LAKEWIDE MANAGEMENT PLAN FOR LAKE ONTARIO

Executive Summary
Stage 1: Problem Definition

May 1998

Introduction

In 1987, the governments of Canada and the United States made a commitment, as part of the Great Lakes Water Quality Agreement (GLWQA), to develop a Lakewide Management Plan (LaMP) for each of the five Great Lakes. According to the 1987 Agreement, "LaMPs shall embody a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in ... open lake waters", including consultation with the public.

This Stage 1 LaMP (the "problem definition" document) for Lake Ontario has been developed by Region II of the U.S. Environmental Protection Agency (USEPA), Environment Canada (EC), the New York State Department of Environmental Conservation (NYSDEC), and the Ontario Ministry of the Environment (MOE) (the Four Parties), in consultation with the public. Stages 2 through 4 of the Lake Ontario LaMP (the schedule for load reduction activities, selection of remedial measures, and results as documented by monitoring) will be developed, with public input, over the next several years. Although this document serves as the Stage 1 document, it includes information from Stages 2-4 where available (i.e., some remedial measures have been or are being implemented and monitoring programs have indicated improvements).

Background

Lake Ontario Toxics Management Plan and Progression to the LaMP

In response to an identified toxics problem in the Niagara River and Lake Ontario, a Niagara River Declaration of Intent was signed on February 4, 1987, by the Four Parties. This document required that a Lake Ontario Toxics Management Plan (LOTMP) be developed. The main purpose of the LOTMP was to define the toxics problem in Lake Ontario and to develop and implement a plan to eliminate the problem through both individual and joint agency actions. The Four Parties developed a draft Toxics Management Plan which was presented for public review in 1988. The completed LOTMP was published in 1989. Updates of the LOTMP were completed in 1991 and in 1993.

Lake Ontario Toxics Management Plan Goals:

- ***Drinking water and fish that are safe for human consumption.***
- ***Natural reproduction, within the ecosystem, of the most sensitive native species, such as bald eagle, osprey, mink, and river otter.***

The LOTMP identified 11 priority toxic chemicals in the lake and provided information regarding ongoing load reduction efforts. The LOTMP has been the primary binational toxic substances reduction planning effort for Lake Ontario. As such, it serves as a foundation for the development of the Lake Ontario LaMP. In May of 1996, the Four Parties signed a Letter of Intent agreeing that the LaMP should provide the binational framework for environmental protection efforts in Lake Ontario.

The Four Parties have reviewed and incorporated all relevant LOTMP commitments into this Stage 1 Plan.

Scope of the LaMP

The Lake Ontario LaMP focuses on resolving:

Lakewide beneficial use impairments as defined in the Great Lakes Water Quality Agreement (Annex 2) and described in Chapter 3 of this LaMP;

Critical pollutants contributing to, or likely to contribute to, these impairments despite past application of regulatory controls, due to their toxicity, persistence in the environment, and/or their ability to accumulate in organisms; and

Physical and biological problems caused by human activities.

***Remedial Action Plans* were also required by the GLWQA. These plans address localized environmental problems within an Area of Concern (AOC). AOCs are specific geographic areas where significant pollution problems have been identified as impairing beneficial uses such as swimming, eating fish, or drinking water.**

The LaMP will address sources of lakewide critical pollutants, which are those substances responsible for beneficial use impairments in the open lake waters of both countries, as well as those substances that exceed criteria and are, therefore, likely to impair such uses, which require binational actions for resolution. The Plan will be coordinated with Remedial Action Plans within the Lake Ontario drainage basin and other localized efforts which are best suited to address issues of local concern. In addition, the Plan will utilize linkages to other natural resource management activities, such as the development of Lake Ontario fish community objectives by the Great Lakes Fishery Commission and the Lake Ontario Committee of fisheries managers. The LaMP will address impairments found in open waters of the lake and nearshore areas, without duplicating the efforts of localized remedial action plans. Tributaries, including the Niagara River, are treated as inputs to the lake. The St. Lawrence River is treated as an output from the lake.

In addition to the Lake Ontario LaMP, there are a number of other environmental planning efforts upstream and downstream of the Lake Ontario basin. Plans are being implemented for the Niagara River, including Remedial Action Plans in both Canada and the U.S., and a binational Toxics Management Plan. The major sources of pollutants within the downstream St. Lawrence River are being addressed through three ongoing planning efforts: Canadian and U.S. Remedial Action Plans for the St. Lawrence River at Cornwall and Massena, respectively, and a St. Lawrence River Action Plan for the section of the river located in the Province of Quebec.

LaMP Ecosystem Goals and Objectives

Ecosystem Goals for Lake Ontario:

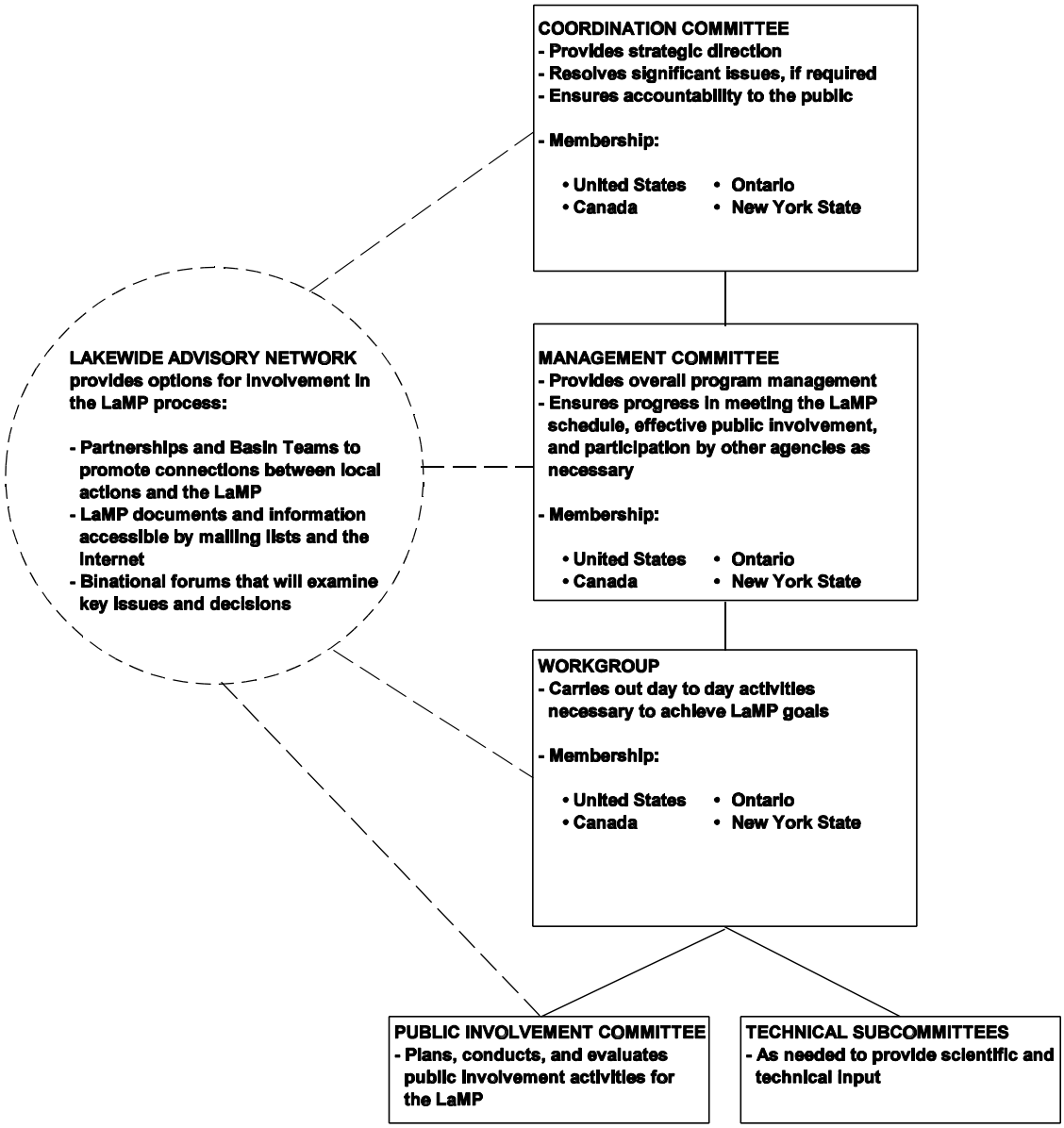
- *The Lake Ontario Ecosystem should be maintained and as necessary restored or enhanced to support self-reproducing diverse biological communities.*
- *The presence of contaminants shall not limit the uses of fish, wildlife, and waters of the Lake Ontario basin by humans and shall not cause adverse health effects in plants and animals.*
- *We as a society shall recognize our capacity to cause great changes in the ecosystem and we shall conduct our activities with responsible stewardship for the Lake Ontario basin.*

The earlier LOTMP developed broad ecosystem goals for Lake Ontario which have been incorporated in the LaMP process. The LaMP will expand on these goals by developing more detailed ecosystem objectives and ecosystem health indicators to be used to measure progress in restoring Lake Ontario. A preliminary effort resulted in the following five objectives which will serve as a starting point for a more comprehensive effort to include broader public, private, and governmental input.

Aquatic Communities (benthic and pelagic): the waters of Lake Ontario shall support diverse and healthy reproducing and self-sustaining communities in dynamic equilibrium, with an emphasis on native species.
Wildlife: the perpetuation of a healthy, diverse, and self-sustaining wildlife community that utilizes the lake for habitat and/or food shall be ensured by attaining and sustaining the waters, coastal wetlands, and upland habitats of the Lake Ontario basin in sufficient quality and quantity.
Human Health: the waters, plants, and animals of Lake Ontario shall be free from contaminants and organisms resulting from human activities at levels that affect human health or aesthetic factors such as tainting, odor, and turbidity.
Habitat: Lake Ontario offshore and nearshore zones and surrounding tributary, wetland, and upland habitats shall be of sufficient quality and quantity to support ecosystem objectives for the health, productivity, and distribution of plants and animals in and adjacent to Lake Ontario.
Stewardship: Human activities and decisions shall embrace environmental ethics and a commitment to responsible stewardship.

Management Structure

The Four Parties have the responsibility for developing the Lake Ontario LaMP and have approved a LaMP management structure that consists of a Coordination Committee, a Management Committee, a Lake Ontario Workgroup, and a Lakewide Advisory Network (see figure below). There are other agencies that have an interest in the LaMP, such as natural resource and human health agencies, and their involvement on specific issues is an important component of LaMP decision-making. Responsibility for ensuring this participation lies with the Management Committee.



Lake Ontario LaMP Management Structure

Public Involvement in the Development of the LaMP

The public involvement program for the LaMP aims to fully support efforts to create and strengthen partnerships with citizens and organizations taking restoration and protection actions in the Lake Ontario basin. Historically, the public involvement process has included the following elements:

Holding open Coordination Committee meetings
Conducting public workshops
Improving connections with the Remedial Action Plans
Collecting information and conducting evaluations
Developing information and education materials

As the Lake Ontario process evolved, the Four Parties asked Lake Ontario stakeholders for guidance on enhancing the public involvement program. As a result, the agencies have adopted a strategy for a Lakewide Advisory Network.

Lakewide Advisory Network:

- *Establish partnerships to promote an understanding of the connections between local watershed activities and their impacts on Lake Ontario, to encourage action to conserve and protect the lake, and to provide input to the LaMP process.*
- *Maintain a mailing connection to keep people informed and solicit interest in the LaMP.*
- *Provide opportunities for binational discussions between representatives from the partnerships and other stakeholders on key issues or other major decisions.*

Public Involvement Goals:

 # Increase public understanding and awareness of Lake Ontario planning efforts.
 # Provide various opportunities for meaningful public consultation in developing and implementing Lake Ontario management plans.
 # Promote individual and corporate, governmental and non-governmental environmental stewardship actions.
 # Build partnerships across the various programs and initiatives that are working to preserve and protect Lake Ontario.

Problem Definition

Significant changes have occurred in the Lake Ontario ecosystem over the last century due to the effects of toxic pollution and habitat loss resulting from the rapid development of the Lake Ontario basin. The extent of these changes was fully realized in the 1960s and 1970s, when Lake Ontario colonial waterbirds experienced nearly total reproductive failures due to high levels of toxic contaminants in the food chain. In 1972, Canada and the United States took actions to ban and control contaminants entering the Great Lakes, and, in 1987, renewed the Great Lakes Water Quality Agreement with the goal to restore the overall health of the Great Lakes ecosystem. Today, as a result of these actions, levels of toxic contaminants in the Lake Ontario ecosystem have decreased significantly, and colonial waterbird populations have overcome most of the recognized contaminant-induced impacts of 25 years ago (i.e., their eggshells show normal thickness, they are reproducing normally, and most population levels are stable or increasing). However, bioaccumulative toxics persist in sediment, water, and biota at levels of concern for some fish species, such as lake trout and salmon, and for higher order predators, such as bald eagles, snapping turtles, mink and otters, and humans. Also, the more subtle chemically-induced effects are being investigated. Studies on Lake Ontario and the Great Lakes are being undertaken to identify the effects of persistent toxic chemicals on wildlife. These will be reported on in future LaMP documents.

The GLWQA provides fourteen indicators of beneficial use impairments (identified in the text box below) to help assess the impact of toxic chemicals and other factors on the Great Lakes ecosystem. These indicators provide a systematic way to identify pollutant impacts on the entire ecosystem, ranging from phytoplankton to birds of prey and mammals, including humans.

As defined by the Great Lakes Water Quality Agreement, "impairment of beneficial use(s)" is a change in the chemical, physical, or biological integrity of the Great Lakes System sufficient to cause any of the following:

1. *Restrictions on fish and wildlife consumption*
2. *Tainting of fish and wildlife flavor*
3. *Degradation of fish and wildlife populations*
4. *Fish tumors or other deformities*
5. *Bird or animal deformities or reproductive problems*
6. *Degradation of benthos*
7. *Restrictions on dredging activities*
8. *Eutrophication or undesirable algae*
9. *Restrictions on drinking water consumption, or taste and odor problems*
10. *Closing of beaches*
11. *Degradation of aesthetics*
12. *Added costs to agriculture or industry*
13. *Degradation of phytoplankton and zooplankton populations*
14. *Loss of fish and wildlife habitat*

The GLWQA defines critical pollutants as "substances that persist at levels that, singly or in synergistic or additive combination, are causing, or are likely to cause, impairment of beneficial uses despite past application of regulatory controls due to their:

1. presence in open lake waters;
2. ability to cause or contribute to a failure to meet Agreement objectives through their recognized threat to human health and aquatic life; or
3. ability to bioaccumulate".

In preparing this binational problem assessment (see summary table on the next page), Canada and the United States first independently evaluated 13 of the Lake Ontario beneficial use impairments for those geographic areas within their jurisdictions (Rang *et al.*, 1992; USEPA and NYSDEC, 1994). The agencies proceeded to integrate their separate evaluations into this binational assessment of the status of beneficial use impairments in Lake Ontario. The fourteenth beneficial use impairment, loss of fish and wildlife habitat, was evaluated using Lake Ontario habitat reports compiled by the United States Fish & Wildlife Service (USF&WS) as part of the LaMP evaluation process (Busch *et al.*, 1993) and others (Whillans *et al*., 1992). The LaMP recognizes the importance of appropriate linkages to other natural resource management initiatives such as fishery management plans, lake-level management, wetlands protection, watershed management plans, and control strategies for exotic species.

This report does not provide a complete analysis of the biological and physical problems facing the lake because the ecosystem objectives and indicators needed to evaluate these problems are still being developed and will be reported on as part of the Stage 2 reporting for the LaMP (see Binational LaMP Workplan). The LaMP will provide an assessment of the physical and biological problems after these objectives and indicators have been completed. Recognizing that the development of ecosystem objectives may require a considerable amount of time, the LaMP will move forward with the development of a critical pollutants reduction strategy rather than wait until all physical and biological problems have been defined.

The Four Parties have identified the lakewide beneficial use impairments of Lake Ontario:

- Restrictions on fish and wildlife consumption
- Degradation of wildlife populations
- Bird or animal deformities or reproductive problems
- Loss of fish and wildlife habitat

There is direct and indirect evidence that PCBs, DDT and its metabolites, mirex, and dioxins/furans are impairing beneficial uses in Lake Ontario.

Summary of Lake Ontario Lakewide Beneficial Use Impairments and Related Critical Pollutants and Other Factors.

Lakewide Impairments	*Impacted Species*	*Lakewide Critical Pollutants & Other Factors*
Restrictions on Fish and Wildlife Consumption	Trout, Salmon, Channel catfish, American eel, Carp, White sucker	PCBs, Dioxins, Mirex
	Walleye, Smallmouth Bass[a]	Mercury[a]
	All waterfowl[b]	PCBs, DDT, Mirex[b]
	Snapping Turtles[b]	PCBs[b]
Degradation of Wildlife Populations	Bald Eagle[c]	PCBs, Dioxin, DDT
	Mink & Otter[c]	PCBs
Bird or Animal Deformities or Reproductive Problems	Bald Eagle[c]	PCBs, Dioxin, DDT
	Mink & Otter[c]	PCBs
Loss of Fish and Wildlife Habitat	A wide range of native fish and wildlife species	Lake Level Management
		Exotic Species
		Physical Loss, Modification, and Destruction of Habitat

[a] Canadian advisories only.
[b] U.S. Advisories only.
[c] Indirect evidence only (based on fish tissue levels).
Notes: Dieldrin, although listed as a LaMP critical pollutant, is not associated with an impairment of beneficial use.
"DDT" includes all DDT metabolites; "Dioxin" refers to all dioxins/furans.

It is also important that the Lake Ontario LaMP consider toxic substances that are **likely** to impair beneficial uses. In this case, there may be no direct evidence that a substance contributes to use impairments, but there is indirect evidence if a chemical exceeds U.S. or Canadian standards, criteria, or guidelines. A review of recent fish tissue contaminant concentrations identified mercury as a lakewide contaminant of concern because mercury concentrations in larger smallmouth bass and walleye are likely to exceed Ontario's 0.5 parts per million (ppm) guideline for fish consumption throughout the lake. Although there are no U.S. or Canadian consumption advisories for smallmouth bass and walleye on a lakewide basis, the data are sufficient to identify mercury as a critical pollutant as part of the LaMP pollutant reduction strategy. Additional sampling may be required to fully characterize contaminant concentrations in some species that are not regularly sampled throughout the lake. As with mercury, dieldrin is not linked to a lakewide impairment but dieldrin concentrations exceed the most stringent criteria for both water and fish tissue. Given the lakewide nature of these exceedences of the most stringent criteria, dieldrin is also included in the list of LaMP critical pollutants.

The Lakewide Critical Pollutants that will be the focus of LaMP source reduction activities are:

- PCBs
- DDT and its metabolites
- mirex
- dioxins/furans
- mercury
- dieldrin

These critical pollutants are of concern because they are persistent (remaining in the water, sediment, and biota for long periods of time) and bioaccumulative (accumulate in aquatic organisms to levels that are harmful to human health). It is the intent of the Four Parties to prevent the development of additional lakewide use impairments that may be caused by other persistent, bioaccumulative toxics entering the lake. Therefore, the LaMP will include actions that will address these critical pollutants and the broader class of chemicals known as persistent, bioaccumulative toxics.

The Four Parties agree that loss of fish and wildlife habitat is a lakewide impairment caused by artificial lake level management; the introduction of exotic species; and the physical loss, modification, and destruction of habitat, such as deforestation and the damming of tributaries.

Local use impairments are also identified in this document. However, these impairments are best addressed on a local level through the development and implementation of Remedial Action Plans and other local management efforts.

Through the LaMP, the Four Parties seek to restore the lakewide beneficial uses of the lake by reducing the input of critical pollutants and persistent, bioaccumulative toxics to the lake, and by addressing the biological and physical factors discussed above. The Four Parties will also improve the database on sources and loadings of critical pollutants and other factors causing these impairments. The critical pollutants identified above are familiar to most citizens involved in Lake Ontario protection efforts, as they have been the subject of ongoing management, reduction, and prevention activities for many years. Despite these activities, levels of these critical pollutants remain a concern due to historic releases and practices contaminating sediments and soils, that are now being leached into Lake Ontario waters slowly; long-range atmospheric transport from distant sources; and inputs from other Great Lakes. Hence, restoring these impairments is an ongoing challenge.

The Four Parties plan to prioritize source reduction efforts to address the most significant contributors of critical pollutants. Based on the limited loadings data available, it appears that a significant load of critical pollutants to the lake originates outside the Lake Ontario basin. The upstream Great Lakes basin contributes the majority of the estimated loadings of PCBs (440 kg/yr), DDT and its metabolites (96 kg/yr), and dieldrin (43 kg/yr). Attention must also be focused on the Niagara River, since most of the mirex entering Lake Ontario originates in the Niagara River basin (1.8 kg/yr), and it also contributes to the load of other critical pollutants to the lake. Atmospheric deposition is a source of critical pollutants and appears to be the largest known source of dioxins/furans, contributing approximately 5 grams per year. The LaMP will also seek to address the inputs of critical pollutants from water discharges within the Lake Ontario basin, including point source discharges directly to the lake and point and non-point source discharges to the tributaries to the lake.

Progress to Date

The Four Parties have implemented programs and undertaken activities, both regulatory and voluntary, that have resulted in measurable improvements lakewide. Other actions have led to small incremental gains in localized areas. Remedial Action Plan projects are reducing pollutants, cleaning up the environment, and restoring habitat in Areas of Concern (AOC). Activities are also ongoing to protect and promote human health in the basin. Joint federal/state and federal/provincial programs to reduce sources of pollutants to the lake have been ongoing under the LOTMP and other initiatives. Environmental progress is evident in the reduced levels of contamination in lake biota and other ecological improvements. Highlights of this progress follow.

Binational Activities

The Niagara River Toxics Management Plan (NRTMP): Significant progress has been made towards achieving the 50 percent reduction of 10 priority toxics in the Niagara River. The 1996 NRTMP Progress Report outlines actions and results achieved by the Four Parties, including the following:

- As of 1995, the number of Ontario point sources directly discharging to the Niagara River had been reduced to 16. The data show that the daily loadings of 18 priority toxics had been reduced by 99 percent.

- In New York State, an 80 percent reduction in 121 organic and inorganic priority pollutants from significant point sources was realized between 1981 and 1986. Between 1986 and 1994, another 25 percent reduction was reported.

In the U.S., 26 hazardous waste sites were identified as having the greatest potential for toxic pollutant loadings to the Niagara River. Accelerated remediation schedules were established for these sites. To date, remedial construction has been completed at 8 of these sites, and remedial activities are underway at 10 sites.

Under Canadian and U.S. programs, contaminated sediments in several tributaries to the Niagara River have been cleaned up.

Development of Mass Balance Models: Mass balance models were developed that relate loadings of toxic contaminants to the lake to levels in water, sediment, and fish. These models provide an initial technical basis for determining load reduction targets, estimating how long it will take to meet these targets, and planning for additional measures necessary to achieve load reduction goals.

Development of Draft Ecosystem Objectives: The development of draft ecosystem objectives for wildlife, habitat, aquatic communities, human health, and environmental stewardship has provided direction and a basis for establishing targets, or ecosystem indicators, as a means to check on the effectiveness of remedial activities.

Activities in the United States

New York State has banned the use of DDT, mirex, and dieldrin. Allowable uses of mercury have also been severely restricted. Production of PCBs and their use in the manufacture of new equipment is no longer allowed. Older equipment and transformers containing PCBs are being systematically removed from service and properly disposed.

In 1993, USEPA conducted pollution prevention inspections at seven industrial facilities in the Lake Ontario basin. As a result of these inspections, pollution prevention measures were implemented that eliminated about 43 percent (213,000 lbs.) of toxic chemical pollutants.

The LOTMP identified seven inactive hazardous waste sites in the Lake Ontario basin where remedial actions had not been completed. Remedial actions at four of these seven sites have now been completed. Two of the remaining sites are under remedial construction and the other site is in design.

USEPA, in partnership with Erie County, New York, has established a “Clean Sweep” program to help farmers in the Lake Ontario basin dispose of unwanted and/or banned pesticides in an environmentally safe manner. To date, the program has been implemented in 15 counties, and over 120,000 pounds (gross) of agricultural hazardous or

toxic products have been collected and properly disposed, including DDTs, dioxin-contaminated pesticides, chlordane, arsenic, lead, and mercury.

USEPA and NYSDEC are conducting a "Source Trackdown" project in order to facilitate the identification and remediation of contaminant sources to the lake. This information will be used to confirm unknown sources, determine the effectiveness of remediation activities, and plan follow-up sampling activities.

Activities in Canada

Ongoing and new activities to reduce critical pollutant loadings to Lake Ontario from Ontario sources are undertaken within the framework of the Canada-Ontario Agreement respecting the Great Lakes Basin Ecosystem (COA). The list of critical pollutants identified in this document has been deliberately included in the COA to support further reductions in releases of the critical pollutants, along with reductions in the releases of these and other chemicals under the Niagara River Toxics Management Plan. The COA Tier I substances, which include the LaMP critical pollutants, are targeted for zero discharge to Ontario waters.

Since 1993, Ontario has promulgated Clean Water Regulations under its MISA (Municipal and Industrial Strategy for Abatement) program for nine industrial sectors: organic chemicals, iron and steel, pulp and paper, petroleum refineries, metal casting, metal mining, inorganic chemicals, industrial minerals, and electric power generation. The goal for the 34 regulated plants located within the basin is the use of best available treatment technologies to substantially reduce pollutant loadings. Compliance with the MISA regulations will achieve more than a 70 percent reduction in the release of toxic pollutants to the waters of Lake Ontario by 1998. The virtual elimination of releases of persistent toxic substances, such as dioxins, is one benefit of this activity.

Ontario has banned the use of several of the Lake Ontario critical pollutants (DDT, dieldrin, and mirex) and, in cooperation with Environment Canada, recently confirmed that no legal use is taking place in Ontario. Long-standing restrictions on the use of PCBs to closed systems has prevented any deliberate releases to the ecosystem; accidental releases are a possibility, which is why the decommissioning and destruction of PCBs are being accelerated in Ontario.

The national program, Accelerate Reduction/Elimination of Toxics (ARET) calls for the voluntary reduction of 101 substances from either direct or indirect industrial discharges to air, land, and water. The goal is a 90 percent reduction of persistent bioaccumulative toxic emissions

and a 50 percent reduction of other toxic substance emissions by the year 2000. Under the ARET challenge, a total of 287 organizations across Canada have responded, over 100 of which are located in Ontario. Together, these facilities have committed to voluntary reductions in emissions of toxic substances of nearly 17,500 metric tonnes nationally (as of year-end 1995).

The Ontario Environmental Coalition, in cooperation with Ontario Farmers, is developing Environmental Farm Plans (EFPs) to assess environmental concerns. EFPs will continue to receive $5.6 million through the year 2000 from the Agricultural Adaptation Council, with technical support provided by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). Approximately 10,000 farmers have voluntarily attended farm plan workshops, and 5,186 approved integrated action plans and implementation strategies are in place to improve pest management and control erosion and agricultural runoff from farms.

Over the past five years, the partnership of OMAFRA and the Crop Protection Institute, MOE, and AgCare has instituted an Agricultural Pesticides Container Collection Program. One million containers have been collected over the last two years.

Areas of Concern

Remedial Action Plan (RAP) development and implementation continues in the Niagara River, Hamilton Harbour, Toronto Harbour, Port Hope, Bay of Quinte, Oswego, Rochester Embayment, and Eighteenmile Creek Areas of Concern. In addition to RAPs, other local environmental planning efforts are underway that will contribute to a reduction in Lake Ontario critical pollutants.

Improving Fish and Wildlife Populations

Many habitat restoration and protection projects are underway in the Lake Ontario basin. For example:

In the U.S., the New York State Open Space Conservation plan provides a statewide process to identify and acquire undeveloped habitats. The Ecological Protection and Restoration Program of USEPA's Great Lakes National Program Office provides funding for a variety of habitat restoration projects in Lake Ontario, including: barrier beach and wetlands habitat restoration on the lake's shoreline; creation of wildlife nesting habitat and exotic vegetation control at Deer Creek Marsh Wildlife Management Area; and protection and restoration of Sandy Pond Peninsula. In 1995, the non-profit New York River Otter Project began the process of introducing nearly 300 river otters to the Lake Ontario basin.

In Canada, EC's Cleanup Fund is currently supporting, in conjunction with its many partners, more than 30 habitat rehabilitation projects in the Lake Ontario watershed. By March of 1996, 45 km of riparian and 40 hectares of wetland habitats had been rehabilitated as a result of project activities supported by the Fund and its partnerships. Rehabilitation of an additional 18 km of riparian habitat and 409 hectares of wetlands is in progress. Canada's Great Lakes Wetlands Conservation Action Plan is a five year plan that focuses on the conservation of coastal wetlands along the lower Great Lakes. Priority areas for protection and rehabilitation have been identified along the Lake Ontario shoreline.

Environmental Trends in the Lake Ontario Ecosystem

Due in part to the programs and initiatives described above, environmental progress has been documented in Lake Ontario, both in the reduction of levels of contaminants found in the organisms, water quality, and sediments within the lake, as well as in the population numbers and reproductive success of various species found in the Lake Ontario basin.

The input of toxic chemicals associated with suspended sediment from the Niagara River has declined, most significantly between 1960 and 1990.

Numbers of fish-eating gulls and cormorants have increased dramatically in the last 20 years. PCB levels in herring gull eggs decreased by an order of magnitude from the mid-1970s to the late 1980s; dieldrin levels decreased by 80 to 90 percent.

New York's bald eagle population is estimated to be growing at an annual rate of between 15 to 30 percent since 1988.

Overall, the fish community has experienced a dramatic reduction in contaminant levels for PCBs and mirex since the mid-1970s, and a slower rate of decline since the mid-1980s. Levels of mercury in fish from eastern Lake Ontario do not show a statistically significant trend.

LaMP Agenda

Based on the impaired beneficial uses of Lake Ontario and the critical pollutants and biological/physical factors contributing to these impairments, the Four Parties have proposed an agenda of ongoing and future activities that will continue efforts to move towards the restoration of beneficial uses of the lake and achieve virtual elimination of critical pollutants. The Four Parties recognize that there are many groups, organizations, and agencies implementing activities to improve and protect the Lake Ontario basin. The LaMP process provides an opportunity to

develop better connections with these various activities and build on the successes already achieved.

Examples of proposed future binational activities include:

The U.S. and Canada will continue to work with their Great Lakes stakeholders to implement the "Canada-United States Strategy for the Virtual Elimination of Persistent Toxic Substances in the Great Lakes Basin" to pursue the goal of virtual elimination of persistent toxic substances in the basin.

The U.S. and Canada will continue to support the Integrated Atmospheric Deposition Network (IADN), a binational network of 19 stations in the U.S. and Canada established and operated for the purpose of monitoring the atmospheric deposition of toxic substances to the Great Lakes.

Examples of proposed future activities in the U.S. include:

Implementation of the USEPA/NYSDEC Performance Partnership Agreement, which sets out mutual understandings of New York State and USEPA regarding environmental projects to be pursued. The two principles upon which the Agreement is based are maintaining the efficiency and effectiveness of existing programs in the state and taking additional action, as necessary, to solve particular problems in particular places through "Community-Based Environmental Protection." The Lake Ontario basin has been identified as one of the priority community-based environmental initiatives for USEPA and NYSDEC.

In February 1998, NYSDEC completed the adoption process and began to implement the regulations, policies, and procedures contained within the Great Lakes Water Quality Guidance (GLWQG) (further described in Chapter 4). The implementation of the GLWQG will result in consistent state water pollution control programs throughout the U.S. Great Lake States and will lead to substantial reductions in the loading of LaMP critical pollutants and other pollutants.

USEPA and NYSDEC will conduct additional trackdown studies in order to pinpoint significant sources of critical pollutants in tributaries to the lake, and will form a trackdown workgroup to identify immediate remedial activities.

In 1996, the citizens of New York passed a $1.75 billion Clean Water/Clean Air Bond Act. Approximately $125 million has been targeted for Clean Water projects in the Great Lakes basin. Funding will support point source, non-point source, and pollution prevention initiatives, as well as activities to restore aquatic habitat and preserve open space.

Examples of proposed ongoing and future activities in Canada include:

EC and MOE will continue to implement COA. The ultimate goal of COA is to achieve the virtual elimination of persistent, bioaccumulative substances from the Great Lakes basin ecosystem by implementing strategies consistent with zero discharge.

Under MOE's Clean Water Regulations, developed under MISA, effluent limits for 10 sectors will be in force by 1998. These include 34 industrial plants in the Lake Ontario basin.

EC's Cleanup Fund will continue to provide funding and technical support to a wide range of contaminated sediment, urban stormwater, and agricultural projects aimed at controlling sources of pollution to Lake Ontario, as well as habitat restoration and enhancement projects.

Canada and Ontario initiated a Lake Ontario Tributary Priority Pollutant Monitoring Study beginning in the spring of 1997, in order to provide recommendations for targeted actions within watersheds identified as significant sources of priority pollutants.

Binational LaMP Workplan

The 1987 GLWQA specifies that, when the problems in the lake have been identified and the Stage 1 LaMP has been completed, a Stage 2 LaMP be prepared which sets out a schedule for load reduction activities. The Four Parties propose to develop the technical information necessary to focus the actions undertaken through the LaMP and provide the foundation for the Stage 2 LaMP.

The Stage 2 LaMP will identify the additional actions that will be necessary to restore the beneficial uses of Lake Ontario. The Four Parties will, however, initiate additional LaMP actions prior to the completion of the Stage 2 document if these actions are identified as necessary to achieve LaMP goals.

The following table identifies the activities that the Four Parties propose to undertake binationally (either jointly or in a complementary fashion) to move towards the completion of the draft Stage 2, and to continue to build partnerships and provide information about the LaMP process. It is the goal of the Four Parties to develop the technical information in draft form within two years. Preparation of the Stage 2 LaMP will then commence, incorporating public input on the draft technical information. It is the goal of the Four Parties to produce a draft Stage 2 document for public review by fall of the year 2000.

Binational Workplan for the Lake Ontario LaMP

Activity	3-year objectives	Priorities	Deliverables (Spring 2000, unless otherwise specified)
Reducing inputs of critical and other pollutants	Continue existing programs to reduce loadings of critical pollutants	Evaluate effectiveness of existing programs Support implementation of Binational Great Lakes Toxics Strategy	a) Table and map identifying likely point and non-point sources of critical pollutants; the data collection will focus on sources in the basin but will also include upstream sources entering via the Niagara river; major atmospheric sources from out of the basin may also be included b) Forecast reductions in loadings as a result of existing activities
	Update pollutant loadings and contaminant levels and instigate new control programs to address identified sources and loadings	Undertake source trackdown to identify sources Update tributary loading Update sewage treatment plant loading Enhance existing mass balance models Facilitate cooperative lakewide monitoring	a) Prioritized listing of point, non-point, and basin sources contributing loadings of critical pollutants to include significant sources on each side of the lake b) Updated table 3-3 and 3-4 for LaMP c) Updated tables 3-5 and 3-6 for LaMP d) First cut mass balance model to describe major fluxes of critical pollutants into and out of Lake Ontario (Spring 1999) e) Binational priorities listing for monitoring needs (Spring 1999) f) Workplan for cooperative monitoring
	Refine LaMP List of Critical Pollutants	Review new data as necessary	Determination of any additional critical pollutants (in consultation with health and resource agencies)

Activity	3-year objectives	Priorities	Deliverables (Spring 2000, unless otherwise specified)
Updating/reassessing beneficial use assessments in open lake waters	Refine beneficial use impairment assessment	Further assess lakewide beneficial uses: Priorities: 1) Chemical impacts on benthos 2) Chemical and other factors influencing phytoplankton and zooplankton populations 3) Updates on status of colonial waterbirds, bald eagles, mink, and otter 4) Updates of all beneficial use impairments as necessary, where data available on impacts of physical and biological factors impacting beneficial uses	a) Updated benthos impairment section for Stage 2 LaMP b) Binational beneficial use assessment of phytoplankton and zooplankton populations using information from the Canadian Department of Fisheries and Oceans Bioindex project, MOE's intake monitoring, USEPA's Lake Guardian research program, and the U.S. Bioindex project carried out by the NYSDEC, U.S. Fish & Wildlife Service, and Cornell University c) Binational update on status, using relevant, readily available data, addressing chemical and nonchemical factors d) A series of prioritized updates to be prepared using relevant data on beneficial use impairment indicators, with management recommendations; may not include update on all 14 indicators for the Stage 2 LaMP
Managing biological and physical factors	Continue habitat protection and restoration activities	Summarize underway/proposed actions for nearshore by fall 1998	Map and table identifying nearshore underway and proposed (to year 2000) actions to protect or restore physical habitat
Developing ecosystem objectives and indicators	Update ecosystem objectives and determine monitoring indicators	Review work completed to date by technical subcommittees; in conjunction with partners, determine next steps	Binational workplan for ecosystem objectives development including role of public consultation, priority objectives for pelagic, benthic, and wildlife communities (Spring 1999); begin implementation of Workplan
	Develop objectives for restoration of beneficial uses	Set restoration objectives, determine necessary loading reduction schedules, develop monitoring mechanisms	Delisting objectives for the LaMP for each of 3 beneficial uses impaired by chemicals as basis for loading reduction schedules, for public consultation in 1999

Activity	3-year objectives	Priorities	Deliverables (Spring 2000, unless otherwise specified)
Facilitating public involvement - three tiered Lakewide Advisory Network	Establish Basin Teams and partnerships	Identify and meet with partners	a) Agreements with Basin Teams and partners to cooperate in sharing information, encouraging actions to preserve and protect the lake and watershed, and providing public input to the LaMP process (Spring 1999) b) Meetings with groups on issues of concern as necessary
	Maintain information connection	Provide updated information via the Lake Ontario LaMP Web page and mailings	a) Up to date Lake Ontario LaMP homepage b) Occasional mailings for informational updates and gathering public input
	Hold binational Lake Ontario forums at significant stages in the LaMP process	Convene binational Lake Ontario forums, as necessary, with participants from Basin Teams, partners, and other interested stakeholders	Binational forum meeting likely in 1999
Reporting	Produce annual status reports	Produce Year 1 Annual Report	A short annual report highlighting progress to be released at joint Lake Ontario LaMP and NRTMP annual meeting
	Produce draft Stage 2 report	1) Assess existing programs 2) Update sources and loadings 3) Present revised objectives and indicators 4) Present draft load reduction schedules	Draft Stage 2 will be available for public review in the fall of 2000

LAKEWIDE MANAGEMENT PLAN FOR LAKE ONTARIO

Stage 1: Problem Definition

May 1998

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ACRONYMS

AOC	Area of Concern
ARCS	Assessment and Remediation of Contaminated Sediments
ARET	Accelerate Reduction/Elimination of Toxics
BCC	Bioaccumulative Chemicals of Concern
CEPA	Canadian Environmental Protection Act
COA	Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem
CSO	Combined Sewer Overflow
CWS	Canadian Wildlife Service
DFO	Department of Fisheries and Oceans (Canada)
EEM	Environmental Effects Monitoring
EC	Environment Canada
GIS	Geographic Information System
GLIMR	Great Lakes Information Management Resource
GLIN	Great Lakes Information Network
GLRC	Great Lakes Research Consortium
GLWCAP	(Canada's) Great Lakes Wetlands Conservation Action Plan
GLWQA	Great Lakes Water Quality Agreement
GLWQG	Great Lakes Water Quality Guidance
IJC	International Joint Commission
LaMP	Lakewide Management Plan
LOTMP	Lake Ontario Toxics Management Plan
MISA	Municipal and Industrial Strategy for Abatement
MNR	Ontario Ministry of Natural Resources
MOU	Memorandum of Understanding
MOE	Ontario Ministry of the Environment
NPDES	National Pollutant Discharge Elimination System
NRTMP	Niagara River Toxic Management Plan
NYSDEC	New York State Department of Environmental Conservation
OLMC	Onondaga Lake Management Conference
OMAFRA	Ontario Ministry of Agriculture, Food, and Rural Affairs
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PISCES	Passive In-Situ Chemical Extraction Samplers
PPA	Performance Partnership Agreement
PSL	Priority Substances List
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
SPDES	State Pollutant Discharge Elimination System
TSDF	Transfer, Storage and Disposal Facility
USACE	U.S. Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USF&WS	U.S. Fish and Wildlife Service

Note: Please refer to the glossary in Appendix A for definitions of technical terms. For your convenience, each term appearing in the glossary is italicized the first time it is used in the text.

CHAPTER 1 INTRODUCTION

1.1 Background and Purpose

In 1987, the governments of Canada and the United States made a commitment, as part of the Great Lakes Water Quality Agreement (GLWQA), to develop a Lakewide Management Plan for each of the five Great Lakes. The purpose of a Lakewide Management Plan (LaMP) is to identify the actions necessary to restore and protect the lake. There are a number of important principles that guide the development of LaMPs. According to the 1987 Agreement, "LaMPs shall embody a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in ... open lake waters", including consultation with the public. LaMPs will also provide an important step towards the virtual elimination of persistent toxic substances and the restoration of "physical, chemical, and biological integrity" (IJC, 1987) of the lakes. Through a LaMP, efforts will be coordinated among governmental agencies to reduce amounts of contaminants entering the lake and address causes of lakewide environmental problems. Plans are being developed in four stages: problem definition (Stage 1), schedule for load reduction activities (Stage 2), selection of remedial measures (Stage 3), and successful results as documented by monitoring (Stage 4).

<u>The 1987 Great Lakes Water Quality Agreement</u> calls for achieving common water quality objectives, improved pollution control throughout the basin, and continued monitoring. It focuses on restoring and maintaining "the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem...the interacting components of air, land, and water and living organisms including man within the drainage basin of the St. Lawrence River."

This Stage 1 LaMP for Lake Ontario has been developed by Region II of the U.S. Environmental Protection Agency (USEPA), Environment Canada (EC), the New York State Department of Environmental Conservation (NYSDEC), and the Ontario Ministry of the Environment (MOE) (the Four Parties) in consultation with the public. It identifies the progress seen to date in the lake as a result of actions already implemented and proposes future actions that the Four Parties can take, individually or jointly, to address identified problems.

One of the challenges of the LaMP is to understand the state of Lake Ontario as it exists today and how it may change in the near future and over the long term. Concentrations of toxic substances in water, sediment, fish, and wildlife respond at different rates to changes in loadings and changes in biological or physical conditions. Programs in place today which have already reduced critical pollutant loadings may not have an impact on environmental levels for decades, particularly in fish and wildlife. This time lag must be considered when evaluating data which were often collected several years before being reported and which reflect loadings which occurred many more years before data collection. Organisms accumulate chemicals or metals that have been in the ecosystem for long periods of time, either in sediment or in organisms which are lower on the food chain. Estimating if current programs will eventually resolve some of these ecosystem issues and over what time frame is an important step in understanding what additional measures are necessary to accelerate the cleanup of Lake Ontario.

The Plan will build on existing programs that are being implemented in the Lake Ontario basin to manage toxic substances. Additional information beyond that which is required for Stage 1 has been included where available (i.e., some remedial measures have been or are being implemented and monitoring programs have indicated improvements). The Four Parties will continue to develop Stages 2 through 4 with public input over the next several years.

This report has taken a number of years to produce. As part of this process, the Four Parties agreed that the cut-off date for adding new information would be November 1996. It is therefore recognized that, in some cases, the background information requires updating. In other cases, new information needs to be reviewed and assessed relative to the conclusions expressed in this report. The binational workplan acknowledges this need and presents a schedule for updating the current data base.

1.2 Physical and Environmental Features of the Lake Ontario Basin

Lake Ontario is the last of the chain of Great Lakes that straddle the Canada/United States border. Its shoreline is bordered by the Province of Ontario on the Canadian side and New York State on the U.S. side (see Figure 1-1). Lake Ontario is the smallest of the Great Lakes, with a surface area of 18,960 km2 (7,340 square miles), but it has the highest ratio of watershed area to lake surface area. It is relatively deep, with an average depth of 86 meters (283 feet) and a maximum depth of 244 meters (802 feet), second only to Lake Superior. Approximately 80 percent of the water flowing into Lake Ontario comes from Lake Erie through the Niagara River (USEPA *et al.*, 1987). The remaining flow comes from Lake Ontario basin tributaries (14%) and precipitation (7%). About 93 percent of the water in Lake Ontario flows out to the St. Lawrence River; the remaining 7 percent leaves through evaporation. Since Lake Ontario is the downstream Great Lake, it is impacted by human activities occurring throughout the Lake Superior, Michigan, Huron, and Erie basins.

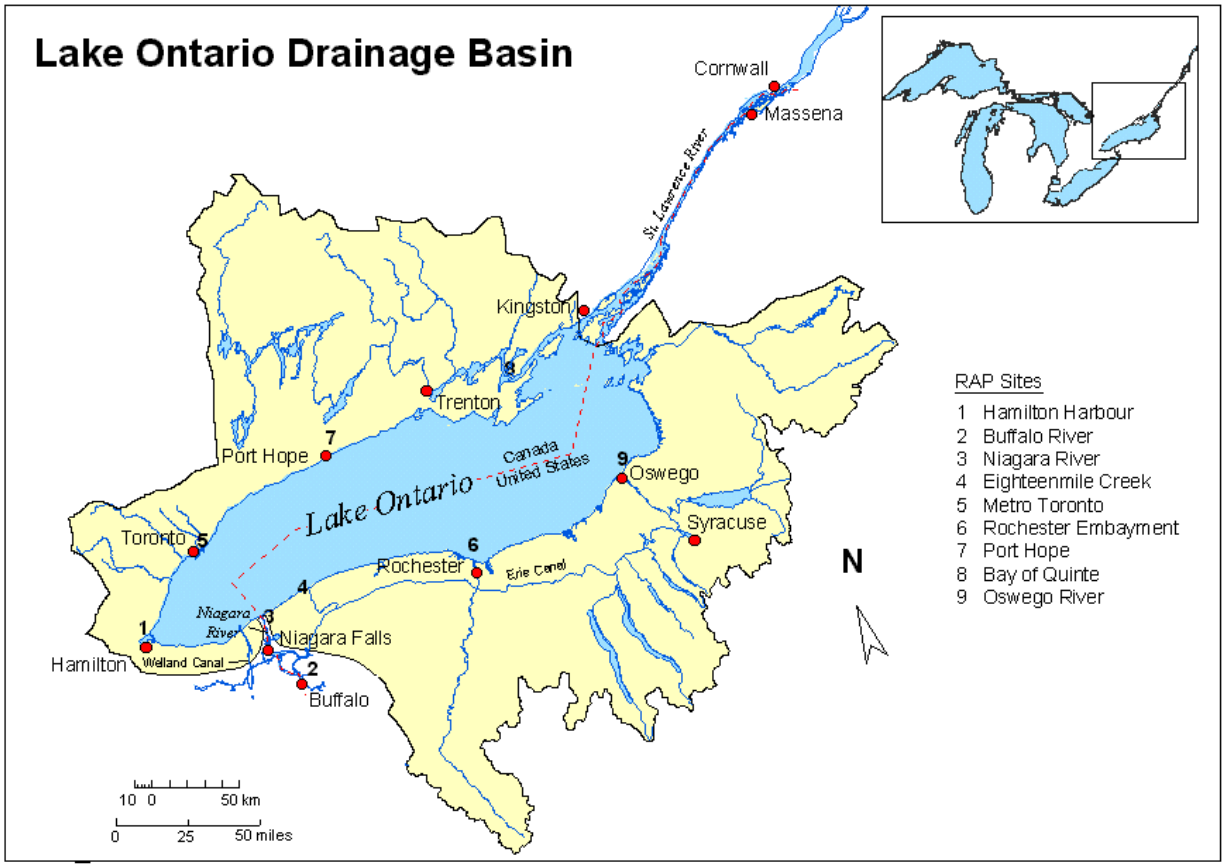


Figure 1-1. Lake Ontario Drainage Basin

Climate

The climate of the entire Great Lakes basin is characterized as humid and temperate (USEPA *et al.*, 1987). The position and size of each lake, together with the effects of outside air masses, further influence climate. Each lake acts as a heat sink, absorbing heat when the air is warm and releasing it when the air is cold. This results in more moderate temperatures at nearshore areas than other locations at the same latitude. The influence of external air masses varies seasonally. In the summer, the Lake Ontario basin is influenced mainly by warm humid air from the Gulf of Mexico, whereas in winter the weather is influenced more by Arctic and Pacific air masses.

Physical Characteristics and Lake Processes

There are two main sedimentary basins within Lake Ontario: 1) the Kingston Basin, which is a shallow basin located northeast of Duck-Galloo Island; and 2) a deeper main basin that covers the rest of the lake (see Figure 1-2). Within the main basin there are three deep sub-basins: the Rochester, Mississauga, and Niagara Basins. These basins are bordered by a shallow inshore zone that extends along the perimeter of the main basin.

Lake Ontario has a seasonally dependent pattern of both horizontal and vertical *thermal stratification.* In the spring, nearshore water warms more quickly than the deep offshore waters. The density of water varies with temperature, resulting in little mixing between these waters. The lake becomes stratified vertically between the nearshore and the offshore zones (except in the Kingston Basin which is shallow throughout). This thermal stratification lasts until around the middle of June when offshore waters warm and mixing occurs between offshore and nearshore waters. For the rest of the summer, there is horizontal stratification between the warm surface waters (epilimnion) and cool deeper waters (hypolimnion). The depth of the *thermocline* varies between sub-basins. Summer water temperatures are generally warmer in the southwest end of the lake and cooler in the northwest end. Mixing of the waters in the epilimnion and the hypolimnion begins during September, when the surface waters have cooled, and continues until *isothermal* conditions occur. During the winter months, inshore areas freeze (including Kingston Basin) but deep waters remain open.

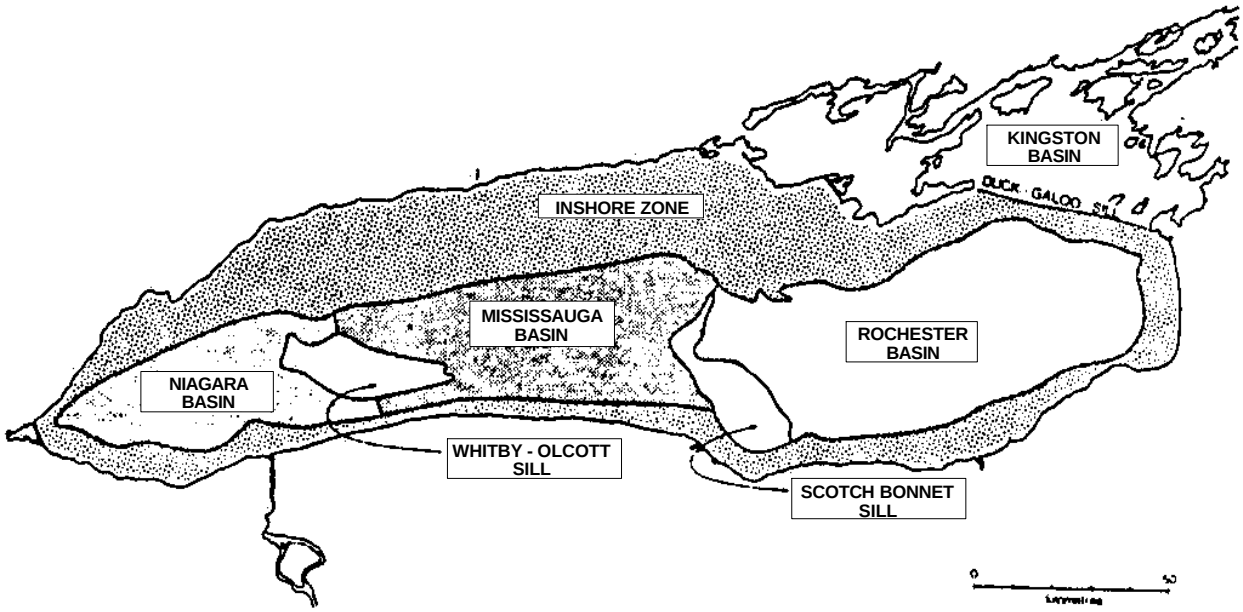


Figure 1-2. Sedimentation Basins in Lake Ontario (Thomas, 1983).

The prevailing west-northwest winds combined with the eastward flow of water from the Niagara River are the most important influences on lake circulation resulting in a counter-clockwise motion (Sly, 1990). Circulation of water generally occurs along the eastern shore and within sub-basins of the main lake. There is very little net flow along the north inshore zone.

Circulation patterns, sedimentation rates, and thermal stratification influence the effects of human activities on the lake. Although water retention time in the lake is estimated to be about seven years, based on inflow and outflow rates it may take much longer for substances such as toxic chemicals to leave the lake (Sly, 1991). Contaminants may bind to sediments on the lake floor, be covered over, and remain indefinitely. Alternatively, contaminants may be resuspended to the water column or ingested by benthic organisms and be introduced to the food chain. In the summer when the lake is stratified, only water from the epilimnion flows out into the St. Lawrence River, but during the winter months when the water is thoroughly mixed, water from the deeper parts of the lake reaches the St. Lawrence. MacKay (1989) suggests that, for some persistent toxics, the lake will actually cleanse itself quicker than reported by Sly.

The trophic status of the lake has been influenced by human activities. Prior to European settlement, Lake Ontario was *oligotrophic*. In the 1960s and 1970s, excess nutrients in the form of phosphorus (from household detergents, for example) caused excess algae growth. The trophic status of the main basin changed from oligotrophic to *mesotrophic*, and many nearshore areas became *eutrophic*. Phosphorus controls were implemented in the 1970s and have been successful in reducing the amount of nutrients entering the lake. Phosphorus levels, which were over 20 ug/L in the 1970s have dropped to less than 10 ug/L since 1986 (Neilson *et al.*, 1994) indicating that the lake is returning to its original oligotrophic condition. The filtering action of zebra and quagga mussels are also thought to have had a role in improving the trophic status of the lake.

Aquatic Communities

The aquatic communities of Lake Ontario are indicative of the trophic status of the lake. Benthic communities in the Kingston and main basins are dominated by the aquatic crustacean, *Diporeia*, a species characteristic of oligotrophic conditions. Benthic communities in most nearshore areas are now totally dominated by zebra and quagga mussels, although oligochaete worms dominate this community in some nearshore areas, reflecting the eutrophic status of these areas. Zooplankton communities are dominated by side-swimmers, and water fleas (cladocerans and cyclopoid copepods). *Diatoms* and green algae are the most common

types of phytoplankton. Mysis, a form of freshwater shrimp, is a very important part of the pelagic *food web*.

The fish communities of Lake Ontario have changed significantly since the 1700s when Europeans first settled along the shores of Lake Ontario. These changes have resulted primarily from human activities including destruction of habitat, overharvesting, the introduction of exotic species, and increased nutrients. Historically, as an oligotrophic lake, Lake Ontario's top predators were lake trout, Atlantic salmon, and burbot. The main forage species were lake herring, lake whitefish, and deepwater sculpin. As early as the 1830s, concerns existed about the decline in Atlantic salmon populations, and this species had disappeared by the late 1800s. Lake trout and burbot populations were almost eliminated in the 1940s. By the 1950s, natural populations of lake trout and deepwater sculpin no longer existed in Lake Ontario.

Charter Fishing
(Michigan Sea Grant)

In addition to severe declines in a number of fish populations, other fish community changes have occurred, resulting from the introduction (both accidental and intentional) of exotic species. Over the past 100 years, exotic forage fish such as alewives, rainbow smelt, and white perch became established and filled open ecological niches. Government stocking programs have also influenced the fish communities of the lake. Stocking of lake trout began as early as the 1890s, but it was not until the 1970s that effective sea lamprey control and expanded stocking programs for several salmonid species resulted in the development of a significant sport fishery for salmon and trout in Lake Ontario and many of its tributaries.

Presently, chinook salmon, coho salmon, and brown trout populations are maintained primarily through stocking programs; very limited natural reproduction of these species has been documented in a few tributary systems. Stocking programs for lake trout and Atlantic salmon are directed at rehabilitation of these two native species. While the Atlantic salmon program is still at an early stage, there are encouraging signs of natural reproduction by lake trout in recent years. Rainbow trout have been very successful in establishing wild populations in a large number of tributaries, particularly on the north shore. Rainbow trout are also stocked into the lake in areas where natural reproduction of this species contributes little to the sport fishery.

In the early 1990s, concerns were raised about the long term stability and sustainability of the openwater fish community. Populations of alewife and smelt have declined due to the lower productivity of the lake and the increased stocking of trout and salmon that feed on these species.

Beginning in 1994, U.S. and Canadian natural resource management agencies reduced stocking rates in recognition of these changing predator-prey relationships in the lake.

Over the past two decades, there have been dramatic improvements in the status of formerly depleted stocks of native species. Beginning in the late 1970s, walleye and lake whitefish populations began to recover in eastern Lake Ontario; populations of these species have now reached historically high levels in the eastern end of the lake. In the 1990s, fisheries assessment programs have documented increasing numbers of lake herring, lake sturgeon, and burbot. In 1996, assessment gear captured several specimens of deepwater sculpin, a native prey species, no longer thought to exist in the lake.

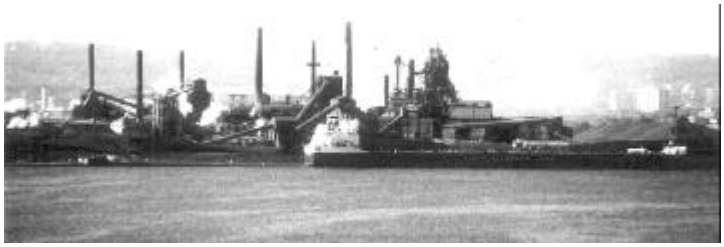
Alewife declines in recent years are believed to be an important factor in the resurgence of native species. Predation and competition by alewife on the juvenile life stages of native species had formerly suppressed their recovery. As a consequence of zebra and quagga mussel invasion, benthic pathways will become more important in the aquatic food web, which should favor benthic and deepwater fish species such as lake trout, burbot, lake sturgeon, and sculpin.

In light of the many changes occurring in the Lake Ontario ecosystem over the last decade, the Ontario Ministry of Natural Resources (MNR) and NYSDEC have initiated a review of the fisheries management direction for the lake, involving fisheries professionals and stakeholders. The draft Fish Community Objectives will be available for formal review in the spring of 1998.

1.3 Demo-graphics and Economy of the Basin

The present day demographics of Lake Ontario are a result of the historical patterns of settlement which were closely tied to the physical and environmental features of the basin. Native people have lived along the shores of the Great Lakes for over 10,000 years. They fished the waters, grew crops on the land, and used the rivers for transportation. Europeans first settled along the shores of Lake Ontario in the 1700s. Cities and towns sprung up near tributaries because of the abundant water supply and transportation opportunities. The mixed hardwood forests provided a rich resource. Logging became a major activity, both for the valuable timber and to clear the land for agriculture. The Lake Ontario basin has an ideal climate and soil types for agriculture. Some areas, such as the Niagara region, are highly specialized in the growing of fruit and vegetable crops.

Lumber camp, c. 1900
(Douglas County Historical Society)



Hamilton, Ontario

Shipping is a major activity on the lake and has led to the growth of manufacturing and population increases in port communities. Major steel mills, that rely on shipping, were established at Hamilton. In the 1900s, the chemical industry was established near Niagara Falls due to the abundant supply of hydroelectric power generated by the Falls.

Commercial fishing yields in Lake Ontario were never as high as more productive lakes such as Lake Erie. Ontario does, however, currently support a Canadian commercial fishery for lake whitefish, American eel, yellow perch, and bullheads that was worth $1.5 million (CDN) in 1996 (Hoyles and Harvey, 1997). The U.S. commercial fishery for Lake Ontario was valued at $68,000 (US) in 1995 (Cluett, 1995). The recreational fishery is based primarily on salmon and trout species in the open lake and tributaries, walleye in the eastern lake, and smaller numbers of perch, smallmouth bass, and panfish species in embayments. The economic value of recreational fishing to local communities is estimated to range from $100 million to over $200 million per year (USEPA *et al.*, 1987; Kerr and LeTendre, 1991).

The Lake Ontario basin, its major sub-basins, and communities are shown in Figure 1-1 (see page 3). At the present time, over 5.4 million people live on the Canadian side of the basin (Statistics Canada, 1994). The northwestern part of the shoreline is a highly urbanized and industrialized area referred to as the "Golden Horseshoe". This area extends from Coburg in the east, around the western end of Lake Ontario to St. Catharines and Niagara Falls. The U.S. side of the lake is not as heavily populated, with approximately 2.2 million residents (NYSDED, 1991). There are, however, concentrated areas of urbanization at Rochester, Syracuse, Oswego, and Watertown, New York.

Land use in the basin and along the shoreline is presented in Tables 1-1 and 1-2, respectively. Forested areas are mainly in the northernmost and southernmost areas of the watershed. Nearer to the lake, forest habitat is highly fragmented.

Table 1-1.
Basin Land Use (%)

	Agriculture	*Residential*	*Forest*	*Other*
Canada	49	6	42	3
U.S.	33	8	53	6
Total	39	7	49	5

Table 1-2.
Shoreline Land Use (%)

	Residential	*Recreational*	*Agricultural*	*Commercial*	*Other*
Canada	25	15	30	18	12
U.S.	40	12	33	8	7

Rural and urban land use activities in the watershed influence the environmental health of Lake Ontario. Herbicides, pesticides, and excess nutrients from agricultural runoff are types of non-point source contaminants. Sources of pollution from urban areas include stormwater runoff from paved streets, effluent from sewage treatment plants, and *combined sewer overflows* (CSOs).

1.4 The Lake Ontario Toxics Management Plan and Progression to the LaMP

In response to an identified toxics problem in the Niagara River and Lake Ontario, a Niagara River Declaration of Intent was signed on February 4, 1987, by the Four Parties. This document included a commitment to develop a Lake Ontario Toxics Management Plan (LOTMP). The main purpose of the LOTMP was to define the toxics problem in Lake Ontario and to develop and implement a plan to eliminate the problem through both individual and joint agency actions. The Four Parties developed a draft Toxics Management Plan which was presented for public review in 1988. The completed LOTMP was published in 1989 (LOTMP, 1989). Updates of the LOTMP were completed in 1991 (LOTMP, 1991) and in 1993 (LOTMP, 1993).

Goals of the Lake Ontario Toxics Management Plan:

- *Drinking water and fish that are safe for unlimited human consumption*
- *Natural reproduction, within the ecosystem, of the most sensitive native species, such as bald eagle, osprey, mink, and river otter*

To achieve the goals, four objectives were developed:

- Reductions in Toxic Inputs Driven by Existing and Developing Programs
- Further Reductions in Toxic Inputs Driven by Special Efforts in Geographic Areas of Concern
- Further Reductions in Toxic Inputs Driven by Lakewide Analyses of Pollutant Fate
- Zero Discharge

The LOTMP identified 11 priority toxic chemicals in the lake (see Appendix B) and provided information regarding ongoing load reduction efforts. This program has been the primary binational toxic substances reduction planning effort for Lake Ontario. As such, it serves as a foundation for the development of the Lake Ontario LaMP, which incorporates an "ecosystem approach" through the assessment of "beneficial uses". In May of 1996, the Four Parties signed a Letter of Intent (see Appendix C) agreeing that the LaMP should provide the binational framework for environmental protection efforts in Lake Ontario. The Four Parties have reviewed and incorporated all relevant LOTMP commitments into this Stage 1 Plan.

1.5 Scope of the LaMP

The Lake Ontario LaMP focuses on resolving:

- Lakewide beneficial use impairments as defined in the Great Lakes Water Quality Agreement (Annex 2) and described in Chapter 3 of this LaMP;
- Critical pollutants contributing to, or likely to contribute to, these impairments despite past application of regulatory controls, due to their toxicity, persistence in the environment, and/or their ability to accumulate in organisms; and
- Physical and biological problems caused by human activities.

***Remedial Action Plans* were also required by the GLWQA. These plans address localized environmental problems within an Area of Concern (AOC). AOCs are specific geographic areas where significant pollution problems have been identified as impairing beneficial uses such as swimming, eating fish, or drinking water. (See Figure 1-1).**

The LaMP will address sources of lakewide critical pollutants, which are those substances responsible, either singly or in synergistic or additive combination, for beneficial use impairments in the open lake waters of both countries, as well as those substances that exceed criteria and are, therefore, likely to impair such uses, which require binational actions for resolution. This Plan will be coordinated with Remedial Action Plans within the Lake Ontario drainage basin and other localized efforts which are best suited to address issues of local concern. In addition, this Plan will utilize linkages to other natural resource management activities, such as the development of Lake Ontario fish community objectives by the Great Lakes Fishery Commission and the Lake Ontario Committee of fisheries managers. The LaMP will address impairments found in open waters of the lake and nearshore areas, without duplicating the efforts of localized remedial action plans. Tributaries, including the Niagara River, are treated as inputs to the lake. The St. Lawrence River is treated as an output from the lake.

This report does not provide a complete analysis of the biological and physical problems facing the lake because the ecosystem objectives and indicators needed to evaluate these problems are still being developed and will be reported on as part of the Stage 2 reporting for the LaMP (see Binational LaMP Workplan). The LaMP will provide an assessment of the physical and biological problems after these objectives and indicators have been completed. Recognizing that the development of ecosystem objectives may require a considerable amount of time, the LaMP will move forward with the development of a critical pollutants reduction strategy rather than wait until all physical and biological problems have been defined.

In addition to the Lake Ontario LaMP, there are a number of other environmental planning efforts upstream and downstream of the Lake Ontario basin. Plans are being implemented for the Niagara River, including Remedial Action Plans in both Canada and the U.S. and a binational Toxics Management Plan. The major sources of pollutants within the downstream St. Lawrence River are being addressed through three ongoing planning efforts: Canadian and U.S. Remedial Action Plans for the St. Lawrence River at Cornwall and Massena, respectively, and a St. Lawrence River Action Plan for the section of the river located in the Province of Quebec.

1.6 Human Health and the Lake Ontario LaMP

The Lake Ontario LaMP is concerned with human health issues related to water quality. Other human health issues, such as air pollutants, infectious diseases, and pesticide residues on food are not addressed as part of the LaMP and are under the jurisdiction of other programs. Three of the LaMP's impairment indicators are directly related to human health issues: Restrictions on Drinking Water Consumption, Fish and Wildlife Consumption, and Beach Closings. Of these three, only fish and wildlife consumption advisories have been identified as a lakewide problem.

Localized beach closings due to occasional high bacteria levels are a problem in some areas and are being addressed by several Remedial Action Plans. While some taste and odor problems have been observed, there are no restrictions on drinking water consumption. The LaMP will work with U.S. and Canadian health agencies to assure that health issues are being adequately addressed.

1.6.1 Potential Human Health Impacts

Potential environmental pathways of human exposure to Great Lakes pollutants include inhalation of air, ingestion of water, foodstuffs, or contaminated soil, and dermal contact with water or airborne particulates. Multimedia analyses indicate that the majority (80 to 90%) of human exposures to chlorinated organic compounds and mercury comes from the

food pathway, a lesser amount (5 to 10%) from air, and minute amounts (less than 1%) from water (Birmingham *et al.*, 1989; Newhook, 1988; Fitzgerald *et al.*, 1995).

Most of the available data on human exposure to toxic substances in the Great Lakes comes from the analyses of contaminant levels in drinking water and sport fish. The consumption of contaminated sport fish and wildlife can significantly increase human exposure to Lake Ontario critical pollutants. The risks associated with fish consumption are greatly reduced if people follow consumption advisories. Those who are unaware of or do not follow these advisories are at greatest risk. Investigators have demonstrated that blood serum levels of these contaminants are significantly increased in consumers of contaminated Great Lakes sport fish as compared to non-fisheaters (Humphrey, 1983a,b; Kearney *et al.*, 1995; Health Canada, 1997; Fitzgerald *et al.*, 1995).

Even though residents of the Great Lakes basin are exposed to toxic substances from many sources originating within and outside the region, the main routes of human exposure to contaminants from the waters of the Great Lakes are ingestion of fish and, to a lesser extent, ingestion of drinking water (DFO and Health and Welfare Canada, 1991). Also, several investigators have shown that exposure from fish far outweighs atmospheric, terrestrial, or water column sources (Swain, 1991; Humphrey, 1983b; Fitzgerald *et al.*, 1995). These patterns may vary for populations living in the vicinity of industrialized areas.

Several epidemiologic investigations have been conducted on the association between water pollutants in the Great Lakes and the health of people in the Great Lakes basin. These studies have demonstrated increased tissue levels of toxic substances in these populations that may be associated with or potentially result in reproductive, developmental, behavioral, neurologic, endocrinologic, and immunologic effects (Fitzgerald *et al.*, 1995).

Some studies have reported subtle effects in children of mothers who consumed large amounts of Great Lakes fish. At birth, some of the children most highly exposed to the mixture of contaminants present in the fish were slightly smaller, showed slightly delayed neuromuscular development during infancy, and had a reduced ability to deal with stressful situations. A small percentage of such children showed slightly delayed or reduced intellectual development during their school years. Recent epidemiologic and laboratory studies complement and continue to build upon the scientific data gathered over the last two decades that document health consequences associated with exposures to persistent toxic substances. The findings of elevated polychlorinated biphenyl (PCB) levels in human populations, together with findings of developmental deficits and neurologic problems in children whose mothers ate PCB-

contaminated fish, have significant health implications. Additional research is necessary to better understand the human health impacts that persistent toxic substances may have on sensitive populations (Johnson *et al.*, draft 1997).

Endocrine disruption has emerged as a major issue in regulatory toxicology with significant human health implications. While human health effects due to endocrine disruption remain controversial, some pesticides and certain industrial chemicals, as well as some naturally occurring substances have been shown to mimic the action of estrogen in tissue cultures and laboratory animal studies. Laboratory and animal studies reveal that fetuses and infants are especially susceptible to bioaccumulating and endocrine disrupting chemicals because exposure occurs during critical periods of early tissue and organ development and growth.

LaMP Human Health Related Issues	Where can I find more information?
Research on potential human health effects (neurological, endocrinological, reproductive, and other effects)	Section 1.6.1
Fish & Wildlife Consumption Advisories	Section 3.3.1
Beach Closings	Section 3.5.5
Drinking Water Quality	Section 3.5.4
Radionuclides	Section 1.6.4
Microbial Pathogens	Section 3.5.5

1.6.2 Wildlife as a Sentinel for Human Health

The health of fish and wildlife provides a good indication of the overall condition of an ecosystem. The dramatic reproductive failure of cormorants on Lake Ontario due to DDT in the 1960s provided a clear indication that something was wrong. Since that time, contaminant reduction programs have succeeded in banning and controlling many toxic substances and, as a result, environmental levels have declined and the cormorants and other sensitive species are reproducing normally. This indicates that the potential risks to human populations posed by persistent environmental contaminants have also declined.

Ongoing fish and wildlife populations can provide an important tool to identify any currently unrecognized contaminant risks that may develop in the future. Given that the metabolisms and diets of fish and wildlife are very different from humans and that these species are exposed to much higher contaminant levels than the general human population, caution must be used when interpreting the significance of fish and wildlife problems for human populations. For example, tumors in fish may reflect

high levels of contaminants in sediment or may be the result of natural causes such as viruses or genetic factors. Nonetheless, Canadian and U.S. health agencies [Health Canada and the Agency for Toxic Substances and Disease Registry (ATSDR)] have concluded that the weight of evidence based on the findings of wildlife biologists, toxicologists, and epidemiologists clearly indicates that populations continue to be exposed to PCBs and other chemical contaminants and that significant health consequences are associated with these exposures (Johnson *et al.*, draft 1997; Health Canada, 1997).

LaMP Wildlife Indicators of Potential Health Concerns	Where can I find more information?
Fish Tumors	Section 3.5.1
Degraded Fish and Wildlife Populations	Section 3.3.2
Degraded Benthic Communities	Section 3.4.1
Degraded Phytoplankton & Zooplankton Populations	Section 3.4.2
Bird and Animal Deformities and Reproduction Problems	Section 3.3.2

1.6.3 Indicators of Human Health Trends

Ideally, indicators of human health would gauge trends in any adverse human health effects related to environmental contaminants. Contaminant concentrations in fish tissue, human tissue, and other environmental media can be used as an indication of changes in contaminants levels and that certain human populations are being exposed. However, except in cases where individuals are exposed to relatively high levels of contaminants that can cause clearly recognizable health effects, it may not be possible to separate out any adverse effects due to environmental contaminants from other human health factors, such as diet, lifestyle, work environment, and genetic factors.

There are a number of U.S. and Canadian stakeholders collaborating to define indicators for the basin and the individual Great Lakes. The development of these human health indicators may provide the basis for future monitoring and data gathering efforts.

1.6.4 Other Key Human Health Issues

Potential health risks posed by levels of radionuclides and bacteria in Lake Ontario were also considered by the LaMP.

Radionuclides

There is ongoing debate as to whether *anthropogenic* concentrations of radionuclides in Lake Ontario water should be regarded as a significant human health issue. Current concentrations of radionuclides in water are below existing standards and criteria. Natural sources of radiation contribute on average more than 98 percent of the human radiation dose. Artificial sources, such as nuclear power and medical facilities, add to the radiation levels.

Long term low level exposure to ionizing radiation has been associated with the development of leukemia and other cancers. Effects other than cancer, such as neurological, developmental, and immunological damage, have been observed only at high doses of radiation, and are generally assumed to be threshold effects. It has been suggested that radiation weakens the immune system, and that exposure even at low levels may lower one's resistance to infectious diseases, as there is a depression in the white blood cell count at high levels of radiation exposure. However, there is no clear mechanism linking low level radiation exposure with obvious immune system damage.

Recreational Water

Local beach closings along some of the more populated shorelines due to elevated levels of E. coli (or fecal coliform bacteria) are indicative of fecal contamination and the possible presence of enteric (intestinal) pathogens which can pose a potential health risk. Microbiological water quality indicators are used as surrogates for the presence of pathogenic organisms that may cause illness. In Lake Ontario, a number of local beach closings occur due to microbial contaminants, primarily along the more populated shorelines. Exceedence of microbial standards and criteria typically occurs following a storm event when the treatment capacity of some sewage treatment plants can be exceeded. Given the localized nature of beach closings and their absence along much of the Lake Ontario shoreline, they are not considered a lakewide problem. The frequency of beach closings is expected to decrease as sewage treatment plants continue to improve and upgrade their systems. It should be noted that beaches may also be closed due to other factors such as storm events, excessive turbidity, or lack of funding.

Drinking Water

Newly recognized concerns related to drinking water include microbes resistant to drinking water disinfection, especially encysted forms of protozoan parasites such as *Cryptosporidium* and toxic by-products of drinking water disinfection such as trihalomethanes. These issues have not been identified as a significant concern for residents of the Lake Ontario basin. Although *Cryptosporidium* has not been identified as a significant concern, those supplies without full treatment are potential candidates for outbreaks of cryptosporidiasis (Health Canada, 1997).

1.7 Developing LaMP Ecosystem Goals and Objectives

Ecosystem Goals for Lake Ontario:

- *The Lake Ontario Ecosystem should be maintained and as necessary restored or enhanced to support self-reproducing diverse biological communities.*
- *The presence of contaminants shall not limit the uses of fish, wildlife, and waters of the Lake Ontario basin by humans and shall not cause adverse health effects in plants and animals.*
- *We as a society shall recognize our capacity to cause great changes in the ecosystem and we shall conduct our activities with responsible stewardship for the Lake Ontario basin.*

The earlier LOTMP developed broad ecosystem goals for Lake Ontario which have been incorporated in the LaMP process. The LaMP will expand on these goals by developing more detailed ecosystem objectives and ecosystem health indicators to be used to measure progress in restoring Lake Ontario. A preliminary effort resulted in the following five objectives which will serve as a starting point for a more comprehensive effort to include broader public, private, and governmental input.

Aquatic Communities (benthic and pelagic): the waters of Lake Ontario shall support diverse and healthy reproducing and self-sustaining communities in dynamic equilibrium, with an emphasis on native species.
Wildlife: the perpetuation of a healthy, diverse, and self-sustaining wildlife community that utilizes the lake for habitat and/or food shall be ensured by attaining and sustaining the waters, coastal wetlands, and upland habitats of the Lake Ontario basin in sufficient quality and quantity.
Human Health: the waters, plants, and animals of Lake Ontario shall be free from contaminants and organisms resulting from human activities at levels that affect human health or aesthetic factors such as tainting, odor, and turbidity.

Habitat: Lake Ontario offshore and nearshore zones and surrounding tributary, wetland, and upland habitats shall be of sufficient quality and quantity to support ecosystem objectives for the health, productivity, and distribution of plants and animals in and adjacent to Lake Ontario.
Stewardship: Human activities and decisions shall embrace environmental ethics and a commitment to responsible stewardship.

Ecosystem objectives need to consider the ecological possibilities and constraints within the lake. Although there is general agreement that the reduction of bioaccumulative contaminants entering the lake should be a priority, consensus may be lacking for many natural resource issues. An individual's point of view regarding the best or most appropriate use of a natural resource is often based on value judgements. For example, some anglers would like to see naturally sustaining populations of native fish, such as lake trout and Atlantic salmon, established as Lake Ontario's top level predator fish. Other anglers advocate stocking of non-native fish, such as Coho salmon and rainbow trout, to promote sport fishing. These will be difficult decisions. The sharing of viewpoints, learning more about these complex issues, and a willingness to work together to develop solutions that "make sense" will be critical in developing objectives that have broad public, private, and governmental support.

1.8 Management Structure

The Four Parties have the responsibility for developing the Lake Ontario LaMP and have approved a LaMP management structure that consists of a Coordination Committee, a Management Committee, a Lake Ontario Workgroup, and a Lakewide Advisory Network (see Figure 1-3 below). There are other agencies that have an interest in the LaMP, such as natural resource and human health agencies, and their involvement on specific issues is an important component of LaMP decision-making. Responsibility for ensuring this participation lies with the Management Committee.

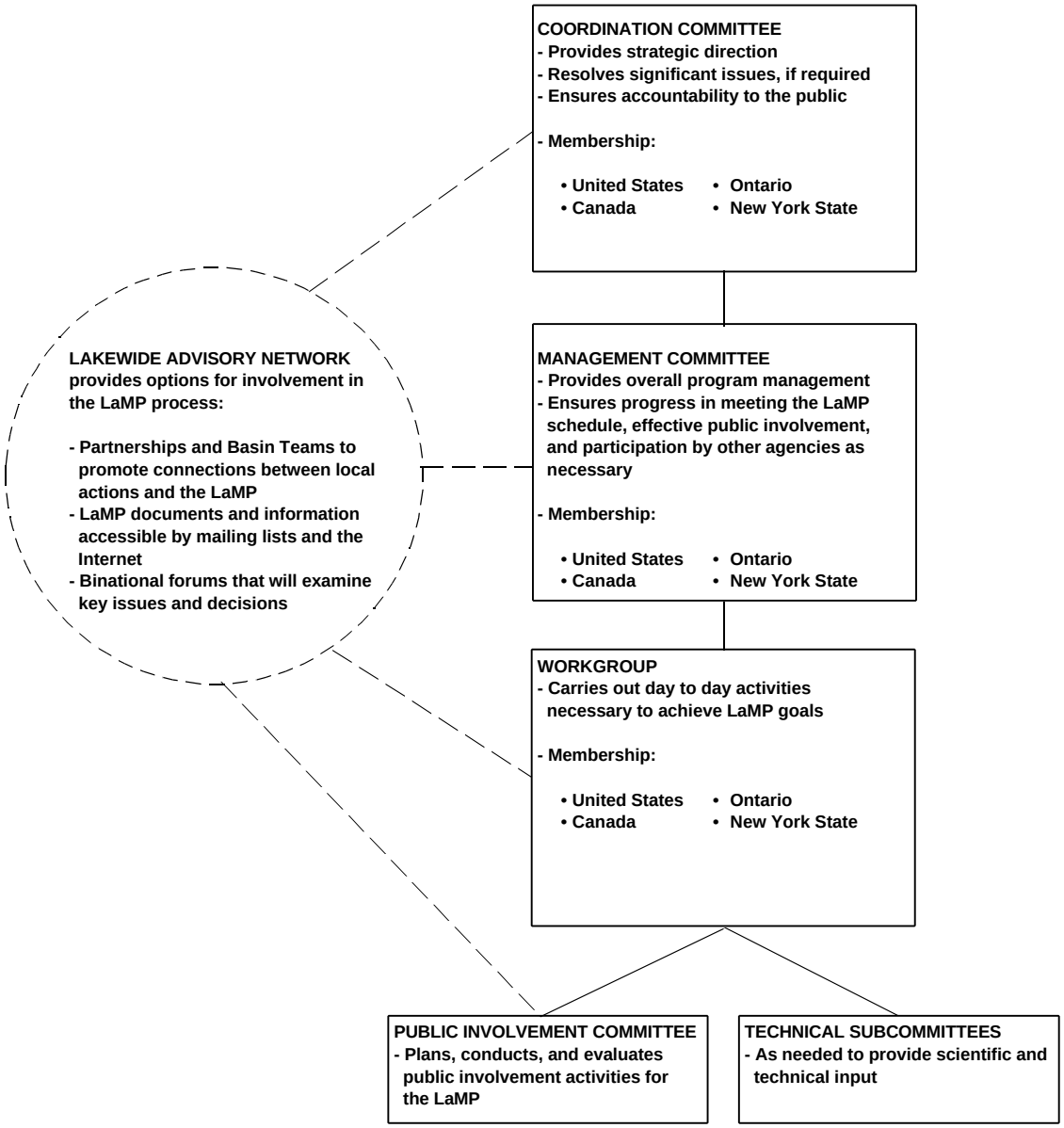


Figure 1-3. Lake Ontario LaMP Management Structure

2.1 Introduction

The Four Parties are committed to an active public involvement program. Public involvement has been sought throughout the development and implementation of the Lake Ontario Toxics Management Plan (LOTMP) and through the transition to the Lake Ontario Lakewide Management Plan (LaMP). In the late 1980s, a Public Involvement Committee, composed of agency public involvement and communications staff, was created to plan, conduct, and evaluate public involvement activities.

Public Involvement Goals:

- *Increase public understanding and awareness of Lake Ontario planning efforts.*
- *Provide various opportunities for meaningful public consultation in developing and implementing Lake Ontario management plans.*
- *Promote individual and corporate, governmental and non-governmental environmental stewardship actions.*
- *Build partnerships across the various programs and initiatives that are working to preserve and protect Lake Ontario.*

During the transition from the LOTMP to the LaMP, public involvement activities focused on keeping Lake Ontario stakeholders informed through informational updates, meetings, and other outreach efforts. The public involvement activities for the Lake Ontario LaMP aim to fully support efforts to create and strengthen partnerships and provide various opportunities for people to become informed about and involved in the LaMP process. It will take all of us working together to restore and protect this Great Lake.

2.2 A Look Back ... 1988-1995

Historically, the public involvement process for the LOTMP, including the shift to the LaMP, has included the following elements:

Holding open Coordination Committee meetings
Conducting public workshops
Improving connections with the Remedial Action Plans
Collecting information and conducting evaluations
Developing information and education materials

Each of these elements supports the overall Lake Ontario public involvement goals. By implementing a variety of activities, the agencies have provided opportunities for the many people concerned with the Lake Ontario basin to learn about and be involved in the planning process. For example:

Open Coordination Committee meetings have provided forums for updating people about key issues and progress and providing opportunities to meet agency decision makers. The agencies evaluated the effectiveness and usefulness of these meetings. After considering public comments, the agencies adjusted the meeting format to better meet both agency and stakeholder expectations.

Lake Ontario Modeling Workshop, Buffalo, NY
(New York Sea Grant Program at SUNY Buffalo)

Public workshops have provided an opportunity to discuss and receive comments and suggestions from stakeholders using facilitated small group discussions.

Communications with the Remedial Action Plan (RAP) committees have strengthened the relationships between the LaMP and Lake Ontario RAPs. These meetings and conversations have provided the opportunity for LaMP and RAP staff and stakeholders to become familiar with each other's programs.

Collecting information about the needs and expectations of people involved in Lake Ontario efforts is an ongoing and necessary process. For example, a 1993 Questionnaire resulted in the development of a Lakewide Advisory Network; feedback from a 1996 Questionnaire was used to develop the framework for obtaining public input on the draft of this document.

Informational materials, such as fact sheets and pamphlets, have been produced in an effort to inform and encourage people to learn about the Lake Ontario ecosystem, take action to conserve and protect Lake Ontario, and participate in Lake Ontario public involvement opportunities.

As the Lake Ontario process evolved, the agencies asked Lake Ontario stakeholders for guidance on enhancing the public involvement program, to be more effective in increasing awareness of the LaMP; provide various opportunities for public consultation; promote environmental stewardship actions; and build partnerships in the Lake Ontario basin.

2.3 A Public Involvement Strategy for the Lake Ontario LaMP

As a result of public consultation, the agencies adopted a strategy for establishing a three-tiered Lakewide Advisory Network. The three levels of the network were specifically designed to ensure that anyone interested in or concerned about Lake Ontario has the opportunity to become informed about and involved in the Lake Ontario LaMP process and actions to improve and protect the Lake Ontario basin. A closer look at the three-tiered network follows:

Lake Ontario Partnerships

There are many groups, agencies, committees, organizations, associations, and businesses planning or implementing water quality and habitat improvement initiatives, programs, and projects within the Lake Ontario basin. Considering this, it seemed inefficient to create a committee specifically for the Lake Ontario LaMP. The Four Parties, as advised by various stakeholder groups, realized it would be more valuable to focus on building connections between local and regional initiatives within the basin. Coordinated approaches to solving water quality and habitat issues within the basin will maximize the benefit to local areas as well as result in an improved Lake Ontario ecosystem. Some examples are:

The important connections between the Lake Ontario RAPs and the Lake Ontario LaMP. Each RAP's individual strategy for local remediation/restoration provides key information about the Area of Concern (AOC) that is fundamental to a comprehensive Lake Ontario LaMP. For example, by identifying sources of critical pollutants in each AOC, the RAPs provide information that will be useful in developing the contaminant reduction strategy under the LaMP. RAPs and LaMPs must work in concert with each other since the LaMP cannot be fully developed or implemented without considering details about specific areas in the basin and the remediation/restoration of AOCs relies upon how the LaMP will address lakewide environmental problems.

Regional groups or alliances in the Lake Ontario basin (e.g., the Finger Lakes-Lake Ontario Watershed Protection Alliance and the Lake Ontario Conservation Authorities Alliance) have great potential for coordinating and implementing actions to solve local watershed concerns. An important connection that cannot be ignored is that by taking action to solve local watershed concerns, these groups/alliances provide an essential link to water quality improvements in Lake Ontario.

Public Involvement Strategy:

- ***Establish partnerships to promote an understanding of the connections between local watershed activities and their impacts on Lake Ontario, to encourage action to conserve and protect the lake, and to provide input to the LaMP process.***
- ***Maintain a mailing network to keep people informed and solicit interest in the LaMP.***
- ***Provide opportunities for binational discussions between representatives from the partnerships and other stakeholders on LaMP development and implementation.***

The agencies are moving forward with efforts to identify, establish, and strengthen partnerships with those taking action in the basin. Although the goal is the same, it is important to realize that the U.S. and Canada will follow slightly different approaches: New York will be encouraging local and regional involvement in Basin Partnership Teams and Canada will focus efforts on developing several key partnerships with existing entities.

The New York State Department of Environmental Conservation (NYSDEC), with support from the U.S. Environmental Protection Agency (USEPA), is working to establish Basin Teams in a portion of the New York State Lake Ontario basin. Essentially, NYSDEC is aiming to create a network of partners at the regional and local levels. These Basin Teams would foster cooperation and facilitate discussions among existing groups such as Remedial Action Committees, County Water Quality Coordinating Committees, Regional Planning Councils, the Finger Lakes-Lake Ontario Watershed Protection Alliance, citizen-based watershed groups, municipalities, businesses, and tribal governments to conserve, improve, and protect the Lake Ontario basin. There are a variety of ways Basin Teams could establish this cooperative approach for water quality and habitat improvements. For example, local and regional partners can enter into written agreements that define how planning and implementation could be integrated. Other opportunities for collaboration include: planning joint conferences/workshops/events, convening meetings/ discussions, and disseminating information updates. Through these efforts the Basin Teams could: provide useful information about sub-watersheds; promote connections between local actions and Lake Ontario ("Act Locally...Think Lake Ontario"); and increase involvement in and support of the Lake Ontario LaMP and other programs that manage and conserve New York's water resources.

Environment Canada (EC) and the Ontario Ministry of the Environment (MOE) will work with existing organizations involved in managing and protecting Lake Ontario. Lake Ontario partners include the Waterfront Regeneration Trust (responsible for the Lake Ontario waterfront from Burlington to Trenton); Remedial Action Plans in Hamilton, Toronto, Port Hope, and Bay of Quinte; Conservation Authorities (responsible for managing watersheds that drain into Lake Ontario); municipalities; First Nations; and other interest groups.

Lake Ontario Information Connection

Information about the Lake Ontario LaMP and public involvement opportunities will be made available in a variety of ways. For example, the Lake Ontario LaMP mailing list includes approximately 1,000 names of U.S. and Canadian citizens and organizations who are interested in the LaMP. To ensure efficient distribution, the mailing list is continually updated. In addition to mailing information, the agencies will maintain a

home page on the Worldwide Web, accessible from either the Great Lakes Information Network (www.epa.gov/glnpo/lakeont) or the Canadian Great Lakes Information Management Resource (www.cciw.ca/glimr/lakes/ontario).

Lake Ontario Forums

At significant stages in the development of the LaMP, the Management Committee will convene a binational meeting of Basin Team representatives and other stakeholders to provide input on major decisions. Rather than a formal committee, this "Forum" will provide an opportunity for binational discussions and sharing of information as required by each stage in the LaMP process.

2.4 Next Steps

Efforts are now underway to build the Lakewide Advisory Network. The agencies are working to establish and strengthen partnerships within the Lake Ontario basin and build awareness of the connections between the LaMP and local initiatives within the basin. Activities that the agencies plan to undertake to further develop the Lakewide Advisory Network are included in the Binational Workplan for the LaMP (see Chapter 5). For example:

Identifying and recognizing Lake Ontario partners and basin teams

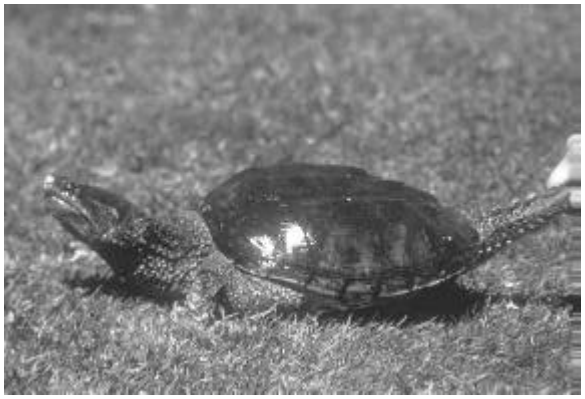
Developing and distributing information materials

Conducting meetings and/or workshops

Improving connections to other Lake Ontario initiatives

Making information accessible on the Internet

Significant changes have occurred in the Lake Ontario ecosystem over the last century due to the effects of toxic pollution and habitat loss resulting from the rapid development of the Lake Ontario basin. The extent of these changes was fully realized in the 1960s and 1970s, when Lake Ontario colonial waterbirds experienced nearly total reproductive failures due to high levels of toxic contaminants in the food chain. In 1972, Canada and the United States took actions to ban and control contaminants entering the Great Lakes, and, in 1987, renewed the Great Lakes Water Quality Agreement (GLWQA) with the goal to restore the overall health of the Great Lakes ecosystem. Today, as a result of these actions, levels of toxic contaminants in the Lake Ontario ecosystem have decreased significantly, and colonial waterbird populations have overcome most of the recognized contaminant-induced impacts of 25 years ago (i.e., their eggshells show normal thickness, they are reproducing normally, and most population levels are stable or increasing). However, *bioaccumulative toxics* persist in sediment, water, and biota at levels of concern for some fish species, such as lake trout and salmon, and for higher order predators, such as bald eagles, snapping turtles, mink and otters, and humans.



Snapping Turtle
(National Park Service, Indiana Dunes National Lakeshore)

This chapter summarizes lakewide impairments of beneficial uses in Lake Ontario caused by chemical pollutants and other factors. These impairments are those beneficial uses of the Great Lakes which cannot presently be realized, as laid out in the GLWQA. The same process is being used to identify problems within the other Great Lakes and in Areas of Concern (AOC). Given the rapid environmental changes that have occurred over the last 20 years, emphasis was placed on using the most recent information to identify current problems facing the Lake Ontario ecosystem. Sources and loadings of critical pollutants, as well as other

3.1 Introduction

As defined by the Great Lakes Water Quality Agreement, "impairment of beneficial use(s)" is a change in the chemical, physical, or biological integrity of the Great Lakes System sufficient to cause any of the following:

1. *Restrictions on fish and wildlife consumption*
2. *Tainting of fish and wildlife flavor*
3. *Degradation of fish and wildlife populations*
4. *Fish tumors or other deformities*
5. *Bird or animal deformities or reproductive problems*
6. *Degradation of benthos*
7. *Restrictions on dredging activities*
8. *Eutrophication or undesirable algae*
9. *Restrictions on drinking water consumption, or taste and odor problems*
10. *Closing of beaches*
11. *Degradation of aesthetics*
12. *Added costs to agriculture or industry*
13. *Degradation of phytoplankton and zooplankton populations*
14. *Loss of fish and wildlife habitat*

factors responsible for the identified problems, are summarized in this chapter as well. Local impairments found in Lake Ontario AOCs and other nearshore areas are also discussed.

The GLWQA provides fourteen indicators of beneficial use impairments (identified in the text box on page 25) to help assess the impact of toxic chemicals and other factors on the Great Lakes ecosystem. These indicators provide a systematic way to identify pollutant impacts on the entire ecosystem, ranging from phytoplankton to birds of prey and mammals, including humans.

3.2 Identifying Lakewide Problems and Critical Pollutants

The LaMP process uses a broad range of ecological factors, in addition to regulatory standards, to identify critical pollutants. The GLWQA defines critical pollutants as "substances that persist at levels that, singly or in synergistic or additive combination, are causing, or are likely to cause, impairment of beneficial uses despite past application of regulatory controls due to their:

1. presence in open lake waters;
2. ability to cause or contribute to a failure to meet Agreement objectives through their recognized threat to human health and aquatic life or;
3. ability to bioaccumulate".

In preparing this binational problem assessment, Canada and the United States first independently evaluated 13 of the Lake Ontario beneficial use impairments for those geographic areas within their jurisdictions (Rang *et al.*, 1992; USEPA and NYSDEC, 1994). The agencies proceeded to integrate their separate evaluations into this binational assessment of the status of beneficial use impairments in Lake Ontario. The fourteenth beneficial use impairment, loss of fish and wildlife habitat, was evaluated using Lake Ontario habitat reports compiled by the United States Fish & Wildlife Service (USF&WS) as part of the LaMP evaluation process (Busch *et al.*, 1993) and others (Whillans *et al*., 1992). The LaMP recognizes the importance of appropriate linkages to other natural resource management initiatives such as fishery management plans, lake-level management, wetlands protection, watershed management plans, and control strategies for exotic species.

The beneficial use impairment assessment identifies the lakewide use impairments in Lake Ontario and the toxic substances contributing to these impairments (i.e., those substances for which we have "direct" evidence that they are impairing beneficial uses). It is also important for the Lake Ontario LaMP to consider toxic substances which are **likely** to impair beneficial uses (i.e., there is "indirect" evidence that these chemicals are impairing beneficial uses if they exceed the most stringent U.S. or Canadian standard, criteria, or guideline). The Four Parties reviewed

recent fish tissue contaminant concentrations and found mercury concentrations in smallmouth bass and walleye to exceed Ontario's 0.5 parts per million (ppm) guideline for fish consumption throughout the lake. Mercury is responsible for local impairments in Canada. In addition, dieldrin was also found to exceed the most stringent water quality and fish tissue criteria lakewide. Although mercury and dieldrin are not causing lakewide impairments of beneficial uses, these contaminants will be included as LaMP critical pollutants given the lakewide nature of these criteria exceedences.

3.3 Lakewide Beneficial Use Impairments

The following is a summary of the technical basis for the beneficial use impairment assessment and the identification of the chemical, physical, and biological factors contributing to these impairments. A general list of references is provided as Appendix G. Detailed references for information sources are provided in the individual United States and Canadian assessment reports that were used for this evaluation. In the development of the LaMP, the lakewide impairment status (impaired, degraded, insufficient information, or unimpaired) was determined after consideration of the Ecosystem Goals for Lake Ontario (section 1.7) and the preliminary ecosystem objectives. This report does not provide a complete analysis of the biological and physical problems facing the lake because the ecosystem objectives and indicators needed to evaluate these problems are still being developed.

Based on the assessment, four lakewide beneficial use impairments exist that require binational actions:

- Restrictions on fish and wildlife consumption
- Degradation of wildlife populations
- Bird or animal deformities or reproductive problems
- Loss of fish and wildlife habitat

These impairments are also used to identify critical pollutants and biological/physical stressors. PCBs, DDT, dioxins, and mirex are the critical pollutants associated with one or more of these lakewide impairments (Table 3-1). Loss of fish and wildlife habitat is due primarily to physical and biological factors rather than toxic contaminants. All Lake Ontario AOCs, except the Port Hope AOC, also list these four impairments as local concerns. The LaMP process will be coordinated with the development of Remedial Action Plans in these local areas to ensure the development of effective strategies for lakewide critical pollutants and other lakewide issues. Through the LaMP process, other existing programs that address these issues will also be supported and coordinated.

Table 3-1. Summary of Lake Ontario Lakewide Beneficial Use Impairments and Related Critical Pollutants and Other Factors.

Lakewide Impairments	*Impacted Species*	*Lakewide Critical Pollutants & Other Factors*
Restrictions on Fish and Wildlife Consumption	Trout, Salmon, Channel catfish, American eel, Carp, White sucker	PCBs, Dioxins, Mirex
	Walleye, Smallmouth Bass[a]	Mercury[a]
	All waterfowl[b]	PCBs, DDT, Mirex[b]
	Snapping Turtles[b]	PCBs[b]
Degradation of Wildlife Populations	Bald Eagle[c]	PCBs, Dioxin, DDT
	Mink & Otter[c]	PCBs
Bird or Animal Deformities or Reproductive Problems	Bald Eagle[c]	PCBs, Dioxin, DDT
	Mink & Otter[c]	PCBs
Loss of Fish and Wildlife Habitat	A wide range of native fish and wildlife species	Lake Level Management
		Exotic Species
		Physical Loss, Modification, and Destruction of Habitat

[a] Canadian advisories only.
[b] U.S. Advisories only.
[c] Indirect evidence only (based on fish tissue levels).
Notes: Dieldrin, although listed as a LaMP critical pollutant, is not associated with an impairment of beneficial use.
"DDT" includes all DDT metabolites; "Dioxin" refers to all dioxins/furans.

3.3.1 Restrictions on Fish and Wildlife Consumption

The Four Parties have agreed that fish and wildlife consumption advisories due to PCBs, dioxins and furans, and mirex are lakewide beneficial use impairments. Most human exposure to many persistent and bioaccumulative contaminants is through eating fish and other aquatic organisms, which far outweighs contaminant exposures related to drinking water, air, or other terrestrial sources. Consumption advisories are developed to help protect people from the potential health impacts associated with long term consumption of contaminated fish and wildlife.

Fish Consumption Advisories

In general, consumption advisories are based on contaminant levels in different species and ages of fish. Both Ontario and New York fish consumption advisories account for the fact that contaminant levels are generally higher in older, larger fish. There are some differences in the fish tissue monitoring processes of the two governments; for example, New York State analyzes entire fillets which include belly-flap and skin (catfish, bullhead, and eels are exceptions since skin is removed before analysis) and Ontario analyzes muscle fillets. These two types of fish samples are not directly comparable. Muscle fillets have lower fat content. Since organochlorine chemicals, such as PCBs and DDT, tend to

concentrate in fatty tissue, muscle fillet samples will generally show lower levels of these contaminants than the levels found in the fattier fillets.

Both jurisdictions agree that PCBs, dioxin, DDT, and mirex are responsible for this lakewide impaired beneficial use and require binational actions. Although not responsible for consumption advisories on a lakewide basis, mercury concentrations in larger smallmouth bass and walleye are likely to exceed Ontario's 0.5 ppm criteria for human consumption and will therefore be considered a critical pollutant.

In Ontario, a Sports Fish Contaminant Monitoring Program is administered by the Ministry of the Environment (MOE) and the Ontario Ministry of Natural Resources (MNR). New York State operates a statewide fish tissue monitoring program. USEPA's Great Lakes National Program Office coordinates a fish tissue monitoring effort as part of a long term contaminant trends monitoring project. Fish tissue samples are also collected by the Canadian Department of Fisheries and Oceans (DFO) as part of its long term contaminant trends monitoring program.

In Ontario, sportfish advisories are published every two years in the Guide to Eating Ontario Sport Fish, which includes tables for the Great Lakes. Appendix E provides a detailed breakdown of Lake Ontario advisories as reported in the 1997-98 Guide. Advisories were reported for 19 species: salmon (chinook, coho), trout (rainbow, brown, lake), white bass, yellow and white perch, whitefish, rainbow smelt, freshwater drum, channel catfish, white and redhorse suckers, brown bullhead, American eel, black crappie, gizzard shad, and carp. The contaminants responsible for advisories are PCBs (50%), dioxins and furans (1%), and mirex (27%). The regular evaluation of commercial catches by DFO's fish inspection program has led to some restrictions on the commercial harvest of carp, large walleye, and channel catfish.

The New York State Department of Health issues annual fish consumption advisories for New York State waters which include specific and general advisories for Lake Ontario. NYSDEC collects and analyzes fish for contaminants. "Eat none" advisories are in place for Lake Ontario American eel, channel catfish, carp, lake trout, rainbow trout, chinook salmon, coho salmon over 21 inches, brown trout over 20 inches, and white perch (west of Point Breeze). "Eat no more than one meal per month" advisories are in effect for Lake Ontario white sucker, coho salmon less than 21 inches, brown trout less than 20 inches, and white perch (east of Point Breeze). "Eat no more than one meal per week" advisories are in effect for many Lake Ontario fish species not listed above. In addition, an "Eat none" advisory, which applies to all Lake Ontario fish, is in effect for all women of childbearing age and children under the age of 15. This stringent advisory is designed to protect these sensitive human populations from any increased exposure to toxic contaminants.

In addition to these lakewide consumption advisories caused by organic contaminants, it is worth noting that a considerable number of local advisories exist in Canadian waters due to mercury. Appendix E provides a detailed breakdown of mercury advisories. Mercury advisories were reported for nine species of fish, including walleye, in fourteen locations. Walleye is an important recreational fishery in the eastern end of Lake Ontario. Fish consumption advisories are periodically reconsidered if new information suggests that more restrictive advisories are necessary to fully protect human health or if contaminant levels have dropped below guidelines.

Wildlife Consumption Advisories

Diving ducks, such as mergansers, feed on fish and other aquatic organisms and, as a result, tend to be the most heavily contaminated waterfowl. New York has a statewide advisory recommending that mergansers not be eaten and that the consumption of other types of waterfowl be limited to no more than two meals per month. The New York State Health Department also advises that wild waterfowl skin and fat should be removed before cooking and that stuffing be discarded. The contaminants of concern for Lake Ontario mergansers in New York are PCBs, DDT, and mirex.

Snapping turtles are another example of a high level predator that is near the top of the food chain. Over their relatively long life span, snapping turtles can accumulate significant levels of persistent toxic substances in their fatty tissues. New York's statewide advisory recommends that women of childbearing age, and children under the age of 15, "eat no" snapping turtles, and recommends that others who choose to consume snapping turtles should reduce their exposure by trimming away all fat and discarding the fat, liver, and eggs prior to cooking the meat or preparing the soup. This advisory is based on PCBs, as the primary contaminants of concern. Studies conducted by the Canadian Wildlife Service of Environment Canada have shown contaminant levels in ducks and turtles to be below guidelines. There are no consumption advisories for wildlife species in the Canadian portion of the Lake Ontario basin.

3.3.2 Degradation of Wildlife Populations and Bird or Animal Deformities or Reproduction Problems

The Four Parties have agreed that wildlife consumption advisories and population and reproduction impairments are lakewide impairments caused by PCBs, dioxin equivalents, and DDT. Wildlife used in the evaluation of this beneficial use indicator include mink, otter, bald eagles, colonial water birds, and a variety of fish species. These species were chosen because of historical, documented problems associated with contaminants or other non-chemical stressors. These species are useful indicators of environmental conditions because of their high level of risk

due to being at or near the top of the food chain or requiring special habitat in order to reproduce successfully.

There is indirect evidence that bald eagle, mink, and otter populations remain degraded along the Lake Ontario shoreline. Levels of PCBs, dioxins, and DDT and its metabolites in the food chain are thought to be important factors that are limiting the recoveries of these wildlife populations. There is no indication that current levels of contaminants in the open waters are degrading fish populations. The two impairments, degradation of fish and wildlife populations and bird or animal reproduction problems, are addressed together in this section since past declines in some wildlife populations are directly related to contaminant-related reproduction problems.

Bald Eagles

Bald eagle populations began to decline in the early 1900s due to hunting and loss of habitat. In the decades following the introduction of DDT in 1946, contaminant-induced eggshell thinning lowered reproductive success throughout North America, including the Lake Ontario basin. During the 1980s, after DDT and other pesticides were banned, a few successful bald eagle nesting territories were re-established in the Lake Ontario basin. By 1995, bald eagles had recovered to the point that they were moved from the U.S. endangered species list to the threatened species list. There are at least six successful bald eagle nesting territories in the Lake Ontario basin that have fledged more than sixty eaglets since 1980 (Nye, 1979, 1992). Although there are no nesting territories located close to the Lake Ontario shore, it is expected that bald eagles will reoccupy historical shoreline nesting territories as their population steadily expands, provided appropriate nesting habitat is available. In 1992, a survey of the entire Lake Ontario shoreline (both Canadian and U.S. sides) for suitable breeding habitat for bald eagles was conducted by Environment Canada, the Ontario Ministry of Natural Resources, and U.S. bald eagle experts. This information will be available in future LaMP documents.

Bald eagle and young at nest
(Don Simonelli
Michigan Travel Bureau)

There is indirect evidence that bald eagle reproduction in the Lake Ontario basin is impacted by persistent toxic contaminants. Studies of bald eagles nesting on other Great Lakes shorelines suggest that levels of PCBs, dioxins, and DDT in the Lake Ontario food web may cause lowered reproductive success, increased eaglet deformities, and early adult mortality (Best, 1992; Bowerman *et al.*, 1991). This could be a concern as shoreline nesting territories become re-established and the eagles feed on contaminated fish during the nesting and breeding season.

Colonial Waterbirds

Colonial waterbirds have a long history of being used as indicators of contaminant effects on Lake Ontario and throughout the Great Lakes (Gilbertson, 1974; Mineau *et al.*, 1984). More than 25 years ago, Gilbertson (1974, 1975) and Postupalsky (1978) found highly elevated contaminant levels in eggs, severe eggshell thinning, elevated embryonic mortality, high rates of deformities, declining population levels, and total reproductive failure among several species of colonial waterbirds on Lake Ontario. Although many of these conditions have improved substantially, [e.g., concentrations of PCBs, dieldrin, total DDT, mirex, mercury, and dioxins have declined significantly in herring gull eggs and, to a lesser extent, in cormorants and Common and Caspian Terns (Weseloh *et al.*, 1979, 1989; Ewins and Weseloh, 1994; Bishop *et al.*, 1992; Pettit *et al.*, 1994), eggshell thickness has returned to normal (Price and Weseloh, 1986; Ewins and Weseloh, 1994), and population levels have increased (Price and Weseloh, 1986; Blokpoel and Tessier, 1996)], the current status of some of these conditions is unknown and some new issues have arisen (physiological biomarkers, endocrine disruption, genetic deformities) in birds as well as in other classes of wildlife. These issues will be the subject of future studies, the results of which will be considered by the LaMP.

Mink & Otter

As with the bald eagle, there is indirect evidence that suggests reproduction of Lake Ontario mink in nearshore areas is affected by persistent toxic contaminants. Laboratory studies corroborate that levels of PCBs and dioxin-like contaminants in the food chain may limit the natural recovery of both mink and otter populations.

Settlement, trapping, and habitat losses during the eighteenth century are believed to have contributed to major population declines for both species. Prior to these changes, the river otter had one of the largest geographic ranges of any North American mammal and was found in all major U.S. and Canadian waterways.

In the 1960s, reproductive failures of ranch mink that had been fed Great Lakes fish led to the discovery that mink are extremely sensitive to PCBs (Hartsough, 1965; Aulerich and Ringer, 1977). Laboratory experiments have shown that a diet of fish, with PCB or other dioxin-like contaminant levels comparable to those found in some Lake Ontario fish, can completely inhibit mink reproduction. However, the fact that mink are highly opportunistic and may rely on muskrat, rabbits, and mice for the bulk of their diet in some locales makes it difficult to estimate the impact that environmental contaminants are having on the populations of this species. Otters, on the other hand, rely almost exclusively on fish for their

diet, but there is little information on the sensitivity and exposure of otters to PCBs and other contaminants.

Information on mink and otter population trends and reproductive rates is extremely limited, which makes it difficult to evaluate their status. Currently, harvest statistics from trappers is the only indicator of population trends. This is a poor indicator as it is influenced by weather, fur prices, disease, and other factors that are not related to health and population status. Field studies of mink and otter populations are extremely labor intensive and not always successful given the secretive nature of these animals. Investigators often need to rely on secondary indicators of presence in an area, such as tracks and scat.

Fish Populations

Fishing from shore
(USDA Natural Resources Conservation Service)

The loss of several fish species and reductions in native fish populations between the early 1800s and the 1960s are attributed primarily to overfishing, loss of habitat, and the impact of exotic species, such as the sea lamprey and alewife. The loss of some species, such as the blue pike, an important predator, has permanently altered the Lake Ontario ecosystem. The contribution of persistent toxic contaminants to the loss of certain fisheries is unclear because fish populations were already severely degraded by the time that significant levels of contaminants began to be released to the environment. Current levels of contaminants in Lake Ontario do not appear to have a measurable impact on fish reproduction as fish culture facilities obtain eggs from Lake Ontario salmon and trout to support stocking programs. Successful culture of these species in the hatchery environment suggests that they are capable of natural reproduction in the wild. However, a sustained population of lake trout has been difficult to re-establish naturally. This is due to excessive predation by alewife on lake trout eggs and fry; degradation of spawning habitats; unsuitable genetic backgrounds of some stocked fish; excessive harvest; and potential sub-lethal impacts of toxic substances. A possible vitamin deficiency problem impacting lake trout and salmon, due to their reliance on alewife as their principal prey, is also a factor inhibiting the natural reproduction of these fish. With declining nutrient levels and decreasing alewife populations, record numbers of naturally reproduced lake trout yearlings were observed in 1995.

Although current levels of toxic contaminants, such as dioxin, are now generally acknowledged to be below toxic levels for lake trout fry, some research suggests that Lake Ontario dioxin concentrations in water and sediment during the 1940s and 1950s may have been sufficiently high to prevent lake trout reproduction. Research is ongoing to recognize and

better understand any potential synergistic or additive effects of contaminants on current fish populations.

Populations of walleye, lake whitefish, and burbot are continuing to increase, and there are now several year classes of lake herring. More recently, there have been increasing reports of native fish catches that were thought to be extinct or severely depleted (e.g., deep water sculpin, lake sturgeon, and stickleback). This information suggests that the ecological stage is set for significant recovery of native Lake Ontario fish species barring any major unforeseen changes in the food web.

3.3.3 Loss of Fish and Wildlife Habitat

The Four Parties agree that loss of fish and wildlife habitat is a lakewide impairment caused by artificial lake level management, the introduction of exotic species, and physical loss, modification, or destruction, such as deforestation and damming of tributaries. Binational evaluations are underway to evaluate potential options to mitigate these impacts. An evaluation of recent (1980-1990) habitat conditions did not identify persistent toxic substances as a significant cause of lakewide habitat loss or degradation.

Artificial Lake-Level Management

There is considerable evidence that the management of lake levels has inadvertently reduced the area, quality, and functioning of some Lake Ontario nearshore wetlands. Nearshore wetlands are important to the ecology of the lake because they provide habitat necessary for many species of fish and wildlife to successfully live and reproduce. These wetlands may be unique or of limited quantity in the number and types (diversity) of plants and soil benthic type (i.e., rocks, sand, or silt). Without wetlands of suitable quality and quantity, many species of fish and wildlife would be at risk. There is also significant concern among the citizens living along the shoreline of Lake Ontario that lake level management is causing increased erosion and property loss. High lake levels are associated with accelerated rates of erosion and property loss in areas susceptible to lake-induced erosion.

Lake level management was first recommended to limit flooding and erosion in the Lake Ontario basin and to prevent flooding of major metropolitan areas along the St. Lawrence River, such as Montreal. Lake Ontario level and St. Lawrence River flow regulations are also used to benefit commercial navigation and hydropower production. The International Joint Commission (IJC) was established in 1909 by the Boundary Waters Treaty to serve as an impartial group with jurisdiction over boundary water uses. The IJC consists of three U.S. members appointed by the President of the United States and three Canadian members appointed by the Prime Minister of Canada. Plans to artificially

manage Lake Ontario water levels began in 1952 when the IJC issued an Order of Approval to construct hydropower facilities in the international reach of the St. Lawrence River at Cornwall, Ontario and Massena, New York. The hydropower facilities were completed in 1960. The IJC amended its order in 1956 to include regulation criteria designed to reduce the range of lake levels and to protect riparian and other interests downstream in the Province of Quebec. This amended order also established the International St. Lawrence River Board of Control to ensure compliance with provisions of the Orders. The St. Lawrence Board consists of ten members chosen by the IJC for their technical expertise.

Lake levels are currently regulated by Plan 1958-D. This plan sets maximum and minimum flow limitations which change week to week to provide adequate hydropower production and, at the same time, maximize depths for navigation and provide protection against flooding in the St. Lawrence River. Authorization may be requested by the Board to deviate from Plan 1958-D when supplies are greater or less than those upon which the plan was developed. During the development of this plan, environmental and recreational factors were not considered. As recommended by the IJC's Levels Reference Study Board, the St. Lawrence Board has been investigating the possibility of changing the current plan and/or procedures to better address environmental and recreational concerns.

Several environmental issues have been identified in studies completed by the Levels Reference Study Board in 1993. As a result of lake level management, Lake Ontario wetlands are no longer experiencing the same range of periodic high and low water levels. This reduction in range has resulted in some wetlands becoming a monoculture of cattails -- a greatly reduced biodiversity of nearshore areas. In addition, the current four foot range in fluctuation for Lake Ontario is too narrow to preclude cattail overpopulation by modifying the timing of water level highs and lows from their natural cycle. This can have a devastating effect on wetlands, often resulting in too little water for fish and wildlife reproduction purposes, but has provided benefits to recreational and commercial boating.

Further studies, which will take a number of years to complete, are underway to identify possible ways to improve the lake level management scheme, to be more sensitive to environmental needs, as well as public health and economic needs. Regulation of lake levels is difficult because changes in precipitation rates and winter ice cover are unpredictable and limit our ability to manage water levels. Shoreline erosion is a natural occurence caused by the energy present in water at the shoreline. The nature of erosion that may occur is related to the soil type and elevation, wind, current, and water level at the time. Where the energy in the water can be absorbed, erosion will be slow, but where the makeup of the shoreline is unstable, the effects of erosion take place more quickly.

Erosion of certain areas of Lake Ontario's shoreline is a natural process that will inevitably occur.

Exotic Species

It is difficult to assess the interactions between newly introduced exotic species, naturalized exotic species, and native species. This evaluation is further complicated by other chemical and physical changes that are taking place in the basin. It is clear, however, that exotic species are having a significant impact on the Lake Ontario ecosystem.

Who controls and manages exotic species?

- ***Great Lakes Fishery Commission***
- ***United States & Canadian Coast Guards***
- ***Ontario Ministry of Natural Resources***
- ***Canadian Department of Fisheries and Oceans***
- ***New York State Department of Environmental Conservation***
- ***U.S. Federal Aquatic Nuisance Species Task Force***
- ***U.S. Fish and Wildlife Service***
- ***U.S. Sea Grant***

The Lake Ontario ecosystem has endured several waves of invasions of exotic species. Some of these species, such as the sea lamprey, have clearly had a negative impact on native species. In fact, sea lamprey predation on lake trout is recognized as one factor that contributed to the demise of that species. The United States-Canadian Great Lakes Fishery Commission was established primarily to control the sea lamprey. Through its efforts, the observed rate of lake trout woundings or mortalities by sea lamprey is now sufficiently low to allow achievement of other fishery management objectives. Currently, with the continuation of control efforts, the sea lamprey is not considered a major limiting factor for the recovery of native fish.

Unlike the sea lamprey, other exotic species have become important components of the Lake Ontario food chain. These species include smelt and alewife, which are now the dominant forage fish. More recently invading exotic species that have potentially significant adverse impacts on the ecosystem include zebra mussels, ruffe, round goby, blueback herring, and the spiny water flea. Although the ruffe, round goby, and blueback herring are now present in the Great Lakes basin, they have not yet reached Lake Ontario. The potential for the round goby and blueback herring to reach Lake Ontario in the near future is considered to be fairly high.

Zebra and quagga mussels have altered the Lake Ontario ecosystem by redirecting nutrients flowing through the system from the pelagic to the benthic food web. This shunting of energy to the benthic food web can reduce productivity in the open lake. Although these changes may resemble natural historical conditions, they are having a negative impact on the naturalized open lake forage fish (alewife and smelt) and predators that are dependent upon those species as a food source. Zebra mussels appear to increase the *bioaccumulation* of toxic chemicals into food chains and decrease *macroinvertebrate* prey of whitefish and slimy sculpin. They also negatively impact beach use, and they appear responsible for declines in native clam populations. In addition, there are increased maintenance costs associated with keeping drinking water and cooling water intakes free of these mussels. Zebra mussels do have some positive effects, including improved water clarity; the development of mussel shell bottoms

favorable to certain macroinvertebrates; increases in native benthic forage fish; and increased survival in young native lake trout, lake whitefish, and potentially lake herring.

It is exceedingly difficult and costly to control exotic species after they have been introduced to an ecosystem, so control programs have concentrated on preventing new introductions and inhibiting the spread of existing species. An important component of these control programs is the regulation that requires ocean-going ships to exchange their ballast water at sea before entering the St. Lawrence Seaway. This requirement seeks to ensure that any exotic species present in the ballast water will not be released into the Great Lakes. It is believed that zebra mussels, the round goby, and the ruffe were all introduced to the Lakes in this way.

The United States and Canadian Coast Guards are working to limit the introduction of non-indigenous species through transoceanic shipping. In addition to the ballast water exchange requirement, chemical treatment measures may be necessary to deal with any organisms that may be left in the tanks after ballast water exchange.

Physical Loss or Destruction of Habitat

The early colonists began to alter the seasonal flows of Lake Ontario tributaries by clearing land. As the land was cleared, water temperatures began to rise, siltation increased, and aquatic vegetation (which provides cover for young fish) was lost. Further, the damming of Lake Ontario tributaries and streams impeded migration of salmon and other native species to their spawning and nursery grounds. The combined impacts of all these factors were devastating to nearshore, tributary, and wetland habitats.

Wetlands provide vital habitat to many species of Lake Ontario's wildlife. It has been estimated that about 50 percent of Lake Ontario's original wetlands throughout the watershed has been lost. Along the intensively urbanized coastlines, 60 to 90 percent of wetlands has been lost. These losses are a result of the multiple effects associated with urban development and human alterations, such as draining wetlands to establish agricultural land, marina construction, dyking, dredging, and disturbances by public utilities. Natural processes, such as erosion, water level fluctuations, succession, storms, and accretion, contribute to the loss of wetlands as well.

Wetland being filled

Currently, approximately 80,000 acres of Lake Ontario's wetlands remain. The largest expanses are located in the eastern portion, along the coastline of Presqui'ile Bay's Provincial Park in Ontario and in Mexico Bay in New York. The pressures of urban and agricultural development continue to threaten wetlands as the public wishes to locate along the lakeshore, have larger marinas in river mouths, achieve more efficient stormwater removal

from streets and properties, or till marginal wetlands in the watershed during dry years. Major government initiatives, including education and regulatory controls, have done much to reduce or prevent the loss of wetlands. More than 20 percent of Lake Ontario's wetlands are fully protected (parks) while additional areas are subject to a variety of municipal, state/provincial, or federal rules, regulations, acts, or programs. Stemming continued losses of wetlands requires action at the most efficient level of organization, and opportunities to protect, restore, or replace these valuable habitats need to be explored.

3.4 Insufficient Information for Lakewide Assessment but Impaired in Areas of Concern

3.4.1 Degradation of Benthos

The term "benthos" refers to the wide range of organisms that live in direct contact with the lake bottom sediments. Benthic organisms are an important food source for fish and other aquatic organisms. As the benthic community is in direct contact with the sediment, it can be a major route for transfer of contaminants to higher trophic levels. All of the Lake Ontario AOCs, which generally have higher levels of sediment contamination than the open water areas, have either listed degraded benthic communities as an impaired use or are in the process of evaluating this issue.

There is currently insufficient information on the nature of macrobenthic communities throughout the lake, including the open water basins, to make a determination on the status of this impairment. This impairment will be evaluated through the LaMP process once sufficient information has been collected and analyzed. A recent investigation collected detailed information on macrobenthic communities from more than 40 locations throughout the lake. This information is currently being evaluated and a follow-up investigation is in progress. In addition to identifying potential impacts of toxic chemicals on benthic communities, information will be collected on the relative extent and density of zebra mussels. Zebra mussels have the potential to degrade native populations of benthic organisms lakewide and warrant special consideration.

Changes within the benthic community are related to the dramatic changes in nutrient levels and fish community structure that occurred between the 1950s and the present. These impacts may have overshadowed any past or present lakewide impacts from toxic contaminants. Although sediment contamination, both organic and inorganic, throughout Lake Ontario has been well documented, not enough is known about the role of physical habitat, predation, or nutrient levels on benthic community structures and populations to isolate the effects of sediment contamination on these organisms.

Quantitative surveys of Lake Ontario benthic communities did not begin until the 1960s (with the exception of one survey in 1922) (Nalepa, 1991). Generally Lake Ontario's open water benthic communities are dominated by small crustaceans (*Diporeia* spp.) and worms (*Stylodrillus heringianus*). Healthy populations of these organisms are considered to be indicators of good environmental quality since they require cold, well oxygenated waters and are pollution intolerant. *Diporeia* spp. is an effective bioaccumulator of organic contaminants and an important food source for Lake Ontario slimy sculpin, smelt, and alewives. Studies of *Diporeia* tissue contaminants show levels of PCBs, DDE, and hexachlorobenzene at much higher levels than the surrounding sediment concentrations; bioaccumulation factors for PCBs were found to range from nine to nineteen in western Lake Ontario. No studies have been specifically designed to assess the long term sub-lethal effects of contaminant levels on benthic communities.

3.4.2 Degradation of Phytoplankton and Zooplankton Populations

Phytoplankton are microscopic forms of aquatic plants, including algae and diatoms, and are at the base of the aquatic food chain. Zooplankton are small aquatic animals that feed on phytoplankton or other zooplankton. Zooplankton are an important food for plankton-eating fish, such as alewife and smelt.

The potential effects of toxic substances on the health and reproduction of phytoplankton and zooplankton are not well understood. Declining phosphorus levels, changes in fish populations, and exotic species may have obscured any impacts that contaminants might have had on these populations. No lakewide studies of plankton were conducted before the loss of major fisheries in the 1920s, the onset of lakewide eutrophication in the 1940s, and toxic pollution in the 1950s (Christie and Thomas, 1981; Stoermer *et al.*, 1975). The first detailed studies of Lake Ontario phytoplankton and zooplankton were conducted in the 1970s; however, these studies were primarily concerned with defining plankton species distributions and productivity and were not designed to evaluate potential contaminant impacts. More research is required to determine if contaminants are having a negative impact on phytoplankton and zooplankton in Lake Ontario.

Recent studies suggest that Lake Ontario phytoplankton community structures are shifting in response to lakewide phosphorus reduction programs and zebra mussel invasion, and total biomass is decreasing for the same reason (Wolin *et al*., 1991 and Makarewicz, 1993). The zooplankton community has changed since the early 1970s, in response to grazing by exotic species (alewife), and the mid-July to mid-October biomass declined by approximately 50 percent in response to both

decreasing phytoplankton biomass and intense grazing by plankton-eating fishes.

Monitoring efforts in the U.S. and Canada are developing a better understanding of Lake Ontario phytoplankton and zooplankton populations. A comprehensive offshore biomonitoring program (Bioindex project) has been conducted by the Canadian Department of Fisheries and Oceans, from 1981 to the present at a mid-lake station, and from 1981 to 1995 at an eastern basin station. The U.S. Lake Ontario Bioindex program, a cooperative research program carried out by the New York State Department of Environmental Conservation, Cornell University, and the U.S. Fish & Wildlife Service, has monitored 35 stations throughout the lake since 1995. In addition, USEPA's Lake Guardian research vessel has monitored eight stations since 1986. MOE has conducted a monitoring program of phytoplankton and related trophic and chemical parameters at six municipal water treatment plant intakes in Lake Ontario since the late 1960s. Phytoplankton composition (to genus) and biomass data are available on a weekly basis and chemical data have been available since 1976. These programs have collected seasonal data on physical and chemical parameters as well as a comprehensive set of data on phytoplankton and zooplankton biomass, species composition, and production. The analysis of these data will consider contaminants as just one of a suite of factors that impact on the impairment of this beneficial use. A detailed report on the findings of these studies will be summarized in future LaMP documents.

3.5 Localized Impairments in Areas of Concern and Other Nearshore Areas

In addition to lakewide impairments, a number of other problems are found in some localized nearshore areas and embayments. This is not surprising as industrial and municipal contamination can become concentrated at the mouths of rivers or harbors. The IJC has identified seven specific geographic AOCs on Lake Ontario (see page 3 for a map of these sites). Remedial Action Plans (RAPs) serve as the primary mechanism for addressing these localized contaminant problems and other issues unrelated to lakewide impairments. Additional nearshore problems beyond the specific AOCs are being addressed through a variety of other environmental management programs. Table 3-2 summarizes the status of these beneficial use impairments. A list of contacts for specific RAPs is provided in Appendix D for those who would like to obtain more detailed information on the status of impairments in AOCs and actions underway to address these problems.

Table 3-2. Summary of Beneficial Use Impairments in Six Lake Ontario Areas of Concern (AOC) and Other Nearshore Areas. Another AOC, the Eighteenmile Creek in the U.S., is in the process of completing its beneficial use impairment assessment.

Indicators of Beneficial Use Impairments	Lakewide Status	Rochester Embayment	Oswego Harbor	Hamilton Harbour	Metro Toronto	Port Hope	Bay of Quinte	Other Nearshore Areas
1. Restrictions on Fish & Wildlife Consumption	X	X	X	X	X		X	X
2. Tainting of Fish & Wildlife Flavor		?						
3. Degradation of Fish or Wildlife Populations	X	X	X	X	X		X	
4. Fish Tumors or Other Deformities		?		X	?		?	Several locations on north shore
5. Bird or Animal Deformities or Reproductive Problems	X	X	X	?	?			
6. Degradation of Benthos	?	?	X	X	X		X	
7. Restrictions on Dredging Activities				X	X	X	X	Several small bays and harbours
8. Eutrophication or Undesirable Algae		X	X	X	X		X	Tributary mouths, harbors, and embayments
9-A. Restrictions on Drinking Water Consumption								
9-B. Drinking Water Taste & Odor Problems		X					X	
10. Beach Closings		X		R	X		X	X
11. Degradation of Aesthetics		X		X	X		X	
12. Added Costs to Agriculture or Industry		X						
13. Degradation of Phytoplankton & Zooplankton Populations	?	?	?	?	?		X	
14. Loss of Fish & Wildlife Habitat	X	X	X	X	X		X	

X - impairment identified ? insufficient information R - beneficial use restored

3.5.1 Fish Tumors

Fish tumors are more common in some species of nearshore fish, such as brown bullheads and white suckers, than others; however, it is very difficult to determine what the o atural tumor incidence rate is for particular location (Hayes *et al*., 1990). Relatively high levels of tumors can be found in fish from both clean and polluted water bodies. For example, skin and liver tumors have been documented in fish taken from relatively pristine drinking water reservoirs in New York and Pennsylvania, where no elevated levels of carcinogens [such as polycyclic aromatic hydrocarbons (PAHs)] have been detected in sediments or water (Bowser *et al.*, 1991). This fact complicates the process of selecting a control or background site to which the incidence of fish tumors in a contaminated area can be compared. Viruses, genetic differences, and naturally occurring carcinogens, in addition to chemical contaminants, are thought to have a role in fish tumor development.

The presence of tumors in Lake Ontario fish was first noted in the early 1900s before persistent toxic contaminants became a problem in the lake. Liver tumors were first identified in wild fish in the 1960s. However, a temporal correlation between any change in the incidence of fish tumors and the onset of the severe environmental contamination problems of the 1960s cannot be firmly established because the first detailed studies of fish tumors in Lake Ontario were not conducted until the 1970s.

A 1996 collection of spawning walleye in the Salmon River, a tributary of the Bay of Quinte, found that the frequency of liver tumors increased with the age of the fish and was more prevalent (87.5%) in female walleye greater than 14 years of age. The frequency-age relationship is comparable to previous walleye collections in the St. Lawrence River. The tumors are non-invasive and it is possible that the tumors are a naturally occurring phenomenon in old walleye. However, before any interpretation of probable cause can be made, it will be necessary to determine the rates of liver tumors in similarly aged walleye from other more pristine habitats.

Contaminant-related fish tumors would be expected to be most prominent in Lake Ontario AOCs where there are generally higher contaminant levels than in open water areas. To date, Hamilton Harbour is the only Lake Ontario AOC which lists this impairment. The Oswego Harbor AOC recently completed a fish tumor study that found no impairment. The Metro Toronto, Bay of Quinte, and Eighteenmile Creek AOCs have each indicated that additional information is necessary to fully evaluate the status of this impairment**.** As there are few reports of tumors in open water fish, fish tumors are not considered to be a lakewide impairment. The lakewide status of this impairment will need to be periodically evaluated as new information is developed on the incidence of tumors in open water

fish as well as the role of contaminants and other factors involved in fish tumor development.

3.5.2 Restrictions on Dredging Activities

Localized areas of sediments with elevated levels of persistent toxic contaminants are found in some Lake Ontario harbors and river mouths. Periodic dredging of these sediments is necessary to maintain shipping and small craft channels. This beneficial use impairment is not considered to be a lakewide impairment because dredging restrictions do not pertain directly to open water areas; however, this impairment is a concern in a number of localized nearshore areas and AOCs.

Criteria that are used to assess dredging activities are not based on whether or not dredging should take place, but rather the mode of dredged material disposal. There are five main ways to dispose of dredged sediments. Clean, uncontaminated sediments can either be placed on beaches or reused along shorelines as fill. The other three methods of disposal, offshore, upland, and confined, are based on the degree of contamination of the sediments. The most highly contaminated sediments require confined disposal in special contaminated sediment facilities. Less contaminated sediments can be stored in landfills or disposed in deep offshore waters.

Dredging

The Canadian Department of Public Works maintains the register for Canadian dredging data. The register records location of dredging, volume of sediments dredged, disposal methods, and chemical analysis data. Information on dredging activities was registered from 1975 until a few years ago when navigational dredging activities declined in the region. From 1980 to 1985, PCBs exceeded the “marginally polluted level” at Hamilton, Toronto, Oshawa, Whitby, and Point Traverse. Dredging was undertaken from 1985 to 1991 at Grimsby, Whitby, Trenton, Kingston, and four times in Oshawa. Based on Ontario’s sediment quality guidelines (1992), PCBs exceeded the “severely polluted level” at Oshawa in 1985, the “slightly polluted level” in 1986, and the “marginally polluted level” in 1991. In 1991, the dredged material was disposed in a closed harbor disposal cell. The Hamilton Harbour, Metro Toronto, Port Hope, and Bay of Quinte AOCs all identify dredging restrictions as an impairment. In addition to organic pollutants, sediment concentrations of heavy metals and conventional parameters, such as nitrogen, phosphorus, and oil and grease, have also been identified as a concern in a number of nearshore areas.

In the United States, the Army Corps of Engineers (USACE) oversees and approves dredging projects in coordination with USEPA. There are currently no restrictions on dredging or dredged material disposal activities in the U.S. waters of Lake Ontario due to contaminated sediments. Sediment dredged from major Lake Ontario harbors meets USEPA and USACE guidelines for open water disposal. No dredging restrictions were identified by the RAPs for Rochester Embayment or Oswego Harbor. The only U.S. dredging restriction applies to the type of dredging methods that can be used on the Genesee River. In response to local concerns regarding excessive turbidity levels, dredging techniques that cause excessive turbidity in the river are not allowed. Critical pollutants are not a cause of these limitations.

In February 1998, USEPA and USACE finalized the Inland Testing Manual, which lays out stringent testing protocols for dredged material disposal in inland waters. Over the next 12 to 18 months, USEPA and USACE will work with their partners to develop a regional manual to implement the national testing protocol in the New York State portions of Lakes Ontario and Erie. The status of this beneficial use could change if future dredging projects encounter sediments that exceed these new, more stringent testing requirements.

3.5.3 Eutrophication or Undesirable Algae

Eutrophication is a process in lakes that is characterized by an overload of nutrients. It is often accompanied by algal blooms, low oxygen concentrations, and changes in food web composition and dynamics. In Lake Ontario, persistent eutrophication and undesirable algae are no longer causes of lakewide problems. The elimination of eutrophication problems in Lake Ontario during the 1950s and 1960s is largely due to the success of the binational phosphorus reduction programs and improvements in wastewater treatment plants throughout the entire Great Lakes basin. In the summer of 1993, the average Lake Ontario total phosphorus level was 9.7 ug/L, near the GLWQA objective of 10 ug/L for open lake spring conditions (IJC, 1980 and Thomas *et al.*, 1980).

In the 1950s and 1960s, algal blooms and fish die-offs occurred throughout Lake Erie and Lake Ontario, raising concerns about the environmental impacts of excessively high phosphorus levels. In an attempt to remedy this problem, the GLWQA set a target load of 7,000 metric tonnes of phosphorus per year. To measure the success of the reduction programs, additional targets were set: phosphorus concentration (10 ug/L), chlorophyll *a* (2.6 ug/L), and water clarity (5.3 m in open waters).

In response to the phosphorus control programs, open lake phosphorus concentrations declined from a peak of about 25 ug/L in 1971 to the 10 ug/L guideline in 1985. By 1991, Lake Ontario phosphorus levels were well below the guideline. In addition, since the early 1980s, water clarity

has increased by 20 percent, photosynthesis has declined approximately 18 percent, and late summer zooplankton production has declined by 50 percent. All of these are positive changes reflecting an overall shift of the lake back towards its original condition of low nutrient levels.

Although significant progress has been made in reducing eutrophication problems in nearshore areas, this is still a concern in local areas. Each of the Lake Ontario AOCs, with the exception of Port Hope, has identified eutrophication as a local impairment. In New York State, Braddock Bay, Irondequoit Bay, Sodus Bay, East Bay, Port Bay, Little Sodus Bay, Chaumont Bay, and Mud Bay are showing signs of eutrophication. Nutrients from agricultural runoff and on-site waste disposal systems (septic systems) are the most frequently identified sources of the problem. County level environmental planning efforts are providing the lead on controlling these localized eutrophication problems in the U.S.

In conclusion, it appears that eutrophication is no longer a problem in offshore waters. This is largely due to the success of the binational phosphorus reduction programs and improvements in wastewater treatment plants throughout the entire Great Lakes basin. Although substantial improvements have been made in the nearshore areas, eutrophication may still be a significant issue in some local areas.

3.5.4 Restrictions on Drinking Water Consumption, or Taste and Odor Problems

Regular monitoring of the quality of water supplies drawn from Lake Ontario shows that water quality meets or exceeds public health standards for drinking supplies. Open lake surveillance monitoring conducted as part of Canadian and United States research efforts also confirms the high quality of Lake Ontario water.

The largest category of consumer complaints about drinking water, worldwide, is taste and odor problems (AWWA, 1987). Changes in the taste of drinking water may indicate possible contamination of the raw water supply, treatment inadequacies, or contamination of the distribution system. Although there are standards for some parameters that may cause taste and odor problems, such as phenolic compounds, there is considerable variation among consumers as to what is acceptable. Aesthetically acceptable drinking water supplies should not have an offensive taste or smell.

Although there are no drinking water restrictions on the use of Lake Ontario water, some nearshore areas, such as Rochester and the Bay of Quinte, report occasional taste and odor problems. Lake Ontario water suppliers most commonly receive consumer complaints regarding an “earthy” or “musty” taste and odors. Studies conducted by Lake Ontario water suppliers have shown that these problems are related to naturally

occurring chemicals, such as geosmin (trans, trans-1,10-dimethyl-9-decalol) and methylisoborneol (MIB), produced by decaying blue-green algae and bacteria. Using chlorine to clear water supply intakes of zebra mussels may also stimulate the production of these taste and odor-causing chemicals. Geosmin and MIB can cause taste and odor problems for sensitive individuals at levels as low as one part per trillion (ppt), well below the detection limits of the analytical equipment currently available to water authorities (2 to 3 ppt). Once identified, taste and odor problems can be eliminated at water treatment plants by the use of powdered activated carbon or potassium permangenate.

Taste and odor problems are more common during algal blooms. Additionally, storm events precipitate these problems by breaking up mats of the green algae Cladophora from their rocky substrate in nearshore areas. Floating mats of Cladophora located in warm shallow water are ideal habitats for blue-green algae and bacteria growth. The presence of these floating mats contributes to taste and odor problems. Localized eutrophication problems in some nearshore areas may also contribute to taste and odor problems.

In summary, taste and odor problems are considered to be a locally impaired beneficial use in some areas. The causes, however, are poorly understood. Naturally occurring algae, eutrophic conditions, and zebra mussel controls may all be important contributing factors.

3.5.5 Beach Closings

Beach closings are restricted largely to shorelines near major metropolitan centers or the mouths of streams and rivers. These closings follow storm events when bacteria-rich surface water runoff is flushed into nearshore areas via streams, rivers, and combined sewer overflows (CSOs). In some instances beaches may be closed based on the potential for high bacteria levels to develop following storm and rain events. Beaches are also closed for aesthetic reasons, such as the presence of algal blooms, dead fish, or garbage. Given the localized nature of beach closings and their absence along much of the Lake Ontario shoreline, they are not a considered lakewide problem.

Windsurfers enjoying the beach

In Ontario, beaches are closed when bacterial (E. coli) levels exceed 100 organisms/100mL. During recent years (1995 to 1997) beach closings have continued in heavily urbanized areas in the western part of the basin due to storm events, but are less frequent in the central and eastern regions. Examples of ongoing problems include the beaches of the Bay of Quinte, Toronto, Burlington, Hamilton, Niagara, Pt. Dalhouse, and St. Catherines. Upgrading stormwater controls through the installation

of collection tanks so stormwater from CSOs can be treated in Toronto and Hamilton should reduce beach closings in these areas.

The only U.S. beach with recent closings is Ontario Beach within the Rochester AOC. These closings have been posted due to rain events, storm runoff, excessive algae, waves greater than four feet, or visibility less than one-half meter. Ontario Beach is routinely closed as a precaution during storm and rain events because these conditions have the potential to cause high bacteria levels along the beach shore. Ontario Beach summer fecal coliform levels have been well below the state's action level of 200 fecal coliforms/100mL. The implementation of a combined sewer overflow abatement program resulted in significant decreases in fecal coliform levels in the Genesee River and adjacent shoreline areas. Actions are also underway to address stormwater problems that impact other areas of the Rochester Embayment.

3.5.6 Degradation of Aesthetics

There are currently no aesthetic problems in the open waters of Lake Ontario. This is attributed to the elimination of widespread eutrophication problems and the restoration of water clarity. However, some Lake Ontario AOCs have identified this impairment. Evaluating aesthetic problems is subjective, often based on individual value judgments. Localized aesthetic problems along Lake Ontario shorelines include algal blooms, dead fish, debris, odor, silty water, improper disposal of boat sewage wastes, and litter problems at parks and scenic highway stops.

On the U.S. side, the Rochester AOC lists silt, odors related to alewife dieoffs, and decaying algae as aesthetic problems. A recent water quality survey conducted at the Oswego Harbor AOC indicates that this beneficial use is not impaired.

On the Canadian side, the Metro Toronto RAP lists debris and litter, turbidity in the vicinity of tributary mouths and landfilling operations, and weed growth along shorelines as aesthetic problems. In addition, the Royal Commission for Toronto's Waterfront noted the continued loss of Toronto area historical buildings and landscapes and the lack of adequate public access to the lake as aesthetic concerns. The Bay of Quinte RAP identified algal blooms as the primary cause of aesthetic concerns. Major causes of aesthetic impairment in Hamilton Harbour include oil sheens, objectionable turbidity, floating scum, debris, putrid matter, and reduced water clarity in shallow areas.

3.5.7 Added Costs to Agriculture or Industry

This is not a lakewide impairment as Lake Ontario waters do not require any additional treatment costs prior to agricultural or industrial use. The Rochester Embayment AOC is the only Lake Ontario AOC to identify this impairment, based on the additional maintenance costs associated with the physical removal of zebra mussels from water intake pipes.

Many industries and municipalities adjacent to Lake Ontario are experiencing zebra mussel infestation in their water intakes. The main treatment for this problem is to use various chlorine compounds, together with other chemicals such as calcium permangenate, to kill the mussels -- an ongoing maintenance cost.

3.6 Unimpaired Beneficial Uses

Tainting of Fish and Wildlife Flavor

The contamination of surface waters by certain types of organic contaminants, such as the class of chemicals known as phenols, can taint fish and wildlife flavor. During the 1950s, 1960s, and 1970s, levels of phenols near the mouth of the Niagara River often exceeded standards designed to prevent tainting of fish and wildlife flavor. Since that time, improvements in wastewater treatment systems have dramatically reduced the amounts of these substances being discharged to surface waters. Today, levels of phenols are well below levels of concern.

There are no existing reports that indicate tainting of fish and wildlife flavor is a concern for the open waters of Lake Ontario. Neither is this potential impairment identified as a problem in any nearshore areas of the lake. Evaluating this type of impairment is difficult given the very subjective nature of taste. Studies have shown that fish consumers cannot consistently detect the difference between tainted and non-tainted fish. The length of time and preservation methods used before cooking fish can also contribute to taste problems.

3.7 Pollutants to be Addressed Through the LaMP

As discussed in the previous section, there is direct and indirect evidence that PCBs, DDT and its metabolites, mirex, and dioxins/furans are impairing beneficial uses in Lake Ontario.[1,2]

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[1]Heptachlor and heptachlor epoxide have been removed from the list of critical pollutants since the April 1997 draft based on new information summarized in Appendix B.

[2]Dieldrin, although it exceeds criteria on a lakewide basis, is no longer believed to be the cause of bald eagle reproduction problems, as explained in Appendix B.

It is also important for the Lake Ontario LaMP to consider toxic substances that are **likely** to impair beneficial uses. In this case, there is no direct evidence that a substance contributes to use impairments, but there is indirect evidence if a chemical exceeds U.S. or Canadian standards, criteria, or guidelines. A review of recent fish tissue contaminant concentrations identified mercury as a lakewide contaminant of concern because mercury concentrations in larger smallmouth bass and walleye are likely to exceed Ontario's 0.5 parts per million guideline for fish consumption throughout the lake. Although there are no U.S. or Canadian consumption advisories for eating smallmouth bass and walleye on a lakewide basis, the data are sufficient to identify mercury as a critical pollutant as part of the LaMP pollutant reduction strategy. As with mercury, dieldrin is not linked to a lakewide impairment but dieldrin concentrations exceed the most stringent criteria for both water and fish tissue. Given the lakewide nature of these exceedences of the most stringent criteria, dieldrin is also included in the list of LaMP critical pollutants.

Previous LOTMP reports had also identified three other contaminants as exceeding standards and criteria: octachlorostyrene (OCS), chlordane, and hexachlorobenzene (HCB). A review of current information showed that none of these contaminants persist as a lakewide issue. OCS, chlordane, and HCB are well below applicable water quality criteria, as described in Appendix B.

The critical pollutants that have been identified as impairing uses in Lake Ontario are persistent, bioaccumulative toxic substances: they remain in the water, sediment, and biota for long periods of time and they accumulate in aquatic organisms to levels that are harmful to human health. It is the intent of the Four Parties to prevent the development of additional lakewide use impairments that may be caused by other persistent, bioaccumulative toxics entering the lake. Therefore, the LaMP will identify actions that will address the critical pollutants identified above as well as the broader class of chemicals known as persistent, bioaccumulative toxics.

***Lakewide Critical Pollutants* are bioaccumulative and persistent toxic substances that are known or suspected to be responsible for lakewide impairments of beneficial uses: PCBs, DDT & its metabolites, mirex, dioxins/ furans, mercury, and dieldrin. These substances will be the focus of the Lake Ontario LaMP source reduction activities.**

Lake Ontario lakewide critical pollutants all resist natural breakdown processes and can bioaccumulate in living organisms. Given these properties, these contaminants will persist in the environment long after most sources of these contaminants have been eliminated or controlled. Improvements in laboratory analytical techniques now allow us to detect most of these contaminants at extremely low levels in air, water, soil, and biota samples.

Strategies to reduce or eliminate critical pollutant inputs need to be based on an understanding of how and where these chemicals were used or are produced and disposed so that their sources can be located and controlled. We also need to understand the various physical and chemical pathways

by which these contaminants move through the ecosystem to be able to determine the appropriate control strategy and to predict the time needed to restore impairments. The following discussion provides a brief overview of the six lakewide critical pollutants and some preliminary contaminant loadings information.

This preliminary attempt to develop estimates of critical pollutants entering the lake identified a number of data gaps. Examples of the types of data gaps to be considered as part of future LaMP efforts include: 1) insufficient data to estimate critical pollutant loadings for many tributaries; 2) limited data on atmospheric loadings of critical pollutants throughout the basin; and 3) the amount of critical pollutants being effectively removed from the system due to burial in the deep basins of the lake.

3.8 Sources and Loadings of Critical Pollutants

3.8.1 Sources of Critical Pollutant Loadings Information

It is extremely difficult to estimate critical pollutant loadings entering Lake Ontario via rivers, precipitation, sewage treatment plants, waste sites, agricultural areas, and other sources. The levels of contaminants entering the lake from these sources are constantly changing in response to many known and unknown factors. As a result, loadings data are often limited and rely on numerous assumptions. Although quantitative loadings information may be difficult to obtain, qualitative indicators provided by the environmental monitoring of water, sediment, and aquatic organisms can often provide sufficient information to identify those contaminant sources that need to be controlled. Improving the database on sources and loadings of critical pollutants is a high priority, as is determining effective ways to virtually eliminate these critical pollutants from Lake Ontario.

Table 3-3 presents four major categories of critical pollutant loadings estimates based on the best data currently available:

1. loadings from sources outside the Lake Ontario basin;
2. loadings from sources inside the Lake Ontario basin;
3. atmospheric loadings; and
4. releases from Lake Ontario to the St. Lawrence River and *volatilization* to the atmosphere.

These are very preliminary estimates and are subject to significant changes as monitoring and loading calculation techniques improve. The data are drawn from a number of information sources and monitoring programs which often use different criteria, methods, and loading calculation methods. These estimates indicate that the volume of some contaminants leaving the lake, such as PCBs and DDT, may be greater than the amount coming in. One explanation for this may be that contaminants are slowly being released from sediments already present in the Lake Ontario system.

Table 3-3. Preliminary Estimates of Lake Ontario Critical Pollutant Loadings Information

	Loadings from Sources Outside the Lake Ontario Basin (Kg/yr)			Loadings from Water Discharges within the Lake Ontario Basin (Kg/yr)				Atmospheric Loadings (Kg/yr)	Amounts Leaving Lake Ontario (Kg/yr)			Net Change (Kg/yr)
	Other Great Lakes	Niagara River Basin	Total	Point and Non-point via Tributaries	Direct Point Source Discharges		Total		via St. Lawrence River	Volatilization to Atmosphere	Total	
					U.S.	Can.						
PCBs	302	138	440	97	0.02	?/ND	97	64	411	440	851	-250
Total DDT	96	ND	96	16	1.5	?/ND	17.5	16	1.8	141	143	-13.5
Mirex	ND	1.8	1.8	0.9	?/ND	?/ND	0.9	ND	0.7	?	0.7	2.0
Dieldrin	43	ND	43	5	4.3	?/ND	9.3	13	43	320	363	-297.7
Dioxins	ND	ND	ND	NQ	?/ND	?/ND	?/ND	0.005	?	?	?	?

? = no information available ND = not detected/not measurable NQ = present but not quantified

NOTE: Loading estimates for mercury could not be completed in time for this report but will be addressed in future LaMP reports.

Data Sources:

Other Great Lakes
Joint Evaluation of Upstream-Downstream Niagara River Monitoring Data, 1992-93, Prepared by Data Interpretation Group, River Monitoring Committee, January 1995. (Loadings measured at the head of the Niagara River at Fort Erie)

Niagara River Basin
Joint Evaluation of Upstream-Downstream Niagara River Monitoring Data, 1992-93, Prepared by Data Interpretation Group, River Monitoring Committee, January 1995. (Difference between loadings measured at Fort Erie and Niagara-on-the Lake).

Atmospheric
Estimating Atmospheric Deposition of Toxic Substances to the Great Lakes, An Update, Eisenreich, S.J. & W.M.J. Strachan, Workshop proceedings, Canada Centre for Inland Waters, Burlington, Ontario, January 31 - February 2, 1992. June 1992. (deposition and volatilization of PCBs, DDT, mirex, dieldrin)
Atmospheric Deposition of toxic chemicals to the Great Lakes: A review of data through 1994. Hoff *et al*., 1996, Atmospheric Environment Vol. 30, No. 20 pp 3305-3527.

Contaminant Loads leaving via St. Lawrence River
Concentrations and loadings of trace organic compounds measured in the St. Lawrence River Headwaters at Wolfe Island 1989-1993.
Prepared by J. Biberhofer, Environment Canada, Environmental Conservation Branch, Ontario Region, Ecosystem Health Division, Report No: EHD\ECB-OR\95-03\I, August 1994.

One of the challenges of the LaMP is to understand the state of Lake Ontario as it exists today and how it may change in the near future and over the long term. Concentrations of toxic substances in water, sediment, fish, and wildlife respond at different rates to changes in loadings and changes in biological or physical conditions. Programs in place today which have already reduced critical pollutant loadings may not have an impact on environmental levels for decades, particularly in fish and wildlife. This time lag must be considered when evaluating data which were often collected several years before being reported and which reflect loadings which occurred many more years before data collection. Organisms accumulate chemicals or metals that have been in the ecosystem for long periods of time, either in sediment or in organisms which are lower on the food chain. Estimating if current programs will eventually resolve some of these ecosystem issues and over what time frame is an important step in understanding what additional measures are necessary to accelerate the cleanup of Lake Ontario.

CSS Limnos
(Environment Canada, National Water Research Institute, Technical Operations)

Long term water quality monitoring programs are conducted by Environment Canada at Fort Erie and Niagara-on-the-Lake (at both ends of the Niagara River), and at Wolfe Island at the head of the St. Lawrence River. These programs use similar sampling and analytical methods. The data provide a good estimate of the critical pollutant loadings that originate from upstream Great Lakes basins, those that originate in the Niagara River basin, and the volume of critical pollutants that leaves Lake Ontario via the St. Lawrence River.

Estimates of atmospheric loadings of critical pollutants to Lake Ontario were developed by the International Atmospheric Deposition Network. Estimates for the amounts of critical pollutants volatilizing to the atmosphere were also provided. Volatilization may be a significant process by which critical pollutants are leaving the Lake Ontario system. Estimating atmospheric deposition is difficult, and these estimates contain a significant degree of uncertainty.

For the purposes of this report, the amounts of critical pollutants entering Lake Ontario via all Lake Ontario basin tributaries were based on representative point and non-point sources within each tributary's watershed. The 22 tributaries with the highest flow rates were included in this review (see Table 3-4). Quantitative and qualitative monitoring techniques, as well as biological monitoring results, were used to estimate loadings or the relative presence or absence of critical pollutants within each tributary watershed.

Table 3-4. Estimates of Atmospheric, Point, and Non-point Source Contaminant Loadings Entering Lake Ontario via Tributaries (Kg/yr)

Source	Country	PCBs (Kg/yr)	Total DDT (Kg/yr)	Dioxins Furans (g/yr)	Dieldrin (Kg/yr)	Mirex (Kg/yr)
Burlington Canal	Canada	2.8(1)\ ¥ (8,10)	¥ (8)	¥ (10)	?	ND ¥(8)
Credit River	Canada	¥ (8)	¥ (8)	?	?	ND ¥ (8)
Don River	Canada	1.1 (3)	0.5(3)	¥ (10)	1.3 (3)	?
Duffins Creek	Canada	¥ (8)	¥ (8)	?	?	?
Humber River	Canada	1.7(3)\ ¥ (8)	0.4(3)\¥ (8)	?	0.1 (3)	ND ¥ (8)
Moira River	Canada	?	?	?	?	?
Napanee River	Canada	?	?	¥ (7)	?	?
Oakville Creek	Canada	¥ (8)	¥ (8)	?	?	?
Salmon River	Canada	?	?	?	?	?
Trent River	Canada	¥ (4)	?	¥ (7,10)	?	?
Twelve Mile Creek	Canada	¥ (8)	¥ (8)	¥ (7)	?	ND ¥ (8)
Welland Ship Canal	Canada	¥ (8)	¥ (8)	¥ (7)	?	¥ (8)
Atmospheric	Canada & US	64 (2)	16 (2)	?	13 (2)	?
Niagara River & upstream Great Lakes	Canada & US	440 (9)	96 (9)	ND* (9)	43 (9)	1.8 (9)
Black River	US	52.2 (5)	0.02 (5)	¥ (7)	1.1 (5)	¥ (5)
Eighteenmile Creek	US	7.3 (5)	0.01 (5)	¥ (5)	0.1 (5)	0.01 (5)
Genesee River	US	14.2 (5)	0.03 (5)	¥ (5)	1.7 (5)	0.03 (5)
Irondequoit Creek	US	0.003 (5)	0.002 (5)	¥ (5)	0.002 (5)	?
Johnson Creek	US	¥ (6)	¥ (6)	¥ (6)	?	?
Northrup Creek	US	?	?	?	?	?
Oak Orchard Creek	US	¥ (5)	¥ (5)	¥ (5)	¥ (5)	¥ (5)
Oswego River	US	17.1	1.5	¥ (5)	1.2 (5)	0.9 (5)
Sandy Creek	US	1.01 (5)	?	?	?	?
Wine Creek	US	0.001 (5)	ND (5)	?	ND	?

References

-1 Fox *et al.*, 1996
-2 Hoff *et al.*, 1996
-3 D'Andrea and Anderton, 1996
-4 Poulton, 1990
-5 Litten, 1996
-6 Estabrooks *et al.*, 1994
-7 MOE, MISA, 1994
-8 MOE Spottail Shiner data
-9 Niagara River upstream/downstream program, 1995
-10 Canviro Consultants, 1988

? No information available for compound
¥ Detected in qualitative monitoring programs or in effluent of facilities discharging to tributary.
ND Not detected
* 2,3,7,8 TCDD

The location of point sources (Figure 3-1) and loadings information (Tables 3-5 and 3-6) are presented for those that discharge directly to the lake. Point sources that discharge to tributaries are included in tributary loading estimates. Jurisdictional differences confound these point source loadings estimates. New York State requires dischargers whose waste-water is known or suspected to contain significant levels of critical pollutants (principally sewage treatment plants) to monitor for those contaminants. There is no current data on Ontario point sources as no Ontario industrial point source discharged the critical pollutants in sufficient quantities to require regulation under MISA. Information on CSOs, stormwater, and other non-point sources may be included in future assessments.

To get copies of the TRI, call the Pollution Prevention Unit at NYSDEC, Sitansu Ghosh (518-457-2553). To get copies of the NPRI, contact the NPRI office in EC's Ontario Region at 416-739-5890 or access it on the internet at http://www.ec.gc.ca/pdb/npri.htmi.)

Information on releases to the environment of critical pollutants and other contaminants is available to the public in publications developed and released on a regular basis by governmental agencies. For sources in the U.S., the annual Toxics Release Inventory (TRI) summarizes on an annual basis the emissions of approximately 650 pollutants from facilities nationwide. For sources in Canada, the National Pollutant Release Inventory (NPRI) provides information on the onsite releases to air, water, and land; on transfers offsite in waste; and on the three R's (recover, reuse, and recycle) of 176 substances. The NPRI is the only legislated nationwide publicly accessible inventory of pollutant releases and transfers in Canada.

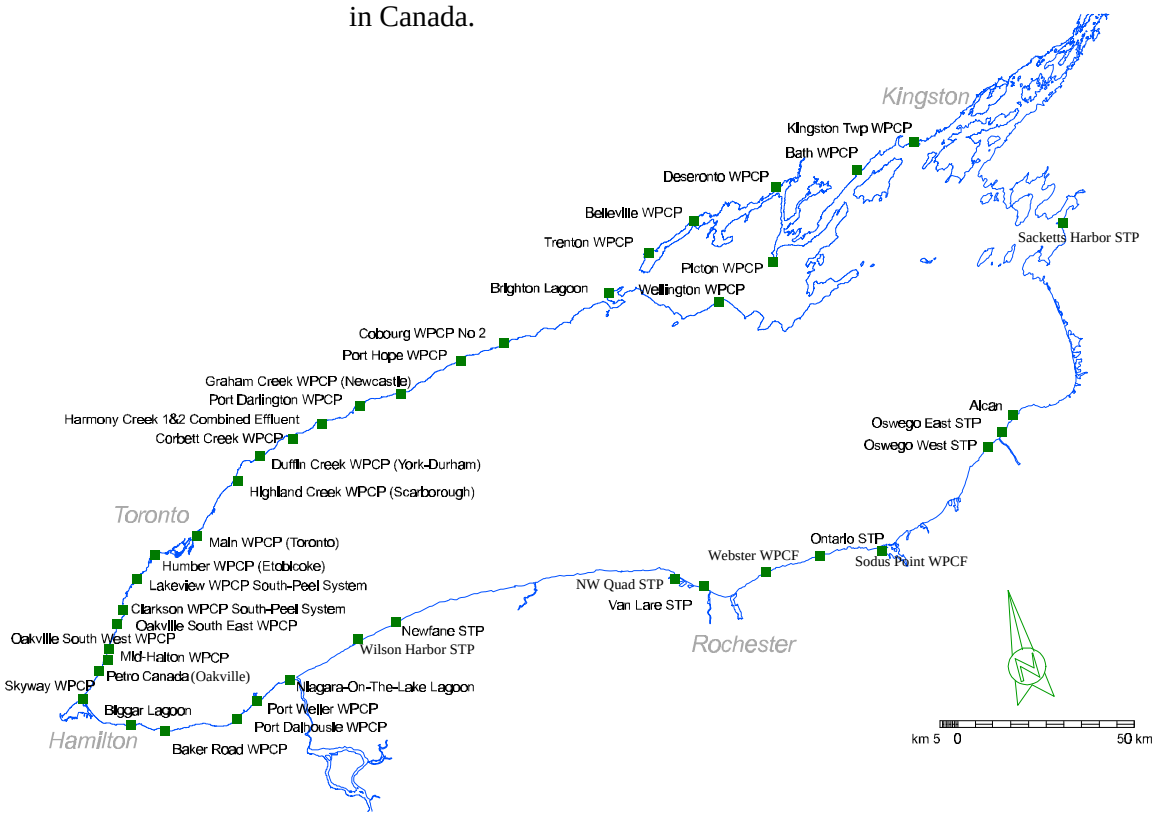


Figure 3-1. Point Sources Directly Discharging to Lake Ontario

[STP - *Sewage Treatment Plant*; WPCF - *Water Pollution Control Facility*; WPCP - *Water Pollution Control Plant*]

Table 3-5. Preliminary Estimate of Lakewide Critical Pollutants Entering Lake Ontario via Direct Discharges in the U.S. (1989-1995).

Point Sources	Country	Discharge Flow (1000 m^3 per day)	PCBs (Kg/yr)	Total DDT (Kg/yr)	Dioxins/ Furans* (g/yr)	Dieldrin (Kg/yr)	Mirex (Kg/yr)
Alcan	US	32.2	0.02	ND	ND	ND	?
Newfane STP	US	5.6	ND	ND	ND	ND	ND
NW Quad STP	US	62	ND	ND	ND	ND	ND
Ontario STP	US	2.3	ND	ND	ND	ND	ND
Oswego East STP	US	11	ND	ND	ND	ND	ND
Oswego West STP	US	15.1	ND	1.5	ND	ND	ND
Sacketts Harbor STP	US	0.02	?	?	?	?	?
Sodus Point WPCF	US	0.02	?	?	?	?	?
Van Lare STP	US	401	ND	ND	?	4.3	?
Webster WPCF	US	28.0	ND	ND	ND	ND	ND
Wilson Harbor STP	US	0.01	?	?	?	?	?

WPCF = Water Pollution Control Facility
STP = Sewage Treatment Plant
* = dioxin/furan loadings reported in grams per year
? = No information available
ND = Not detected

Data Sources: New York State SPDES program
Litten, NYSDEC 1996

Note: Estimates are based on standard monitoring performed by the POTW operators as well as non-standard research methods used by NYSDEC investigators that can detect lower levels of contaminants than standard methodologies. As a result, contaminants reported to be "not detected" by standard analytical methods might be "detected" if non-standard research methods are used. Therefore, the details of a specific POTW's operation, flow rate, and the analytical methods used need to be carefully considered before the significance of a reported "non-detect" can be completely understood.

Note: This table only includes the more significant wastewater point source dischargers. Discharges related to power generation plants and small dischargers are not included in this table. A more complete review of these dischargers will be performed as part of future LaMP activities.

Table 3-6. Preliminary Estimate of Lakewide Critical Pollutants Entering Lake Ontario via Direct Discharges in Canada (1989-1995).

Point Sources	Country	Discharge Flow (1000 m^3 per day)	PCBs (Kg/yr)	Total DDT (Kg/yr)	Dioxins/ Furans* (g/yr)	Dieldrin (Kg/yr)	Mirex (Kg/yr)
Baker Road WPCP (Grimsby)	Canada	14.7	ND	ND	ND	ND	ND
Bath WPCP	Canada	1.2	?	?	?	?	?
Belleville WPCP	Canada	30.5	?	?	?	?	?
Biggar Lagoon	Canada	1.1	?	?	?	?	?
Brighton Lagoon	Canada	2.6	?	?	?	?	?
Clarkson WPCP (Mississauga)	Canada	99.6	ND	ND	ND	ND	ND
Cobourg WPCP No 1	Canada	9.9	?	?	?	?	?
Cobourg WPCP No 2	Canada	5.8	?	?	?	?	?
Corbett Creek WPCP (Oshawa)	Canada	34.9	?	?	?	?	?
Deseronto WPCP	Canada	1.4	?	?	?	?	?
Duffins Creek WPCP (Pickering)	Canada	237.6	ND	ND	ND	ND	ND
Graham Creek WPCP (Newcastle)	Canada	2.04	?	?	?	?	?
Harmony Creek 1&2 (Oshawa)	Canada	52.8	?	?	?	?	?
Highland Creek WPCP (Scarborough)	Canada	160.2	ND	ND	ND	ND	ND
Humber WPCP (Etobicoke)	Canada	337.7	ND	ND	ND	ND	ND
Kingston Twp WPCP	Canada	22.1	ND	ND	ND	ND	ND
Lakeview WPCP (Mississauga)	Canada	268.4	ND	ND	ND	ND	ND
Main WPCP (Toronto)	Canada	680.1	ND	ND	ND	ND	ND
Mid-Halton WPCP	Canada	11.4	?	?	?	?	?
Niagara-On-The-Lake Lagoon	Canada	4.02	ND	ND	ND	ND	ND
Oakville South East WPCP	Canada	72.4	ND	ND	ND	ND	ND
Oakville South West WPCP	Canada	33.1	?	?	?	?	?
Petro Canada Ltd (Oakville)	Canada	?	?	?	?	?	?
Petro Canada Ltd (Mississauga)	Canada	9.5	?	?	ND	?	?
Picton WPCP	Canada	3.7	?	?	?	?	?
Port Dalhousie WPCP	Canada	72.3	?	?	?	?	?
Port Darlington WPCP	Canada	8.3	?	?	?	?	?
Port Hope WPCP	Canada	5.5	?	?	?	?	?
Port Weller WPCP	Canada	49.3	?	?	?	?	?
Skyway WPCP (Burlington)	Canada	76.5	?	?	?	?	?
Trenton WPCP	Canada	12.4	?	?	?	?	?
Wellington WPCP	Canada	0.5	?	?	?	?	?

WPCP = Water Pollution Control Plant
STP = Sewage Treatment Plant
* = dioxin/furan loadings reported in grams per year
? = No information available
ND = Not detected

Data Source: Ontario Ministry of the Environment

Note: This table only includes the more significant wastewater point source dischargers. Discharges related to power generation plants and small dischargers are not included in this table. A more complete review of these dischargers will be performed as part of future LaMP activities.

3.8.2 Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs) were manufactured between 1929 and 1977. PCBs were considered an important industrial safety product for conditions where high heat or powerful electric currents posed explosive and fire hazards. For example, PCB oil-filled electric switches eliminated electric sparking problems that could trigger explosions at petroleum refineries. PCB oils were used in electrical transformers as a non-flammable electrical insulating fluid. PCBs were also used as industrial lubricating oils to replace earlier types of hydraulic oils that could more easily catch fire under conditions of high pressure and temperature.

The production of PCBs was halted following the discovery that PCBs released into the environment were bioaccumulating to levels of concern in a wide range of organisms. The hazards posed by PCBs were discovered in the 1960s when ranch mink, that had been fed a diet of Great Lakes fish, experienced reproductive failures. The investigations that followed determined that Great Lakes fish were contaminated with PCBs at levels that warranted human fish consumption advisories. Since that time, production of PCBs in North America has been banned, and the use of PCBs is being systematically eliminated. In Canada, old electrical transformers and other equipment that contain PCBs are being stockpiled until they can be safely destroyed. In the U.S., old transformers and equipment containing PCBs must be properly disposed within one year.

Levels of PCBs in the environment have decreased in response to the banning and phasing out of the various uses of PCBs. PCBs are identified as a LaMP critical pollutant because levels of PCBs in Lake Ontario fish and wildlife continue to exceed human health standards and because PCB levels in the Lake Ontario food chain may pose health and reproduction problems for bald eagles, mink, and otter.

The majority of these estimated PCB loadings to Lake Ontario originate outside the Lake Ontario basin (see Figure 3-2). The upstream Great Lakes basins contribute the largest amount (302 kg/yr), followed by the Niagara River basin (138 kg/yr). Within the Lake Ontario basin, point and non-point sources contribute approximately 100 kg/yr, 80 percent of which enters the Lake via streams and rivers. Atmospheric loadings contribute 64 kg/yr directly to the lake surface. Some of the tributary loadings are no doubt due to atmospheric deposition within the watershed. When the loss of PCBs from the Lake basin via volatilization (440 kg/yr) and the St. Lawrence River (411 kg/yr) is considered, the total amount of PCBs within Lake Ontario appears to be decreasing at a rate of 250 kg/yr, only to be transferred downstream, downwind, or buried in the bottom sediments.

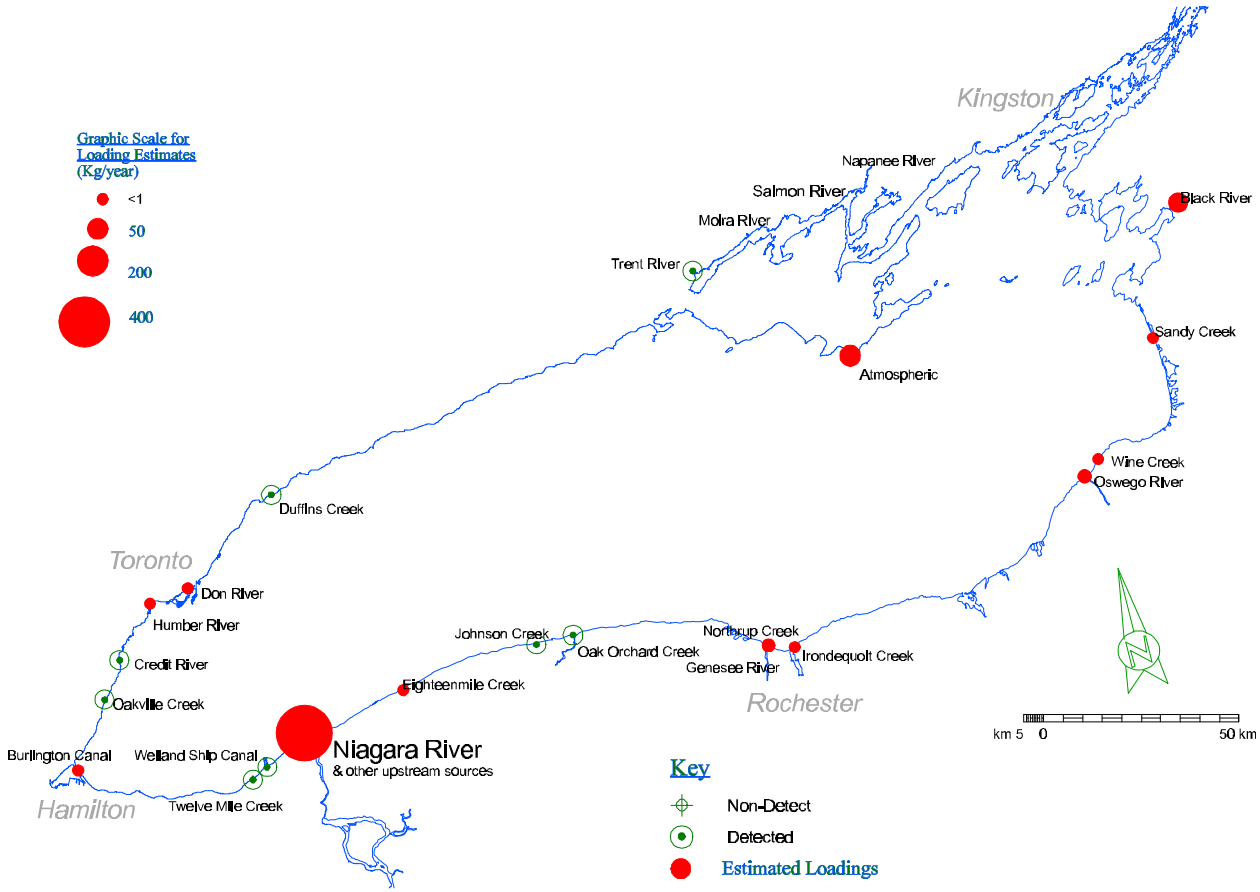


Figure 3-2. Summary of Non-point Source Loadings Information for PCBs (1990-1995).

3.8.3 DDT and Its Metabolites

The development of the pesticide DDT in the 1940s was considered a major breakthrough in the battle against diseases, such as malaria, and in controlling crop pests. Highly effective and cheap to produce, DDT was the most widely used pesticide in North America and other countries from 1946 to 1972. Agricultural use of DDT has since been banned in North America following the discovery that DDT and its breakdown products were causing widespread reproductive failures in eagles and other wildlife species. Although DDT continues to be used in other parts of the world, levels of DDT in the North American environment have decreased significantly since this pesticide was banned, and species impacted by DDT, such as the bald eagle, are recovering. DDT and its metabolites are identified as LaMP critical pollutants because they are responsible for wildlife consumption advisories and are identified as a potential problem contaminant for bald eagles once they re-establish their shoreline nesting territories.

The upper Great Lakes are the largest source of DDT and its metabolites to the Lake Ontario basin (96 kg/yr) (see Figure 3-3). Atmospheric deposition and sources within the Lake Ontario basin contribute approximately 33.5 kg/yr combined. Much of the tributary loadings likely consist of atmospheric fallout in the watershed given the banning of these materials from use in the watershed. The Niagara River Basin does not appear to be a significant source of DDT. Approximately 143 kg/yr of DDT leave Lake Ontario via volatilization to the atmosphere (141 kg/yr) and the St. Lawrence River (2 kg/yr), for a net loss from Lake Ontario of approximately 13 kg/yr.

3.8.4 Mirex (Dechlorane)

The discovery of elevated levels of mirex in Lake Ontario fish during the 1960s triggered lakewide fish consumption advisories. Investigations determined that most of the mirex originated from a chemical production facility on the Niagara River. Use and production of mirex, also known as dechlorane, are now banned in North America. Mirex is identified as a LaMP critical pollutant because levels in some Lake Ontario fish continue to exceed human health standards; a number of fish consumption advisories exist. Although mirex is most widely known for its use as a pesticide, approximately 75 percent of the mirex produced was used as a flame retardant in a variety of industrial, manufacturing, and military

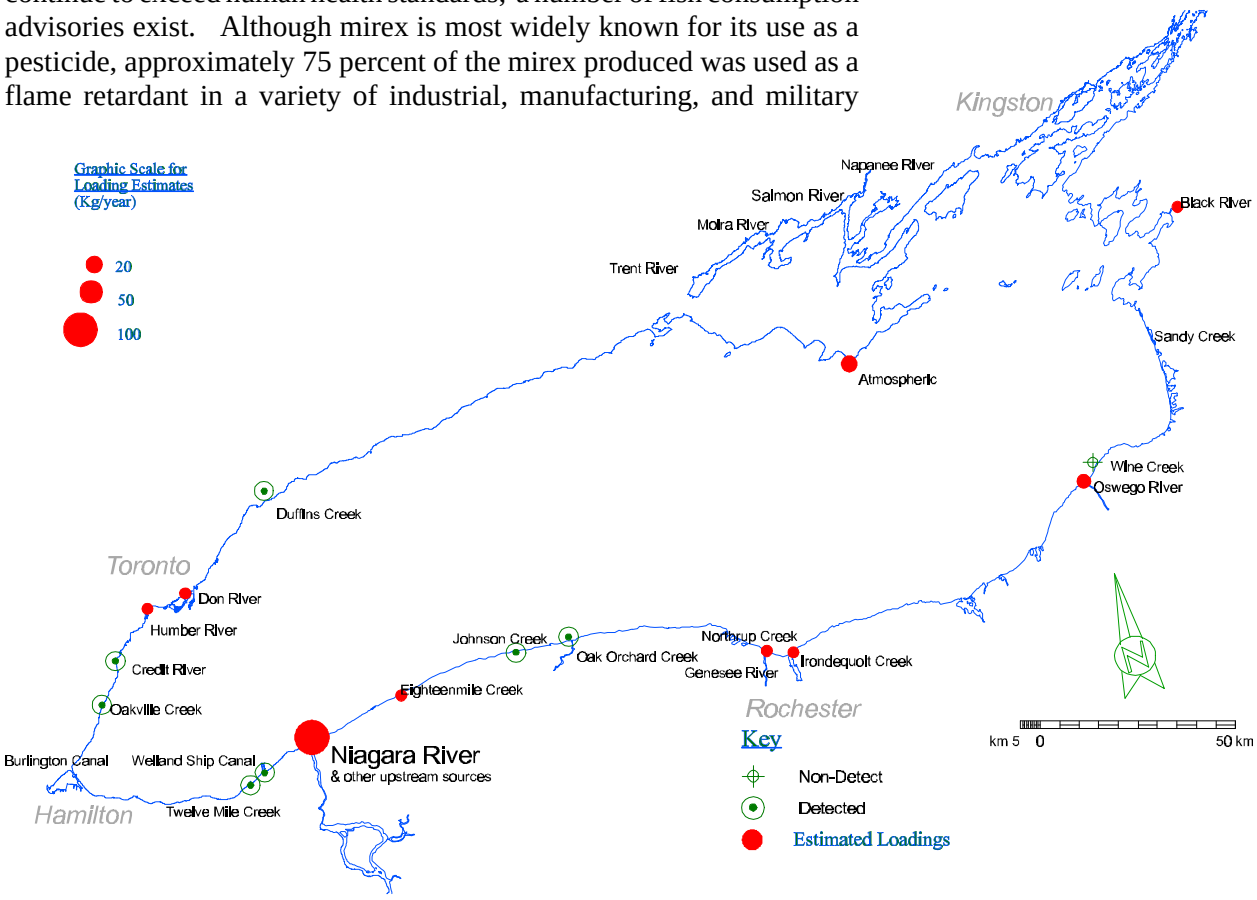


Figure 3-3. Summary of Non-point Source Loadings Information for Total DDT (1990-1995).

applications. Available sales records suggest that more than 50,000 pounds of mirex were used for industrial and manufacturing flame retardant purposes in the Lake Ontario basin. More than 75,000 pounds of mirex were used as a flame retardant in other Great Lakes basins.

Most of the mirex entering Lake Ontario originates in the Niagara River basin (1.8 kg/yr) and an additional 0.9 kg/yr enters via the Oswego River (Figure 3-4). Approximately 0.7 kg/yr of mirex leaves Lake Ontario via the St. Lawrence River. No reliable estimates of atmospheric deposition or volatilization are available at this time.

3.8.5 Dioxins and Furans

Dioxins and furans are a group of unwanted chemical by-products that are created by a variety of chemical and combustion processes. Laboratory studies have shown some wildlife species to be extremely sensitive to the toxic effects of these contaminants. The potential impacts of the very low levels of these contaminants found in Lake Ontario fish, wildlife, and humans are poorly understood. Therefore, health standards for these

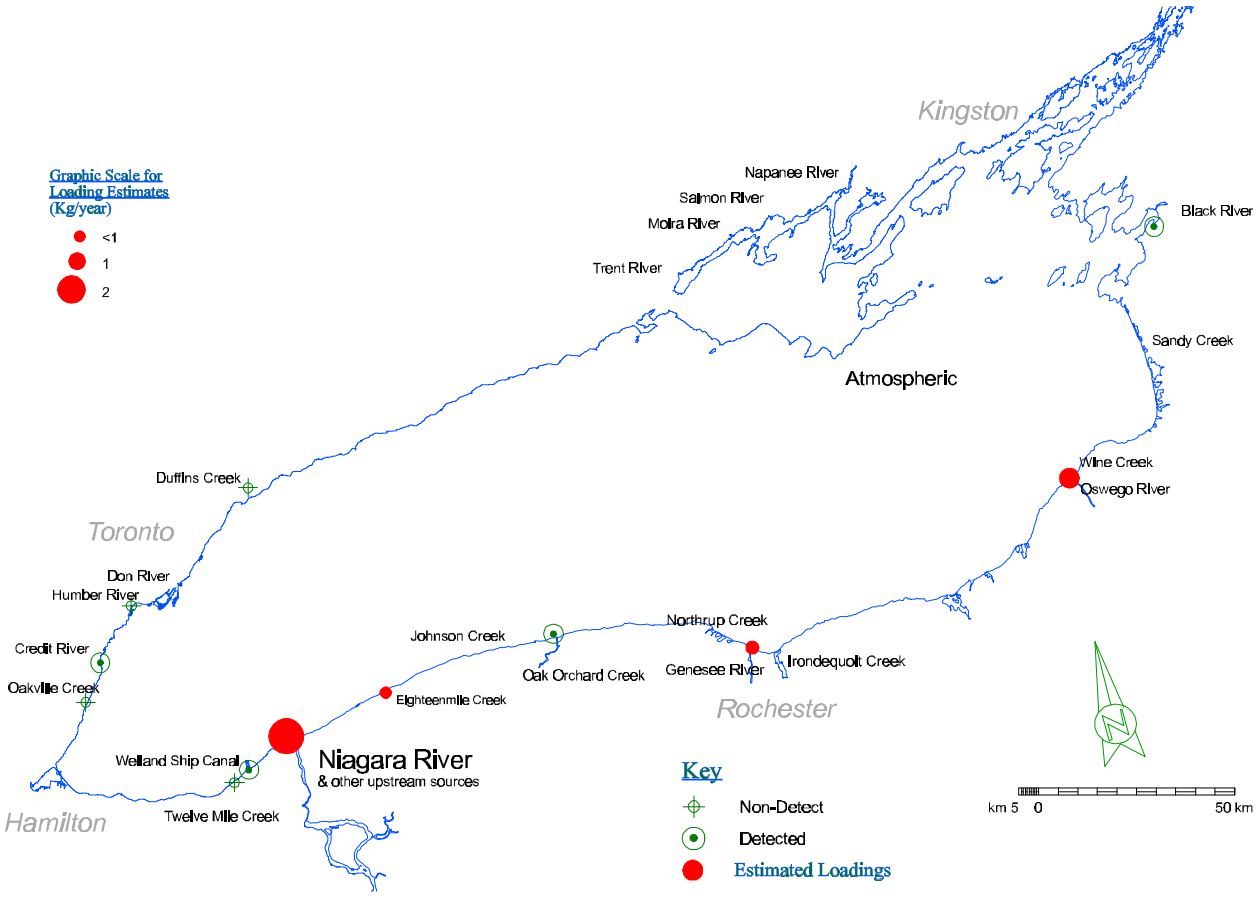


Figure 3-4. Summary of Non-point Source Loadings Information for Mirex (1990-1995).

contaminants have been set very low. Steps have been taken to control and limit those processes that produce high levels of dioxins and furans, resulting in a significant decrease in environmental levels of these chemicals over the last two decades. Some of the processes that can produce dioxins and furans include the use of internal combustion engines, incinerators, and a variety of other chemical processes, which are part of our modern way of life and may be difficult to eliminate altogether. Forest fires and wood burning stoves also produce low levels of dioxins and furans.

Dioxins and furans are identified as LaMP critical pollutants because levels of these contaminants exceed human health standards in some Lake Ontario fish and because these chemicals may limit the full recovery of the Lake Ontario bald eagle, mink, and otter populations by reducing the overall fitness and reproductive health of these species.

Dioxins and furans exist at very low levels in the environment and, as a result, are difficult and costly to detect and accurately quantify. The Niagara River upstream-downstream program monitors exclusively for 2,3,7,8 TCDD (dioxin) and 2,3,7,8 TCDF (furan), the most toxic forms of these compounds; none have been detected. Despite this analytical limitation, data from other media (mussels, spottail shiners, and sediment cores) indicate that there are several sources of both dioxins and furans in the Niagara River and that the River is a source of these pollutants to Lake Ontario. Atmospheric deposition appears to be the largest known source of dioxins/furans, contributing approximately 5 grams per year. Dioxins and furans have been detected in a number of Lake Ontario tributaries using qualitative water and biological sampling methods. No reliable estimates are available for the volume of dioxins/furans that may be leaving the lake via volatilization to the atmosphere.

3.8.6 Mercury

Mercury is a naturally occurring metal, which is found in small amounts in most soils and rocks. Although mercury is best known for its use in thermometers and medical and dental products, it is also used in batteries and in the production of various synthetic materials such as urethane foam. Historically, mercury was added to paints as an anti-mildew agent. Some uses of mercury have now been banned. Loading estimates for mercury could not be completed in time for this report since it was identified as a critical pollutant late in the Stage 1 development process, but it will be included and addressed in future LaMP reports.

3.8.7 Dieldrin

Dieldrin is a formerly used pesticide that is now banned from use in the Lake Ontario basin and throughout North America. Aldrin, another formerly used pesticide, transforms into dieldrin through natural breakdown processes. Dieldrin is identified as a LaMP critical pollutant because dieldrin concentrations in water and fish tissue exceed the U.S. Great Lakes Water Quality Initiative (GLI) criteria throughout the lake. The GLI criterion for water is 0.0000065 parts per billion and Lake Ontario water averages 0.17 parts per billion. The corresponding GLI fish tissue criterion is 0.0025 parts per million. Most Lake Ontario fish clearly exceed this criterion as dieldrin is detectable at concentrations ranging from approximately 0.005 to 0.030 parts per million. Although the GLI criteria are being exceeded, dieldrin concentrations in the environment have been steadily declining. Between 1985 and 1995, dieldrin concentrations in the lake have declined from 0.35 to 0.17 parts per billion based on information collected through Niagara River and Wolfe Island monitoring programs.

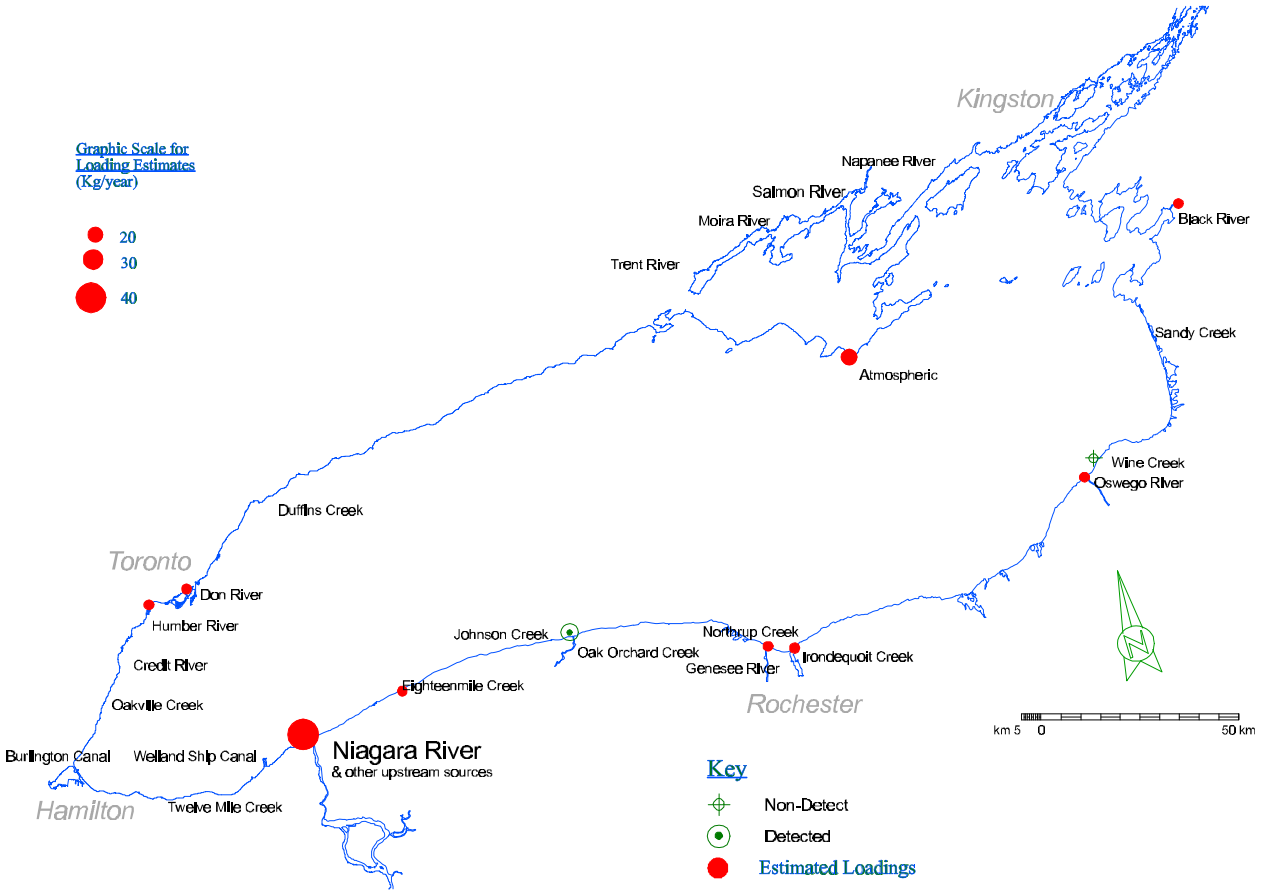


Figure 3-5. Summary of Non-point Source Loadings Information for Dieldrin (1989-1995).

The upper Great Lakes are the largest source of dieldrin to the Lake Ontario basin (43 kg/yr). Atmospheric deposition and point and non-point sources within the Lake Ontario basin are approximately equal (13 kg/yr and 9 kg/yr) (see Figure 3-5). Estimates for the rate of loss of dieldrin in Lake Ontario due to volatilization (320 kg/yr) and the St. Lawrence River (43 kg/yr) suggest that the volume of dieldrin in the lake is decreasing at a rate of 298 kg/yr.

3.9 Summary

In this chapter, the Four Parties have identified the lakewide and local beneficial use impairments of Lake Ontario. The four lakewide beneficial use impairments have been identified as:

- Restrictions on fish and wildlife consumption
- Degradation of wildlife populations
- Bird or animal deformities or reproductive problems
- Loss of fish and wildlife habitat

The lakewide critical pollutants that have been identified as impairing or likely to impair these beneficial uses include PCBs, DDT and its metabolites, dioxins/furans, mirex, mercury, and dieldrin. Exotic species, lake level management, and the physical loss, modification, and destruction of habitat have been identified as the biological and physical factors contributing to lakewide use impairments.

The Four Parties plan to prioritize source reduction efforts to address the most significant contributors of critical pollutants to Lake Ontario. Based on the limited loadings data available, it appears that a significant load of critical pollutants to the lake originates outside the Lake Ontario basin. The upstream Great Lakes basin contributes the majority of the estimated loadings of PCBs (440 kg/yr), DDT and its metabolites (96 kg/yr), and dieldrin (43 kg/yr). Attention must also be focused on the Niagara River, since most of the mirex entering Lake Ontario originates in the Niagara River basin (1.8 kg/yr) and it also contributes to the load of other critical pollutants into the lake. Atmospheric deposition is a source of critical pollutants and appears to be the largest known source of dioxins/furans, contributing approximately 5 grams per year.

The LaMP will also seek to address the inputs of critical pollutants from water discharges within the Lake Ontario basin, including point sources discharged directly to the lake and point and non-point discharges into tributaries to the lake.

The local use impairments identified in this chapter are best addressed on a local level through the development and implementation of Remedial Action Plans and other local management efforts. Through the LaMP, the Four Parties seek to restore the lakewide beneficial uses of the lake by reducing the input of critical pollutants and persistent, bioaccumulative toxics to the lake and by addressing the biological and physical factors identified above. The Four Parties will also work to improve the database on sources and loadings of critical pollutants and other factors causing these impairments.

4.1 Introduction

The Four Parties have implemented programs and undertaken activities, both regulatory and voluntary, that have resulted in measurable improvements lakewide. Other actions have led to small incremental gains in localized areas. Remedial Action Plan (RAP) projects are reducing pollutants, cleaning up the environment, and restoring habitat in Areas of Concern (AOC). Joint federal/state and federal/provincial programs to reduce sources of pollutants to the lake have been ongoing under the Lake Ontario Toxics Management Plan (LOTMP). There is a renewed commitment, in the 1996 Letter of Intent signed by the Four Parties (see Appendix C) and in this Plan, to those LOTMP programs that have been working to restore the beneficial uses of the lake.

Environmental progress is evident in the reduced levels of contaminants in lake biota and other ecological improvements.

This chapter provides a summary of the progress, both programmatic and environmental, that has been made to date in Lake Ontario. In both the U.S. and Canada, there has been progress in fulfilling commitments that were made in the LOTMP, as well as in initiatives undertaken outside the scope of the LOTMP. Environmental progress is evident in the reduced levels of contaminants in lake biota and other ecological improvements.

4.2 Progress Under The LOTMP

The LOTMP has focused specifically on the reduction of persistent toxic contaminant loadings to the lake. Commitments were made by the Four Parties in 1989, 1991, and 1993, and include both existing and developing programs. Highlights of achievements under these programs are described below. A detailed table specifying LOTMP commitments and their status is provided in Appendix F.

Binational Activities

Niagara River Toxics Management Plan

The Niagara River Toxics Management Plan (NRTMP) was initiated in 1987 as a binational process designed to achieve significant reductions of toxic pollutants in the Niagara River. Eighteen priority toxics were identified and 10 (including Lake Ontario LaMP critical pollutants dioxin, mercury, mirex, and PCBs) were selected for 50 percent reduction because these were deemed to have Niagara River sources. The 1996 NRTMP progress report indicates that the Four Parties have made significant progress towards achieving the commitments made in the 1987 Niagara River Declaration of Intent. Remedial actions at sources have substantially reduced inputs of chemical pollutants to the Niagara River. A Letter of Support was signed by the Four Parties on December 3, 1996, to continue the commitment to the Declaration of Intent and to further actions to reduce loadings of toxic chemicals to the Niagara River.

NRTMP Letter of Support -- The Four Parties reaffirmed their commitment and set a new goal of reducing toxic chemicals in the river in order to achieve water quality that protects human health, aquatic life, and wildlife.

Point Sources — Under the Canadian portion of the NRTMP, the Ontario Ministry of the Environment (MOE) monitored the effectiveness of control actions at 21 Canadian point sources between 1986 and 1995. As of 1995, the number of Ontario point sources directly discharging to the Niagara River had been reduced to 16. The data show that the daily loadings of 18 priority toxics have been reduced by 99 percent over that period of time. None of the 10 chemicals targeted for 50 percent reduction were detected at any of the 15 facilities sampled in 1995.

Under the U.S. plan, the New York State Department of Environmental Conservation (NYSDEC) monitored the 29 most significant U.S. point sources of toxic pollutants to the river. Twenty-six of these dischargers are still operating. Between 1981/1982 and 1985/1986, NYSDEC reported an 80 percent reduction in 121 organic and inorganic priority pollutants from these significant point sources. Between 1985/1986 and 1993/1994, another 25 percent reduction was reported. The NYSDEC monitoring program does not specifically track the 10 chemicals of concern, although most of them are included in the suite of the United States Environmental Protection Agency (USEPA) priority pollutants reported.

Based on information available in 1987, the U.S. identified the Falls Street Tunnel as the largest of any of its point sources of toxic pollutants. The Tunnel was once a major unlined industrial sewer cut into the bedrock under the City of Niagara Falls. By the mid-1980s, it only received overflows of wastewater from the sewers of a Niagara Falls industrial area and contaminated groundwater from major waste sites that infiltrated through cracks in the bedrock. Unlike flows from other point sources, flows from the Falls Street Tunnel entered the Niagara River untreated. In 1993, USEPA and NYSDEC required the City of Niagara Falls to treat the contaminated water flowing in the Falls Street Tunnel during dry weather at the Niagara Falls treatment plant. Information gathered by the U.S. shows that wastewater treatment has reduced loadings to the river of mercury by 70 percent, tetrachloroethylene by 85 percent, and four other priority toxic chemicals by almost 100 percent. The Tunnel's wet weather flow is intermittent and, in 1994, averaged about 3 million gallons on overflow days. Monitoring by the City of Niagara Falls continues to better characterize the Tunnel's wet weather loads of toxic chemicals.

Non-Point Sources — Given the limited available information on non-point sources, the U.S. has proceeded with its actions based on the conclusions of the NRTMP that hazardous waste sites and contaminated sediments are the most significant non-point sources of toxic chemicals to the river.

Under their non-point source plan, USEPA and NYSDEC surveyed their hazardous waste sites and identified 26 sites believed to have the greatest potential for toxic pollutant loadings to the Niagara River. Accelerated

remediation schedules were established for these sites. To date, remedial construction has been completed at 8 of these sites, and remedial activities are underway at 10 sites. The remaining sites are under design or study. Based on various simplifying assumptions that are still being tested, USEPA estimates that remediations to date have reduced loadings to the river by at least 25 percent. USEPA also estimates that remedial activities to be completed by 1998 will reduce the loadings to the river by 90 percent. Remedial measures designed to minimize or eliminate offsite loadings of contaminants include removal and/or containment of contaminated soils and groundwaters, and treatment of contaminated groundwaters. All of the sites will be remediated by the year 2000.

Under the Canadian non-point source plan, MOE surveyed its landfills in a 1981-1984 study. Five municipal landfills were identified as having the potential to contribute contaminants to the river. Later studies conducted by MOE, in 1991 and 1993, showed that these landfills had minimal impact on the river.

Under Canadian and U.S. programs, contaminated sediments in several tributaries to the Niagara River have been cleaned up. Using innovative dredging techniques, 10,500 m^3 (13,800 yds^3) of sediments contaminated with heavy metals, oil, and grease were removed from the Welland River. Adjacent wetlands are being restored. About 6,000 m^3 (8,000 yds^3) of contaminated sediments were removed from Gill Creek and 22,000 m^3 (29,000 yds^3) of contaminated sediments were removed from Bloody Run Creek. Pettit Creek Cove was restored to a wetlands after 18,000 m^3 (23,500 yds^3) of contaminated sediments were removed.

The progress made at the hazardous waste sites and in tributary cleanups appears to be reflected in a preliminary analysis of biomonitoring data recently collected by MOE. Data were from caged mussels placed at the mouth of Bloody Run Creek and in the Pettit Flume. Bloody Run Creek was historically contaminated with dioxin from the Occidental Chemical Hyde Park site. As shown in Figure 4-1, the concentrations of dioxin in caged mussels in 1994 and 1995 are less than half those found in 1993, suggesting that remedial actions may have considerably reduced the bioavailability of pollutants to the Niagara River from this area. The preliminary data in Figure 4-2 also show that concentrations of several chlorobenzenes in caged mussels at Pettit Flume were considerably lower in 1995 than those found in previous years, suggesting the positive effects of remedial activities undertaken to date at Occidental Chemical Durez in North Tonawanda.

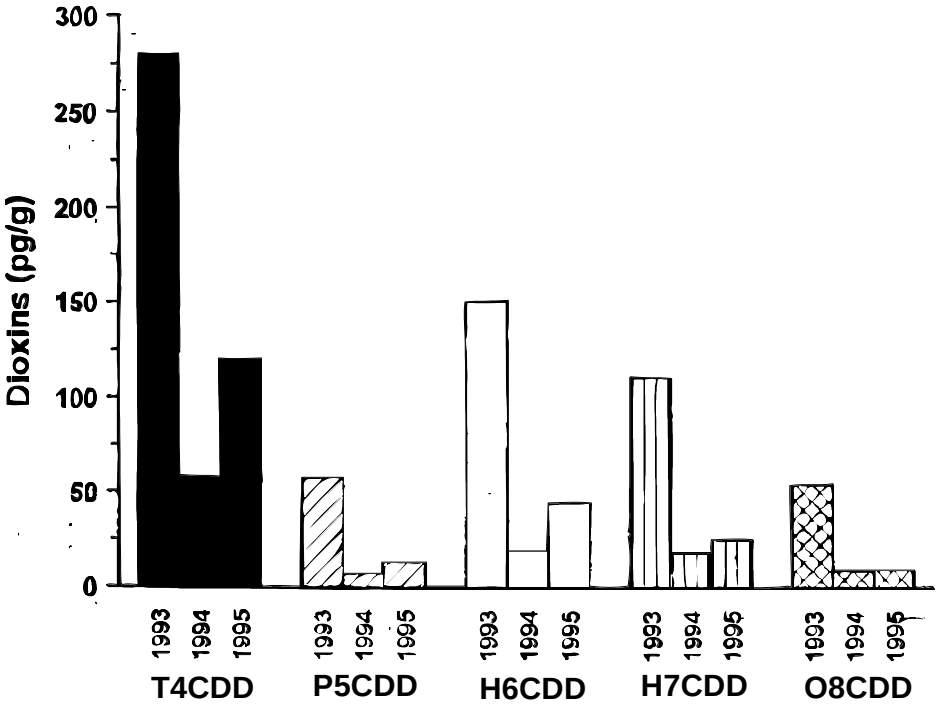


Figure 4-1. Caged Mussel Tissue Concentrations (n=1)
Niagara River, 1993-1995; Bloody Run Creek

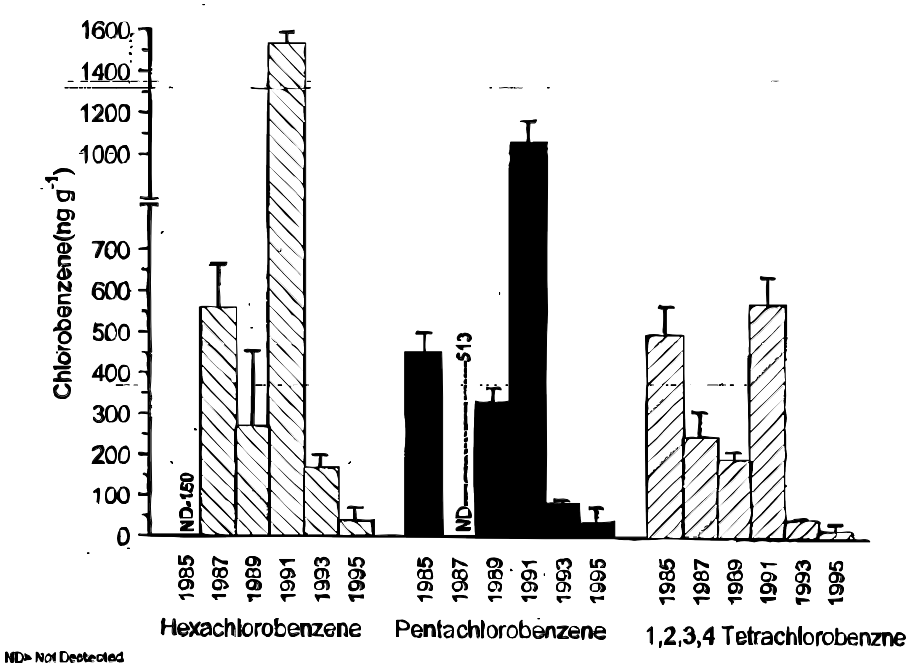


Figure 4-2. Caged Mussel Tissue Concentrations (mean±SD, N=3)
Niagara River, 1985-1995; Pettit Flume

Mass Balance Models

Mass balance models were developed that relate loadings of toxic contaminants to the lake to levels in water, sediment, and fish. These models provide an initial technical basis for determining load reduction targets, estimating how long it will take to meet these targets, and planning for additional measures necessary to achieve load reduction goals.

Draft Ecosystem Objectives

Draft ecosystem objectives were developed for wildlife, habitat, aquatic communities, human health, and stewardship. These have provided a basis for establishing targets, or ecosystem indicators, as a means to check on the effectiveness of remedial activities.

Setting Priorities for Toxic Chemicals

Toxic chemicals were categorized by comparing Lake Ontario ambient data (fish tissue, water column, and sediment) to U.S. and Canadian standards, criteria, and guidelines. This system is used to determine either that a toxic chemical warrants corrective action on a priority basis, or that it can be controlled more routinely through the implementation of existing and developing programs that apply to the control of all toxics.

United States Activities

Point Sources

The Clean Water Act (CWA) authorizes USEPA and approved states to administer the National Pollutant Discharge Elimination System (NPDES) program, which is the basic regulatory mechanism for controlling the discharge of pollutants from point sources to surface waters of the United States. The NPDES program was delegated to NYSDEC on October 28, 1975, and is referred to as the State Pollutant Discharge Elimination System (SPDES). New York's SPDES program regulates wastewater discharges to surface and ground waters, ensuring that all major industrial permits in New York's Lake Ontario basin include the best available technologies that are economically achievable for toxic pollutants, and all major publicly owned treatment works meet the requirements of secondary treatment or advanced treatment necessary to achieve water quality requirements. Permits have been revised to include more stringent limits as required to meet ambient *water quality standards*. In the New York portion of the Great Lakes basin, there is widespread compliance with SPDES permits. Through the SPDES program, NYSDEC also operates a data management system, compliance monitoring program, operator technical assistance program, enforcement program, and inspection program, as well as responds to citizen complaints and third party legal actions. USEPA and NYSDEC have established formal enforcement

processes to identify instances of significant non-compliance, and NYSDEC's enforcement program addresses all NYSDEC permit program violations of the approximate 1,620 universe of significant permitted dischargers in New York State. NYSDEC and USEPA conduct annual inspections at major facilities in the state. NYSDEC regularly updates permit development and enforcement data in the Permit Compliance System (PCS) national data base.

To achieve the LOTMP goal of 100 percent compliance with *Final Effluent Limits,* the Great Lakes Enforcement Strategy identified seven facilities with significant pollution violations in 1994. Follow-up activities returned three of these facilities to compliance; the remaining four are engaged in formal enforcement actions that will lead to the correction of their problems. All of the 39 major municipal dischargers are now in compliance with Final Effluent Limits (FEL) or have judicially enforceable schedules to meet FELs.

Pollution Prevention

New York State has banned the use of DDT, mirex, and dieldrin. Allowable uses of mercury have also been severely restricted. Production of PCBs and their use in the manufacture of new equipment are no longer allowed. Older equipment and transformers containing PCBs are being systematically removed from service and properly disposed.

In 1993, USEPA conducted pollution prevention inspections at seven industrial facilities in the Lake Ontario basin. These facilities included manufacturers of electrical insulators, treated wood products, and metal cans. As a result of the inspections, pollution prevention measures were implemented that eliminated about 43 percent (213,000 lbs.) of toxic chemical pollutants.

USEPA's *33/50 Program,* which was completed in 1996, targeted 17 toxic chemicals for reduction through voluntary partnerships with industries throughout the U.S. The program's goals were to reduce releases of the targeted chemicals by 33 percent, from 1988 to 1992, and by 50 percent by 1995. In New York State alone, 230 facilities participated in this program. 1994 data show a reduction of 49.8 million pounds of toxic chemicals (from a 1988 baseline of 72.9 million lbs.). Although still under review, these data demonstrate that the 50 percent goal has already been exceeded in New York.

Non-Point Sources

New York State's solid waste program promotes integrated waste management using the following priorities: 1) waste reduction; 2) recycling and reuse; 3) waste to energy; and 4) landfilling. New regulations require specific measures to be taken to safeguard public

health and the environment through monitoring, investigation, and the use of state of the art technologies. Solid waste facilities are required to demonstrate that recycling options have been explored. Programs within the Lake Ontario basin are working to achieve a 50 percent waste reduction/recycling target from 1989 levels, close the 55 environmentally unsound landfills, and close approximately 300 municipal, institutional, and private waste incinerators. All of these activities will contribute to achieving an overall reduction of emissions and releases of a wide variety of contaminants -- goals of the LOTMP.

New York State completed a registration program that compiles information on the installation, maintenance, and monitoring of bulk storage facilities. USEPA completed a user friendly data base and hotline which makes information on chemical spills more widely available to the public.

Hazardous waste treatment, storage, and disposal facilities (TSDFs) are managed under the federal Resource Conservation and Recovery Act (RCRA) through a permit process. Active waste facilities are required to meet minimum safety standards in the construction of facilities, treatment equipment, and storage tanks. Facility operators are also required to identify existing on-site contamination problems and to develop corrective action programs to address these problems. These facilities are also required to certify that waste minimization is an important component of the facility's operation. Forty-six hazardous waste management facilities operate in the Lake Ontario drainage basin on the U.S. side. Since 1988, eight of the nine hazardous waste land disposal sites have been or are in the process of being closed (e.g., these sites no longer accept hazardous waste). One facility (Chem Waste Management) currently operates an active land disposal facility and is in regulatory compliance. Thirty-five storage and treatment facilities are all in regulatory compliance, and 80 percent of these facilities are in the process of being closed. Two incinerator facilities are in regulatory compliance.

The LOTMP identified seven inactive hazardous waste sites in the Lake Ontario basin, under the federal Superfund program, where remedial actions had not been completed. Remedial actions at four of these seven sites have now been completed. Two of the remaining sites are under remedial construction and the other site is in design.

USEPA, in partnership with Erie County (New York), has established a "Clean Sweep" program to help farmers in the Lake Ontario basin dispose of unwanted and/or banned pesticides in an environmentally safe manner. Starting with a pilot program in Erie County, the Clean Sweep program has spread to 14 other New York State counties, and more are expected to be added. To date, over 120,000 pounds (gross) of agricultural hazardous or toxic products have been collected and properly disposed, including DDTs, dioxin-contaminated pesticides, chlordane, arsenic, lead, and mercury.

Clean Sweep
(Pesticide Collection)
Monroe County, New York
(Monroe County Cooperative Extension)

USEPA funded Genesee, Livingston, Orleans, and Wyoming Counties to hold two Household Hazardous Waste Collection Events in April 1996. The purpose of these events was two-fold: 1) to recycle or safely dispose of household hazardous waste; and 2) to educate the public about managing existing hazardous materials to reduce waste in the future. A total of 510 citizens participated in this event, and the following materials were collected: 3,717 pounds of pesticides, 86 pounds of dioxin-contaminated pesticides, 32,000 gallons of various hazardous materials, and other waste materials such as tires and lead acid batteries. Some materials were incinerated or landfilled, but as much as possible was recycled.

In January of 1990, USEPA approved NYSDEC's Non-point Source (NPS) Management Program, which makes recommendations for reducing the most significant sources of NPS pollution in waters of New York State. Since that time, USEPA has provided $19.17 million to NYSDEC for implementation of this program, including funding for local implementation efforts. Funding provided by USEPA is supplemented by New York State's Environmental Protection Fund (EPF). The EPF is a dedicated environmental fund that can be used to finance non-point source water pollution abatement and control projects. Six of the seven separate programs under the EPF provide funding to eligible recipients in the Lake Ontario watershed:

- Non-point Source Implementation Grants Program (non agriculture) whose eligible recipients are municipalities or entities designated to act on their behalf;

- Agricultural Non-point Source Abatement and Control Grants Program whose eligible recipients are County Soil and Water Conservation Districts;

- Title 3 and Title 5 Solid Waste Program whose chief goal is the funding of the proper closure of municipally-owned solid waste landfills;

- Open Space Program for the purchase of sites and easements that are listed in the State Open Space Conservation Plan;

- Agricultural Open Space Program for projects that implement approved local agricultural protection plans; and

- Title 11 - Local Waterfront Revitalization Program for the funding of planning and construction of projects including waterfront revitalization, public access, natural resource protection including water quality improvement, and water dependent uses and activities. Eligible recipients are cities, towns, and villages located along coastal areas of the state and certain inland waterways.

A number of other programs support the implementation of non-point source control projects in the Lake Ontario watershed including:

Clean Water State Revolving Fund (CWSRF)
Pursuant to the Clean Water Act, USEPA provides grants to NYSDEC to help capitalize the CWSRF, enabling NYSDEC to provide loan assistance for non-point source projects. To be eligible for CWSRF financing, a project must be publicly-owned and the primary purpose of the project must be water quality protection.

Clean Water/Clean Air Bond Act of 1996
In November 1996, New York voters approved the expenditure of $1.75 billion for the Clean Water/Clean Air Bond Act. A portion of these funds will be used to construct non-point source projects. Projects located within specific geographic areas and identified as a need in water quality management plans (including the Lake Ontario LaMP) will receive a higher priority for funding.

Environmental Quality Incentives Program (EQIP)
This program is derived from the 1996 Federal Farm Bill. It is designed to provide grants to farmers for eligible conservation practices including those whose primary purpose is water quality protection.

Conservation Reserve Program
Like the EQIP Program, this is a new program derived from the 1996 Federal Farm Bill. It is designed to provide grants to farmers, land owners, and producers for eligible conservation practices including those whose primary purpose is water quality protection and wildlife management.

Skaneateles Lake Watershed Agricultural Program
This program was created by the City of Syracuse. The primary emphasis is to ensure the long-term protection of the water supply source for the people served by this water system. The funding takes the form of “whole farm planning” and covers a multitude of point and non-point source pollution abatement projects within the Skaneateles Lake Watershed.

Clean Vessel Assistance Program
With funds provided by the U.S. Department of the Interior’s Fish & Wildlife Service, NYSDEC assists local marina operators to install pump-out facilities. Approximately $2 million in grants has been provided to date to fund these activities.

Canadian Activities

Activities conducted by Canadian federal and provincial agencies have focused on addressing the sources, fate, and impacts of persistent toxic substances. These activities have, in large measure, addressed the commitments under the LOTMP. The LOTMP list of priority pollutants was derived based on these individual or binational activities (see Appendix B). This list, along with the chemicals identified in the Niagara River Toxics Management Plan, the Lake Superior Binational Program, and the International Joint Commission's list of 11 priority chemicals subsequently provided the basis for Canada's and Ontario's Tier I substance list. Tier I substances are targeted for virtual elimination in the 1994 Canada-Ontario Agreement respecting the Great Lakes Basin Ecosystem (COA). COA has adopted the philosophy of zero discharge for local or direct sources, and the agency activities under COA (described more fully in section 4.3 and Chapter 5) have targeted the chemicals PCBs, mirex, dieldrin, DDT, dioxins, and mercury, which are also critical pollutants of the Lake Ontario LaMP.

Point Sources

Since 1993, Ontario has promulgated Clean Water Regulations under its MISA (Municipal and Industrial Strategy for Abatement) program for nine industrial sectors: organic chemicals, iron and steel, pulp and paper, petroleum refineries, metal casting, metal mining, inorganic chemicals, industrial minerals, and electric power generation. Initiated in 1988, these regulations predate the LaMP, but recognize the LOTMP goals and objectives in that the MISA goal is to ensure necessary treatment or technology is applied to direct discharges to eliminate toxicity or local impacts and achieve the virtual elimination of persistent toxic and bioaccumulative substances. The regulations provide for reductions of toxic contaminants that are discharged to Ontario's waterways and stipulate that these discharges must not be acutely lethal to fish or water fleas. The goal for the 34 regulated plants located within the basin is the use of best available treatment technologies to substantially reduce pollutant loadings. Compliance with the MISA regulations will achieve more than a 70 percent reduction in the release of toxic pollutants to the waters of Lake Ontario by 1998. The virtual elimination of releases of persistent toxic substances, such as dioxins, is one benefit of this activity.

New federal pulp and paper regulations, effective in 1992, apply to eight pulp and paper mills in the Lake Ontario basin, five in the St. Catharines/Thorold area and three in the Bay of Quinte. These regulations prevent the formation of highly toxic dioxins and furans and also set stringent controls on acute toxicity.

Pollution Prevention

Canada and Ontario have established a number of voluntary partnerships with industrial and commercial associations, communities, municipalities, and member companies to prevent toxic chemical discharges to the Great Lakes. These partnerships use a variety of instruments, such as Memoranda of Understanding (MOUs) and the Pollution Prevention Pledge Program (P_4). Voluntary projects under these programs are designed to target reductions in the use, generation, and release of toxic substances, such as chlorinated solvents, volatile organic carbons, and PCBs.

Substantial progress has occurred as a result of pollution prevention projects. The Auto Parts Manufacturers, Chemical Producers, and Metal Finishers reported a reduction of over 16,000 metric tonnes of toxic substances and wastes, province-wide, by the end of 1995. An additional reduction of 21,000 metric tonnes has been reported by facilities involved in the P_4 program. The Motor Vehicle Manufacturing Association has reported reducing/eliminating over 800 metric tonnes of PCBs from plants located in the Lake Ontario basin.

The national program, Accelerate Reduction/Elimination of Toxics (ARET) also focuses on voluntary reductions of emissions; 101 substances are targeted for reduction from either direct or indirect industrial discharges to air, land, and water. The goal is a 90 percent reduction of persistent bioaccumulative toxic emissions and a 50 percent reduction of other toxic substance emissions by the year 2000. Under the ARET challenge, a total of 287 organizations across Canada have responded, over 100 of which are located in Ontario. Together, these facilities have committed to voluntary reductions in emissions of toxic substances of nearly 17,500 metric tonnes nationally (as of year-end 1995). By tying this voluntary program to the national Pollutant Release Inventory, which requires an annual reporting of 187 chemicals, the amounts of chemicals reduced will be tracked.

Non-Point Sources

MOE, in conjunction with municipalities, has implemented measures designed to improve water quality and restore degraded areas. To abate sewer overflows and stormwater discharges, combined sewer overflow (CSO) storage facilities have been constructed and sewage treatment plant operations have been changed to reduce CSO by-passes. MOE financially supported a number of abatement projects in communities in the Lake Ontario basin. These projects will significantly reduce beach pollution, control algae problems, and enhance nearshore

aquatic ecosystems that have been stressed by contaminants from combined sewer overflows and stormwater. MOE has also developed several guidance documents and procedures to assist communities in the development of stormwater management/CSO control measures and the preparation of sub-watershed management plans.

Farmers in Ontario are developing and implementing Environmental Farm Plans (EFPs) with up to $5.6 million in support through the year 2000 from the Agriculture Adaptation Council. A number of agricultural organizations, such as Ontario Soil and Crop Improvement Association, Ontario Federation of Agriculture, AgCare, and the Christian Farmers Federation, are lending support. The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) will continue to provide technical support to the EFP initiative. Approximately 10,000 farmers have voluntarily attended farm plan workshops, and 5,186 approved integrated action plans and implementation strategies are in place to improve pest management and control erosion and agricultural runoff from farms.

Over the past five years, the partnership of OMAFRA and the Crop Protection Institute, MOE, and AgCare has instituted an Agricultural Pesticides Container Collection Program. One million containers have been collected over the past two years. These containers are then recycled into agricultural products, such as 475,000 fence posts in 1996. By diverting containers from landfill sites, this program reduces the potential for environmental impacts from the residual pesticides in the container. The number of containers collected is expected to decrease in forthcoming years because more efficient pesticide use results in the generation of fewer containers. Ontario has banned the use of several of the Lake Ontario critical pollutants (DDT, dieldrin, and mirex) and, in cooperation with Environment Canada (EC), recently confirmed that no legal use is taking place in Ontario. Long-standing restrictions on the use of PCBs to closed systems have prevented any deliberate releases to the ecosystem; accidental releases are a possibility, which is why the decommissioning and destruction of PCBs are being accelerated in Ontario.

Remedial Action Plans in Areas of Concern

Remedial Action Plan development and implementation continues in the Niagara River, Hamilton Harbour, Toronto Harbour, Port Hope, Bay of Quinte, Oswego, Rochester Embayment, and Eighteenmile Creek Areas of Concern. Table 4-1 outlines the status of RAP development for all Lake Ontario Areas of Concern. RAPs are developed and implemented in three phases:

1) problem definition,
2) recommended actions and implementation plan, and
3) monitoring to confirm restoration of beneficial uses.

Table 4-1. Status of RAP Development

		Stage 1	Stage 2	Stage 3
Canadian Remedial Action Plans	Hamilton Harbour	X	X*	
	Metro Toronto	X	X	
	Port Hope	X		
	Bay of Quinte	X	X	
Niagara River	Canada	X	X	
	U.S.	X	X	
United States Remedial Action Plans	Oswego River	X	X	
	Rochester Embayment	X	X	
	Eighteenmile Creek	X	X	

*Hamilton Harbour's Stage 2 includes an implementation annex.

In addition to RAPs, other local environmental planning efforts are underway that will contribute to a reduction in Lake Ontario critical pollutants. These efforts include a wide range of pollution prevention programs. For example, the Onondaga Lake Management Conference (OLMC), in the Syracuse area, is developing a comprehensive restoration, conservation, and management plan to coordinate a wide range of state, federal, and local efforts aimed at improving the environmental quality of Onondaga Lake. Although this plan is primarily focused on conventional pollutants common to most municipal sewage systems, the plan also identifies waste sites that contain Lake Ontario critical pollutants, such as PCBs. The OLMC makes specific action recommendations to ensure that contaminants at these waste sites, which include Lake Ontario critical pollutants, will be fully addressed.

4.3 Progress Under Initiatives Outside the Scope of the LOTMP

Lake Ontario Specific Initiatives

United States Activities

USEPA and NYSDEC are conducting a "Source Trackdown" project in order to facilitate the identification and remediation of contaminant sources to the lake. "Trackdown" involves the use of qualitative tools (Passive In-Situ Chemical Extraction Samplers, or "PISCES") for organic sampling in order to find tributaries that have the highest concentrations of PCBs. Once these tributaries are identified, the PISCES are moved upstream to trackdown the source of the contamination. The findings of the initial sampling are provided in NYSDEC's April 1996 report entitled "Trackdown of Chemical Contaminants to Lake Ontario from New York State Tributaries". USEPA and NYSDEC are forming a federal/state workgroup to use the findings of this report to focus source reduction efforts on the most contaminated sub-basins throughout Lake Ontario, as well as to confirm unknown sources, determine the effectiveness of remediation activities, and plan follow-up sampling activities. NYSDEC has conducted similar sampling efforts in the Niagara River. Additionally,

NYSDEC developed and maintains a Great Lakes Sediment Inventory to identify hot spots of contaminated sediments and to prioritize remediation efforts.

USEPA and NYSDEC have implemented a long-term plan to improve modeling capabilities, with a small but steady outlay of funds, to increase confidence in the use of models over time and obtain results that can be practically applied. The Great Lakes Research Consortium (GLRC) has been funded to determine the steps necessary to enhance existing models for Lake Ontario. These agencies expect to be able to implement a set of improvements each year and hope to obtain matching funds from interested parties. USEPA and NYSDEC will consult with Canadian scientists/modelers in the development of this program. The agencies expect to make incremental improvements over an approximate 10 year time period. The program will be evaluated annually and necessary modifications will be made.

Canadian Activities

EC has completed the demonstration of a number of contaminated sediment removal and treatment technologies from around the world. Many of these technologies have been used in completing full-scale sediment removal and cleanup along Toronto's waterfront (47,000 m^3) and others have been demonstrated in Hamilton Harbour.

EC has also been working closely with municipalities and MOE to demonstrate cost effective solutions to control urban drainage and CSOs, as well as optimize sewage treatment plants. In Hamilton, the installation of two CSO settling tanks has resulted in the opening of beaches at the revitalized Pier 4 Park and the new Harbourfront Park. Throughout Lake Ontario communities, the Cleanup Fund and MOE are working with municipalities and research agencies to retrofit stormwater ponds for improving water quality. Pollution Control Plans that identify sources of urban drainage pollution and recommendations for their control have also been undertaken at St. Catharines, Toronto, Hamilton-Wentworth, Scarborough, Kingston, and Belleville. In addition, two Metro Toronto waterfront improvement planning projects have been completed.

A preliminary Historical Land Use Inventory was prepared for the Waterfront Regeneration Trust's Lake Ontario Greenway which extends from Burlington to Trenton along the north shore of Lake Ontario. This inventory consists of locations of past and current land uses that could have caused contamination of structures, soils, groundwater, and/or surface water.

Great Lakes-wide or State/Province-wide Initiatives

United States Activities

The Great Lakes Water Quality Guidance (GLWQG) represents a major United States-specific effort to reduce the loadings of persistent bioaccumulative chemicals of concern (BCCs) to the Great Lakes basin and establish consistency among the water pollution control programs of the U.S. Great Lakes States. The final GLWQG is the result of the 1990 Great Lakes Critical Programs Act, which required USEPA to develop and publish the GLWQG. The eight Great Lakes States have completed the adoption process and are beginning to implement the regulations, policies, and procedures contained in the Guidance. More details on the effects of New York's implementation of the Guidance are provided in Chapter 5.

Over the last five years, USEPA has published hazardous air pollutants (HAP) emission standards for many industries. These Maximum Achievable Control Technology (MACT) standards will require about 80 percent HAP emission controls from chemical, refining, coke-ovens, chromplating, degreasing, dry-cleaning, and other industries. These standards also require sources to control fugitive emissions and are expected to reduce the air emission loading substantially. NYSDEC is currently planning to modify its air toxics program to meet the MACT program.

A workgroup of the eight Great Lakes States and three USEPA Regions was formed in 1992 to develop an Enforcement Strategy to ensure consistent enforcement for persistent toxic substances in the Great Lakes. The Great Lakes Enforcement Strategy was issued on September 17, 1993, and was implemented beginning October 1, 1993. Since that time, the number of critical pollutant violations has been reduced by 30 percent, and point source loadings for these pollutants have also diminished.

Canadian Activities

In Canada, the implementation of the Great Lakes Water Quality Agreement is a shared federal-provincial responsibility. The COA was signed in 1994 and follows federal/provincial agreements which have been in place since 1971.

The Second Progress Report under the 1994 Agreement was released in the fall of 1997 and focuses on the progress achieved toward the reduction of substances of concern by Canada, Ontario, and their partners, since the publication of the First Progress Report in September 1995:

Forty-six percent of the high level liquid PCBs in Ontario have been decommissioned (i.e., placed in storage) from a baseline of 10,650 metric tonnes. Thirty percent of the high level PCB wastes in Ontario have been destroyed from a baseline of 18,600 metric tonnes. Twenty percent of the stored low level PCB wastes have been destroyed from a baseline of 98,000 metric tonnes.

Total releases of seven Tier I substances targeted for 90 percent reduction have been estimated at 22 metric tonnes per year. Some reductions have occurred with respect to alkyl-lead (85%), octachlorostyrene (18%), dioxins and furans (66%), and B(a)P (20%). Reductions have occurred in the release of four of the eight Tier II substances: cadmium (20%), 1,4-dichlorobenzene (40%), PAH (30%), and pentachlorophenol (5%).

COA Target Achieved: Based on a comprehensive review, no legal commercial use or availability within Ontario's commercial sectors of the five priority substances (aldrin/dieldrin, chlordane, DDT, toxaphene, and mirex) have been confirmed.

Some success has been achieved in attaining industry commitments and implementation of pollution prevention programs province-wide. Reductions reported through MOUs include:

-- 1,600 metric tonnes volatile organic compounds;
-- 1,500 metric tonnes hydrocarbons;
-- 660 metric tonnes wastewater treatment sludges;
-- 450 metric tonnes metal working fluids; and
-- 330 metric tonnes paints/paint sludges.

In 1996, two new guidelines were introduced in Ontario which will contribute to Canada's overall load reduction effort in the Lake Ontario basin. An Incineration Guideline includes stringent emission limits for new municipal incinerators. The new guideline is based on emission levels that are protective of the environment and human health and requires the best currently available technology. This requirement is equivalent to the limits imposed in other jurisdictions. Guidelines for Use at Contaminated Sites in Ontario (Decommissioning Guidelines) have replaced existing guidelines and provide clearer direction and information on approaches to managing and restoring contaminated sites.

4.4 Progress In Improving Fish and Wildlife Habitat and Populations

Many habitat restoration and protection projects are underway in the Lake Ontario basin (Figure 4-3). The following information provides some highlights of the projects supported, in part, by federal, provincial, and state agencies as well as various county, conservation authority, municipal, and private organizations.

Over the last two decades, governmental regulations protecting lake-connected wetlands, shorelines, and *littoral* zones have significantly reduced the rate of loss of these valuable habitats. Since the loss of significant wetland and shoreline habitats has been curtailed, more attention is now being given to identifying the opportunities to restore and replace degraded or lost habitats.

United States Activities

Several New York State habitat restoration and protection projects are being conducted through the cooperative efforts of county, city, local, and private organizations as well as state and federal agencies. The New York

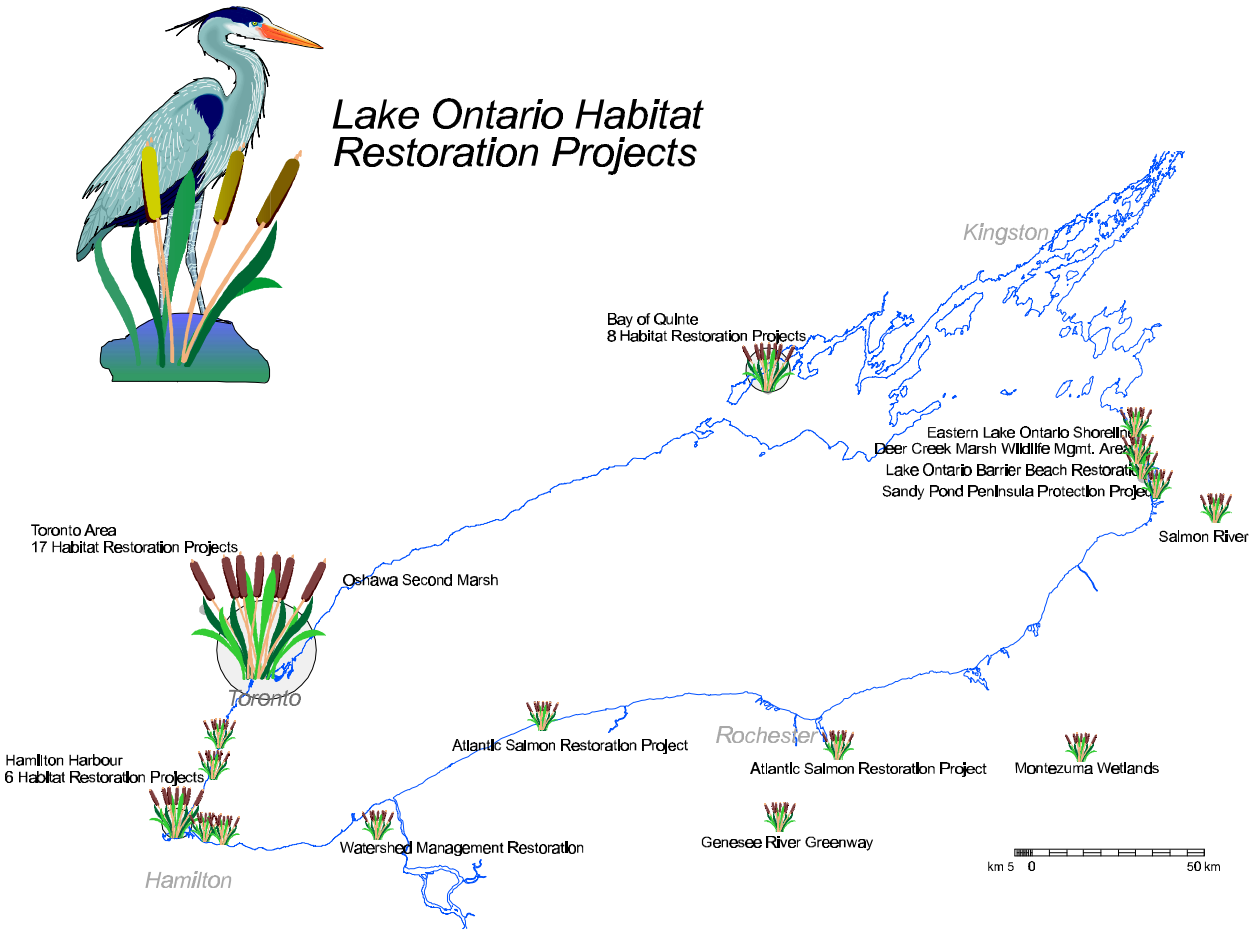


Figure 4-3. Lake Ontario Habitat Restoration Projects [Many local restoration projects are in progress or proposed in the Lake Ontario basin which are not highlighted in this figure.]

State Open Space Conservation Plan provides a statewide process to identify and acquire undeveloped habitats. The state works in partnership with local governments, non-profit conservation organizations, and private landowners to establish and achieve land conservation goals. Funding for the program is provided by the state's Environmental Protection Fund and, where possible, leveraged by federal and other sources of funding. Ongoing habitat acquisition programs include: Salmon River Corridor, Northern Montezuma Wetlands, Genessee Greenway, and Eastern Lake Ontario shoreline.

The Ecological Protection and Restoration Program of USEPA's Great Lakes National Program Office provides funding for a variety of Great Lakes habitat restoration projects. For Lake Ontario, projects include: wetland creation in the Lower Genessee River/Irondequoit Bay; barrier beach and wetlands habitat restoration on the Lake's shoreline; barrier beach restoration and stabilization; public education; creation of wildlife nesting habitat and exotic vegetation control at Deer Creek Marsh Wildlife Management Area; and protection and restoration of Sandy Pond Peninsula.

Wildlife population rehabilitation occurs primarily indirectly through habitat creation and restoration projects. However, direct efforts are currently underway to assist the recovery of river otter populations in the Lake Ontario basin. In 1995, the non-profit New York River Otter Project began the process of introducing nearly 300 river otters to the Lake Ontario basin.

Canadian Activities

EC's Cleanup Fund is currently supporting, in conjunction with its many partners, more than 30 habitat rehabilitation projects in the Lake Ontario watershed. These projects, primarily in Toronto, Hamilton, and the Bay of Quinte, include creating various nesting and loafing areas for birds such as eagles, ospreys, and terns; enhancing fish spawning habitats; improving littoral and deep water habitats; improving fish access; rehabilitating and creating riparian habitat; and placing structural fish habitat in the form of shoals, reefs, brush bundles, and log cribs. Other projects focus on coastal wetland rehabilitation and reforestation activities on flood plains and stream banks. A total of 76 projects has been initiated in the Lake Ontario basin since 1990. The Cleanup Fund's support of these projects is over $16 million, with additional partners contributing $33 million.

In the Lake Ontario basin, by March of 1996, 45 km of riparian and 40 hectares (ha) of wetland habitats had been rehabilitated as a result of project activities supported by the Cleanup Fund and its partners.

Rehabilitation of an additional 18 km of riparian habitat and 409 ha of wetlands is in progress. Further, approximately 80 km of riparian habitat has been protected through activities associated with the rehabilitation projects.

Re-establishing aquatic vegetation at Bluffers Park, Toronto, Ontario
(Metro Toronto Region Conservation Authority)

Throughout Lake Ontario, initiatives are underway that will benefit other rehabilitation projects such as techniques for the control of carp, nesting platforms, re-establishing tall grass prairie, erosion control using bio-engineering techniques, and techniques to prevent wildlife from consuming newly planted vegetation.

Canada's Great Lakes Wetlands Conservation Action Plan (GLWCAP) is a five year plan that focuses on the conservation of coastal wetlands along the lower Great Lakes. A priority acquisition list for coastal wetland sites has been developed (Great Lakes Wetlands Conservation Action Plan, 1995a). Of the 15 sites identified, 10 are on Lake Ontario; several of these are marsh complexes rather than single discrete sites. Specific actions and priority areas for protection and rehabilitation have also been identified, including 5 along the western Lake Ontario shoreline between the Niagara River and Hamilton, 17 along the northern shore, and the remainder in eastern Lake Ontario (Great Lakes Wetlands Conservation Action Plan, 1995b). GLWCAP is being implemented through a cooperative partnership between governments and non-governmental organizations in Canada. So far, nearly 900 hectares of wetlands have been protected at priority Lake Ontario sites.

The Waterfront Regeneration Trust, a Crown Corporation, was created by a provincial act of the Legislature and received royal assent in 1992. Working with a steering committee consisting of representatives of waterfront municipalities, conservation authorities, provincial and federal ministries, and community groups, the Trust prepared and published the Lake Ontario Greenway Strategy in 1995. The strategy describes the actions needed to regenerate the waterfront from Burlington Bay to Trenton by protecting and restoring ecological health, and developing community and economic vitality. Between 1993 and 1995, the Waterfront Regeneration Trust conducted a natural heritage study, identifying significant natural areas and corridors along the north shore of Lake Ontario. This natural heritage system has been mapped on GIS and a database of associated sources of information has been tagged to each area ("A Natural Heritage Strategy for the Lake Ontario Greenway"). The Trust has also conducted an analysis of coastal processes along the north shore ("Shore Management Opportunities for the Lake Ontario Greenway").

Binational Activities

Fish population restoration activities are managed jointly by the natural resource agencies with jurisdiction for Lake Ontario. These include the Ontario Ministry of Natural Resources (MNR), the Department of Fisheries and Oceans (DFO), the U.S. Fish and Wildlife Service (USF&WS), and the NYSDEC. A binational process to develop Fish Community Objectives is underway, led by MNR and NYSDEC, and including public consultation. This process will produce long term directions for management actions such as fish stocking and habitat protection. The development of Fish Community Objectives by the Lake Ontario Committee will take into consideration a variety of interests including commercial and recreational fisheries, stocking policies, and food web dynamics. The rehabilitation of lake trout is guided by the Joint Plan for Rehabilitation of Lake Ontario Lake Trout (Schneider *et al.*, 1995). Some progress has been achieved. By 1994, natural production of lake trout in the Kingston Basin had been documented for several years (Rawson *et al*., 1994). The survival rate of adult lake trout in 1994 and 1995 exceeded the rehabilitation target of 60 percent per year. In addition, mortality induced by sea lamprey wounding has been reduced.

Efforts to restore partial self-sustainability of Atlantic salmon populations have been limited due to the damming, deforestation, and stream modification of tributaries used for spawning, as well as competition with rainbow trout.

There has been a dramatic recovery of lake whitefish and walleye populations in the east end of the lake. More active management could contribute to the further recovery of these native species.

4.5 Environmental Trends in the Lake Ontario Ecosystem

Due in part to the programs and initiatives described above, environmental progress has been documented in Lake Ontario, both in the reductions of levels of contaminants found in the organisms, water quality, and sediments within the lake and in the population numbers and reproductive success of various species found in the Lake Ontario basin. The following sections will provide a summary of trends for the lake, based on monitoring of fish and lower trophic species, water quality, and sediment during the last 20 to 25 years.

Trends in the Niagara River

The agencies' efforts to reduce point and non-point sources of toxic chemicals, combined with other widespread efforts, such as pollution prevention programs, may account for the overall reductions in toxic chemical levels that the Four Parties have observed in water, fish, and sediment data.

The Upstream/Downstream water sampling program operated by EC shows substantial decreases in the concentrations of several chemicals (e.g., octachlorostyrene, hexachlorobutadiene, and mirex). These data can be used as indicators of progress in reducing the concentrations of chemical pollutants in the river (Figures 4-4, 4-5, and 4-6). The data show decreases, not only in overall concentrations, but also in the number and magnitude of the “spikes”.

Spottail shiner (fish) monitoring data show that PCB concentrations have decreased substantially from the 1970s to the 1980s, although the decreases appear to have slowed or reversed in the latter half of the 1980s (Figure 4-7). The reasons for the recent trends are being investigated.

Sediment cores collected from the bottom of Lake Ontario at the mouth of the Niagara River tell the history of chemical inputs from the river to the lake, because many toxic pollutants are transported through the water attached to suspended sediments that eventually settle to the lake bottom. Analyses of core sample segments can show the concentrations of chemicals on deposits from different time frames. The results presented in Figures 4-8 and 4-9 show that the input of toxic chemicals associated with suspended sediment from the river has declined, most significantly between 1960 and 1990. The results were similar for all priority toxic chemicals. Figure 4-9 also shows a column entitled "MOE’s LEL (Lowest Effect Level)", that indicates the level at which a toxic contaminant can be expected to begin to affect some benthic organisms. The surface concentrations of all priority chemicals, except PCBs, in these core samples are now less than these toxic levels.

Fish-Eating Birds

Over the last 20-25 years, perhaps the most dramatic examples of the effects of toxic chemicals in the Great Lakes have been associated with fish-eating birds.

The fish-eating bird community in Lake Ontario is dominated by two species: gulls and cormorants. While the numbers of birds within these species have increased dramatically in the last 20 years, other species have remained relatively stable. Reproductive failures of cormorants from severe eggshell thinning, during the 1960s and 1970s, are associated with high levels of DDE in the cormorant diet. Cormorant numbers began to recover in the 1970s, coinciding with bans on the use of DDT products. The cormorant population exploded in the 1980s. In recent years, the rate of increase in the cormorant population has slowed, perhaps in response to declining food supplies, habitat competition, and

Herring Gull
(National Park Service, Indiana Dunes National Lakeshore)

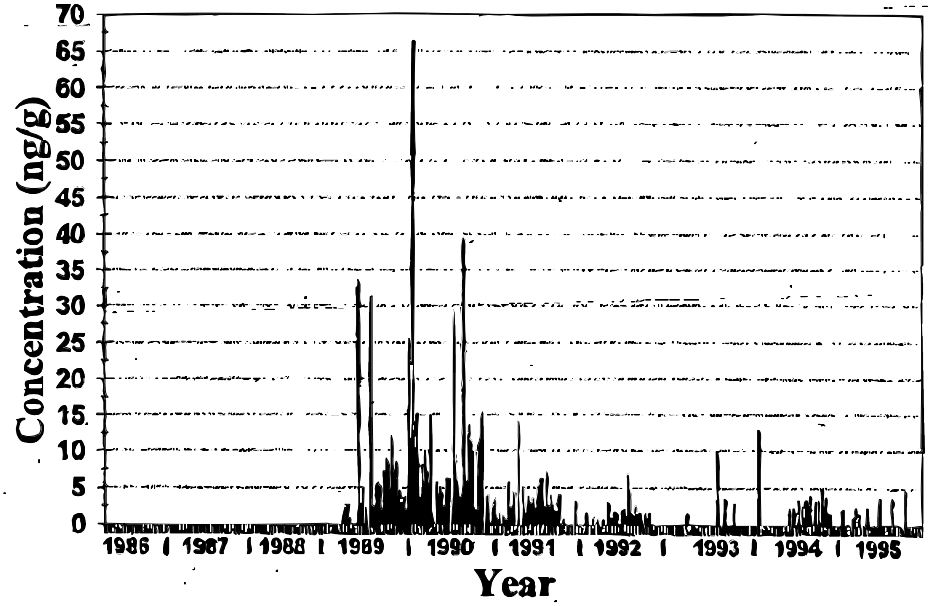


Figure 4-4. OCS Concentrations on Suspended Solids at Niagara-on-the-Lake, 1989-1995 (sampling begun 1989)

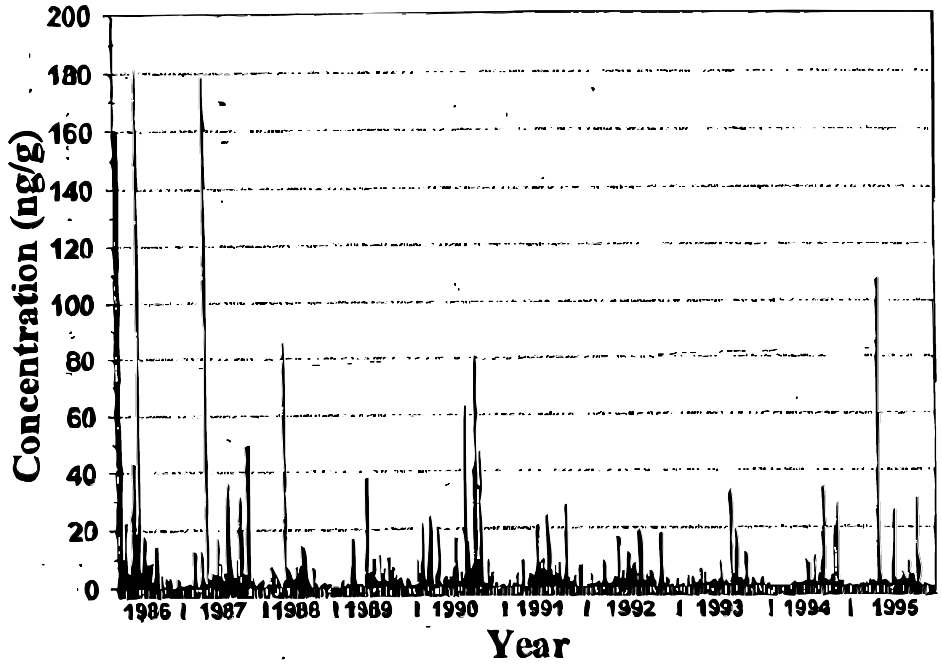


Figure 4-5. HCBD Concentrations on Suspended Solids at Niagara-on-the-Lake, 1986-1995

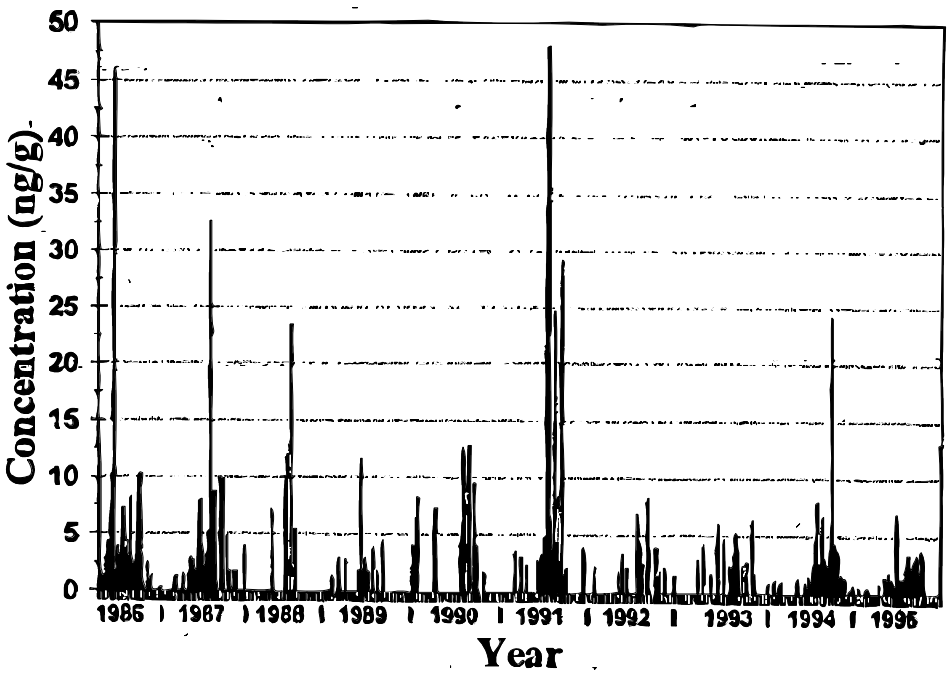


Figure 4-6. Mirex Concentrations on Suspended Solids at Niagara-on-the-Lake, 1986-1995

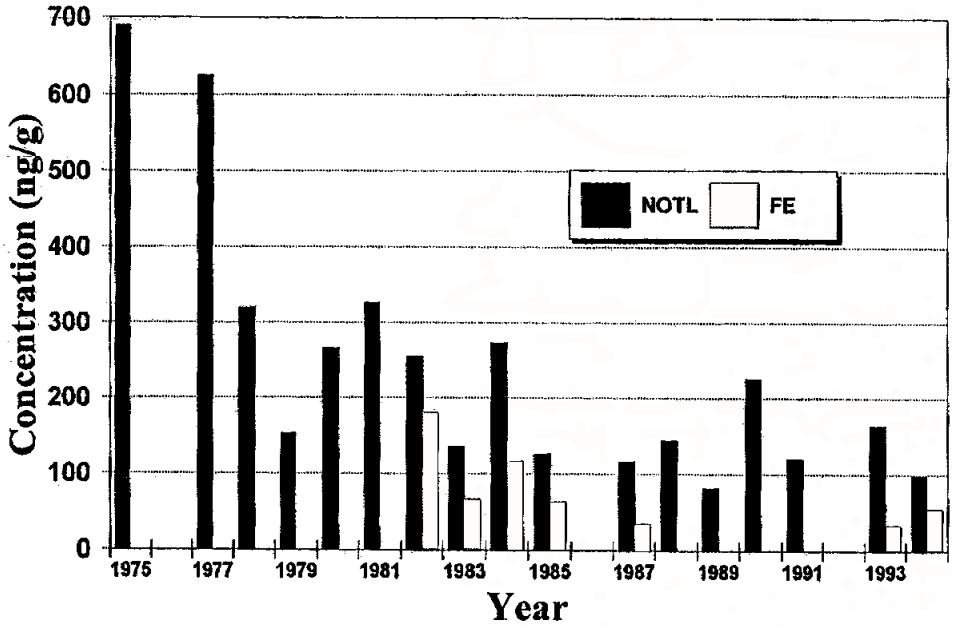


Figure 4-7. PCB Concentrations in Spottail Shiners at Fort Erie and Niagara-on-the-Lake

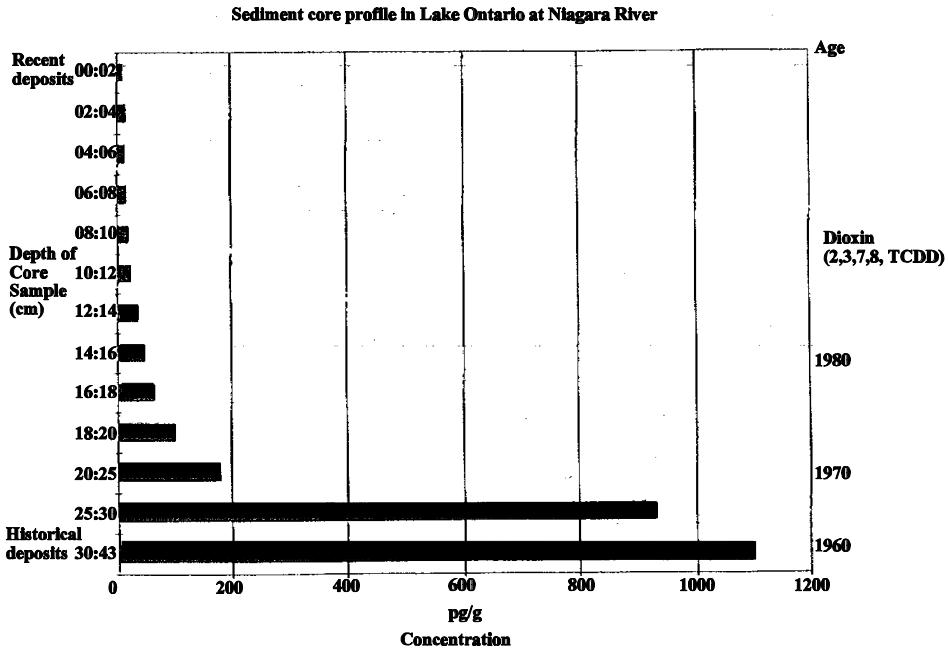


Figure 4-8. Dioxin analyses of sediments from the mouth of the Niagara River, taken at various depths below the lake bottom, show that levels of this contaminant decreased significantly between 1960 and 1980.

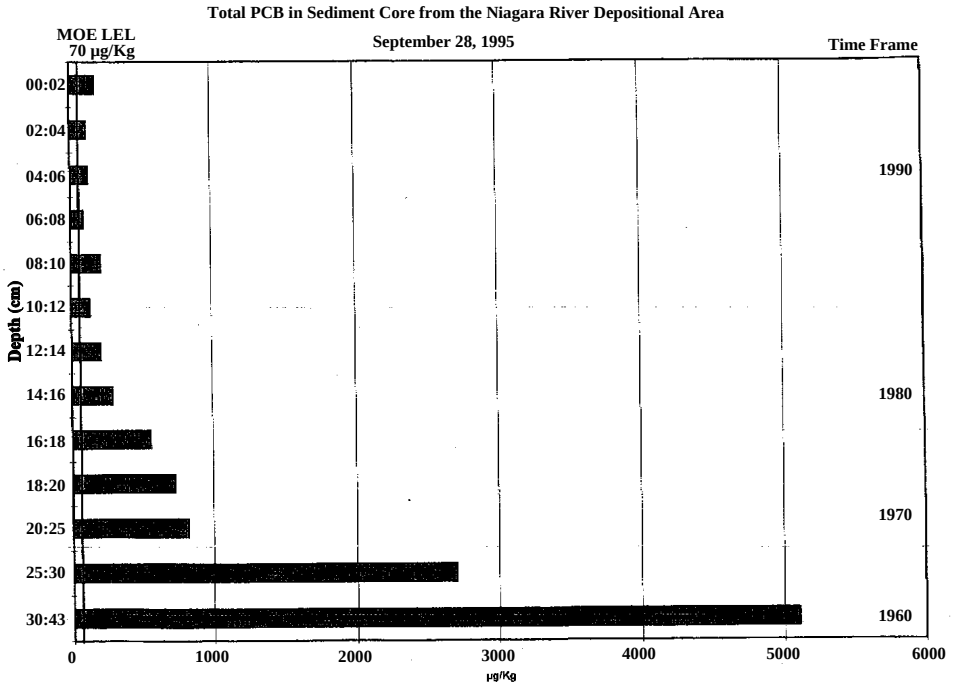


Figure 4-9. Total PCB congener analyses of sediments from the mouth of the Niagara River, taken at various depths below the lake bottom, show that levels of this contaminant decreased significantly between 1960 and 1980. Although PCBs have decreased significantly, current levels continue to exceed Ontario Ministry of the Environment's (MOE) lower effect level sediment quality guideline.

predation. In a similar pattern, the low reproductive success rate of herring gulls in the 1960s and 1970s shifted to a full recovery, with no signs of contaminants, by the early 1980s.

The direct correlation of load reduction activities and ecosystem improvements, such as reduced contaminants in herring gull eggs, is further illustrated in Figures 4-10 and 4-11. PCB levels in herring gull eggs decreased by an order of magnitude from the mid-1970s to the late 1980s; dieldrin levels decreased by 80 percent and some Lake Ontario colonies have shown reductions of more than 90 percent. Dioxin (2,3,7,8 TCDD) levels declined dramatically until 1982. The rate of decline in dioxin levels has been much slower since 1982, and this contaminant is still an issue for Lake Ontario. Levels of dieldrin in herring gull eggs have declined. For example, dieldrin concentrations in herring gull colonies in the eastern part of the lake declined from 0.36 ug/g in 1982 to 0.12 ug/g in 1992.

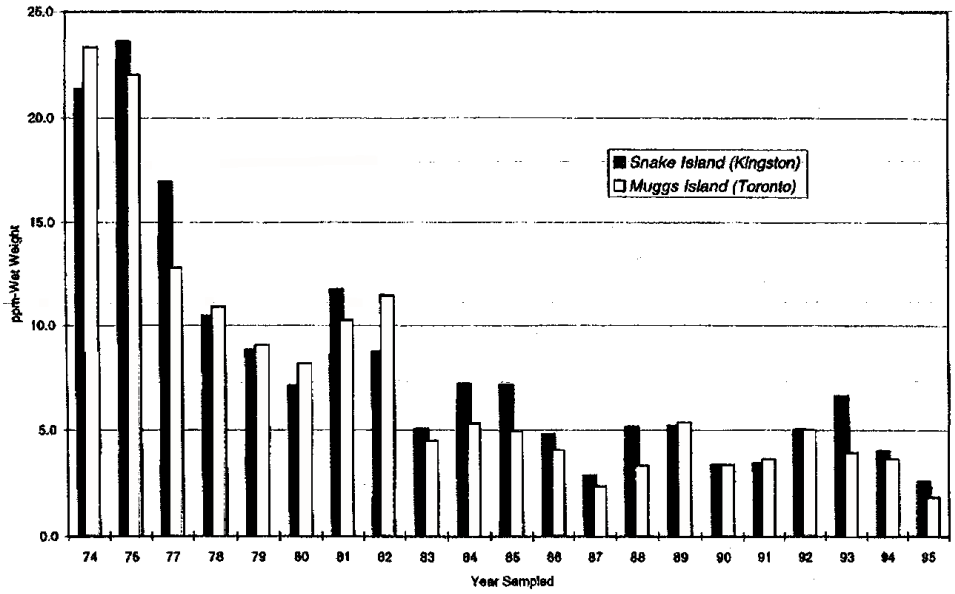
Populations of bald eagles, once plentiful in the Great Lakes basin, also suffered as a result of toxic contaminants in the ecosystem. With efforts to reduce contaminant levels and provide nesting platforms, the return of the bald eagle to the Lake Ontario shore is anticipated. In 1993, 20 bald eagle breeding territories were confirmed in New York State. Six breeding territories are located in the Lake Ontario basin and one breeding territory is within 8 kilometres of the shore. New York's bald eagle population is estimated to be growing at an annual rate of between 15 and 30 percent since 1988 (Nye, 1992).

Fish

Information on contaminant levels in Great Lakes fish provides a comprehensive picture of trends over time and spatial patterns in fish from different trophic levels. Open lake and nearshore fish monitoring programs have been conducted since 1975. These programs collect sport and forage fish to determine contaminant concentrations in the fish community at various trophic levels and to provide information for the setting of consumption advisories.

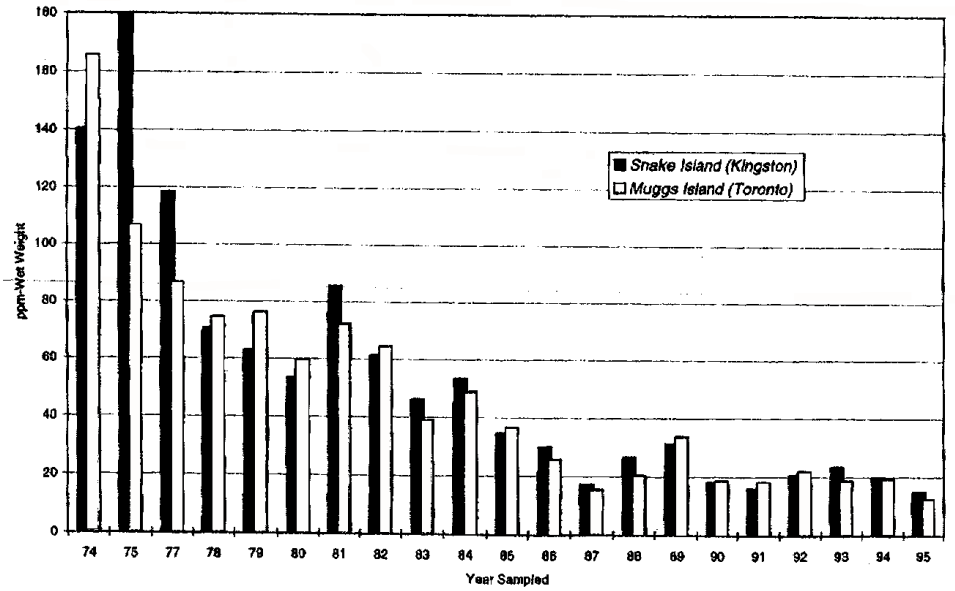
Concentrations of PCBs, DDE, and mirex in lake trout and smelt tend to be higher in the western basin of Lake Ontario than the eastern basin. This reflects the magnitude of contaminant inputs from the upper lakes and the Niagara River and the industrialized nature of the western end of the lake. Spottail shiner results have also shown mirex at consistently elevated levels in the Niagara River and the Credit River.

Overall, the fish community has experienced a dramatic reduction in contaminant levels since the mid-1970s and a slower rate of decline since



Source: Bishop et al., *1992; Pettit* et al., *1994 ; CWS Unpublished Data*

Figure 4-10. DDE in Herring Gull Eggs



Source: Bishop* et al., *1992; Pettit* et al., *1994 ; CWS Unpublished Data

Figure 4-11. PCBs in Herring Gull Eggs

the mid-1980s. This trend is best illustrated by lake trout, smelt, and spottail shiners for PCBs, DDT, and dieldrin (Suns *et al*., 1985, 1991a,b; MOE unpublished data). In the case of mirex, the downward trend continued until the early 1990s and has since leveled off. Considerable fluctuations have been observed in dioxin (2,3,7,8 TCDD) levels with no discernable trend. The most recent collections still indicate that PCB levels in lake trout and smelt often exceed the GLWQA Objective of 0.1 ppm (whole fish), and spottail shiners often exceed the guideline of 100ng/g for the protection of fish-eating birds and mammals. Recent changes in Lake Ontario's food web may result in increases or decreases in contaminant levels in some fish. This can result if fish such as lake trout or salmon become dependent on or switch to a different food source that is more or less contaminated than their previous diet. Potential changes in Lake Ontario's food web and the resulting effect on contaminant levels in fish need to be closely monitored.

Bottom Sediments/Water Quality

The determination of trends in bottom sediment and water quality is difficult given the wide range of variability encountered among sampling events. Differences in water and sediment sampling locations from year to year account for much of the variation in the results. Water movement patterns vary greatly and also influence results on a much smaller time scale.

Bottom sediments do reflect water quality conditions and sediment core samples that can be dated provide one means to establish trends over many decades. Based on a 1995 sediment coring project, levels of persistent toxic substances in Lake Ontario sediments have steadily decreased since the 1970s at most locations that were sampled. Of particular interest are the data from the Niagara River that show that concentrations of most persistent toxic contaminants in sediments have decreased significantly over time (Figure 4-9). PCBs, however, continue to be found at elevated levels (exceeding New York and Ontario criteria and objectives) in the uppermost portion of the sediment cores, which reflects the most recent inputs.

The 10 year data-set from the Niagara River Upstream/Downstream ambient water monitoring program is the most complete water quality sampling effort in the Great Lakes basin and has provided weekly data on contaminant levels flowing into the lake from the river, including contributions from the upper Great Lakes. Preliminary statistical analyses have been carried out by EC on the 18 priority toxic chemicals by comparing 1994 data with 1986 data. The initial results show that, with the exception of a few chemicals in the suspended sediment phase, most of the chemicals have been considerably reduced in concentration since 1986.

5.1 Introduction

The primary goal of this management plan for Lake Ontario is to reduce the chemical, physical, and biological factors that are directly or indirectly contributing to use impairments on a lakewide basis. As described in Chapter 3, the Four Parties have identified the lakewide beneficial use impairments of Lake Ontario as:

Restrictions on Fish and Wildlife Consumption
Degradation of Wildlife Populations
Bird or Animal Deformities or Reproductive Problems
Loss of Fish and Wildlife Habitat

The toxic chemicals that directly or indirectly contribute to these impairments include PCBs, DDT, dioxin, mirex, mercury, and dieldrin. These chemicals are persistent, bioaccumulative toxic substances; they remain in the water, sediment, and biota for long periods of time and they accumulate in aquatic organisms to levels that are harmful to human health. It is the intent of the Four Parties to prevent the development of additional lakewide use impairments that may be caused by other persistent, bioaccumulative toxics entering the lake. The biological and physical factors contributing to the identified use impairments include lake level management; exotic species; and the physical loss, modification, and destruction of habitat. As such, the Four Parties seek to restore the beneficial uses of the lake by reducing the input of critical pollutants and persistent, bioaccumulative toxics to the lake, and by addressing the biological and physical factors causing lakewide impairments.

The successful control of atmospheric transport and deposition of critical pollutants will require actions both inside and outside the Lake Ontario basin. Sources of atmospheric releases of critical pollutants within the Lake Ontario basin will be targeted by the LaMP as part of its pollutant reduction strategy. However, significant sources of critical pollutants may also be found to originate outside the basin. The LaMP will raise issues related to out of basin sources to the attention of other environmental initiatives such as the U.S. Clean Air Act, the Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem (COA), the 1997 Binational Strategy, and the 1997 North American Regional Action Plan.

This chapter provides a description of the actions that the Four Parties propose to implement, both individually and jointly, in support of the LaMP. The Four Parties recognize that there are many groups, organizations, and agencies implementing activities to improve and protect the Lake Ontario basin. The LaMP process provides the opportunity to develop better connections with these various activities and build on the successes already achieved.

5.2 Ongoing and Future Binational Activities

Binational Virtual Elimination Strategy

The U.S. and Canada have developed a binational strategy entitled "Canada-United States Strategy for the Virtual Elimination of Persistent Toxic Substances in the Great Lakes Basin". This binational strategy sets forth a collaborative process by which Environment Canada (EC) and the United States Environmental Protection Agency (USEPA), in consultation with other Great Lakes stakeholders, will work towards the goal of virtual elimination of persistent toxic substances and a means to track progress in the reduction of loadings to the basin. An implementation framework is currently being prepared with stakeholder input.

Integrated Atmospheric Deposition Network (IADN)

The Integrated Atmospheric Deposition Network (IADN) is a binational network of 19 stations in the U.S. and Canada established and operated for the purpose of monitoring the atmospheric deposition of toxic substances to the Great Lakes. IADN has been in operation since 1990, providing the data used by the U.S. and Canadian governments to report loadings of toxics to the Great Lakes biennially as called for in the Great Lakes Water Quality Agreement (GLWQA). The Four Parties will continue to support these efforts in order to learn more about significant sources of airborne pollutants into the Great Lakes.

5.3 Ongoing and Future Activities in the U.S.

USEPA/New York State Performance Partnership Agreement

On November 26, 1996, the New York State Department of Environmental Conservation (NYSDEC) and USEPA entered into a cooperative partnership to protect and enhance the water resources of New York State for the benefit of its citizens.

While NYSDEC and USEPA have always worked cooperatively to protect New York's water resources, this new Agreement, under the National Environmental Performance Partnership System, provided an opportunity for the state and USEPA to jointly establish priorities, direction, and accountability for water resource management in New York. The Agreement includes mutual understandings of the state and USEPA regarding environmental projects to be pursued as well as the lead agencies responsible for the successful implementation of these projects.

The Performance Partnership Agreement (PPA) is built on two principles:

Maintaining the efficiency and effectiveness of existing programs in the state.

Taking more action, beyond these ongoing programs, as necessary to solve particular problems in particular places - through "Community-Based Environmental Protection".

The Agreement contains an environmental and programmatic self-assessment, individual strategies for each of the existing programs and for all identified community-based environmental protection efforts, agreed upon indicators of success, fiscal accountability, public involvement procedures, and a process for reporting success.

Through the Agreement, USEPA and NYSDEC continue their commitment to implement the existing regulatory programs, described in Chapter 4, in order to reduce the load of critical pollutants to the lake from point and non-point sources. The Agreement then lays out commitments specific to the Lake Ontario Community-Based Environmental Protection Initiative. A number of these community-based activities are described below.

The 1997/1998 PPA was entered into by USEPA, NYSDEC, and the New York State Department of Health (NYSDOH). This PPA was expanded in scope to include programs under the Safe Drinking Water Act that are under the purview of NYSDOH. Further information and details regarding the commitments laid out in the PPA can be obtained by viewing USEPA's Worldwide Web Site at www.epa.gov\regional\pps\docs.htm.

Great Lakes Water Quality Guidance

In February 1998, NYSDEC completed the adoption process and began to implement the regulations, policies, and procedures contained within the Great Lakes Water Quality Guidance (GLWQG) (further described in Chapter 4). The implementation of the GLWQG will result in consistent state water pollution control programs throughout the U.S. Great Lake States and will lead to substantial reductions in the loading of LaMP critical pollutants and other pollutants.

The GLWQG will play a major role in addressing all of the lakewide impairments identified in this document. The following illustrates how the implementation of the GLWQG by the eight Great Lakes States will significantly address these concerns.

Restrictions on Fish and Wildlife Consumption: The GLWQG requires that the eight Great Lakes States adopt human health criteria based on the consumption of aquatic life, which will result in the eventual elimination of restrictions on fish and wildlife consumption by humans. The GLWQG includes numeric human health criteria for 16 pollutants, and methodologies to derive cancer and non-cancer human health criteria for additional pollutants.

Degradation of Wildlife Populations and Bird or Animal Deformities or Reproductive Problems: The GLWQG requires that the eight Great Lakes States adopt wildlife criteria, which, once achieved, will result in the eventual elimination of degraded wildlife populations and bird or animal deformities or reproductive problems. The GLWQG includes numeric criteria to protect wildlife from four pollutants (PCBs, DDT and its metabolites, dioxin, and mercury) and a methodology to derive criteria for additional bioaccumulative chemicals of concern (BCCs) discharged to the Great Lakes system.

Targeting the Pollutants of Concern, which are Bioaccumulative and Persistent: The GLWQG focuses on the reduction of 22 known chemicals of concern, including PCBs, dieldrin, DDT and its metabolites, and dioxin. In addition to requiring the adoption of numeric water quality criteria for BCCs and other pollutants, as well as the detailed methodologies to develop criteria for additional pollutants, the GLWQG also includes implementation procedures that will result in loading reductions of BCCs to the Great Lakes basin. These include requirements for the development of more consistent, enforceable water quality-based effluent limits in discharge permits (including requirements for pollution minimization plans to track down and eliminate sources of BCCs); the development and implementation of total maximum daily loads for pollutants that can be allowed to reach the Great Lakes and their tributaries from all sources; and antidegradation policies and procedures which further restrict new or increased discharges of BCCs.

The Majority of the Loadings of these Pollutants are from other Great Lakes: Since the GLWQG will be implemented in all eight Great Lakes States, the loadings of the identified pollutants of concern will be significantly reduced throughout the entire Great Lakes basin. Therefore, the major source of the loadings of the pollutants of concern to Lake Ontario will be substantially reduced.

Clean Sweep Projects

USEPA is continuing its commitment to reduce inputs of agricultural pesticides into Lake Ontario, by funding the County of Erie to expand its Clean Sweep project throughout the Lake Ontario basin. Erie County will use the strategies that were successful in previous Clean Sweep projects to solicit new participating counties and will provide local project management teams with the guidance and technical expertise necessary for successful implementation of this program.

Source Trackdown

USEPA and NYSDEC will conduct additional trackdown studies in order to pinpoint significant sources of critical pollutants in tributaries to the lake. USEPA and NYSDEC will form a trackdown workgroup to identify immediate remedial activities and future monitoring activities for sources of persistent, bioaccumulative toxics to the lake.

Clean Water/Clean Air Bond Act

In 1996, the citizens of New York passed a $1.75 billion Clean Water/Clean Air Bond Act. Over the next five to ten years, the Bond Act will fund capital projects that will result in the protection of and improvements to the environment. Approximately $125 million has been targeted for Clean Water projects in the Great Lakes basin, including $25 million specifically intended to implement NYSDEC's Great Lakes Program, which includes Remedial Action Plans (RAPs) and LaMPs. Funding will support point source, non-point source, and pollution prevention initiatives, as well as activities to restore aquatic habitat and preserve open space.

Hazardous Waste Site Report

NYSDEC will use the findings of a July 1995 report, entitled "Preliminary Review of New York State Inactive Hazardous Waste Disposal Sites in the Lake Ontario Basin", as a first step in identifying which sites contribute significant amounts of critical pollutants to the lake. Where possible, NYSDEC will accelerate schedules for cleaning up these sites. NYSDEC will complete its sources and loadings report for Lake Ontario, documenting the existing knowledge of U.S. sources and loadings of contaminants to the lake.

Fish Advisory Project

USEPA and NYSDEC will continue to implement outreach programs in the Lake Ontario basin to more effectively communicate the risk of consuming contaminated fish. This project involves translating public

outreach pamphlets and brochures into different languages and training citizens to effectively communicate risk in various languages.

Niagara Falls Public Information Office

USEPA will continue to support the Niagara Falls Public Information Office in order to provide the public with easily accessible information on activities in Lake Ontario.

5.4 Ongoing and Future Activities in Canada

Canada-Ontario Agreement (COA)

COA is the primary mechanism for addressing Canadian commitments under the GLWQA. This Agreement was signed by the federal and provincial governments in July 1994. COA sets out a six year plan of action that establishes priorities, targets, and schedules for environmental issues of concern and provides a framework for strategic coordination of environmental responsibilities in the Great Lakes basin and efforts to fulfill Canada's obligations to the GLWQA. COA focuses on results in three main areas: restoration of degraded areas; prevention and control of pollution; and conservation and protection of human and ecosystem health.

COA identifies more than 55 programs and targets to ensure that progress towards the three objectives over the six-year term of the Agreement is measurable. Examples of key targets under Objective 2 – prevent and control pollution – are shown below. The ultimate goal of COA is to achieve the virtual elimination of persistent, bioaccumulative substances from the Great Lakes basin ecosystem by implementing strategies consistent with zero discharge.

- Decommission 90 percent of the high-level PCBs in use; destroy 50 percent of the high level PCBs now in storage; and accelerate the destruction of stored low-level PCB waste.

- Achieve a 90 percent reduction in the use, generation, and release of seven toxic substances by the year 2000 (benzo(a)pyrene, hexachlorobenzene, alkyl lead, mercury, octachlorostyrene, dioxins, and furans).

- Collaborate with, and provide support for, voluntary programs by industry and others to reduce the use, release, or generation of Tier II substances, and establish specific timelines and targets for achieving their virtual elimination.

As part of COA, Canada and Ontario will continue to develop essential information on the fate and effects of selected toxic pollutants from industrial, urban, and agricultural sources and to identify and quantify toxic chemical inputs from the atmosphere. Canada and Ontario are also conducting a coordinated evaluation of registered and scheduled pesticides through a multi-agency Pesticides Review Committee established under COA.

Under the revised Canadian Environmental Protection Act (CEPA), Environment and Health Canada may be able to request pollution prevention and virtual elimination plans from high priority sources of identified substances. The LaMP critical pollutants are thus candidates for mandatory elimination plans from major sources.

Municipal and Industrial Strategy for Abatement (MISA)

Under MOE's Clean Water Regulations, developed under MISA, effluent limits for 10 sectors will be in force by 1998. These include 34 industrial plants in the Lake Ontario basin.

Petroleum Refining and Pulp and Paper sector regulations were enacted in September and November 1993 and both came into force on January 1, 1996, controlling 11 Lake Ontario basin sources.

Metal Mining, Industrial Minerals, and Metal Casting sector regulations were enacted in August 1994; all came into force in August 1997, controlling 9 Lake Ontario basin sources.

Organic Chemical Manufacturing and Inorganic Chemical sector regulations were enacted in February 1995; these regulations came into force in February 1998, controlling 7 Lake Ontario basin sources.

Iron and Steel Manufacturing and Electric Power Generation regulations were enacted in April 1995; these regulations came into force in April 1998, controlling 8 Lake Ontario basin sources.

Accelerated Reduction/Elimination of Toxics (ARET)

Under ARET, voluntary activities and commitments by sources of persistent, toxic, and bioaccumulative substances are publicly reported on a multi-media basis. Industries and municipalities alike are encouraged by the governments to use ARET to publicly commit to pollutant reductions beyond compliance. The 1995 update of Canada's National Pollutant Release Inventory was released in winter 1997.

Tributary Priority Pollutant Monitoring Study

Canada and Ontario initiated a Lake Ontario Tributary Priority Pollutant Monitoring Study beginning in the spring of 1997. The objectives of the collaborative study are to:

Identify those tributary discharges along the Canadian shore of Lake Ontario that contribute significant loadings of Priority Pollutants (including all LaMP critical pollutants).

Establish the range of concentrations of priority pollutants present in the most significant tributaries.

Where feasible, use the concentration data in conjunction with federal and federal/provincial flow data to estimate the mean annual mass discharge of priority pollutants for those Lake Ontario tributaries that have been selected for monitoring.

Provide the degree of certainty associated with estimates of the mean concentration and mass discharges.

Provide recommendations for targeted action within watersheds identified as significant sources of priority pollutants, such as source trackdown and load reduction activities.

Cleanup Fund

Environment Canada's (EC's) Cleanup Fund (in place until the year 2000) will continue to provide funding and technical support to a wide range of contaminated sediment, urban stormwater, and agricultural projects aimed at controlling sources of pollution to Lake Ontario, both in RAPs and other areas. The Fund will also support a wide range of habitat restoration and enhancement projects in the Lake Ontario basin.

Site Remediation Activities

Contaminated site remediation activities will continue at "orphan sites" (those sites which have been abandoned by their owners and the owners cannot be located). EC has provided funding for the cleanup of these orphan sites in the past under the National Contaminated Sites Remediation Program. This was a 5 year program that expired in March of 1995. The sites remediated under this program include: Chemical Waste Management Ltd. PCB Spill Site, Smithville; National Hard Chrome Site, North York; and Deloro Mine Site, Deloro.

Outreach Programs

EC will conduct outreach programs for PCB owners in the Toronto area and other Lake Ontario communities. EC will conduct a residential pesticide reduction project in the Toronto area and training and workshops to reduce the use of pesticides by Lake Ontario municipalities. Outreach will continue to the farming community to reduce the impact of rural land use practices. The MOE-MNR Guide to Eating Ontario Sport Fish provides health related advice to the public.

5.5 Binational LaMP Workplan

The 1987 GLWQA specifies that, when the problems in the lake have been identified and the Stage 1 LaMP has been completed, a Stage 2 LaMP be prepared which sets out a schedule for load reduction activities. The Four Parties propose to develop the technical information necessary to focus the actions undertaken through the LaMP and provide the foundation for the Stage 2 LaMP. Table 5 identifies the activities that the Four Parties propose to undertake binationally (either jointly or in a complementary fashion) to move towards the completion of the draft Stage 2, and to continue to build partnerships and provide information about the LaMP process. It is the goal of the Four Parties to develop the technical information in draft form within two years. Preparation of the Stage 2 LaMP will then commence, incorporating public input on the draft technical information. It is the goal of the Four Parties to produce a draft Stage 2 document for public review by fall of the year 2000.

5.6 Summary

In Chapter 3, the impaired beneficial uses of Lake Ontario and the critical pollutants and biological/physical factors contributing to these impairments were identified.

In this chapter, the Four Parties have identified the ongoing and future activities that will continue efforts to move towards the restoration of beneficial uses of the lake and achieve virtual elimination of critical pollutants. The Four Parties have also proposed joint or complementary actions that will, within two years, provide the technical basis for the Stage 2 LaMP. It is the goal of the Four Parties to produce a draft Stage 2 LaMP for public review by fall of the year 2000.

The Stage 2 LaMP will identify the additional actions that will be necessary to restore the beneficial uses of Lake Ontario. The Four Parties will, however, initiate additional LaMP actions prior to the completion of the Stage 2 document if these actions are identified as necessary to achieve LaMP goals.

Table 5. Binational Workplan for the Lake Ontario LaMP

Activity	3-year objectives	Priorities	Deliverables (Spring 2000, unless otherwise specified)
Reducing inputs of critical and other pollutants	Continue existing programs to reduce loadings of critical pollutants	Evaluate effectiveness of existing programs Support implementation of Binational Great Lakes Toxics Strategy	a) Table and map identifying likely point and non-point sources of critical pollutants; the data collection will focus on sources in the basin but will also include upstream sources entering via the Niagara river; major atmospheric sources from out of the basin may also be included b) Forecast reductions in loadings as a result of existing activities
	Update pollutant loadings and contaminant levels and instigate new control programs to address identified sources and loadings	Undertake source trackdown to identify sources Update tributary loading Update sewage treatment plant loading Enhance existing mass balance models Facilitate cooperative lakewide monitoring	a) Prioritized listing of point, non-point, and basin sources contributing loadings of critical pollutants to include significant sources on each side of the lake b) Updated table 3-3 and 3-4 for LaMP c) Updated tables 3-5 and 3-6 for LaMP d) First cut mass balance model to describe major fluxes of critical pollutants into and out of Lake Ontario (Spring 1999) e) Binational priorities listing for monitoring needs (Spring 1999) f) Workplan for cooperative monitoring
	Refine LaMP List of Critical Pollutants	Review new data as necessary	Determination of any additional critical pollutants (in consultation with health and resource agencies)

Activity	3-year objectives	Priorities	Deliverables (Spring 2000, unless otherwise specified)
Updating/reassessing beneficial use assessments in open lake waters	Refine beneficial use impairment assessment	Further assess lakewide beneficial uses: Priorities: 1) Chemical impacts on benthos 2) Chemical and other factors influencing phytoplankton and zooplankton populations 3) Updates on status of colonial waterbirds, bald eagles, mink, and otter 4) Updates of all beneficial use impairments as necessary, where data available on impacts of physical and biological factors impacting beneficial uses	a) Updated benthos impairment section for Stage 2 LaMP b) Binational beneficial use assessment of phytoplankton and zooplankton populations using information from the Canadian Department of Fisheries and Oceans Bioindex project, MOE's intake monitoring, USEPA's Lake Guardian research program, and the U.S. Bioindex project carried out by the NYSDEC, U.S. Fish & Wildlife Service, and Cornell University c) Binational update on status, using relevant, readily available data, addressing chemical and nonchemical factors d) A series of prioritized updates to be prepared using relevant data on beneficial use impairment indicators, with management recommendations; may not include update on all 14 indicators for the Stage 2 LaMP
Managing biological and physical factors	Continue habitat protection and restoration activities	Summarize underway/proposed actions for nearshore by fall 1998	Map and table identifying nearshore underway and proposed (to year 2000) actions to protect or restore physical habitat
Developing ecosystem objectives and indicators	Update ecosystem objectives and determine monitoring indicators	Review work completed to date by technical subcommittees; in conjunction with partners, determine next steps	Binational workplan for ecosystem objectives development including role of public consultation, priority objectives for pelagic, benthic, and wildlife communities (Spring 1999); begin implementation of Workplan
	Develop objectives for restoration of beneficial uses	Set restoration objectives, determine necessary loading reduction schedules, develop monitoring mechanisms	Delisting objectives for the LaMP for each of 3 beneficial uses impaired by chemicals as basis for loading reduction schedules, for public consultation in 1999

FUTURE AGENDA FOR THE LaMP

Activity	3-year objectives	Priorities	Deliverables (Spring 2000, unless otherwise specified)
Facilitating public involvement - three tiered Lakewide Advisory Network	Establish Basin Teams and partnerships	Identify and meet with partners	a) Agreements with Basin Teams and partners to cooperate in sharing information, encouraging actions to preserve and protect the lake and watershed, and providing public input to the LaMP process (Spring 1999) b) Meetings with groups on issues of concern as necessary
	Maintain information connection	Provide updated information via the Lake Ontario LaMP Web page and mailings	a) Up to date Lake Ontario LaMP homepage b) Occasional mailings for informational updates and gathering public input
	Hold binational Lake Ontario forums at significant stages in the LaMP process	Convene binational Lake Ontario forums, as necessary, with participants from Basin Teams, partners, and other interested stakeholders	Binational forum meeting likely in 1999
Reporting	Produce annual status reports	Produce Year 1 Annual Report	A short annual report highlighting progress to be released at joint Lake Ontario LaMP and NRTMP annual meeting
	Produce draft Stage 2 report	1) Assess existing programs 2) Update sources and loadings 3) Present revised objectives and indicators 4) Present draft load reduction schedules	Draft Stage 2 will be available for public review in the fall of 2000

GLOSSARY

33/50 Program: A pollution prevention program sponsored by USEPA in voluntary partnerships with industry. The program's goals are to reduce targeted chemicals by 33 percent by 1992 and 50 percent by 1995.

Anthropogenic: Effects or processes that are derived from human activities, as opposed to natural effects or processes that occur in the environment without human influence.

Benthic: Pertaining to plants and animals that live on the bottom of aquatic environments.

Bioaccumulation: The accumulation by organisms of contaminants through ingestion or contact with skin or respiratory tissue.

Bioaccumulative Chemical of Concern (BCC) (Bioaccumulative Toxics): Any chemical that has the potential to cause adverse effects which upon entering the surface waters, by itself or as its toxic transformation products, accumulates in aquatic organisms by a human health bioaccumulation factor greater than 1000, after considering metabolism and other physiochemical properties that might enhance or inhibit bioaccumulation, in accordance with the methodology in Appendix B of Part 132 - Water Quality Guidance for the Great Lakes System. Source: Water Quality Guidance for the Great Lakes System.

Combined Sewer Overflow (CSO): A pipe that, during storms, discharges untreated wastewater from a sewer system that carries both sanitary wastewater and stormwater. The overflow occurs because the system does not have the capacity to transport and treat the increased flow caused by stormwater runoff.

Deforestation: The clearing of wooded areas.

Degradation: A term used in the indicators of beneficial use impairments defined by the Great Lakes Water Quality Agreement to indicate an environmental condition or state that is considered to be unacceptable or less than the condition that would exist in a healthy ecosystem. In the development of the LaMP the condition was determined after consideration of the Ecosystem Goals for Lake Ontario (Section 1.7) and the preliminary ecosystem objectives.

Diatoms: A class of planktonic one-celled algae with skeletons of silica.

Ecosystem: An ecological community and its environment functioning as a unit in nature.

Eutrophic: Relatively high amounts of nutrients (phosphorus and nitrogen) in the water column. Although eutrophic conditions occur naturally in the late stages of many lakes, rapid increases in nutrients due to human activities can destabilize aquatic food webs because plants and aquatic organisms cannot adjust to rapid changes in nutrient levels.

Final Effluent Limits: The amount of a pollutant allowed to be discharged by a U.S. industry or municipality.

Food Web: A network of interconnected food chains and feeding interactions among organisms.

Isothermal: Marked by equality of temperature.

Littoral: Relating to or existing on a shore.

Macroinvertebrates: Small organisms that do not have spinal columns; may filter bottom sediments and water for food.

Mesotrophic: Refers to a lake with relatively moderate amounts of nutrients (phosphorus and nitrogen) in its surface water.

Metric Tonne: Unit of weight used in Canada equal to 1,000 kilograms or 2,246 pounds. Equivalent to 1.102 U.S. tons.

Non-point Source: An indirect discharge, not from a pipe or other specific source.

Oligotrophic: Relatively low amounts of nutrients (phosphorus and nitrogen) in the water column. Lake Ontario's original nutrient levels can best be described as oligotrophic.

Pelagic: Related to or living in the open lake, rather than waters adjacent to the land.

Persistent Toxic Substance (Persistent Toxic Chemical): Any toxic substance with a half-life, i.e., the time required for the concentration of a substance to diminish to one-half of its original value, in any medium -- water, air, sediment, soil, or biota -- of greater than eight weeks, as well as those toxic substances that bioaccumulate in the tissue of living organisms. Source: Great Lakes Water Quality Agreement of 1978, expanded by the IJC's Sixth Biennial Report of Great Lakes Water Quality.

Phytoplankton: Microscopic forms of aquatic plants.

Publicly-owned Treatment Works (POTW): A system that treats (which can include recycling and reclamation) municipal sewage or industrial wastes of a liquid nature. Large facilities are generally owned and operated by local governments.

Riparian: Habitat occurring along the bank of a waterway.

Sewage Treatment Plant (STP): A system that treats (which can include recycling and reclamation) municipal sewage or industrial wastes of a liquid nature. Large facilities are generally owned and operated by local governments.

Thermal Stratification (Thermocline): Differential rates of seasonal heating and cooling of shallow and deep waters result in the development of two horizontal layers of water having very different water temperatures. The depth where this abrupt temperature change occurs is known as the thermocline.

Toxic Substance: Any substance which can cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological or reproductive malfunctions, or physical deformities in any organism or its offspring, or which can become poisonous after concentration in the food chain or in combination with other substances. Source: 1978 Great Lakes Water Quality Agreement.

Volatilization: Evaporation.

Watershed: The land area that drains into a stream, river, estuary, or other water body; same as drainage area.

Water Quality Standards: In the U.S., a designated use of a water body (i.e., swimming, fishing, etc.) and the numerical or other criteria to protect that use.

Water Pollution Control Facility (WPCF): A system that treats (which can include recycling and reclamation) municipal sewage or industrial wastes of a liquid nature. Large facilities are generally owned and operated by local governments.

Water Pollution Control Plant (WPCP): A system that treats (which can include recycling and reclamation) municipal sewage or industrial wastes of a liquid nature. Large facilities are generally owned and operated by local governments.

Zooplankton: Microscopic animals that move passively in aquatic ecosystems.

HISTORY OF
LAKE ONTARIO PRIORITY CONTAMINANTS

Table B-1.
History of Lake Ontario Priority Contaminants

	Priority Toxics in 1989 LOTMP	Priority Toxics in 1991 LOTMP	Proposed to be Included in LaMP
Mirex	X	X	X
PCBs	X	X	X[1]
DDT & Metabolites	X	X	X[1]
Dioxins and Furans	X	X	X[1]
Dieldrin	X	X	X[2]
Octachlorostyrene	X	X	-
Hexachlorobenzene	X	X	-
Mercury	X	X	X[2]
Chlordane	X	X	-
Iron	X	-	-
Aluminum	X	-	-
Heptachlor\Heptachlor Epoxide	-	-	-
Total	11	9	6

[1]Found to impair beneficial uses on a lakewide basis
[2]Likely to impair beneficial uses due to exceedances of criteria

HISTORY

Priority Toxics in the 1989 Lake Ontario Toxic Management Plan

To implement a chemical-by-chemical approach to control toxics in the lake, the Lake Ontario Toxics Committee developed a comprehensive system to categorize toxic chemicals and established a work group (Lake Ontario Categorization Work Group) to take a preliminary cut at categorizing the chemicals. There are two major groups of chemicals: those for which acceptable ambient data are available (Category 1), and those chemicals for which ambient data are not available (Category 2). Ambient data were available for 42 chemicals. Of these 42, 7 chemicals exceeded enforceable water quality or fish tissue standards, or both, and 4 chemicals exceeded more stringent, but unenforceable, criteria or guidelines in the water column, fish tissue, or both. These “11 Priority Toxics”, as shown in the above table, became the focus of the LOTMP.

Although water quality/fish tissue numbers may be referred to as a standard, objective, criteria, or guideline, the term criteria is used in this discussion to represent any of these terms.

Priority Toxics in the 1991 LOTMP Update

The 1991 LOTMP Update removed iron and aluminum from the 1989 list for two reasons:

1. Iron and aluminum may not be reliable indicators of toxicity. No single number is ideal because of the variety of forms of these metals that may be present in ambient waters; and

2. It is difficult to determine whether loadings of these metals originate from natural or human sources.

LaMP Critical Pollutants/Lakewide Contaminants of Concern

Subsequent to the 1991 LOTMP Update, the Categorization Work Group was charged with updating the categorization of chemicals. Based on data from this analysis, as well as more recent data, three chemicals were removed from the list (octachlorostyrene, hexachlorobenzene, and chlordane). The reasons for these changes are summarized below:

Octachlorostyrene (OCS)

OCS was identified as a LOTMP priority contaminant based on lake trout samples collected in 1988, 1989, and 1990. Other lake trout data sets for the same years showed fish tissue levels to be below the lowest Four Party criterion. Data sets for chinook salmon, coho salmon, brown trout, white sucker, and smallmouth bass were also below the lowest criterion. U.S. and Canadian fish monitoring experts for Lake Ontario do not regard OCS as a significant problem in Lake Ontario.

There are no water quality criteria for OCS. The Niagara River Upstream-Downstream Monitoring Program measured mean levels of OCS on suspended solids of 0.004 ng/L (equivalent water concentration) in 1992-1993. Preliminary results of dated sediment cores collected in Lake Ontario in 1995 indicate that OCS is not detected in recent stratum.

Hexachlorobenzene (HCB)

Levels of HCB in fish tissue are one to two orders of magnitude below the most stringent Four Party criterion of 0.22 ppm for the protection of piscivorous fish.

HCB was identified in the 1989 LOTMP report as exceeding water quality criteria due to a typographical error which presented the most stringent criterion (i.e., USEPA guidance value) as 0.072 ng/L instead of the correct value of 0.72 ng/L. As stated in the first report, the 90 percent upper confidence level for lakewide concentrations of 0.1 ng/L were well below the 0.72 ng/L criterion.

HCB has not been detected in Lake Ontario waters at concentrations above the most stringent Four Party water quality criterion. Lakewide sampling programs found mean levels of HCB in Lake Ontario to be approximately one order of magnitude lower than the most stringent water quality criterion of 0.75 ng/L or the new Great Lakes Initiative (GLI) water quality criterion of 0.45 ng/L. HCB has not been identified as exceeding water quality standards by the Niagara River Upstream-Downstream Monitoring Program.

Chlordane

Chlordane was identified in the 1989 LOTMP as exceeding the 0.037 ppm fish criterion for protection of human health. This was based on 1985 samples of 5 to 10 year old lake trout taken from Stony Island in the eastern basin that had levels of total chlordane ranging from 0.2 to 0.61 ppm. Sampling results of 5 to 8 year old lake trout in 1987 found chlordane levels to be below the criterion, except for one of the older lake trout. Criteria exceedances have not been observed in any fish species since 1987.

Chlordane has not been detected in Lake Ontario waters at concentrations above the most stringent Four Party criterion. Lakewide sampling in 1986 and 1988 found total chlordane concentrations of approximately 0.05 ng/L, which are below the most stringent water quality number of 0.25 ng/L and the most stringent criterion of 0.5 ng/L for the protection of human health. Sampling in 1990 indicates chlordane levels are less than 0.11 ng/L, and chlordane has not been identified as exceeding water quality standards by the Niagara River Upstream-Downstream Program.

Revisions to Critical Pollutants List as Proposed in April 1997 Draft Stage I LaMP

The following is a summary of changes made to the Critical Pollutants List subsequent to the public comment period, and the reasons for these changes:

Heptachlor/Heptachlor Epoxide

Heptachlor and its breakdown product heptachlor epoxide were proposed in earlier drafts of this document as critical pollutants due to the presence of heptachlor epoxide in open waters lakewide at concentrations above the most stringent water quality standard (0.1 ng/L). Data from 1986, 1988, and 1990 showed the average concentrations varied between 0.1 and 0.3 ng/L. 1993 concentrations which were evaluated after the April 1997 draft were approximately 0.03 ng/L, well below the 0.1 ng/L criteria. Steady declines of these contaminants are attributed to product bans in the U.S. and Canada. Heptachlor and heptachlor epoxide were not included on the current list of critical pollutants based on this new information. These contaminants will continue to be monitored as part of a variety of ongoing environmental monitoring programs.

Dieldrin

Dieldrin had been proposed as a critical pollutant in earlier drafts of this document based on studies that suggested that dieldrin could limit the recovery of bald eagle populations due to its potential to poison adult eagles. Comments received during the public comment period questioned if current levels of dieldrin in the environment posed a hazard and if dieldrin warranted the same level of concern as PCBs, dioxins, and the other critical pollutants. Bald eagle experts agreed that, although dieldrin had been a concern in the 1970s and early 1980s, it is no longer considered to be a significant concern for eagle populations.

Dieldrin was used extensively as a seed treatment and a soil insecticide for vegetables and lawns in Ontario until the early 1970s (Frank *et al.*, 1975) when restrictions on use came into effect (Agriculture Canada, 1976b). Historically, dieldrin was used extensively and, because of its high toxicity, caused numerous mortalities in wildlife.

Currently, there are no data to support the hypothesis that environmental levels of dieldrin are affecting the health of Lake Ontario herring gull populations. Levels of dieldrin in herring gull eggs collected from several breeding colonies on Lake Ontario since 1974 never approached the 1.0 ppm effect level (Environment Canada, 1997). Initially, egg concentrations were in the 0.5 ppm range and have since declined to approximately 0.1 ppm or less at the two monitoring sites on Lake Ontario in 1996.

A bald eagle egg which was not going to hatch was collected in the Lake Ontario basin in 1995 from a nest approximately 10 kilometers from the lake shore. This egg was found to have dieldrin concentrations of 0.13 ppm, well below the 1.0 ppm threshold effects level. While herring gull eggs analyzed from Lake Ontario are well below the 1.0 ppm threshold value, bald eagles, which are higher on the food chain, may produce eggs with higher concentrations of dieldrin. This would be possible in the future if they breed on the Lake Ontario shoreline where their diet would contain more contaminated fish than at more inland locations.

Dieldrin remains on the LaMP list of critical pollutants because its concentration in water and fish tissue exceeds the U.S. Great Lakes Water Quality Initiative (GLI) criteria throughout the lake. The GLI criterion for water is 0.006 parts per billion and Lake Ontario water averages 0.6 parts per billion. The corresponding GLI fish tissue criterion is 0.0025 parts per million. Most Lake Ontario fish clearly exceed this criterion as dieldrin is detectable at concentrations ranging from approximately 0.005 to 0.030 parts per million.

Mercury

Mercury was not proposed to be a Critical Pollutant in earlier drafts of this document, since estimates of the water quality concentrations, based on fish tissue observations, indicated that lake levels were below that of the GLI water quality criterion of 3.3 ng/L. As noted in the draft document, the Four Parties agreed to continue their assessment based on recent environmental data. The Four Parties reviewed recent fish tissue contaminant concentrations and found mercury concentrations in smallmouth bass and walleye to exceed Ontario's 0.5 ppm guideline for fish consumption throughout the lake. Therefore, although mercury is not causing lakewide impairments of beneficial uses, this contaminant will be included as a LaMP critical pollutant given the lakewide nature of these criteria exceedences. More details regarding this analysis is provided at the end of this Appendix.

CONSIDERATION OF RECENT U.S. GREAT LAKES WATER QUALITY INITIATIVE CRITERIA

As indicated above, reviews of existing information had suggested that OCS, HCB, chlordane, and mercury were no longer a concern in the open waters of Lake Ontario. To confirm this position, a second review was performed which considered the new, generally much lower, water quality criteria contained in the U.S. Great Lakes Water Quality Initiative (Table B-2). The results of this second review continued to support removing three of these chemicals from the list of lakewide contaminants of concern. The following provides a brief summary of the results of this second evaluation.

Table B-2.
GLI Human Health WQC and Fish Flesh Values Used

Substance	GLI WQC (ug/L)	Fish Tissue Value (ppm) (based on 3.1% lipid content)
Chlordane	0.00025*	0.04
Dieldrin	0.0000006	0.0025
HCB	0.00045*	0.03
Mercury	0.0033**	0.37
OCS	0.000054***	0.11

* Tier I human health cancer criterion, which was published in the March 23, 1995 GLI.
** Tier I human health non-cancer criterion which was updated subsequent to the March 23, 1995 GLI, based on an updated RfD.
*** Tier I human health non-cancer criterion, which was derived subsequent to the March 23, 1995 GLI, using the Tier methodology and all available data.

Data Used

Water Quality: Lake Ontario ambient water quality was compared to the GLI human health-based water quality criteria (WQC) using the most recently published Niagara River Upstream/Downstream monitoring data (1990 & 1993), as well as Environment Canada's most recent lakewide sampling information (1992-93 & 1993-94).

Fish Tissue: The fish tissue data used for this assessment were collected through New York State and Ontario fish tissue monitoring programs (1986 - 1993). Fish known to inhabit and range throughout the open waters of Lake Ontario were selected (brown trout, lake trout, rainbow trout, coho salmon and chinook salmon) in order to characterize lakewide conditions.

In addition, in order to be consistent with the GLI methodology, decisions were made to: compare the mean fish tissue concentrations to the GLI-based fish flesh values to accurately account for the life long exposure to contaminants over a wide range of concentrations (consistent with USEPA policy and both NYSDEC and NYSDOH techniques); and the fish tissue lipid content, whenever possible, was normalized to 3.1 percent, (based on the GLI criteria).

Findings/Conclusions

The most current information indicates that lakewide concentrations of chlordane, HCB, and OCS do not exceed the applicable GLIWQC or GLI-derived fish flesh values on a lakewide basis. Chlordane, HCB, and OCS concentrations are approximately one order of magnitude below the applicable GLIWQC. Mean fish tissue concentrations of OCS, chlordane, and HCB (normalized to 3.1% lipid concentration) are, with the exception of one data set, well below the GLI-derived values for these contaminants.

Although there are no reliable water quality data for mercury, mercury levels in fish tissue provide a qualitative indication that water column mercury levels are also below the GLIWQC. An assessment of mercury in fish tissue found no exceedences of the GLI fish flesh criteria for "open water" fish such as lake trout and salmon. However, mercury is problematic with some near shore species such as smallmouth bass and walleye exceeding Ontario's 0.5 ppm criterion. Other nearshore species also exceed the lower (0.37 ppm) GLI criterion. Dieldrin was found to exceed both water quality and fish flesh criteria throughout the lake.

Based upon the results of this evaluation, OCS, chlordane, and HCB are not considered to be exceeding GLIWQC on a lakewide basis. Mercury and dieldrin are considered to be exceeding GLIWQC and are, accordingly, considered LaMP Critical Pollutants.

Future Actions

It is recommended that future evaluations be used to compare Lake Ontario surface water quality and fish tissue data to all of the GLI BCC WQC and associated fish tissue values in order to identify any, as yet unrecognized, contaminant problems that should be considered for special priority actions on a lakewide basis.

MERCURY ANALYSIS

Comparison of Ontario and New York data for mercury in fish was conducted using as a basis the following rules:

Use only mercury data for fish collections from 1990 through the present time for all species, except walleye. For walleye, data from 1987 through the present time was used due to the similarity of the data between locations and over time, and to obtain an adequate data base for evaluation;

Use only data from Lake Ontario, Bay of Quinte, and the lower Niagara River;

A classification of mercury as a lakewide chemical of concern may be made when a species of fish exceeds either 500 ng/g or 1000 ng/g mercury in edible tissues at nearly all sites sampled on both sides of the lake;

A classification of mercury as a regional chemical of concern may be made when a species of fish exceeds either 500 ng/g or 1000 ng/g mercury in a given area of the lake; and

No classification of a species as either a lakewide or regional chemical of concern will be made where the data: (1) demonstrate that mercury concentrations for a fish species at all locations are below 500 ng/g, (2) are inconsistent for either the entire lake or regions of the lake, or (3) are lacking from both sides of the lake.

Data Available

-- The entire shoreline of Lake Ontario is represented, plus the lower Niagara River and Bay of Quinte.

-- Ontario mercury data from 1990 through 1995 for 21 species of fish representing 19 locations (in some instances, data from several locations may be combined for evaluation due to the regional proximity of the locations). In addition, for walleye, mercury data for the period from 1987 through the present is used to better represent the species throughout the lake.

-- New York mercury data from 1993 through 1996 for 28 species of fish representing seven locations.

Conclusions

-- None of the species contain mercury at concentrations sufficient to be considered either a lakewide or regional chemical of concern when a mercury criterion of 1000 ng/g is used.

-- When a mercury criterion of 500 ng/g is used, mercury is a lakewide chemical of concern for smallmouth bass and walleye only. Smallmouth bass greater than about 380 mm and walleye greater than about 550 mm are likely to contain mercury concentrations greater than 500 ng/g.

-- When a mercury criterion of 500 ng/g is used, mercury is a regional chemical of concern for largemouth bass (south shore), northern pike (eastern lake), channel catfish (Bay of Quinte and Oswego), and freshwater drum (south shore and lower Niagara River). Some of the largest fish of each species listed contain mercury concentrations greater than 500 ng/g. Specific comments on the data base for each species follows:

- Largemouth bass - there were little recent data for the species from Ontario waters of Lake Ontario; the species is adequately represented on the south shore.

- Northern pike - Sufficient data were available for all Ontario waters of the lake but, in New York waters, only the eastern lake is represented. The Ontario data suggest elevated mercury concentrations are limited to large fish in the eastern end of the lake for this species.

- Channel catfish - There is limited representation by this species on both the north and south shores of the lake. For large individuals of this species, only the Bay of Quinte and Oswego can be indicated as having mercury concentrations in excess of 500 ng/g.

- Freshwater drum - The New York waters are adequately represented in the data base but the only Ontario waters represented by this species are the lower Niagara River and Bay of Quinte.

- Inconsistent data were available for white perch and white sucker so they were not classified; however, occasional detection of mercury at concentrations greater than 500 ng/g were found in large fish as reported by Canadian authorities. Similar findings were not reported by New York.

- All other fish species examined contained mercury concentrations which were below 500 ng/g.

Health Advisory Criteria

-- Health advisories issued by New York or Ontario have differing criteria for determining the advice to be issued to the public. The criteria and the corresponding advice is summarized below. The advice may be tailored to represent regions of a waterbody and to reflect size-mercury concentration relationships for a species of fish.

Mercury Concentration (Fg/g)	Health Advisory	
	New York	Ontario
<0.5	One meal per week	Eight meals per month
0.5 to 1.0	One meal per week	One meal per week
1.0 to 1.5	One meal per month; women of childbearing age and children under 15 years should not consume fish	Two meals per month for all populations
>1.5	Eat none	Eat none

-- New York considers a health advisory based on mercury concentrations in fish to be an impairment of water usage when the mercury concentration exceeds 1.0 Fg/g. Ontario considers a health advisory based on mercury concentrations in fish to be an impairment of water usage when the mercury concentration exceeds 0.5 Fg/g.

Authors: Lawrence C. Skinner, New York State Department of Environmental Conservation, and Alan

Hayton, Ontario Ministry of the Environment, September 10, 1997.

LAKE ONTARIO LETTER OF INTENT

Lake Ontario MAY 22 1996

Progression of Toxics Management Plan to Lakewide Management Plan Letter of Intent

In 1987, the Niagara River Declaration of Intent (DOI) committed the Four Parties (Environment Canada, U.S. Environmental Protection Agency, Ontario Ministry of the Environment, and New York State Department of Environmental Conservation) to develop Toxics Management Plans for the Niagara River and Lake Ontario. The Lake Ontario Toxics Management Plan (LOTMP) was developed in 1989 and was updated in 1991 and 1993.

The goal of the LOTMP is a lake that provides drinking water and fish that are safe for unlimited consumption and allows natural reproduction of the most sensitive native species. The LOTMP reduces toxic inputs to the Lake through the implementation of new and existing programs and the development of basin-wide pollution prevention strategies. The LOTMP has been the primary toxic substances reduction planning effort for Lake Ontario.

The 1987 amendments to the Great Lakes Water Quality Agreement committed the federal governments of the United States and Canada to develop Lakewide Management Plans (LaMP) for each of the five Great Lakes. The LaMP will provide a comprehensive ecosystem approach to restore beneficial uses by reducing levels of critical pollutants that cause lakewide problems. Critical pollutants are substances that singly or in combination pose a threat to human health or aquatic life due to their toxicity, persistence in the environment and/or their ability to accumulate in organisms.

The Four Parties agree that one program (the LaMP) should be developed which provides an overall framework for our efforts. The LOTMP has been the primary toxic substances reduction planning effort for Lake Ontario. As such, it serves as a foundation for the development of the Lake Ontario LaMP. In order to assure that the LaMP documents reflect the intent of the LOTMP, the Four Parties have agreed to review and incorporate all relevant commitments from the LOTMP. Documentation of the progress that has been achieved towards these goals will be provided in the first LaMP document.

The LaMP process provides a mechanism to continue to deliver the LOTMP committed to in the 1987 DOI. The attached Lake Ontario LaMP Workplan establishes commitments and milestones for the development of the LaMP, within the constraints of available resources.

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APPENDIX D

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LaMP Document Repositories

United States Repositories

U.S. Environmental Protection Agency
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Niagara Falls, New York 14303
(716) 285-8842

New York State Department of Environmental Conservation Regional Offices

NYSDEC - Region 6
317 Washington Street
Watertown, New York 13601
(315) 785-2239

NYSDEC - Region 7
615 Erie Blvd. West
Syracuse, New York 13204-2400
(315) 428-4497

NYSDEC - Region 8
6274 East Avon-Lima Road
Avon, New York 14414
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NYSEC - Region 9
270 Michigan Avenue
Buffalo, New York 14202
(716) 851-7000

University Libraries

SUNY Brockport
Drake Library
Brockport, New York 14220

Science and Engineering Library
Capen Hall
SUNY Center Buffalo
Buffalo, New York 14214

Penfield Library
SUNY Oswego
Oswego, New York 13126

Collection Division Office
Butlers Library
SUNY Buffalo
1300 Elmwood Avenue
Buffalo, New York 14222

Archives Moon Library
SUNY Environmental Science and Forestry
Syracuse, New York 13210

Not-For-Profit Agencies

Atlantic States Legal Foundation Inc.
656 West Onondaga Street
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(315) 475-1170

Canadian Repositories

Environment Canada
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Ontario Ministry of the Environment Offices

Ontario Ministry of the Environment
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Port Hope RAP (Inactive at this time)
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Bureau of Watershed Management
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Remedial Action Plan References

United States

Eighteenmile Creek

Eighteenmile Creek Remedial Action Plan, prepared by the New York State Department of Environmental Conservation in cooperation with the Eighteenmile Creek Remedial Action Committee, NYSDEC, 50 Wolf Road, Albany, New York, 12233-3508.

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Rochester Embayment

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Niagara River

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Oswego River

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Oswego River Remedial Action Plan Update. 1996. New York State Department of Environmental Conservation, December 1996, 50 Wolf Road, Albany, New York, 12233-3508.

Canada

Niagara River

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Report of the Niagara River Secretariat Relative to the Status of Commitments under the Niagara River Declaration of Intent, Environment Canada, USEPA, Ontario Ministry of Environment and Energy, New York State Department of Environmental Conservation. June 16, 1994.

Stage 1 Update: Environmental Conditions and Problem Definition. March 1995.

Stage 2 Report: The Cleanup Connection. June 1995.

Stage 2 Report Summary: The Cleanup Connection. April 1995.

Hamilton Harbour

Stage 1 Report: Remedial Action Plan for Harbour Environmental Conditions and Problem Definition. March 1989.

The Remedial Action Plan (RAP) for Harbour - Stage 2A. July 1991.

Final Stage 2 Report (to COA RAP Steering Committee) and Implementation Annex. November 1992.

Second Edition of the Stage 1 Report "Environmental Conditions and Problem Definition". October 1992.

Remedial Action Plan for Hamilton Harbour - 1995 Update to the HHRAP Stage 2 Report "Contaminated Sediment in Hamilton Harbour". December 1995.

Metro Toronto and Region

Stage 1: Environmental Conditions and Problem Definition. 1988. (Executive Summary available in English and French)

Strategies for Restoring our Waters. 1991. (Also available in French)

Clean Waters, Clear Choices: Recommendations for Action. 1994. (Summary available in English and French)

Port Hope

Port Hope Harbour Remedial Action Plan Stage 1: Environmental Conditions and Problem Definition. January 1990.

LAKE ONTARIO SPORTFISH ADVISORIES

Appendix E

United States Lake Ontario Fish Consumption Advisories, 1996-1997

The following recommendations are based on contaminant levels in fish. To minimize potential adverse health impacts, the New York State Department of Health recommends:

Eat no more than one meal (one-half pound) per week of fish.

Women of childbearing age, infants, and children under the age of 15 should not eat any fish.

In addition to these general recommendations, more stringent advisories exist for the following species and locations:

Table E-1.

Location	Species	Recommendations	Chemical(s) of Concern
Including Niagara River below Niagara Falls (see Niagara River for additional advice)	American eel, channel catfish, carp, lake trout, chinook salmon, rainbow trout, coho salmon over 21", and brown trout over 20"	Eat none	PCB, Minex, Dioxin
	White sucker, smaller coho salmon and brown trout	Eat no more than one meal per month	PCB, Mirex, Dioxin
West of Point Breeze	White Perch	Eat none	PCB, Mirex, Dioxin
East of Point Breeze	White Perch	Eat no more than one meal per month	PCB, Mirex, Dioxin

Contaminants Causing Sport Fish Consumption Advisories in Canadian Waters of Lake Ontario, 1997-1998

Consumption recommendations for sport fish from the Canadian waters of Lake Ontario are given in the **1997-1998 Guide to Eating Ontario Sport Fish** published by the Ontario Ministry of the Environment and Ministry of Natural Resources. Fish consumption advisory tables are provided in blocks or regions for the lake. Consumption advice is specific to the location where the fish is caught, the species of fish, and the size of fish.

The following table summarizes the principal contaminant of concern which is responsible for causing the consumption restrictions. Blocks refer to the 1997-1998 **Guide to Eating Ontario Sport Fish.**

Table E-2.
Ontario Sportfish Consumption Advisories, 1985-1994

Block	Species	Contaminant
1a. Upper Niagara River	Rainbow Trout	-
	Northern Pike	-
	Smallmouth Bass	Mercury
	Largemouth Bass	-
	Yellow Perch	-
	White Bass	PCBs
	Rock Bass	-
	Brown Bullhead	-
	Carp	PCBs
	Freshwater Drum	-
	White Sucker	-
	Redhorse Sucker	Mercury
	Rainbow Smelt	PCBs
1b. Lower Niagara River	Chinook	Mirex
	Rainbow Trout	PCBs
	Lake Trout	PCBs
	Smallmouth Bass	PCBs
	Yellow Perch	Mercury
	White Perch	PCBs
	White Bass	PCBs
	Rock Bass	-
	Brown Bullhead	PCBs
	Carp	PCBs
	Channel Catfish	PCBs
	Freshwater Drum	-
	White Sucker	PCBs
	Redhorse Sucker	PCBs
	American Eel	PCBs
	Rainbow Smelt	PCBs
2. Western Lake Ontario	Chinook	PCBs/mirex
	Coho	PCBs
	Rainbow Trout	Mirex/PCBs
	Brown Trout	PCBs
	Lake Trout	PCBs
	Walleye	Mercury
	Northern Pike	-
	Smallmouth Bass	Mercury
	Yellow Perch	-
	White Perch	PCBs
	White Bass	PCBs
	Brown Bullhead	PCBs
	Channel Catfish	PCBs
	Freshwater Drum	Mercury
	Carp	PCBs
	Rainbow Smelt	PCBs
3. Hamilton Harbour	Brown Trout	PCBs/mirex
	Yellow Perch	PCBs
	White Perch	PCBs
	White Bass	PCBs
	Black Crappie	PCBs
	Brown Bullhead	PCBs/mirex
	Channel Catfish	PCBs
	Freshwater Drum	PCBs
	Carp	PCBs
	White Sucker	PCBs
	Rainbow Smelt	Mirex/PCBs

Block	Species	Contaminant
4. Toronto Offshore	Chinook Brown Trout Lake Trout Yellow Perch Carp White Sucker	PCBs/mirex PCBs PCBs/mirex/dioxins - PCBs -
4a. Toronto Waterfront	Brown Trout Lake Trout Northern Pike Largemouth Bass Yellow Perch White Perch Rock Bass Pumpkinseed Bluegill Brown Bullhead Carp White Sucker Rainbow Smelt	PCBs/mirex PCBs - Mercury - PCBs Mercury - - Mirex PCBs PCBs PCBs
5. Credit River	Chinook Coho Rainbow Trout Brown Trout	Mirex/PCBs Mirex Mirex Mirex
6. Northwestern Lake Ontario	Chinook Rainbow Trout Brown Trout Lake Trout Walleye Smallmouth Bass White Bass Brown Bullhead Rainbow Smelt Gizzard Shad	PCBs PCBs PCBs/mirex Dioxins Mercury Mercury PCBs - PCBs PCBs
6a. Frenchman Bay	Northern Pike Yellow Perch Brown Bullhead Carp	Mercury - PCBs PCBs
6b. Whitby Harbour	Northern Pike Brown Bullhead White Sucker	- Mercury -
7. Ganaraska River	Chinook Coho Rainbow Trout Brown Trout Lake Trout	PCBs/mirex Mirex/PCBs Mirex PCBs/mirex PCBs
8. Northeastern Lake Ontario	Chinook Rainbow Trout Brown Trout Lake Trout Smallmouth Bass Rock Bass Walleye American Eel	Mirex/PCBs Mirex PCBs/mirex Mirex/PCBs Mercury - Mercury PCBs

Block	Species	Contaminant
9. Upper Bay of Quinte	Walleye	Mercury
	Northern Pike	-
	Smallmouth Bass	-
	Largemouth Bass	-
	Yellow Perch	-
	White Perch	-
	Pumpkinseed	-
	Brown Bullhead	-
	Channel Catfish	-
	Freshwater Drum	-
	White Sucker	-
	American Eel	PCBs
10. Middle Bay of Quinte	Walleye	-
	Northern Pike	-
	Yellow Perch	-
	White Perch	-
	Pumpkinseed	-
	Brown Bullhead	-
	White Sucker	-
	American Eel	PCBs
	Gizzard Shad	PCBs
11. Lower Bay of Quinte/ Eastern Lake Ontario	Chinook	PCBs
	Brown Trout	Mirex
	Lake Trout	PCBs/mirex
	Walleye	Mercury/mirex
	Northern Pike	Mercury
	Smallmouth Bass	Mercury
	Yellow Perch	PCBs
	White Perch	-
	Rock Bass	-
	Whitefish	Dioxins
	Freshwater Drum	-
	White Sucker	PCBs
	American Eel	PCBs/mirex

Table E-3.
Ontario Sport Fish Consumption Advisories Caused by Mercury, 1985-1995

Area	Species	Location	Year
Upper Niagara River	Smallmouth Bass Redhorse Sucker Freshwater Drum	Strawberry Island Fort Erie Fort Erie	1994 1985 1985*
Lower Niagara River	Yellow Perch Smallmouth Bass	Queenston/Fort George Queenston-Whirlpool	1995 1985*
Western Lake Ontario	Walleye Smallmouth Bass	Niagara Bar Niagara Bar	1994 1994
Toronto Waterfront	Largemouth Bass Rock Bass	Toronto Islands Ontario Place	1990 1992
Hamilton Harbour	Freshwater Drum		1985**
Northwestern Lake Ontario	Walleye Smallmouth Bass	Pickering NGS Rouge Marsh	1989 1993
Frenchman Bay	Northern Pike		1986
Whitby Harbour	Brown Bullhead		1993
Northeastern Lake Ontario	Smallmouth Bass Walleye	Block Gravelly Bay	1995 1987
Upper Bay of Quinte	Walleye American Eel	Block Block	1995 1993**
Lower Bay of Quinte/ Eastern Lake Ontario	Walleye Northern Pike Smallmouth Bass	Block Nearshore, North Channel Block	1994 1989 1993

* No longer an advisory restriction due to mercury, due to updated results.
** Advisory restriction now based on PCBs, due to lowering of guideline.

UPDATED LAKE ONTARIO TOXICS MANAGEMENT PLAN COMMITMENT TABLE

The Lake Ontario Toxic Management Plans (1989, 1991, 1993) set out individual and joint agency commitments to implement activities to reduce sources of toxic substances to Lake Ontario. This table provides an update on the status (as of November 1996) of the commitments set out in the 1993 LOTMP and indicates commitments which are completed and those that will be carried over into the LaMP.

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PUBLIC INVOLVEMENT PROCESS FOR DEVELOPMENT OF STAGE I LAKE ONTARIO LaMP

APPENDIX H

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One of the goals of the Public Involvement program of the Lake Ontario LaMP is to "provide opportunities for meaningful public consultation in developing and implementing Lake Ontario management plans". As part of this commitment, the agencies conducted a number of activities to inform interested parties about the Lake Ontario Draft Stage 1: Problem Definition report and gather comments on the document.

Open Houses/Public Meetings

To highlight the availability of the Draft Stage 1 for review/comment and to provide information to people interested in the LaMP, open houses and informal public meetings were held in the Lake Ontario basin in the spring of 1997. Four open houses were held in various locations in Ontario, Canada and six informal public meetings were held in various locations in New York State. Generally, open house attendees and public meeting participants were seeking more information about the Lake Ontario LaMP process, clarification of where issues of concern fit into the process, and an explanation of how people can have input to and become involved in the plans to restore and protect the Lake Ontario ecosystem.

Distribution of the Draft

Copies of the Draft Stage 1 document were distributed at the open houses and informal public meetings, and mailed to people on the Lake Ontario mailing lists and to those who had requested a copy. The draft was also made available on the Lake Ontario LaMP website. Accompanying the draft document was a piece titled Topics For Your Consideration which contained questions to help gather comments, suggestions, and/or concerns about key aspects of the Draft Stage 1 document.

Public Comments

The following provides a general overview of the kinds of comments the agencies received either in writing or during the open houses or informal public meetings:

Generally, public comments indicated that the document was well-written, easy to understand, covered a range of complex issues in an understandable fashion, and made good use of lists, tables, and figures. There appeared to be some need for clarification of terms and an expanded glossary that would include acronyms. Specific comments about Chapter 1 (Introduction) indicated that the chapter was sufficient and applauded the inclusion of information about various local programs and statistics. There were, however, a number of suggestions for information that, if included, would improve the chapter.

Regarding the concept of Basin Teams and Partnerships outlined in Chapter 2, comments were generally focused on the need to better explain the Basin Team/Partnership approaches. A key suggestion urged the agencies to develop a succinct blueprint of how the Basin Teams/Partnerships will be constructed. Other comments reiterated the need to clarify the connections between RAPs, LaMPs, and other watershed management initiatives. In response to a question about how the agencies could work with groups/organizations, comments emphasized the need for coordinating and communicating information using existing groups or through local channels and contacts. Creating more committees was not seen as a favorable approach.

The majority of the comments indicated agreement with the lakewide problems as defined in the Draft Stage 1 document. There were some concerns that lake levels management was not adequately addressed and that there was a lack of information about human health issues. Other lakewide issues that were seen as needing

further attention included: atmospheric deposition, non-point sources of contaminants, erosion, mercury, and funding issues.

Regarding the Future Agenda as described in the Draft Stage 1, comments indicated that the Future Agenda was definitely a step in the right direction. However, most reviewers thought that the Agenda should include more details, schedules, and action items. There was also general concern about the length of time it will take to fully develop and implement the LaMP; things need to proceed quickly. Most responses indicated agreement with the overall direction that the four agencies described in the LaMP Agenda. Again, there were a variety of suggestions about ways to improve the LaMP process while moving it in the same direction.

A Summary of Comments and Responses

There were some significant changes made to the document as a result of the public review period. Examples of these include the addition of Mercury to the list of critical pollutants, additional information on human health effects, and the revision of the Workplan to make it more detailed and action-oriented.

A detailed outline, called a Summary of Comments and Responses on the Lake Ontario LaMP, has been prepared so that those who provided comments can see how the agencies used their input as the Stage 1 was finalized. The Summary explains what changes were made to the LaMP document as a result of the comment, or if no change was made to the document, why a change was not appropriate.

While the Summary of Comments and Responses is not a part of this report, copies have been sent to those who made specific comments to the agencies. A copy may be obtained on our websites at **www.cciw.ca/glimr/lakes/ontario/ (**in Canada), at **www.epa.gov\glnpo\lakeont (**in the United States) or by contacting:

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