

SUPPLEMENTAL REPORT
UNDER THE REFERENCE ON
POLLUTION IN THE GREAT LAKES SYSTEM
FROM LAND USE ACTIVITIES

ON

**PHOSPHORUS MANAGEMENT
STRATEGIES**



INTERNATIONAL JOINT COMMISSION

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SUMMARY

The International Joint Commission confirms that the target loads contained in Annex 3 of the 1978 Great Lakes Water Quality Agreement are the best estimates available at the present time of maximum annual phosphorus loads that would achieve the goals in the Agreement.

If the target loads are adopted, the Commission presents one strategy to reach them, primarily an expansion of the strategy that PLUARG found to be the most cost effective of the measures studied. The Commission notes that other cost-effective strategies to achieve the target loads may also be possible.

The Commission further notes that the target loads were based primarily on scientific and technical considerations. Other factors that might be further considered in the development of the target loads and programs to meet them, include the projected impacts of present control programs, biological availability, nearshore problems, and socio-economic considerations. The Governments are committed to confirming the target loads by May 22, 1981, by which time they should also determine the need to study these factors further.

If further consideration of any of these factors is required, an intensive study program is recommended, together with an interim strategy of phosphorus management, essentially that proposed by the IJC Task Force on Phosphorus Management Strategies. This recommended program, which would be the required minimum strategy in either case, includes both point and non-point controls, the retention of the detergent phosphate limitation, and its expansion to all Great Lakes Basin jurisdictions.

SUPPLEMENTAL REPORT ON PHOSPHORUS MANAGEMENT STRATEGIES

I. Background

This document is a Supplemental Report to the Governments on phosphorus management strategies for the Great Lakes Basin under the April, 1972 Reference (Appendix A to this report) to the Commission concerning pollution of the Great Lakes System from land use activities and completes the Commission's investigations under this Reference. Statements in this Report concerning previous or interim findings of the Commission refer to those contained in its earlier report, Pollution in the Great Lakes Basin from Land Use Activities, which also provides a summary of the nature of the eutrophication problem and the derivation of both current loading estimates and target loads for the Great Lakes.

The control of excessive inputs of phosphorus has been recognized since the 1960's as the most important factor in combatting eutrophication and its associated problems in the Great Lakes. For this reason, phosphorus was a major focus of the 1972 Great Lakes Water Quality Agreement between the United States and Canada, under which a number of programs were undertaken in both countries to reduce the substantial phosphorus loads to the Lakes from municipal wastewater treatment plants in the Basin, as well as to reduce the phosphate content of detergents. More recent studies, notably those of this Commission's Pollution from Land Use Activities Reference Group (PLUARG), have also identified substantial phosphorus in drainage from "non-point" sources, particularly agricultural and urban lands, as an important component of the overall phosphorus inputs to the Great Lakes.

Notwithstanding the progress that has been achieved to date in reducing phosphorus inputs, much remains to be done to reach environmentally acceptable phosphorus levels in the Great Lakes. This is evident in the 1978 Great Lakes Water Quality Agreement which, despite greater emphasis on other pollution problems, renewed the commitment of both countries to reduce phosphorus inputs to the Lakes. Annex 3 of the Agreement (Appendix B of this report) included tentative "future phosphorus loads" objectives (target loads). These target loads were subject to confirmation by the Parties to the Agreement, and phosphorus loading allocations and compliance schedules were to be established, within 18 months of the November 22, 1978 signing of the Agreement. This review by the Parties was to take into account the recommendations of the Commission arising from the PLUARG study. The date for completion of the governmental review was subsequently extended, by an exchange of diplomatic notes, to May 22, 1981.

During the same period as the negotiation of the 1978 Agreement by the Governments, the Task Force on Phosphorus Management Strategies was established by the Great Lakes Science Advisory Board to assess alternative phosphorus management strategies for the Great Lakes. The Terms of Reference and membership of the Task Force were expanded in 1979, becoming a joint activity of the Great Lakes Science Advisory and Water Quality Boards, in order to address a number of additional related topics. These included certain inconsistencies between the findings on present and target loads by PLUARG, the Water Quality Board, and Task Group III which was the binational governmental working group established to review these matters in preparation for the negotiation of the 1978 Great Lakes Water Quality Agreement.

An interim report addressing several specific questions asked by the Governments was provided by the Task Force to the Commission in December, 1979 and was forwarded without comment to the Governments. Subsequent to this interim report, the Commission's Report, Pollution in the Great Lakes Basin from Land Use Activities (dated March, 1980), contained interim findings on phosphorus inputs and appropriate target loads, but the Commission withheld its final conclusions and recommendations on optimal phosphorus management strategies pending its receipt of the final report of the Task Force.

The final report of the Task Force was completed in July, 1980 and was forwarded to the Governments of the United States and Canada, at their request, immediately following its receipt and prior to its review by the Commission. The report has since been reviewed by the Science Advisory Board, the Water Quality Board, and the Commission in order to provide recommendations on phosphorus management strategies for the Great Lakes Basin. Public Hearings were held during November, 1980 in Windsor, Ontario and Buffalo, New York to allow the public to express its views on this general subject and on the final report of the Task Force. The testimony provided at these Hearings, which is available for inspection at the Offices of the Commission, and the views presented by the Boards were of considerable value to the Commission in its preparation of this report.

II. Target Loads

The Commission concurs with the Task Force in confirming the earlier finding that the "future phosphorus loads" in the 1978 Agreement are valid target loads for phosphorus control efforts. The Commission believes that these target loads represent the best scientific opinion available at the present time as to the maximum annual phosphorus loads that would allow the achievement of the specific phosphorus control

goals in Annex 3 of the Agreement. The Commission further believes that the reduction of phosphorus loads to these levels will be required in order to achieve and maintain acceptable ecological conditions, taking into account the practical limitation of technology. It therefore recommends that the Governments confirm the target loads contained in Annex 3.

The Commission reiterates its previous observation that the interpretation of the phosphorus control goals that was used to derive the target loads for Lake Erie and Saginaw Bay may not adequately reflect the intent of these goals as they are expressed in Annex 3, Section 1.

For Lake Erie, the goal in Annex 3 is the restoration of year-round aerobic conditions in the bottom waters of the central basin. The target load of 11,000 metric tons, however, is predicted to reduce the anoxic area in the hypolimnion by 90 percent. If the goal for Lake Erie is the complete elimination of the anoxic area, the annual phosphorus load should not exceed 9,500 metric tons, according to Task Group III. The Task Group stated that this lower target load would "ensure optimum conditions for fish in the Central basin hypolimnion", with respect to oxygen.

In the case of Saginaw Bay, the target load of 440 metric tons was developed principally to reduce taste, odor and filter-clogging problems at the main water treatment plants using Saginaw Bay water. The phosphorus control goal for bays in Annex 3 is to eliminate algal nuisances in such areas. An annual load of 220 metric tons per year may be the maximum allowable load to achieve this stricter interpretation of the phosphorus goal for Saginaw Bay.

In addition, the Commission received information at its Public Hearings that recent eutrophication modelling efforts have substantiated the Lake Ontario and Saginaw Bay target loads currently in the Agreement. The revised modelling results for Lake Erie indicate that a lower target load than that currently in the Agreement may be necessary to achieve even the less stringent interpretation of the phosphorus goal for that Lake. This recent information suggests that reduction in phosphorus loads even beyond the target levels in the Agreement may ultimately be required.

Actual or present phosphorus loads have also been the subject of review by the Task Force. A measure of the present phosphorus inputs to each Lake from various sources is necessary as a reference point against which required phosphorus reductions and the progress of control programs can be assessed. The Task Force has provided a "best estimate" of the 1976 phosphorus loads based on a complete review of the estimates made by PLUARG, the Great Lakes Water Quality Board, Task Group III, and the Lake Erie Wastewater Management Study. The Commission notes that phosphorus inputs to the Lakes will vary from year to year, depending largely on variations in non-point sources resulting from differing rainfall patterns from year to year.

Nevertheless, in view of the relatively similar reported inputs to the Lakes up to the present time, and noting the magnitude of both the present inputs and the necessary reductions to meet the target loads, the Commission accepts the "best estimates" provided by the Task Force as the most reliable and accurate estimates available of the present phosphorus loads to the Lakes. The Commission, therefore, reaffirms its previous conclusion that these values (Appendix C of this report) represent the state of the art and hence should be used as the reference values for developing phosphorus control policies.

III. Remedial Programs to Meet Target Loads

The difference between the actual loadings of phosphorus and the target loads is the measure of the loading reductions required, on the basis of current scientific knowledge, to meet the phosphorus control goals of the Agreement.

The Commission has received no further information to justify departing from the fundamental findings of PLUARG, contained in its report, Environmental Management Strategy for the Great Lakes System, concerning the most cost-effective combination of remedial measures studied. The need for an approach involving a mix of further point source control and non-point measures for most of the Lakes has been reinforced by the Task Force report.

The following remedial strategy to meet the target loads has evolved during the Commission's consideration of the PLUARG recommendations:

- throughout the Basin, a minimum of "Level 1" non-point measures*;
- a maximum concentration of 1.0 mg/L in effluents from municipal wastewater treatment plants discharging in excess of 3,800 m³/d (1 MGD) in Lakes Superior and Michigan;

* Level 1 non-point controls include:

Rural - sound management practices such as proper nutrient application, minimum tillage, mulching, avoiding slopes near streams; these measures are believed to be achievable at minimal cost.

Urban - reduction of pollutants and stormwater at source, including development of controls, use of natural storage capacities, street-cleaning.

Level 2 non-point controls include Level 1 controls plus:

Rural - conservation tillage, contour strip cropping, use of cover crops.

Urban - artificial detention and sedimentation of stormwater runoff.

- the same measures for Lake Huron, except for the southern portion of the Lake including Saginaw Bay, which would require reductions in municipal effluents to at least 0.5 mg/L and more intensive ("Level 2") non-point measures in rural areas;
- municipal effluent concentrations of 0.5 mg/L for Lake Erie, together with more intensive ("Level 2") non-point control measures in agricultural and urban areas;
- municipal effluent concentrations of 0.5 mg/L or less, together with more intensive ("Level 2") non-point measures in urban areas for Lake Ontario; it was recognized that reductions in the Lake Erie load could have a substantial effect on the programs required in the Lake Ontario basin.

In all areas, it was recognized that since these above measures are whole-lake program measures, more intensive measures may be required in a number of nearshore areas, such as restricted embayments, to address local water quality problems.

PLUARG estimated in 1978 the total minimum annual costs of the above program in the southern Lake Huron, Lake Erie and Lake Ontario basins to be \$76 million in the United States and \$29.5 million in Canada, a total annual cost of \$105.5 million. These are incremental costs beyond those that would be required to meet the 1.0 mg/L phosphorus effluent provisions of the 1972 Great Lakes Water Quality Agreement.

The Commission notes that PLUARG was not able to explore the full range of possible strategies for phosphorus control. Other strategies: may well prove to be reasonable and practicable approaches for achieving the target loads.

Specific measures which could be considered include point source effluent limitations between 0.5 and 1.0 mg/L, as well as other combinations of point and non-point source controls.

Annex 3 of the 1978 Agreement calls for a reduction of phosphorus in household detergents to 0.5 percent (by weight) where necessary to meet the target loads or to meet local conditions, whichever are more stringent. The Commission continues to recommend that the detergent phosphorus limitation be retained in those jurisdictions now having one, and that it be extended to those portions of Ohio and Pennsylvania lying within the Great Lakes Basin. The Commission makes this recommendation for several reasons.

Several jurisdictions in the Basin with a detergent phosphate limitation have reported substantial reductions in influent phosphorus concentrations to municipal wastewater treatment plants. The jurisdictions have attributed these reductions to the detergent phosphate limitation. Lower influent concentrations reduce the amount of phosphorus to be removed at municipal wastewater treatment plants in order to meet effluent standards, and also reduce associated sludge production. The Commission believes that every effort should be made to reduce phosphorus effluent concentrations and that by reducing influent concentrations, the detergent phosphate limitation is valuable. A number of municipal wastewater treatment plants currently not meeting their effluent requirements, and not expected to do so in the immediate future, are located in Ohio and Pennsylvania, which do not have a detergent phosphate limitation.

The detergent phosphate limitation also reduces phosphorus inputs to the Lakes from combined sewer overflows, and those resulting from municipal wastewater treatment plant breakdowns. It also reduces phosphorus inputs from the non-sewered population in the Basin, especially from malfunctioning septic tank systems or septic systems located in unsuitable soils. Further, since the phosphorus in detergent formulations is principally in the biologically available form, the water quality impacts of reducing this portion of the phosphorus load should be relatively greater than those predicted on the basis of the quantity of total phosphorus, not all of which is readily available for use by aquatic plants. This latter aspect is discussed further in the next section.

The Commission's Science Advisory Board has reported that there are substitutes for phosphorus in detergent formulations which appear to be safe from the environmental and health points of view. The Commission is aware of the position of the soap and detergent industry that it is more cost effective, when all the direct and indirect costs are considered, to remove phosphorus at municipal wastewater treatment plants.

The total costs cited by the industry include those for increased use of clothes brighteners and softeners, increased hot water and energy use, and increased wear and tear on clothes and machines. One of the concerns of the Commission with this analysis is that it does not consider the full range of possible phosphate substitutes on the cost-effectiveness of chemical treatment versus detergent phosphate limitations.

The Commission believes that any governmental re-evaluation of the efficacy of detergent phosphate limitations should await the completion and the consistent, reliable operation of the necessary point and non-point control programs to meet the target loads.

IV. Additional Considerations Relating to Target Loads and Required Programs

Further to the Commission's conclusions on the validity of target loads and present loading estimates, the Commission draws the attention of the Governments to a number of scientific and policy issues, not incorporated in the development of these values, which may affect the shape and extent of required programs. Should the Governments determine during their negotiations, to be completed by May 22, 1981, that these matters deserve further investigation, the Commission recommends that an intensive program to resolve them be instituted immediately in order to provide more definitive information by the time of the required comprehensive review of the 1978 Agreement following the Commission's third biennial report.

If such a study program is instituted, the Commission recommends that an interim program of phosphorus control, such as that outlined in Section V of this report and essentially that recommended by the Task Force, should be implemented immediately by the Governments. The Commission recommends these measures as minimum requirements that will be required in any event, whether additional studies are undertaken or not, and which could be implemented in such a way as not to inhibit further phosphorus programs in the future.

Impact of Current Programs. The identification of programs needed to achieve target loads is based, in part, on projections of the impacts of current programs that have yet to be fully implemented. As reviewed in the Commission's Seventh Annual Report on Great Lakes Water Quality, progress has been made in implementing point source phosphorus controls, although several large plants in the U.S. portion of the Basin have yet to complete their construction programs. In addition, a number of plants in both countries have yet to achieve operational efficiency to design levels.

While it can be concluded from the PLUARG, Task Force and other studies that additional point source measures, as well as non-point programs, will be required to achieve the target loads, concern has been expressed at the Public Hearings, particularly by municipal officials, about the necessity of implementing more restrictive effluent limitations prior to a better understanding of what is achievable with current and planned remedial programs.

Biological Availability. The only comprehensive data base available for phosphorus in the Great Lakes is that for "total phosphorus". Considerable discussion has taken place as to the importance of the relative biological availability of phosphorus from various sources as a factor in developing optimal control strategies. Biologically available phosphorus is that fraction of the total phosphorus input that can be readily used by algae and other aquatic plants. While all phosphorus may be ultimately "available" over time, those sources with a high proportion of immediately available phosphorus may deserve greater priority in control efforts. There has been no comprehensive analysis of the biologically available portion of the total phosphorus inputs to the Great Lakes from various sources or of phosphorus dynamics in the Great Lakes System.

The Commission concludes that, at the present time, knowledge concerning biological availability can most effectively be used to help identify priorities among phosphorus control options, that is, in directing priority control efforts to the sources known to be contributing large quantities of biologically available phosphorus. These sources include phosphorus being contributed by municipal wastewater treatment plant effluents and detergent phosphates. Furthermore, the Governments may wish to take into account the degree to which the biological availability of phosphorus may be altered in its transport to the Great Lakes from sources some distance from the Lakes.

Nearshore and Variability Problems. The desirability of setting target loads based on whole-lake problems is also a consideration. All the mathematical models used by Task Group III were structured so as to produce a target load to achieve desirable lake conditions on a whole-lake basis. None of the models, however, directly addressed eutrophication problems in the nearshore zones. This is also an important practical consideration since, as noted by the Task Force, public awareness of eutrophication and its impacts on public use of the water are based primarily on conditions in the nearshore zone. In general, this area is strongly affected by local inputs, it degrades more readily than the lake as a whole and, conversely, it will respond more quickly to phosphorus control efforts. To derive target loads which incorporate consideration of nearshore problems, however, will require more sophisticated modelling efforts than now generally available.

The Commission has previously pointed out the uncertainties involved in the variability over time of phosphorus loads and effects. These include differences in loads and their impacts on phosphorus concentrations over the seasons of the year and, more importantly, from year to year due to climatic variation.

Socio-Economic Considerations. Another issue for which there is limited information at present relates to socio-economic considerations. The Task Force has pointed out that there is a serious gap in the understanding of the linkage between Great Lakes water quality and the use of this resource, that is, the socio-economic values involved. It recommended an effort to develop a better understanding of the social benefits and costs of control measures. While there has been some consideration of the practicability of phosphorus control measures and their relative cost-effectiveness, there has not been an assessment of social desirability of achieving, or failing to achieve, the levels of pollution control required to reach the target loads.

It should be borne in mind that the target loads contained in Annex 3 of the Agreement are based primarily on scientific and ecological considerations. These criteria are accepted by the Commission as the best basis at present by which to develop target loads for the Great Lakes. If it is determined, however, that considerations other than scientific criteria should be a factor in determining phosphorus target loads or the extent of control programs, this decision should be made explicitly and should be based on firmer empirical evidence regarding social benefits and costs of phosphorus control programs than is presently available. The Commission has supported the need for further information in this area. At the same time, the Commission takes the view that the achievement of both ecological and economic goals is not necessarily inconsistent.

V. An Interim Strategy

If Governments should determine that additional information is required before implementing programs to achieve fully the target loads, the Commission recommends that the following interim program, directed principally to the Lower Lakes, and based largely on the Task Force recommendations with some important modifications noted under the element concerned, be adopted immediately. The elements of this strategy should also be incorporated, if not superseded by more intensive measures, within any strategy developed by the Governments to achieve the target loads.

- All municipal wastewater treatment plants discharging in excess of 3,800 m³/d (1 MGD) in the Great Lakes Basin should be designed and operated so that the total phosphorus concentrations in their effluents will not exceed a maximum of 1.0 mg/L.

The Commission wishes to emphasize the need to implement managerial and training programs to ensure the consistent operation of plants at optimal operational efficiency.

- Municipal wastewater treatment plants in the Lake Ontario, Lake Erie and southern Lake Huron drainage basins, including Saginaw Bay, that are now required to meet a phosphorus effluent limitation of 1.0 mg/L should be operated to concentrations below 1.0 mg/L where this can be achieved by improving operating procedures. The Governments may wish to consider means to provide incentives for plants which can operate at lower effluent concentrations to bear the additional costs involved in such operation. The Commission extends this recommendation to the entire geographic area noted above, which was identified by PLUARG as the area in which the most cost-effective strategy considered for meeting the target loads included point source control to a 0.5 mg/L effluent phosphorus concentration.
- All future municipal wastewater treatment projects to discharge greater than 3,800 m³/d (1 MGD) should be designed to permit phosphorus removal to the level achievable by best available technology, taking into account alternative or innovative technologies including land treatment where feasible.

This recommendation goes beyond that of the Task Force in order to allow for the maximum reduction of phosphorus effluents from new or significantly expanded point source discharges. In providing such systems, it may not be necessary to construct and operate them for maximum phosphorus removal at the initial stage, but provision should at least be made for expansion should it be required in the future.

- Governments should consider basing all aspects of phosphorus management strategies, including discharge objectives from municipal facilities, on mass loading allocations.

The mass loading concept involves developing control strategies and phosphorus load allocations on the basis of total loadings to a water body, rather than on fixed effluent standards. The former is consistent with the target load approach since it is not affected by changes in the total quantity of effluent or the phosphorus concentrations contained therein, but rather is based on the total mass of phosphorus entering the Lakes. It also allows jurisdictions to identify the most cost-effective mix of programs to meet phosphorus goals.

- The limitation of phosphorus in household laundry detergents within the Great Lakes Basin should be retained in those jurisdictions which now have such regulations, and extended to the portions of the States of Ohio and Pennsylvania within the Basin.

The rationale for this recommendation is given in Section III of this Report and is supported by recommendations of the Great Lakes Water Quality Board and the Task Force.

The Commission does not believe that a further study of this matter is warranted at this time, at least until programs are fully in place and operating consistently to meet the target loads.

- The Governments should initiate technology development and demonstration programs for alternative and innovative treatment technologies to achieve the lowest practicable effluent concentrations. As one specific application of such a

program, land treatment of municipal wastewaters should be given serious consideration where feasible on technical, environmental and social grounds and where cost effective.

- Non-point programs for phosphorus control in rural and urban areas should be initiated as recommended in the Commission's Report, Pollution in the Great Lakes Basin from Land Use Activities. These included, within a comprehensive management strategy for pollution control for the Great Lakes:
 - the development and implementation of remedial plans for non-point pollution control in priority areas;
 - the implementation of low-cost, but generally beneficial measures (to at least "Level 1" PLUARG measures) throughout the Basin;
 - the use of voluntary mechanisms where possible, supported by adequate educational, technical and financial support.

The Commission also concurs with the value of studying further the issues outlined in Recommendations 7 and 9 of the Task Force Report, concurrently with the implementation of the other elements of this interim strategy. These included: quantification of reductions in toxic and hazardous substances that would occur concurrent with phosphorus removal; continued refinement of phosphorus models and appropriate data bases; biological availability of phosphorus; social costs and benefits of phosphorus control measures; and the appropriateness of institutional approaches. The Commission does not wish at the present time, however, to comment on the most appropriate mechanism for conducting such studies.

Signed this 30th day of January, 1981 as the International Joint Commission's Supplemental Report to the Governments of the United States and Canada under the Reference on Pollution in the Great Lakes System from Land Use Activities, on Phosphorus Management Strategies.

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APPENDICES

APPENDIX A

TERMS OF REFERENCE

Text of Reference to the International Joint Commission to Study Pollution in the Great Lakes System from Agriculture, Forestry and other Land use Activities

I have the honour to inform you that the Governments of the United States of America and Canada, pursuant to Article IX of the Boundary Waters Treaty of 1909, have agreed to request the International Joint Commission to conduct a study of pollution of the boundary waters of the Great Lakes System from agricultural, forestry and other land use activities, in the light of provision of Article IV of the Treaty which provides that the boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health and property on the other side, and in the light also of the Great Lakes Water Quality Agreement signed on this date.

The Commission is requested to enquire into and report to the two Governments upon the following questions:

- (1) Are the boundary waters of the Great Lakes System being polluted by land drainage (including ground and surface runoff and sediments) from agriculture, forestry, urban and industrial land development, recreational and park land development, utility and transportation systems and natural sources?
- (2) If the answer to the foregoing question is in the affirmative, to what extent, by what causes, and in what localities is the pollution taking place?
- (3) If the Commission should find that pollution of the character just referred to is taking place, what remedial measure would, in its judgement, be most practicable and what would be the probable cost thereof?

The Commission is requested to consider the adequacy of existing programs and control measures, and the need for improvements thereto, relating to:

- (a) inputs of nutrients, pest control products, sediments, and other pollutants from the sources referred to above;
- (b) land use;
- (c) land fills, land dumping, and deep well disposal practices;
- (d) confined livestock feeding operations and other animal husbandry operations; and
- (e) pollution from other agricultural, forestry and land use sources.

In carrying out its study, the Commission should identify deficiencies in technology and recommend actions for their correction.

The Commission should submit its report and recommendations to the two Governments as soon as possible and should submit reports from time to time on the progress of its investigation.

In the conduct of its investigation and otherwise in the performance of its duties under this reference, the Commission may utilize the services of qualified persons and other resources made available by the concerned agencies in Canada and the United States and should as far as possible make use of information and technical data heretofore acquired or which may become available during the course of the investigation, including information and data acquired by the Commission in the course of its investigations and surveillance activities conducted on the lower Great Lakes and in the connecting channels.

In conducting its investigation, the Commission should utilize the services of the international board structure provided for in Article VII of the Great Lakes Water Quality Agreement.

APPENDIX B

GREAT LAKES WATER QUALITY AGREEMENT OF 1978

Annex 3

CONTROL OF PHOSPHORUS

"1. The purpose of the following programs is to minimize eutrophication problems and to prevent degradation with regard to phosphorus in the boundary waters of the Great Lakes System. The goals of phosphorus control are:

- (a) Restoration of year-round aerobic conditions in the bottom waters of the Central basin of Lake Erie;
- (b) Substantial reduction in the present levels of algal biomass to a level below that of a nuisance condition in Lake Erie;
- (c) Reduction in present levels of algal biomass to below that of a nuisance condition in Lake Ontario including the International Section of the St. Lawrence River;
- (d) Maintenance of the oligotrophic state and relative algal biomass of Lakes Superior and Huron;
- (e) Substantial elimination of algal nuisance growths in Lake Michigan to restore it to an oligotrophic state; and
- (f) The elimination of algal nuisance in bays and in other areas wherever they occur.

2. The following programs shall be developed and implemented to reduce input of phosphorus to the Great Lakes:

- (a) Construction and operation of municipal waste treatment facilities in all plants discharging more than one million gallons per day to achieve, where necessary to meet the loading allocations to be developed pursuant to paragraph 3 below, or to meet local conditions, whichever are more stringent, effluent concentrations of 1.0 milligram per litre total phosphorus maximum for plants in the basins of Lakes Superior, Michigan, and Huron, and of 0.5 milligram per litre total phosphorus maximum for plants in the basins of Lakes Ontario and Erie.
- (b) Regulation of phosphorus introduction from industrial discharges to the

maximum practicable extent.

- (c) Reduction to the maximum extent practicable of phosphorus introduced from diffuse sources into Lakes Superior, Michigan, and Huron; and reduction by 30 per cent of phosphorus introduced from diffuse sources into Lakes Ontario and Erie, where necessary to meet the loading allocations to be developed pursuant to paragraph 3 below, or to meet local conditions, whichever are more stringent.
- (d) Reduction of phosphorus in household detergents to 0.5 per cent by weight where necessary to meet the loading allocations to be developed pursuant to paragraph 3 below, or to meet local conditions, whichever are more stringent.
- (e) Maintenance of a viable research program to seek maximum efficiency and effectiveness in the control of phosphorus introductions into the Great Lakes.

3. The following table established phosphorus loads for the base year (1976) and future phosphorus loads. The Parties, in cooperation with the State and Provincial Governments, shall within eighteen months after the date of entry into force of this Agreement confirm the future phosphorus loads, and based on these establish load allocations and compliance schedules, taking into account the recommendations of the International Joint Commission arising from the Pollution from Land Use Activities Reference. Until such loading allocations and compliance schedules are established, the Parties agree to maintain the programs and other measures specified in Annex 2 of the Great Lakes Water Quality Agreement of 1972.

| Basin | 1976 Phosphorus Load in Metric Tonnes Per Year | Future Phosphorus Load in Metric Tonnes Per Year |
|-----------------|---|---|
| Lake Superior | 3600 | 3400* |
| Lake Michigan | 6700 | 5600* |
| Main Lake Huron | 3000 | 2800* |
| Georgian Bay | 630 | 600* |
| North Channel | 550 | 520* |
| Saginaw Bay | 870 | 440** |
| Lake Erie | 20000 | 11000** |
| Lake Ontario | 11000 | 7000** |

* These loadings would result if all municipal plants over one million gallons per day achieved an effluent of 1 milligram per litre of phosphorus.

* * These loadings are required to meet the goals stated in paragraph 1 above."

APPENDIX C

"BEST ESTIMATE" OF 1976 TOTAL PHOSPHORUS LOADS (metric tons per year)

| Lake | Direct Municipal | Direct Industrial | Tributary* Total | Atmosphere | Urban Direct | Upstream Load | Total |
|----------|---------------------|----------------------|---------------------|------------|--------------|------------------|--------|
| SUPERIOR | 72 | 103 | 2,455 | 1,566 | 16 | - | 4,212 |
| MICHIGAN | 1,041 | 38 | 3,596 | 1,682 | - | - | 6,357 |
| HURON | 126 | 38 | 2,901 | 1,129 | 16 | 657 | 4,867 |
| ERIE | 6,292 | 275 | 9,960 | 774 | 44 | 1,080 | 18,425 |
| ONTARIO | 2,093 | 82 | 4,047 | 488 | 324 | 4,769 | 11,803 |

* Consists of indirect point sources and nonpoint sources in each tributary basin.

Source: Phosphorus Management Strategies for the Great Lakes. Final Report of the Phosphorus Management Strategies Task Force, p. 22.