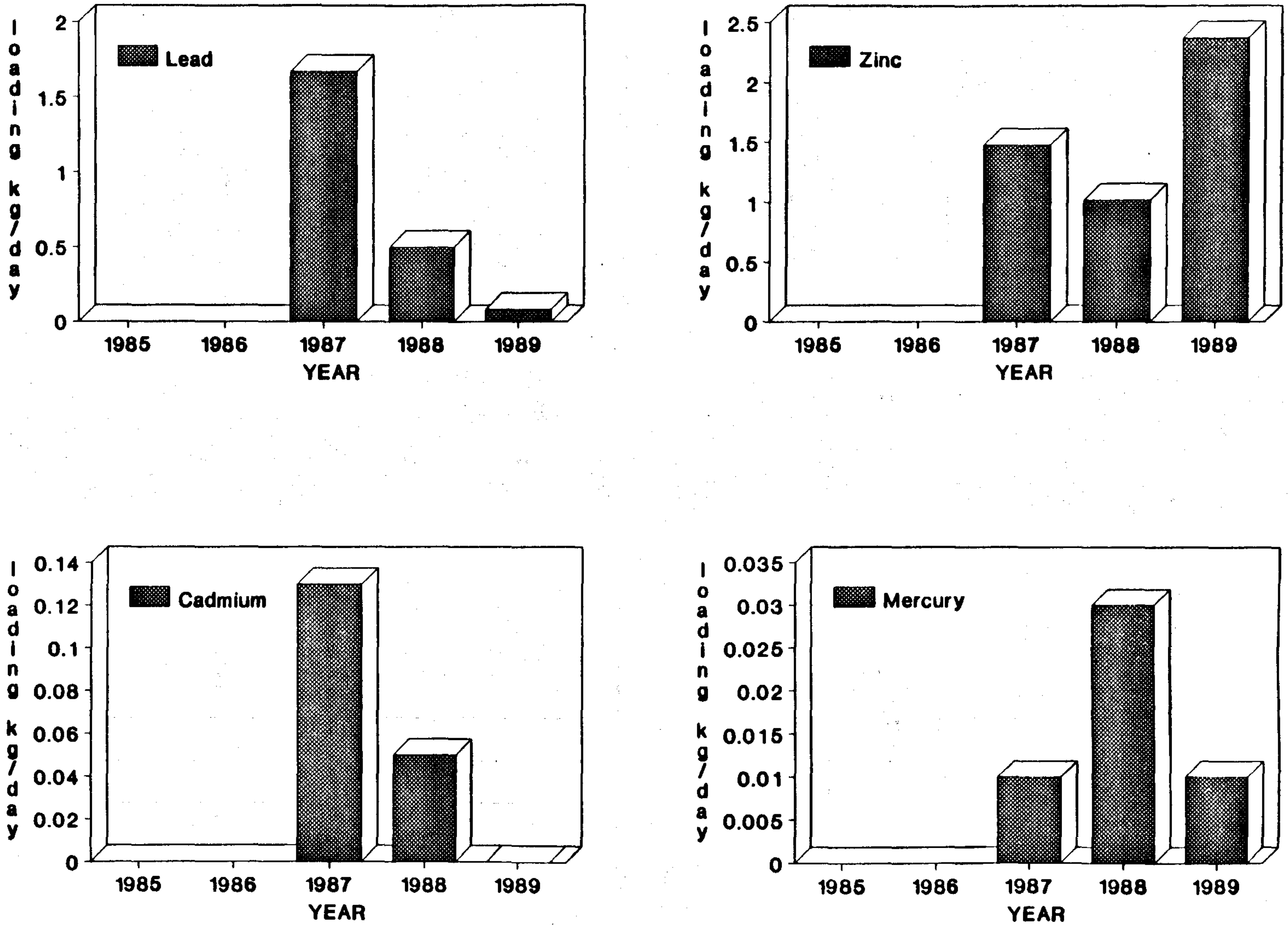


Figure 8-10. (Continued) Loads of some heavy metals and conventional pollutants from the Little River WPCP.

The raw sewage enters the plant into a 6.3M X 8.7M inlet chamber and passes through two sets of course bar screens Link Belt Straightline FMC Corporation. The screens are 2.4M wide by 3.9M high with 75 mm (3") clear openings and are mechanically cleaned. The automatic rake cleaning is activated when the liquid differential between upstream and downstream sides of the screens indicates that the screen should be cleaned. The screenings are sent by belt conveyor to a container for pickup and disposal at a landfill site.

The raw sewage wet well has two chambers and has a capacity of 623 cubic metres. To keep settled solids insuspension there is a 20" pipe wash system directed at the suction bell of each sewage pump. Each half of the raw sewage well has three pumps connected to it. The pumps are located in an annular dry well around the circular wet well. The maximum pumping capacity of all six raw sewage pumps is 953,000 cubic metres (210 MGD).

Raw sewage pumps discharge to two 1.5 M diameter reinforced concrete pressure pipe headers which convey the raw sewage to the fine screening and grit removal facilities. The raw sewage flows are measured in each header with Sparling Propeller Meters Type 906.

The raw sewage passes to two Passavant Posirake Model 1230 fine bar screens and two Rex Chain Belt (Canada) Ltd. fine bar screens. Each screen has a capacity of 341,000 cubic metres/day. The screens are automatically cleaned with the cleanings going to a storage hopper and then to landfill.

The sewage then flows through four aerated grit removal chambers each with the capacity of 112,500 cubic metres/day and two vortex grit removal changers each with a capacity of 170,000 cubic metres/day. The aerated grit chambers have retention times of 3 minute 10 seconds at design flow and the vortex grit chambers have a retention time of 24 seconds at design flow. Grit is removed in the aerated chambers by a pump mounted on a travelling bridge which travels the length of the tank. In the vortex chambers grit is removed by an air lift pump. The grit from all the chambers is further classified to remove organics which are sent back to the sewage flow and the grit which is sent to a hopper for storage and then it is taken to landfill.

The sewage then flows in two channels one to four primary clarifiers and one to two primary clarifiers. The flow is measured in each channel with a Parshall flume and flow control sluice gates equipped with Limitorque Modutronic electric operators to regulate the flow to ensure equal flow distribution among all the clarifiers. The 6 clarifiers are Eimco Corporation Type CT with a diameter of 36.6 M and a sidewall depth of 3.35 M. The capacity of each clarifier is 27,000 cubic metres/D.

A chemical solution of ferric chloride or aluminum trichloride (alum) is added to the raw sewage at the grit chamber discharge to promote the precipitation of phosphorous. Alum is being added now as the supplier was the lowest bidder.

The settled effluent from the clarifiers is collected into the tank effluent launder and conveyed to an outfall chamber where the effluent is chlorinated. Prior to discharging to the Detroit River the chlorinated effluent passes through automatic chlorine residual sampling facilities. The residual chlorine is automatically maintained between 0.5 and 1.0 ppm. The outfall line is used as the chlorine contact chamber and provides 15 minutes contact time before discharing to the Detroit River. The discharge outfall is located about 15 metres from shore in 2 metres of water.

Sludge from the clarifiers is directed to the sludge dewatering facilities where it passes through two inline macerators prior to discharge to the sludge holding tank. Sludge is pumped from the sludge holding tank to the dewatering centrifuges. An anionic polymer which promotes dewatering of the sludge solids is introduced to the primary sludge before it enters the centrifuge. The sludge cake is transferred by screw conveyor to sludge cake storage facilities. The liquid of cnetrifuge centrate is returned to the plant inlet works. There are two Bird Model HB6400 solid bowl centrifuges and 1 Bird LBC 900 X 1800 continuous solid bowl centrifuge. The cake produced has a solids content of 28%.

The sludge was composted by a private contractor at the West Windsor Plant from 1978 to 1990. The compost product was applied to a close landfill as a final cover and also used on right of ways and City gardens. In 1990 the same contractor was awarded a contract to lime stabilize the sewage sludge. The sludge cake is trucked off site to a site where the contractor adds lime to the sludge. Mixers in the truck mix the line and sludge. The sludge is them dumped on the old compost pads where it is allowed to stabilize. The stabilized sludge is presently being used as daily cover at a landfill. Some of the stabilized sludge may be applied to farmland in the future.

The facility is authorized to discharge treated municipal and industrial wastewater to the Detroit River, with industrial sources accounting for about 28% of the total flow. Such discharge shall be limited and monitored as specified below:

	Discharge Limitations			
Effluent Characteristic	Annual Average	Monthly Average	Sample Type	Measurement Frequency
Flow				
Biochemical Oxygen Demand (BOD_5)	50% removal		24-hr Comp.	
Suspended Solids	70% removal		24-hr Comp.	
Total Phosphorus		1 mg/l	24-hr Comp.	

Loadings for selected parameters are presented in Figure 8-11 and Appendix 8-3 for the period 1986 to 1989.

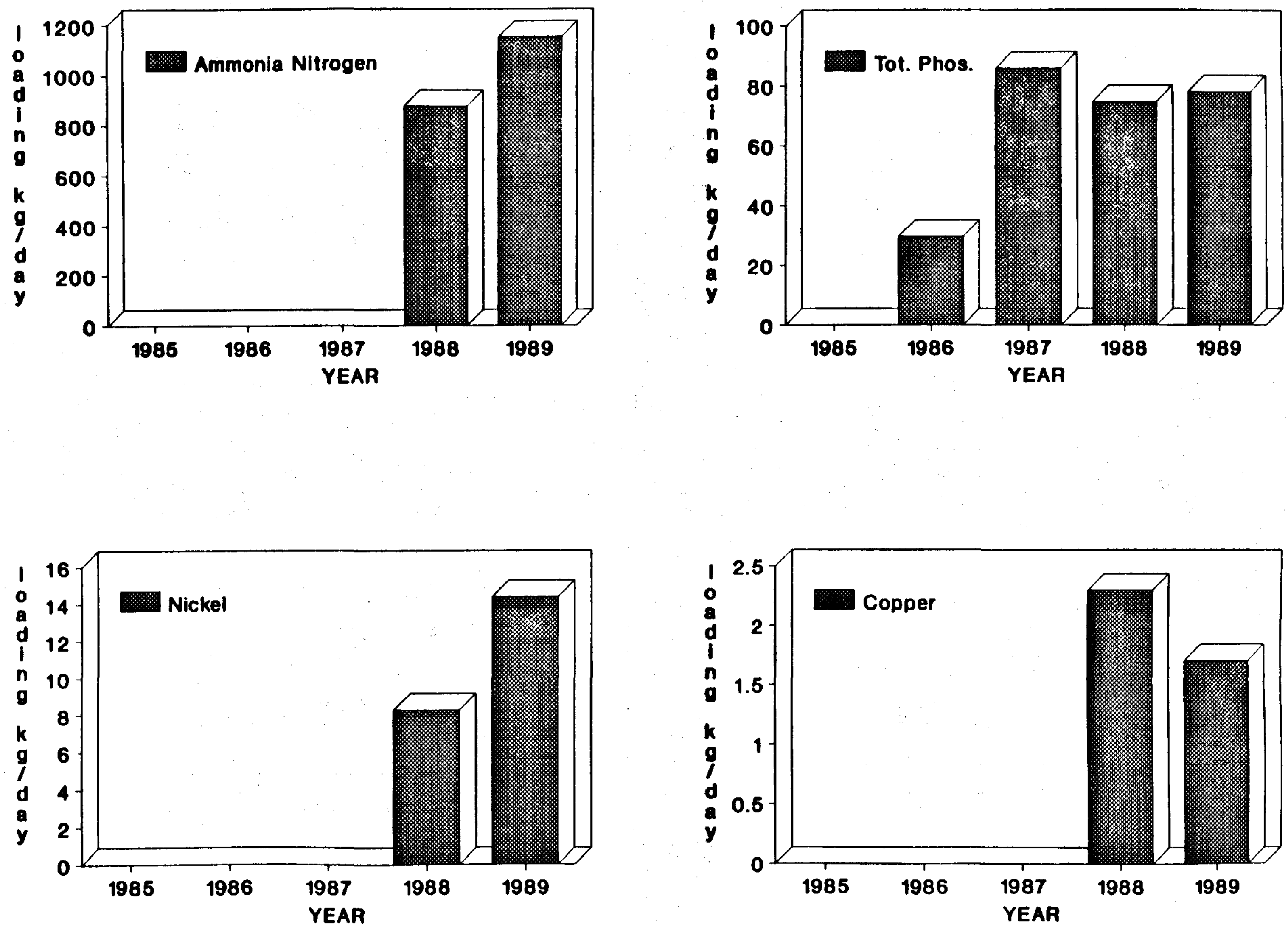


Figure 8-11. Loads of some heavy metals and conventional pollutants from the West Windsor WPCP.

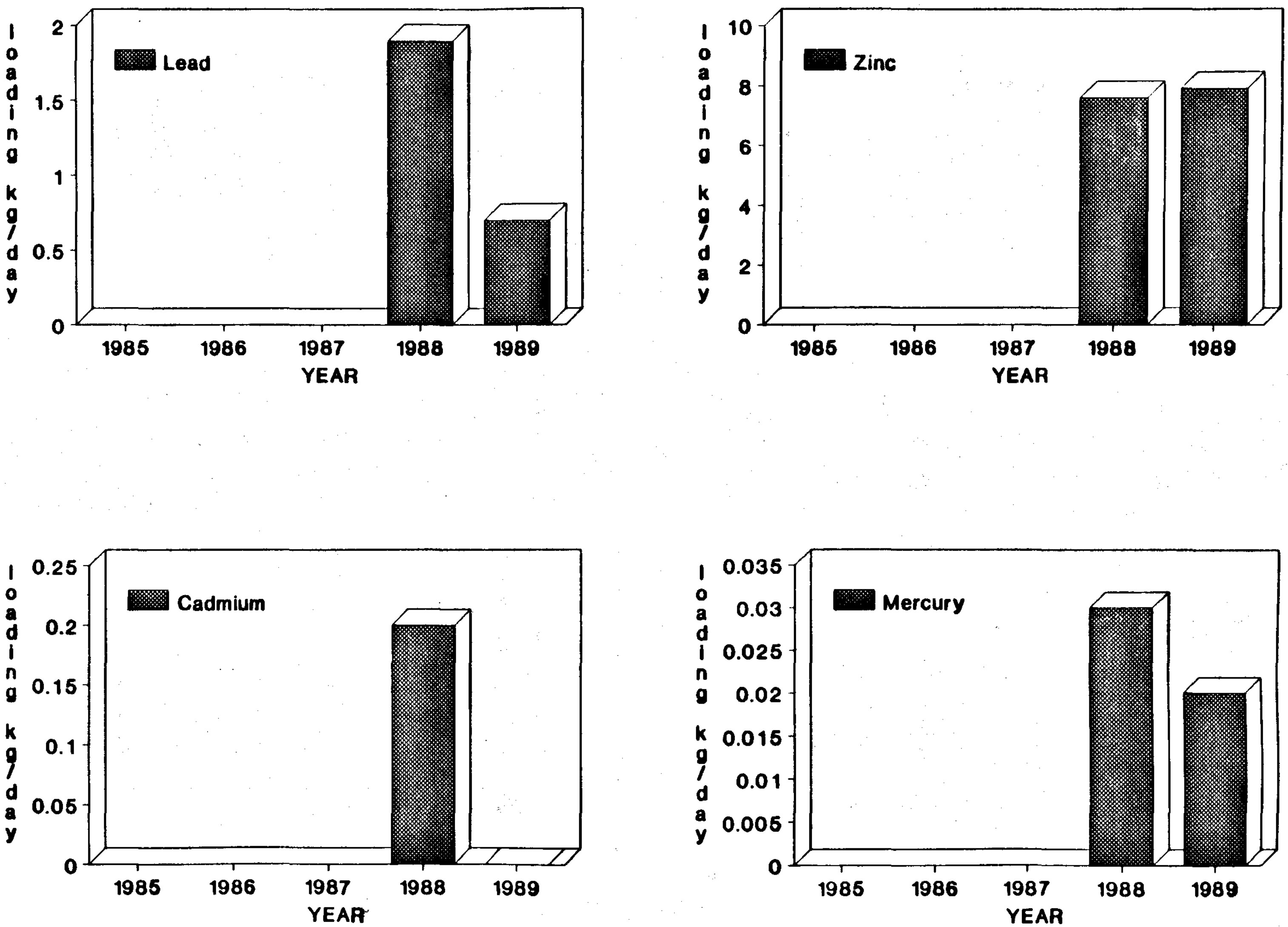


Figure 8-11. (Continued) Loads of some heavy metals and conventional pollutants from the West Windsor WPCP.

1. Special Condition - MISA Pilot Monitoring Study

The West Windsor WPCP was selected as part of a 1987 MISA municipal plant pilot study to monitor thirty-five final effluent parameters. Results of the five day monitoring (February 16 to February 20, 1987) are shown in Appendix 8-3.

The facility was in compliance with its suspended solids, biochemical oxygen demand and total phosphorus effluent limits, as identified in Figure 8-6.

8.2.2.7 Wickes Manufacturing Company Ltd. (001060003)

The Wickes Manufacturing Company formerly manufactured car and truck bumpers from flat rolled steel and electroplated the bumpers with a zinc or nickel and chrome finish.

The facility closed operations in September of 1990. No announcements with respect to the possible re-opening or decommissioning of the plant have been made.

Wickes was expected to be connected to the municipal sewer system in June 1990, following completion of the Little River Pollution Control Plant expansion and a sewer connection. The sewer line was completed; however, connection to the municipal sanitary sewer system was conditional upon completion of the expansion of the Little River Pollution Control Plant later in 1990, and also satisfactory performance of the private wastewater works.

Former effluent treatment occurred through chemical precipitation and sedimentation.

The facility is currently permitted to discharge treated wastewater to the Little River. The Certificate of Approval will remain in force until such time as the plant is decommissioned or sold. Such discharge shall be limited and monitored by the facility as specified below:

	Discharge Limitations		Monitoring Requirements	
Effluent Characteristic	Monthly Average	kg/day Yearly Average	Sample Type	Measurement Frequency
Flow				Daily
Suspended Solids (R)	15 mg/l	12.5	24-Hr Comp.	Daily
Total Chromium (G)	1 mg/l	0.83	24-Hr Comp.	Daily
Chromium (G)				Daily
Total Copper (R)	1 mg/l	0.83	24-Hr Comp.	Daily
Total Iron (R)	17 mg/l	14.1	Grab	Daily

Total Nickel (R)	1 mg/l	0.83	24-Hr Comp.	Daily
Total Zinc (G)	5 mg/l		Grab	Daily
	Daily Maximum	Daily Minimum		
pH (R)	9.5	5.5		

(G) : Guideline
(R): Requirement

1. Special Condition - Certificate of Approval

The above effluent criteria must not be exceeded as condition of Certificate of Approval No. 4-0151-87-886 approved by Section 24 of the Ontario Water Resources Act (issued May 17, 1988). These requirements were implemented to ensure the maintenance of the water quality of the Little River during construction of a wastewater treatment works at Wickes Mfg. Pretreated wastewater from the facility was diverted to the Little River WPCP for further treatment. Pretreatment provided by Wickes Manufacturing must meet the effluent quality required by the Sewer Use Bylaw of the City of Windsor.

The facility exceeded suspended solids, nickel and pH requirements during all months in 1988, as identified in Figure 8-6.

Loadings of monitored parameters in final effluent are presented in Figure 8-12 and Appendix 8-3. Wickes was charged in 1988 and fined $15,000.00 for infractions under the Fisheries Act.

Results of 1988 aquatic toxicity testing indicated the final effluent concentrations of 80.6% was acutely lethal to rainbow trout.

8.2.2.8 Edgewater Beach Lagoon

The Edgewater Beach lagoon is operated by Environment Ontario. The treatment system is a conventional lagoon with continuous phosphorus removal. It is discharged in the late spring into the Detroit River. Data from 1988 and 1989 sampling are presented in Appendix 8-3.

The Edgewater Beach Lagoon has a design influent capacity of $1.60 \times 10^3 m^3$/day. During 1988, the average daily flows to the lagoon were $0.52 \times 10^3 m^3$/day. Annual average spring discharges amounted to $51.81 \times 10^3/m^3$.

Influent is monitored on a monthly basis, while effluent quality is measured concurrent with the late spring discharge. Effluent quality is compared to the Ministry of the Environment general effluent guidelines. Biological Oxygen Demand (BOD) and Suspended Solids (SS) are assessed on an annual average, based on the operating requirements of Policy 08-01 "Levels of Treatment for Municipal and Private Sewage Treatment Works Discharging to Surface Waters".

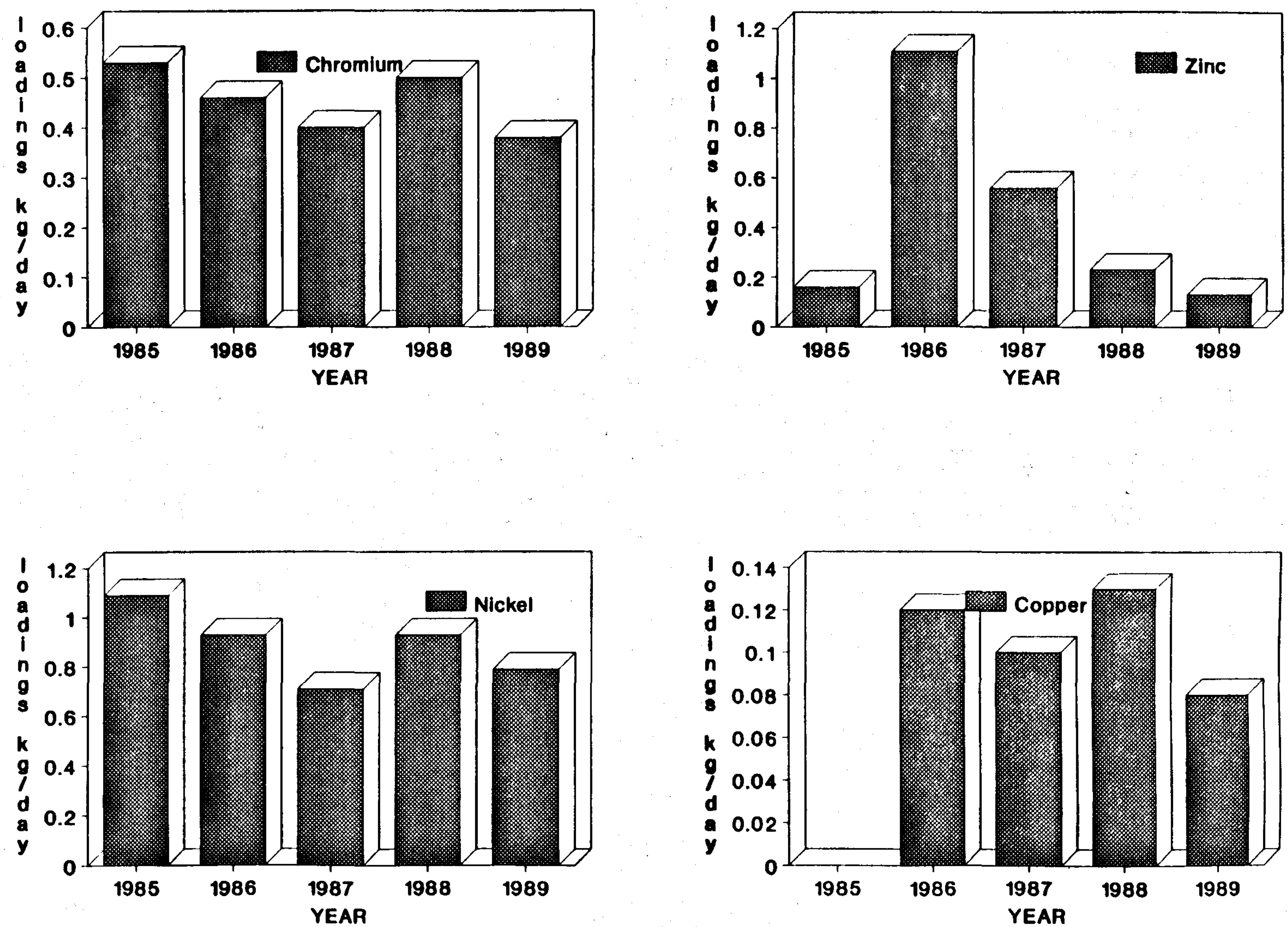


Figure 8-12. Loads of chromium, zinc, nickel and copper from Wickes Manufacturing Company, Ltd.

Prior to 1985, total phosphorus was also assessed on an annual average basis as stipulated in Policy 08-04 "Provision and Operation of Phosphorus Removal Facilities at Institutional and Private Treatment Works". However, in 1983 the United States and Canada agreed to tighten the control of total phosphorus discharged to the Great Lakes Basin. Currently, total phosphorus is assessed on a monthly average basis as specified in the Canada-US Agreement on Great Lakes Water Quality (October 1983). Policy 08-04 is currently under revision to reflect this more stringent requirement.

Effluent quality for the Edgewater Beach Lagoon from 1988 is within the MOE general effluent guidelines of 30, 40 and 1 mg/l, respectively for BOD, SS and TP (Figure 8-6).

8.2.2.9 Boblo Island Lagoon

Boblo Island lagoon is operated by the Island of Boblo Company. The island is located at the lower end of the Detroit River and operates seasonally as an amusement park. A certificate was issued by Environment Ontario for the building of their lagoon, which permits a yearly discharge in the Spring. Boblo Island lagoon effluent concentrations are similar to lagoons which have set limits imposed on them (Appendix 8-3).

The Boblo Island Lagoon discharges an estimated $3.63x10^3/m^3$ annually. A Certificate of Approval (3-0001-72-006) was issued for the construction of a sewage system/waste stabilization pond. In 1987, an extension of the C of A was issued to enable a boat sewage pumpout facility to discharge to the lagoon. Effluent results from 1988 and 1989 (Appendix 8-3) indicate that effluent quality is in accordance with MOE general effluent guidelines (Figure 8-6). In the event that these guidelines are not met, the facility would be required to discharge onto adjacent lands, with no discharge to the watercourse.

8.2.2.10 Essex Lagoon S.W.

The Essex Lagoon S.W. is operated by Environment Ontario. The treatment system is a conventional lagoon with continuous phosphorus removal. It is discharged into the Canard River twice a year, in April and November. Data from 1988 and 1989 sampling are presented in Appendix 8-3.

The Essex Lagoon S.W. has a design influent capacity of $1.52x10^3/m^3$/day. During 1988, average daily flows to the lagoon were $1.00x10^3m^3$/day. As the facility discharges on a semi-annual basis, average lagoon discharges were $95.35x10^3m^3$.

Influent is monitored on a monthly basis and effluents measured concurrent with the semi-annual discharge. Effluent quality is compared to the Ministry of the Environment general effluent guidelines.

Effluent quality from the Essex Lagoon S.W. is within the MOE general effluent guidelines of 30 mg/l for BOD, 40 mg/l for suspended solids and 1.0 mg/l for Total Phosphorus, as per Figure 8-6*. Effluent is also

*One Exception is noted for suspended solids in November 1988.

monitored for the following parameters: Ammonia, Total Kjeldahl Nitrogen, Nitrite and Nitrate.

8.2.2.11 The Canadian Salt Company Ltd.

The Canadian Salt Company Ltd. currently has one outfall which discharges into the Detroit River. The Company had two outfalls while monitoring with the IMIS (Industrial Monitoring Information System) program, but combined them into one for MISA monitoring. The MISA monitoring started February 1, 1990, and results won't be available until early in the summer. Canada Salt mines salt and prepares it for use. Their effluent contains dissolved salt (chlorides), is not treated and is discharged continuously to the Detroit River.

The company was in compliance with guidelines during 1988 (Figure 8-13); however, no Certificate of Approval is issued for this facility and it is required to meet Federal and Provincial guidelines, as identified in Section 8.2.2. Suspended Solids and pH have guideline levels of 15 mg/l and a range of 5.5 to 9.5 respectively. A summary of compliance with these guidelines is presented in Figure 8-6.

IMIS monitoring results from 1985 to 1989 are presented in Figure 8-13 for chloride and other selected parameters.

8.2.2.12 J. Clark Keith Generating Station

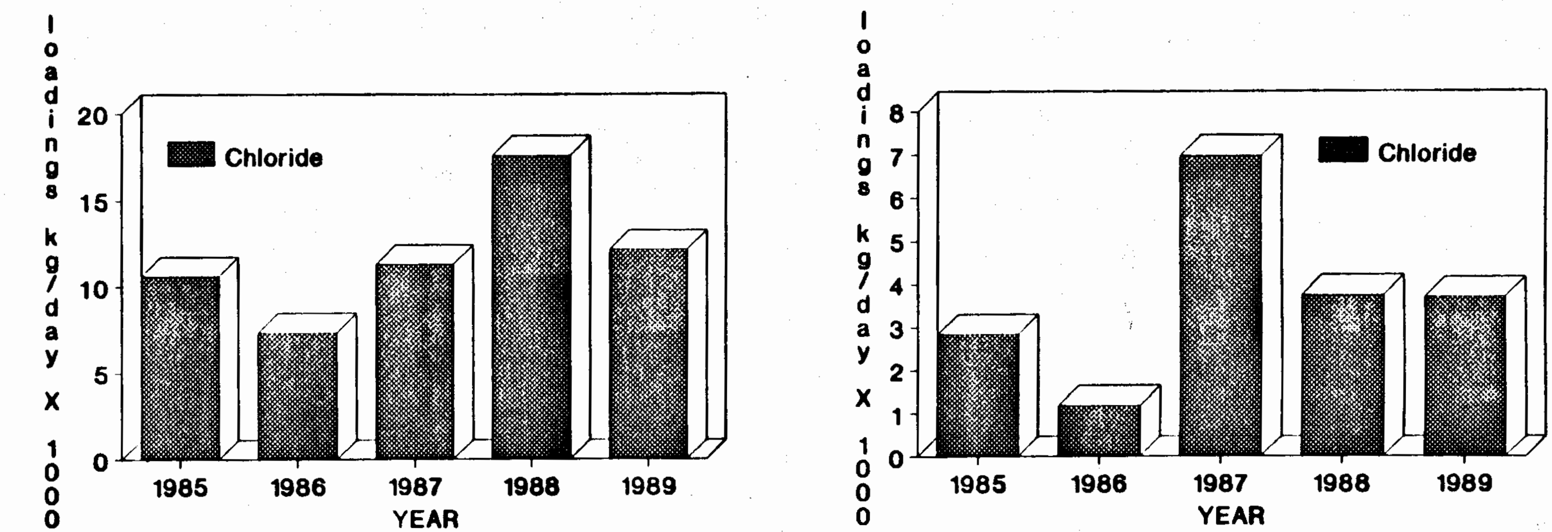
The J. Clark Keith Generating Station is located in the west end of the City of Windsor. It is owned by Ontario Hydro and was operated as a coal-fired station between the early 1950s (generating units were installed between June 5, 1952 and October 18, 1953) and early 1984.

There is currently a proposal by Ontario Hydro to operate two combustion turbine units in the province. J. Clark Keith is under consideration for one of those units.

The units will be designed to operate primarily on natural gas, with oil as a reserve fuel. An Environmental Assessment will be filed with Environment Ontario by the end of this year, identifying the preferred sites and documenting supporting studies. Pending approval, the first site is scheduled to be in service toward the end of 1993 and the second at the end of 1994.

J.C. Keith Switchyard is still operational, with drainage of the yard and former coal storage area entering the Detroit River by way of ash lagoons and primary and secondary weirs. At the present time only stormwater discharge is monitored.

MISA monitoring commenced in June 1990 for two areas of this facility: at the ash lagoon discharge and the yard drainage discharge. No limits will be imposed by MISA unless the plant is reactivated. If appropriate, requirements may be imposed by the District Office based on best management practices.



Control Pt. 1

Control Pt. 2

Figure 8-13. Chloride loads from Canadian Salt Company, Ltd.

MISA monitoring consists of grab samples obtained during storm events (i.e. rainfall exceeding 5 m in 24 hour period). Sampling is done once per month. As part of the MISA monitoring program, attempts are being made to obtain at least 12 samples from the monitoring period, in order that a satisfactory assessment may be made with respect to runoff quality.

If this station is chosen to house the new units, then effluent monitoring will be required under MISA's electric power generation sector.

8.2.3 Summary of Major Point Source Discharges to the Detroit River

The major point sources dischargers and estimated loads to the Detroit River are listed in Table 8-25. Most of these facilities are direct dischargers although some are located on tributaries near their confluence with the Detroit River.

Three sources of data were used to calculate loads from Michigan facilities. The data sources include self monitoring data, Short Term Waste Characterization Studies and Compliance Survey Inspections. The self monitoring data sets were preferred because they had to most observations and were the most recent. If self monitoring data were not available then the results of short term waste characterization studies were used. The results of compliance survey inspections were used when no self monitoring or waste characterization data were available. In addition, some of the samples collected during 1986 Compliance Survey Inspections were analyzed by EPA-LLRS as part of the UGLCCS effort. The results from EPA-LLRS analyses were used when concentrations of some parameters were not detected and lower detection levels were required. If concentrations were not detected, then loads were calculated using the level of detection and loads were present in Table 8-25 with a less than symbol. The flows and concentrations used to calculate the point source loads are presented in Appendix 8-4.

The loads from Ontario facilities were calculated using self monitoring data and data collected as part of UGLCCS. The flows and concentrations used to estimate loads are present Appendix 8-4.

All of the loads from Michigan facilities are gross effluent loads and facilities that discharge large volumes of water will generally have the largest loads even when concentrations are low. Industrial facilities that use large quantities of Detroit River water may also discharge relatively large loads of some contaminants while concentrations in the intake and effluent are similar. Some loads from Ontario facilities were gross loads while others were net loads. Net loads would be the best indication of the magnitude of contaminant loads generated by a facility. However, in many cases intake data were not sufficiently available to estimate net loads.

Also, as previously noted, lower levels of detection used by some U.S. labs may have enabled loads from Michigan dischargers to be detected and quantified while loads of similar magnitude (if present) could not have been estimated using data from some Ontario labs.

Table 8-25. Summary of major point source loads to the Detroit River, 1986 to 1990. Loads are given in kilograms per day and (pounds per day).

Facility	Total Phosphorus	Ammonia Nitrogen	Suspended Solids	BOD5*	Chloride	Cadmium	Cobalt	Chromium	Copper	Iron	Lead
Major Michigan Sources											
Detroit WWTP	1850 (3950)	26900 (59200)	35900 (79100)	34200 (75100)	421000 (928000)	4.05 (8.92)	32.4 (71.4)	9.72 (21.4)	81.0 (179)	1820 (4000)	2.97 (6.54)
Wayne Co. Wyandotte WWTP	305 (672)	2790 (6140)	6590 (14500)	6180 (13600)	22900 (50400)	5.21 (11.5)	<2.29 (<5.04)	1.12 (2.47)	4.21 (9.27)	203 (447)	2.72 (5.99)
Trenton WWTP	14.2 (31.2)	69.9 (153.8)	407 (895)	221 (486)	1907 (4201)	0.000983 (0.00217)	0.0163 (0.0359)	0.393 (0.866)	0.649 (1.43)	29.8 (65.6)	0.0393 (0.0866)
Grosse Ile WWTP	4.44 (9.77)	24.9 (54.8)	70.4 (155)	70.2 (155)	796 (1750)	0.000570 (0.00125)	0.00125 (0.00275)	0.0484 (0.107)	0.0780 (0.172)	10.0 (22.1)	0.00859 (0.0189)
Wayne County Huron Valley WWTP	36.9 (81.1)	159 (350)	239 (525)	354 (779)	3980 (8770)	0.00801 (0.0177)	NA NA	<0.080 (<0.177)	0.304 (0.671)	8.84 (19.5)	0.0614 (0.135)
McLouth Steel Trenton	1.56 (3.43)	54.0 (118.9)	626 (1380)	156 (343)	3840 (8460)	0.083 (0.183)	<2.60 (<5.72)	0.431 (0.949)	3.11 (6.86)	17.8 (39.1)	2.34 (5.14)
McLouth Steel Gibraltar	0.614 (1.35)	2.66 (5.86)	31.8 (70.0)	20.5 (45.1)	1410 (3110)	0.00174 (0.00383)	0.0088 (0.0194)	0.129 (0.284)	0.043 (0.0946)	696 (1530)	0.040 (0.089)
National Steel 80" Mill	8.30 (18.3)	1.66 (3.66)	1960 (4320)	<830 (<1830)	2600 (5730)	0.268 (0.591)	<2.77 (<6.09)	6.36 (14.0)	3.74 (8.23)	266 (587)	2.41 (5.30)
National Steel Ecorse	1.37 (3.01)	2.97 (6.55)	183 (402)	278 (611)	3300 (7260)	0.0269 (0.0593)	0.00729 (0.0161)	0.404 (0.889)	0.295 (0.651)	43.8 (95.6)	0.0613 (0.135)
National Steel Zug Island	8.34 (18.4)	112 (247)	3490 (7680)	<455 (<1000)	2580 (5680)	0.106 (0.234)	<1.52 (<3.34)	1.26 (2.77)	1.32 (2.90)	255 (561)	0.834 (1.84)
Pennwalt	4.86 (10.7)	15.7 (34.6)	350 (771)	301 (663)	1360 (2990)	0.0261 (0.0576)	0.00545 (0.0120)	0.131 (0.289)	0.142 (0.313)	39.6 (87.2)	0.359 (0.790)
PVS	0.341 (0.750)	2.27 (5.0)	34.1 (75.1)	11.4 (25.0)	379 (835)	0.0042 (0.0092)	<0.038 (<0.084)	0.00792 (0.0174)	0.0394 (0.0868)	3.15 (6.94)	0.0284 (0.0626)
BASF Wyandotte	0.836 (1.84)	1.82 (4.01)	122 (269)	296 (652)	476 (1050)	0.00325 (0.00716)	0.00740 (0.0163)	0.0303 (0.0668)	0.0625 (0.138)	5.77 (12.7)	0.011 (0.025)
Monsanto	6.76 (14.9)	23.9 (52.7)	390 (859)	104 (229)	468 (1030)	0.0104 (0.0229)	0.00796 (0.0175)	0.0956 (0.211)	0.0442 (0.0973)	16.5 (36.4)	0.099 (0.218)
Detroit Coke	1.55 (3.40)	0.193 (0.426)	541 (1190)	<38.6 (<85.1)	193 (426)	0.0116 (0.0255)	0.00464 (0.0102)	0.0676 (0.149)	0.464 (1.02)	22.8 (50.2)	0.367 (0.809)
Michigan Totals	2250 (4940)	30200 (66400)	50900 (112000)	43500 (95700)	467000 (1030000)	9.81 (21.6)	41.7 (91.7)	20.3 (44.6)	95.5 (210)	3440 (7560)	12.3 (27.2)

Table 8-25. Continued.

Facility	Mercury	Nickel	Zinc	Cyanide	Phenols	Oil and Grease	PCBs*	HCB*	OCS*	PAHs*
Major Michigan Sources										
Detroit WWTP	0.079 (0.175)	135 (300)	216 (476)	24.3 (53.5)	37.2 (82.0)	14400 (31800)	0.257 (0.566)	0.00132 (0.00291)	0.0000362 (0.0000797)	NA NA
Wayne Co. Wyandotte WWTP	0.0114 (0.0252)	2.56 (5.64)	27.4 (60.4)	4.80 (10.6)	0.420 (0.920)	990 (2180)	0.020 (0.0441)	0.000222 (0.000488)	0.0000485 (0.000107)	NA NA
Trenton WWTP	0.00254 (0.00559)	0.275 (0.606)	0.492 (1.08)	0.177 (0.390)	0.472 (1.04)	342 (754)	0.000244 (0.000537)	0.00000669 (0.0000147)	0.000000197 (0.000000433)	NA NA
Grosse Ile WWTP	<0.000215 (<0.000473)	0.0250 (0.0550)	0.0702 (0.155)	<0.039 (<0.086)	0.0336 (0.0739)	<15.6 (<34.4)	0.000312 (0.000688)	0.0000101 (0.0000223)	NA NA	NA NA
Wayne County Huron Valley WWTP	<0.0134 (<0.0294)	0.166 (0.365)	0.855 (1.88)	<0.134 (<0.294)	0.702 (1.55)	721 (1590)	NA NA	NA NA	NA NA	NA NA
McLouth Steel Trenton	0.00065 (0.00143)	0.223 (0.492)	106 (234)	1.67 (3.67)	1.69 (3.70)	299 (658)	NA NA	0.0000493 (0.000109)	NA NA	NA NA
McLouth Steel Gibraltar	0.000116 (0.000255)	0.563 (1.24)	0.072 (0.159)	<0.0511 (<0.113)	<0.102 (<0.225)	37.8 (83.2)	0.000202 (0.000444)	0.00000338 (0.00000744)	NA NA	NA NA
National Steel 80" Mill	0.00318 (0.00701)	6.09 (13.4)	7.19 (15.9)	<1.38 (<3.05)	<2.77 (<6.09)	421 (925)	0.00454 (0.00999)	0.0000719 (0.000158)	NA NA	NA NA
National Steel Ecorse	0.0000735 (0.000162)	0.235 (0.518)	5.45 (12.0)	0.182 (0.400)	0.606 (1.33)	1240 (2740)	0.000430 (0.000948)	0.00000786 (0.0000173)	0.00000147 (0.00000324)	NA NA
National Steel Zug Island	0.00288 (0.00634)	0.303 (0.668)	44.6 (98.1)	1.36 (3.0)	4.85 (10.7)	4850 (10700)	0.0144 (0.0317)	0.0000637 (0.000140)	0.00000150 (0.00000330)	NA NA
Pennwalt	0.0127 (0.028)	0.269 (0.592)	0.833 (1.8)	<0.075 (<0.165)	0.672 (1.48)	101 (222)	0.00218 (0.0048)	0.0000971 (0.000218)	NA NA	NA NA
PVS	0.000265 (0.000584)	0.0421 (0.0926)	0.050 (0.110)	<0.015 (<0.033)	0.0129 (0.0284)	<7.58 (<16.7)	0.000233 (0.000512)	0.0000796 (0.000175)	NA NA	NA NA
BASF Wyandotte	0.0032 (0.0071)	0.0591 (0.13)	0.408 (0.899)	0.114 (0.25)	48.6 (107)	66.0 (145)	0.00066 (0.00145)	0.000039 (0.000085)	0.0000000082 (0.000000018)	NA NA
Monsanto	0.00109 (0.0024)	0.0780 (0.172)	0.988 (2.18)	<0.026 (<0.0572)	0.218 (0.481)	<52.0 (<115)	0.00185 (0.00407)	0.0000416 (0.0000916)	NA NA	NA NA
Detroit Coke	0.000147 (0.000323)	0.0367 (0.0809)	0.442 (0.975)	<0.097 (<0.213)	0.290 (0.638)	85.0 (187)	0.000238 (0.000523)	0.00000213 (0.00000468)	NA	NA
Michigan Totals	0.131 (0.288)	146 (321)	411 (904)	34.4 (75.7)	98.6 (217)	23600 (52000)	0.302 (0.665)	0.00201 (0.00442)	0.0000879 (0.000193)	NA NA

Table 8-25. Continued.

Facility	Total Phosphorus	Ammonia Nitrogen	Suspended Solids	BOD5*	Chloride	Cadmium	Cobalt	Chromium	Copper	Iron	Lead
Major Ontario Sources											
West Windsor	80.1 # (176)	779 (1710)	3171 # (6980)	3870 # (8510)	9400 (20700)	BD BD	1.95 (4.29)	1.54 (3.4)	3.43 (7.55)	79.7 (175)	0.13 (0.286)
Little River WWTP	13.3 # (29.3)	85 (187)	259 # (570)	149 # (328)	2540 (5588)	BD BD	0.53 (1.17)	0.53 (1.16)	1.14 (2.51)	50 (110)	0.11 (0.242)
Amherstburg WPCP	5.7 # (12.5)	76 (167)	152 # (334)	154 # (339)	3330 (7330)	BD BD	BD BD	2.12 (4.66)	0.46 (1.01)	54 (119)	0.025 (0.055)
General Chemical	6.5 (14.3)	174 # (383)	157 # (345)	NA NA	650000 # (1430000)	0.13 (0.286)	5.64 (12.4)	2.21 (4.86)	17.2 (37.8)	BD BD	BD BD
Ford Canada	4.1 (9.0)	37 (81.4)	2670 # (5870)	NA NA	407 (895)	0.797 (1.75)	BD BD	0.47 (1.03)	3.44 (7.57)	69 # (152)	30.3 (66.7)
Wickes Manufacturing	1.22 (2.68)	10.2 (22.4)	297 # (653)	NA NA	337 (741)	BD BD	BD BD	13.8 (30.4)	0.099 # (0.218)	0.26 # (0.572)	BD BD
Ontario Totals	111 (244)	1160 (2560)	6710 (14800)	4170 (9170)	666000 (1470000)	0.927 (2.04)	8.12 (17.9)	20.7 (45.5)	25.8 (56.8)	253 (557)	30.6 (67.2)
Michigan and Ontario Totals	2360 (5190)	31400 (69000)	57600 (127000)	47700 (105000)	1130000 (2490000)	10.7 (23.6)	49.8 (110)	41 (92)	121 (267)	3690 (8120)	43 (94.4)

Table 8-25. Continued.

Facility	Mercury	Nickel	Zinc	Cyanide	Phenols	Oil and Grease	PCBs*	HCB*	OCS*	PAHs*
Major Ontario Sources										
West Windsor	0.0004	6.7	18.8	NA	1.6	1130	NA	BD	NA	0.311
	(0.00088)	(14.7)	(41.4)	NA	3.52	(2490)	NA	BD	NA	(0.684)
Little River WWTP	0.002	0.55	4.5	NA	0.34	320	BD	BD	BD	0.006
	(0.0044)	(1.21)	(9.9)	NA	(0.748)	(704)	BD	BD	BD	(0.013)
Amherstburg WPCP	0.0008	BD	2.9	NA	0.05	46	NA	BD	NA	0.0047
	(0.00176)	BD	(6.38)	NA	(0.11)	(101)	NA	BD	NA	(0.0103)
General Chemical	0.0033	BD	7.9	NA	0.31	128	BD	BD	BD	0.052
	(0.00726)	BD	(17.4)	NA	(0.66)	(282)	BD	BD	BD	(0.114)
Ford Canada	BD	0.44	132	2.28	28.7 #	212 #	0.0392	BD	NA	0.44
	BD	(0.968)	(290)	(5.02)	(63.1)	(466)	(0.0862)	BD	NA	(0.968)
Wickes Manufacturing	BD	0.93 #	0.23 #	0.03	0.06	18.9	BD	BD	NA	0.0086
	BD	(2.05)	(0.506)	0.066	(0.132)	41.6	BD	BD	NA	(0.0189)
Ontario Totals	0.0065	8.62	166	2.31	31	1860	0.0392	BD	NA	0.822
	(0.0143)	(19.0)	(365)	(5.08)	(68.3)	(4080)	(0.0862)	BD	NA	(1.81)
Michigan and Ontario Totals	0.138	155	577	37	130	25500	0.341	0.00201	0.0000879	0.822
	(0.303)	(340)	(1270)	(80.8)	(285)	(56000)	(0.751)	(0.00442)	(0.000193)	(1.81)

NA Not Analyzed.

The total point source loads were calculated excluding loads that were estimated with concentrations below levels of detection (Table 8-25). Wastewater Treatment Plants were generally the largest contributers to the total point source loads. The City of Detroit WWTP contributed the largest loads of 16 of 21 parameters measured. Wayne County Wyandotte WWTP contributed the larges loads of cadmium and the second largest loads of five other parameters. The largest loads of PAHs and lead came from Ford Canada and the largest loads of chlorides came from General Chemical. The significance of these loads relative to other sources is discussed in Sections 8.4 and 8.5.

8.3 NON-POINT SOURCES

Contaminants enter the Detroit River from various non point sources, including tributaries, urban runoff, groundwater discharges, direct spills along the shore or from boats and the atmosphere. In addition, point and nonpoint sources of pollution to waters upstream of the Detroit River may eventually impact the river. These sources of contaminants and the magnitude of their contaminant contributions are discussed below.

8.3.1 Tributary Inputs

8.3.1.1 Michigan Tributary Loadings

Tributaries were monitored near their confluence with the Detroit River and include loads from point source discharges, CSOs, stormwater and groundwater. The calculated contaminant loads for these tributaries are shown in Table 8-26. Loads of some constitutents were determined as part of a three year Rouge River monitoring program in which samples were collected at regular intervals plus during storm events. Loads were estimated using stratified estimation techniques (Day 1990).

Loads from the Ecorse and Rouge Rivers were estimated as part of UGLCCS. Selected chemical constituents were measured every 12 hours for two one week periods in 1986 and concentrations were multiplied by tributary flow to estimate loads to the Detroit River (Table 8-26). However, loads estimated in this manner are often biased because they do not account for seasonal variations in concentrations of some contaminants and they do not account for variations in concentrations and flows caused by storm events (Day 1990).

The loads calculated as part of UGLCCS may be biased but are sufficient to estimate the contribution of contaminants relative to other sources. Tributary loads generally account for a minor portion of the total load compared to point sources. Estimated tributary loads of suspended solids were similar or higher than point source loads. Michigan tributaries contributed a higher percentage of chlorides, suspended solids, PCBs and other heavy metals per hectare of watershed than Ontario tributaries.

Loads of suspended solids, chlorides, nitrate-N, total phosphorus and ammonia were variable from 1984 to 1986. These differences were attributed to differences in annual discharge from the Rouge River. If loads from other tributaries are responding in a similar manner then

Table 8-26. Michigan and Ontario Detroit River tributary contaminant loads, 1984-1986. Estimates are in kg/day and (lbs/day)

	UNITED STATES							
Tributaries Sampled	Rouge		Rouge		Rouge		Rouge and Ecorse	
Year Sampled	1984		1985		1986		1986	
Number of Samples							2-28	
% of Drainage Basin	54%		54%		54%		77%	
Reported by:	MDNR[1]		MDNR[1]		MDNR[1]		UGLCCS[2]	
	kg/day	(lbs/day)	kg/day	(lbs/day)	kg/day	(lbs/day)	kg/day	(lbs/day)
Chemical Constituents								
Ammonia	1,070	(2350)	1,750	(3850)	1,340	(2950)	-	-
Total Phosphorus	313	(689)	510	(1120)	347	(763)	-	-
Nitrate-N	1,700	(3740)	2,583	(5680)	1,542	(3390)	-	-
Chloride	159,000	(350,000)	275,000	(605,000)	218,000	(480,000)	-	-
Suspended Solids	66,300	(146,000)	115,000	(253,000)	69,000	(152,000)	-	-
Total Lead	-	-	-	-	-	-	21.3	(46.9)
Total Cadmium	-	-	-	-	-	-	3.15	(6.93)
Total Copper	-	-	-	-	-	-	14.8	(32.6)
Total Iron	-	-	-	-	-	-	113.4	(249.5)
Total Mercury	-	-	-	-	-	-	-	-
Total Nickel	-	-	-	-	-	-	8.15	(17.9)
Total Zinc	-	-	-	-	-	-	275	(605)
Total PCBs	-	-	-	-	-	-	0.116	(.255)
HCB	-	-	-	-	-	-	0.001	(.0022)

1 Michigan DNR data from high flow event monitoring, 1984-1986 (Day 1990).
2 From Detroit River System Mass Balance Study, UGLCCS 1987.
3 Average Daily loads were calculated using instantaneous loads (mg/sec) provided by Johnson and Kauss, 1984.
4 From Wall et al., 1987.
5 This value applies to Turkey Creek only.

Table 8-26. (continued)

	CANADIAN TRIBUTARIES					
Tributaries Sampled	Little, Canard and Turkey		Little, Canard and Turkey		Little and Turkey	
Year Sampled	1984-1986		1984 & 1985		1986	
Number of Samples			7-31		2-28	
% of Drainage Basin			20%		4%	
Reported by:	Johnson and Kauss[3]		Wall et al[4]		USEPA[2]	
Chemical Constituents						
Ammonia	-	-	-	-	-	-
Total Phosphorus	-	-	284	(625)	42.6	(93.7)
Nitrate-N	-	-	1,722	(3,788)	-	-
Chloride	-	-	20,095	(44,209)	9806.4	(21,574)
Suspended Solids	-	-	-	-	3,023.1	(6,650.8)
Total Lead	-	-	2.3	(4.8)	0.5	(1.1)
Total Cadmium	0.11	(0.24)	-	-	0.01	(0.022)
Total Copper	2.3	(5.0)	-	-	0.5	(1.1)
Total Iron	1400	(3000)	-	-	3.6	(7.9)
Total Mercury	0.0058	(0.013)	-	-	0.002	(0.0044)
Total Nickel	5.3	(11.7)	-	-	49.2	(108)
Total Zinc	9.8	(22)	-	-	5.3	(12)
Total PCBs	0.12	(0.27)	-	-	0.001[5]	(0.002)
HCB	0.00014	(0.0030)	-	-	-	-

1 Michigan DNR data from high flow event monitoring, 1984-1986 (Day 1990).
2 From Detroit River System Mass Balance Study, UGLCCS 1987.
3 Average Daily loads were calculated using instantaneous loads (mg/sec) provided by Johnson and Kauss, 1984.
4 From Wall et al., 1987.
5 This value applies to Turkey Creek only.

these variations in loads may cause the annual fluctuations in ambient concentrations of conventional pollutants discussed in section 6.1.2.

8.3.1.2 Ontario Tributary Loadings

The Ontario tributaries, Turkey Creek and the Little and Canard Rivers, were monitored periodically between 1984 and 1985 (Johnson and Kauss 1990 draft report). Wall et al. (1987) extrapolated instantaneous loading values to daily averages (Table 8-26). In addition, daily averages were also monitored in 1986 in a similar fashion as the Rouge and Ecorse described above, and loadings were calculated in the same fashion. They contributed a higher percentage of total phosphorus, nitrates and nickel per hectare than the Michigan tributaries.

These data reflect the land uses, primarily urban/industrial and agricultural, in Michigan and Ontario, respectively.

Little River:

Historically, the Little River has experienced elevated bacteriological counts due to inadequate treatment at the Little River WWTP (Kinkead and Hamdy 1976; Hamdy and Johnson 1987).

The WWTP is undergoing expansion to improve its hydraulic capacity and the City of Windsor is currently evaluating options to further improve water quality in the Little River. It should be noted that the Little River WWTP treats mainly domestic sewage, while somewhat more industrial wastes from the Windsor area are directed to the West Windsor WWTP.

Industrial wastes from Wickes Manufacturing (Windsor Bumper), an electroplating industry which formally discharged directly to the Little River, contained elevated levels of heavy metals (e.g. nickel, chromium and zinc); however, the facility did not appear to be a source of organic contaminants (Edwardson and King 1988). Improvements to the waste treatment facilities at Wickes were completed; however, it was never hooked up to the sanitary sewer, and the facility subsequently ceased operations in September of 1990.

Turkey Creek:

A series of drains and ditches lead to Turkey Creek south of Windsor. Sediments in the Grand Marais Drain and ditches near Zalev Brothers scrap yard contained elevated PCB levels in 1986. Water and sediment samples taken in 1987 from the Grand Marais Drain and Turkey Creek revealed very low PCB levels. Can-Am Petroleum, a waste oil recycler is also currently operating in the watershed.

The Grand Marais Drain is subject to discharges from storm sewers, septic tanks, and various small industrial operations. This area of Windsor is not entirely serviced by sanitary sewers and is currently undergoing a $40 million construction project to replace inadequate septic systems with sanitary sewers (Hamdy and Johnson 1987).

Until the mid-1980s the Chrysler Canada automotive facility discharged effluent from their oily waste treatment plant directly to Turkey

Creek. Chrysler presently operates a wastewater treatment facility with effluent being directed to the municipal sanitary sewers, in accordance with local Sewer Use Bylaw Requirements.

Canard River (Riviere aux Canards):

Industrial operations in the Canard River watershed are limited to the manufacture of soda ash by General Chemical. While Brine Wells and MacGregor quarry are located in the Canard River watershed, General Chemical's major operation of soda ash is not.

Big Creek:

Big Creek drains a predominantly rural marshy area southeast of Amherstburg. Occasional oil wells and a rock quarry may result in some inorganic salts being elevated, while agricultural practices may increase pesticide contamination. As only a limited number of samples have been made, it is not possible to present loads from this creek. Also, as it does not discharge to the Detroit River AOC, information is not included here.

As part of the Ministry of the Environment effort to enhance the tributary monitoring program, annual phosphorus loadings are calculated for the Canard River. This data for the period 1985 to 1987 is contained in Table 8-27.

Loadings measured during 1984 (Johnson and Kauss 1989 draft report) from the Little River, Turkey Creek and Canard River, are reported in Tables 8-27 to 8-30 for numerous heavy metals, industrial organic compounds and pesticides. A comparison of instananeous tributary loadings for selected parameters measured during 1984-1985 with Detroit River with estimated loads from a head and mouth survey (Johnson and Kauss 1987), indicated that tributary sources from Ontario are relatively minor inputs in context of the entire Detroit River loading (Table 8-31).

Instantaneous loads were converted to average daily loads so that the relative magnitude of these loads could be compared to other sources. Extrapolation of this data to average daily loads can lead to biased estimates for reasons previously noted.

8.3.2 Urban Runoff

Stormwater is the excess water that flows over land and into collection basins or sewers in urban areas or tributaries in rural areas. This water washes the ground, collecting the fine particulate matter which may have come from smoke, exhaust and automobile traffic as well as trash, animal wastes, spilled materials like oils, paints, herbicides etc., and a variety of other materials. Stormwater runoff may contain metals, organic contaminants, oxygen consuming substances, nutrients, bacteria and other materials. Also, much of the runoff from the SAOC enters into combined stormwater and municipal sewage systems. During wet weather events, dilute but untreated wastewater overflows to the Detroit River or tributaries when the capacity of the system is exceeded.

Table 8-27. Total phosphorus loadings rates - Canard River

Year	Mean Annual Discharge (CMS)	Total Phosphorus Loadings Rates					
		Daily Loading		Std. Error		Annual Load	
		kg/day	(lbs/day)	(+ -)	(lbs/day)	Metric T.	(tons)
1985	2.2	60.4	(133)	14.5	(31.9)	22.0	(24.3)
1986	4.6	172	(378)	11.6	(25.5)	63.0	(69.4)
1987	2.96	80.1	(176)	9.83	(21.6)	29.2	(32.2)

Source MOE - Water Resources Branch, Watershed Management Section

Table 8-28. Mean instantaneous whole water loading values for inorganics (mg/sec). Average daily loads are presented in kg/day and (lbs/day).

	Little River			Turkey Creek			Canard River		
	mg/sec	kg/day	(lbs/day)	mg/sec	kg/day	(lbs/day)	mg/sec	kg/day	(lbs/day)
Aluminum	1,785	154.2	(339.2)	326	28.2	(62.0)	10,698	924	(2033)
Arsenic	0.91	0.079	(0.17)	0.72	0.0622	(0.139)	2.48	0.214	(0.471)
Cadmium	0.20	0.017	(0.038)	0.32	0.0276	(0.061)	0.75	0.064	(0.143)
Chromium	20.78	1.795	(3.950	3.14	0.271	(0.597)	17.99	1.55	(3.42)
Cobalt	1.67	0.144	(0.317)	1.00	0.0864	(0.190)	8.50	0.734	(1.62)
Copper	5.79	0.500	(1.10)	3.62	0.313	(0.689)	17.04	1.472	(3.24)
Iron	2,543	219.7	(483.4)	493	42.6	(93.7)	12,916	1116	(2455)
Lead	3.34	0.289	(0.635)	3.62	0.313	(0.688)	15.14	1.31	(2.88)
Manganese	22.37	1.932	(4.252)	22.98	1.99	(4.37)	24.76	2.14	(4.71)
Mercury	0.022	0.0019	(0.0042)	0.014	0.00121	(0.00266)	0.031	0.0027	(0.0059)
Nickel	37.79	3.265	(7.183)	5.60	0.483	(1.06)	18.34	1.585	(3.486)
Selenium	0.54	0.047	(0.10)	0.42	0.036	(0.0798)	2.02	0.175	(0.384)
Zinc	26.16	2.260	(4.972)	23.63	2.041	(4.49)	63.38	5.476	(12.0)

Table 8-29. Mean instantaneous whole water loading values for industrial organics (ug/sec). Average daily loads are presented in kg/day and (lbs/day).

	Little River			Turkey Creek			Canard River		
	mg/sec	kg/day	(lbs/day)	mg/sec	kg/day	(lbs/day)	mg/sec	kg/day	(lbs/day
Hexachloroethane	0.20	.000017	(.000038)	0.00	--	--	0.41	0.000035	(0.000077)
Hexachlorobutadiene	0.18	.000015	(.000034)	0.00	--	--	1.98	0.000171	(0.000376)
Hexachlorobenzene	1.03	.00088	(.000195)	0.48	0.000041	(.000091)	0.06	0.000005	(0.000011)
Octachlorostyrene	0.00	--	--	0.00	--	--	0.00	--	--
Total PCBs	0.00	--	--	0.00	--	--	0.00	--	--
Phenols	2,216	0.191	(0.421)	1,093	0.094	(0.208)	4,366	0.377	(0.830)
Pentachlorophenol	0.00	--	--	11.70	0.00101	(0.0022)	0.00	--	--

Table 8-30. Mean instantaneous whole water loading values for pesticides (ug/sec). Average daily loads are presented in kg/day and (lbs/day).

	Little River			Turkey Creek			Canard River		
	mg/sec	kg/sec	(lbs/sec)	mg/sec	kg/sec	(lbs/sec)	mg/sec	kg/sec	(lbs/sec)
Atrazine	0	--	--	0	--	--	33	--	--
Alpha-BHC	1.74	0.00174	(0.00150)	0.47	0.00040	(0.000089)	0.51	0.000044	(0.000096)
Gamma-BHC	8.07	0.00807	(0.00697)	1.42	0.000122	(0.000269)	3.95	0.000341	(0.000750)
Dieldrin	0.00	--	--	0.00			0.00		
Alpha-Endosulphan	0.00	--	--	1.88	0.000162	(0.000357)	0.00	--	--
p,p'-DDE	0.35	0.000030	(0.000066)	0.00	--	--	3.95	0.000341	(0.000750)
p,p'-DDD	0.00	--	--	0.00	--	--	0.00	--	--
p,p'-DDT	0.00	--	--	0.00	--	--	0.00	--	--
Endrin	0.00	--	--	0.00	--	--	0.00	--	--
Methoxychlor	0.00	--	--	0.00	--	--	0.00	--	--

Table 8-31. Magnitude of tributary loadings relative to river system loadings (mg/sec).

DETROIT RIVER:

Parameter	Head-Mouth[1]	Tributary Inputs[2]	Tributary Inputs As % of River
Suspended Solids	37×10^6	0.28×10^6	0.8
Dissolved Org. Carbon	0.74×10^6	0.02×10^6	2.7
Chloride	3.2×10^6	0.14×10^6	4.4
Phosphorus	80×10^3	1.2×10^3	1.5
Lead	22×10^5	22.1	0.001
Iron	13×10^5	0.16×10^5	1.2
Mercury	69.6	0.07	0.10
Zinc	19×10^3	113	0.6
Hexachlorobenzene	2.3	0.001	0.4
Octachlorostyrene	2.4	0	0
Total PCBs	-24	1.43	-

[1] = Net change in loading between head and mouth of Detroit River in 1984 (Johnson and Kauss 1987).

[2] = Sum of loadings from Ontario tributaries sampled in 1984-1985.

Rural runoff would consist mainly of agricultural runoff from storm events. Loads of parameters from rural runoff would be reflected in tributary loads.

8.3.2.1 Michigan SAOC Combined Sewer Overflows

From a Michigan regulatory standpoint, the discussion of CSOs belongs in the point source section since discharges are regulated as point sources by NPDES permits. However, loads from CSOs are related to wet weather events and are discussed here in the nonpoint section.

There are 250 combined sewer outfalls discharges to the Detroit River SAOC from Michigan. There are 56 CSOs that discharge directly to the Detroit River along the Michigan shoreline, plus 168 from the Rouge River, 11 from Ecorse Creek and 19 that discharge to Lake St. Clair just upstream of the head of the Detroit River (Rouge River RAP 1988, MDNR unpublished files, personal communication, Dean Tuomari). The cities of Detroit, Grosse Point Farms, Grosse Point Shores, Grosse Point Park, Ecorse, Southgate, Wyandotte and Trenton, as well as the Macomb County Sanitary District, the Wayne/Macomb County Drainage Board and the Macomb County Intra County Drainage Board are responsible for direct discharges to Lake St. Clair and the Detroit River.

The quantity and quality of the discharge from 45 City of Detroit CSOs was estimated during 1979. All of the CSOs studied discharge directly to the Detroit River except for three that discharge to the Rouge River (downstream of the Rouge River monitoring location) (Figure 8-14). In 1979 the total CSO discharge from the City of Detroit to the Detroit River was estimated to be 16.8 billion gallons (Giffels et al. 1980). The largest discharges from Detroit CSOs to the Detroit River were from the Lieb (4,952 million gallons/yr) and Connors Creek/Freud/Fairview (2,766 million gallons/yr) overflows located near Belle Isle along Michigan mainland shoreline, and the First Hamilton/Bates/Woodward (386 million gallons/yr) and Summit CSOs located approximately 1.5 miles up and downstream, respectively, of the Ambassador Bridge. The average yearly discharge from these 45 CSOs was estimated to be 12.45 billion gallons (Giffels et al. 1980).

The average concentration of selected chemical constituents from the discharge of 42 City of Detroit CSOs to the Detroit River and three City of Detroit CSOs to the Rouge River are shown in Table 8-32 along with the estimated loads. Since the data used to calculate loadings from the City of Detroit CSOs were collected in 1979, it is likely that the magnitude of these estimates have changed. For example, the Industrial Pretreatment Program was implemented in 1979 and probably has reduced the concentration of toxic substances in industrial sewage.

As previously noted there are a total of 67 CSOs that discharge directly or indirectly to the Detroit River from the SAOC (excluding the Rouge river above the tributary monitoring location) and loads have only been estimated for 45 of these. Therefore, flow and concentration data from 45 CSOs were used to estimated total loads from CSOs to the Detroit River. Loads were determined by multiplying concentrations by average yearly flow, a units correction factor, and 1.49 (67 CSOs divided by 45 City of Detroit CSOs). Load estimates from the 67 CSOs are presented in Table 8-32. These estimates are likely to be biased both by the age of

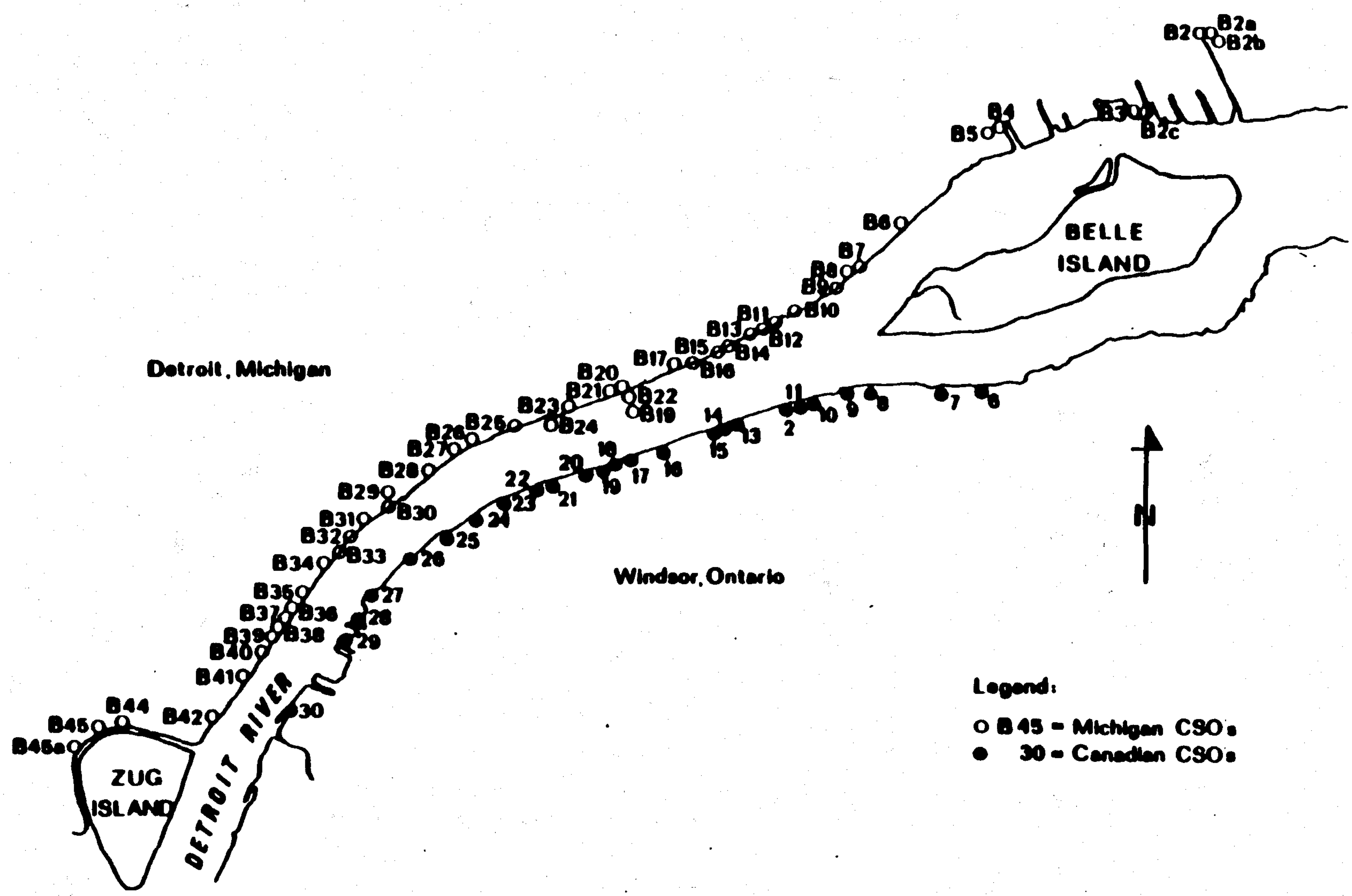


Figure 8-14. Detroit and Windsor combined sewer outfalls to the upper Detroit River.

Table 8-32. Mean contaminant concentrations and estimated loads from combined sewer overflows from Detroit (1979) and Michigan.

Parameter	Concentration	Estimated Load from 45 City of Detroit CSOs*		Estimated Load from 67 Michigan CSOs**	
	mg/l	kg/day	(lbs/day)	kg/day	(lbs/day)
Total Phosphorus	3.9	680	1500	750	1700
Chloride	44	7800	17000	8500	19000
Suspended solids	205	36000	79000	39000	87000
Arsenic	0.069	12	27	13	29
Cadmium	0.041	7.1	16	7.9	17
Chromium	0.129	22	50	25	55
Copper	0.218	38	84	42	92
Iron	2.27	400	870	440	960
Lead	0.447	78	170	86	190
Mercury	0.045	7.8	17	8.7	19
Nickel	0.139	24	53	27	59
Silver	0.038	6.6	16	7.3	16
Zinc	0.555	97	210	107	240
Oil/grease	94	16000	36000	18000	40000
Phenols	0.017	3.0	6.5	3.3	7.2
Total PCBs	0.0024	0.42	0.92	0.46	1.0

* Based on 1979 concentration data and estimated annual discharge of 16.8 billion gallons (Giffels et al. 1980).

** Based on 1979 concentration data, average yearly discharge of 12.8 billion gallons (Giffels et al. 1980) and interpolated to include a total of 67 CSOs.

study and the interpolation of data to CSOs that have not been studied. However, the estimates should be useful in ranking the relative magnitude of various sources of contaminants to the Detroit River (Section 8.4).

8.3.2.2 Michigan SAOC Stormwater Discharges

There are no documented direct stormwater discharges to the Detroit River from the municipalities of River Rouge, Ecorse, Lincoln Park, Grosse Ile or Gibraltar. Stormwater from most of these cities enters the combined sewer system and is treated at the Detroit WWTP, or is discharged directly through CSO outfalls to the Detroit River. The municipalities of Wyandotte and Trenton have 13 and 18 direct stormwater discharges to the Detroit River, respectively. Riverview has 17 and Trenton has 19 stormwater discharges through Monguagon Creek and Frank and Poet Drain (MDNR unpublished files).

The contaminant loadings from these outfalls have not been directly measured, however, estimates of total loads of parameters from stormwater have been calculated using data from other areas. Stormwater quality was monitored as part of the Nationwide Urban Runoff Program (NURP) in 19 cities around the United States. Although samples were not collected in Detroit, concentrations of parameters in Wayne County stormwater may be within the ranges found in other large cities. Therefore, the average concentration of the low and high range of concentrations was used as a "best guess" for Wayne County Stormwater. Concentrations from Windsor stormwater were used when NURP data was not available. Ranges and estimated concentrations are presented in Table 8-33 along with the source of the data.

Average annual stormwater flow can be calculated by multiplying area by annual precipitation and a runoff coefficient. The runoff coefficient is equal to the percent of precipitation that becomes stormwater (as opposed to evaporating or infiltrating into the ground). The runoff coefficient is dependent on the amount of paved or covered surfaces and the coefficient used for Wayne County was 50% which corresponds to 50-75% pavement or roof cover (U.S. EPA 1983).

The average discharge from Wayne County stormsewers to the Detroit River or tributaries, excluding the Rouge River, was estimated to be 346,131 cubic meters/day or 91.4 million gallons per day. This flow was used to obtain an estimate of the relative magnitude of loads to the Detroit River from stormwater (Table 8-33). These loads are rough estimates but may be compared to other sources in an effort to assess the impacts of stormwater loads relative to other sources (Section 8.4).

8.3.2.3 Ontario (Windsor) SAOC Storm and Combined Sewer Overflows

Mean concentration and loads of selected chemical constituents discharged in stormwater and CSOs in Windsor are shown in Tables 8-34 and 8-35. In cases where two loads are presented with a single parameter, this reflects the range of loadings as calculated from a range of concentrations observed during the study. These reflect the low and high estimates of loadings from measured concentrations and simulated runoff volumes.

Table 8-33. Estimated concentrations and loads of pollutants in Michigan stormwater.

Parameter	Range of concentrations (mg/l)	Estimated Concentration	Load kg/day	Load lbs/day
BOD5		12*	4300	9400
Tot. Phos.	0.24-0.31#	0.42	150	330
Ammonia	0.28-0.43#	0.34	120	260
Chloride	120-240#	180	64000	140000
Sus. Solid.		180	64000	140000
Arsenic	0.001-0.01*	0.026	9.0	20
Cadmium	0.001-0.014*	0.0070	2.5	5.5
Chromium	0.001-0.034*	0.018	6.4	14
Cobalt	0.004-0.017#	0.011	3.9	8.6
Copper	0.001-0.10*	0.05	18	39
Iron	3.0-6.9*	5.2	1900	4100
Lead	0.006-0.460*	0.233	83	180
Mercury	0.000018-0.00006#	0.0004	0.014	0.032
Nickel	0.001-0.182*	0.091	32	71
Silver	0.20-0.80*	0.50	180	390
Zinc	0.10-2.4*	1.25	450	980
Oil & Grease	1.4-5.8#	2.8	1000	2200
Phenols	0.0045-0.0535*	0.029	10	23
Cyanide	0.002-0.033*	0.018	6.2	14
HCB	0.0000002-0.0000014#	0.00000058	0.00021	0.00046
PAHs	0.01-0.0765*	0.034	15	34
Tot. PCBs		0.00003*	0.011	0.024

Data collected in Windsor and reported by Marsalek and Ng (1987). The estimated concentration was calculated using concentration data from residential, commercial and industrial areas.

* Data collected in Nineteen U.S. cities as part of the NURPs study. The range represents high and low values found the across the U.S. and the estimated concentration is the mean of all high and low concentrations.

Table 8-34. Mean contaminant concentrations measured in stormwater and combined sewer overflows in Windsor, 1985-1986 (Marsalek and Ng 1987).

Parameters	Units	Stormwater: Residential	Stormwater: Commercial	Stormwater: Industrial	Combined Sewer Overflows
Ammonia	mg/l	0.28	0.30	0.43	2.5
Tot. Phosphorus	mg/l	0.24	0.17	0.31	0.54
Chloride	mg/l	-	120# 240#	-	26.0
Sus. Solids	mg/l	-	-	-	-
Arsenic	mg/l	-	-	-	-
Cadmium	mg/l	0.00 0.01	0.001 0.009 0.006*	0.0006 0.0086	0.001 0.0072 0.008*
Chromium	mg/l	-	-	-	-
Cobalt	mg/l	0.00 0.02	0.0014 0.017 0.0035*	0.0004 0.017	0.0006 0.017 0.003*
Copper	mg/l	0.018	0.03	0.048	0.10
Iron	mg/l	5.8	3.0	6.9	1.2
Lead	mg/l	0.13	0.184	0.21	0.05
Mercury	ug/l	0.018 0.06	0.03	0.043 0.05	0.043
Nickel	mg/l	0.008 0.021	0.026	0.017 0.028	0.010 0.044
Silver	mg/l	-	-	-	-
Zinc	mg/l	0.16 0.25	0.23	0.30	0.34 0.50
Oil/Grease	mg/l	1.4	2.3	1.7 5.8	12.3
Phenols	mg/l	0.0025	0.004	0.005	0.008
Cyanide	mg/l	0.003	0.003	0.003	0.003
HCB	mg/l	1.4	0.0 0.4	0.2 0.92	1.09
OCS	mg/l	-	-	-	-
Tot. PCBs	ng/l	31.6	25.8	109.0	100.0
PAHs (17)	ug/l	1.1 1.6	2.1 2.6	4.6 5.7	4.0 4.4

\# Equivalent mean concentration

* Mean of concentration detected in all three subareas

Table 8-35. Estimated contaminant loadings to the Detroit River from the City of Windsor's 28 stormwater and combined sewer overflows*. Results in kgs/yr.

Parameter	Stormwater	Combined Sewer Overflows	Total
Ammonia (as N)	7,200	13,000	20,200
Total Phosphorus	5,600	2,800	8,400
Chloride	2,550,000	135,000	2,685,000
Cadmium	6.5	5.2	11.7
	133.8[1]	41.6[1]	175.4[1]
Cobalt	6	3	9
	420(78)[1]	88(16)[1]	508(94)[1]
Chromium	--	--	--
Copper	613	520	1,133
Iron	127,600	6,200	133,800
Lead	3,539	260	3,790
		830	4,360
Mercury	0.6	0.2	0.8
	1.1		1.3
Nickel	285	52	337
	524	229	753
Zinc	4,600	1,770	6,370
		2,600	7,200
Oil and Grease	35,700	64,000	99,700
	59,700		123,700
Total Phenols	75	42	117
Cyanide	67	16	83
HCB	0.021	0.006	0.027
	0.026		0.032
OCS[2]	0.045	0.010	0.055
Total PCBs	0.5	0.5	1.0
	1.1		1.6
PAHs (17)	49	21	70
	63	23	86
Suspended Solids	--	--	--

* From Marsalek and Ng (1987).
[1] Calculated from data above detection limit.
[2] Based on Sarnia data (St. Clair River area).

Windsor has 28 CSOs which discharge directly to the Detroit River (Figure 8-14). Industrial runoff and CSOs contained higher concentrations of most constituents than commercial and residential land use areas. Some constituents (ammonia and lead) were an order of magnitude lower in residential versus other areas. Approximately 72 to 94% of the Windsor loads occurred during storm events (about twice a month and 20 to 42 hours per event). Sixty-five percent of the load occurred in February, March and April with the greatest loads during March. Mixed stormwater/ sanitary wastewater discharges to the river whenever flow in the combined sewers exceeds 2.5 times the dry weather flow, otherwise the mixed wastewater discharges to one of the two Windsor water pollution control plants (Marsalek and Ng, 1987).

8.3.3 Waste Disposal Sites and Sites of Environmental Contamination

An inventory of active and inactive waste sites within 19 km of the Detroit River was conducted as part of UGLCCS. Ninety four sites of known and potential ground water contamination were found in Monroe and Wayne counties as of January 1, 1987 (Note: the Detroit River SAOC does not include Monroe County). The majority of sites are solid waste landfills, hazardous waste disposal sites, regulated storage sites and spills. Twenty three sites in the Ontario SAOC were also identified. Locations of 29 selected sites out of 96 Michigan waste sites and monitoring wells are shown in Figure 8-15. A study conducted as part of UGLCCS estimated that groundwater discharge accounted for 10% of the total tributary input to the Detroit River (Nonpoint Source Workgroup report, April, 1988). This would be less than 0.1% of the total river flow.

8.3.3.1 Michigan Waste Sites

There were a total of 96 Oakland and Macomb counties sites including 77 Act 307 sites of environmental contamination, 9 open licensed Type II and/or Type III landfills, and ten hazardous waste treatment, storage or disposal facilities (refer to Chapter 4, Regulatory Programs, for detailed descriptions of these programs). Appendix 8-5 contains specific information on the status of remedial actions and assessment procedures at the 307 sites. Licensed Type II and Type III landfills have not been documented as sources of groundwater contamination.

In 1988, sites located in the areas directly discharging groundwater to the Detroit River were ranked using the USEPA's DRASTIC system and prioritized by the United States Geological Survey for potential Detroit River impacts (U.S. EPA and EC, 1988). Additions and minor modifications to this ranking system were based on the site's potential for contributing contaminants via the groundwater, using local hydrogeology, the nature of the waste and the distance to the Detroit River. Table 8-36 lists the 16 highest ranked sites of the 94 sites considered in the Detroit River area during UGLCCS. These sites were in sandy, unconsolidated surficial material, located adjacent to, or near the Detroit River. The water table at the highest ranked sites is generally less than 4.5 m below land surface.

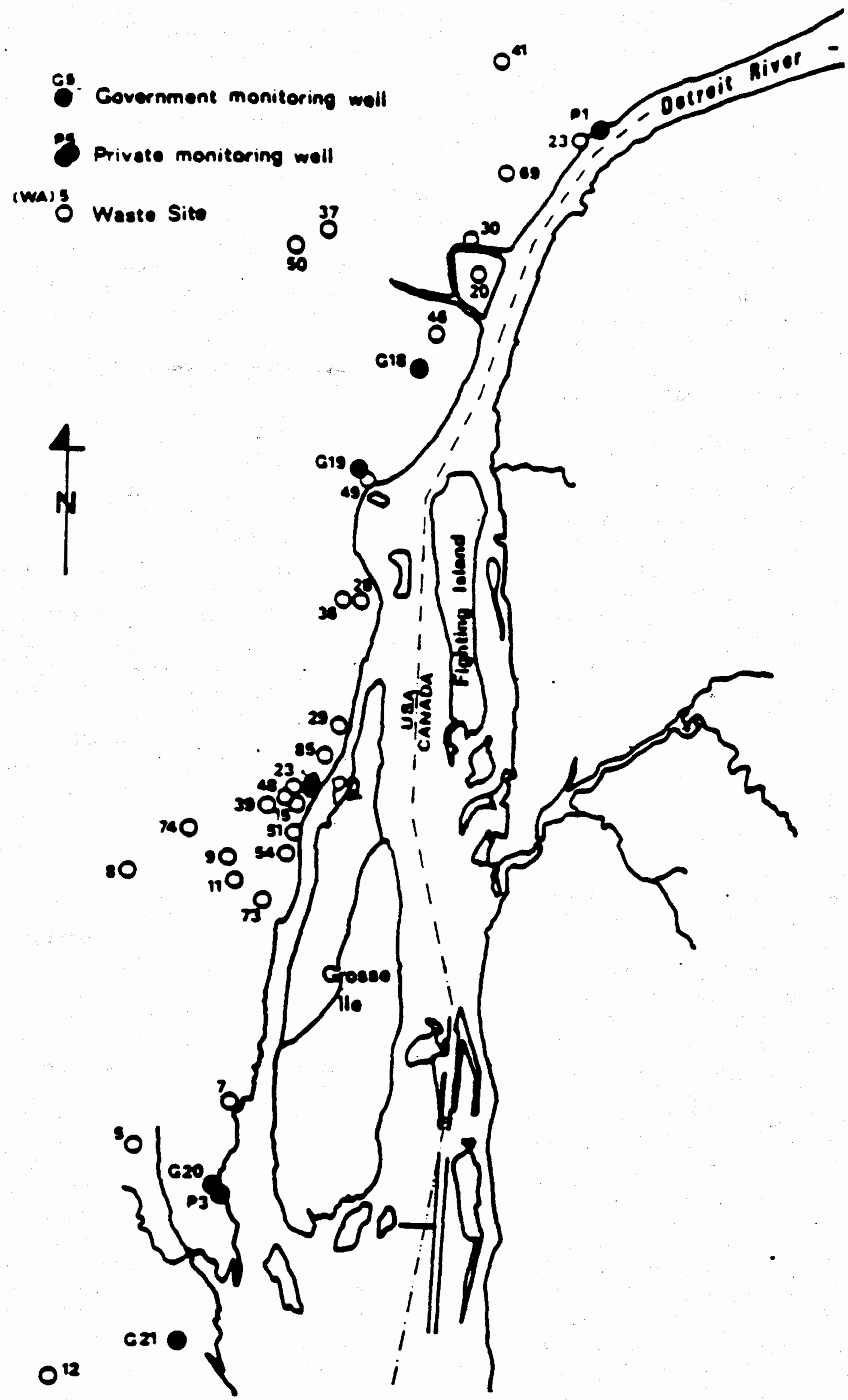


Figure 8-15. Sites of known or suspected groundwater contamination and private wells located near the Detroit River. (Source: UGLCCS 1988).

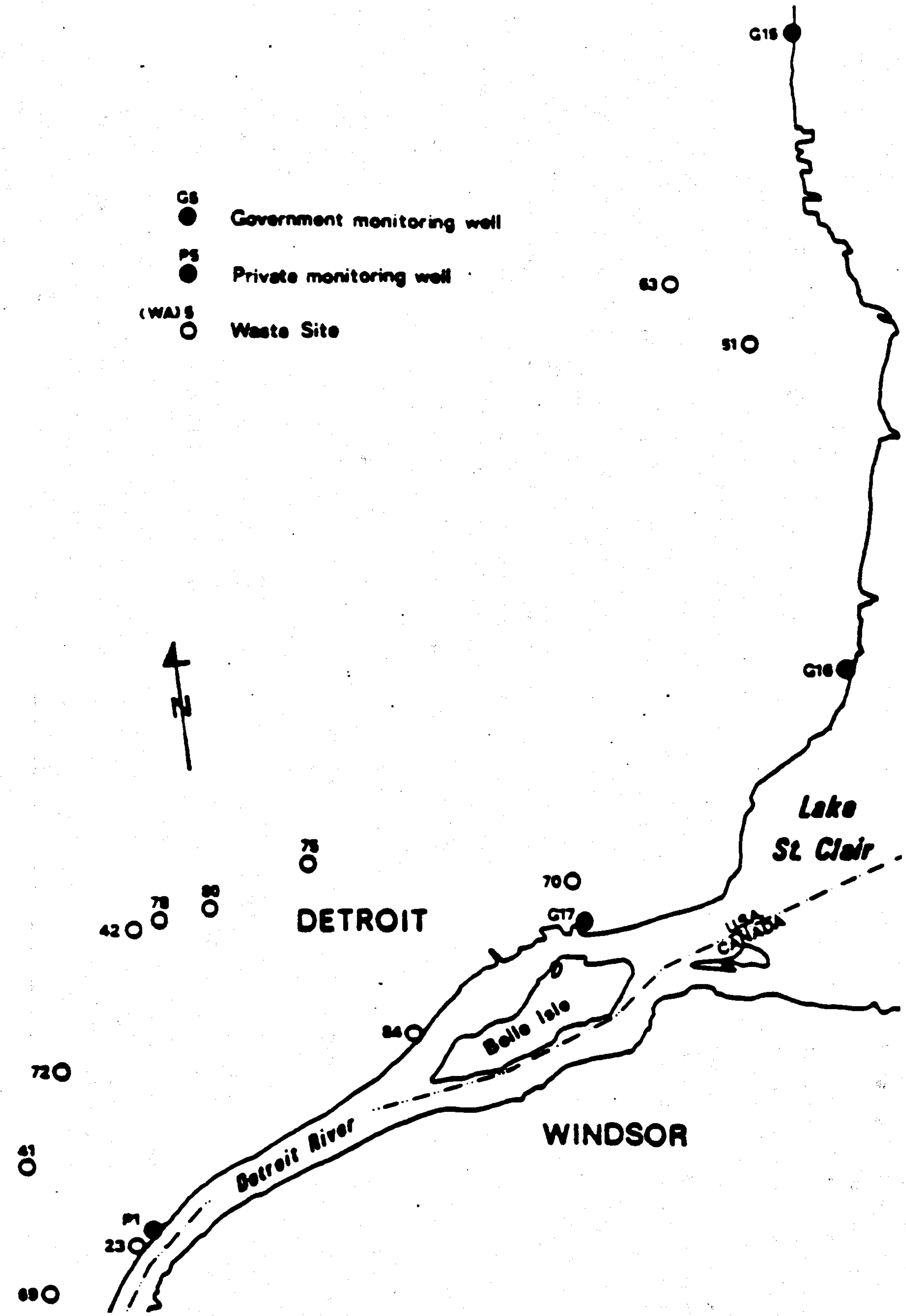


Figure 8-15. Continued.

Table 8-36. Confirmed or possible Michigan contamination sites within Detroit River groundwater discharge areas.

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1. Zug Island Great Lakes Steel (CERCLIS/RCRA/Act 307)
The Zug Island Great Lake Steel site is an island in the Detroit River near the mouth of the River Rouge. Industrial wastes were used to enlarge the island. Wastes which have been disposed of here contained heavy metals, asbestos and oily wastes and sludges.

2. Federal Marine Terminal Properties (CERCLIS/RCRA/Act 307)
The Federal Marine Terminal Properties site is an unpermitted landfill located adjacent to the Trenton Channel of the Detroit River. Mercury, chlorinated hydrocarbons, phenols and anthracene have been identified in the groundwater, ponded surface water and sediments on the site (MDNR). One-half of the on-site groundwater drains to the Detroit River and one-half drains to Monguagon Creek.

   Unpermitted dumping of chemical manufacturing waste, primarily soda ash, from BASF Wyandotte took place prior to initial efforts to prepare the site as a docking facility. Mercury, arsenic, naphthalene, and benzo(a)pyrene have been found in groundwater samples. The Consent Agreement signed by BASF, USEPA, and MDNR outlines a Remedial Action Plan for the site, and the provisions of the Consent Degree include clay capping of the site, shoreline stabilization, and a monitoring and inspection program.

3. Industrial Landfill (Firestone) (CERCLIS/RCRA/Act 307)
The Industrial Landfill was owned and operated by Firestone Steel Products Company. General plant wastes including scrap metal, phosphate sludge, paint sludge, treatment pond sludge and degreasing solvent residue were placed in the landfill. The site is crossed by surface drainage (Monguagon Creek and Huntington Drain) which empties into the Trenton Channel of the Detroit River. Groundwater and surface water contamination is indicated in the Act 307 listing. There are some monitoring wells located on-site.

4. Michigan Consolidated Riverside Park (CERCLIS/RCRA/Act 307)
The Michigan Consolidated Riverside Park site is a former coal gasification facility which has been converted to a park. All waste materials are covered by at least 2 feet of soil. The soils consist primarily of sandy clay and rubble interspersed with sands and organic material. Groundwater contamination is not indicated in the Act 307 listing. There are no monitoring wells.

5. B.A.S.F. Wyandotte South Works (CERCLIS/RCRA/Act 307)
The B.A.S.F. Wyandotte South Works site is a former chemical company plant site. The plant has been closed and demolished. The eastern half of the site is mostly reclaimed river bottom and marsh land consisting of fill material. There are several groundwater contamination sites on the South Works property. Ground and surface water contamination are indicated in the Act 307 listing. There are some monitoring wells on-site.

Table 8-36. (continued)

6. B.A.S.F. Wyandotte North Works (CERCLIS/RCRA/Act 307)
The B.A.S.F. Wyandotte North Works site is a chemical company plant site. In addition to permitted solid waste management units, there are several sites of unidentified fill material. The fill sites contain black odoriferous "cinders" and clay-like sludge material. Groundwater, surface-water, and soil contamination are indicated in the Act 307 listing. There are some monitoring wells located on-site.

MDNR sampling of groundwater showed contamination of the top aquifer with cloroform, and of the lower aquifer with lead, cyanide and benzo(a)pyrene. MDNR sampling of a site outfall shows contamination with 1,2-dichloropropane, 1,2-dichloroethane, phenol and benzene.

7. Huron Valley Steel Corporation (RCRA)
The Huron Valley Steel Corporation site is a RCRA-permitted facility that stores emission control dust/sludge (from the primary production of steel in electric furnaces) in tanks. There are no monitoring wells.

8. Edward C. Levy Co. Plant No. 3 (RCRA)
The Edward C. Levy Co. Plant No. 3 site is a RCRA transporter and treatment/storage/disposal facility. This plant stores and treats spent pickle liquor from steel finishing operations. There are 4 monitoring wells.

9. Edward C. Levy Co. Trenton Plant (RCRA)
The Edward C. Levy Co. Trenton Plant site is a RCRA transporter and treatment/storage/disposal facility. This plant stores and treats spent pickle liquor from steel finishing operations. There are 4 monitoring wells.

10. McLouth Steel Products Corporation (RCRA)
The Edward C. Levy Trenton Plant is located on the property of McLouth Steel Products Corporation. The facility is located in a mainly heavy industrial area. There is a small strip of residential land within 1000 feet of the facility to the west. The Detroit River borders the facility on the east. Inspection of tanks storing spent pickle liquor (K062) indicate that releases to the surrounding soils have occurred. The company has not performed closure including cleanup of their releases. No known hydrogeological information on the site exists.

11. Diversey Corporation (CERCLIS/RCRA)
The Diversey Corporation site is a generator and treatment, storage and/or disposal facility. There are no monitoring wells.

The site received a high modified DRASTIC score due to a shallow water table, sandy surficial material and close proximity, within one-half mile of the Detroit River.

12. Pennwalt Corporation (CERCLIS/RCRA/Act 307)
The Pennwalt Corporation site is a RCRA generator and treatment, storage and/or disposal facility. The Pennwalt property east of Jefferson Avenue consists of 50% fill which was placed along the Detroit River. The nature of the material used for filling is not known. Groundwater contamination is not indicated in the Act 307 listing.

Table 8-36. (continued)

13. Monsanto Company (CERCLIS/RCRA)
The Monsanto Company site is a RCRA generator and a treatment, storage and/or disposal facility located on the shore of the Trenton Channel of the Detroit River. One-half of the site property is composed of fill which was placed in the river. A monitoring system consisting of twenty wells have documented groundwater contamination with arsenic.

Monsanto has been on location since 1941. The 175 acre facility, which is bounded on the east by the Detroit River produces, or has produced phosphate for industrial metal cleaning, food-grade inorganic chemicals and plastic sheet for safety glass. Like virtually all industrial riverfront sites in the down-river area, land facing the river has been considerably modified by fill, much of which came from industrial sources. Groundwater here contains elevated levels of arsenic, as well as elevated pH, sodium and sulphates. Groundwater elevations are significantly affected by recharge from wastewater ponds. Groundwater discharge is to the Detroit River and Elizabeth Park Canal.

14. Jones Chemicals Inc. (RCRA)
The Jones Chemicals Inc. site is a RCRA transporter and treatment, storage and/or disposal facility. Corrosive waters are treated or stored in tanks. There are no monitoring wells.

15. Petro-Chem Processing Inc. (RCRA)
The Petro-Chem Processing site is a RCRA generator, transporter, and treatment, storage and/or disposal facility. This company processes petroleum products, the primary product produced is Chem-Fuel #5. The site is underlain by 6 to 10 ft of heterogeneous fill which overlies 1 to 5 ft of peat, and a thick layer of clay. Groundwater chemical analysis revealed only trace levels of petroleum-related chemicals despite nearly a century of heavy industry in the area. There are no underground storage tanks and the above ground tanks are diked. There are 6 monitoring wells. Petro-Chem has only been in operation since 1982, but previous site owners have carried out fuel blending since 1976 (KOI Petroleum) and petroleum distribution activities for many years prior to that (Amoco).

16. Chrysler Trenton Plant (RCRA/Act 307)
A MDNR site inspection discovered 3000 drums of solvents on site as well as saturated, ignitable soils. Wells are located on-site.

CERCLIS: Site is listed within the information system for Superfund and is considered for cleanup under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended.

RCRA: Facility has a Resource Conservation and Recovery Act (RCRA) identification number.

Act 307: Site is listed on Michigan's compilation of sites of known and possible environmental degradation.

During UGLCCS, analyses of groundwater quality from eight wells (5 observation and 3 private) within the Michigan Detroit River discharge area were obtained. Of these eight wells, three were located down-gradient of 3 of the 15 top ranked waste sites: Michigan Consolidated Gas-Riverside Park (P1 on Figure 8-14), Pennwalt Corporation (P2) and Petro-Chem Processing (G17). Unfiltered groundwater samples from these wells contained concentrations of organic and inorganic constituents suggesting groundwater contamination, as shown below:

Michigan Consolidated Gas-Riverside Park:

Total volatiles 1440 ug/l; total PAHs 287 ug/l; dissolved barium 2000 ug/l; total cadmium 40 ug/l; total arsenic 58 ug/l; total chromium 120 ug/l; total cobalt 160 ug/l; total copper 660 ug/l; total lead 2500 ug/l; total mercury 55 ug/l.

Pennwalt Corporation:

Total volatiles 5.9 ug/l; total PAHs 269 ug/l; total phthalates 150 ug/l; total phenolics 95 ug/l; total copper 530 ug/l; total lead 800 ug/l; total nickel 1500 ug/l; phenol 47 ug/l; and 2,4-dimethyphenol 48 ug/l..

G17: Total PAHs 58 ug/l; total phthalates 364 ug/l; total copper 2500 ug/l; total lead 4700 ug/l; dissolved barium 2400 ug/l; dissolved beryllium 13 ug/l; total cobalt 50 ug/l; total iron 570 ug/l; total mercury 2.2 ug/l.

Additional wells located downgradient of other lower-ranked waste sites also showed some contamination. The contaminant concentrations were based on unfiltered samples and are not indicative of contaminant loadings to the Detroit River from ground-water discharge. However, groundwater at some locations contained high chemical concentrations suggesting that contaminant loadings to the Detroit River may be occurring through the groundwater. A quantitative estimate cannot be determined with the present data but as previously noted, groundwater inputs contribute less than 0.1% of the total river flow and loads would be relatively small.

8.3.3.2 Ontario Waste Sites

One Ontario waste disposal site had the potential for impact on human health and safety and perhaps the Detroit River. This site, used by Wickes Manufacturing Ltd., is located near the Little River and had elevated levels of chromium and iron in the groundwater. The waste ponds were drained in 1985 and the materials moved to a certified disposal site in 1986. Subsequent tests indicated limited groundwater contamination and the site remains under investigation. A waste site inventory has been prepared by the Ontario Ministry of the Environment (GTC 1986). Waste sites with potential to impact the Detroit River, as identified in this report are as follows:

Domestic and industrial solid wastes from Chrysler, Ford, General Motors and Hiram Walker were disposed of at a City of Windsor disposal site prior to 1973. Shallow groundwater in this vicinity travels northward to Lake St. Clair by way of the Little River drainage basin. Leachate from this site has been identified by MOE; however, it has not been characterized. Further investigations will be required to document the potential impact on the water quality in the Little River (GTC 1986).

Wickes Manufacturing which is adjacent to the Little River, operates a landfill containing process sludges and neutralized "plating" solutions. Surface runoff is being monitored; however, no groundwater monitoring equipment has been installed (GTC 1986). The Canard River watershed is primarily agricultural with little industrial or municipal impacts. A waste site inventory (GTC 1986) of the area did not highlight any landfills with potential runoff to the Canard River. A waste site operated by Allied Chemical prior to 1982 was demonstrated to impact the Big Creek marsh and local domestic wells (GTC 1986). A new settling basin has been in use since 1982 operated by General Chemical, with no anticipated discharge to Big Creek. The North Drain discharge, which enters the Detroit River, is monitored on a daily basis.

Two dumps located in Anderdon Township, located within 50 metres of the Canard River, have been closed since 1957 and 1969 respectively. The Ministry of the Environment District Office has no information on file from the Anderdon Township which would indicate possible leaching or impacts on the Canard River.

8.3.3.3 Island Waste Sites

Two waste disposal sites are located on Detroit River islands: Fighting Island (Ontario) and Point Hennepin, on Grosse Ile (Michigan). Fighting Island is the second largest island in the Detroit River (approximately 3 km^2). Except for its northern tip, the entire island was used by BASF Wyandotte Corporation (North Works) to dispose of chemical process wastes. Samples from 51 test sites on Fighting Island collected between 1982 and 1984 indicated that groundwater and leachate samples contain high levels of zinc (less than 0.01 mg/l - 50.3 mg/l), cadmium (less than 0.01 mg/l - 0.65 mg/l), and phenols (0.016 mg/l - 56 mg/l). Compared to groundwater contamint levels at some Michigan sites, the Fighting Island concentrations are low and the volume of leachate is small (UGLCCS 1988).

Originally a marshland, Fighting Island is now virtually buried in salt and carbonate spoils derived from soda ash and propylene oxide production at the Wyandotte manufacturing facilities. It is now understood that the source of the low level organics identified in the spoils is the by-products derived from the processing of raw material and chlorination of chemicals used in the production of the soda ash and propylene oxide.

During the past 20 years, various investigations were conducted on Fighting Island. Although the overall database is disjointed, when considered as a whole, it provides some insight into historical activities on Fighting Island, and permits a reasonable assessment of its condition.

The spoil on Fighting Island consists of large quantities of calcium chloride and smaller quantities of sodium chloride, magnesium chloride, calcium sulphate, calcium carbonate, sodium carbonate, calcium hydroxide, magnesium hydroxide and silica. These compounds contribute to the high pH and high chlorides in the spoil.

Contained in the spoil and the saturdated zone within the spoil (which forms the Island's shallow groundwater aquifer) are some priority pollutants (as identified by the U.S. EPA in Federal Register, Volume 44, No. 233). Generally, it can be assumed that the level of contaminants is not of serious concern. PCBs and priority pollutant pesticides, dioxins and furans were not detected on the Island.

Three potential pathways for off-site migration of contaminants are seepage of groundwater through the peripheral dykes; lateral flow of groundwater through the organic layer overlying the silty-clay till and underlying the spoil; and airborne spoil particles.

Existing data support the postulation that migration of contaminants, through groundwater to the Detroit River, is retarded.

Fighting Island is located on the Canadian side of the Detroit River. The island is owned by BASF-Wyandotte, an American company. Two-thirds of the island is a lagoon that is no longer in use. Officials at BASF say there is minimal runoff from the island into the Detroit River. The former settling beds are surrounded by dykes consisting of rockfill, river sediments and lime residues. The beds include decant ponds that discharge directly into the river. To discourage leachate seepage through the dykes, surface runoff ditches have been constructed behind the dykes. The dykes are inspected semi-annually to ensure their integrity (GTC 1986). The runoff is mostly from storm events and the river dilutes it to non-detectable levels.

Biomonitoring studies by the Ontario Ministry of the Environment (Kauss and Hamdy 1985) do not identify any impacts on caged clams in the vicinity of Fighting Island.

Point Hennepin, on Grosse Ile, is approximately 1 km^2. This site was an industrial waste lagoon/disposal site by BASF Wayndotte (South Works). Little is known about the type and quantity of wastes disposed here. The large sinkholes on Pt. Hennepin may connect the surface water and groundwater aquifers. A surface leachate sample taken on the eastern side of the peninsula in 1983 was highly toxic in the Microtox toxicity bioassay (Ribo et al. 1985).

8.3.3.4 Underground Injection Wells

Pressurized injection of industrial liquid wastes has occurred in the Detroit River watershed for many years at depths ranging from 200 m to over 1,200 m and injection pressures ranging from 580 to 1,600 psi (approximately 20 to 50 kBar). There are five classes of injection wells regulated by U.S. law. Class I wells are industrial and municipal wells which discharge below the lowermost formation containing an underground source of drinking water (USDW). Class II injection wells are associated with oil and gas production and liquid hydrocarbon storage. Class III wells are special process wells used in conjunction with solution mining of minerals. Class IV wells, which were banned in 1985, are hazardous waste wells which inject into or above a USDW, and Class V injection wells are those not fitting into any of the above categories, such as cesspools and heat exchange wells.

On the Michigan side of the Detroit River, 234 injection wells have operated or are currently operating. Of the six Class I wells, three are plugged and abondoned and three are currently operating at the Detroit Coke facility. The facility disposed of waste that contained chloride, ammonia, phenols, cyanide and sulfide. Class II well records indicate a total of 24 wells operating near the Detroit River, and consist of five salt water disposal wells and 19 hydrocarbon storage wells. Two Class III facilities (Pennwalt and BASF-Wyandotte) operated a total of 150 wells, of which only five are still active, and the active wells are scheduled to be plugged and abandoned soon. Approximately 66 Class V wells are presently operating in the Detroit River SAOC. The impact of these underground injection wells on the Detroit River and its ecosystem is unknown.

8.3.4 Spills

A listing of Michigan pollution incidents reported for the Detroit River (and Rouge River) in 1989 are in Table 8-37. Appendix 8-6 lists spills occuring in 1986. A variety of chemical, oil and wastewater spills occurred during 1989. The Detroit U.S. Coast Guard Marine Safety Office (MSO) responds to reported pollution incidents from many sources occurring in the area from the Detroit River light to Tawas (North). Reported incidences do not always indicate that there was a pollution incident. In some cases incidents are investigated and no pollution is found, or in other cases there may be only the potential for pollution. Reports received that involve spills from Ontario sources or that do not involve Coast Guard personnel are not documented in detail in the USGS database. The MSO at Detroit received 26 reports of pollution incidents to the Detroit or Rouge Rivers from Michigan sources or involving USGS personnel (Table 8-37). Sixteen of these incidents involved waste oil, lubricants, or diesel oil, with an estimated quantity of 1791 gallons spilled and 1162 gallons recovered. Other reported incidents involved hydrochloric acid, anhydrous ammonia and vegetable oil.

The following statistics were provided by the USGS MSO Detroit and refer to the entire response area (i.e. not limited to the Detroit River AOC):

1989 Spill Facts at MSO Detroit

* 126 oil and chemical spills were reported to MSO Detroit in 1989 an increase of 38% from 1988 (approximately one spill every three days).

* Reported chemical spills decreased from 28% of all spills 1988 to 23% of all spills in 1989.

* 6% of all spills reported to the MSO in 1989 were from Canadian sources.

* 16% of all chemical spills reported to the MSO in 1989 were from Canadian sources.

Table 8-37. Pollution incidents reported to the USCG Marine Safety Office, Detroit, in 1989. (Rouge and Detroit Rivers).

Contaminant	Source	Quantity Spilled (gal)	Quantity Recovered (gal)	Activities
Oil, waste/lubricants	McLouth Steel-Trenton	25	0	dissipated
Oil, waste/lubricants	McLouth Steel-Trenton	25	0	none
Oil, waste/lubricants	Ford Motor/DWSD outfall*	40	0	non-removable
Oil, waste/lubricants	Unknown*	10	0	non-removable
Oil, waste/lubricants	Unknown*	5	0	non-removable
Hydrochloric Acid	Ford Motor Company*	800	0	NEC
Oil, waste/lubricants	Unknown*	75	25	Cleanup performed
Potential spill of carbon black feedstock	Barge (aground)	0	NA	No spill occurred
Potential spill of carbon black feedstock	Barge (aground)	0	NA	No spill occurred
Potential spill of oil	Underground fuel tanks at boat yard (being removed)	0	NA	No spill occurred
Hydrochloric Acid	Rouge Steel*	6400 lbs HCl**	0	NEC
Unknown (surface pollutants)	Unknown			No threat
Oil, waste/lubricants	Grosse Ile Airport	50	1	NEC
Oil, waste/lubricants	Unknown	25	10	Cleanup performed
Oil, waste/lubricants	DWSD outfall	25	0	Non-removable
Ammonia, anhydrous	GLS-Zug Island	2500 lbs	0	Non-removable
Oil, waste/lubricants	Tugboat*	1226	926	Cleanup performed
Oil, waste/lubricants	GLS	5	0	Non-removable

Table 8-37. (continued)

Contaminant	Source	Quantity Spilled (gal)	Quantity Recovered (gal)	Activities
Potential spill of rotting plant material	Unknown (at Grosse Ile)	0	NA	No spill occurred
Oil, edible: vegetable	Unknown	10	7	Cleanup performed
Mud	Doisch Brothers Hazardous Waste Haulers	20	0	Non-removable

*Receiving water: Rouge River.
**Discharge of 5% HCl solution to 22,000 gallons liquid.

NEC Not Elsewhere Classified

* 42% of all spills reported to the MSO in 1989 occurred on the Detroit River. 19% occurred on the St. Clair River. 7% on the River Rouge.

* 49% of all spills reported to the MSO in 1989 were from unknown sources.

Reported spills from Ontario sources occurring in 1989 are listed in Table 8-38. Appendix 8.6 contains an inventory of recent spills from 1986 and 1988 to present. All spills of a pollutant must be reported to Environment Ontario, as stated in the Environmental Protection Act, Part IX, Section 80 (refer to Chapter 4, Regulatory Programs, for further information). Environment Ontario has established the Spills Action Centre for recording all spills of pollutants into the environment.

It is difficult to determine the impact and significance of spills to the Detroit River. However, contaminant loads from some spills may result in localized impairments

8.3.5 Atmospheric Deposition

There are no data on direct atmospheric deposition of contaminants to the Detroit River. However, contaminant loadings from indirect atmospheric deposition to the watershed are reflected in tributary contributions, CSO load estimates and stormwater load estimates Atmospheric deposition directly to the Detroit River would be relatively minor given the small surficial area of the River in relation to its flow. Loads of contaminants from atmospheric deposition to watersheds upstream of the Detroit River would be reflected in upstream inputs which are discussed in Section 8.3.6.

Air concentrations of selected constituents for Wayne County are shown in Table 8-39, and sampling locations are shown in Figure 8-16. The highest concentrations of these constituents are near Zug Island. Areas located 2 to 3 km north of Zug Island generally had the lowest concentrations.

8.3.6 Upstream Inputs and Downstream Outputs

Mass balance studies were conducted, as part of the UGLCCS efforts, for the entire Detroit River. One goal of the studies was to assess the statistical significance of differences between upstream and downstream loads. The loads were calculated using flow and concentration data collected between April 21 to 29, 1986 and July 25 to August 5, 1986, at upstream and downstream transects (Table 8-40). The upstream inputs reflect the loads associated with ambient water entering the Detroit River while the downstream outputs reflect the loads associated with ambient water entering Lake Erie.

With sufficient data, mass balance calculations are useful for determining:

1) Whether an area is a source or a sink of contaminants; and

2) The relative importance of known and unknown contaminant sources.

Table 8-38. Spills into the Detroit River from Ontario sources reported in 1989.

Date	Location	Occurrence
23-Nov-88	Amherstburg	Canadian Coast Guard - reports petroleum product in Amherstburg channel.
13-Jan-89	Windsor	oil sheen sited near Fighting Island
28-Jan-89	Windsor	Chrysler - wastewater to Grand Marais drain, minor (flows into Turkey Creek)
15-Feb-89	Windsor	oil sheen on Detroit River
05-Apr-89	Windsor	Ford - oil sheen on Detroit River cause unknown
07-Apr-89	Amherstburg	light oil sheen on Detroit River from unknown source
27-Apr-89	Windsor	Ford - soap spill to Detroit River
11-May-89	Sandwich West	Canadian Coast Guard - reports an oil sheen by Fighting Island
14-May-89	Amherstburg	General Chemical - 150 litres lubricating oil to Detroit River
31-May-89	Windsor	report of barge emitting a fuel spill in harbor
08-Jun-89	Amherstburg	General Chemical - release of wastewater chlorides 100000 ppm
09-Jun-89	Windsor	Canadian Coast Guard - reports oil sheen on Detroit River
10-Jun-89	Windsor	Ford - light oil sheen in Detroit River
30-Jul-89	Windsor	oil slick in canal at mouth of Detroit River
18-Aug-89	Amherstburg	brine to Detroit River from over-flowing tank
06-Nov-89	Amherstburg	Allied Chemical, spill of fluorides to Detroit River, quantity unknown
07-Nov-89	Amherstburg	General Chemical - milk of lime discharge to Detroit River

Data compiled from Environment Ontario's Spills Action Centre.

Table 8-39. Mean concentrations of selected chemical constituents in the air above Wayne County, Michigan, within four miles of the Detroit River, 1980-1986[1].

Constituent	Station Number 2	60/61	5	9	10	34
Benzo(a)pyrene ng/m^3	1.27	--	3.49	--	--	--
Beryllium ug/m^3	--	--	0.0003	--	--	0.0007
Cadmium ug/m^3	--	--	0.058	--	--	0.0038
Carbon Monoxide ug/m^3	--	--	--	--	--	--
Chromium ug/m^3	--	--	0.012	--	--	0.009
Iron ug/m^3	--	--	1.53	--	--	1.21
Lead ug/m^3	--	--	0.27	--	--	0.14
Mercury ug/m^3	--	--	0.0003	--	--	0.0004
Nickel ug/m^3	--	--	0.013	--	--	0.010
Nitrogen Dioxide ug/m^3	--	65	--	--	--	--
Ozone ppm	--	--	--	--	--	--
Sulfur Dioxide ug/m^3	16	34	39	24	--	--
Total Susp. Particles ug/m^3	57	66	89	68	52	--
Zinc ug/m^3	--	--	0.33	--	--	0.37

[1] From Michigan DNR, Wayne County yearly air quality data.

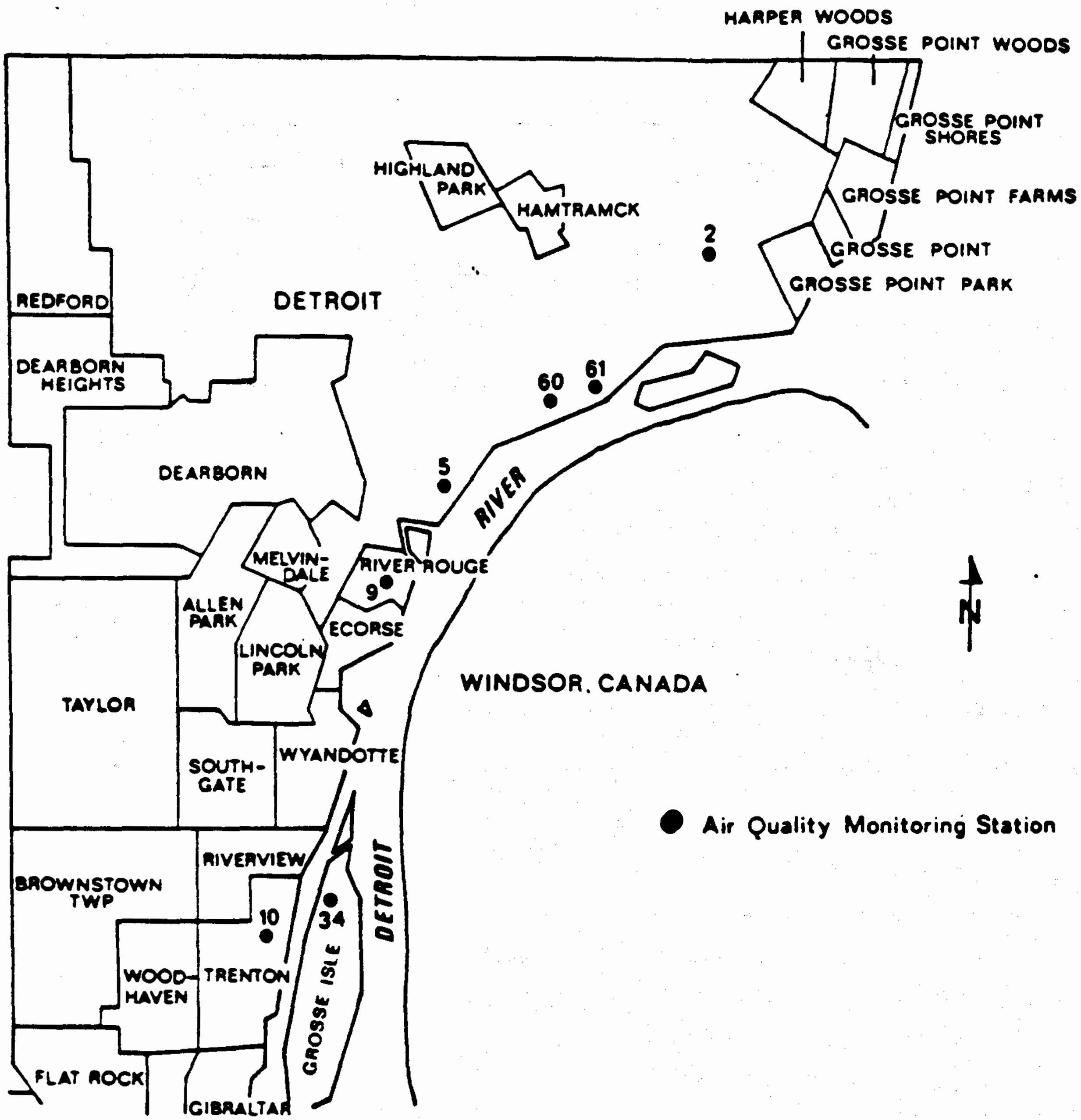

Figure 8-16. Wayne County Air Quality Monitoring Network.

Table 8-40. Upstream inputs to the Detroit River and downstream outputs to Lake Erie, 1986. Results are in kg/day and (lbs/day).

Parameter	Upstream: April 21-29, 1986		Upstream: July 25-August 5, 1986		Downstream: April 21-29, 1986		Downstream: July 25-August 5, 1986	
Suspended Solids	4,847,000	(10,660,000)	4,640,000	(10,200,000)	6,292,000	(13,840,000)	6,673,000	(14,680,000)
Total Phosphorus	4,900	(11,000)	4,400	(9,700)	8,900	(20,000)	6,500	(14,000)
Chloride	3,784,000	(8,324,000)	3,872,000	(8,518,000)	4,713,000	(10,370,000)	4,695,000	(10,330,000)
Zinc	689	(1,520)	644	(1,420)	1840	(4,050)	1,016	(2,235)
Nickel	548	(1,210)	502	(1,100)	644	(1,420)	747	(1,640)
Lead	79.7	(175)	58.0	(128)	93.9	(207)	92.6	(204)
Copper	723	(1,590)	472	(1,040)	920	(2,020)	663	(1,460)
Cadmium	11.1	(24.4)	8.9	(20)	21.7	(47.7)	14.3	(31.5)
Mercury	4.7	(10)	7.1	(16)	4.8	(11)	8.7	(19)
PCBs	0.77	(1.7)	0.85	(1.9)	1.63	(3.59)	2.09	(4.60)
HCB	0.11	(0.24)	0.26	(0.57)	0.12	(0.26)	0.26	(0.57)
Iron*		114,000	(251,000)			230,000	(506,000)	
OCS*		0.009	(0.02)			0.03	(0.07)	

* Load estimates from 1984 (Johnson and Kauss 1987).

It is important to preface any discussion of mass balance models with some indication of strengths and weaknesses with respect to the application of data.

The Upper Great Lakes Connecting Channels Study mass balance offers several advantages and disadvantages. The advantages include the following:

1) Field sampling and analytical work is conducted utilizing standardized protocols for both in river and source sampling.

2) This consistency enables relative comparisons of upstream, downstream, point source and nonpoint source loads.

The disadvantages include the following:

1) Samples were obtained over only a very brief period of time on two occasions during 1986 and represent qualitative, instantaneous contaminant loads.

2) Samples were collected along transects situated at the head and mouth of the Detroit River; however, due to resource constraints only selected sources were monitored within the area of concern boundary.

3) The inherent variability in sources and the analysis of contaminants at or below method detection levels, combined with extremely large flow volumes entering and exiting the Detroit River, contribute to error in these load calculations.

The 1988 UGLCCS mass balance study indicated that the Detroit River AOC was a statistically significant source of suspended solids, cadmium, copper, lead, chlorides, mercury (in one of two studies), zinc, nickel, total phosphorus and total PCBs. Johnson and Kauss (1987) concluded that in 1984 the SAOC was a significant source of iron and OCS.

Upstream inputs and downstream outputs are compared to the total load from sources within the AOC in Figure 8-17. Estimated loads of cadmium, mercury, zinc and lead from within the AOC are larger than the estimated downstream output, indicating the Detroit River is a potential sink of these compounds. However, this phenomena could also be the result of: 1) inaccurate estimates of loads; 2) differences in sampling strategies used to estimate loads (i.e. "snapshots" versus loads quantified in studies designed to provide annual estimates); or 3) differences in the age of the data used. The data are not sufficient to determine the most likely cause of the phenomena.

Figure 8-17 also indicates that the downstream outputs of chlorides, suspended solids, iron and OCS were substantially greater than the sum of the upstream inputs and AOC inputs. This could be caused by contaminants loads that were not quantified (i.e. loads from previously contaminated sediments, spills, etc.). Other explanations include: 1) inaccurate estimates of loads; 2) differences in sampling strategies used to estimate loads (i.e. "snapshots" versus loads quantified designed to provide annual estimates); or 3) differences in the age of the data

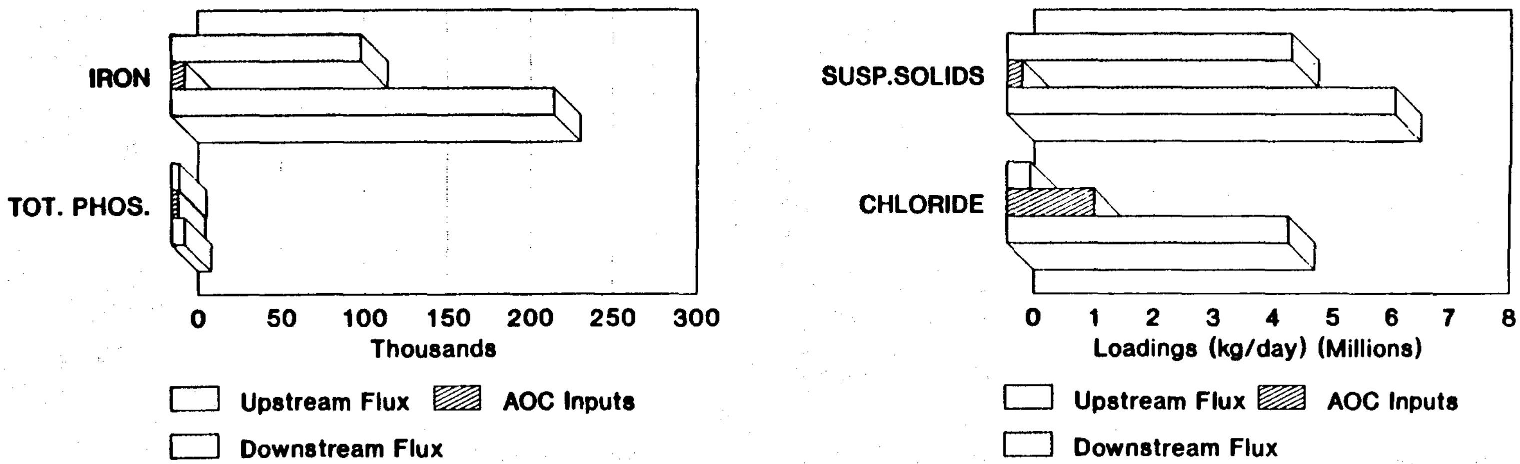

Figure 8-17. Loads from upstream sources, downstream loads and loads (or flux) from within the AOC.

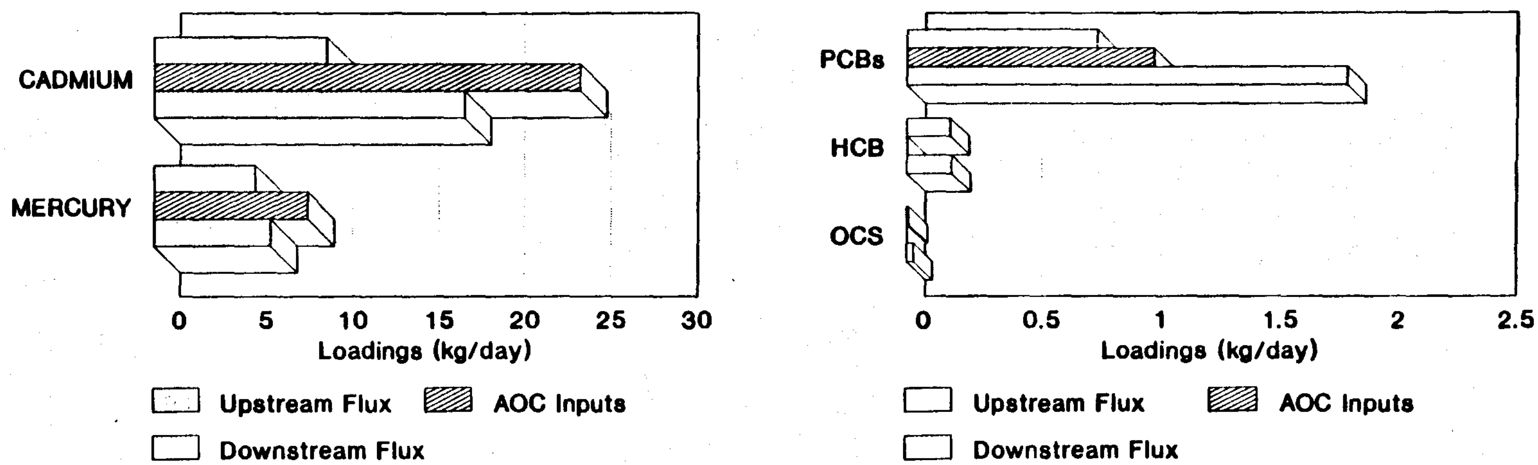

Figure 8-17. (Continued) Loads from upstream sources, downstream loads and loads (or flux) from within the AOC.

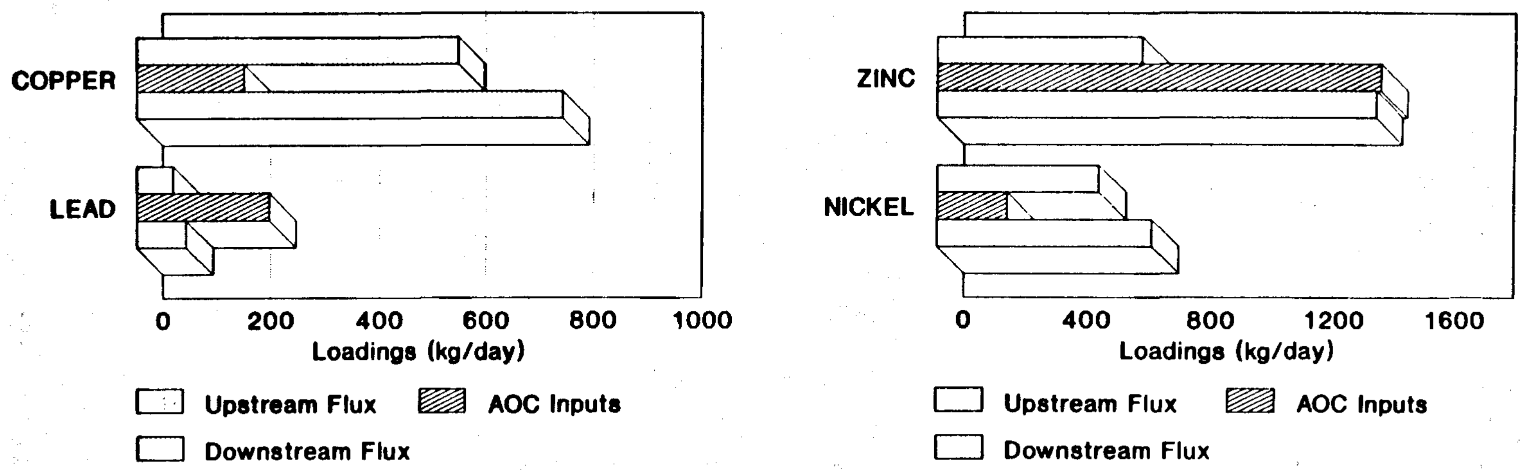

Figure 8-17. (Continued) Loads from upstream sources, downstream loads and loads (or flux) from within the AOC.

used. Again, the data are not sufficient to determine the most likely explanation for the apparent discrepancy.

Bias in the upstream inputs estimates may have been caused by insufficient temporal or spatial sampling but these loads should be useful for relative comparison to other loads (Section 8.4).

8.4 SUMMARY OF POLLUTANT LOADS TO THE DETROIT RIVER

The relative magnitude of measured pollutant loads to the Detroit River is summarized in Table 8-41 and Figure 8-18. Estimated loads from various sources are presented along with the estimated percent of the total load. All of the loads presented in the table have been discussed in previous sections. Some of the data are several years old and all of the estimated loads have limitations which are discussed in previous appropriate sections.

The total inputs to the river were calculated by adding upstream inputs (or background levels) to the point source and nonpoint source inputs in Table 8-41 and Figure 8-18 (when upstream loads were available). For most contaminants, upstream inputs were the largest source of loads to the Detroit River AOC. This is due in part to the large volume of water that enters the Detroit River (average flow = 5300 cubic meters per second or 190,000 cubic feet per second).

A primary focus of the Detroit River RAP is to identify contaminants of concern which are discharged to the Detroit River from sources within the Area of Concern even when upstream inputs are determined to be the major source. Identification of upstream inputs, or ambient levels, is important in the process of evaluating the dynamics of the system. The relative contribution of the upstream inputs provide information necessary to set realistic goals for the Detroit River AOC. The relative contribution of upstream inputs also provides insight into evaluating use impairments that will need to be addressed by remediating sources outside of the AOC or at the Great Lakes Basinwide level.

As previously noted, upstream inputs were usually the largest loads to the Detroit River. However, if upstream inputs are excluded from the total loads then point sources are the largest source of most contaminants. Michigan point sources contribute the largest loads of ammonia, total phosphorus, oil and grease, cadmium, cobalt, copper, iron, nickel, total phenols, cyanide and HCB to the Detroit River from the SAOC. Ontario point sources contributed the largest loads of chlorides from the SAOC.

Michigan CSOs contributed the largest loads of chromium, lead and mercury. Total PCB loads from Michigan CSOs were second only to the upstream input load. Windsor CSOs accounted one percent, or less, of the load of all parameters measured.

Michigan tributaries (Rouge and Ecorse) accounted for less than 1% to 13% of the total loads to the Detroit River for the various parameters. Tributary loads of suspended solids to the Detroit River were second only to the upstream input load. Ontario tributaries (Little, Turkey and Canard) contributed less than 1% to 6.5% of the total loads of various parameters.

Table 8-41a. Estimated daily loads of selected chemical constituents to the Detroit River from Michigan and Ontario using the most recent point and nonpoint source measured data collected between 1979 and 1990. Estimates are reported in kilograms per day.

Parameter	Total Load	Michigan Point Source	Percent	Ontario Point Source	Percent	Michigan CSOs	Percent	Windsor CSOs	Percent
Ammonia	39700	30200	76	1160	3	NA	NA	35.6	<1
Phosphorus	8610	2250	26	111	1	750	9	7.67	<1
Chlorides	1830000	467000	25	666000	36	8500	<1	370	<1
Suspended solids	4990000	50900	1	6710	<1	39000	1	NA	NA
Oil/Grease	44800	23600	53	1860	4	18000	40	175	<1
Cadmium	34.7	9.81	28	0.927	3	7.9	23	0.0641	<1
Cobalt	55.2	41.7	75	8.12	15	NA	NA	0.0977	<1
Chromium	76	20.3	27	20.7	27	25	33	NA	NA
Copper	799	95.5	12	25.8	3	42	5	1.42	<1
Iron	136000	3440	3	253	<1	440	<1	17	<1
Lead	316	12.3	4	30.6	10	86	27	1.49	<1
Mercury	14.8	0.131	1	0.0065	<1	8.7	59	0.000548	<1
Nickel	754	146	19	8.62	1	27	4	0.385	<1
Zinc	2110	411	20	166	8	110	5	5.99	<1
Total phenols	144	98.6	69	31	22	3.3	2	0.115	<1
Cyanide	325	34.4	11	2.31	1	NA	NA	0.0438	<1
HCB	0.188	0.00201	1	NA	NA	NA	NA	0.0000164	<1
Total PCBs	1.86	0.302	16	0.0392	2	0.46	25	0.00137	<1
OCS	0.00321	0.0000879	3	NA	NA	NA	NA	0.0000273	1
17 PAHs	119	NA	NA	0.822	1	NA	NA	0.0603	<1

• UGLCCS Mass Balance Study
UGLCCS data
** MDNR Unpublished data
NA Not Available

Table 8-41a. Continued.

Parameter	Michigan Stormwater	Percent	Windsor Stormwater	Percent	Michigan Tributaries	Percent	Ontario Tributaries	Percent	Upstream Inputs	Percent
Ammonia	120	<1	19.7	<1	1390	4	1720	4	5040 **	13
Phosphorus	150	2	15.3	<1	390	5	284	3	4650 *	54
Chlorides	64000	3	6990	<1	217000	12	20100	1	383000 *	21
Suspended solids	64000	1	NA	NA	83400	2	3020	<1	4740000 *	95
Oil/Grease	1000	2	131	<1	NA	NA	NA	NA	NA	NA
Cadmium	2.5	7	0.192	1	3.15	9	0.11	<1	10 *	29
Cobalt	3.9	7	0.46	1	NA	NA	0.97	2	NA	NA
Chromium	6.4	8	NA	NA	NA	NA	3.6	5	NA	NA
Copper	18	2	1.68	<1	14.8	2	2.3	<1	598 *	75
Iron	1900	1	350	<1	113	<1	1400	1	128000 **	94
Lead	83	26	9.7	3	21.3	7	2.3	1	68.9 *	22
Mercury	0.014	<1	0.00233	<1	NA	NA	0.00581	<1	5.9 *	40
Nickel	32	4	1.11	<1	8.15	1	5.3	1	525 *	70
Zinc	450	21	12.6	1	275	13	9.8	1	667 *	32
Total phenols	10	7	0.205	<1	NA	NA	0.66	1	NA	NA
Cyanide	6.2	2	0.184	<1	NA	NA	NA	NA	282 **	87
HCB	0.00021	<1	0.0000644	<1	0.001	1	0.000135	<1	0.185 *	98
Total PCBs	0.011	1	0.00219	<1	0.116	6	0.12	6	0.81 *	44
OCS	NA	NA	0.000123	4	NA	NA	NA	NA	0.00298 #	93
17 PAHs	15	13	0.153	<1	NA	NA	NA	NA	103 #	87

* UGLCCS Mass Balance Study
\# UGLCCS data
** MDNR Unpublished data
NA Not Available

Table 8-41b. Estimated daily loads of selected chemical constituents to the Detroit River from Michigan and Ontario using the most recent point and nonpoint source measured data collected between 1979 and 1990. Estimates are reported in pounds per day.

Parameter	Total Load	Michigan Point Source	Percent	Ontario Point Source	Percent	Michigan CSOs	Percent	Windsor CSOs	Percent
Ammonia	87300	66400	76	2550	3	NA	NA	78.4	<1
Phosphorus	18900	4950	26	244	1	1650	9	16.9	<1
Chlorides	4030000	1030000	25	1470000	36	18700	<1	814	<1
Suspended solids	11000000	112000	1	14800	<1	85800	1	NA	NA
Oil/Grease	98500	51900	53	4080	4	39600	40	386	<1
Cadmium	76.2	21.6	28	2.04	3	17.4	23	0.141	<1
Cobalt	122	91.7	75	17.9	15	NA	NA	0.215	<1
Chromium	167	44.7	27	45.5	27	55	33	NA	NA
Copper	1760	210	12	56.8	3	92.4	5	3.13	<1
Iron	300000	7570	3	557	<1	968	<1	37.4	<1
Lead	694	27.1	4	67.3	10	189	27	3.28	<1
Mercury	32.5	0.288	1	0.0143	<1	19.1	59	0.00121	<1
Nickel	1660	321	19	19.0	1	59.4	4	0.847	<1
Zinc	4640	904	20	366	8	242	5	13.2	<1
Total phenols	317	217	69	68.2	22	7.26	2	0.253	<1
Cyanide	715	75.7	11	5.08	1	NA	NA	0.0964	<1
HCB	0.415	0.00443	1	NA	NA	NA	NA	0.000036	<1
Total PCBs	4.1	0.664	16	0.0862	2	1.01	25	0.00301	<1
OCS	0.00707	0.000193	3	NA	NA	NA	NA	0.000060	1
17 PAHs	262	NA	NA	1.81	1	NA	NA	0.133	<1

• UGLCCS Mass Balance Study

UGLCCS data

** MDNR Unpublished data

NA Not Available

Table 8-41b. Continued.

Parameter	Michigan Stormwater	Percent	Windsor Stormwater	Percent	Michigan Tributaries	Percent	Ontario Tributaries	Percent	Upstream Inputs	Percent
Ammonia	264	<1	43.4	<1	3060	4	3790	4	11100 **	13
Phosphorus	330	2	33.8	<1	858	5	625	3	10200 *	54
Chlorides	141000	3	15400	<1	477000	12	44200	1	842000 *	21
Suspended solids	141000	1	NA	NA	183000	2	6650	<1	10400000 *	95
Oil/Grease	2200	2	288	<1	NA	NA	NA	NA	NA	NA
Cadmium	5.5	7	0.423	1	6.93	9	0.242	<1	22 *	29
Cobalt	8.58	7	1.01	1	NA	NA	2.13	2	NA	NA
Chromium	14.1	8	NA	NA	NA	NA	7.92	5	NA	NA
Copper	39.6	2	3.69	<1	32.6	2	5.06	<1	1310 *	75
Iron	4180	1	769	<1	249	<1	3080	1	282000 **	94
Lead	183	26	21.3	3	46.9	7	5.06	1	151 *	22
Mercury	0.0308	<1	0.00512	<1	NA	NA	0.0128	<1	13.0 *	40
Nickel	70.4	4	2.44	<1	17.9	1	11.7	1	1160 *	70
Zinc	990	21	27.7	1	605	13	21.6	1	1470 *	32
Total phenols	22	7	0.452	<1	NA	NA	1.45	1	NA	NA
Cyanide	13.6	2	0.404	<1	NA	NA	NA	NA	621 **	87
HCB	0.000462	<1	0.000141	<1	0.0022	1	0.000297	<1	0.407 *	98
Total PCBs	0.0242	1	0.00482	<1	0.255	6	0.264	6	1.78 *	44
OCS	NA	NA	0.000271	4	NA	NA	NA	NA	0.00655 #	93
17 PAHs	33	13	0.338	<1	NA	NA	NA	NA	227 #	87

* UGLCCS Mass Balance Study
\# UGLCCS data
** MDNR Unpublished data
NA Not Available

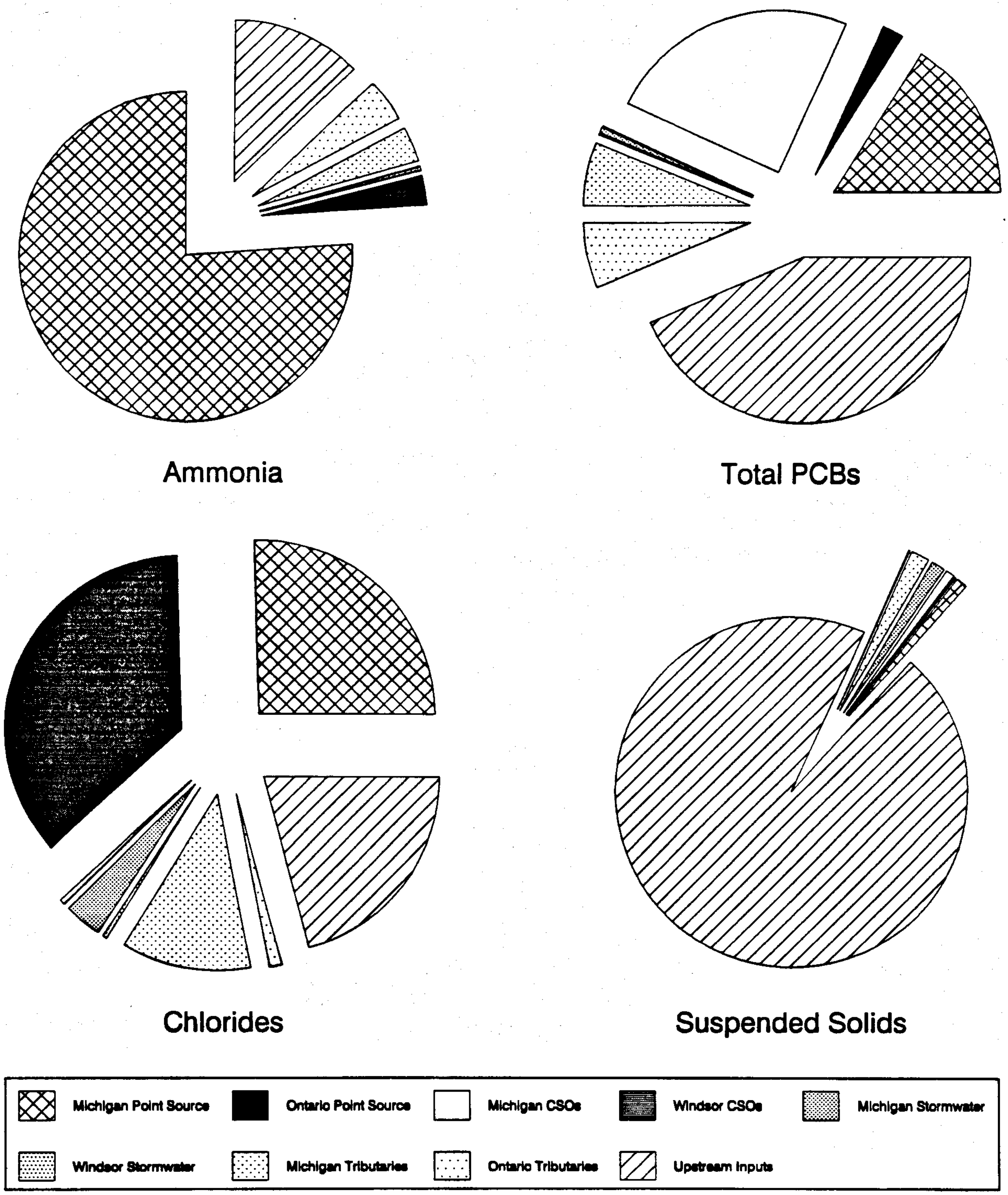

Figure 8-18. Relative contributions of parameters to the Detroit River from Michigan and Ontario point and nonpoint sources based on estimated daily loadings. Some of the data are several years old and all of the load estimates have limitations that have been discussed in previous sections.

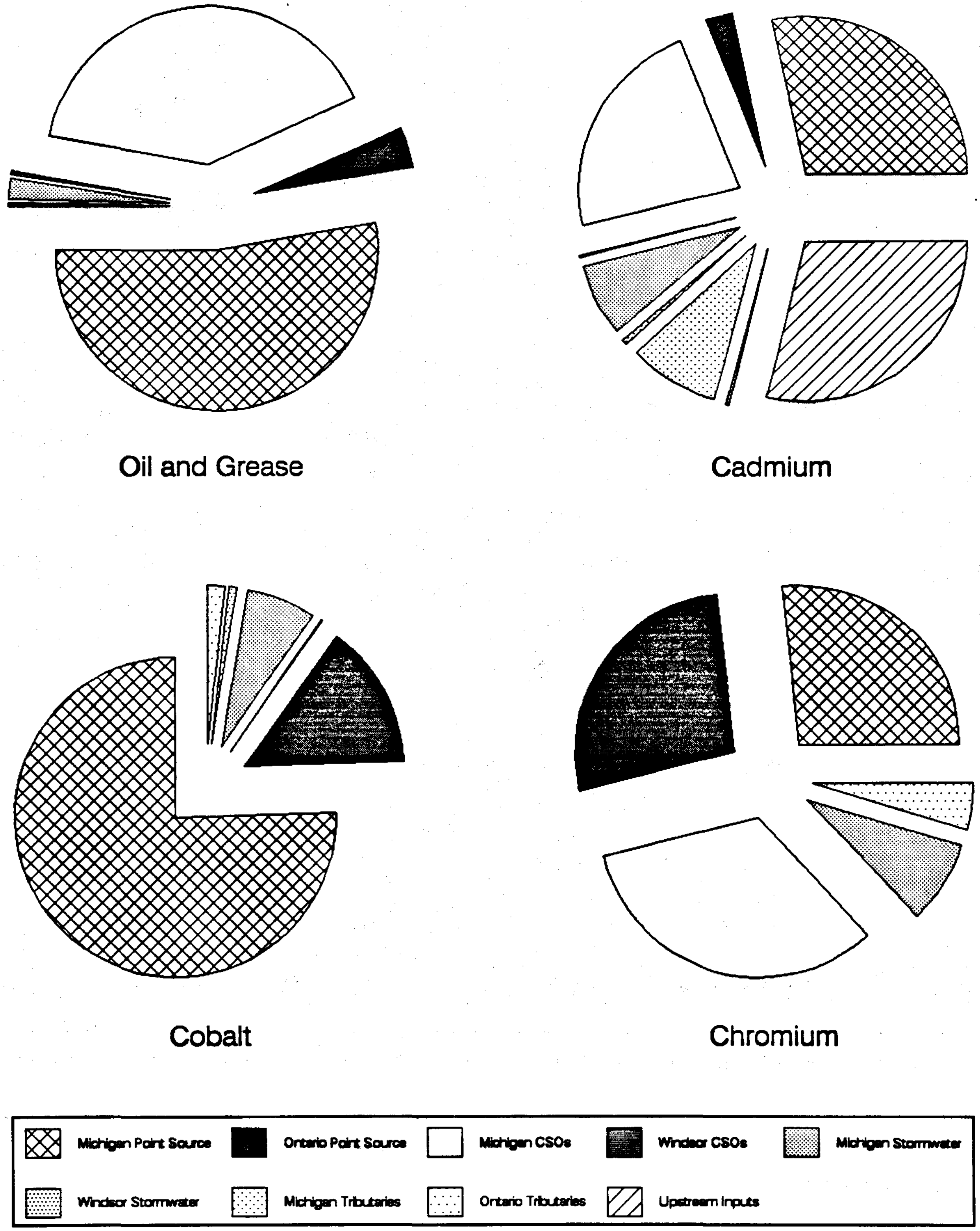

Figure 8-18. Continued.

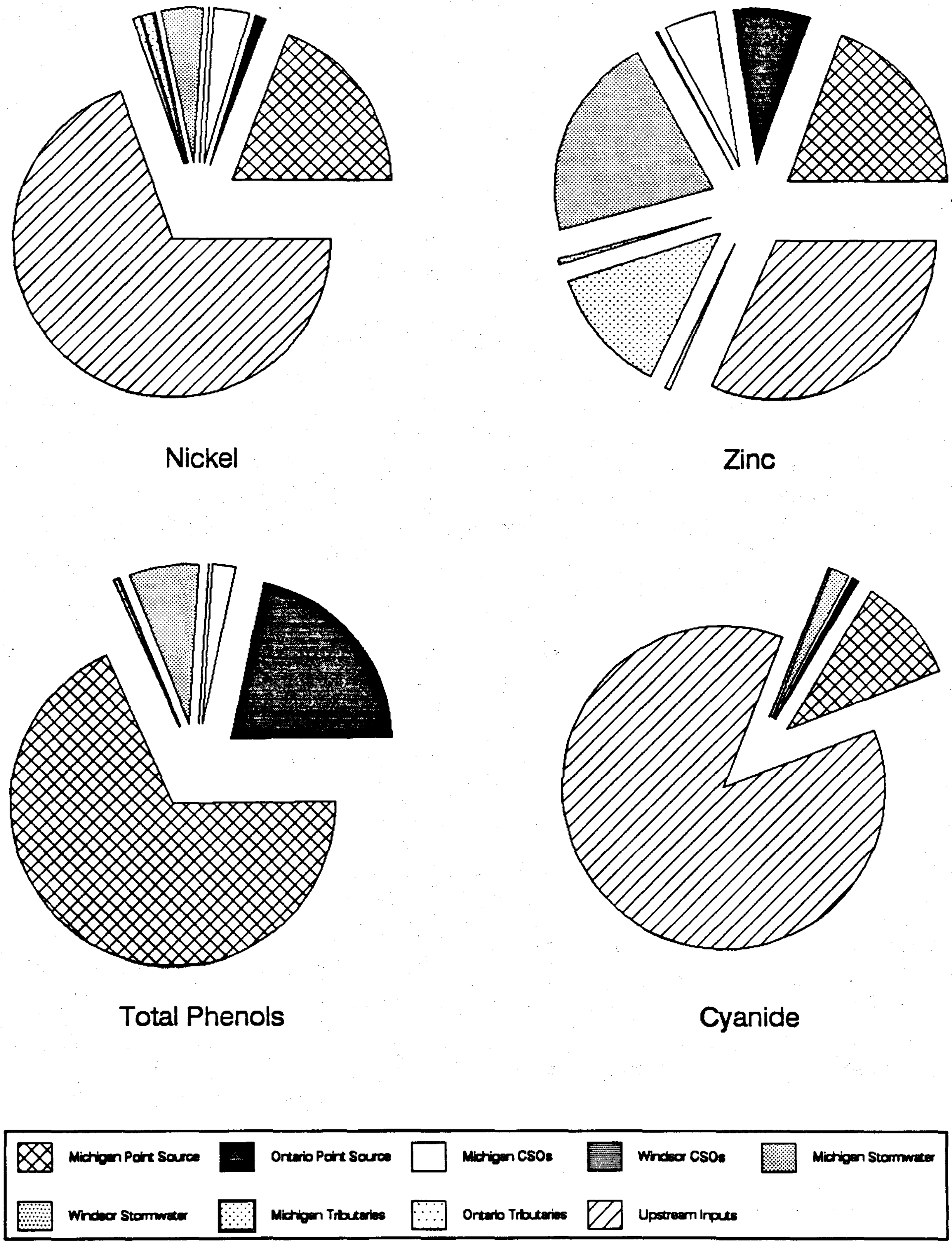

Figure 8-18. Continued.

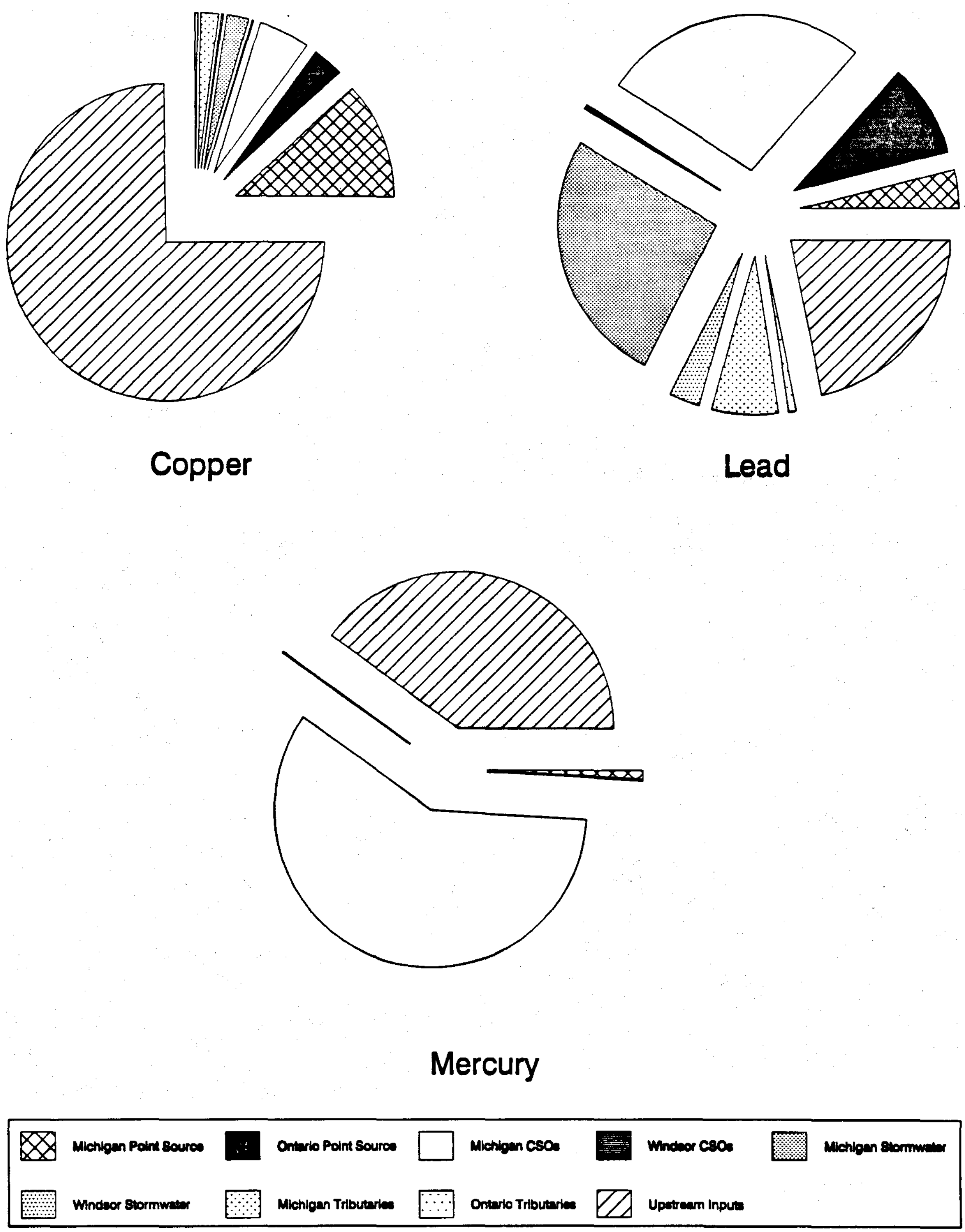

Figure 8-18. Continued.

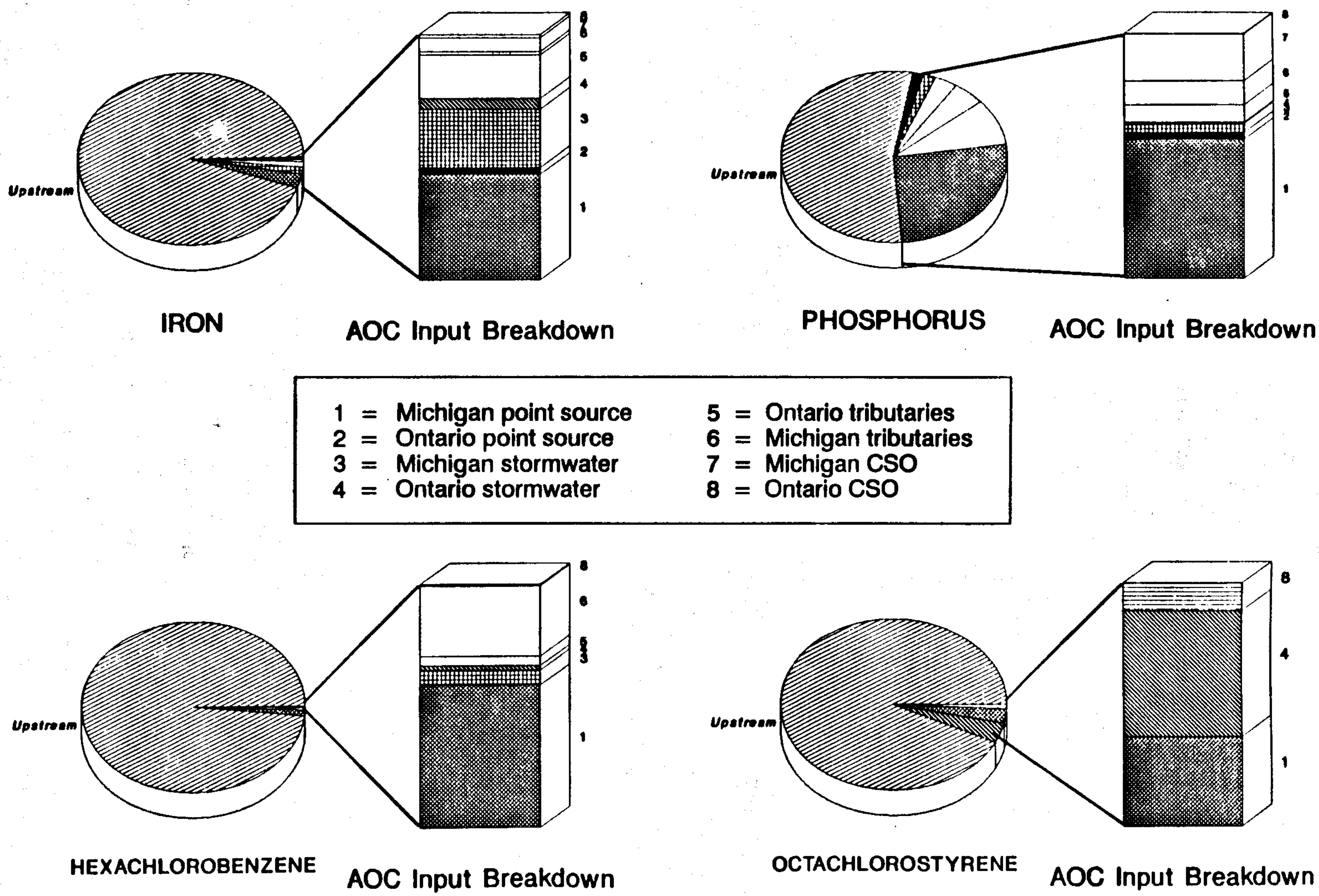

Figure 8-18. Continued.

Windsor stormwater loads contributed from 4% to less than 1% of the estimated total loads to the river. Loads of OCS from Windsor stormwater were second only to upstream inputs. Michigan stormwater was estimated to contribute from less than 1% to 21% of loads to the Detroit River. Loads of zinc and PAHs from Michigan stormwater were second only to upstream inputs. Again, these estimates were calculated using data from the NURP Study and may not adequately represent the loads from stormwater (see Section 8.3.2.2). However, it seems likely that stormwater is a significant source of some contaminants to the Detroit River.

8.5 CAUSES OF IMPAIRMENTS

A summary of water quality impairments was presented in Chapter 7 and sources of contaminants were summarized in Section 8.4. The purpose of this section is to estimate which sources and pollutants are the most significant for each identified impaired use.

8.5.1 Fish Consumption Advisories

Advisories for restricted fish consumption, issued in 1990 by Michigan and/or Ontario, include carp (PCBs), freshwater drum, rock bass and walleye (mercury). Measured point and nonpoint sources of PCBs and mercury are presented below.

PCBs

Total = 1.86 kg/day (4.1 lbs/day)
Upstream Inputs = 44%
Michigan CSOs = 25%
Michigan Point Sources = 16%
Michigan Tributaries = 6%
Ontario Tributaries = 6%
Ontario Point Sources = 2%
Other = 1%

Mercury

Total = 14.8 kg/day (32.6 lbs/day)
Michigan CSOs = 59%
Upstream Inputs = 40%
Others = 1%

Michigan CSOs and upstream inputs have been estimated to contribute the largest percentage of PCBs and mercury while Michigan point sources were also a large source of PCBs to the river.

The pathways of contaminants into fish are poorly understood. In addition to direct uptake from water it is possible that Detroit River sediments historically contaminated with mercury and PCBs contribute to the problem either by releasing contaminants to the water column or by accumulation of contaminants by benthic organisms that are eaten by fish.

8.5.2 Fish Tumors or Other Deformities

Neoplasms and pre-neoplastic lesions were observed in bowfins, bullhead, redhorse suckers, walleye and white suckers. The causes of tumors in fish are unknown but may be related to contaminants in the sediments. Investigators have linked the presence of some PAHs in sediments to liver tumors although no such linkages have been demonstrated for fish in the Detroit River (Kreis 1989) (see Section 6.6.8 for expanded discussion).

Data were not available to calculate PAH loads from most of the point sources, Michigan CSOs, Michigan and Ontario tributaries and atmospheric deposition. According to the UGLCCS report, PAH concentrations were 100-200 ng/l at the head of the Detroit River and were as high as 6,100 ng/l along the Michigan shore at downstream stations. Also, high concentrations of PAHs were found immediately below the Rouge River and large sources of PAHs appear to exist in the Rouge River area (UGLCCS 1987). Therefore, it seems likely that the total load is substantially underestimated and undetermined loads from Michigan sources may be relatively large. An OMOE investigation during 1988 tentatively identified several PAH compounds in samples obtained along the Ontario shoreline; however, levels approached the Method Detection Limit and could not be quantified with confidence.

Since combustion of fossil fuels is a primary source of PAHs the largest loads may come from nonpoint sources, some industrial point sources and municipal facilities that treat stormwater or combined sewage.

8.5.3 Degradation of Benthos

Degraded benthic communities have been noted along the Michigan shoreline from the Rouge River to the mouth of the Detroit River. Sediment toxicity to benthic organisms is discussed in Section 6.2.3. Benthic community impairment can be caused by organic enrichment, or heavy metals and organic contaminants. The cause of degradation has not been attributed to any single pollutant or combination of pollutants so it is difficult to relate sources to degraded benthic communities. No biologically based sediment criteria have been formalized and ambient sediment contaminant levels cannot be compared to any meaningful criteria at this time. However, OMOE has developed a draft Biologically Based Provincial Sediment Quality Guidelines currently under review. Pending completion of these guidelines, a reassessment of sediment quality may be performed. Contaminated sediments and sources of contaminants are described in more detail in Section 8.6.4.

8.5.4 Restrictions on Dredging Activities

Contaminants in sediments were evaluated in Section 6.2 and sediments were divided into three categories (heavily polluted, moderately polluted and nonpolluted) based on U.S. EPA Region V Guidelines for the Classification of Great Lakes Harbor Sediments. Sediment maps presented in Section 6.2 summarize the areal extent of contaminated sediments.

Detroit River sediments were classified as heavily or moderately polluted with PCBs, cyanide and a number of metals. The sources of contaminants are presented in Table 8-42.

8.5.4.1 Michigan Sediments

Most of the sediments sampled along the entire Michigan shoreline were classified as heavily or moderately polluted. Upstream inputs from Lake St. Clair account for the largest estimated loads of total PCBs, cyanide, zinc, cadmium, copper, iron and nickel (Table 8-42). Michigan CSOs contributed the largest estimated loads of mercury, lead and chromium

Table 8-42. Sources of pollutants currently found at high levels in Detroit River sediments.

				Michigan sources (% of total)				Ontario sources (% of total)			
Parameter	Total load kg/dy	(lbs/dy)	Upstream inputs	Mich. CSOs	Point sources	Mich. storm-water	Tribs.	Windsor CSOs	Point sources	Windsor storm-water	Tribs.
Total PCBs	1.86	(4.1)	44%	25%	16%	1%	6%	<1%	2%	<1%	6%
Cyanide	325	(715)	87%	NA	11%	2%	NA	<1%	1%	<1%	NA
Mercury	14.8	(32.5)	40%	59%	1%	<1%	NA	<1%	<1%	<1%	<1%
Zinc	2110	(4640)	32%	5%	20%	21%	13%	<1%	8%	1%	1%
Lead	316	(694)	22%	27%	4%	26%	7%	<1%	10%	3%	1%
Cadmium*	34.7	(76.2)	29%	23%	28%	7%	9%	<1%	3%	1%	<1%
Chromium	76	(167)	NA	33%	27%	8%	NA	NA	27%	NA	5%
Copper	799	(1760)	75%	5%	12%	2%	2%	<1%	3%	<1%	<1%
Iron	136000	(300000)	94%	<1%	3%	1%	<1%	<1%	<1%	<1%	1%
Nickel*	754	(1660)	70%	4%	19%	4%	1%	<1%	1%	<1%	1%
Oil and Grease*	44800	(98500)	NA	40%	53%	2%	NA	<1%	4%	<1%	NA

* No restrictions on dredging along Ontario shoreline based on sediment concentrations of these parameters.

NA Not Available.

while Michigan point sources contributed the largest estimated load of oil and grease. Spills are unquantified sources that may be having an impact on sediments.

The estimated loads of pollutants are relatively recent considering the length of time that the SAOC has been industrialized. No trend data is available to analyze changes in sediment contaminant levels, however pollutant concentrations in ambient water and in animal tissue have decreased over the past 20 years in response to point source controls. Decreases in concentrations correspond to decreases in loads. Recent load estimates are not adequate to describe historical contamination of the sediments. Most contaminants bind to fine sediments (less than 62 micrometers in diameter) and sediment particles may retain these contaminants after the sources have been reduced or eliminated (IJC 1988). It is likely that historical contamination was significant. Present data are not sufficient to determine if contamination of sediments is continuing.

8.5.4.2 Ontario Sediments

The areal extent of sediment contamination is described in detail in Section 6.2. In summary, sediments near the mouth of Turkey Creek were classified as moderately polluted with chromium, cyanide, iron, lead, mercury and zinc. Sediments near the mouth of Little River were moderately polluted with cadmium and lead. Sediments near the mouth of the Canard River were moderately polluted with chromium, cyanide and PCBs while sediments along the shoreline near Windsor were moderately polluted with chromium, copper, zinc, PCBs and mercury.

The most likely sources of contamination would be from Ontario sources and upstream inputs, due to the hydraulic characteristics of the Detroit River (Section 5.2.3.2). The largest loads came from upstream inputs. Ontario tributaries contributed relatively small loads of pollutants yet most of the contaminated sediments were located near tributary mouths. Again, ambient concentration data indicate that current load estimates may not reflect past load estimates from Ontario tributaries. As previously noted, these current load estimates are insufficient to determine if sediments are continuing to be contaminated.

8.5.5 Total Body Contact Advisories

Total body contact activities in areas of the river are periodically impaired due to elevated bacteria levels. Bacteriological water quality is described in Section 6.1.1 and as noted the most significant sources of bacteria are CSOs. Additional sources include stormwater runoff, wastewater treatment plants, and tributary inputs. Tributaries would receive bacteria from any of the sources listed above and, in some cases, agricultural sources.

Section 6.1.1 identifies the Little River WPCP and Amherstburg WPCP as known sources of bacteria. Fecal coliform densities observed downstream of these point sources were higher than those measured at corresponding upstream stations.

Each of the five Michigan WWTPs have fecal coliform limits in their NPDES permits (see Section 8.2). No fecal coliform exceedances were reported by Detroit WWTP. However, the other four facilities reported some exceedances. Wayne County Huron Valley WWTP exceeded its permitted monthly average concentration three times and its 7-day average concentration four times in 1988 (April through July). The City of Trenton exceeded its permitted monthly seven day average once in October of 1987 wile the Grosse Ile WWTP exceeded its permitted monthly seven day average three times in 1989. Wayne County Wyandotte exceeded its permitted monthly average and seven day average twice in 1988 and twice in 1989. All of these exceedances contribute to bacteria degradation of the Detroit River but are probably less important than Michigan CSO discharges.

8.5.6 Exceedences of Ambient Water Quality Criteria

Exceedences of Michigan's Rule 57(2) ambient water quality criteria have occurred on occasion as follows: mercury, PCBs (entire river); copper (downstream of Zug Island); zinc, cadmium and lead (Michigan and Ontario waters - lower river). In addition, GLWQA Annex 1 Specific Objectives and Ontario PWQO for contaminants in water have been exceeded as follows: PCBs (entire river); mercury (Trenton Channel); zinc and cadmium (Michigan and Ontario waters - lower river).

The estimated loads of these contaminants are listed in Table 8-43. The largest loads of PCBs, zinc, copper and cadmium were from upstream inputs while the largest loads of mercury and lead came from Michigan CSOs.

Additional suspected sources include spills and historically contaminated sediments but conclusions about their significance cannot be made with the data available.

8.5.7 Degradation of Aesthetics

Degradation of Aesthetics is a more subjective category and it is difficult to "quantify" sources of impairment. However, oil and grease, discharges from slaughter houses and other types of objectionable deposits and debris have been observed in CSO discharges (Roy Schrameck, MDNR, Personal Communication). Combined Sewer Overflows contribute approximately 40% of the oil and grease to the Detroit River. Occasional oil sheens and slicks have also been noted and many were likely caused by oil related spills, CSO discharges, and point sources. A number of Michigan facilities discharge oil and grease and several facilities have exceeded their permitted discharge limits of oil and grease over the past three years (see Sections 8.2.1.2 through 8.2.1.16). Michigan point sources contribute more than 50 percent of the estimated total load of oil and grease to the Detroit River.

8.5.8 Summary of the Causes of Impairments

Sources of the largest loads of contaminants causing impaired uses are presented in Table 8-44. Again, upstream inputs were a major source of most contaminants. However, the Detroit River RAP must focus attention on contaminants of concern which are discharged to the Detroit River

Table 8-43. Sources of contaminants that occasionally exceed ambient water quality criteria.

				Michigan sources (% of total)				Ontario sources (% of total)			
Parameter	Total load kg/dy	(lbs/dy)	Upstream inputs	Mich. CSOs	Point sources	Mich. storm-water	Tribs.	Windsor CSOs	Point sources	Windsor storm-water	Tribs.
Total PCBs	1.86	(4.1)	44%	25%	16%	1%	6%	<1%	2%	<1%	6%
Mercury	14.8	(32.5)	40%	59%	1%	<1%	NA	<1%	<1%	<1%	<1%
Zinc	2110	(4640)	32%	5%	20%	21%	13%	<1%	8%	1%	1%
Lead	316	(694)	22%	27%	4%	26%	7%	<1%	10%	3%	1%
Cadmium	34.7	(76.2)	29%	23%	28%	7%	9%	<1%	3%	1%	<1%
Copper	799	(1760)	75%	5%	12%	2%	2%	<1%	3%	<1%	<1%

NA Not Available.

Table 8-44. Major sources of parameters identified as a cause of impaired uses. A major source is defined here as any source that contributes 10% or more to the total load.

	Major Sources						
Parameters of Concern	Upstream Inputs*	Michigan Point Sources	Michigan CSOs	Michigan Stormwater	Michigan Tributaries	Ontario Point Sources	Windsor CSOs
Total PCBs	X	X	X				
Mercury	X		X		N.A.		
17 PAHs	X	N.A.	N.A.	X	N.A.		
Cyanide	X	X	N.A.		N.A.		
Zinc	X	X		X	X		
Lead	X		X	X		X	
Cadmium	X	X	X				
Chromium	N.A.	X	X	X	X	N.A.	N.A.
Copper	X	X					
Iron	X						
Nickel	X	X					
Oil and Grease	N.A.	X	X		N.A.		
Bacteria**			X		X	X	X

N.A. - Load estimate was not available.
* via Lake St. Clair.
** No bacteria loads were estimated. However, Michigan CSOs, Windsor CSOs and Ontario point sources have been identified as sources of bacterial degradation.

from sources within the AOC. Michigan point sources and Michigan CSOs are major sources of many contaminants identifies as causing impaired uses. Michigan stormwater, Michigan tributaries (Rouge and Ecorse), Ontario point sources and Windsor CSOs were all identified as major sources of at least one parameter of concern.

Bacterial loads were not estimated. Several Michigan and Ontario wastewater treatment plants were identified as sources of bacterial degradation although their contributions were substantially less than CSOs. Four Michigan WWTPs exceeded permitts bacteria effluent requirements and contributed to bacteria degradation of the river. Two Ontario WPCPs were identified as sources of bacteria contamination.

Detroit River sediments have likely been accumulating contaminants since before the SAOC was industrialized. As previously noted, loads of pollutants have decreased since the 1970s and the influence of the most recent load estimates to sediments are not known. At present, the data are insufficient to determine if sediments continued to be contaminated.

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