United States
Environmental Protection
Agency

Great Lakes National
Program Office
536 South Clark Street
Chicago, Illinois 60605

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August 1985

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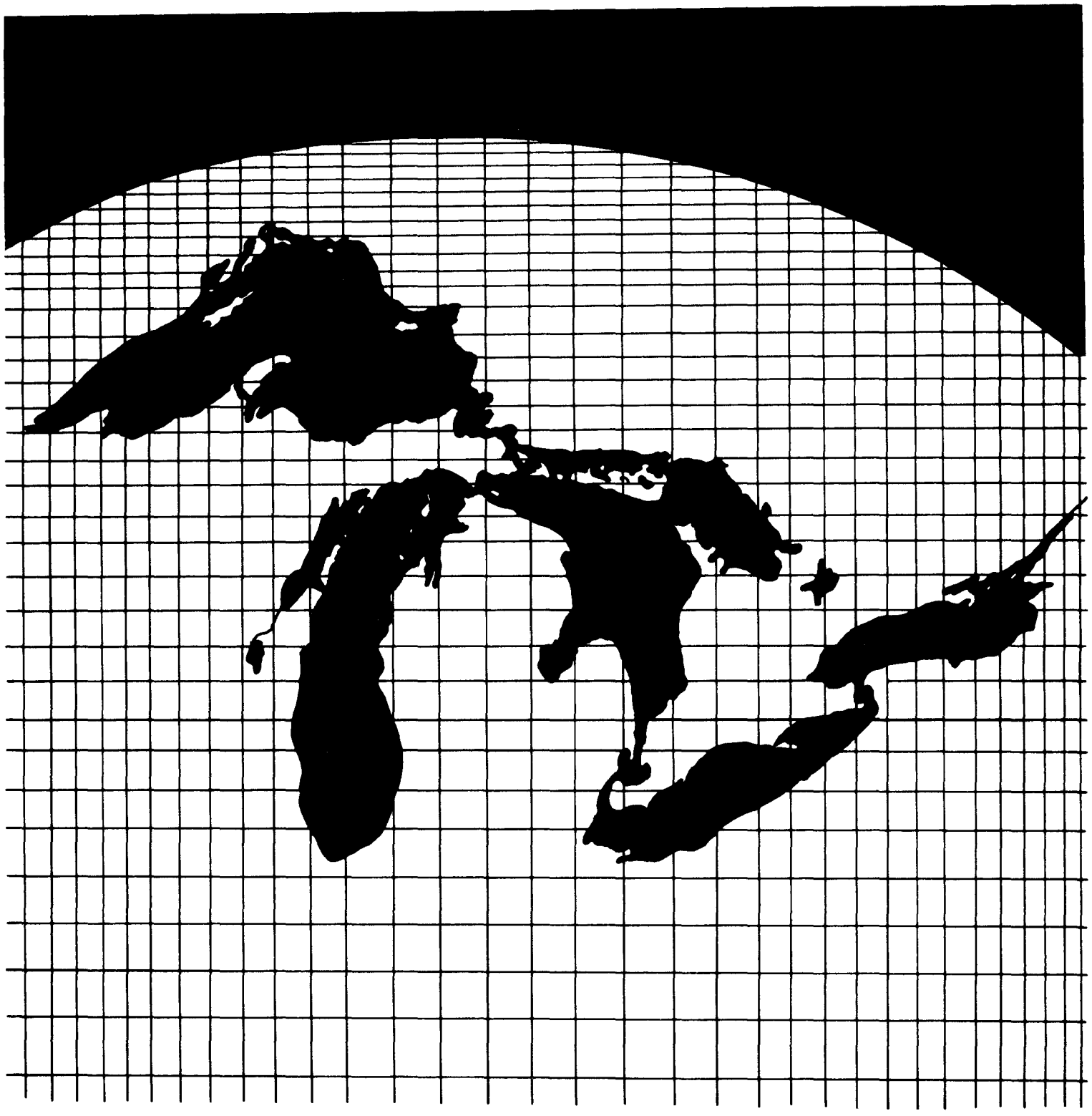
EPA

Five Year Program Strategy for Great Lakes National Program Office 1986-1990



EPA-905/9-85-002
August 1985

A FIVE YEAR PROGRAM STRATEGY

FOR THE

GREAT LAKES NATIONAL PROGRAM OFFICE

OF THE

U.S. ENVIRONMENTAL PROTECTION AGENCY

1986 - 1990

Great Lakes National Program Report #85-01
Great Lakes National Program Office
U.S. Environmental Protection Agency
536 South Clark Street
Chicago, Illinois 60604
June, 1985

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I. INTRODUCTION

This document lays out a five year program strategy for the Great Lakes National Program Office of the Environmental Protection Agency (EPA). This office coordinates with other EPA programs and with other agencies to support activities that benefit the Great Lakes and assist implementation of the Great Lakes Water Quality Agreement with Canada.

The program strategy has two purposes. One is to inform other EPA programs, federal agencies and the states how the Great Lakes Office will address its longterm goals from 1986 to 1990. The other is to assist efficient use of resources and annual budgeting by setting program priorities.

The goals of the five year program strategy for the Great Lakes are:

1. To apply an ecosystem approach to management by considering effects of use of the lakes on the health of biota and human health;

2. To obtain sufficient information about sources, fates and effects of toxic contaminants to support a mass balance approach in remedial programs;

3. To develop and implement remedial programs in all areas of concern;

4. To evaluate results of remedial programs for conventional pollutants, including phosphorus controls, and to determine whether more stringent controls are needed; and

5. To develop a stronger partnership with Great Lake states, other EPA programs and other federal agencies for implementation of the Great Lakes Agreement with Canada.

The Great Lakes are North America's largest reservoir of fresh surface water. The size and nature of this system provides a sensitive laboratory for detecting environmental problems and testing possible solutions. The earlier cooperative process for reducing phosphorus loadings is now underway for control of toxic contamination. The five year strategy provides for continued monitoring of responses to phosphorus controls but emphasizes control of toxic contamination as the measure now needed to protect beneficial uses of the lakes for the future.

The Great Lakes Water Quality Agreement with Canada provides a binational framework for Great Lakes management and assigns oversight responsibility to the International Joint Commission (IJC). The IJC relies on its Water Quality Board for reports on progress but implementation of the agreement depends on national programs. Since EPA is the lead agency for fulfilling agreement obligations on the U.S. side, the

Great Lakes Office provides staff support to the Water Quality Board and coordinates participation by EPA and other agencies in the IJC activities for the Great Lakes agreement.

The Great Lakes Office is located in Region V of the U.S. Environmental Protection Agency in Chicago but also works with Region II in New York and Region III in Philadelphia to integrate Great Lakes cleanup with EPA's other mandates for environmental protection. Within EPA, the Great Lakes Office coordinates its activities with the programs for water, environmental services, hazardous wastes and toxic substances, and air as well as does the Central Regional Laboratory and EPA research units. The Great Lakes Office also assists coordination of state programs and cooperates with other federal agencies.

The strategy described here assumes five stages in development of environmental solutions:

1. Identification of problems;

2. Quantification and determination of significance of effects;

3. Proposal and testing of solutions;

4. Implementation of remedial programs; and

5. Evaluation of results and feedback to remedial programs.

Evaluation will lead to needed modification of programs. Therefore, the strategy will be reviewed and updated as required by changes in understanding of problems, evaluation of results of control efforts or other events.

Achievement of all the objectives and completion of all the activities outlined in Chapter VII depends in part on the availability of funding. Yet, articulation of the strategy will assist setting priorities if there is not enough funding available to carry out the full program on the schedule that is outlined here. If necessary, because of lack of resources, implementation can be extended over a longer period.

In summary, the strategy is based on the current status of progress in addressing Great Lakes problems and considers the further progress that can be made in addressing them over the next five years. It sets priorities for action and lays out specific activities for the Great Lakes National Program Office year by year from 1986 to 1990. The strategy provides that the Great Lakes Office will assist achievement of an ecosystem approach by integration of multimedia efforts for the Great Lakes within EPA as well as by coordination with other federal agencies and the states.

The strategy also considers the ecosystem approach to management called for in the 1978 Great Lakes agreement. While the program strategy is most concerned with cleanup and prevention of pollution of waters of the Great Lakes themselves, an ecosystem perspective requires attention to the tributaries, to land and to the atmosphere as sources of contamination to the lakes. The strategy considers human health because an ecosystem approach is concerned with human uses of the lakes as well as the ecological integrity of natural systems.

Finally, the strategy assumes that public support depends on public understanding of the environmental problems that affect the Great Lakes. Therefore the strategy includes public information and education as a necessary component of long term efforts to clean up pollution from the past and to prevent continued environmental damage in the future.

II. MISSION STATEMENT FOR THE GREAT LAKES NATIONAL PROGRAM OFFICE

The mission of the Great Lakes National Program Office includes two chief functions. The first is to take the lead in ensuring fulfillment of United States obligations under the Great Lakes Water Quality Agreement with Canada. The second is to assist EPA's management of the Great Lakes under national laws and policies. Both purposes require integration of the activities of the Great Lakes Program Office with EPA's funding and regulatory programs, including the programs that have been delegated to the states.

The Great Lakes National Program Office is administered within the Region V office of EPA because this region includes six of the eight Great Lake states (Minnesota, Wisconsin, Illinois, Indiana, Michigan and Ohio). The office also provides leadership, assistance and coordination on Great Lakes issues to the EPA Region II office in New York and the Region III office in Pennsylvania.

The international Great Lakes agreement requires remedial programs, research, surveillance and monitoring. Remedial actions are accomplished entirely by the separate national programs of each country. U.S. policy requires delegation to the states of as much responsibility for implementation of federal environmental programs as possible. For this reason, the Great Lakes office works with other EPA program offices to promote attention by the states to Great Lakes needs.

In EPA, the Water Divisions have the primary responsibility for regulatory and remedial programs under the Clean Water Act. Great Lakes issues are considered in review of grants to the states for administration of permits under the National Pollution Discharge Elimination System (NPDES), for implementation of the construction grants program for municipal sewage treatment systems, for setting and enforcement of water quality standards and for planning.

An ecosystem perspective in control of toxic contamination also requires cooperation between the Great Lakes Office and the offices responsible for hazardous waste management, drinking water and air quality. The Great Lakes Office will work with these offices to integrate Great Lakes concerns into their programs.

Under the international agreement, surveillance and monitoring and some research are accomplished by coordination and cooperation with Canadian agencies and with other federal and state agencies through the IJC. The staff of the Great Lakes Office serves on IJC boards, committees and task forces that plan, carry out and report on activities related to the Great Lakes agreement. It also provides staff services to the regional administrator of Region V, who traditionally serves as the U.S. Chairman of the IJC Water Quality Board.

The research responsibilities of the Great Lakes Office include identifying Great Lakes research needs for Region V, for the Office of Research and Development (ORD) in EPA headquarters and for the agency's national laboratories. The Great Lakes Office often funds needed research within EPA and cooperates with other federal agencies in identifying and supporting research. The office contracts directly with universities and private consultants for research as needed.

In addition to its oversight and coordinating functions for remedial programs and research, the Great Lakes Office carries out EPA's Great Lakes surveillance and monitoring program. The lake surveillance program is required under the Great Lakes agreement. The program includes funding by contract operation of the research vessel the Roger R. Simons and the Central Regional Laboratory in Region V. It also requires coordination with the states, with other federal agencies and with Canadian agencies. The surveillance program is the chief operating activity of the Great Lakes Office and absorbs the majority of its budget.

Finally, the Great Lakes Office operates the Great Lakes Demonstration Grant Program under Section 108 of the Clean Water Act. The program is authorized to show the feasibility of using innovative methods of controlling pollution of the Great Lakes. The Lake Surveillance Program and the Section 108 Demonstration Grant Program are the only EPA field programs operated by the Great Lakes National Program Office.

III. THE GREAT LAKES ECOSYSTEM

The Great Lakes system is the largest reservoir of fresh surface water on North America and contains about 20 percent of the world's supply. The Great Lakes are a fishery resource, a transportation system, a water supply, a recreation resource, a modifier of climate and a means of waste disposal. In both Canada and the United States, all of these uses contributed to development of one of the world's largest inland concentrations of population and industry.

The Great Lakes are being looked to as a basis for rebuilding the regional economy. Yet the physical, chemical and biological change and degradation of water quality that accompanied past development must be avoided in order to sustain development in the region in the future.

New understanding about the Great Lakes has been gained with experience in cleanup of the lakes under domestic laws and the Great Lakes agreement with Canada. This experience has led to a new concept of need for an ecosystem approach to management. The ecosystem perspective requires management of the Great Lakes as an integrated system of land, air and water, inhabited by humans and other organisms. It also requires understanding of how the natural system has changed in the past 200 years and helps to predict future changes.

CHARACTERISTICS OF THE NATURAL SYSTEM

The Great Lakes system flows from Lake Superior 600 feet above sea level through the other four lakes and the connecting channels out through the St. Lawrence River to the Atlantic Ocean. The system contains five distinct drainage basins but the land area is relatively small in relation to the large and numerous bodies of waters. One-third of the total 300,000 square mile drainage basin is covered by water. Another feature is the numerous tributaries that drain a large variety of land uses and many types of soil. The hydrologic features of the five lakes are compared below.

COMPARATIVE HYDROLOGIC FEATURES OF THE FIVE GREAT LAKES

Lake	Drainage Area, Square Miles	Surface Area, Square Miles	Volume, Cubic Miles	Residence Time, Years	Depth, Feet
Superior	49,300	31,700	2,935	200	489 average 1,335 maximum
Michigan	45,600	22,300	1,180	100	279 average 925 maximum
Huron	51,700	23,000	849	25	195 average 750 maximum
Erie	22,700	9,910	116	3	62 average 210 maximum
Ontario	27,300	7,340	393	6	283 average 802 maximum

Less than one percent of the total volume of water in the system flows out the St. Lawrence each year. The relatively closed nature of the system makes the Great Lakes more vulnerable to pollution while the huge volume of water makes reversal of change due to pollution more difficult.

The response to pollution and cleanup is different in each lake. Lake Erie is the shallowest, its shores are highly urbanized and its major tributaries drain intensely farmed cornbelt soils. For these reasons, Lake Erie was the first to show lakewide signs of cultural eutrophication but also responded more quickly to cleanup.

Lake Ontario is smaller in area but deeper than Erie. Being downstream, it receives nutrients from Erie and probably receives persistent toxicants from the rest of the system as well as the Niagara River. Ontario has the highest concentrations of toxic contaminants.

Lake Michigan's vulnerability to both overenrichment and toxic contamination is compounded by a long residence time of about 100 years. It receives high loadings of nutrients, heavy metals and contaminants from the atmosphere over its large surface area. Chloride levels are several times higher in this lake than at the turn of the century.

Lake Superior and Lake Huron are the Upper Great Lakes whose drainage basins have lower population densities and more forested lands. Maintenance of Superior's pristine, oligotrophic state is an objective of the water quality agreement. In Huron, as throughout the entire Great Lakes system, nearshore waters and embayments are more eutrophic and have higher contaminant levels than the open lake. Such areas are enclosed, shallow and also receive more concentrated loadings of pollutants, with less circulation than the open lakes.

The levels and flows of the system are governed more by the natural hydrologic cycle than by existing manmade diversions and regulation for navigation and hydropower production. The Army Corps of Engineers has found that the net cumulative change in lake levels due to operation of control locks and to diversions since 1909 is only a few inches. A 1981 IJC study suggested the possibility, however, of potential consumptive uses over the next 50 years that could reduce the flow out the St. Lawrence by as much as 8 percent over the next century. The resulting change in lake levels could affect wetlands as well as other uses of the lakes. There is also concern about possible ecological consequences of potential new major interbasin transfers in the future.

The average annual precipitation over the entire Great Lakes basin is 31 inches. There is approximately 10 percent greater precipitation over the Great Lakes than over the surrounding land. Both wet and dry deposition of airborne toxic substances are significant sources to the lakes, which serve as a sink for polychlorinated biphenyls (PCBs) and other contaminants from many sources.

WATER QUALITY IN THE GREAT LAKES SYSTEM

Concerns about water quality in the Great Lakes have passed through four general stages dealing with disease organisms, oxygen depletion, nutrients and eutrophication and now toxic contamination as the cause of pollution. Appreciation for the complexity of the causes of water quality degradation in the Great Lakes has grown with experience in monitoring responses to pollution control measures over the past 20 years.

Before intensive settlement and development of the region, the waters of the Great Lakes were clear and cold throughout the system. Algae growth was low and there were many species of fish, some of which are now extinct. The average size of individual fish was much larger and longer-lived species such as sturgeon and lake trout were abundant. It is difficult to distinguish the causes of the drastic changes in the fishery between accidental and deliberate introduction of exotic species, over-fishing and habitat changes. An ecosystem approach to management assumes, however, a link between the health of natural biota and habitat.

As cities grew, local degradation due to waste disposal at first seemed inconsequential in the large lakes. Later it was realized that fundamental change in such a large system may not become obvious until it is well-advanced. By the 1880s, contamination of drinking water intakes by human sewage led to primary treatment and disinfection of sewage.

With better treatment of drinking water, sewage treatment solved the disease problem through the first half of the 20th century except for diseases contracted by swimming. Even with primary treatment for sewage, however, overenrichment by organic wastes from many sources was causing subtle change in life in the lakes in many locations through the first half of this century. Beaches were closed to swimming because of high fecal coliform counts or were unused because of algae, odors, floating oil or dead fish.

Algae growth increased and promoted oxygen depletion and destruction of biota in nearshore and estuary areas. How such changes could affect a whole Great Lake was not recognized until eutrophication became obvious in vulnerable Lake Erie. By 1960, changes in productivity and the annual cycle of algae bloom, decay and oxygen depletion in Lake Erie had been linked to overenrichment. The public demanded pollution control and the federal government promoted secondary treatment of sewage and control of direct discharges of industrial wastes.

After scientific consensus was reached that phosphorus is the limiting nutrient for the Great Lakes, reduction of phosphorus became the chief objective of the first Great Lakes Water Quality Agreement with Canada in 1972. In the same year, Congress adopted the 1972 Federal Water Pollution Control Act amendments (PL 92-500). This legislation provides the chief vehicle for fulfilling U.S. obligations under the binational compact.

By 1980, decreased algae growth and increased dissolved oxygen levels were evidence that water quality is improved in most of the Great Lakes. Today, although acceleration of eutrophication appears to have been controlled in the open lakes by reduction of phosphorus loadings, toxic contamination is considered a long term threat to sensitive uses of the lakes. Remaining Great Lakes problems are described in Section IV.

IV. REMAINING GREAT LAKES PROBLEMS

To date, substantial progress has been made in controlling overenrichment by nutrients and in reducing other forms of Great Lakes pollution. Two major categories of problems remain: impairment of beneficial uses in numerous geographic locations that the IJC identifies as "areas of concern" and accumulation of toxic contamination throughout the system.

Although water quality in the Great Lakes has improved from many standpoints in recent decades, the IJC has identified 28 areas of concern in the United States where beneficial uses are impaired. In these locations, even though there may be less pollution than formerly, the water quality objectives of the Great Lakes agreement and federal and state pollution control requirements are not being met. The areas of concern are shown on the map on page 9.

The conventional pollutants that remain a problem in areas of concern are in addition to the toxic contamination that are believed to be a threat to biota and potentially to human health throughout the system. Progress toward control of toxic contamination currently is at an early stage in the process that begins with recognition of the problem. Reduction of conventional pollution is at an advanced stage where results can be measured and controls refined.

CONVENTIONAL POLLUTANTS

Lower dissolved solids, reduced biochemical oxygen demand and less algae growth in many Great Lakes locations are believed to reflect greater control of conventional pollutants, especially from direct discharges. How this control has been achieved in U.S. programs is discussed in Section VI. Full attainment of the objectives for phosphorus reduction called for in the Great Lakes agreement will require further control of land runoff.

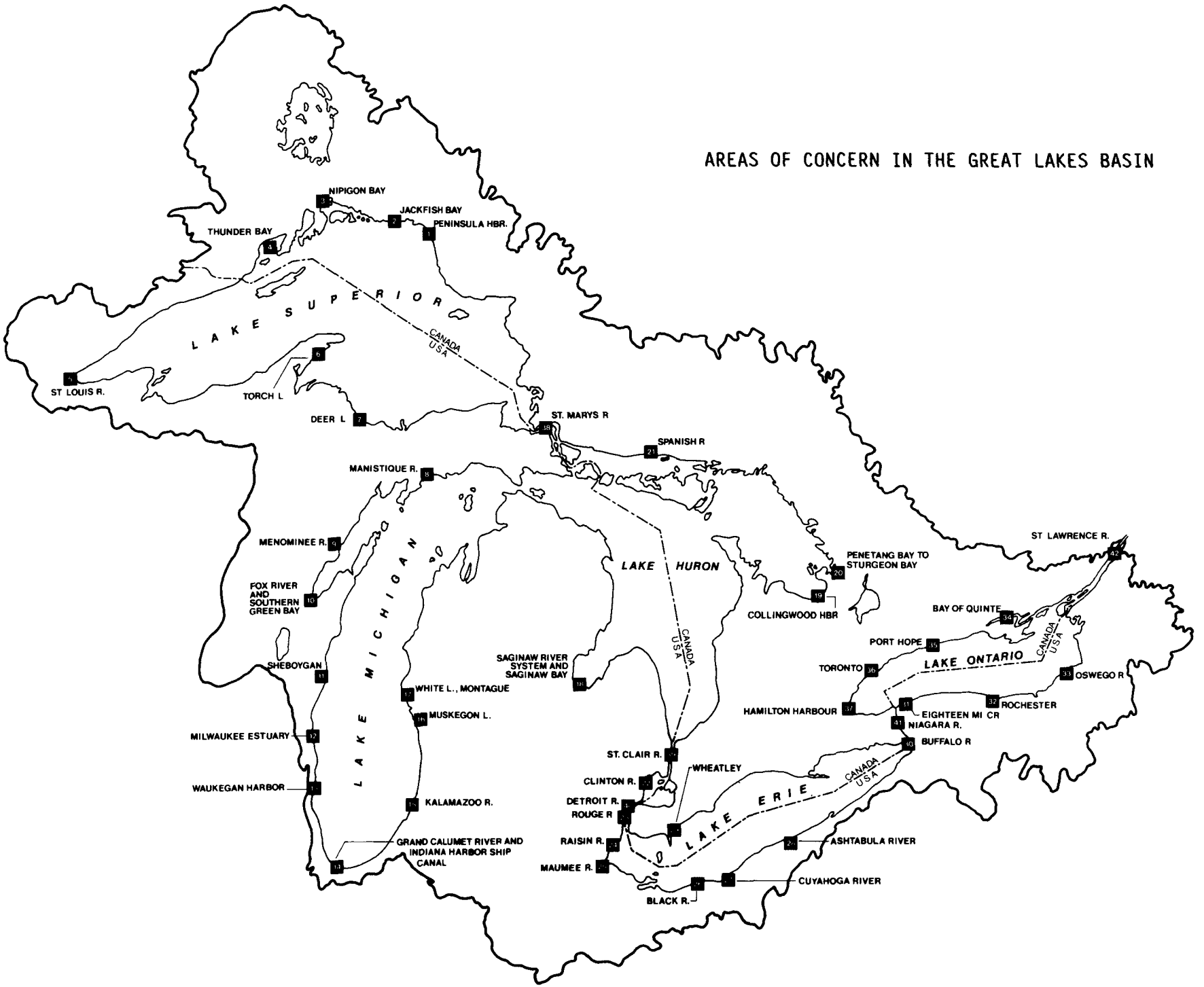
POINT SOURCES OF CONVENTIONAL POLLUTANTS

Target loadings of phosphorus have been achieved for the open lakes in Huron and Michigan with reduced direct discharges of wastes from industry and municipal sources, detergent phosphate bans and nonpoint source controls. Monitoring will continue to determine how the reductions in nutrient levels affect productivity.

Results of productivity monitoring as well as monitoring of water chemistry and mass balance modeling will help determine whether current controls are sufficient to maintain water quality in Lake Superior and to enhance conditions in Huron and Michigan. The need for stricter controls in these lakes depends on whether the biota are protected by current target limits of conventional pollutants, including phosphorus.

For Lakes Erie and Ontario and Saginaw Bay in Lake Huron, further efforts are needed to meet the target loadings that are specified in plans being completed in 1985. All municipal sewage treatment systems will need to meet the 1 mg/l effluent limit required for phosphorus under the Great Lakes agreement. Within the next five years, monitoring will determine where stricter limits are needed to meet the target loads for phosphorus as major permits are revised.

AREAS OF CONCERN IN THE GREAT LAKES BASIN



NONPOINT SOURCES OF CONVENTIONAL POLLUTANTS

Most areas of concern are in nearshore and estuary areas near the mouths of tributaries and most are also near major metropolitan concentrations of population. Combined sewer overflows are a major problem in many locations such as the Grand Calumet area at the south end of Lake Michigan. Reduction of pollution from this source will require innovative technologies and investigation of what can be achieved by best management practices.

Agricultural runoff has been reduced by use of alternative low tillage techniques in some locations such as the Maumee River basin in Ohio but further reductions are needed there and elsewhere. The Great Lakes Office will continue to track use of conservation tillage techniques and to seek ways to reduce loadings to the Great Lakes by reduction of land runoff.

TOXIC CONTAMINATION

Contamination by toxic chemicals and heavy metals is a major but less obvious change in water quality. In 1985, the sources and role of toxic contaminants are not understood well enough to determine whether current laws and environmental programs will be adequate for cleanup. Research on sources and fates and effects as well as mass balance modeling is needed to assist development of remedial programs for toxic contamination.

Great Lakes toxicants are many and varied. A few, such as DDT and mercury, have been successfully controlled after their effects were identified. PCB loadings remain high even though uses are controlled under the Toxic Substances Control Act of 1976 and levels have decreased in fish in some locations.

At present, no concentrations of chemicals or heavy metals are found in the lakes at levels that are known to be acutely toxic to organisms during brief exposure. The greatest concern is about possible long term effects of small quantities of numerous substances through bioconcentration and bioaccumulation and about possible additive and synergistic actions.

Many substances have been found at levels too low to be regulated under existing laws even though the rate of accumulation in the ecosystem may be high. In 1983, the Water Quality Board reported to the IJC that 900 chemicals and heavy metals potentially dangerous to human health and the biota have been identified in the Great Lakes. The potential for human exposure by fish consumption is increased by bioconcentration and bioaccumulation in the food chain. Major known locations of toxic substances in the Great Lakes are shown on page 15.

Concern about potential human health effects has increased with growing evidence of links between the presence of contaminants and carcinogenicity for fish, genetic defects in fish-eating birds, and reproductive disorders in biota. Further, possible links have been reported between developmental disorders in human infants and prenatal exposure to PCBs because of consumption of certain Great Lakes fish by their mothers. The contaminants reach the lakes by many pathways, from both point and nonpoint sources.

TOXICANTS FROM POINT SOURCES

The pretreatment program of the Clean Water Act can be a major means of control of toxic contaminants from point sources. Pretreatment is required for industrial wastes that are discharged into municipal systems. Without pretreatment, sewage treatment works in nearly all areas of concern would be significant sources of toxic contaminants.

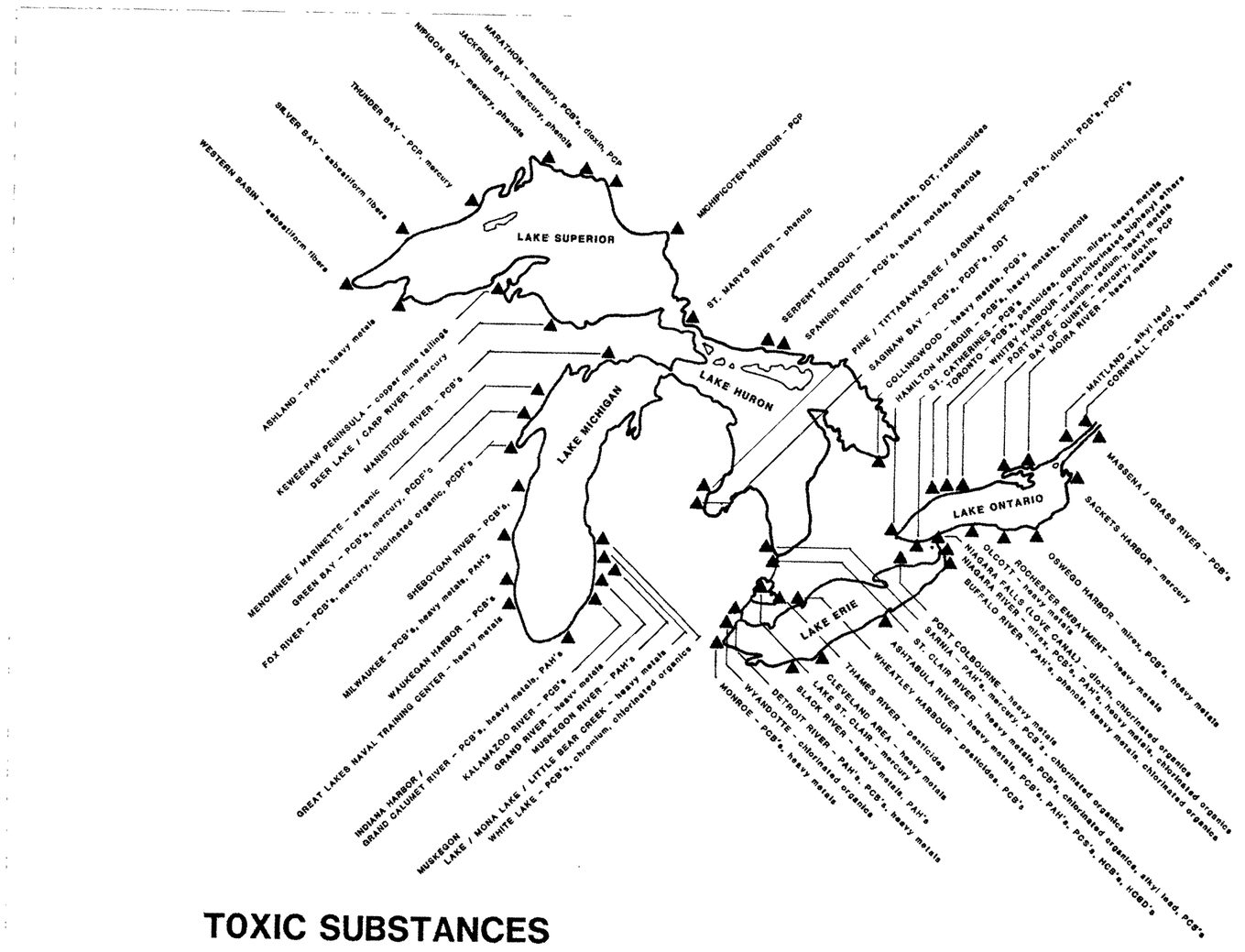
Pretreatment requirements are now being adopted in many locations. Once biological monitoring and fate and effect research provide sufficient information for mass balance modeling, stricter effluent limits may become necessary for more toxic substances.

TOXICANTS FROM NONPOINT SOURCES

It is now known that toxic substances can be released into the environment during transport, use and disposal to reach the lakes by many pathways. Research in the 1970s showed that atmospheric deposition is a major source to the lakes of organic chemicals such as PCBs and toxaphene and of metals such as lead, zinc and cadmium.

Atmospheric transport is believed to be the only source for some toxic chemicals to the Upper Great Lakes, where neither direct discharges nor land runoff can otherwise account for their presence in fish. More information is needed about sources to the atmosphere, including the role of combustion, evaporation, and volatilization, to assist development of controls. The lakes themselves may even contribute to atmospheric contamination, since evaporation of PCBs from the water surface into the air has been reported.

Sediments are another potential source of both toxic chemicals and nutrients that have settled out of the water column to become in-place pollutants. In many areas of concern, toxic contaminants are concentrated in sediments that may be in relatively specific "toxic hotspots" or dispersed over wide areas in embayments and in tributaries. They tend to accumulate below direct discharges of effluents with a high solid content and may remain in place indefinitely. Sediments become a source of contamination when toxic substances are released by biological action, by physical disturbance from boats or storms, or by the necessity to dredge navigation channels for shipping. Methods for safe removal and disposal of contaminated sediments are urgently needed.



TOXIC SUBSTANCES

In areas where sediments have high concentrations of toxic chemicals, fish have higher concentrations of toxic chemicals in their tissues. Concern about these in-place pollutants has grown with discovery of high rates of lip tumors in bullheads that feed on the bottom where sediments are known to have high concentrations of contaminants. The volume of contaminated sediments is so large that removal or other potential remedies are very expensive. Contaminants can be resuspended in the water column in the course of removal of sediments by dredging. Also, there is a lack of treatment and disposal methods to assure safe disposal after removal. Whether the environmental impact is greater from removal of contaminated sediments or from leaving them in place is a major issue in many areas of concern.

Leaching from landfills, directly or through groundwater, can be another source of contaminants to the lakes. Concern about this route has grown with confirmation of substantial loadings from landfills to the Niagara River and with known groundwater contamination from many sources throughout the Great Lakes drainage basin.

Where leaching from landfills is a factor, remedial actions will have to be coordinated with the Superfund and Resource and Conservation Recovery Act programs. Whether to remove contaminated sediments will require consideration of whether removal will add to overall environmental contamination. High costs may constrain removal even when it appears to be desirable.

Agricultural runoff is another nonpoint source of chemicals of unknown dimensions. Continuing increase in the use of pesticides remains a major concern that needs to be evaluated.

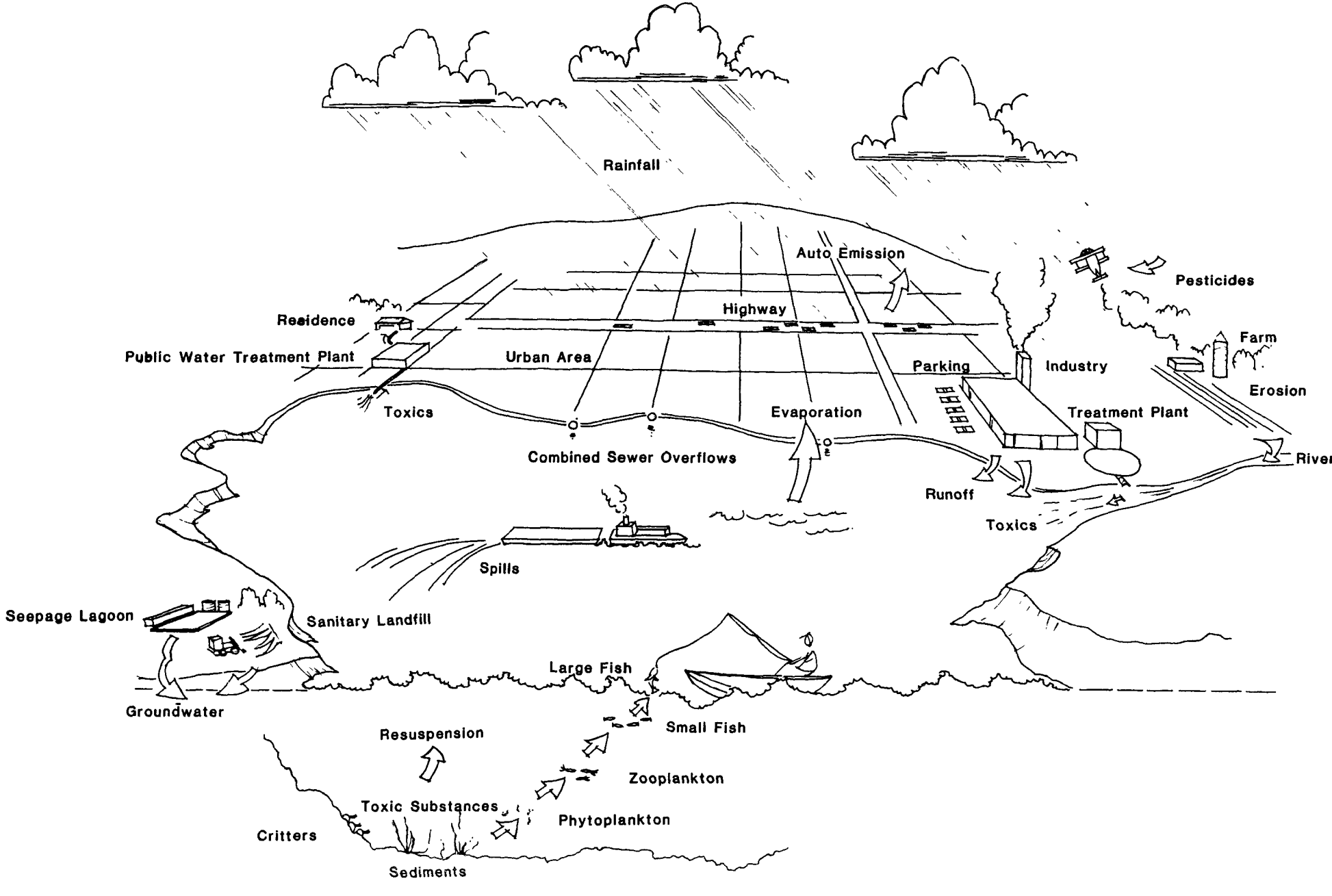
Atmospheric deposition of toxic contaminants adds yet another complex dimension to eventual control of toxic contaminants because of the uncertainties about both sources and means of control. Recent research has shown how substances that have settled out in sediments can be excreted by benthic organisms in gasses as well as resuspended when the sediments are stirred up by the physical activities of organisms. Volatile organic chemicals also evaporate directly from the water surface into the air. Thus, substances that entered the lakes by atmospheric deposition may be recycled by various mechnisms. Current understanding of how toxic contaminants cycle in the Great Lakes ecosystem is illustrated on page 18.

In summary, control of both conventional and toxic pollution in areas of concern involves multiple problems that will require special remedial action plans to fit the specific situation. State and federal wasteload allocations may be necessary, along with development and testing of innovative technologies.

High concentrations of both toxic and conventional pollutants may remain from past discharges. Direct discharges of pollutants may be continuing in violation of discharge permit conditions. The accumulations may also be from land runoff or combined sewer overflows.

Since most of the areas of concern are at the mouths of tributaries, the accumulations may be from upstream as well as nearby sources. In a few cases, such as Waukegan Harbor, Illinois, the area of concern may eligible for cleanup as a Superfund site. In others, such as Sheboygan Harbor, Wisconsin, the site may not satisfy Superfund criteria even though the problems include a "toxic hotspot" of PCBs or other contaminants.

All areas of concern reflect multiple problems that will require special remedial action plans to fit the specific situation. Research and innovative demonstration projects may be needed to address such problems as safe removal and disposal of sediments as well as wasteload allocations. The Great Lakes Office will work with the states and with EPA program offices to coordinate development and implementation of appropriate remedial plans for all areas of concern in the five year period from 1986 through 1990.


Rainfall
Auto Emission
Pesticides
Highway
Residence
Farm
Public Water Treatment Plant
Urban Area
Parking
Industry
Erosion
Toxics
Evaporation
Treatment Plant
Combined Sewer Overflows
River
Runoff
Toxics
Spills
Seepage Lagoon
Sanitary Landfill
Large Fish
Groundwater
Small Fish
Resuspension
Zooplankton
Toxic Substances
Phytoplankton
Critters
Sediments

TOXIC CYCLE

V. THE GREAT LAKES WATER QUALITY AGREEMENT

The Boundary Waters Treaty of 1909 affirmed that Canada and the United States have equal rights to use of waterways that cross the international border and that neither country has the right to pollute its neighbors resources. The International Joint Commission (IJC) was established as an independent agency to assist the governments under the treaty.

For many years the treaty chiefly provided a peaceful process for limited regulation of water levels and flows for navigation and power production. In 1978, a second Great Lakes Water Quality Agreement added an ecosystem approach to management and essentially zero discharge of pollutants to the water quality objectives of the first agreement that was signed in 1972.

The agreement calls for remedial actions against pollution and research and monitoring of progress toward solving problems. Implementation in each country depends on integration of necessary remedial programs into the national, provincial and state laws and policies.

The common purpose expressed by the agreement is "to restore and enhance water quality in the Great Lakes System" and "to prevent further pollution of the Great Lakes Basin Ecosystem." EPA is the lead agency on the U.S. side and the Great Lakes National Program Office was established to coordinate EPA activities for the agreement. The Great Lakes Office manages some research, the Section 108 Demonstration Grant Program and the Lakes Surveillance Program.

All responsibilities under the agreement are divided equally between the parties. The IJC operates a binational Great Lakes Regional Office in Windsor, Ontario, that provides secretariat services to the two boards of experts called for in the agreement. The agencies represented in the membership of the boards fund the participation of their own staff and the activities required to serve the needs of the boards; no funds for services by government agencies are provided by the IJC.

ROLE OF THE INTERNATIONAL JOINT COMMISSION

The International Joint Commission can call attention to problems or recommend actions to the governments. Requests from the governments for advice or study of problems are submitted as references. The Great Lakes agreement specifies IJC responsibilities for implementation.

Membership in the two boards is divided along national lines. The purpose of the Water Quality Board is to advise the IJC about progress under the agreement and to propose needed actions. Its members generally represent environmental management agencies, with the administrator of Region V, EPA, traditionally serving as chairman of the U.S. section. Support to the U.S. chairman is provided by the Great Lakes Office.

The Science Advisory Board advises both the IJC and the Water Quality Board about needed scientific research and carries out special investigations on request. The membership includes managers of Great Lakes research programs and other experts.

Both boards are assisted by task forces, subcommittees and special committees for specific tasks. Some activities are related to the annexes of the agreement; others carry out special projects and investigations required by references to or from the IJC.

The staff of the Great Lakes Office exchanges information with other U.S. and Canadian agencies by participation in numerous IJC bodies. They assist in design of research projects and to develop programs to be accomplished by EPA or in cooperation with other agencies. Much time is spent in planning, writing and producing reports for the IJC activities. Assignments of EPA staff to IJC joint institutions are shown on the next page.

Flexibility in the Great Lakes agreement process is assured by provisions for notification between the parties about problems that require immediate attention, for coordination of research, and for review and change of objectives if needed. The 1978 agreement responded to experience under the first agreement in two ways.

First, while the 1972 agreement called for control of pesticides, the 1978 agreement calls for control of all toxic substances that could endanger the health or well-being of any living organism. Second, restoration and enhancement are called for throughout the Great Lakes Basin, not just in the waters of the Great Lakes. The general purposes and obligations are described in the text of the agreement but specific measures to reduce and prevent degradation are listed in the 12 annexes. For EPA, Annexes 3, 11 and 12 are most important.

Annex 3 focuses on phosphorus control. It calls for restoration of aerobic conditions year round in the central basin of Lake Erie, elimination of nuisance growths of algae in Ontario and Michigan, and maintenance of the oligotrophic status of Lakes Huron and Superior. The need to meet target loads for phosphorus for each lake established under this annex is recognized in administration of the NPDES and construction grants programs under the Clean Water Act. Target loads are now being met for Superior and Huron but more reduction is needed in Saginaw Bay. Plans to meet the target loads for Michigan, Ontario and Erie are due in 1985.

Annex 11 calls for joint surveillance and monitoring to assess compliance with requirements for pollution control in the various jurisdictions, to evaluate water quality trends, and to identify emerging problems. The EPA Great Lakes Office operates the U.S. surveillance and monitoring program under the agreement.

Annex 12 states that persistent toxic substances should be regulated in order to virtually eliminate toxic substances from the Great Lakes ecosystem. Regulation should protect human health and assure continued productivity of aquatic resources. This annex requires research on how to protect fish and wildlife as well as humans from exposure to toxicants and an early warning system for future problems due to toxic substances.

Annex 12 reinforces the function of the Great Lakes as an early warning system for environmental problems in the biosphere. U.S. compliance with the Great Lakes agreement depends on integration of remedial activities, research and monitoring with domestic environmental programs.

MEMBERSHIP OF GREAT LAKES OFFICE STAFF ON INTERNATIONAL BOARDS, COMMITTEES AND TASK FORCES

IJC Water Quality Board

Programs Committee
Toxic Substances Committee
Nonpoint Source.Committee
Surveillance Work Group
  Lake Michigan Task Force
  Lake Ontario Task Force
  Lake Superior Task Force
  Lake Huron Task Force
  Lake Erie Task Force
Dredging Subcommittee

Upper Great Lakes Connecting Channels Study

Management Committee
Activity Integration Committee
Point Source Work Group
Criteria Task Force
Sediment Work Group
Nonpoint Source Work Group
Water Work Group
Biota Work Group

St. Mary's River, St. Clair River, Lake St. Clair and Detroit River Task Force

Great Lakes Fishery Commission

Fish Habitat Advisory Committee

Niagara River Toxics Committee

United States/Soviet Union of Soviet Socialist Republics Environmental Exchange

VI. UNITED STATES PROGRAMS

This section discusses how control of point and nonpoint source pollution of the Great Lakes is addressed by U.S. environmental programs and agencies and the status of compliance to date.

REMEDIAL PROGRAMS

U.S. water pollution control programs are implemented in a partnership between EPA's Water Divisions and the states that operate these programs under authority delegated to them. The Clean Water Act requires a comprehensive program of technology-based effluent controls for pollution from point sources.

Requirements that cover both conventional and toxic pollutants include secondary treatment and best practical treatment. Best conventional treatment can be required for conventional pollutants and best available treatment and categorical pretreatment for toxic substances. In addition, water quality-based controls must be established where technology-based requirements are not stringent enough to protect receiving waters.

Sources of toxic contamination other than point sources cannot be controlled by water pollution control programs alone, however. Other remedial programs that will assist control of toxic contamination are authorized under the Clean Air Act, the Toxic Substances Control Act (TSCA), the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response Compensation and Liability Act (CERCLA or Superfund), the Federal Insecticide, Fungicide, Rodenticide Act (FIFRA), and the Safe Drinking Water Act.

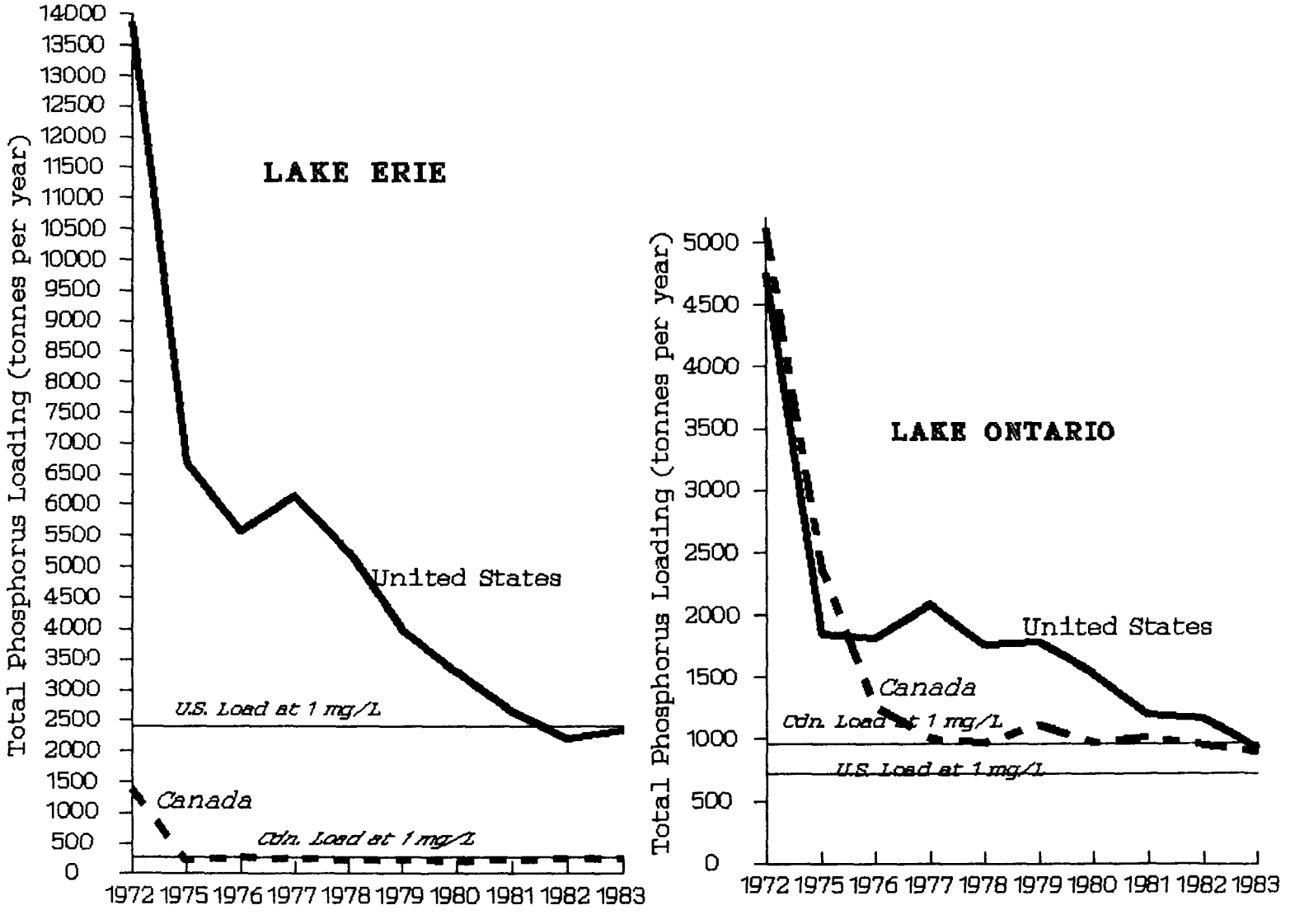
The eight Great Lakes states also have their own environmental laws and regulations. Some state programs are to comply with federal requirements for delegation of implementation authority to state agencies. Others are to implement state policies that are different from or that supplement federal policy.

COMPLIANCE RESULTS

Direct discharges into the Great Lakes system are now regulated under nearly 4800 discharge permits for industry and municipal sewage treatment facilities. Through 1984, $7.0 billion in federal and state grants has been invested in the Great Lakes basin for municipal sewage treatment works.

In 1985, more than 95 percent of the population in the Great Lakes states in Region V is served by publicly owned treatment systems and 99 percent of the sanitary wastes in sewered areas receive at least secondary treatment. Additional phosphorus removal is provided for 79 percent of sewage, and 163 of 187 major facilities comply with the 1 mg/l effluent limit for phosphorus. Advanced waste treatment is used in 15 percent of publicly owned treatment works and 8 percent provide high level nitrogen control.

The figure on page 25 shows that reduction in phosphorus discharged from municipal sewage treatment plants to Lakes Erie and Ontario or approximately 80% reduction since 1972. Discharges of biological oxygen demand and suspended solids have been reduced by approximately the same magnitude. Such substantial compliance is reflected in clearer water, less algae growth and return of desirable fish species to many locations. The Great Lakes Office has provided special compliance reports and funds for special studies to other EPA programs, the states and other federal agencies.



MUNICIPAL PHOSPHORUS LOADINGS TO THE LOWER GREAT LAKES

ROLE OF THE GREAT LAKES OFFICE

The Great Lakes Office routinely advises other EPA programs on how federally funded state programs can support the Great Lakes agreement. Technical guidance is also provided to the states and to EPA's Water Divisions on consistency between water quality standards and agreement objectives. Priority is now being given to setting discharge limits for toxic chemicals and heavy metals in NPDES permits and to establishment of pretreatment requirements for industrial discharges into publicly owned treatment systems.

Technical assistance is also provided by review of selected NPDES permits and construction grant issues. For example, 25 selected permits were reviewed to determine whether specific facilities in areas of concern are likely sources of pollutants concentrated in sediments and whether appropriate controls are in place for prevention of further pollution. In another project, phosphorus loadings were analyzed in combined sewer overflows in 17 major metropolitan areas.

Where wasteload allocations are needed to protect beneficial uses, the Great Lakes program may support development of needed modeling. In 1985, the Region V Water Division completed a master plan for the Grand Calumet area in Indiana, a major Lake Michigan area of concern, with support for public involvement from the Great Lakes Office. A plan for the Rouge River near Detroit is being developed by a consultant contract funded by the Great Lakes Office. Development of remedial action plans in areas of concern will have high priority from 1986 to 1990.

The Great Lakes Office also initiates development of information or treatment technology needed to promote regulatory actions. For example, information about entrainment of organisms in cooling water systems was provided by Great Lakes Office studies. Improved phosphorus removal technology has been developed with support from the Great Lakes Office and analysis of industrial processes has provided better understanding of possible sources of toxic contaminants.

Some coordination occurs through IJC institutions and studies. EPA also participates in the National Marine Research Plan for the Oceans and Great Lakes that is developed under the lead of the National Oceanic and Atmospheric Administration (NOAA). EPA and other agencies also cooperate directly. For example, the United States Geological Survey (USGS) will assist evaluation of groundwater connections and potential contamination from landfills in the Upper Great Lakes Connecting Channels Study.

Development of a uniform fish consumption advisory for Lake Michigan during 1985 is another example of the role of the Great Lakes Office as a catalyst and an expediter. The office facilitated obtaining agreement among health, fishery and water quality agencies in four states and among federal agencies.

RESEARCH

The Centre for Inland Waters carries out most federally-sponsored Great Lakes research in Canada but U.S. research programs reflect the more complex government structure and larger population. U.S. research for the lakes is carried out by several agencies, including EPA, that coordinate and cooperate with each other.

Within EPA, Great Lakes research is carried out principally by the Large Lakes Research Station at Grosse Ile, Michigan, and the National Water Quality Laboratory at Duluth, Minnesota. Research is sponsored by the Office of Research and Development in EPA headquarters as well as by the Great Lakes Office. Contracts with universities, private consultants and other federal agencies supplement EPA programs. Large and complex research projects are often carried out by interagency agreement. Some research is coordinated with Canadian research.

Modeling of eutrophication processes by the Grosse Ile laboratory has provided essential information for understanding how the Great Lakes have responded to phosphorus controls. This laboratory has also supported unique epidemiological research on human health effects of exposure to PCBs by fish consumption.

The NOAA Great Lakes Environmental Research Laboratory (GLERL) at Ann Arbor, Michigan, carries out basic hydrologic and limnologic research. GLERL research assisted basic understanding of the role of phosphorus in the Great Lakes ecosystem. A long-term GLERL study of how toxicants cycle in the Great Lakes will assist development of management programs.

The Great Lakes Fishery Laboratory of the Fish and Wildlife Service primarily provides research and monitoring service to the Great Lakes Fishery Commission, another Canada-U.S. agency. The Fish and Wildlife Service also cooperates with numerous other agencies in the fish monitoring programs that are coordinated by EPA.

Some state funding for Great Lakes research is provided to the Sea Grant College programs in state universities. Federal Sea Grant funding is provided by NOAA. The Sea Grant colleges presently support substantial research on bioaccumulation of toxicants in fish and effects on other biota.

The Great Lakes Office has supported extensive research by Argonne National Laboratory on atmospheric deposition to Lake Michigan. Argonne has also carried out major research on Lake Michigan biological systems. Research by the Army Corps of Engineers focuses on levels and flows and on dredging and disposal of dredge materials.

Most of the research supported by Great Lakes Office assists management programs. For example, application of results of Grosse Ile modeling studies continues to assist assessment of results of phosphorus controls.

EPA-sponsored research assisted development of the Dredging Guidelines that are now used by both EPA and the Corps of Engineers in decisions on confined disposal of dredge materials. Further research may be needed as removal of in-place pollutants in sediments is carried out in areas of concern.

Research may be undertaken to answer a specific question, for example, whether there is a link between an environmental problem such as genetic defects in biota and a specific substance. In one case a research grant was made to the State University of New York at Buffalo to identify manufacturing and waste disposal processes that could be potential sources of the polychlorinated styrenes which have accumulated in sediments and fish in the Fields Brook-Ashtubla River and Niagara River areas. GLNPO forwarded the results of this sources characterization, along with toxicity data generated by Canadian researchers, to EPA's Existing Chemical Assessment Division of the Office of Toxic Substances (OTS). As a result, OTS initiated a preliminary review of polychlorinated styrenes under the Toxic Substances Control Act that may lead to further testing and subsequent rule-making.

Other research is designed to answer more general questions. The Pollution from Land Use Reference Group (PLUARG) research was designed to answer questions about nonpoint source pollution. With coordination and major funding by EPA, U.S. participants included the Soil Conservation Service of the Department of Agriculture, the Army Corps of Engineers, NOAA and state and local agencies. Results provided a basis for promoting conservation tillage with demonstration grants in the Lake Erie basin and elsewhere. PLUARG research also identified atmospheric deposition as a major nonpoint source.

Great Lakes research in the 1970s demonstrated that both wet and dry deposition from the atmosphere is a major source of pollutants to the Great Lakes but little is known about sources or transport. Additional research grants will be made to assist development of remedial programs for atmospheric deposition.

As discussed earlier, the Great Lakes system serves as a laboratory for identification of major environmental problems and for testing solutions. Past Great Lakes research has provided significant information about connections between land, air and water pollution. Recognition of bioaccumulation of pesticides and other toxicants in the Great Lakes food chain revealed a new route for possible human exposure through fish consumption. Great Lakes research can be expected to provide new environmental lessons in the future.

FUNDING FOR GRANT PROGRAMS AND THE GREAT LAKES OFFICE

The grant programs authorized in Sections 104 and 108 of the Clean Water Act support EPA's role as the lead agency for meeting U.S. obliga-

tions under the Great Lakes Water Quality Agreement with Canada. Nutrient control has also depended on integration of Great Lakes agreement objectives in the construction grants program under Section 201 and in the NPDES program.

Section 104 authorizes funding of a wide range of EPA programs including the Great Lakes Program which appears as a line item in the EPA budget. Annual funding for the Office has ranged from 7.5 to 4.7 million per year with 1985 funding standing at 5.2 million.

Section 108 authorized the Great Lakes Demonstration Grant Program for the purpose of demonstrating new methods and techniques for the control of pollution within the Great Lakes Basin. Authorization for Section 108 was set at 20 million in 1982 and 18 million of the authority has been used to date.

About three-fourths of the 108 grants have addressed nonpoint sources and related control practices. During the past three years, most Section 108 projects have promoted conservation tillage and thereby substantially reduced Great Lakes pollution by land runoff. These Great Lakes projects have also helped reduce loss of top soil, another critical national problem.

Other Section 108 grants have supported evaluation of how natural wetlands reduce water pollution from septic systems; phosphorus removal techniques for small municipal systems; and control of red clay erosion on the shores of Lake Superior.

Over $7 billion of federal and state funds has been spent to construct municipal sewage treatment works in the U.S. Great Lakes states since 1972. While not a special Great Lakes program, federal assistance to municipalities has been essential to improved water quality in the lakes.

The Great Lakes have also benefited from the areawide water quality management plans required under Section 208 in the 1972 act and the continuing state water quality management planning under Section 205 (j) of the 1977 Clean Water Act amendments. Program grants to the states under Section 106 provide support for a variety of abatement and control activities ranging from surveillance to enforcement.

The 104 appropriation covers salaries and other staff expenses for the program, including the cost of EPA staff support to IJC boards, committees and task forces. It also covers operation of the research vessel, the Roger R. Simons, other monitoring and surveillance activities and for research that is commissioned from universities, other agencies and consultants.

SURVEILLANCE AND MONITORING

The goal of the Great Lakes monitoring program is to assess the health of the ecosystem, including effects of use of the lakes on human health. A new focus on the structure of the ecosystem and interactions between species and between biota and their environment has evolved from an

earlier focus on water chemistry. For EPA Region V, the regional monitoring strategy further describes the integration of related monitoring activities.

The original Great Lakes Environmental Surveillance Plan (GLISP) called for intensive monitoring of one lake at a time with every lake covered once or twice a decade. The first nine-year GLISP schedule began in 1976, to be completed in 1983. For conventional pollutants, a new long term surveillance program has now evolved that requires less intensive and less expensive collection of chemistry data but provides information about every lake annually. Expanded monitoring for toxic contaminants will be more costly, however.

The Great Lakes surveillance program meets the Great Lakes agreement requirement for monitoring compliance with the agreement's general and specific water quality objectives in the various jurisdictions. It also assists EPA's evaluation of program results. Finally, emerging problems are detected. While the monitoring program formerly focused on measuring levels of pollution, the surveillance and monitoring strategy now aims also to evaluate biological changes due to pollution.

The surveillance strategy to be continued from 1986 to 1990 responds to the need for annual measurements and to budgetary restrictions. It will provide a long-term base of both biological and chemical information for the four lakes affected by eutrophication (Ontario, Erie, Michigan and Huron) and for oligotrophic Superior. In addition to further assessment of phosphorus control results, it will provide vitally needed information for remedial programs for toxic contaminants.

Samples from municipal water intakes will supplement open lake sampling by EPA. Tributary monitoring by the states and the intake sampling provide information about nearshore waters in the areas of concern that will be the focus of so much Great Lakes effort in 1986 to 1990.

By 1986, new lake-by-lake surveillance plans will have been reviewed by the Water Quality Board. The surveillance strategy has three major components: limnology, fish and atmospheric deposition. In addition, sediments and dredge sites have been sampled for in-place pollution in the past. They will be examined again on a case-by-case basis in areas of concern for nutrients, heavy metals, toxic organic compounds and oils and grease.

In the limnology program, eutrophication models are being developed and tested to assist annual monitoring of both water chemistry and biological productivity with less data collection. The productivity measurements will then assist interpretation of species lists and evidence of community changes.

The conceptual eutrophication, or WASP, models developed by the Grosse Ile Large Lakes Research Station and Manhattan College relate phytoplankton productivity to phosphorus loadings. The models will be transferred from

EPA's mainframe computer in 1986 to personal computers and new software developed to assist the surveillance-research-management process. The EPA vessel will collect samples in Lakes Erie, Huron and Michigan. Data for Ontario and Superior will be obtained by interagency agreements, grants or direct assessment as needed.

The samples from water intakes with long-term records will also allow evaluation of acute conditions during spring runoff and major storms and/or behind the thermal bar during stratification. Evaluation in 1988 using data obtained in 1983 to 1987 will help determine the validity of earlier assumptions about relationships between phosphorus loadings and algal productivity.

The fish monitoring program is carried out in cooperation with 20 state and federal agencies listed below. The four elements of the program are open lake monitoring of migratory fish, nearshore monitoring of resident species to detect sources of contaminants, evaluation of potential human exposure, and assessment of effects of contaminants on biota.

Tissues of migratory species are collected and analyzed to detect trends in contamination for the lakes as a whole. The potential for human exposure is evaluated by analysis of edible portions rather than the whole fish. Concentrations of toxic substances will be located by analysis of resident fish species and sediments.

The Great Lakes Office is also field testing a program to determine the effectiveness of biochemical indicators of fish health. The study will support development of long-term monitoring programs to determine the impacts of contaminants on fish populations. In addition to EPA, agencies cooperating in the fish monitoring program are:

U.S. Fish and Wildlife Service
U.S. Food and Drug Administration
National Cancer Institute
The Smithsonian Institution
New York Department of Environmental Conservation
Pennsylvania Department of Natural Resources
Ohio Department of Natural Resources
Ohio Environmental Protection Agency
Michigan Department of Public Health
Michigan Department of Natural Resources
Indiana State Board of Health
Indiana Department of Natural Resources
Illinois Department of Public Health
Illinois Environmental Protection Agency
Wisconsin Department of Natural Resources
Wisconsin Department of Health and Consumer Affairs
Wisconsin Department of Agriculture
Minnesota Department of Natural Resources
Minnesota Pollution Control Agency

In 1981 the Great Lakes Office established the Great Lakes Air Deposition (GLAD) network for three purposes: (1) to determine atmospheric loadings of metals and nutrients; (2) to evaluate annual trends; and (3) to assess results of various program strategies. The addition of GLAD network data to the EPA Acid Deposition System provides a single repository for atmospheric deposition monitoring data for North America. Participants in the GLAD network are listed on the following page:

Illinois Environmental Protection Agency
Michigan Department of Natural Resources
Minnesota Pollution Control Agency
New York Department of Environmental Conservation
Ohio Environmental Protection Agency
Ohio State University Research Foundation
Erie County, Pennsylvania, Department of Health
Wisconsin Department of Natural Resources
Environment Canada, Canada Centre for Inland Waters

SPECIAL STUDIES

In some cases, special studies are undertaken by interagency agreement. EPA, Environment Canada, the State of New York and the Ministry of Environment of Ontario formed the Niagara River Toxics Committee and undertook a special study of the Niagara River in 1984. The Niagara study provided comprehensive information about sources of toxic chemicals to the river and confirmed that chemicals were entering the river by leaching from nearby landfills. The study also confirmed that the river is a major source of toxic contaminants to Lake Ontario.

The Upper Great Lakes Connecting Channels Study was organized in 1984 by U.S. and Canadian resource agencies. Collectively, the St. Marys, St. Clair and Detroit rivers and Lake St. Clair have been identified as problem areas and then as areas of concern by the IJC since 1974. The multiyear study is expected to provide needed information about sediment transport and connections between contaminated groundwater and the lakes to assist development of a mass balance framework for management and long-term monitoring in the connecting channels.

It is also expected to assist design of remedial action plans for other areas of concern as well as development of a mass balance framework for future management of toxic contamination of the entire Great Lakes system. Finally, the ecosystem perspective of the study is a major step toward the ecosystem approach to management called for in the 1978 Great Lakes agreement. The ecosystem approach considers relationships between land, air and water in identifying sources and causes of degradation and in development of remedial measures for past pollution and prevention of future environmental damage.

VII. A FIVE YEAR PROGRAM STRATEGY FOR THE GREAT LAKES

This section lays out the program strategy for the Great Lakes National Program Office for the next five years. Remaining environmental problems for the Great Lakes have been described in previous sections. This section describes by sources of pollution what the Great Lakes Office wants to accomplish by 1990 in cooperation with other EPA programs, the states and other agencies.

The total strategy described here is ambitious. The actions proposed are believed to be necessary to address Great Lakes problems as they are currently understood. In some cases, the Great Lakes Office will continue to rely on other EPA programs and on other agencies to carry out certain tasks. Articulation of the overall strategy will enable the Great Lakes Office to focus its own activities logically and to use available resources more efficiently. This strategy is designed to be consistent with and utilized in the EPA planning process. It is anticipated that this document will be updated every other year.

The program strategy is based on several concepts. One concept is that there are sequential stages in solving environmental problems. The time required for each varies, and they may overlap. In each case, and for each source, the proposed streategy considers the current stage of efforts to address the problem. Thus, much has already been accomplished in control of conventional pollutants, but control of toxic contaminants is at an earlier stage, the strategy approaches these problems in different ways.

One concept of the strategy is that environmental problems are solved in stages. The five stages are as follows:

1. Identification is the stage in which the problem is recognized as an existing or potential threat. The problem may be revealed accidentally or may be discovered by ongoing surveillance and monitoring.

2. Assessment/Characterization is the stage in which the extent of the problem is qualitatively and quantatively characterized well enough to lead to consensus that corrective action is needed.

3. Proposal of Solutions involves testing ways to solve the problem. Modeling and demonstration projects may be undertaken to test the practicality and feasibility of possible solutions.

4. Implementation establishes and executes remedial programs.

5. Monitoring and Feedback includes measuring results and evaluating success in reversing the problem and preventing further degradation. Ongoing monitoring is necessary to detect new problems even when remedial efforts have abated the original problem. Remedial programs may be modified to respond to new information.

Another concept is that pollution control must be pursued concurrently on long-term and short-term tracks. Long-term activities are identified that seek to measure the mass balance for toxic contaminants, that is, what is received from all sources and remains in the system. A mass balance approach considers loadings from all sources in regulating to eliminate toxic effects.

A MASS BALANCE APPROACH TO MANAGEMENT OF TOXIC SUBSTANCES

Traditionally, the management of water quality focused on control of direct discharges of pollutants. Such sources were the easiest to identify, characterize and control, and the regulatory laws dealt with air, water and land as separate mediums. For these reasons, restoration and maintenance of water quality was tied to control of point sources from which contaminants were discharged directly into the nation's waterways.

With recognition that pollutants are also introduced indirectly from contaminated air, soil and sediments that act as reservoirs, the entire approach to management of Great Lakes water quality had to be reassessed. The reassessment led to the conclusion that the total contributions of pollutants from all point and nonpoint sources have to be quantified to support a mass balance approach.

In a mass balance approach, the law of conservation of mass is applied to the allocation of research, remedial action and regulation efforts for water quality management. The approach requires that the quantities of contaminants entering the system, less quantities stored, transformed or degraded within the system, must equal the quantity leaving the system. Once a mass balance budget has been established for each pollutant of concern, the long term effects on water quality of the lakes can be simulated by mathematical modeling.

If the projected concentrations from known sources are much lower than the measured concentrations, the mass contribution of known sources must be greater than presently estimated or as yet unidentified sources must exist. In this case, further investigation of sources is required. If mathematical simulation reveals that a water quality standard will eventually be exceeded at the present or projected loading rate from all sources, efforts can be directed to reduction from the sources most amenable to control and remediation.

The substances that already exceed water quality standards in the open waters of the Great Lakes are highly persistent substances whose masses entered the Great Lakes faster than they were lost, resulting in accumulation over time. The mass balance approach requires that discharge of such pollutants be reduced as much as possible to allow the Great Lakes to flush themselves in a meaningful timeframe.

While the concept of mass balance is not new, only recently has sufficient understanding of the routes and rates at which contaminants enter, accumulate and leave the Great Lakes system been acquired to make long term management of water quality possible according to mass balance principles. Over the next five years, the Great Lakes Office intends to increase the accuracy with which rates of entry of pollutants to the lakes can be measured or estimated, to test the adequacy of existing mathematical models and to develop new models to address deficiences that are identified in the models.

The overall aim is, with available human, physical and fiscal resources, to develop the best mix of remedial and regulatory activities to achieve the most rapid remedial action for the critical pollutants identified by the IJC Water Quality Board. Even with priorities set and a directed program, years may be required to achieve a mass balance approach. Meanwhile, as sources and loadings are understood, activities are identified to assist immediate regulatory actions. These actions may be localized where the threat of the sources is known, leading to geographic scope as another concept in the strategy.

The activities described here have a range of geographic scope as well as time. Some activities consider impacts on the entire Great Lakes ecosystem; others, like the remedial action plans for the areas of concern, are site specific. The Upper Great Lakes Connecting Channels Study covers three localized areas of concern. The mass balance concept on which this study is based is expected to serve as a laboratory for much of the work proposed in the five year strategy.

Finally, the Great Lakes Office will continue its commitment to assess results of remedial efforts and to detect emerging problems. While surveillance and monitoring will continue to evolve and may be modified as new understanding develops, the rationale for the current direction of the program is also discussed here.

Objectives of the five-year program for various sources and problems and year-by-year activities to accomplish the objectives are discussed below. The activities described are believed necessary to achieve the objectives and will be pursued over a longer period of time if resources do not allow completion within the next five years.

CONVENTIONAL POLLUTANTS

Great progress has been made in controlling conventional pollution in the Great Lakes, but target loadings for phosphorus required by the

binational agreement have not been achieved for Erie and Ontario. Mass balance estimates for phosphorus for each lake have revealed that meeting the target loadings will require compliance with the 1 mg/l effluent limit by all major publicly owned treatment works, plus additional reductions of loadings from nonpoint sources such as land runoff. Without more nonpoint reductions, additional point source controls will be needed to meet the target loadings in Saginaw Bay, and Lakes Erie and Ontario.

Current remedial programs assume that phosphorus is the limiting nutrient for the Great Lakes. As target loadings are met, productivity monitoring will reveal the results of reducing phosphorus loadings. Increases of other conventional pollutants must be watched and understood, especially for sodium, chlorides and nitrates. The concern is that, although current levels are still low, the rates of increase are high enough in some parts of the system to lead to potential environmental change in the future.

Although abatement of toxic contamination is needed in most IJC areas of concern, more control of conventional pollutants, such as BOD and total dissolved solids, is also still needed in many cases. In general, gross pollution by conventional pollutants as well as toxic contamination is now concentrated in certain areas of concern such as the Grand Calumet River basin and Saginaw Bay.

POINT SOURCES OF CONVENTIONAL POLLUTANTS

By 1990, all publicly owned treatment works should be meeting the 1 mg/l limit for phosphorus discharges into the Great Lakes. Permit requirements should be in place for all municipal systems that will need to meet stricter limits for phosphorus than 1 mg/l.

The Great Lakes Office will track compliance and provide technical assistance to states and to EPA Water Divisions. Demonstration projects for innovative technologies will be supported, particularly for combined sewer overflows. Information on the effectiveness of phosphorus detergent bans will be provided throughout the period.

Year by year, the chief activities of the five year strategy are as follows:

FY 86

- Report/track compliance rates of publicly owned treatment systems. *
- Provide technical information on detergent phosphate bans. *
- Assist Water Divisions with NPDES permit revisions to conform with current information about pollutants and their effects on biota and water quality. *

* Ongoing activity through the five year period.

- Identify industrial sources of phosphorus to the Great Lakes. *

- Begin demonstration on the RIM-NUT technology for phosphorus removal and complete the A/O phosphorus uptake project. **

- Finalize binational protocols on biological monitoring to track lake/biota reactions to declining phosphorus loadings.

FY 87
- Provide technical assistance in implementation of Best Conventional Technology (BCT) regulation. *

- Hold a workshop to report on innovative technologies including RIM-NUT. **

FY 88
- Determine by state, through audit of surveillance results, if additional phosphorus controls will be required for publicly owned treatment systems.

- Identify industrial sources in each state that may need stricter control limits than Best Control Technology (BCT).

- Implement revised water chemistry surveillance.

FY 89/90
- Continue surveillance and remedial program assistance.

NONPOINT SOURCES OF CONVENTIONAL POLLUTANTS

In five years nonpoint source programs for Saginaw Bay, Lake Erie and Lake Ontario should be near completion and routine. The accuracy and effectiveness of the programs should have been assessed. Plans should be completed for dealing with combined sewer overflows (CSOs) that cause dissolved oxygen problems. Development of CSO plans will depend on integration of remedial activities, research and monitoring into the continuing planning process for water quality. Funding to implement CSO plans should be identified and implementation underway.

Year by year activities are as follows:

FY 86/87
- Provide technical assistance, as requested, for implementation of state nonpoint source programs. *

* Ongoing activity through the five year period.

** RIM-NUT is an innovative technology that is said to achieve 0.1 mg/l removal with a salable product and the A/O technology is said to provide low cost treatment to below 1 mg/l.

- Monitor state implementation of phosphorus reduction plans. *

- Complete revisions to U.S. phosphorus control plans for nonpoint sources and review water quality management plan submissions for Water Divisions.

- Complete Erie and Ontario low tillage demonstration projects.

- Implement a revised system for tracking nonpoint control practices.

- Complete study to determine effectiveness of various approaches to manage pollution from nonpoint sources.

- Assist development of remedial action plans for CSOs and support demonstration projects.

- Develop recommendations related to the impact of sodium and chlorides in the aquatic ecosystem. Identify issues related to nitrate increases.

FY 88/89

- Determine rate of implementation of nonpoint source reductions and impacts on implementation of point source control program for each state.

- Assist Water Division review of CSO remedial action plans.

FY 90

- Continue monitoring and remedial program assistance.

CONTROL OF TOXIC CONTAMINANTS

Existing U.S. laws and programs are adequate to deal with toxic contaminants from point sources if the source is well quantified. Toxicants from some sources, such as groundwater leachates and sediments, have not been fully dealt with under existing laws and programs. For toxic contaminants transported in the atmosphere, existing legislative mandates may not be adequate.

This strategy addresses both toxicity for Great Lakes biota and potential human health impacts from fish consumption or other direct exposure. The Great Lakes Office is participating in and supporting measurement of current concentrations, trends in toxic contamination and effectiveness of remedial actions. This and other work on mass balance models is intended to support remedial programs.

Obtaining information on toxicants from all sources so that mass balance models can lead to regulatory actions will require time and more information on loadings from several sources. To direct research in support of mass balance work, the IJC Water Quality Board has identified the chemicals that represent the families of chemicals for which there is a consensus that control is needed.

* Ongoing activity through the five year period.

The long-term work toward mass balance models will not limit EPA's response to known problems in the short term. When acute or chronic toxicity affects human health or other criteria are being violated, the Great Lakes Office will support remedial actions regardless of the source of the pollutants.

POINT SOURCES OF TOXIC CONTAMINANTS

The aim of the strategy is that, to the extent possible, by 1990 there should be no direct discharges in the Great Lakes basin of effluents that are acutely or chronically toxic to aquatic biota. The characteristics and amounts of toxic chemicals in all point source effluents should be known. Total loadings of critical toxicants can then be quantified and a mass balance approach taken to regulation that aims to preserve ecological integrity.

The Great Lakes program will provide technical support and financial assistance for innovative demonstration projects and track compliance with remedial programs toward this end. Proposed yearly activities are:

FY 86

- Provide assistance as necessary in development and implementation of water-quality based effluent limits for NPDES permits, including reviewing standards and pretreatment requirements, wasteload allocations and major (selected) permit modifications. *

- Assist the Water Divisions in promoting biological testing of effluents, both in developing state capacity and pilot testing of point sources.

- Design an information system that supports use of point source data in mass balance modeling.

- Initiate dialogue with the Office of Water to develop criteria for the addition of selected Great Lakes chemicals of concern to the Section 307 Priority Pollutant List of the Clean Water Act.

FY 87/88

- Report on the extent of remaining toxicity in effluents from point sources in the basin. Continue to assist Water Divisions with permit revisions. *

- Quantify point source loadings of critical chemicals for mass balance models.

FY 89/90

- Determine, to the extent possible, which point sources still contribute to loadings that exceed limits dictated by mass balance models, that is, that affect beneficial water uses, and initiate appropriate controls.

* Ongoing activity through the five year period.

TOXIC CONTAMINANTS FROM NONPOINT SOURCES

Significant toxicant loadings from nonpoint sources will also need to be determined to the extent possible by 1990. In this strategy, nonpoint sources include urban stormwater runoff, combined sewer overflows (CSOs), and agricultural runoff. Atmospheric deposition, in-place polluted sediments and groundwater are treated separately.

The Great Lakes Office will support monitoring and modeling to obtain loading estimates for all nonpoint sources. Persistent chemicals will be tracked, and where necessary, referred to EPA's Office of Pesticides and Toxic Substances for potential regulation.

FY 86

- Design and test a monitoring program to estimate agricultural loadings.
- Identify and carry out biomonitoring tests for toxicants from CSOs.
- Assist development of remedial actions for areas of concern where CSOs are causing toxic problems.
- Determine whether additional monitoring studies are necessary for separate stormwater sewers that discharge into the system.

FY 87

- Work with the Office of Pesticide Programs for early identification of pesticides that are bioaccumulating in the Great Lakes as an early warning system for pesticides that cause environmental problems. *
- Modify tributary monitoring to incorporate the findings from agricultural monitoring programs. Continue testing and demonstrations as needed.
- Begin development of predictive models for total loadings from nonpoint sources.

FY 88/89

- Continue to monitor nonpoint sources to help test and refine loading models.
- Track and assist implementation of CSO controls in areas of concern.
- Assess effectiveness of Best Management Practices to reduce toxic loadings, and demonstrate and promote alternative methods, if necessary.

* Ongoing activity through the five year period.

FY 90

- Report on whether there is any need for additional control of toxicants from nonpoint sources.

- Recommend additional regulatory or nonregulatory measures if success appears unlikely with existing programs.

ATMOSPHERIC DEPOSITION

The atmospheric deposition program has three objectives: (1) to determine the portion of total loadings of critical toxic pollutants by atmospheric deposition; (2) to recommend the extent to which additional remedial programs and and international activities are needed to control atmospheric sources, and (3) to provide source information for immediate regulatory action.

The GLAD network has been operational since 1981 but certain technical questions need to be addressed. When there is confidence that accurate loading estimates are being obtained, modeling (including analysis of fate and transport) needs to be completed.

The Great Lakes Office will continue to operate the GLAD network in cooperation with the states and to determine whether there is a need for additional regulatory authority to control toxicants in the atmosphere. It will also support refinements of the ability of the Air Divisions to monitor, model and regulate toxic air pollutants under existing authority.

FY 86

- Operate the GLAD network. *

- Complete redesign of the GLAD network. Working with the Air Divisions, reach agreement with Canada on technical issues and network design using recommendations from the states and the list of critical pollutants identified by the Water Quality Board.

- Complete analysis of atmospheric deposition samplers.

- Report on initial findings of first five years of GLAD sampling, with hypothesis on relative significance of atmospheric loadings.

FY 87

- Modify GLAD network to reflect findings reported in FY 86.

- With Air Divisions, devise system to identify sources and categories of sources of atmospheric loadings. Assist regulatory programs if possible.

- Determine modeling needs for atmospheric deposition to complete mass balance work on toxic contaminants in the lakes. Begin design of modeling program with Air Divisions and ORD.

* Ongoing activity through the five year period.

- Undertake study to determine significance of volatilization.

FY 88/89

- Complete and test fate, transport and loading models of critical toxic contaminants.

- Using models and GLAD results, report significance of atmospheric loadings.

- Analyze options for regulatory control, if necessary.

- Using source information generated in FY 87, estimate loadings by sources and locations.

FY 90

- Complete a program plan to quantify, to the extent possible, atmospheric transport of toxicants, with recommendations for regulatory programs, if warranted.

- Assist remedial programs as possible.

IN-PLACE POLLUTED SEDIMENTS

All 28 areas of concern in the United States have polluted in-place sediments. For contamination from this source, the objectives by 1990 are: (1) a remedial action plan submitted to the Water Quality Board and certified as an updated water quality management plan; (2) determination of where removal and disposal of contaminated sediments is the best option; and (3) remedial action plans that are underway or complete. Criteria should be in place and bioaccumulation tests agreed on, with methodologies and procedures for in-place pollutants in sediments tested, refined and recommended.

FY 86

- Assist review of remedial plans for areas of concern through the water quality management process of the Water Divisions. *

- Provide technical assistance to Waste and Water Divisions. *

- Assist the states in completing remedial action plans for areas of concern. *

- Track and report implementation of alternative removal and disposal technologies by the Corps and by the Water and Waste Divisions.

- Design a demonstation program for removal to be supported by the Great Lakes Office.

* On-going activity through the five year period.

- Begin development of use of biological indicators for determining bioaccumulation rates in biota from contaminated sediments, to help measure results of remedial actions, to identify toxic hot spots that need attention and to determine where no action is the best alternative.

- Develop a memorandum of understanding with the Corps of Engineers and Fish and Wildlife Service for monitoring of in-place polluted sediments.

- Assist completion of sediment criteria.

- Inventory models and data for transport/fate assessment in sediments.

FY 87/88

- Begin implementation of a multiyear demonstration program for removal, treatment and disposal of polluted sediments in areas of concern.

- Track results of remedial activities of EPA, the states and the Corps. *

- Using the methods developed earlier, report on biological impacts of polluted sediments in all existing areas of concern.

- Field test transport-fate models.

FY 90

- Report on polluted sediment demonstration project, with recommendations for removal, treatment and disposal technologies.

- Recommend addition programs, if deemed necessary.

- Apply field-validated models to high priority area of concern sites.

TOXIC CONTAMINATION FROM GROUNDWATER

In five years, toxic pollution of the Great Lakes by groundwater infiltration should be understood and loadings estimated. It will be necessary to develop models and project sources and loadings. The Great Lakes Office will assist the Waste Divisions of EPA with remedial programs for landfills or other sources that contaminate the Great Lakes system through groundwaters.

FY 86

- Assist regulatory programs as necessary. *

* Ongoing activity through the five year period.

- Demonstration projects with Water Divisions, states and the U.S. Geological Survey (USGS) to determine actual loadings from groundwaters in certain areas of concern, such as the Upper Great Lakes Connecting Channels.

- Assist the Water and Waste Divisions and the states to inventory potential sources of groundwater pollution such as landfills and deep well injections.

- With EPA's ORD and the USGS, design a study project to produce a predictive model for total groundwater loadings of critical toxic pollutants.

- Complete and monitor groundwater infiltration demonstration projects Support additional projects if needed.

- Complete source inventory.

- Complete and test predictive model.

FY 90

- Report findings of demonstration projects and begin using information to project total loadings.

- Recommend additional remedial activities if needed.

PRIORITIZATION AND MASS BALANCE MODELING FOR TOXICANTS

It is unrealistic to expect verifiable mass balance models by 1990 for critical toxicants from all sources to the Great Lakes but major progress can be made. The following activities should be achieved: (1) critical toxic pollutants listed; (2) a mass balance predictive model designed; (3) loading models completed, tested and in use for each source; (4) the overall mass balance model tested for certain pollutants in specific geographic areas such as Saginaw Bay or Green Bay, and (5) work started to apply the model to an entire lake such as Ontario or Erie.

The Great Lakes Office will participate in Water Quality Board activities to promote this work and will support ORD and others to develop needed programs.

FY 86

- Continue review of critical pollutant list. *

- Support detailed analysis of modeling needs.

- Support and participate in testing of mass balance modeling in the Upper Great Lakes Connecting Channel Study.

- Through the Water Quality Board, complete a list of critical pollutants.

* Ongoing activity through the five year period.

FY 87

- Design a mass balance modeling program for critical toxic pollutants, including a test program for four geographic areas of concern and begin testing the model using data generated by other elements of this study.

- Report on the connecting channels study.

FY 88/89

- Refine model and complete work in geographic areas of concern. Begin work on a lake-wide mass balance model.

- Revise source-specific models and use to direct surveillance activities.

FY 90

- Continue development of lake-wide mass balance model; expand to additional critical toxic pollutants.

FISH MONITORING AND HEALTH EFFECTS

The objectives of the fish monitoring program are to relate toxic contamination of the Great Lakes to effects on biota and to determine potential human exposure by fish consumption. By 1990, accomplishments should include: (1) binational agreement on technical methods for development of consensus on reporting fish advisories; (2) binational protocols for measuring aquatic chronic and acute toxicity; (3) binational understanding of risk assessment methodologies used in setting fish advisories, and (4) increased understanding of epidemiological effects of fish consumption and other pathways for human exposure to critical toxic pollutants in the Great Lakes.

FY 86

- Continue collection and analysis of migratory and resident fish. *

- Participate in Water Quality Board forums on risk assessment. *

- Continue trend monitoring for critical chemicals.

- Reach agreement on methods and standards for state fish advisories and begin discussions with Canada for system-wide uniform standards.

FY 86 continued

- Outline biological monitoring techniques for aquatic toxicity measurements and recommend international protocols.

- Complete inventory of epidemiological data and design a long-term study for assessment of human health risks.

* Ongoing activity through the five year period.

FY 87/88

- Refine U.S. public health fish advisories and seek agreement with Canada on binational methods.

- Initiate discussions with states on uniform standards for fish advisories.

- Work with the Food and Drug Administration to refine interstate commerce advisories to reflect most recent information.

- Reach binational accord on biological monitoring procedures and undertake joint demonstration programs.

- Encourage continued epidemiological studies of human health impacts of exposure by fish consumption.

FY 89/90

- Initiate a study to assess potential multimedia exposure for humans to Great Lakes toxicants by fish consumption and other means.

SURVEILLANCE OF CONVENTIONAL AND TOXIC POLLUTANTS

The Great Lakes surveillance program will continue to evolve as problems and remedial programs change. Monitoring obligations under the Great Lakes agreement will be met, including support for laboratory work, in cooperation with the Water, Waste and Air Divisions and the states. In accordance with EPA policy, all environmental measurement projects will have a quality assurance project plan.

By 1990, the program for conventional pollutants should be redesigned to address productivity and annual trends in wet and dry atmospheric loadings of metals and nutrients should have been determined. Monitoring of toxic pollutants in the five year period will support mass balance modeling and trend analysis for contamination by critical toxic chemicals.

Many of the activities described earlier for addressing toxic contamination, such as operation of the GLAD network and fish monitoring, are part of the overall surveillance and monitoring program but are not repeated here in detail. Monitoring activities for conventional pollutants are listed below:

FY 86

- Transfer WASP model to IBM-PC-ATs

- Continued collection of precipitation samples of metals and nutrients. *

- Submit GLAD network data to the International Acid Deposition system. *

* Ongoing activity through the five year period.

- Begin biota productivity monitoring for Lake Michigan and Ontario. *

- Redesign of GLAD network, with co-located monitoring with Environment Canada at Niagara-on-the-Lake and at Milwaukee.

- Assist and support monitoring programs concerning toxic pollutants from nonpoint sources, including sediments and groundwater.

- Collect open lake data for trend analysis in all five lakes.

- Continue open lake annual limnology program on Lake Michigan, Huron and Erie. Expand limnology program to Lake Ontario to obtain basic data.

FY 87

- Continue productivity monitoring on Lake Michigan and Lake Ontario. Evaluate results of FY 86 work to determine if productivity monitoring should be expanded to Lakes Huron and Erie.

- Use mass balance techniques to determine contribution of atmospheric loadings to Great Lakes and provide technical assistance to remedial and regulatory programs. *

- Implement revised GLAD network. *

FY 88/90

- Evaluate the open lake limnology program. Design program for open-lake for FY 89-90 based on evaluation of results from FY 83-87.

PUBLIC INFORMATION

Public support was critical for the programs that addessed degradation caused by overenrichment and conventional pollutants. A public information program is needed to increase public understanding of toxic contamination and the ecosystem approach to management that this complex problem requires.

Over the next five years, the Great Lakes Office will seek to assist public knowledge of the Great Lakes ecosystem as well as about how problems are being addressed. Special efforts will be made to involve communities in development of remedial action plans for areas of concern. Activities will include:

FY 86

- Support public involvement in development of remedial action plans for areas of concern. *

- Complete development of an ongoing outreach program of public education about the Great Lakes ecosystem and current problems.

* Ongoing activity through the five year period.

- Produce and distribute an atlas of Great Lakes resources.

- Complete an annual report of EPA Great Lakes activities for public use.

- Report on results of special studies and surveillance activities.

FY 87

- Produce and distribute an annotated index of EPA Great Lakes publications.

- Support public education activities related to U.S. implementation of the Great Lakes Water Quality Agreement.

- In cooperation with other agencies, compile a listing of sources of Great Lakes information for the general public.

FY 88/90

- Continue reporting on EPA Great Lakes programs and projects.

- Continue support for public involvement in area of concern plans.

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15. SUPPLEMENTARY NOTES
Kent Fuller, Project Officer

16. ABSTRACT

This document lays out a five year program strategy for the Great Lakes National Program Office of the Environmental Protection Agency (EPA). This office coordinates with other EPA programs and with other agencies to support activities that benefit the Great Lakes and assist implementation of the Great Lakes Water Quality Agreement with Canada.

The program strategy has two purposes. One is to inform other EPA programs, federal agencies and the states how the Great Lakes Office will address its longterm goals from 1986 to 1990. The other is to assist efficient use of resources and annual budgeting by setting program priorities.

17. KEY WORDS AND DOCUMENT ANALYSIS

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