POLLUTION IN THE GREAT LAKES BASIN FROM LAND USE ACTIVITIES

International Joint Commission

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INTRODUCTION

The conversion over many decades of land from its natural covering of mostly forest to more intensified uses such as urban developments and extensive areas of row crops in farming has been a major causative agent in the degradation of water and other components of the Great Lakes Basin Ecosystem. In many cases, pollution from man's activities on land continues to worsen as the years pass, as a result of increasing population and technological change. The Governments of the United States and Canada requested in April 1972 that the International Joint Commission study and make recommendations on the extent and causes of land use pollution and possible remedies.

This Report is written in response to that request. It focuses on pollution from land-use (nonpoint) sources. Nonpoint sources are different from sources such as industrial and municipal sewage treatment plants (point sources), in that the former is caused by a larger number of diffuse sources causing individually insignificant, but cumulatively significant, quantities of pollution.

To assist the Commission in this study, a binational group of scientists and other specialists, the Pollution from Land Use Activities Reference Group (PLUARG), was formed. The basic questions asked by the Governments were: are the boundary waters of the Great Lakes System being polluted by land drainage from land use activities? If such pollution is occurring, by what causes, to what extent, and where is the pollution taking place? What remedial measures would be most practicable to deal with such pollution, and what would be their probable cost? The Reference Group was also asked to assess the adequacy of existing programs and control measures for addressing nonpoint pollution.

The desire for widespread citizen input to the PLUARG program led the Reference Group to initiate a new approach in public participation. Nine public consultation panels in the U.S. and eight in Ontario were established to discuss the environmental, social and economic aspects of the study, and to present their resulting views and recommendations thereof. As well, the panels had the opportunity to review the PLUARG report and provide comments prior to its being completed. Additional public input was available directly to the Commission through public hearings held both before and after the study.

The information received through this process and subsequent reports forms the basis for the Commission's consideration and conclusions.

POLLUTION FROM LAND USE ACTIVITIES

The Commission agrees in general with the study finding that the Great Lakes are being polluted from land drainage sources. Such pollution occurs most seriously from land areas of intensive agricultural and urban use. The most significant pollutants from these sources are phosphorus, sediment, a number of industrial organic compounds and pesticides and some heavy metals.

Phosphorus is of significance to the Great Lakes Ecosystem because it is the principal controlling factor in eutrophication (nutrient enrichment), which can cause severe water quality degradation. While phosphorus comes from natural sources, phosphorus loadings have been increased by man's activities (e.g., agricultural and urban land use) to levels which are of environmental concern. Land use activities contribute from a third to a half of the total phosphorus loads to the various lakes. The highest loadings are associated with the most intensely-polluted lakes, Erie and Ontario. The movement of phosphorus downstream from one lake to another, and deposition of phosphorus from the atmosphere are significant sources in some lakes.

Cropland was the major source of nonpoint loads, especially in areas characterized by high density row crops and fine-grained (clay) soils, particularly northeastern Ohio, southwestern Ontario and southern Wisconsin, and where insufficient attention is paid to soil conservation and drainage practices. Nutrient runoff from feedlots and other livestock operations can contribute significantly to total phosphorus loads, especially in central-southern Ontario and southern Wisconsin. Other agricultural sources of phosphorus pollution, particularly affecting local areas, stem from improper or excessive fertilizer application, including the spreading of manure in winter. A large proportion of the nonpoint phosphorus loads, especially to lakes Ontario and Erie, comes from urban areas, due to their large impervious surfaces, rapid runoff characteristics and large quantities of loose phosphorus-laden soil particles in such areas. The highest phosphorus contributions per unit of surface area are from lands undergoing construction. Except for Lake Superior, private, non-sewered waste disposal systems (e.g., septic tanks), forestry operations over large areas and atmospheric inputs all contribute notable, but overall, not large components of the total phosphorus loads to the various lakes. Other land uses have minimal impacts.

The Commission has reviewed questions concerning present total phosphorus loads and the proposed target loading levels in the 1978 Great Lakes Water Quality Agreement in order to assist the governments in determining the quantities by which phosphorus loadings should be reduced in order to achieve desired water quality or other conditions in the lakes as well as the appropriate strategies for meeting these goals. Partly on the basis of an interim report from its Task Force on Phosphorus Management Strategies, the Commission has concluded tentatively that the phosphorus loads contained in Table 5 with this Report, represents the best estimate available at the present time and should be used as a basis for developing phosphorus control strategies. With respect to target loads, the Commission has concluded (pending a further report from its Task Force) that those outlined in the 1978 Great Lakes Water Quality Agreement are generally valid goals for phosphorus reduction programs, although the adequacy of the target loads for Lake Erie and Saginaw Bay for reaching the objectives expressed in the Agreement is questioned. A number of scientific questions relevant to final policy decisions remain to be resolved, including the relative biological availability of phosphorus from various land use sources, and the variability of loads and effects on the lakes, both over time and between the nearshore and open water areas.

Pollution by toxic and hazardous substances from land drainage is an equal, if not greater, concern in the Great Lakes Basin Ecosystem. Approximately 2800 chemicals, including 2200 organic compounds, are being

produced or used in the Great Lakes Basin. About 400 organic compounds have been identified in the Great Lakes ecosystem including many of the compounds in the above inventory. Residual levels of persistent pesticide compounds, specifically DDT, aldrin-dieldrin and chlordane, continue to appear in Great Lakes biota, although their use in the Basin has been banned or severely restricted in recent years.

Unacceptable levels of industrial organic compounds, heavy metals and other trace elements are also present in the water of the Great Lakes. Lakes Ontario and Erie sediments, particularly those adjacent to large urban areas, are highly contaminated with PCBs, which represent an environmental hazard because they are exceptionally stable and bioaccumulate readily through the food chain in fish, birds and human beings. While they have been used in the basin for over 40 years, steps to ban their use were taken only recently. Hexachlorobenzine and Mirex are two additional hazardous organic compounds that pose environmental and health problems.

While a number of heavy metals and trace elements were identified as present or potential pollutants of the Great Lakes System, mercury and lead were identified as being of greatest concern. Various point source discharges of mercury have contaminated the sediments and fish of Lake St. Clair. Subsequent control of these sources has resulted in encouraging declines of mercury to the extent that re-opening of the Lake St. Clair commercial fishery is being considered. Substantial inputs of lead from nonpoint sources such as automobile exhausts have produced measurable lead concentrations in lake sediments. While concentrations of lead in Great Lakes fish are below the currently acdeptable guidelines, further studies of its potential for methylation to a more toxic organic form may lead to revised guidelines.

The input of sediments to the Great Lakes, is most often associated with siltation and its effects, such as drinking water limitations, aesthetics, siltation effects of fish spawning grounds and interferences with navigation. It has more recently been identified with other ecological concerns. Sediments function as both pollutant carriers and as pollutant traps. Because as many as 11 million metric tons of sediments from agricultural, urban and forested lands reach the lakes each year, they play a significant role in transporting phosphorus, metals and other pollutants to the lakes; on the other hand, they can also bind toxic and other pollutants to the sediment particles thereby removing the pollutants from the water itself. The nature of the sediment-associated pollutants and the conditions in the water are important factors in this regard.

In addition to the wide array of toxic and hazardous materials that reach the lakes from land drainage sources, many pollutants are transported to the lakes via the atmosphere. Recent investigations, including those carried out by PLUARG, indicate that substantial amounts of phosphorus PCBs and other pollutants are carried to the lakes in this manner. While acid rain so far has had little direct effect on the Great Lakes because of their high buffering capacity (which counteracts the acidity), effects on vegetation and small lakes in the Basin with low buffering capacities have been significant especially in upstate New York and the Canadian Shield area of Ontario. To the extent that these inland lakes drain into the Great Lakes, continued high acidity in rain may ultimately have measurable effects on at least some components of the Great Lakes Ecosystem.

The disposal of hazardous liquid and solid wastes, generated by the intense industrial activity in the Great Lakes Basin, is another matter of urgent and immediate concern. With the recent appreciation of the magnitude of the environmental and health problems associated with the disposal of these wastes, it is being realized that adequate treatment and disposal regulations and facilities do not now exist, nor has adequate concern been directed at methods to reduce the generation of pollutants and to dispose of such wastes. The Commission is also aware that many old inactive but potentially dangerous waste disposal sites exist throughout the Basin, and sees the problem of hazardous waste management as requiring immediate attention.

COMPREHENSIVE MANAGEMENT STRATEGY

The Commission believes that remedial measures required to deal with these and other pollution problems should be identified and implemented within a comprehensive management strategy. A framework is required for ensuring comprehensive, consistent and equitable action across the Great Lakes Basin. There are various components to the recommended framework, which is an expansion of the concept recommended by PLUARG. As a starting point, there is value in adopting a basin-wide, long-term perspective which includes taking account of the impacts of all of man's activities on the natural and socio-economic systems. This concept has become known as the "Ecosystem Approach." With nonpoint pollution, perhaps more than other types, seemingly simple management decisions with respect to the many diffuse sources may have complex ramifications that, if not taken into account, could have unintended consequences or even result in the failure of the program concerned. It is within this perspective that the Commission outlines a tiered system of developing management strategies, plans and specific remedies at all levels of jurisdiction. Such a framework, however, should not delay development and implementation of immediately needed remedial measures.

At the international level, using Article VI of the Great Lakes Water Quality Agreement as a basis, there is a need for a clear understanding concerning the goals and general nature of programs required to deal with nonpoint pollution. Within this mechanism, each country should ensure the development and/or strengthening of interjurisdictional coordinating mechanisms to ensure comprehensive, effective action by relevant jurisdictions. The third level of coordination required is between the various agencies of the jurisdictions. The myriad of policies and programs both within and beyond the environmental policy area, but affecting the actions of corporations and individuals contributing to nonpoint pollution, have generally not been well coordinated or necessarily consistent. Resulting gaps and conflicts in policies and programs, as well as funding and manpower constraints, can be minimized by developing a more cooperative approach to government. This goal would be fostered by a strong mechanism for inter-agency coordination, and by reaching clear understandings on agency roles and responsibilities. The institutional basis for such coordination exists in all jurisdictions, but needs to be strengthened and formalized. Established institutions might well be used for this process and for the implementation of programs. While then more effective use may be desirable, this should not, however, inhibit the establishment of new mechanisms if necessary.

Within such an institutional environment, but not necessarily waiting for it to come about before any action is taken, the jurisdictions can set about

developing management plans with particular reference to nonpoint pollution. Priorities should be established for major remedial measures, with highest priority to areas in the drainage basins of the lakes and lake segments having the worst water quality (Lakes Erie, Ontario, Saginaw Bay and southern Lake Huron) and within those to the potential contributing areas identified in this Report, especially the hydrologically active areas therein.

On the other hand, certain environmentally sound or "best management" practices should be encouraged, or in some cases required, throughout the Basin. These are generally low-cost measures, such as certain soil conservation practices that could well result in a direct economic advantage, at least in the long term. This would, if widely adopted, assist in controlling nonpoint pollution, while not bringing an undue or inequitable burden on any group of land-owners or other individuals.

While the Commission generally endorses the pollutor-pays principle, it believes that there is a basis for exception with respect to small farming operations which are often marginally viable as well as local municipalities, which form an important part of our two nations' social and economic fabrics.

With major, site-specific measures, the cost-effectiveness of all alternative remedies should be assessed in order to select the best approach both within and between sites. The Commission notes the paucity of data and even meaningful measurement criteria with respect to the socio-economic benefits and costs of controlling - or failing to control - pollution in the Great Lakes, particularly from the perspective of nonpoint source pollution. There is a recommendation, therefore, that governments initiate a program to assess the social and economic implications of pollution control concurrently with the development of management strategies.

In the review of specific legislative and administrative changes that might be required to implement remedial programs, the jurisdictions should consider three additional elements:

- The value of using and improving on voluntary programs where practical, rather than relying solely on regulations, should be recognized. In order for this to be successful, however, a greater effort will be essential to develop an informed public through both general education and technical assistance. The Commission provides a broad outline of the needs in this area. In some cases, however, regulation will still be required. Three specific instances identified in this Report are the prohibition of winter spreading of manure on frozen ground, the regulation of sediment runoff from new urban development, and the regulation of industrial waste management.

- Adequate legislation and mechanisms for implementing pollution control measures cannot be effective if sufficient funding and manpower is not provided. The failure to appropriate sufficient (or any) funds and/or necessary manpower have been commonly experienced problems in environmental programs throughout the Basin's jurisdictions.

- While basic control and coordination should be maintained and strengthened at the senior levels of government, there is considerable merit in delegating a large degree of implementation

responsibility and managment-planning to the local level. The provision of guidance and technical/financial assistance will, however, be required. Appropriate mechanisms for such partnership appear to exist in the Conservation Authorities in Canada, and the Section 208 planning agencies, as well as Soil and Water Conservation Districts, in the United States.

Finally, with respect to the Management Framework, there will be a need for further water quality monitoring, and review of the overall strategy, jurisdictional management plans and the effectiveness of remedial progams.

SPECIFIC RECOMMENDED REMEDIAL PROGRAMS

The Commission reviewed the applicability of various specific remedial measures. These should be considered within the context of the proposed management strategy. Their implementation, however, should not necessarily await the full development of this strategy.

For phosphorus control, PLUARG reviewed various scenarios and found that, of the measures reviewed that could accomplish target loads, the implementation of a 0.5 mg/L effluent limitation on major municipal treatment plants was the most cost-effective option of those considered. With this effluent limitation, nonpoint pollution programs of varying intensity would also be required to meet target loads on Lakes Erie, Ontario, Saginaw Bay and southern Lake Huron. The incremental cost of further reductions in conventional treatment plant effluents to 0.3 mg/L is high, being comparable to some of the most expensive agricultural phosphorus reduction programs. The Commission believes that the cost-effectiveness estimates for nonpoint measures establish a firm basis for developing remedial strategies for pollution from land use activities. It does not consider it possible at the present time, however, to make a recommendation on controlling municipal treatment plant effluents to a level of 0.5 mg/L. A further review of its feasibility throughout the Basin and of alternative measures is required. The Commission's Task Force on Phosphorus Management Strategies is expected to address this issue in its Final Report, and provide the basis for further Commission recommendations.

A number of agricultural measures deserve the attention of Governments in developing management plans for both broad and site-specific measures. These measures include the encouragement of sound soil conservation practices, which will usually be of minimal cost and may even yield benefits to individual farmers, but which will require a clear demonstration of need and technical assistance. More intensive and expensive soil conservation measures are required in certain hydrologically active areas with fine-grained soils, possibly also requiring financial incentives. Fertilizer application should be the subject of an effective training and information program to back up the technical services now available. The registration process of fertilizers for manufacture and marketing should take environmental criteria into account. Winter spreading of manure on frozen ground should be prohibited, environmentally-sound storage measures encouraged, and provision made for financial aid to affected farmers. The application of sewage sludge and effluents on land requires increased attention.

Livestock operations may require regulatory action (large operations are already covered under NPDES in the United States) if measures cannot be

developed to encourage the implementation of strict voluntary guidelines. Existing programs of this nature should be reviewed to ensure their adequacy with respect to water pollution.

In the urban areas, greater attention should be paid to the water quality aspects of erosion and stormwater runoff control. Systems for their control, using natural drainage characteristics where possible, should be required in all development design. As these concepts have not been widely recognized, there will be need for further education, technical assistance and financial incentives to local level planners and decision-makers. Sediment control from new urban areas under construction, on the other hand, should be required by regulation, with the costs incorporated into overall development costs. Governments should also ensure that further urban expansion does not add to the problem of combined sewer overflows.

In older, developed urban areas, the only practicable measures for immediate implementation may be reduction at the source of pollutants that can be carried to the lakes by runoff during storms. These measures include street cleaning, public education to reduce spills and intentional disposal of toxic and oil-based substances, and even the control of air pollution. Incentives for encouraging the use of non-leaded gasoline should be considered.

Hazardous waste disposal, particularly concerns relating to the identification, transport and disposal of hazardous industrial wastes, has become a major and growing area of concern. Emerging programs of the various jurisdictions are described in this Report, with a view to giving guidance on some shortcomings and strengths of the various programs to date. The Commission recommends that Governments conduct a complete inventory of waste disposal sites in the Basin, a determination of their capability, and the adequacy of their regulation; that every effort be made to reduce generation of such wastes, to identify and secure abandoned sites and to establish safe disposal sites that can be acceptable to the public; and that governments establish a compatible manifest system between all jurisdictions within and beyond the Great Lakes Basin.

Various measures for tightening the prevention of pollution from sources having mainly local impact are suggested. These measures include proper design, location and maintenance of private waste disposal systems. Government control over forestry practices and mineral extraction operations is generally adequate, but may be inhibited by funding and manpower shortages.

Three special considerations relevant to the Reference, but not strictly part of it, are noted by the Commission. As much of the pollution of the Great Lakes results from a waste of resources, a greater and continuing attention should be directed to developing a conservation ethic among individuals, municipalities and industry, and specifically on such measures as recycling, resource recovery, and conservation in the content and use of products. Secondly, there is environmental and social value in preserving prime agricultural lands, since more marginal lands when farmed tend to create increased pollution runoff. Thirdly, land-use planning and regulation should recognize the values of wetland areas, both as buffers between developed lands and the lakes, and as important biological habitats in their own right.

Finally, the Commission has noted a number of subject areas requiring further research. The pursuit of such further work should not prevent or

divert attention from the early implementation of control action. Rather, the Commission suggests the concurrent initiation of additional studies to refine the management strategies being implemented.

I. INTRODUCTION

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This Report is the Commission's response to the third of three related References received from the Governments over the past fifteen years, each asking the Commission to examine and report on a specific aspect of pollution of the Great Lakes Basin.

In October 1964, the Governments of Canada and the United States directed the Commission's attention to certain concerns related to the Lower Great Lakes and requested the IJC to enquire into the extent of pollution in Lakes Erie, Ontario and the International Section of the St. Lawrence River. Should such pollution be causing or likely to cause injury on the other side of the boundary, the Commission was to determine its causes and localities and also the most practicable remedial measures. In 1970, after a six year study, the Commission, in its Report on "Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River", stated that the advanced state of eutrophication in the lower Lakes demanded urgent remedial actions by the two Governments. It recommended that the countries enter into an agreement on programs and measures to implement water quality objectives, and that the 1964 Reference be extended to an investigation of pollution in the Upper Great Lakes.

Two years later on April 15, 1972, as recommended in the Commission's Report, the Canada-United States Great Lakes Water Quality Agreement was signed. Concurrently with the signing of the Agreement, the Governments gave two additional Great Lakes References to the Commission for study and recommendations.

In one Reference, the Commission was requested to conduct a study of water quality in Lake Huron and Lake Superior to determine whether the lakes were being polluted, the transboundary and downstream effects of this pollution and the localities of such pollution and to recommend remedial measures where necessary, or preventative measures where the waters are of high quality. The Commission reported in May 1979 that the overall water quality of the Upper Lakes is excellent, but that there are many sources of localized pollution which should be reduced or eliminated if the existing high water quality is to be maintained. The Commission recommended a policy of non-degradation in these lakes where applicable as the long term goal for the preservation of their unique values, in conjunction with an offset policy to permit growth in the basins without adverse effect on water quality. This offset policy, applicable only to substances which are biodegradable, non-toxic and non-cumulative, and based on the application of more effective waste treatment and control technology or alternative production processes, would permit future discharges of such substances only to the extent that the receiving waters can accommodate such discharges without altering existing water quality. By contrast, noting the impending threat posed by toxic and hazardous chemicals (e.g. PCBs, DDT, mercury), the Commission concluded that no discharge of these substances to the environment should be allowed and, hence, recommended strict control over the production and handling of these types of non-degradable, bioaccumulating chemicals. The Commission also recommended that there should be no production or use of materials whose escape into the environment is inevitable because of their nature or use.

The second of the two 1972 Great Lakes References directed the Commission to investigate the question of the pollution of the Great Lakes from various land use activities. The Commission's answers to the following Reference questions, the full text of which appears in Appendix 1, form the basis of this report.

(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 measures would, in its judgment, be most practicable and what would be the probable cost thereof?

The Commission was requested to consider the adequacy of existing programs and control measures relating to nonpoint sources and pollutants and the need for improvements thereto relating to each of the sources potential, and to identify deficiencies in technology and recommended corrective action where necessary.

The earlier 1964 Reference on the pollution of the Lower Great Lakes, and the 1972 Reference on the pollution of the Upper Great Lakes (Huron and Superior) concentrated on the water quality of the lakes, and on solutions which tended to address point sources of pollution. Nonpoint sources were recognized but not analyzed in detail. The Reference on pollution of the Great Lakes from land use shifted the focus to a study of these nonpoint sources, and thereby to the direct impact on Great Lakes water quality of many dispersed actions, through various rural or urban land use activities, rather than the more institutionalized and identifiable point sources of pollution.

II. THE STUDY PROCESS

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The International Reference Group on Pollution of the Great Lakes from Land Use Activities was established in November 1972 to assist the Commission in responding to the Reference. The group, consisting of nine Canadian and nine United States members, was instructed to carry out the necessary studies according to the terms of the April 15, 1972 Reference.

After establishing the Pollution from Land Use Activities Reference Group (PLUARG), the Commission held a series of pre-study public hearings in December 1972 and January 1973. The main purpose of the hearings was to acquaint interested persons and organizations in the Great Lakes Basin with the study plans and to receive suggestions and water quality information which might be of assistance to PLUARG in the conduct of its investigations.

Most of the testimony received by the Commission highlighted local pollution problems of which the Commission and members of PLUARG were already aware. Nevertheless the hearings were beneficial in corroborating problem areas and indicating to some extent the pollution problems that were then of the greatest concern to people living in various parts of the Basin -- urban growth, erosion/ sedimentation, and agricultural runoff.

Detailed plans for binational study were developed in early 1973 and updated in 1976. The following major tasks or activities were conducted during the course of the study:

(A) Task A - An assessment of the current state of the art, including an assessment of problems, management programs and effects of present land use activities, from the best information available, on water quality in the Great Lakes, the legislative and institutional framework, existing and alternative remedial measures, and the probable costs of remedial measures applied to problem areas affecting Great Lakes water quality.

(B) Task B - An inventory of major and specialized land uses and land use practices in the Great Lakes Basin, with emphasis on certain trends to 1980 and to 2020 where appropriate.

(C) Task C - Intensive studies of a small number of representative watersheds, selected and conducted to permit some extrapolation of the data to the entire Great Lakes Basin in order to evaluate the extent, causes and localities of pollution from land drainage.

(D) Task D - An assessment of the degree of impairment to Great Lakes water quality resulting from land-derived source of pollution.

The need for widespread citizen input to the program to aid in identifying public concerns and practicable management strategies led PLUARG to initiate a new approach in public participation. Nine public consultation panels in the United States and eight in Ontario were established in the autumn of 1977 to provide for this purpose. Individual panelists were selected to be as

representative as possible of the public in the Great Lakes Basin. Each panel, after discussing the environmental, social and economic aspects of the study, submitted a report to PLUARG containing its views and recommendations.

In addition, each panel was given the opportunity to provide input into the drafting of the PLUARG final report. The panel reports included broad recommendations for Great Lakes clean-up plans. In general, they recommended that uniform water quality standards, based on recommended IJC objectives, be established and implemented for the Great Lakes. The panels called for broad based environmental educational programs, clarification of public review process, including public funding and class actions in courts of law; streamlining and enforcement of existing legislation; public access to government and private research; a stress on prevention of pollution rather than treatment; and the installation of the conserver society ethic. These recommendations were taken into account in the final PLUARG Report and in the writing of this Report.

III. PUBLIC HEARING ISSUES

III. PUBLIC HEARING ISSUES

The International Reference Group on Pollution from Land Use Activities (PLUARG) completed its assessment of the extent and source of pollution of the Great Lakes from land use activities and submitted its final report to the Commission in July 1978. Public hearings were held in November and December of 1978 at various locations wthin the Great Lakes Basin to obtain public reaction to the PLUARG Report. Shortly before the hearings, information meetings were arranged to familiarize citizens with the results of PLUARG's work.

Hearings were held in Buffalo, New York; Cleveland, Ohio; Chicago, Illinois; Sheboygan, Wisconsin; Duluth, Minnesota; Thunder Bay, Ontario; Toronto, Ontario; Kingston, Ontario; Chatham, Ontario; Lansing, Michigan; and Sault Ste. Marie, Ontario; in November and December of 1978.

A variety of issues were addressed and considerable attention was focused on the following areas: fiscal arrangements; voluntary versus regulatory measures; control strategies; institutional and legislative questions; phosphorus; toxics. A summary of comments directed to these general topics follows. These represent an overview of public concerns expressed at the hearings, some of which contradicted PLUARG findings.

(1) Fiscal Arrangements

It was obvious that there was a strong public desire to see the implementation of programs to clean up pollution. Indeed, few people questioned the need for nonpoint source pollution control efforts. Many people, however, were also seriously concerned about how such programs would be managed and funded. Because PLUARG's recommendations were seen as having major cost implications, many people, particularly those from the farming community, said they were unable to afford the high investment required for remedial measures. Substantial compensation, in the form of subsidies, was seen as being necessary to encourage farmers to participate in programs involving considerable costs.

Some municipal officials representing their jurisdictions stated that the implementation of remedial measures would be a major financial burden and could jeopardize other urban programs. In view of scarce financial resources at the local level management plans for new environmental programs must carefully weigh the associated costs and the availability of funds before such programs are implemented. These witnesses recognized, however, that certain programs are required in areas where pollution impacts are severe and may soon be irreversible.

It was generally recognized that success in pollution control will require a commitment from all levels of government and may require the alteration of existing program priorities. In order to ensure effective implementation and adequate funding, overall coordination and monitoring of all programs should be left in the hands of senior governments. At the same time, local governments should be given adequate finances to implement remedial measures in their respective jurisdictions.

(2) Voluntary versus Regulatory Measures

A preference for voluntary implementation of remedial measures rather than more regulation, was frequently expressed. Regulations should be used only where cooperative participation is not forthcoming or effective (e.g. certain aspects of toxics control). Many farmers, it was noted, are already implementing conservation practices and should be given the opportunity to voluntarily implement other programs.

The contrary view was also frequently expressed, that is, a reliance on voluntary controls would be ineffective, and that specific control measures and their enforcement were necessary to ensure the resolution of nonpoint water pollution problems.

(3) Control Strategies

Two basic options suggested were that:

(a) a selective approach be used to identify and concentrate on only the most critical problems; or
(b) all areas be treated uniformly.

In considering the above options, it was noted by some, that the immediate implementation of new and costly nonpoint programs would be unwise without knowing the results of meeting point source targets. Therefore, an incremental or selective approach would be better. Experimental remedial programs should be tested selectively before embarking on extensive unproven programs.

A counter argument of other individuals, proposed equal treatment for all on the basis that requiring remedial action on the part of one individual but not another was unfair. The "equal treatment for all" approach, by avoiding incentives at a later date for those who choose not to participate initially on a voluntary basis would thus not penalize those who lead in pollution control.

It was often suggested that the elements of any successful strategy should include the identification of all major contributing areas of nonpoint pollutants, long term planning and management, research and public education.

(4) Institutional and Legislative Questions

While there was general agreement that some lead agency or agencies should be given the mandate to develop a coordinated approach involving all jurisdictional levels, there was disagreement over the assignment of this function. Some said that the federal governments must take the lead by setting minimum standards, and also by assuming jurisdiction if the various states on the United States side, and Ontario on the Canadian side fail to act. Although Ontario is only in the early stages of developing plans to cope with nonpoint sources of pollution, it has the necessary legislative authority within which administrative regulatory action can be taken.

Occasionally witnesses called for the IJC to provide overall long term coordination, and to assign duties to existing agencies rather than creating new ones. In opposition to this view was the suggestion that an independent

body be given the task of assuming the responsibility to monitor and coordinate the PLUARG implementation program.

A number of statements by members of the public indicated that there is a lack of confidence in existing institutions and legislation. Because existing pollution control laws are often not implemented, it was stated that there is a need to evaluate all existing legislation and programs. Better planning mechanisms and information are needed to improve the competence of agencies at the local, state and provincial levels. On the other hand, some programs, such as the United States Section 208 program, were noted as having a firm planning approach but were inadequate at the implementation stage. The inability of governments to deal with the large backlog of issues, often seen as a relaxation of enforcement efforts, not only inhibits pollution control but also undermines the morale of citizens seeking stricter enforcement.

Other concerns expressed were that stronger and more specific recommendations than those submitted by PLUARG are needed for legislative and management changes. To be successful, these will need the backing of adequate funding and personnel.

(5) Phosphorus

On several occasions people questioned PLUARG's estimate of phosphorus inputs to the Great Lakes from nonpoint sources, and the method used to derive the phosphorus target loads in the 1978 Water Quality Agreement. More studies to clarify the phosphorus ambiguities were recommended by a number of witnesses. The role of phosphorus from farm fertilizers as a major source of plant nutrients was questioned by some members of the agricultural community on the basis that phosphorus adheres to soil particles and as long as it remains immobile in the soil it is unavailable to aquatic plants. It was argued that the phosphorus that ultimately reaches the lakes would still be fixed to sediment and would not remain in suspension for any significant period of time, and hence would remain relatively unavailable to aquatic plants. PLUARG's estimate of available phosphorus from tributaries was also questioned as being based on insufficient data and inadequate algal bioassay techniques.

Some of the comments on phosphorus were directed to specific jurisdictions. Ohio was identified as an important source of agricultural phosphorus and sediments. It was also urged that Ohio should legislate a reduction in its detergent phosphates to the level that has been adopted by other states. That Canadian detergent phosphate regulations also be tightened to 0.5 percent by weight was viewed by the industry as being unsupportable given that only a small proportion of the total detergent phosphorus contributed to the lakes originates on the Canadian side. The adequacy of Ontario programs for controlling livestock wastes and agricultural runoff was also questioned in some areas.

Some municipal officials commented on the recommendation that there be a further reduction of the phosphorus effluent target level from 1 mg/L to 0.5 mg/L. They suggested that no further reduction of point source phosphorus be contemplated until the effectiveness of existing programs is determined and its practicability further demonstrated. Other witnesses favoured further reductions in effluent levels as soon as possible.

(6) Toxic and Hazardous Substances

With the recent Love Canal incident fresh in the mind of the public, considerable attention at the hearings was given to the toxics problem in the Great Lakes. Love Canal was not viewed as an isolated event, but an event which could occur in other locations if the disposal of toxic wastes was uncontrolled. The existence of many inadequately regulated dumps was given as evidence that the toxics problem demands immediate attention. In the opinion of some, the lakes may now be in a more precarious state than ever before because of contamination by toxics in spite of the introduction of recent pollution control programs.

Some criticism was directed at the PLUARG Report for concentrating too heavily on the phosphorus issue, and for not closely scrutinizing the problem of toxics. It was proposed that this weakness could be remedied with specific IJC recommendations to expand and improve toxic sampling programs and efforts to identify the health effects of toxic residues on humans.

Industrial discharges, inadequate sewage treatment facilities, airborn pollutants (e.g. PCBs) urban stormwater runoff, and new pesticides were variously identified as sources of toxics which enter the lakes and eventually contaminate the lakes and their resources. Solutions recommended to cope with these problems included more and better surveillance efforts, the establishment of methods to control the handling and disposal of all contaminated materials and expanded research efforts ranging from and examination of the contribution of asbestos to Lake Superior through various land uses to a search for the source of heavy metals.

(7) Private Waste Disposal and Landfills

Most problems associated with private waste disposal and landfills were seen as being primarily local in nature requiring local solutions. Many of the local laws and regulations governing landfills, deep well disposal, septic tank control and the operation of sewage treatment plants were seen as being inadequate and in need of upgrading.

Non-sewered waste disposal was seen by several witnesses as a serious problem, since about 20% of the Great Lakes population uses septic tanks and drain field systems. Up to 30% of such installations may be faulty, and thus may be an important source of phosphorus to the lakes. Increasing density of residential development in non-sewered areas, especially in recreational areas, was held to be a major component of this problem.

(8) Heavy Metals

Although referred to on only a few occasions throughout the hearings, lead was seen in terms of being a "pollution time bomb". One witness suggested that there is an urgent need to develop a long term view of the risks of all heavy metals. The distribution of some heavy metals, such as lead, does not follow the expected or predicted distribution based on the level of its use by man and this further complicates the identification and control of their sources.

In response to questions raised at the Public Hearings, PLUARG provided the Commission with supplementary reports in March and June, 1979 which were utilized by the Commission in the preparation of this Report. The reports are available on request from the Commission.

IV. THE COMMISSION'S CONSIDERATIONS AND CONCLUSIONS REGARDING THE CAUSE AND LOCATION OF POLLUTION FROM LAND USE ACTIVITIES

IV. THE COMMISSION'S CONSIDERATIONS AND CONCLUSIONS REGARDING THE CAUSE AND LOCATION OF POLLUTION FROM LAND USE ACTIVITIES

The first Reference question asked by the Governments of the Commission was to determine whether the boundary waters of the Great Lakes System were being polluted by land drainage. The Commission agrees with PLUARG's general findings that the Great Lakes are being polluted from land drainage sources by phosphorus, sediments, a number of industrial organic compounds and pesticides and, potentially, some heavy metals.

The Commission also agrees in general with PLUARG's findings in answer to the second question of the Reference, namely, the extent, causes and localities of pollution from land use activities. The localities generally coincide with the areas of greatest agricultural and urban land use. The quantities of pollutants from these sources vary across the Basin, depending on a number of factors. Some special problems, including landfills, septic systems, forestry and atmospheric pollution were also identified. The major concerns regarding the identified pollutants associated with land drainage sources are highlighted below. The Executive Summary of the PLUARG Report, including its conclusions and recommendations, is contained in Appendix 2. More details are available in PLUARG's Final Report, Environmental Management Strategy for the Great Lakes System, (Appendix III, No. 001) and the supporting Technical Reports listed in Appendix III.

1. Phosphorus

The inflow of phosphorus to the Great Lakes has been a focus of concern for many years. A report by the International Joint Commission in 1970, Pollution of Lakes Erie, Ontario and the International Section of the St. Lawrence River identified severe phosphorus pollution of the Lower Great Lakes. The control of phosphorus was a primary focus of the 1972 Great Lakes Water Quality Agreement, and continues to be an important component of the 1978 Great Lakes Water Quality Agreement. The quantification of actual loads and target loads, the relative contribution from various land uses, and appropriate remedial strategies for controlling phosphorus occupied much of the attention of the PLUARG study.

The basis for this concern is the role of phosphorus as an aquatic plant nutrient, and hence as a critical factor in the process of accelerated eutrophication. Eutrophication is a natural aging process common to all lakes, whereby they become filled naturally with sediments and organic materials which enter from streams draining the surrounding watershed, and from atmospheric fallout as well as from primary production of aquatic plants (algae, macrophytes) occurring within the water body. The natural eutrophication process has a geologic time scale.

Man's activities in a watershed, however, can greatly increase the quantities of phosphorus and other materials entering a water body, and thereby can greatly accelerate the eutrophication process. This situation is

usually designated as "cultural eutrophication", to distinguish it from the natural process. Cultural eutrophication is caused by nutrient inputs, especially phosphorus of sufficient magnitude that the natural assimilation capacity of a waterbody, is exceeded. The excess nutrients produce excessive or nuisance growths of algae and other aquatic plants which interfere with man's use of the water. The process can also produce fundamental changes in the chemical balances of a water body, as well as changes in the biological communities. Desirable species of fish and algae may be replaced by less desirable species able to compete more efficiently in nutrient-rich water bodies. In extreme cases, decay of excessive algae growth can produce oxygen depletion in bottom waters, rendering them devoid of fish life.

The role of phosphorus in this process, is that it is generally the nutrient in the Great Lakes which acts as the constraining or limiting factor on aquatic plant growth. Thus, if phosphorus inputs to the lakes are controlled, so then is the growth and decay of aquatic plants, and hence the extent of eutrophication.

Changes resulting from cultural eutrophication usually produce a deterioration of water quality, which can greatly hinder the use of the water for domestic and industrial water supplies, for irrigation and for recreational purposes, such as swimming and boating. While the socio-economic impact of these effects has not been studied in sufficient detail to quantify its magnitude, there is adequate information from case studies, experience, and scientific knowledge of the extent of eutrophication and its impact, to show this problem deserves the concentration and continued efforts of Governments in further controlling the input of phosphorus to the Great Lakes System, so as to alleviate problems associated with eutrophication. The ultimate extent of control efforts required or feasible is somewhat uncertain, however, pending the evaluation of present and desirable phosphorus target loads and their implications for management strategies. The remainder of this section addresses the current knowledge of present (1976) phosphorus loads, target loads, and specific sources of phosphorus pollution.

It is emphasized that the terms "major" and "minor" as applied in this report to the quantities or effects of pollution from various sources are used in a general qualitative sense only to convey orders of magnitude with respect to whole-lake effects. They should not be construed, in themselves, as a designation of ultimate importance or significance with respect to the need for remedial measures. Other factors are also part of this determination, including remedial costs, implementation practicability, local water quality implications, indirect benefits and equity, as will be discussed in Chapter V.

(A) PHOSPHORUS LOADS TO THE GREAT LAKES

As part of its efforts, PLUARG provided an estimate of the United States and Canadian phosphorus loads to each of the Great Lakes, as well as the International Section of the St. Lawrence River. Because most of PLUARG's detailed studies on tributaries were conducted during the mid 1970's, the estimates of present loads to the lakes is for the year 1976. These estimates are presented in Table 1, by major type of source: the "traditional" point sources (municipal and industrial effluents), and the nonpoint including "land use" sources of phosphorus. The land use sources are conveyed to the lakes by natural runoff to tributaries, ditches,

TABLE 1: SUMMARY OF 1976 PHOSPHORUS LOADS TO THE GREAT LAKES BY MAJOR SOURCES [1]
(Metric tons)

SOURCE	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO	INT'L ST. LAWRENCE R.
UNITED STATES						
Municipal STP's	201	2,498	325	6,573	1,581	63
Industrial	33	279	112	183	51	0
Land use	769	1,891	1,564	6,675	2,169	659
Sub Total[3]	1,003	4,668	2,001	13,431	3,801	722
CANADA						
Municipal STP's	67	-	190	255	1,234	84
Industrial	102	-	0	164	51	42
Land use	1,469	-	880	1,770	1,412	88
Sub Total[3]	1,638	-	1,070	2,189	2,697	214
BOTH COUNTRIES						
Municipal STP's	268	2,498	515	6,828	2,815	147
Industrial	135	279	122	347	102	42
Land use	2,238	1,891	2,442	8,445	3,581	747
Atmospheric[2]	1,566	1,682	1,129	774	488	-
Load from Upstream Lakes[2]	-	-	657	1,070	4,769	4,545
TOTAL[3]	4,207	6,350	4,857	17,474	11,755	5,481

Notes:

1. These estimates do not include internal phosphorus loading from lake bottom sediments. The role of sediments as a source and/or sink for phosphorus and other materials is presented in a following section. Load estimates do not include phosphorus from shoreline erosions which, while substantial in quantity, is primarily in a form that does not contribute to eutrophication.

2. Loads from atmospheric and upstream sources which were not attributed to either specific country.

3. Individual lake loads are not additive to a basin total due to the inclusion of contributions from upstream lakes.

groundwater, storm sewers, or as combined sewer overflows, and are usually associated with various land use activities. A portion of nonpoint phosphorus enters the Great Lakes System via the deposition of this substance from the air.

The sources of phosphorus entering the Great Lakes, and their relative importance vary considerably between the lakes. Phosphorus loads were estimated for point and nonpoint sources, distinguishing between those entering the lakes directly from their shores, and those passing first through tributaries prior to entering the lakes.

In all cases, the contribution of phosphorus from land use sources was substantial. Except for Lake Michigan, this component of total phosphorus load was greater than the load from municipal wastewater treatment plants. The land use sources ranged from about half of the total load to Lakes Superior, Huron and Erie to about one-third of the total load to Lakes Michigan and Ontario in 1976.

The magnitude of the sources of phosphorus must also be examined in view of the land use activities which produced them. Table 2 presents a compilation of the major land uses in the Great Lakes Basin.

Comparison of Tables 1 and 2 shows that the lakes receiving the largest phosphorus loads are generally those with the greatest degree of urban and agricultural development in their basins, relative to their size. This illustrates the concept of the "unit area load" (the quantity of phosphorus or other pollutants, generated per unit area of land). For example, the large heavily-forested areas, such as most of the Lake Superior Basin, contribute less phosphorus to the lakes than smaller areas of urban and agricultural lands. This is because the quantity of phosphorus generated per unit area of forested land is considerably less than that produced per unit area of urban and agricultural land. The basins with the largest areas in agricultural and urban land uses also have the largest inputs from municipal wastewater treatment plants.

In addition to the land-derived nonpoint contributions, phosphorus also enters the lakes through atmospheric deposition, both directly to the lakes and to their drainage basins. The PLUARG study results indicate that atmospheric pollution is relatively significant source of phosphorus in the Upper Great Lakes (Superior, Michigan, Huron), but of less relative importance in the Lower Lakes, due to the very large inputs from other sources in their basins as well as to their smaller drainage areas.

While most of the phosphorus entering a lake is retained within the lake by sedimentation and other processes, some phosphorus from each of the Great Lakes is transferred to the downstream lakes by way of the interconnecting channels. The upstream lake loads are of particular importance to Lake Ontario and the International Section of the St. Lawrence River (41 and 83%, respectively, of their total loads excluding shoreline erosion). The upstream load from Lake Huron constitutes about six percent of the Lake Erie input. Thus, measures taken to control phosphorus upstream could have measurable effects on the quality of these waters. PLUARG data for 1976 (Table 1) indicate that 22% of the Lake Huron load, 27% of the Lake Erie load and 39% of the Lake Ontario load passes downstream.

TABLE 2: MAJOR LAND USES IN THE GREAT LAKES BASIN AND THEIR CONTRIBUTION TO DIFFUSE TRIBUTARY PHOSPHORUS LOADS

	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ERIE	LAKE ONTARIO	TOTAL BASIN
TOTAL LAND AREA (thousand hectares)						
United States	4,400	11,741	4,192	5,559	4,577	30,469
Canada	9,459	0	8,694	2,318	2,950	23,421
Total	13,859	11,741	12,886	7,877	7,527	53,890
URBAN AREA AS % OF TOTAL LAND AREA						
United States	1	3	3	11	4	4
Canada	1	-	1	4	16	2
Total	1	3	2	9	4	3
% of Tributary Diffuse Load	7	12	12	21	19	-
CROPLAND AREA AS % OF TOTAL LAND AREA						
United States	1	12	16	35	9	15
Canada	1	-	6	51	13	9
Total	1	12	9	39	11	12
% of Tributary Diffuse Load	4	64	61	61	55	-
PASTURE AREA AS % OF TOTAL LAND AREA						
United States	2.6	11	9	16	11	11
Canada	1	-	15	29	36	13
Total	1	11	13	20	21	12
% of Tributary Diffuse Load	3	7	7	5	11	-
FOREST AREA AS % OF TOTAL LAND AREA						
United States	85	50	48	18	64	51
Canada	99	-	74	15	43	74
Total	94	50	66	17	56	61
% of Tributary Diffuse Load	74	3	11	1	3	-

(B) PRINCIPAL NONPOINT SOURCES OF PHOSPHORUS

The PLUARG analysis of pollution sources (including phosphorus) was based on a series of approximately thirty individual watershed studies (pilot watersheds) to determine unit area loads for a variety of land use activities and land characteristics. These pilot watershed studies showed that the amount of phosphorus entering the Great Lakes from nonpoint sources on land is a complex function of the physical, chemical and hydrological characteristics of the land, the type and intensity of land use and the land use practices, including materials applied to the land and land management practices. Thus, it was found that unit area loads exhibited a high variation between localities and the different uses of land.

A detailed summary of unit area loads for phosphorus and other selected pollutants from the pilot watershed studies is presented in the Final Report of PLUARG (Table 14) and will not be repeated here. It is instructive, however, to note a range of 0.2 to 9.1 kg/ha/yr (0.11 - 10.2 lb/acre/yr) for phosphorus contributions from rural (agricultural land and a range of 0.1 - 4.1 kg/ha/yr (0.11 - 4.6 lb/acre/yr) for urban land (except for urban areas under construction, which have a significantly higher unit area load). Forested areas in the pilot watershed studies have a markedly lower unit area load than urban or agricultural lands, ranging from 0.02 to 0.67 kg/ha/yr (0.02 - 0.75 lb/acre/yr). The urban and agricultural unit area loads thus overlap considerably. It appears that, overall for areas of man-associated land uses, the variation of phosphorus unit area loads can be greater within major land use types, than between major land uses, due primarily to differing land characteristics and land management practices.

Cropland is the major contributor of nonpoint phosphorus loads in all the lakes, except for Lake Superior, where it is an insignificant component of land use. The highest phosphorus unit area loads occur in the Ohio and southwestern Ontario portions of the western Lake Erie Basin and the southern portion of Green Bay in Lake Michigan. Major areas of moderately high unit area loads include southeastern Wisconsin in the Lake Michigan Basin, the Michigan and Ontario portions of the southern Lake Huron Basin, both shores of central Lake Erie, the Niagara area of Lake Ontario, and the eastern end of Lake Ontario. Although PLUARG also notes other factors of importance in affecting phosphorus inputs from croplands, these areas of highest unit area loads are generally characterized by high density row crops and fine-grained clay soils.

PLUARG found that phosphorus unit area loads tended to increase in proportion to the percentage of the land in row crops and the fineness of the soil. Runoff of water is greatest in fine-grained, low permeability soils. This runoff carries with it sediment and phosphorus, as well as other pollutants, and it can eventually reach surface waters draining to the lakes. By contrast, coarse, sandy soils, being more permeable allow greater infiltration of water and its associated pollutant content. Such coarse soils are also less susceptible to soil erosion.

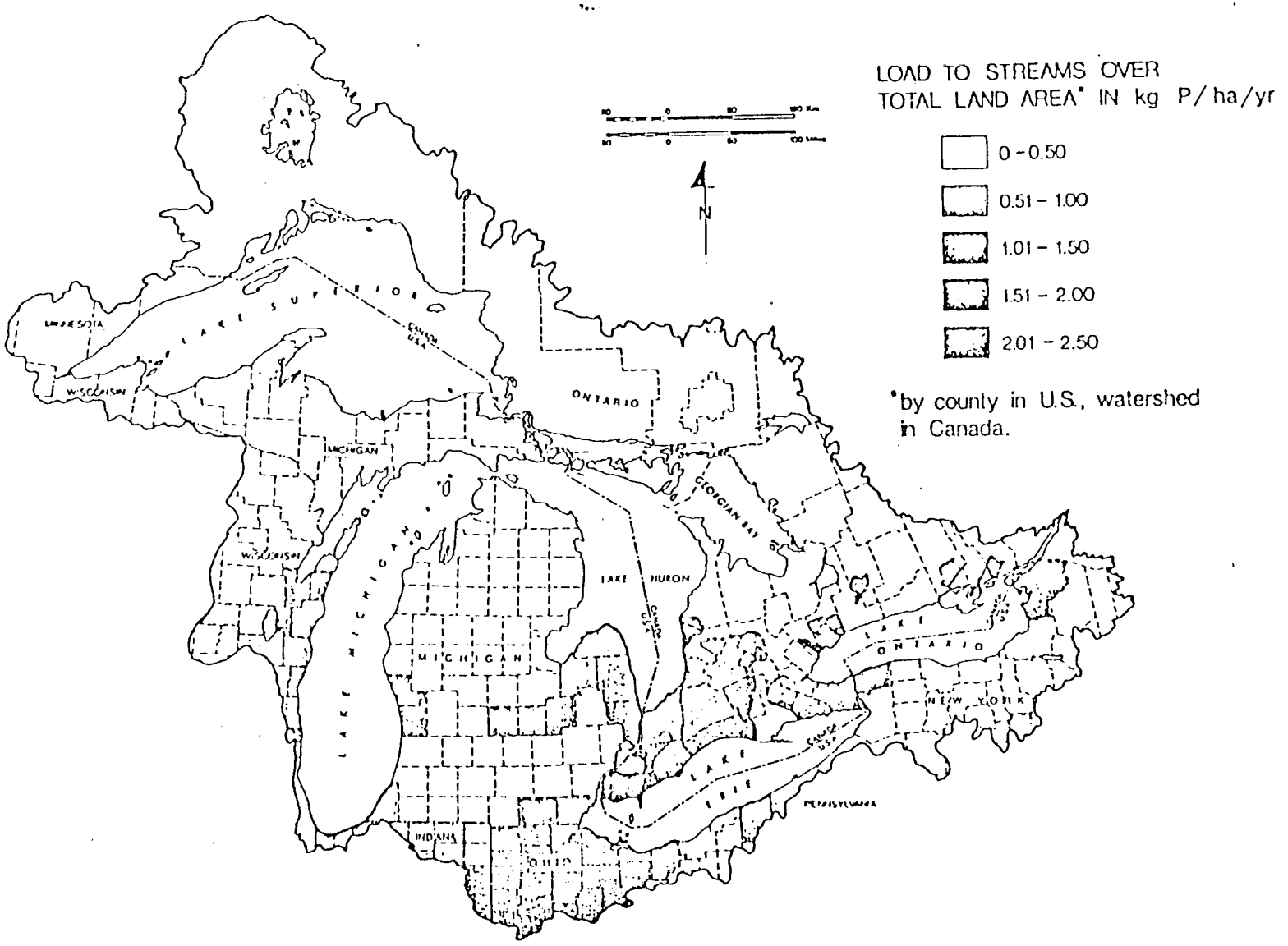

FIGURE 1. LOCATIONS OF ESTIMATED AGRICULTURAL CONTRIBUTIONS OF TOTAL PHOSPHORUS TO STREAM LOADINGS (by extrapolation, 1976 data).

High natural levels of phosphorus in calcareous soils, steep slopes and poor natural drainage contribute to high phosphorus unit area loads from agricultural lands. Farm management practices can be another important factor. Minimization of vegetative buffer strips along stream banks, as well as any farming practices which expose soil to various forms of erosion, such as intensive cultivation especially during the Fall, are significant in increasing phosphorus loads from croplands. Thus, continuous and widely-spaced row crops usually lead to a high degree of soil erosion and associated phosphorus inputs to Great Lakes tributaries.

The Commission concludes that intensive row cropping on fine-grained soils in areas in which they are prevalent, and with insufficient regard for proper soil conservation and drainage techniques, are a major cause of high nonpoint phosphorus loads from croplands into the Great Lakes. It is also noted that the excessive application of commercial fertilizers relative to soil and crop needs, and the failure to incorporate fertilizers into the soil, increase nutrient runoff, although this is not a cause of lakewide nonpoint phosphorus pollution at the present time.

Livestock Operations also produce elevated phosphorus loads and, in fact, contribute about 20 percent of the total phosphorus load in several agricultural watersheds. The runoff of phosphorus from feedlots, barnyards and manure storage areas, in particular those located near stream banks, on relatively impervious surfaces (due to compaction, soil structure and in some cases pavement), and those exposed to the elements, can result in phosphorus pollution. Cattle operations contribute the largest quantities of livestock-derived phosphorus, although pig and poultry operations can also contribute large quantities. Other associated detrimental practices include the spreading of manure on frozen ground during the winter, and allowing cattle access to streams and stream banks, resulting both in direct deposition of manure and in destabilizing of stream banks, which leads to increased erosion of soils that may have high natural contents of phosphorus.

The area of highest phosphorus loading to streams from livestock operations are the counties between the Bruce Peninsula in Ontario and Lake Erie, flowing into central Lake Erie, as well as Georgian Bay and southern Lake Huron (Figure 2). Moderately high unit area loads from this source principally occur over much of southeastern Wisconsin and the northeastern corner of Indiana in the Lake Michigan Basin, and the portion of eastern Ontario lying between Lake Simcoe and central Lake Ontario.

The Commission concluded that cattle operations can contribute significantly to high phosphorus loads in some tributary streams, and add further phosphorus contributions to portions of the Great Lakes also impacted by other agricultural activities, as noted earlier above. These high unit area loads are due to the concentration of livestock operations in the areas indicated above, and in some degree to inadequate design, site location and manure handling practices.

Urban Areas are a third source of high phosphorus unit area loads. About 20 percent of the nonpoint tributary loads for Lakes Erie and Ontario are from urban areas. The urban proportion is about 12 percent in Lakes Michigan and Huron, and about 7 percent in Lake Superior, reflecting the smaller fractions of urbanized land in these latter three basins.

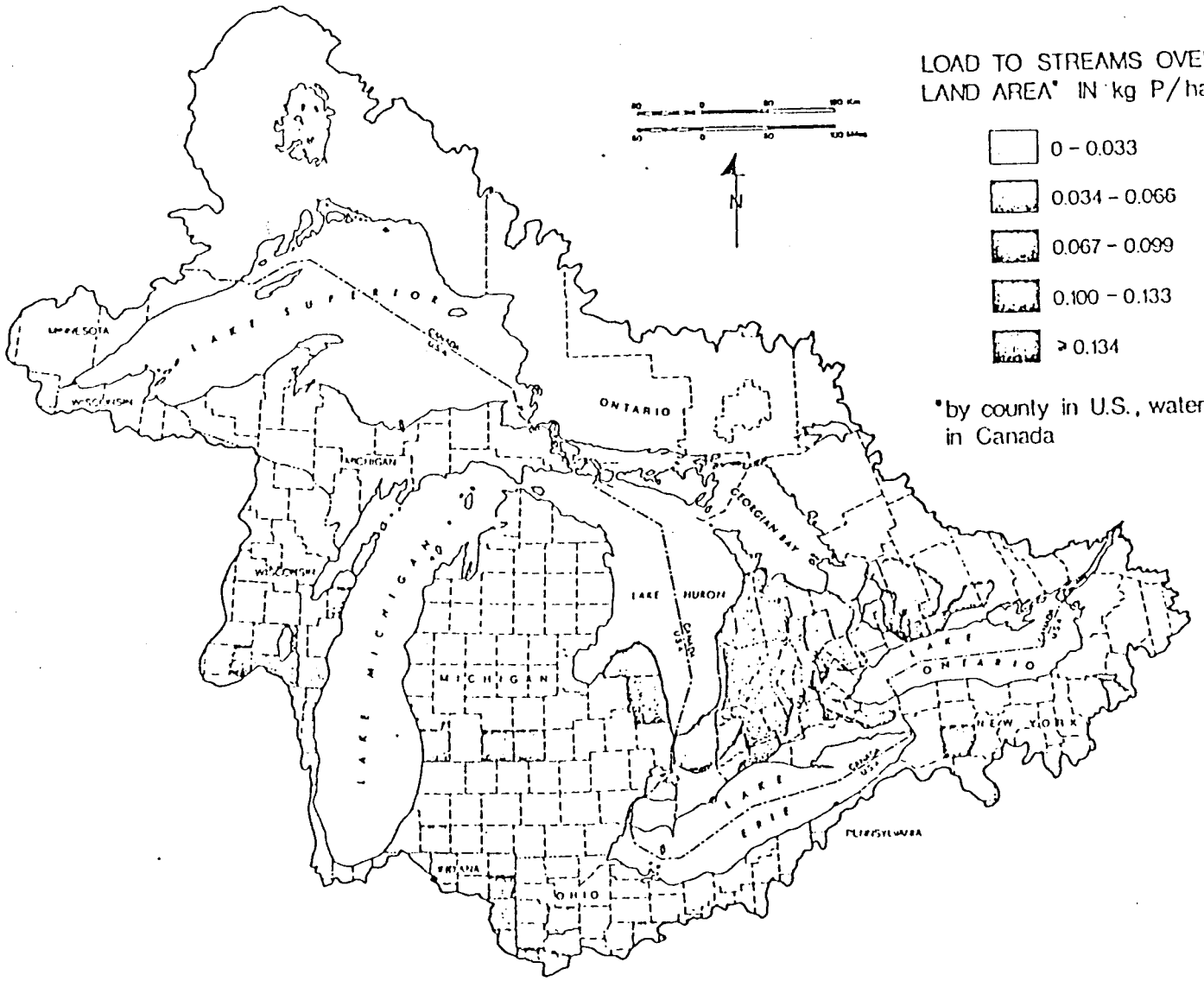

FIGURE 2: LOCATIONS OF LIVESTOCK ESTIMATED PHOSPHORUS LOADINGS TO STREAMS (by extrapolation, 1976 data).

Within urban areas, phosphorus loads are related to the intensity and type of urban land. At one extreme, parks and undeveloped lands contribute very little phosphorus, while at the other extreme, newly-developing urban areas, particularly those under active construction, produce extremely high phosphorus unit area loads, up to a thousand times that of established low-medium density, residential areas.

The fundamental cause of high unit area loads in urban areas is the large, impervious nature of the land surface in these areas, along with the high quantities of loose particulate matter and a man-made drainage system which allows for the rapid runoff of storm water containing phosphorus-laden soil particles. Replacement of natural land surfaces, which allow infiltration of storm water into the soil and settling of particulate material, with large continuous areas of impervious surfaces (streets, roofs, sidewalks) which allow for rapid and large-scale drainage, is a major factor in high phosphorus loads from urban areas.

As would be expected, the highest urban unit loads are from areas of intense urban density, including the belt between Sheboygan, Wisconsin, and South Bend, Indiana, in Lake Michigan, the Detroit and Cleveland areas and the southeast shoreline of Lake Erie, the Niagara Peninsula and Toronto-Cobourg areas of Lake Ontario (Figure 3). Moderately high unit area loads originate in virtually all of southern Michigan, the remaining United States Lake Erie watershed, the western half of the Lake Ontario Basin and the Rochester-Syracuse region of New York State.

A special problem in urban areas concerns combined sewer overflows, which exist particularly in older urban centers which generally do not have separate storm and sanitary sewers. In such situations, storm events can cause the overflow of combined sewers, which then bypass waste treatment plants and discharge directly into the lakes and tributary streams. In some cases, these overflows occur frequently and though variable in impact, can increase the annual phosphorus load from large urban areas by as much as ten percent.

Another special concern in urban centers are areas under construction. The accompanying massive disruption of vegetative cover and soil results in a high degree of erosion. If the loose soils are not stabilized or allowed to settle prior to reaching water courses, large quantities of sediment and its associated pollutants including phosphorus can enter the Great Lakes System. The encroachment of urban development on flood plains, areas of high natural erosion and steep slopes are especially sensitive areas.

The Commission concluded that urban areas, particularly those that are large and densely developed, contribute substantial nonpoint phosphorus loads to the Great Lakes, and that these loadings can to some degree be ameliorated by more environmentally-sound urban planning, design and maintenance procedures.

(C) OTHER NONPOINT SOURCES OF PHOSPHORUS

Private, non-sewered waste disposal systems (usually septic tanks with a soil absorption field) can contribute to phosphorus loads if they are poorly designed, located in unsuitable soils (e.g., impermeable clayey

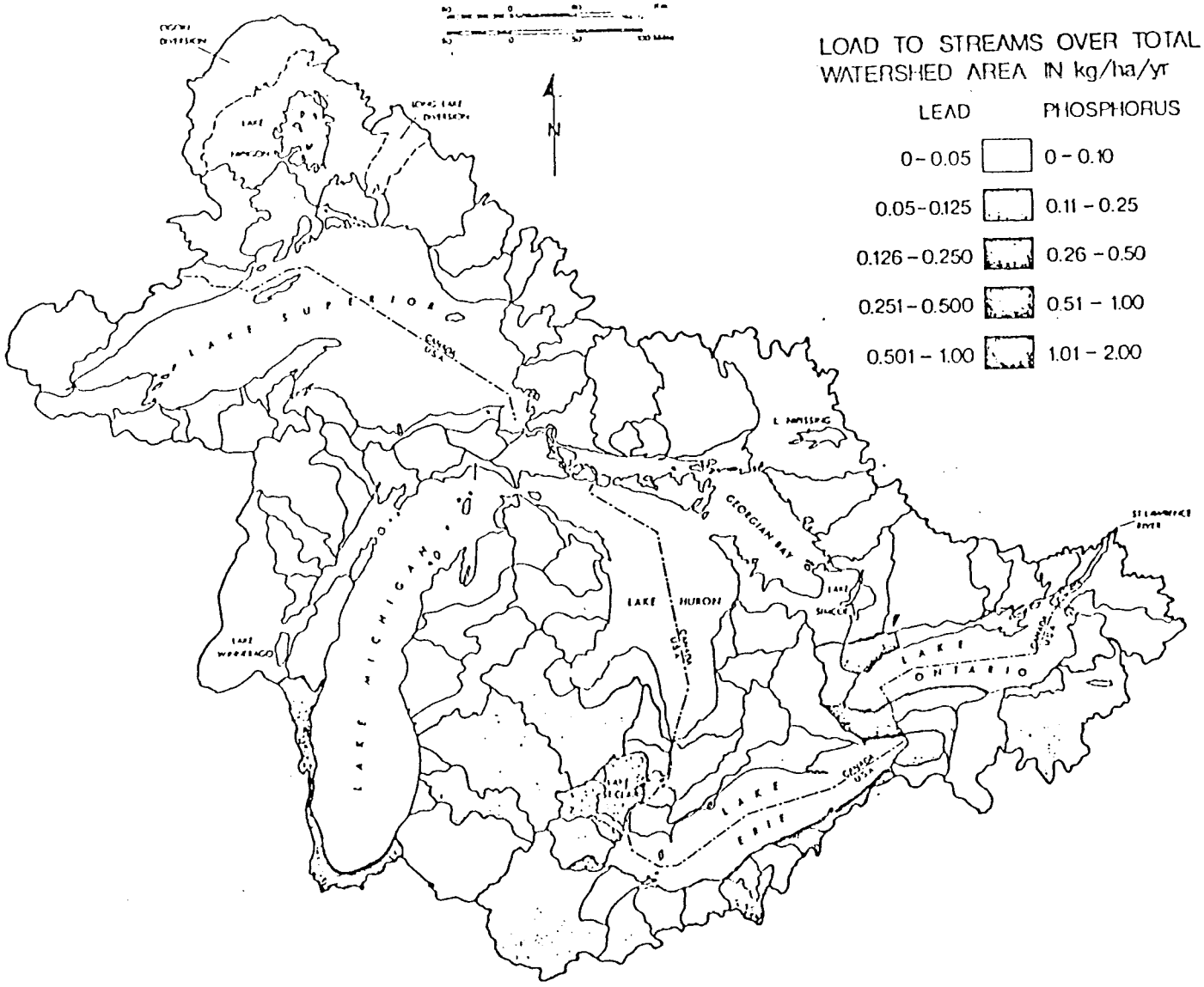

FIGURE 3. LOCATIONS OF ESTIMATED URBAN CONTRIBUTIONS OF TOTAL PHOSPHORUS AND LEAD TO STREAM LOADINGS (by extrapolation, 1976 data).

soils or soils with a low sorption capacity for phosphorus) and/or not adequately maintained. Improperly designed or faulty septic systems may produce localized pollution by phosphorus in areas where urban and rural populations are concentrated and where they use private waste disposal systems, particularly in areas with soils not suited for such purposes. Generally, regulation and inspection of septic tank installations fall within the direct jurisdiction of local health authorities. However, such regulation has been in the past primarily concerned with preventing bacterial rather than nutrient pollution. Further, monitoring programs are often inadequate to identify system failures, if at all, until the systems become totally inoperable. As a result, septic systems, the method of sewage disposal for at least 20 percent of the population in the basin, have led to instances of localized water quality problems (e.g., the cottage country shoreline of Georgian Bay). Private waste disposal systems do not appear, however, to be a lakewide source of phosphorus pollution at the present time.

Forested lands are not a significant source of nonpoint tributary phosphorus loads, except to Lake Superior. While three quarters of Lake Superior's nonpoint phosphorus load comes from forests, unit area loads for forests are very small. Certain large-scale forestry practices such as clear-cutting and scarification can lead to elevated phosphorus loads in individual streams, but these are generally short term in duration, due to a usually rapid revegetation.

Atmospheric inputs (including rain and dry fallout) were found to contribute a substantial portion of the phosphorus load to several of the lakes. In the strictest sense, the atmosphere does not constitute a land drainage source; rather it is a vehicle for transportation for pollutants generated on land to the lakes. The actual source of the pollutant may be from inside or outside the Great Lakes Basin. The present state of knowledge does not yet allow for an accurate determination of the locations or quantities of pollutants discharged to the atmosphere. PLUARG found that a larger proportion of the total phosphorus load to the Upper Lakes was contributed by the atmosphere than the Lower Lakes (e.g., 37 percent of the total load for Lake Superior versus only four percent in Lake Erie). This was because there are many more phosphorus sources in the Lower Lakes than in the Upper Lakes, thereby decreasing the relative magnitude of the atmospheric inputs in the Lower Lakes. It is noted that the estimation of atmospheric inputs of pollutants to the Great Lakes is still in an early stage of development, and the task of relating atmospheric loads to specific sources on the land is presently very difficult, if not impossible. The atmosphere as a source of other pollutants is discussed in sections of this chapter.

Specialized land uses, including landfills, transportation corridors, mineral extraction areas and recreational land, while they may have localized impacts, have minimal impacts on the phosphorus loads to the Lakes.

The Commission concludes that land use other than agriculture and urban do not contribute major quantities of phosphorus to the Great Lakes. Localized impacts, however, may result from inadequate design, siting, and maintenance of private sewage disposal systems and from large-scale forestry operations.

(D) PHOSPHORUS TARGET LOADS

The determination of whether phosphorus loads should be a public policy concern is a matter not only of their quantity and source, but also of their impact on the environment and other uses of the lakes. As noted earlier, the inflow of phosphorus is to some degree a natural occurrence, and further, the Great Lakes have an assimilative capacity even above natural phosphorus levels within which phosphorus inputs may not cause measurable water quality or use deterioration. In this regard, the Commission and the Parties to the Great Lakes Water Quality Agreements of 1972 and 1978 have distinguished between the improvement of existing degraded waters and the principle of non-degradation of high quality waters.

In either case, the procedure that has been used to establish acceptable phosphorus loads and hence the degree to which current loads are considered to be a harmful pollutant, was to establish target loads. The difference between current and target loads represents the quantities by which phosphorus should be reduced by remedial measures, in order to achieve acceptable water quality conditions.

As part of its study, PLUARG defined target loads for the various lakes and sub-basins thereof, generally based on relevant definitions of acceptable water quality for each basin, on a whole-lake basis. These target loads had the same basis as those targets developed by Task Group III. Task Group III was a bilateral technical working group established jointly by the U.S. and Canadian Governments to develop phosphorus loading objectives (target loads) for each of the Great Lakes as part of the required fifth year review and renegotiation of the 1972 Great Lakes Water Quality Agreement. The tentative target loads for the Great Lakes contained in the 1978 Agreement are identical to those recommended by Task Group III.

The interference with water uses by man was the general guiding criterion used by Task Group III (TG) to establish the target loads, and this criterion was related primarily to limnological considerations in the Great Lakes. Because of the prominence of the TG effort in development of PLUARG's target loads, a review of the TG exercise is presented below.

The basic approach used by TG to establish its target loads was to define desired water quality objectives in the lakes and then to determine what phosphorus load would produce these water quality conditions. Desirable water quality was based on achieving specific total phosphorus concentrations in the lakes except for Lake Erie and Saginaw Bay. The Lake Erie target load was based on elimination of the anoxic area (the area without oxygen in bottom waters) in the lake's central basin; hence dissolved oxygen was the water quality parameter focussed on in this water body. The Saginaw Bay target load was based primarily on reduction of taste and odor problems and secondarily on reversal of inner bay degradation. These latter two cases are discussed further below.

The total phosphorus concentration objectives used by the TG were developed by the Science Advisory Board's Scientific Basis for Water Quality Criteria (SBWQC). These objectives are applicable for the early spring, the time of the year that nutrient concentrations in the lakes are

usually at their peak. The objectives were developed as lakewide or sub-basin average concentrations. Limnologists have generally accepted as "rule-of-thumb" values, that total phosphorus concentrations below 10 µg/L signify oligotrophic water bodies, while concentrations above 20 µg/L are indicative of eutrophic waters. The intermediate concentrations between 10 to 20 µg/L represent mesotrophic waters (waters in a transition state between oligotrophic and eutrophic).

With these concentration objectives as guides, the goals for the target loads in the 1978 Agreement are presented below:

- Restoration of year-round aerobic conditions in the bottom waters of the Central Basin of Lake Erie;
- Substantial reduction in the present levels of algal biomass to a level below that of a nuisance condition in Lake Erie;
- 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;
- Maintenance of the oligotrophic state and relative algal biomass of Lakes Superior and Huron;
- Substantial elimination of algal nuisance growths in Lake Michigan to restore it to an oligotrophic state; and
- The elimination of algal nuisance in bays and in other areas wherever they occur.

The Task Group concluded that present water quality in Lakes Superior, Michigan and Huron (except for Saginaw Bay) was adequate and acceptable. Therefore, TG indicated that reduction of phosphorus in municipal wastewater treatment plant effluents to a 1 mg/L limitation in plants discharging in excess of one million gallons per day was sufficient to maintain the present acceptable conditions in these lakes. The 1978 Agreement target loads for these lakes were developed on this basis. These loads corresponded also to the total phosphorus concentration objectives for these lakes established by SBWQC.

The Task Group used mathematical models in Lakes Erie and Ontario, and in Saginaw Bay, to determine the phosphorus loads corresponding to either the total phosphorus or dissolved oxygen goals. These loads were thus the target loads. At least three models were used for each basin or sub-basin. The basic approach used by TG was to calibrate its models to "existing conditions in each lake" and then rerun the models in order to determine the necessary reduced phosphorus loads to meet the total phosphorus or dissolved oxygen goals. The overall criteria used for those water bodies were:

Saginaw Bay - The primary criterion used was elimination of taste and odor problems at the Whitestone Point Water Filtration Plant (which processes about 85 percent of the water taken from Saginaw Bay for drinking purposes). SBWQC recommended 15 µg/L as an objective for Saginaw Bay, which corresponds to a target load of about 440 metric

tons/yr according to the models used. This load would place Saginaw Bay in a mesotrophic state. The models indicated that 210 metric tons/yr would eliminate taste and odor problems completely, but that the large diffuse load reduction necessary to achieve this load was impractical.

Thus, on the basis of reduction of taste and odor problems and reversal of some of the inner bay ecosystem degradation, TG recommended a target load of 440 metric tons/yr for Saginaw Bay.

Lake Ontario - The primary criterion was degradation of the lake ecosystem, using the total phosphorus concentration as the principal indicator. The average of the three models used for this lake suggested that a total phosphorus concentration of 10 µg/L (recommended also by SBWQC) corresponded to a phosphorus load of about 7,000 metric tons/yr. This would place Lake Ontario at the oligotrophic/mesotrophic boundary condition. Thus, TG recommended a target load of 7,000 metric tons/yr for Lake Ontario.

Lake Erie - Although total phosphorus and chlorophyll a concentrations were also examined, the primary criterion was the dissolved oxygen concentration in Lake Erie's central basin. Model results suggested a 90 percent reduction of the anoxic area and elimination of "any substantial amount" of phosphorus by regeneration from lake bottom sediments corresponded to a phosphorus load of 11,000 metric tons/yr. Complete elimination of the anoxic area, and assurance of an average of at least 4 mg O_2/L for fish in the hypolimnion, would require a phosphorus load of no more than 9,500 metric tons/yr. However, this latter target load was deemed to be impractical by TG, in view of the large diffuse source reductions necessary to achieve it. Thus, TG recommended a target load of 11,000 metric tons/yr for Lake Erie.

In establishing its target loads, PLUARG used the same philosophy as that used by Task Group III. The target loads for the Upper Lakes (i.e. Superior, Michigan and Huron) were based on achievement of a 1 mg/L effluent limitation for phosphorus in all municipal wastewater treatment plants discharging in excess of one million gallons per day. Differences in the target loads of the 1978 Water Quality Agreement (i.e. the Task Group III loads) and those of PLUARG result as indicated earlier mainly because PLUARG had some different estimates for the atmospheric and nonpoint sources for these lakes. The basis for the target loads is identical, although some specific data for these lakes differ between TG and PLUARG.

For Lakes Erie and Ontario, and Saginaw Bay, PLUARG accepted without change both the rationale and the target loads developed by Task Group III. PLUARG felt it could not improve on the modelling approach used by TG to establish the target loads for these water bodies. Hence, the target loads for these water bodies are the same as those developed by TG, and which appear in Annex 3 of the 1978 Agreement.

Based on this approach, the PLUARG target loads for the Great Lakes are presented in Table 3.

TABLE 3: PRESENT (1976) AND TARGET LOADS AND NECESSARY REDUCTIONS TO MEET TARGET LOADS (PLUARG)[1]
(Metric tons)

LAKE	PRESENT (1976) LOAD	TARGET LOAD	NECESSARY REDUCTION IN PRESENT LOAD
Superior	4,207	4,000	207
Michigan	6,350	4,900	1,450
Huron	4,857	4,400	457
Erie	17,474	11,000	6,474
Ontario	11,755	7,000	4,755

Note:

1. All loads exclude shoreline erosion.

(E) VALIDITY OF PHOSPHORUS LOAD AND TARGET LOAD FINDINGS

PLUARG recognized that it was presenting 1976 actual and target load estimates that differed in several instances from those developed by Task Group III. PLUARG phosphorus loads also differed from those developed by the Great Lakes Water Quality Board. Table 4 summarizes the loading estimate differences between these groups.

Because of these differences, and subsequent to receiving the Final Report of PLUARG, the Commission was advised by its Great Lakes Water Quality Board that, despite its overall concurrence with the PLUARG findings, it had reservations concerning the accuracy and validity of some of the PLUARG phosphorus load estimates and target loads. Its observations centered on the implications for the nature and magnitude of the remedial programs necessary to achieve target loads. As noted above, the necessary degree of phosphorus reduction to reach the target loads depends on the difference between the present loads and the target loads. Thus, the accuracy of both of these numbers is of importance in determining by how much the loads need to be reduced.

In response to the concerns of the Water Quality Board, PLUARG reviewed the various loading estimates of all three groups. It found that differences in the 1976 loading estimates were generally explainable on the basis of different assumptions or data with respect to constituent source estimates, or to omissions of specific point source contributions by one or more of the groups. Lakes Superior and Michigan load estimates were similar, except for the PLUARG higher atmospheric estimate and lower tributary load estimate, respectively. The original PLUARG values were still believed to be the more accurate estimates in these two cases. The lower Task Group III estimate for Lake Huron was due to a lower tributary

load estimate. The greatest differences were for Lake Erie, with that in the PLUARG Report being midway between the other two estimates. In its review, PLUARG generally accepted the Task Group III estimate as being more accurate except for the Canadian tributary component. The lower PLUARG estimate for Lake Ontario was primarily due to the lower, and believed to be more accurate, estimate of the upstream lake load from Lake Erie to Lake Ontario.

TABLE 4: SUMMARY OF 1976 AND TARGET PHOSPHORUS LOADS ESTIMATED BY PLUARG, TASK GROUP III AND THE GREAT LAKES WATER QUALITY BOARD (Metric tons)

LAKE	1976 LOADS			PROPOSED TARGET LOADS	
	PLUARG	TASK GROUP III	WATER QUALITY BOARD	PLUARG	TASK GROUP III[1]
Superior	4,207	3,570	3,550	4,000	3,400
Michigan	6,350	6,671	6,642	4,900	5,600
Huron	4,857	4,293	4,798	4,400	4,360
Erie	17,474	19,677	15,416	11,000	11,000
Ontario	11,755	12,799	12,695	7,000	7,000

Note:

1. These target loads were those incorporated into the 1978 Great Lakes Water Quality Agreement, but are subject to confirmation or revision by the Parties within 18 months of the November 22, 1978 signing of the Agreement.

In terms of the target loads, it is noted that the phosphorus control strategy for the Upper Lakes except Saginaw Bay remained unchanged from the requirements of the 1972 Great Lakes Water Quality Agreement; that is, 1 mg/L effluent limitation for phosphorus in municipal wastewater treatment plants discharging one million gallons per day or more. Thus, while the actual load estimates may be different between PLUARG and Task Group III, these differences are of no actual consequence in terms of necessary phosphorus management strategies for these lakes.

In contrast, the development of management strategies for the Lower Lakes and Saginaw Bay require a review of target loads, despite the agreement on these values by PLUARG and Task Group III. This is because the proposed target loads were derived with the use of several mathematical models simulating lake responses to phosphorus inputs. Thus, the appropriateness of the target loads is dependent on the validity of these models and the basic data used.

The Commission, having noted these differences in loading and target load estimates and acting upon the advice and information of PLUARG and the Great Lakes Water Quality Board, concluded in 1978 that sufficient uncertainty still existed, despite PLUARG's valued reassessment, to require further study and technical advice before the Commission could be

in a position to advise the Governments with confidence on the phosphorus loads and targets and consequently the required remedial programs. These concerns and others were therefore referred subsequently to a joint Task Force of the Water Quality Board and the Great Lakes Science Advisory Board for further investigation. This joint Task Force on Phosphorus Management Strategies is scheduled to present a report addressing these topics and others to the Commission in 1980, after which the Boards may forward any additional commentary that they deem appropriate. At the further request of the Commission, stemming from the need fo early advice to the United States and Canadian Governments, who are in the process of considering future phosphorus load allocations and compliance schedules under Annex 3 of the 1978 Great Lakes Water Quality Agreement, the Task Force provided an interim report in December 1979 on the adequacy of the actual and targe load estimates, as well as the significance of phosphorus availability in developing phosphorus management strategies.

The interim findings of the Task Force and the Commission's conclusions resulting therefrom follow. The Commission wishes to stress, however, that these Task Force findings are tentative and subject to reconsideration and possible revision once the Task Force study is completed. In any event, it should be noted that both data acquisition and analytical capability are dynamic processes that are expected to improve over time, and that any conclusions, either now or in the future, must be tempered by the realization that they are subject to change as the quality and quantity of data and their analysis improve.

The Task Force reviewed the various estimates of phosphorus loadings and, in essence, concluded that the PLUARG estimates with minor revisions (except for Lake Erie) were the "best estimates" of 1976 loads. The estimated loading for Lake Erie is higher because, for the Canadian section of that basin, the average of the PLUARG and larger Task Group III estimates was deemed to be a more reasonable estimate than the former alone. The minor adjustments to the PLUARG loading estimates for other lakes are due to clarification of certain direct municipal and industrial discharge data. The Task Force's "best estimates" are provided in Table 5.

The estimates in Table 5 are believed by the Task Force to be within 10 to 20% of the actual load for the sources of total phosphorus included in the estimates, acknowledging the lack of a rigorous scientific basis for this estimate of uncertainty, due in part to the inclusion of estimated rather than measured loads from sources where actual data were not available.

The Commission concludes that the phosphorus load estimates in Table 5, despite some inadequacies noted below, represent the "state of the art", and hence should be used as a basis for developing phosphorus control policies.

In the Task Force's evaluation of the ability of the models to predict lake responses to phosphorus inputs, it was concluded that the expected lake effects, for the Lower Lakes and Saginaw Bay, would be within 10 to 30 percent of those predicted by the models. This shows, in the opinion of the Task Force, that the models are sufficiently accurate to be used in formulating and assessing alternative phosphorus management strategies. The Task Force has not yet been able to conclude what

specific target loads would assure achieving the stated water quality objectives for the lake bodies in question, since these are dependent not only on the accuracy of the models themselves but also on other factors including the quality of data, biological availability of phosphorus from various sources, and variation in natural conditions. This matter is being addressed further by the Task Force in the preparation of its final report.

TABLE 5: "BEST" ESTIMATE OF 1976 PHOSPHORUS LOAD
(Metric tons)

LAKE	DIRECT MUNICIPAL	DIRECT INDUSTRIAL	TRIB-UTARY TOTAL[1,2]	DIRECT URBAN RUNOFF	ATMO-SPHERE[3]	UP-STREAM LOAD	TOTAL	SHORE-LINE EROSION
Superior	72	103	2,455	16	1,566	-	4,212	3,800
Michigan	1,041	38	3,595	-	1,682	-	6,357	3,700
Huron	126	38	2,901	16	1,129	657	4,867	794
Erie	6,292	275	9,950	44	774	1,080	18,425	10,526
Ontario	2,093	82	4,047	324	488	4,769	11,803	1,280

Notes:

1. Includes land use, atmospheric and point sources contributions entering the lakes through tributaries. It excludes direct urban runoff to the lakes listed separately.

2. Indirect point source contributions (metric tons per year) as estimated by PLUARG are: Lake Superior - 233; Lake Michigan - 1,705; Lake Huron - 473; Lake Erie - 1,242; Lake Ontario - 790. The difference between these figures and the tributary total provides a conservative estimate of land use contributions to tributary loads.

3. Atmospheric inputs directly onto lake surface.

The Commission concludes that, pending the final report of its Task Force on Phosphorus Management Strategies, the target loads outlined in the 1978 Great Lakes Water Quality Agreement are valid goals on which to formulate phosphorus reduction programs. This conclusion for Lakes Superior, Michigan, Ontario and Huron (except Saginaw Bay) is founded on a review of the target loads that should permit the achievement of acceptable water quality conditions in these Lakes.

The proposed target load for Lake Erie (11,000 metric tons/yr) represents a substantial reduction from its current phosphorus input. While noting that present limnological knowledge concerning oxygen depletion in Lake Erie, especially that relating to long term sediment responses, is still incomplete, the Commission concludes that the Lake Erie target load represents a substantial step toward achieving the goal stated in the 1978 Great Lakes Water Quality Agreement of restoration of year-round aerobic conditions in the bottom waters at the central basin.

The Commission also notes, however, that Task Group III reported the 11,000 metric ton/yr target load would achieve a reduction of only about 90 percent of the anoxic area in the central basin of the lake, in an average water year. According to Task Group III, complete elimination of the anoxic area, and assurance of an optimal oxygen concentration of 4 mg/l for fish in the hypolimnion, would require a phosphorus load of no more than 9,500 metric tons/yr in an average water year. These distinctions have not been made clear in the wording of the Lake Erie oxygen objective and the associated tentative target load presented in Annex 3 of the 1978 Agreement. Further, more recent research and modeling efforts, while still undergoing review and refinement, suggest that a complete and consistent elimination of the anoxic area under all conditions could require as little as 8,000 metric tons/yr, depending on the specific model used in the analysis. Based on these observations, it appears to the Commission that achieving the optimal limnological conditions for fish in the hypolimnion in Lake Erie would require a phosphorus input substantially lower than the 11,000 metric ton/yr target load presented in Annex 3 of the 1978 Agreement.

Task Group III defined taste and odor problems in drinking water at the major water filtration plant on Saginaw Bay as the primary criterion for establishing phosphorus target loads. This definition was also accepted by PLUARG. A reduction of taste and odor problems would be achieved with a phosphorus reduction from its present level to the proposed target load of 440 metric tons/yr. To eliminate virtually all taste and odor problems, however, a phosphorus load of no more than 210 metric tons/yr is called for, according to the best available estimate. It is not clear what measure of "nuisance" was intended by the Parties in establishing "elimination of algal nuisance in bays" as a goal for phosphorus control within the 1978 Great Lakes Water Quality Agreement. If other measures or definitions of nuisance conditions were applied to Saginaw Bay, then indicated target loads might be different.

(F) BIOLOGICAL AVAILABILITY OF PHOSPHORUS

The control of phosphorus in the Great Lakes Basin has to-date been based on considerations of total phosphorus. While this approach may have been adequate while phosphorus control strategies were directed primarily at the relatively reasonably easily-removable fraction of phosphorus from municipal wastewater treatment plants and the regulation of phosphorus content of detergents, the situation will be much more complex in the future, when the control of phosphorus in runoff from land use activities of various types by various means, and a range of alternative point source technologies must be taken into account as possible alternatives versus further control of the phosphorus content of effluents in existing or planned municipal treatment plants.

The key issue is the biological availability of phosphorus in different forms and from different sources; that is, the fraction of the total phosphorus load in a form that is readily available or could become available for uptake by aquatic plant life.

The biological availability of phosphorus relates to the ability of algae and other aquatic plants to readily use the phosphorus. Biologically available phosphorus is in a chemical form which can be easily used by algae for growth and reproduction. By contrast, unavailable phosphorus is the phosphorus which because of its form, cannot be readily used by the algae. This availability factor varies considerably between the various forms of phosphorus.

The proportion of algal-available phosphorus associated with particulate matter in tributaries is of particular interest because such phosphorus is usually associated with sediment particles reaching rivers and streams from land runoff, and hence has implications also for sediment control. PLUARG studies showed that the proportion of biologically available phosphorus varied between point and diffuse sources and between lake basins, as well as from stream to stream and from season to season. Further, some initially unavailable phosphorus may become slowly "available" over time, or the reverse may occur. Overall, it appears that a sizeable portion of the phosphorus from tributaries is not in the available form. The various studies showed that on average, a third of the phosphorus associated with suspended sediments in tributaries was in available form. Phosphorus from shoreline erosion, while substantial in quantity, is not considered to be a significant problem in terms of Great Lakes eutrophication since it is primarily in an unavailable form, according to best current estimates. By contrast, phosphorus in municipal wastewater effluents is generally 80%+ in the available form. The net effect from all sources is that about half of the phosphorus entering the Great Lakes from tributaries is biologically available.

A number of aspects of the availability question remain unresolved at the present time, including the availability of various forms of phosphorus and release rates under different lake dynamics, the available fractions from different sources such as various types of sewage treatment, agricultural runoff, urban runoff, etc. and the effects during transmission of such inputs through tributaries to the lakes.

The information and knowledge available to PLUARG was insufficient, within its time frame, to pursue further the availability issue. For example, studies on selected Canadian watersheds were not able to detect any clear relationships between land uses within a watershed and the available fraction of phosphorus at the tributary mouth. Consequently, PLUARG based its conclusions on target loads and remedial strategies on total phosphorus values, while suggesting further study of the biological availability and transmission through tributaries to the lakes of phosphorus and other pollutants from different types of land uses.

In view of this continued uncertainty, the concerns of the Water Quality Board, and testimony received during its public hearings on the crucial role of this factor in phosphorus management strategies, the Commission determined that further investigation was required before advising the Governments on the importance of biological availability and indeed on the entire question of phosphorus target loads and control strategies. As a result, this matter was also referred to the Task Force on Phosphorus Management Strategies, through the Great Lakes Water Quality and Science Advisory Boards.

In its interim report, the Task Force underlines the importance of phosphorus availability as a factor in developing management strategies. The Task Force also notes, however, the wide range of estimates of the proportion of available phosphorus in tributary sediments, based on the incomparability of analyses to date. The Task Force concluded, therefore, that since the only current comprehensive data base is for total phosphorus, management strategies in the near future will have to be based on the consideration of total phosphorus inputs.

The Commission considers the matter of phosphorus availability to be a factor that could have relevance to the selection of specific phosphorus pollution control programs. However, due to the lack of data and even understanding of some of the physical-chemical relationships in the ecosystem that affect biological availability recognizing that phosphorus except that from shoreline erosion has potential to be biologically available, and noting that controlling total phosphorus has usually produced improvement in water quality in other lake systems, the Commission can see no alternative at least in the short run, to developing overall management plans on the basis of total phosphorus. It is pointed out that most phosphorus reduction programs in the past have concentrated on point sources, such as municipal wastewater treatment plants. As indicated above, such sources generally produce phosphorus loads containing a high proportion of available phosphorus. Thus, although total phosphorus was being reduced, the net effect was in fact to reduce input of the available fraction. Therefore, higher availability from sources such as municipal treatment plants and detergent phosphorus, as well as specific types of land use activities should be kept in mind when establishing priorities for specific remedial actions. In the meantime, the Commission recommends a reassessment of surveillance and research activities to ensure the development of a data base adequate to address the question of relative biological availability of phosphorus in the Great Lakes, from various direct and tributary point and nonpoint sources, so that choices as to the efficacy of point versus nonpoint source control can be more precisely determined.

(G) VARIABILITY OF PHOSPHORUS LOADS AND EFFECTS

Variability in climatic conditions results in fluctuations in tributary streamflow, from year to year. To the extent that phosphorus loads vary with the quantity of land runoff and stream flow, fluctuations in precipitation can affect phosphorus load estimates and actual loads from year to year.

While phosphorus (and other pollutants) is believed to vary in total quantities as flows change, there is neither a long term data base for tributary phosphorus concentrations, nor evidence to show a simple relationship between total phosphorus concentrations and discharge. Since the modelling exercise used by PLUARG to assess phosphorus management options was based on expected annual conditions, however, it was suggested that the basic phosphorus management strategy developed by PLUARG for the Great Lakes remains relevant.

A further issue of variability relates to the difference between open-lake phosphorus concentrations and those in nearshore areas. While PLUARG emphasized (as does the Commission) whole-lake problems and

solutions due to the nature of its mandate with respect to the pollution of boundary waters, it recognized the need for greater emphasis on the study of nearshore areas which due to their location, differing physical/chemical/biological dynamic characteristics and obvious direct interface with man and his activities, could and do in some cases result in an exacerbation of both phosphorus concentrations and their detrimental impacts over those occurring in the open lakes. This suggests the need for closer attention to the causes of and solutions to phosphorus loadings to particular lakes than would be indicated by the whole-lake loading-target load approach.

The Commission views phosphorus load and impact variability, due to climate and intralake (nearshore/open-lake) complexities, as matters which lie outside the scope of this report, but which merit careful further study of expected phosphorus loadings, target loads, and indicated remedial programs. With regard to climatic variations and trends, the Commission recognizes that the calculations of loadings would change from year to year. It also suggests though that, until such time as it can be demonstrated that periodic higher phosphorus loadings than the long term mean for one or a series of years do not have a longer term effect on the lake ecosytems, the Governments adopt the approach of developing phosphorus management strategies for phosphorus loads and targets based on 1976, the year for which comprehensive data are available. The seasonal variation in loading, and its relationship to ecological effects, is another matter that merits further attention.

The interrelationship between the cumulative effects of a number of nearshore problems and an open-lake problem is not well understood. The Commission suggests that the problems and interrelationships between nearshore and open-lake problems be further examined in order to determine whether whole-lake loadings and target loads -- which are the current basis of analysis, except for the major subdivisions of Lake Erie and Lake Huron -- are always the most relevant measures of appropriate pollution control strategies.

Despite the perceived needs for further study in these areas, the Commission supports the view that, given the present state of knowledge, the broad scale of policy with which this report is primarily concerned, and the need for early remedial action where possible and feasible, the pollution data and control strategy for land use pollutants outlined in this report are relevant to the present stage of policy decision-making and merit early consideration and implementation by the jurisdictions in a manner that will be sufficiently flexible to permit future adjustments as better information becomes available.

2. Toxic and Hazardous Substances

The pollution of the Great Lakes by toxic and hazardous substances from land drainage was also a major concern of PLUARG. The potentially severe consequences posed by toxic and hazardous substances in the environment have received wide recognition only in the past few years. It is now clear that such substances, especially organic pollutants, are of equal if not greater concern than phosphorus in the Great Lakes ecosystem. Indeed, they constitute a potentially more serious environmental problem related to land use than the relative weight given them in the PLUARG report would seem to indicate.

Various classes of organic pollutants can degrade biologically or chemically, and may produce varying degrees of oxygen reduction in the water, as well as taste and odor problems in water supplies or fish. However, the main class of such substances which are of environmental concern are those which do not readily degrade and which may bioconcentrate or bioaccumulate in aquatic organisms, or which may be directly toxic to aquatic life or to consumers of aquatic life. Another possibility which warrants concern is that some organic pollutants can also be metabolized or changed to a more toxic form in a water body. Since little is known about the chemical and biological movement or their fate in the environment, or even the individual or combined effects of many such pollutants, special vigilance must be accorded to their presence in the environment. Indeed, a wide variety of persistent synthetic organic contaminants has been identified either qualitatively or quantitatively in the environment, including water, fish and fish-eating birds, and sediments in the Great Lakes ecosystem. Threats posed by toxic and hazardous substances in the Great Lakes Basin ecosystem were highlighted in the Commission report to Governments on water quality in the Upper Great Lakes, and Water Quality Annual Reports of recent years.

Heavy metals can have both direct chronic and subtle acute effects on biota. They may be taken up by organisms directly from the water or through the food chain and cause severe growth and reproductive problems, as well as problems related to changes in behavior patterns. As with organic compounds, biomagnification in fish tissues can also occur, depending on the metal, and be a hazard both to the fish and to fish consumers, including man, if such tissue levels are sufficiently high.

PLUARG found that land use activities (as well as the atmosphere as a mechanism for pollutant transport) are presently contributing or have contributed to the Great Lakes several groups of toxic or hazardous substances with actual or potential detrimental environmental effects. The categories of substances identified by PLUARG include trace elements (especially the heavy metals, mercury and lead) and organic compounds (some pesticides, PCBs, and several industrial organic compounds). These are discussed briefly below.

(A) PESTICIDES

PLUARG studies indicate that Great Lakes biota continue to show residual levels of DDT, aldrin-dieldrin and chlordane, all of whose use has either been banned or restricted in the Great Lakes Basin in recent years. Heptachlor- heptachlor epoxide and atrazine were also found, but are not determined to be an environmental problem at the present time.

PLUARG noted that organochlorine pesticides (e.g. DDT) were first used in the Great Lakes Basin following World War II. These pesticides were widely used because they were very effective in controlling insect pests and were easy to apply. The capacity of these substances to resist normal degradation in the environment, and their resulting bioaccumulation in aquatic organisms, were subsequently discovered and their biological implications appreciated. Because of these factors, all of these particular pesticides have either been eliminated or greatly restricted in the Great Lakes Basin. PLUARG focussed its initial concern on these pesticides.

Current problems concerning DDT relate to its past widespread use. PLUARG studies show that total DDT levels in fish are well below the United States and Canadian guideline of 5.0 mg/kg, with the exception of Lake Michigan where 1976 lake trout DDT levels still exceed this level. The initial rate of decline in DDT levels following the 1972 ban has slowed in recent years.

Aldrin-dieldrin has never received the same attention as DDT, although it has been in use as long. Levels in fish from 1969 to 1974 have been just at or below the 0.3 mg/kg guideline. Levels in lake trout and chub exceeded the guidelines in 1975 and 1976. The reason for the elevated levels in Lake Michigan alone are unknown. Current bans on the use of dieldrin in both countries. appear to be responsible for its declining levels in Great Lakes fish, although sporadic findings of higher levels are still noted.

Chlordane was detected by PLUARG in all components of the Lakes Erie and Ontario ecosystems in 1976. Levels exceeded established guidelines in fish samples in the mouth of the Niagara River in 1977, and increases in chlordane residues were also found in fish sampled near Point Pelee in Lake Erie. The use of chlordane is currently restricted and PLUARG anticipated that this should produce a decline in chlordane residues, although the process may be slow.

The pesticides atrazine and heptachlor-heptachlor epoxide were also found in Great Lakes waters. Past bans on the use of heptachlor in the Great Lakes Basin appear to have eliminated this pesticide as a water quality problem at the present time. PLUARG found atrazine in every Ontario rivermouth sample taken during its study and concluded that because of its relatively rapid biodegradation in the environment atrazine was not be a problem at the present time. No residues of atrazine were found in Great Lakes fish. Nevertheless, the difficulties involved in determining "safe" levels for such compounds gives cause for caution in permitting undesirable levels in the water.

The new pesticides being used in the Great Lakes Basin (e.g. organophosphates, carbamates) generally have chemical properties which either allow them to be rapidly degraded or else not bioaccumulated in biota. Consequently, no water quality problem relating to their use is evident at present, although continued monitoring is warranted.

(B) INDUSTRIAL ORGANIC COMPOUNDS

PCBs (polychlorinated biphenyls) were found to be widely distributed throughout the Great Lakes ecosystem, having been used in the basin for more than 40 years. PCBs have been called one of the most persistent toxic pollutants in the environment. PCBs are exceptionally stable compounds that have been used in a wide variety of industrial and commercial applications, principally in electrical transformers, paper coating and the use of PCB-contaminated oils on unsurfaced roads. They are very resistant to biodegradation, and they can usually be successfully destroyed only by high temperature incineration. Although the U.S. Environmental Protection Agency banned the manufacture of PCBs in 1976, a total ban on the use and transport of PCBs (except by EPA - approved permit), did not go into effect until mid-1979. In Canada, a ban on the

use of PCBs, except for their continued use (but not replenishment) in certain existing electrical equipment, has been proposed but is still under review.

While PCBs are only sparingly soluble in water, they are quite soluble in fat, and as a result can bioaccumulate readily in the fatty tissues of fish, birds and human beings. It is for this reason that they represent an environmental hazard, with the effects noted below. This is reflected in the PLUARG findings that even when levels of PCBs may be barely detectable in water, PCB levels in fish tissue can exceed established guideline concentrations for human consumption. The average concentration of PCBs in fish for the past eight years has exceeded the United States and Canadian guidelines only in Lakes Michigan and Ontario, although the maximum levels of the range of PCB concentrations in fish exceeded the guidelines in all the lakes.

The bioaccumulation effects of PCBs, which cause reproductive failure and deformities in fish-eating birds, were seen in Lake Ontario herring gulls. Adult gulls exhibited a sharp decline in egg hatching, and their young were often grossly deformed, particularly their bills, rendering them incapable of eating. While there is no toxicological data as yet on the human effects of PCBs, it was found that subjects with the highest levels of PCB in fat tissues were also those who consumed large quantities of fish from the Great Lakes. Because of elevated PCB levels, numerous warnings and several bans have been issued in the past concerning commercial fishing of coho and chinook salmon in Lake Huron, Georgian Bay, North Channel, Lake Erie and Lake Ontario; catfish and eel in Lake Ontario; and salmon in Lake Michigan. PLUARG found that the levels of PCBs in fish tissue have not changed significantly over the past 8-9 years.

Sediments in the Great Lakes, particularly Lakes Ontario and Erie, are highly contaminated with PCBs (Figure 4). The sediment contamination pattern indicates that large urban areas are major sources of PCBs. They are found in both municipal and industrial wastewaters. Also the widespread dispersion of PCBs throughout the Great Lakes sediments suggests that the atmosphere is transporter of PCBs to the Lakes.

Hexachlorobenzene (HCB), an organic material used in the plastic and dye industry, has been shown to be very stable in the environment and readily bioaccumulative, although it is easily volatilized. HCB has been shown to be carcinogenic in laboratory tests. PLUARG studies showed levels of 10-25 µg/kg in fish tissues in Lake Ontario tributaries. Lake surveillance data show concentrations ranging from non-detectable to 20 µg/kg in Lakes Ontario and Erie. The sources of HCB are not well known at present. It is noted that there are no formal guidelines for HCB in fish for human consumption at the present time.

Mirex is a substance which, while used in pesticides in southern parts of the United States, is considered primarily an industrial chemical in the Great Lakes Basin. It is used in the manufacture of plastics, as well as a fire retardant in synthetic fibers. It has never been registered for use in pesticides in Canada.

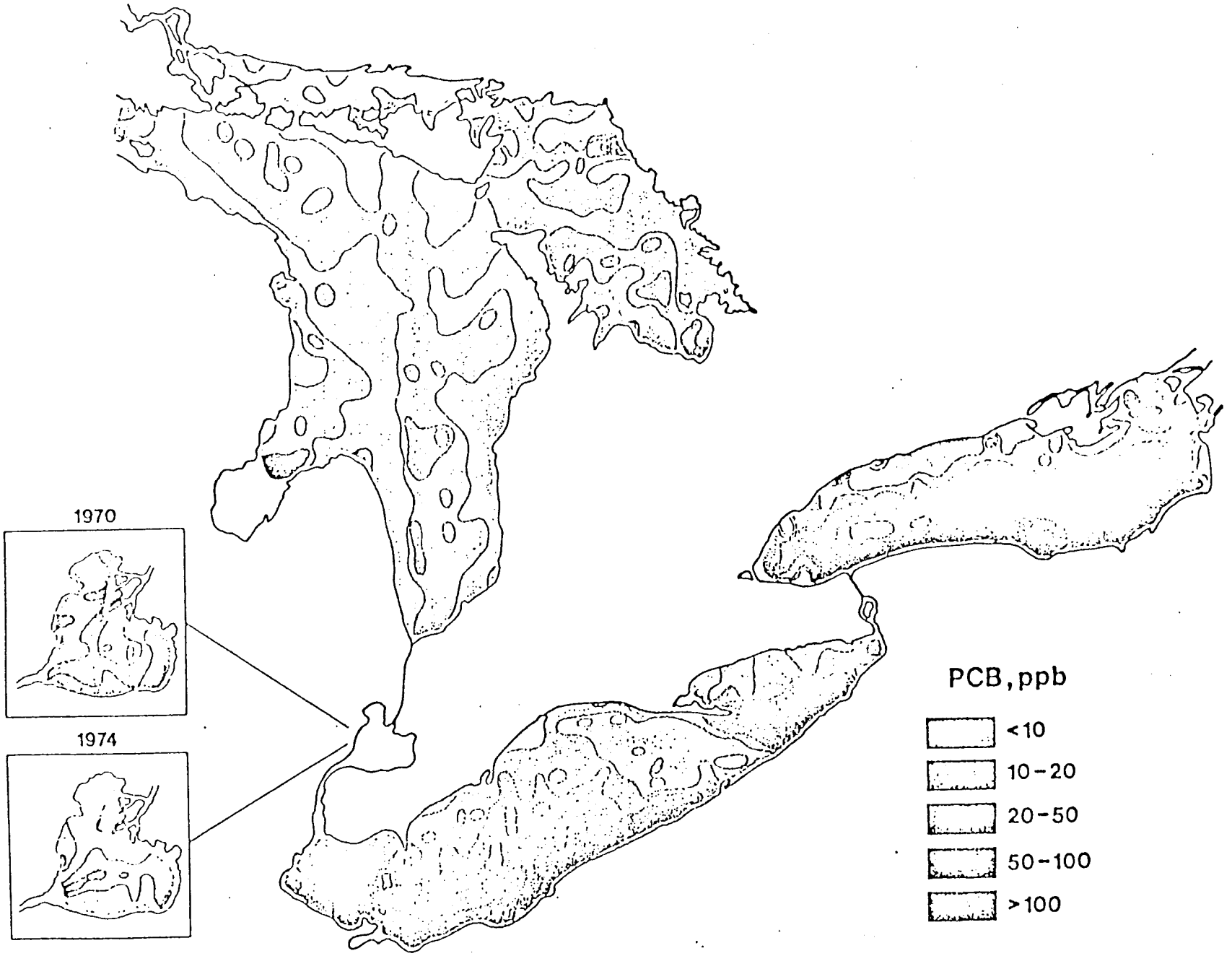

FIGURE 4. PCB CONCENTRATIONS IN SURFACE SEDIMENTS OF LAKES HURON, ERIE AND ONTARIO. (ppb = µg/kg)

Mirex was first reported in Lake Ontario fish in 1974, and continued without decline to 1977. The input was traced to point sources on the Niagara and Oswego Rivers of New York. No source was detected in Canadian tributary suspended sediments in 1974-75; high levels of mirex were detected in fish in Kettle Creek, Ontario during 1978, but not in fish collected in the open-lake. The 1978 Great Lakes Water Quality Agreement established an objective of substantially eliminating mirex and its degradation products from water and aquatic organisms.

Many other chemicals produced and used in the United States and Canada may pose severe environmental or health problems. However, our knowledge of the potential risks associated with many chemicals is relatively scarce. Indeed, in many cases we do not learn of the risks associated with chemicals until after they have produced damage to human or environmental health. Examples are asbestos, DDT and PCBs. A recent inventory prepared by the IJC's Science Advisory Board indicates approximately 2800 chemicals are produced or used in the Great Lakes Basin, with nearly 2200 of these chemicals being organic compounds. The IJC's Water Quality Board reported that about 400 organic compounds have been identified in either discharges to the lakes, in sludges, in lake water, sediments, benthos, plankton, fish or wildlife, or in the air. Another 100 organic contaminants are currently being evaluated. Both man-associated and natural sources are believed to be contributing these materials to the lakes.

(C) HEAVY METALS AND OTHER TRACE ELEMENTS

The beginning of heavy metals entering the Great Lakes above natural levels roughly corresponds with the beginning of European settlement of the basin in the mid-1800's, and the clearing of large areas of land for agricultural and urban use. The rapid growth of industry in the basin since that time has produced significant increases in inputs of heavy metals to the basin. PLUARG studies involving lake sediment cores demonstrate that man has been instrumental in increasing inputs of virtually all pollutants to the Great Lakes.

PLUARG determined that several trace elements were present or potential pollutants to the Great Lakes System, some but not all of these being heavy metals. The substances of concern are mercury, lead, arsenic, cadmium, selenium, copper, zinc, chromium, and vanadium.

PLUARG indicated that the basic criteria for establishing the potential for environmental contamination for these above listed elements should be based on their accumulation in the sediments and biota above natural background levels, and more importantly, on their ability to undergo methylation to a more toxic form. Based primarily on this latter criterion, PLUARG determined that mercury and lead are of greatest concern in the Great Lakes ecosystem.

The concern with mercury stems from the discovery that some microorganisms in lake bottom sediments can convert inorganic mercury in sediments into an organic form, methyl mercury which can undergo bioaccumulation in fish and is a very potent human nerve poison.

Sediments and fish, especially in Lakes Ontario, Erie and St. Clair, are presently contaminated with mercury. This mercury is derived from several sources, including pesticides, past point source discharges from several chlor-alkali industries in the Lake St. Clair Basin, and present atmospheric deposition both directly into the Great Lakes, and onto the land surface with subsequent drainage to the lakes.

As a result primarily of the point source discharges to Lake St. Clair and the Detroit River, the sediments and fish of Lake St. Clair became contaminated with mercury. The commercial fishery was subsequently closed, bans on sport fishery were also imposed on for Lake St. Clair and for certain fish in Lakes Huron, Erie and Ontario.

It is noted that as a result of the control of point sources of mercury discharges, an encouraging decline in mercury levels occurred in Lake St. Clair fish between 1970 and 1977. Re-opening of the Lake St. Clair commercial fishery is being considered. It is also noted, however, that mercury-laden sediments are moving slowly eastward into Lakes Erie and Ontario.

Lead has also been identified by PLUARG as a pollutant of concern mainly because of its potential for undergoing methylation to a more toxic form. PLUARG did not identify lead as an actual environmental concern at present, but rather cited its potential for undergoing biomethylation as a reason for concern and continued monitoring. Substantial inputs of lead from nonpoint sources, particularly from automobile exhausts in the large urban complexes of the Lakes Erie and Ontario Basins, have had a measurable effect on the concentration of lead in lake sediments. The influence of large urban centers, in particular, can be seen in the lead levels in sediments of Lakes Erie and Ontario. The importance of the atmosphere as a transport mechanism for lead entering the Great Lakes was stressed by PLUARG. At present, the levels of total lead in Great Lakes fish are below the accepted guideline of 10 mg/kg. PLUARG did note, however, that the early stage of evaluation of methyl lead levels in fish may ultimately lead to a revision of the guideline for fish.

(D) SEDIMENTS

Erosion of land and the subsequent input of sediments into the Great Lakes is a natural phenomenon which has been occurring since the formation of the lakes. With the settlement of the basin, and subsequent clearing of land for agricultural and urban uses, has come an increase in sediment loads to the lakes.

The immediate effects of sedimentation are the problems observed in the downstream portions of tributary streams and in harbours and bays in the nearshore areas of the lakes, where siltation may impair the use of water for drinking or may present aesthetic problems. Sedimentation may also hamper shipping activities, or reduce the viability of fish spawning grounds.

Another concern related to sediments is their role as a "pollutant carrier" on the one hand, and a pollutant sink or trap on the other. This phenomenon applies to virtually all pollutants discussed thus far, including organic compounds, phosphorus and heavy metals, and depends to a large extent on the chemical conditions in the water.

Sediment particles can transport pollutants to the lakes and thus be a pollutant "source", when the latter become bound to the particle surface, especially clay-sized particles. The pollutant-laden particle can then be carried to the lakes, where the pollutant may become unbound from the particle surface under certain conditions, such as oxygen depletion in the water. It will then be available for uptake by organisms in the lakes. This is the manner in which phosphorus regeneration from lake bottom sediments ("internal loading") generally occurs.

Conversely, pollutant-laden sediment particles may not release the pollutant to the water. In addition, sediment particles may adsorb pollutants from the lake water. In this case, the sediment is acting as a pollutant trap or "sink" by rendering the pollutant unavailable for uptake by aquatic organisms. The bound pollutant may remain unavailable essentially permanently when the sediment particle sinks to the bottom of the lakes or leaves the lake by way of the outflow stream. Alternately, the pollutant may be slowly released to the water and become available over time, depending on the biochemical conditions in the lake.

As a general rule, pollutants are released from sediments under chemically-reducing conditions in the water, such as occur under conditions of oxygen depletion. Phosphorus, for example, is usually released from sediments in large quantities when this occurs in the hypolimnetic waters of Lake Erie's central basin. Metals are also released under reducing conditions. By contrast, chemically-oxidized conditions generally cause pollutants to remain attached to sediment particles. If any release does occur, it is usually very slow, so that the pollutant in effect becomes buried in the bottom sediments. Metals, for example, usually remain bound to particles under such conditions, while phosphorus release is usually non-existent or very slow. As a result, it is generally preferable, from the point of view of water quality, to maintain oxygenated conditions in water bodies since this tends to decrease pollutant releases from sediment particles. This dual nature of the role and effects of sediment particles should be kept in mind when assessing the impact of sedimentation on the Great Lakes ecosystem.

Sediment sources in the Great Lakes include surface runoff from a variety of land uses, including agricultural and urban areas, forests and other land uses, as well as shoreline erosion. Of these sources, erosion of agricultural land, particularly croplands and streambank erosion, are the primary contributors of sediments. PLUARG observed that unit area loads of suspended solids (sediment) ranged from 60-960 kg/ha/yr (67-1,075 lb/acre/yr). The total loadings of suspended solids and sediments from the above sources amount to an estimated 60,423,560 metric tons per year. Tributary inputs, which include runoff from agricultural, urban and forested lands account for 11,266,560 metric tons, while the remaining 49,157,000 metric tons are from shoreline erosion. It is evident that soil losses, apart from any associated pollution problems, can represent a substantial economic loss to the Great Lakes Basin, in terms of lost production to individual farmers. It is also noted, however, that the absolute quantities of inputs of sediments to the lakes should be viewed with caution when considering their actual impacts on the water quality of the lakes. Sediment from shoreline erosion, while large in quantity basinwide, does not usually carry substances which can affect water

quality to the same degree as agricultural or urban sediments. Even where chemical substances of concern are a natural component of shoreline sediments, they are not generally as concentrated or in a form readily assimilated by organisms or lake waters (particularly the apatite form of phosphorus). Hence the potential impact on water quality from shoreline erosion is less severe than similar or even much smaller quantities of sediment from developed areas where polluting substances are generated in large part by man's activities.

Highly-erodible soil, and erosion-sensitive land uses, do not necessarily result in high sediment loading rates, since the location and management of waterways that could receive eroded sediments (including streams and ditches) as well as soil management practices can also have a significant effect on soil erosion and transport to the Great Lakes. The effect of such remedial management practices as buffering waterways with grass or trees can be to decrease sediment loads. PLUARG results indicate that a substantial reduction in the transport of fine-grain sediments by improved erosion and sediment control programs, coupled with such established measures as contour cultivation, would also reduce the loads of sediment-associated pollutants, particularly phosphorus, nitrogen and pesticide residues.

3. Localized Nonpoint Pollution Problems

PLUARG pointed out in its study that while some pollutants did not consititute lakewide, transboundary problems, they did have actual or potential environmental consequences on a localized scale. These pollutants are discussed below.

(A) MICROORGANISMS

Pathogenic bacteria (i.e. disease-causing bacteria) of human and animal origin enter the Great Lakes through direct sewage plant discharges, direct storm sewer discharges, combined storm and sanitary sewer overflows and private waste disposal system failures, discussed earlier in the section on phosphorus . A major component of the urban diffuse bacterial load is of non-human origin (e.g. pets).

PLUARG studies indicated that, comparatively speaking, bacteria entering the Great Lakes due to land drainage do not represent a major water quality problem in the basin at present. Bacterial impact is generally restricted to the nearshore zone of the lakes. Local problems could arise within the vicinity of municipal water intake, or in areas where surface waters are used for swimming. Beach closings resulting from bacterial contamination have been common in recent years in the Lower Great Lakes. Hence, increased vigilance is necessary in such areas.

(B) CHLORIDES

The use of road deicing salts (especially chlorides) in the Great Lakes Basin has been increasing since the turn of the century. The heavy use of salts, and related snow disposal practices, has resulted in a substantial input of chlorides to the lakes. It is also noted, however, that industrial sources are the major sources of salts to the lakes,

accounting for 57-93 percent of the total input, depending on the lake basin.

Localized problems due to chloride pollution have been observed in some nearshore zones and harbours and bays, particularly near urban areas. In terms of Great Lakes environmental problems, however, chlorides from diffuse sources are not of concern to open-lake water quality or biota since present concentrations are far below detrimental levels, although changes in algal species caused by rising chloride levels have been identified in the literature. From the ecosystem viewpoint, other problems are caused such as the social costs of automobile corrosion and damage to vegetation and clothing. These factors warrant consideration and concern in assessing the benefits of salt application.

(C) NITROGEN

Nitrogen is of localized concern where it contributes to groundwater pollution. As such it affects the use of groundwater as a drinking water supply. Nitrogen levels about 10 mg/L in drinking waters can affect newly-born infants, causing the health problem known as methyloglobinemia. In terms of Great Lakes water quality, however, PLUARG determined that nitrogen from diffuse sources is not a concern at present.

4. Waste Disposal

(A) SANITARY LANDFILLS

Leachate from sanitary landfills can contain elevated levels of heavy metals, organic and inorganic compounds and chlorides. Such leachate from improperly designed or managed landfills may percolate down to contaminate groundwaters or leak out from improperly sealed sites to contaminate surface waters.

Some localized pollution from sanitary landfills has been identified in the Great Lakes Basin. PLUARG, however, determined that properly designed and managed landfills used for disposal of normal human produced refuse (i.e. garbage) minimize potential impacts and present little threat to Great Lakes water quality. It must be emphasized that this is a different problem from that of hazardous waste disposal sites discussed below.

It is now realized that many landfill operations, both regulated and unauthorized, contain large quantities of hazardous wastes, yet the types, quantities and, often locations of hazardous waste in the basin are often not clearly known. The relative importance of landfills as sources of PCBs, for example, compared to other sources is not known. Further, existing landfill sites are often not designed to safely contain hazardous materials over the long term. Improperly designed or located hazardous waste disposal sites have considerable implications for Great Lakes water quality. The siting and proper operation of sites for disposal of hazardous wastes has been identified as a severe problem in the Great Lakes Basin by the Great Lakes Water Quality Board.

(B) HAZARDOUS WASTE DISPOSAL

Because the Great Lakes Basin is the "industrial heartland" of the United States and Canada, industry of all types can be found there, especially near population centres. A by-product of this intense industrial activity is a wide variety of liquid and solid wastes, including about one-fourth of all the hazardous materials produced in the United States.

The locations and types of hazardous waste disposal sites were surveyed by PLUARG as part of its inventory of specialized land uses.

However, because the sites were only those that could be identified, and which handle a great variety of wastes, not all of which are clearly identified, the numbers only hint at the scope of the problem of controlling and assessing the impacts of hazardous waste disposal in the Great Lakes Basin.

Only recently has the full magnitude of the environmental and health problems associated with the disposal of hazardous wastes become appreciated. In the United States, the Environmental Protection Agency (EPA) has estimated that more than 35 million tons (70 billion pounds) of hazardous wastes are produced annually across the country, mainly in the chemical, petroleum, metals or related industries. Government actions in recent years which restrict the discharges of hazardous and toxic wastes to municipal sewer systems and to water bodies in order that both such systems might be protected, have helped focus attention on the problems of the ultimate disposal of a wide variety of toxic or hazardous industrial wastes.

Hazardous and toxic wastes, usually produced as by-products of manufacturing processes, can have a multitude of effects in the environment. Of primary concern is that they threaten human and animal health. Hazardous wastes can cause birth defects and cancer in humans and they can also harm or kill fish and wildlife. These wastes can severely affect water quality if allowed to enter water bodies, and can result in serious economic losses to users of the water.

The leaching of liquid wastes through the underlying surface of disposal sites into the groundwater and/or ultimately into surface waters pose a serious threat to human and environmental health. Other routes of exposure also exist, including overflow and runoff from disposal sites, the atmosphere (through improper incineration, evaporation or wind erosion), fire and/or explosions due to chemical reactions occurring at sites, direct contact of humans or wildlife with the wastes, and possibly of most importance to humans in the Great Lakes Basin, adversely affecting human health through the food chain via bioaccumulation in the fish eaten by humans.

At a recent World Health Organization (WHO) meeting it was noted that in Europe nearly a thousand new chemicals go into production each year. Experts at this meeting spoke out strongly for a world-wide plan to deal with chemical pollution, noting that "national legislation was insufficient to deal with the hazards of uncontrolled or improper use."

It is ironic that environmental laws aimed at protecting the air and waters have in part forced more and more wastes to be disposed of on the land. Many of the resulting disposal sites have proven to be wholly inadequate for such purposes. Even adequate industrial landfills may be inadequately secured after they have become filled (i.e. "capped"), so that they can eventually leak chemicals. Incomplete and unsecured dump sites, are potentially even more serious, both because they are numerous and because often their existence is unknown. Hence people who live near such sites can be exposed to the effects of such chemicals without their knowledge. In recent year it has become common to find barrels of unidentified chemicals hidden in abandoned warehouses or stored on lots in rundown sections of cities, under elevated roadways or open fields beside them.

Further, chemicals are often indiscriminantly dumped on vacant lands or poured into municipal sewers or private disposal wells. There are now in the United States about 18,500 sites for municipal solid waste disposal, 23,000 sites for sewage sludge disposal, and more than 100,000 sites for industrial wastes, not counting those sites of known quality which have been closed. The United States EPA has, in fact, documented more than 400 cases of damage to health and the environment which have occurred as a result of the improper management of hazardous wastes, a situation described as the "tip of the iceberg".

The Great Lakes Basin Commission has concluded that "adequate treatment and disposal capacity for hazardous wastes in the Great Lakes Basin does not exist." It further concluded that "old, inactive disposal sites which may contain hazardous wastes exist around the Basin. The specific number, location and potential hazards of these sites are unknown." Yet because of the concentration of industry in the Great Lakes Basin, maintaining of this region's economy, while at the same time assuring adequate environmental and health protection, depends more on the ability of the population in this region to adequately address problems associated with production of hazardous materials than it would in other less industrialized areas of the United States and Canada.

5. Atmospheric Pollution

The atmosphere acts as a mechanism to transport pollutants from a large number of different sources to, and within, the Great Lakes Basin. These pollutants are deposited directly into the lakes or on the land within the basin, and then carried by storm runoff and snowmelt into the lakes and tributaries. While the atmosphere is not a source of pollution in itself, it can carry large quantities of polluting substances over great distances. During this transport process, certain pollutants from land sources can also be transformed into more toxic forms than their original form. PLUARG found that the amounts of material deposited into the individual lakes were generally proportional to the lake surface area.

It was found that the atmospheric input was surprisingly high in some instances. For example, the atmosphere contributed about 1,600 metric tons of phosphorus in 1976 to both Lakes Superior and Michigan. The 1976 phosphorus input to Lake Huron was about 1,100 metric tons. Even the relatively small surface areas of Lakes Erie and Ontario received about 800 and 500 metric tons of phosphorus during this period.

The atmospheric inputs of several other materials investigated by PLUARG were also significant. The Reference Group noted that lead was contributed to the Great Lakes by the transport of lead through the air from automobile exhausts. Also, atmospheric inputs of asbestos from vehicular brake linings occurs in the Great Lakes Basin.

Toxic materials were also found to be transported via the atmosphere. Urban areas are major sources for PCB pollution of the Great Lakes. PLUARG also observed, however, that the widespread dispersal of PCBs throughout the sediment of the lakes, including areas remote from industrial centres, indicates the importance of atmospheric transport of PCBs throughout the entire Basin.

Wind erosion results in lifting soil and sediments from the land surface. This is so especially in construction areas and in other land areas whose surfaces have been cleared, thus exposing the soil to wind action. The dust bowl in the southwestern United States during the 1930's serves as an extreme example of soil movement through the air as a result of wind erosion.

Acid rain is a dramatic and serious example of industrial emissions being transported over long distances through the atmosphere and undergoing chemical transformation in the process to produce a severe environmental problem. Indeed, the problems of acid rain are becoming global in nature. Acid rain is produced when sulfurous oxides (especially from coal-burning thermal electric plants and smelters) and nitrous oxides (mainly from automobile exhaust emissions) interact with moisture in the atmosphere producing water with substantially increased acidity. This water is then distributed over land and water surfaces as precipitation. The impacts of the resulting acid rain have been shown to be severe to biota, especially fish, in lakes with low "buffering" capacities. Such lakes exist in areas whose geological characteristics are such that there is little or no natural capacity to neutralize the increased acidity which enters the lakes. In severe cases, essentially lifeless lakes have been produced.

Acid rain has received considerable attention in the Great Lakes region in recent months because it affects some lakes in upstate New York, and lakes in the Canadian Shield area of Ontario. In terms of Great Lakes water quality, however, PLUARG concluded that acid rain has no measurable effect at present, except in two isolated embayments in Georgian Bay. Because of the large volume of water in the Great Lakes, and an enormous buffering capacity, the likelihood of the pH changing as a result of acid rain is remote.

Nevertheless, the effects of acid rain on inland lakes, vegetation and biota in the Great Lakes Basin can be severe. Such effects have received considerable attention in upper New York State and in the Canadian Shield area. Furthermore, acid rain can lead to the mobilization of heavy metals from soil and sediment into the water and may then be transported to the Great Lakes. Thus, the effects of acid rain on the land and tributaries may ultimately be shown to have a measurable effect on the Great Lakes ecosystem.

It is clear from the PLUARG study that atmospheric inputs of materials to the Great Lakes deserves much more consideration. Virtually any material discharged into the atmosphere (e.g. stack emissions, automobile exhausts) will eventually be returned to the land or water surface in dry fallout or precipitation. Materials may be deposited in the Great Lakes Basin from sources both within the basin and outside the basin. Such long range transport of pollutants is already a problem of global nature, as exemplified in acid rain problems occurring in numerous regions in Europe and North America and as highlighted in recent reports of the IJC's Science Advisory Board and Water Quality Board. These concerns will become more severe in the future as energy demands increase the burning of coal as an alternate energy source both within and outside the Great Lakes Basin.

V. THE COMMISSION'S CONSIDERATIONS AND CONCLUSIONS REGARDING REMEDIAL MEASURES AND PROBABLE COSTS: A COMPREHENSIVE MANAGEMENT STRATEGY

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In advising the Commission on the nature and cost of remedial measures, PLUARG adopted the approach of outlining an overall framework for the assessment and implementation of the required measures. This framework is outlined in Chapter 3 of the final PLUARG Report Environmental Management Strategy for the Great Lakes System.

As noted earlier, the reference requested further to the assessment of remedial measures, that the Commission "Consider the adequacy of existing programs and central measures and the need for improvements thereto." Therefore, the Commission has reviewed the general adequacy of governmental programs and legislation and recommends some specific measures in Chapter VI on the basis of the information available to it. With some updating, the basic sources of information to the Commission were the series of technical documents created within the PLUARG project and the Public Hearings. The PLUARG Technical Reports 011, 012 and 013 are listed in Appendix III of this Report. PLUARG itself did not provide an extensive review of existing programs in its Final Report.

This chapter presents the Commission's considerations, conclusions and recommendations regarding the requirements for an overall management strategy identifying its elements, current shortcomings and possible new directions, as requested in the Reference. Chapter VI deals in a similar manner with specific remedial measures that are appropriate for dealing with various nonpoint pollution problems.

The Commission recognizes the value of the comprehensive framework for addressing land use pollution problems, and accepts PLUARG's concept of a comprehensive management strategy, in principle. The Commission recommends that the Governments of Canada and the United States in partnership with the state and provincial governments, and local jurisdictions where relevant, should undertake to develop a comprehensive strategy of pollution control for the Great Lakes which would be specifically directed at but not restricted to nonpoint pollution. The goal would be to provide a coordinated, consistent and effective approach to the management of the Great Lakes ecosystem. The Commission further recommends that such a strategy have sufficient flexibility to permit individual jurisdictions to maintain their resource and land management prerogatives to the extent that they are consistent with the Great Lakes Water Quality Agreement of 1978. This flexibility should also ensure that the strategy can be responsive to future scientific, technological and socio-economic developments concerning the means and effects of pollution control. While this overall strategy should form the basis for dealing with nonpoint pollution in the Great Lakes Basin, ongoing and priority programs should be pursued in the meantime.

There are several components to the overall strategy which the Commission believes it should recommend as a planning and management framework. These are discussed in a descending order of generality as follows:

- o An Ecosystem Viewpoint
  - the need for a comprehensive, Basin-wide perspective
- o A Management Framework
  - the development of programs by each jurisdiction within a coordinated, Great Lakes framework, and provision for monitoring the effectiveness of these programs.
- o Coordination and Assignment of Responsibilities within Jurisdictions
  - the need to ensure a mechanism for improved coordinated consideration of environmental issues in government decision-making
- o Identification of Broadscale Remedial Programs and Priorities
  - the need to establish priorities while ensuring equity between the various segments of the population affected in different degrees by remedial programs, as well as ensuring a broad minimal level of acceptable land use practices throughout the Basin
- o Assessment of Cost-Effectiveness and Implementation Practicability
  - the need for assessing alternative remedial measures from a practical and socio-economic standpoint, and the difficulties of doing so
- o Administrative and Legislative Requirements
  - the adequacy of current legislation and administrative systems in general, from the management framework perspective (specific requirements to be noted in Chapter VI)
- o Public Involvement and Information
  - the need for, and some ways to achieve, better public knowledge, involvement, and action
- o Monitoring and Review of Management Plans and Remedial Programs.

1. An Ecosystem Viewpoint

An ecosystem approach to environmental management means recognition of the unity and the complexity of interconnections within the ecological system of which man is a major component. The natural system has a fixed or "finite" capacity for stress from man's activities. This is being pushed to the limits, especially in certain sub-components of the ecosystem; the created stress is turned back on mankind in the form of detrimental impacts on human health, aesthetics and the economic system itself.

All of man's activities, either individual or in the form of institutionalized (e.g. urban and industrial) activities, have a potential series of impacts throughout the complex set of interrelationships which make up the ecosystem. Not all or even most of these impacts are obvious but they

could appear much later in time, or at other places in the ecosystem, some of them unexpected. Therefore, it is important that, to the extent possible, the probable impacts of actions, are assessed. This approach should be applied to actions capable of causing major social or environmental change so that informed and rational decisions can be made and, if necessary, approached with caution.

While it has become clear that such an approach is required for major development or resource management decisions, it applies also to the area of nonpoint pollution and control strategies. The impacts of land-use activities often may not be clearly definable or attributable to specific actions or individuals, but rather are the cumulative result of individually minor or apparently unrelated actions which, together and over time do cause serious harm. Similarly, efforts to remedy such problems may have far-reaching effects and should be dealt with in a comprehensive manner.

An example will serve to illustrate the value of the ecosystem approach. There have been proposals that fertilizer application on agricultural land should be limited, as a measure to reduce phosphorus runoff into the Great Lakes. Some of the considerations that would be relevant are:

- the relative and absolute impacts on water quality and aquatic resources in both the lakes and tributary streams; (phosphorus loads from fertilizer use have not been shown to be a major component of total whole-lake loadings, but may cause local problems and contribute to the problem);

- alternate measures of phosphorus pollution control both within and outside the agricultural sector, to ensure the best action; (other measures could result in larger reductions, but the relative practicality and cost-effectiveness must be assessed);

- the short and long term effects of such measures on agricultural productivity as opposed to others such as erosion and runoff controls, or phosphorus control in other places; (the proper application of fertilizers may reduce phosphorus loads sufficiently to avoid other actions that would affect productivity. On the other hand, large reductions in applications could also reduce productivity; therefore, the trade-offs should be assessed);

- the implications of such measures for the control and impacts of other substances such as toxic substances in the same sub-ecosystem; (limiting fertilizers may induce other measures to increase productivity, such as increasing herbicides, that could present greater environmental dangers);

- administrative and legislative implications including the enforcement capabilities; (does the legislative basis exist, or is it desirable, if so, could it be enforced);

- the relative efficiency of farmer education and setting guidelines as opposed to regulations concerning best management practices for fertilizer application; (persuasion and incentives may be more appropriate, given the scope of the problem and practicability of regulations);

- the economic and energy consequences of alternate measures for both the individual farmers and the regional economy (other measures might be more beneficial with regard to farm economics and the use of energy).

Undoubtedly, there are other considerations that could be noted, as this example is but illustrative and very broad in definition. The point is that even seemingly simple management decisions can have complex ramifications throughout natural and socio-economic systems and that, if these ramifications are not taken into account, may result in unintended consequences including economic and social harm without commensurate benefit, or the absolute failure of the program.

In its Fifth and Sixth Annual Reports on Great Lakes Water Quality, the Commission endorsed the ecosystem approach to the study and management of the boundary waters of the Great Lakes System. The basis of this approach was contained in recommendations of the Great Lakes Science Advisory Board and in particular its 1978 special report, "The Ecosystem Approach". The validity of an ecosystem approach was given recognition in the revised Great Lakes Water Quality Agreement of 1978 which uses the term "Great Lakes Basin Ecosystem", and is the perspective of this Report.

2. A Management Framework

Due to the nature of nonpoint pollution, there is a need for a management strategy that is somewhat different and more complex than that for point source pollution. It should include detailed plans for coordinated and comprehensive action at all levels of jurisdiction and between jurisdictions that can be assessed as to their adequacy and effectiveness in reaching agreed-on goals for the control of nonpoint pollution of the Great Lakes.

At the international level, there is a need for a clear understanding between all Great Lakes jurisdictions which sets out the goals and general nature of programs required. The basis for such an understanding exists at the binational level in Article VI of the 1978 Great Lakes Water Quality Agreement which provides for a wide variety of programs and other measures to meet the objectives of the Agreement. The jurisdictions could build on this part of the Agreement, to ensure a basic understanding as to the desired scope and nature of nonpoint pollution control, within the overall pollution control context for the Great Lakes. Within this international understanding, an adequate process for ensuring comprehensive action within Canada and the United States is required. The purpose of such understandings, both internationally and within each country could be at least three-fold:

(a) to make explicit a commitment by all jurisdictions to nonpoint pollution control, and also to assure cooperative, coordinated and comprehensive programs of research, planning and implementation, so that efforts in one jurisdiction would not be rendered ineffective by the land management policies of other jurisdictions. At the same time, it is important to recognize that identical programs or approaches to pollution control may not be relevant to all jurisdictions and that the precise nature of remedial programs remain within the prerogative of each relevant jurisdiction as long as the water quality objectives of the Great Lakes system are met or exceeded;

(b) to the degree consistent with the need for mutual and effective action, to deal with concerns that control of nonpoint Great Lakes pollution would have differential impacts on various jurisdictions, areas or groups of individuals, that would not be justified in terms of equity, impacts on the Great Lakes and/or cause comparative economic disadvantages.

(c) to establish the portion of the requirements of Article VI of the Great Lakes Water Quality Agreement to be met by nonpoint source control so that, together with water quality objectives and surveillence data, the Parties to the Agreement and this Commission can better assess the adequacy of the programs which are implemented.

In Canada, the Federal government does not, in general, have jurisdiction over land use and related pollution problems, these being primarily within provincial jurisdiction. A number of mechanisms exist for federal-provincial coordination, however, including the provision in the Canada Water Act for formal cost-sharing Agreements, and consultation such as through the Council of Resource and Environmental Ministers.

With respect to the Great Lakes, the Canada-Ontario Water Quality Agreement has provided the basis for cooperative implementation of the 1972 Great Lakes Water Quality Agreement, with specific agreements on using water quality objectives, acceleration of investment in sewage treatment facilities, the development of research strategies, and research in a number of areas including phosphates, their removal and alternatives, sewage disposal and basic ecological processes. A Federal-Provincial Review Board administers the Agreement. This Agreement, when renewed, could serve as a useful vehicle for an expanded joint program, within which an expanded research program and provision for a management plan for dealing with nonpoint pollution should receive special attention.

In the United States, the Federal government has the power to implement programs in this area but relevant legislative measures and administrative policies place primary responsibility for implementation on the States. Formal cooperative arrangements between the Federal and State Governments have recently been established with the institution of annual agreements between the U.S. Environmental Protection Agency and the Basin states regarding priorities for environmental problems and how they are to be addressed. As these agreements are renewed, they could incorporate explicit and special consideration of the needs for nonpoint pollution control programs, such as contained in the proposed Ohio agreement.

Other provisions for Federal-State linkage have existed in the discharge permit system for point sources, and the provision of funding (including construction grants) and technical assistance for planning and remedial actions meeting set standards. The major example of relevance to nonpoint pollution has been the development of the Water Quality Management Plans developed under Section 208 of PL 92-500*, which are intended to ensure that controls over land runoff are developed where required and include water quality considerations. These plans have been a comprehensive, effective measure from a planning standpoint, but lack adequate implementation

*Another relevant example of Federal-State-Local cooperation discussed elsewhere in this report, are the voluntary programs of soil and water conservation such as that of the Soil Conservation Service.

assurances for non-point source control. In addition, the Great Lakes Basin Commission provides a state-federal mechanism for basinwide water-related planning, but has no implementation authority.

The degree of concern for environmental problems varies greatly between states, although it is generally increasing. In that the EPA Federal-State agreements noted above recognize the requirements of the Great Lakes Water Quality Agreement, it is hoped that they will lead to a stronger more effective commitment of all States to the Great Lakes Water Quality Agreement and coordinated nonpoint remedial programs in particular. With respect to cooperation between states, there are mechanisms in place such as the Great Lakes Basin Commission that could serve as a forum for discussion and the basis for more formal arrangements.

The following subsections present the Commission's considerations of various elements of the management plan, identifying current shortcomings and possible new directions, as requested in the Reference.

3. Coordination and Assignment of Responsibilities Within Jurisdictions

It is a general observation that, at least until recently, many policies and programs have been developed with respect to the great variety of activities pertinent to nonpoint pollution, without sufficient and consistent consideration of the environmental ramifications. This can in large part be attributed to the inherent complexity of government and the difficulty of turning around major programs as the appreciation of environmental considerations slowly emerges. Certain legislation and programs that may have been very comprehensive when instituted, may not yet have caught up with the growing awareness of environmental impacts and values.

One problem that was noted in the PLUARG review of the current institutional framework and which was expressed at the Public Hearings, is that the separation of responsibilities between agencies dealing with the regulation of human activities, such as agriculture, urban development, public health and forestry, from those of the newer environmental agencies, has resulted in some cases in insufficient environmental constraints on regulatory decisions which alter land use and its ecological impacts. Conflicting goals and mandates of various agencies, such as production vs. environmental concerns, remedial and research needs vs. fiscal restraint, lead to a policy milieu that contains inherent conflicts, and programs that are silent or inadequate respecting environmental criteria and that in some cases provide an incentive to pollute.

This has been a problem in both the United States and Canada. On one hand, for example, agencies charged with regulating land use or associated practices, and having a legislative mandate to meet certain goals that may not be entirely consistent with environmental concerns have not traditionally taken them into account. On the other hand, because of legislated exclusions or administrative practices, environmental agencies may not have sufficient authority to impose conditions and then may face resistance. In some cases, this may be due in part to their failure to be sufficiently attuned to the traditions and needs of established programs. In other instances, the duplication or overlapping of responsibilities can result in policy gaps since neither agency feels that it has adequate jurisdiction or the required range of administrative and regulatory tools to deal with the problem, or that such action might be construed as being the pregative of the other agency.

A further general problem is that, in all jurisdictions, there are instances of agencies being constrained from fully implementing their mandates for environmental protection due to insufficient staff and funding. This problem is discussed further below, so that it is sufficient to note here that it is a further reason for instituting better intra-governmental coordination, including with the financial agencies of government.

Some examples of the lack of coordination between policies, and the failure to ensure commitment to environmental considerations within various jurisdictions, for whatever reason, serve to indicate the nature and scope of this problem.

At the Federal level in Canada, the goals of line agencies are not always compatible with environmental protection - some are development-oriented and, coupled with fiscal restraint, may not pay adequate attention to environmental concerns. The Environmental Assessment and Review Process, while a major step forward at the time it was implemented, is severely limited in its application only to major federal projects and is discretionary rather than a statutory requirement. Various statutes are restricted as to jurisdiction (resource ownership and management being a provincial responsibility) or are single purpose, with environmental control responsibility, if any, vested in the operating agencies. Fiscal and energy policies do not always promote environmentally-sound practices, such as the system of tax write-offs for various activities, gasoline pricing which encourages the use of leaded gas, and decisions on pipelines, and sources of energy; all of these policies rest primarily in agencies other than Environment. Regulatory programs tend to be more health and production-oriented than water quality-oriented, and not all grant programs ensure that environmental criteria are adequately considered (such as those for housing development with respect to sediment control).

In the Province of Ontario, despite some major environmental initiatives, the actual implementation of legislation has been gradual or in non-environmental legislation has in some cases not encouraged environmentally sound practices. For example, the Environmental Assessment Act has been implemented slowly and with major exclusions. The Drainage Act makes provision for but does not encourage environmental design and maintenance, and it has been stated the Ontario Ministry of the Environment has either inadequate power, or has not exercised it, over drains, septic tanks and urban subdivision agreements (PLUARG Technical Report No.013).

As for United States Federal situation, the statutory mandate of EPA is strong and both EPA and the Council on Environmental Quality have coordinating roles. It is not clear to the Commission, however, that a coordinating mechanism among federal agencies, has been effectively maintained with respect to the implementation of programs affecting water quality in the Great Lakes Basin. A further problem is that federal measures usually apply throughout the United States so that priorities are not always those most pertinent to the Great Lakes Basin, funding and manpower resources are limited due to the need to deal with problems over the wider area and, for both reasons the problems of the Great Lakes may not receive the degree of concentrated attention that they might require.

In the United States, federal agencies have inadequacies with respect to abandoned landfills and despite having legal authority, the Environmental Protection Agency has not exercised this authority over the implementation of

controls on pollution stemming from most land use practices. In most Great Lakes Basin States, matters such as sediment control and agricultural drainage have traditionally rested largely with local agencies whose responsibilities are not oriented towards water quality protection. Also, the regulation of private sewage waste disposal systems has been primarily directed at public health rather than water quality considerations.

Examples of agencies with potentially very effective mandates that could use their powers more broadly but may be inhibited by lack of funding, expertise, or other priorities, include the Conservation Authorities in Ontario, and County Drainage Boards and many Soil and Water Conservation Districts in the United States.

Thus, while there have been advances in incorporating environmental concerns and major new pollution control programs, there remains a need for jurisdictions to develop and implement comprehensive pollution control strategies, particularly with respect to dealing with diffuse sources in a systematic manner. The development and implementation of a consistent, comprehensive approach which can overcome gaps and inconsistencies both within and beyond the environmental policy area, as well as the provision of adequate technical and financial resources, is believed to be important to achieving effective progress in an equitable manner. Furthermore, by this means, governments will be able to put into practice a more holistic approach to decision-making, presented in this Report as the Ecosystem Approach, which will encourage the consideration and balancing of all societal goals, both short term and long term, as opposed to continuing a race for funding and individual agency goals that can only result in an emphasis on short term and relatively narrow perspectives. The problem of pollution from nonpoint sources on which a myriad of policies both direct and indirect are brought to bear, demonstrates the dangers of the more compartmentalized approach to government which may have been fruitful and indeed necessary in the past.

The Commission does not wish to imply that the adoption of this broader perspective will be easy or accomplished immediately. On the contrary, its implementation will take time and will be difficult. The Commission does believe, however, that governments should take real steps to move in this direction. Furthermore, the Commission does not wish to imply that governments and environmental agencies have not made substantial progress, but rather that they have done so under severe constraints, and that it is desirable to move into a new era of environmental ethic, to be accomplished in partnership with all agencies of government.

A major element in achieving such an approach, would be the provision of a strong coordinating mechanism within each jurisdiction that would ensure:

- o intergovernmental coordination;
- o that programs to achieve minimum standards or guidelines are met;
- o the resolution of priorities in a rational manner which meets, to the degree possible, the needs of the Great Lakes system;

- that all governmental policies and programs are reviewed and coordinated with respect to ensuring that environmental quality implications are not overlooked or given too low a priority by agencies with primary responsibilities in other areas, and that a long term, ecosystem perspective is given to governmental decision-making;

- the clear definition of responsibilities for action where more than one agency is involved in the management of a particular activity such as agriculture or urban development; and

- the dedication of adequate funding and manpower to carry out programs in the manner described above.

While a high degree of coordination is important, it will be also necessary to instill the need for active cooperation between agencies, and for the understanding and recognition of conflicting needs. The issuing of formal policy statements to this end does not always result in their implementation at the field level. Hence, the achievement of effective environmental control does not necessarily evolve from imposed environmental assessment requirements when there is no mutual understanding and commitment. This situation can result in an atmosphere of attempts to gain exceptions, or to meet only minimum constraints. In order to achieve a true integration of production, development, health, natural resource management and environmental interests, a major internal program of education and the development of working interrelationships will be required in each jurisdiction.

The Commission believes that, in general, the elements of this system are in place in the federal, state/provincial and even local jurisdictions. In each case, however, the mechanism should be strengthened and expanded to ensure comprehensive coverage of all policies and programs affecting the generation and control of pollution from land use activities, and the ability to implement the management strategies that result.

At the Federal level, a logical focal point rests in the central environmental agencies, Environment Canada and the Environmental Protection Agency. In Canada, the power of the Department has been primarily that of persuasion, with the Environmental Assessment and Review Process not being a statutory requirement, as noted earlier. The power of persuasion can and has been effective, however, and has operated through both bilateral contacts and working relationships with other agencies, and through the more formalized interdepartmental committees, such as the Interdepartmental Committee on Water. A strengthening of the ability to bring about cooperation and serious consideration of environmental factors would be beneficial. This does not presuppose that these factors should be supreme or that this one agency should have lead responsibility in all or even most instances. This would help ensure, however, that a consistent, long term environmental viewpoint is carefully considered in policy formulation, including that of relevant fiscal policy in which the Federal Government has such a powerful role.

In the United States, in order to improve the coordination of programs and ensure high priority for Great Lakes programs, the active coordination of the Great Lakes Basin activities of all relevant federal agencies is required. The relevant agencies would include the Environmental Protection Service, the National Oceanic and Atmospheric Administration, the U.S. Army Corps of

Engineers, the Fish and Wildlife Service, the Soil Conservation Service and the U.S. Agricultural Stabilization and Conservation Service, as well as others.

All States and the Province of Ontario have mechanisms that could serve a coordinating role, if given an adequate mandate and input into the decisions of agencies operating under present or future legislation. In Ontario, the Planning Act itself is a powerful tool, which could accomplish a great deal in the realm of nonpoint pollution prevention, particularly in urban areas. The implementation of the Planning Act has involved interagency review but has not been fundamentally environment-oriented, although it could be so utilized to a greater degree. The Environmental Assessment Act is similarly wide-ranging and could be used as a further basis for an active coordinating mechanism, although its applicability to diffuse sources of pollution is not clear. In any event, the system of interdepartmental coordination such as the Land Use Committee with representation from the Ministries of Agriculture and Food, Environment, Housing, Natural Resources, Transportation and Communication and Labour, could be an appropriate vehicle.

All States have environmentally-oriented agencies, but with a wide variety in their scope of powers. Agencies having responsibilities such as agriculture also have major responsibilities in the field of pollution control in some cases. Provisions for coordination exists at the State level, but are limited in scope and degree, and vary between states. There is a general need to strengthen such mechanisms. Further, with some notable exceptions, for most of the major nonpoint pollution problems the exercise of control power has traditionally been left to the local jurisdictions and in many cases not used.

Potential coordinating agencies also exist at the local level as will be discussed in a later section. It is important to recognize, however, that reliance on local jurisdictions for environmental policy development and regulatory control has generally resulted in uneven application of environmental standards of behaviour, with effective controls or even consideration of ultimate environmental consequences being the exception rather than the rule. This is due in large part to the narrow geographical and functional scope of local concern. With their broad powers, the senior levels of government as relevant within each country should assume basic control and monitoring of nonpoint pollution control measures, centered in a lead agency or coordinating mechanism, although implementation may well be accomplished at least in part at the local level.

4. Identification of Broadscale Remedial Programs and Priorities

Once a conceptual management framework and cooperative implementation mechanism have been developed, but prior to a plan of action for dealing with the problems identified, it will be necessary to determine a basic approach to remedial action. Two fundamental methods were identified, and received much discussion, in the PLUARG Report and subsequent Public Hearings. These are:

- the selective approach, whereby specific priority areas (mainly those causing the greatest pollution or easiest to control) are identified for intensive attention while other areas, of less concern from a water quality standpoint, are left alone or for a later time once the most severe problems have been solved; and

- the broadscale approach, whereby measures are applied equally throughout the Great Lakes Basin in order to achieve a reduction in pollution from all land areas within a particular land use category or polluting activity.

The PLUARG Report stressed a site-specific, selective approach to major remedial action, with priorities based on three basic criteria:

(a) the water quality conditions within each lake, or sub-section thereof;

(b) the "potential contributing areas" identified by PLUARG in its assessment of potential pollutant loadings;

(c) the most hydrologically active areas within the potential contributing areas, the former being defined as those areas that have the highest potential for pollutant delivery to receiving waters due to their hydrological characteristics.

The rationale for emphasizing the selective approach to major remedial action was three-fold:

- since technical and financial resource will likely be inadequate to solve all pollution problems simulataneously, there is a need to establish priorities to solve the worst problems first and obtain the maximum possible improvement in environmental quality with available resources;

- if the contribution to pollution from certain areas or uses is minor, then it should not be necessary, and would not be justifiable or equitable, to impose corrective measures that are required to deal with pollution levels caused elsewhere;

- in order to be practicable, solutions have to be designed for specific locations, since only then can the required practices and supporting measures be defined, due to a virtually infinite variety in the physical, chemical and hydrological characteristics of the land, and of ongoing land management practices.

The concern expressed about the selective application of remedial measures is that some of the affected individuals would be penalized relative to other citizens or producers (particularly if they are in a competitive situation such as selling farm products) solely on the basis of geographical location. The recent increase in knowledge about the causes and effects of pollution is seen as leading to an unfair burden on persons who, by accident or due to a lack of knowledge and concern about environmental impacts when they began their activity, happen to occupy land in a potentially contributing area. Furthermore, this burden is imposed to achieve pollution control benefits that accrue to society as a whole, possibly to the detriment of other social imperatives such as the family farm and food supply.

Applying remedial requirements equally to all units in a land use category, regardless of the severity of pollution occurring, the broadscale approach, is seen by its proponents as being more equitable, in that it is broader-based and spreads the burden. The common application of these requirements could be on the basis of defining acceptable or unacceptable

practices, required technologies, performance standards or across-the-board percentage reductions in loadings. In addition, it has been suggested that such an approach would be more effectively and easily applied, monitored and enforced than the selective one since there would be no need to inspect, assess or monitor individual sites and practices. These procedures can require large and costly manpower and ancillary resources that are often lacking even at current levels of management. While such resources would also be required to ensure broadscale compliance, they would likely be less extensive and based on spot-checks or some form of reporting.

In considering these approaches, the Commission concludes that resolving the "dual equity" question requires a two-tiered application of programs, on the basis of the costs and benefits involved: relatively low cost but generally beneficial measures should be applied throughout the Basin, with more costly or selectively relevant measures applied in priority areas. It is clear that there are certain measures to reduce pollutant loadings (particularly nutrients and sedimentation), which can and should be applied to all activities within a land use category generally, without regard for the criteria suggested above for establishing priorities. Thus the broadscale approach should also be applied.

The concept of establishing priorities for major remedial measures from locational and land use perspectives is also logical, cost-effective and indeed equitable. Consequently, the Commission endorses the PLUARG recommendation for the development of regional priorities for implementing major remedial programs within management plans, but within the following constraints:

- the designation of priorities on the basis of lake conditions for various pollutants should bear in mind not only stated water quality objectives, but also the following: the principle of non-degradation of higher quality waters (further to the Commission's Report on Water Quality of the Upper Great Lakes specifically Chapter 7), impacts on other elements of environmental conditions such as fish stocks and wildlife, the occurrence of severe local problems (in particular nearshore areas or tributary streams), and the impact of controlling upstream lake pollution on total lake loadings via connecting channels;

- the concentration on potential contributing areas for specific pollutants and land use activities should not preclude nonpoint pollution controls throughout the Basin if they are readily achievable. Further, the control of nonpoint sources should not be considered in isolation of point source pollution and the relative cost-effectiveness of further controls thereon, including new or developing technologies;

- the imposition of remedial programs to individual areas should take cognizance of the economic and social impacts, with a view to developing measures that would counteract or alleviate undesirable side effects of the environmental measures.

The Commission recommends that, as part of the management plans, governments develop and implement remedial plans as may be necessary for achieving the desired reduction in pollution from priority areas. Priority

areas should be selected on the basis of the most severe whole lake and nearshore water quality problems, the present land use activities and areas which have a high potential for contributing pollutants, and (within these) hydrologically active areas. The major contributing areas for phosphorus are identified in Figure 1-3. More detailed information will require an assessment of water quality data, soils maps and farming practices, much of which is available, at least at the regional or local level. The assessment of such information, or the provision of additional data where gaps occur should be an integral part of both the overall strategy and the management plans.

The Commission also recommends that Governments develop and implement plans to bring about environmentally-conscious planning and land management practices throughout the Basin.

Measures to be applied across the Basin should generally be those that are low cost, applicable to a large number of locations for a land use activity; they may well be also beneficial for other reasons in addition to pollution control, for example by actually increasing agricultural production or reducing material costs. While these will be discussed in more detail in the second section of this chapter, a few examples serve to illustrate the types of measures that should be implemented throughout the Basin. For the most part, these correspond to proper management practices and what PLUARG termed "Level 1 Measures"; they are:

- soil conservation practices in farming, including appropriate plowing techniques and avoiding tillage of steep slopes or stream banks;

- application of inorganic fertilizers and manures at rates that are not excessive to soil and crop needs, and their proper incorporation into the soil;

- avoidance of winter spreading of manure on frozen ground; (this can be a "major" measure if the construction of new holding facilities is needed);

- application of environmentally sound drainage design and adequate maintenance of drainage systems;

- reduction of urban pollutants at source including provision for the proper disposal of toxic and oil-based substances;

- adequate planning and design of urban developments to minimize the disruption of natural stormwater retention capacities to the extent possible, avoid development on particularly erosion-sensitive areas and flood plains, and the provision of sediment control measures in all developments;

- proper design and maintenance of private, non-sewered waste disposal systems.

While the Commission generally endorses the "pollutor-pays principle", (that is, that sources of pollution should internalize the costs of pollution control rather than generalizing the social costs by causing environmental degradation or by using publicly funded pollution control programs), it

believes that this should be modified with regard to the implementation of major remedial measures by certain nonpoint sources, particularly small-scale agricultural operations. In order to avoid harmful economic effects and to encourage the cooperation of the many small-area farmers who contribute individually minor although cumulatively significant pollutant loadings, but whose economic existence is often marginal and highly cost competitive, adequate programs of financial assistance are required. Subsidies or tax measures, for example, could spread the burden of compliance in a manner that would not be done by market forces, and thereby meet much of the concern about the potential social inequity of the selective approach. To a lesser degree, the same concept could be applied to local municipalities which are suffering under an increasing burden of providing expensive infrastructure and services on a narrow taxation base.

5. Assessment of Cost-Effectiveness and Implementation Practicability

With respect to major remedial measures, once priority areas have been identified, the next stage is to identify practicable pollution control measures and assess their relative cost-effectiveness, that is, the amount of pollutants reduced per dollar of expenditure, in order to assist in selecting the best measure.

Alternative measures can be designed. In some instances, this will apply to fairly large areas and a range of land use operations, whereas in others it may be necessary to develop site-specific solutions for the individual farm or community. This can be determined, although there may be major implications of time and expert manpower, and many complexities may be involved in arriving at practicable remedial measures commensurate with the scope and significance of the site and its runoff problems.

The question of the costs, ultimate effectiveness and benefits of the proposed or alternative solutions is much more difficult to determine, given the rudimentary current state of knowledge concerning nonpoint pollution control and the complex interactions of the many natural and management uncertainties. Costs may be identified with some degree of assurance for individual sites, but can only be estimated within wide bounds for larger areas. Effectiveness of programs is somewhat speculative, due to a large number of natural and human factors, singly and in combination, that can have an impact on the successful application of management plans. These include climate, surface/groundwater interrelationships, the transmission of pollutants through tributaries (perhaps over great distances) prior to reaching the Great Lakes, and the degree of dependability with which land owners will implement the prescribed procedures of the management plans. To a large degree, this is dependent on the amount of understanding, commitment, information and technical support, and follow-up action that is involved.

The matter of benefits is still more difficult. Even if the effectiveness of measures in terms of pollutant loading reduction is known, very little information is available about its significance in terms of social welfare or benefit, except in a general, qualitative way. The ramifications through the ecosystem are not well known, and if they were, they involve public resources which do not have established values through the market system. Both PLUARG and the Commission have recognized the lack of effort towards measuring quantifiable benefits from Great Lakes pollution control except in those few

instances where clear implications for public health and property are involved.

Despite the difficulties involved, it is becoming increasingly evident that governments wish to have information on cost-effectiveness of remedial programs when restricted public funds, are involved, or when private interests are to be impelled or persuaded to bear additional costs. Certain dangers exist in this area of policy analysis. Economics is only one aspect of decision-making, and while improvements have been made in recent years in the methodology of environmental economics, it is not possible to obtain a complete accounting of all costs and benefits, both tangible and intangible. Some relevant considerations cannot be measured in concrete terms, and for others the analysis is so complex or lacking in basic data, that the results could be misleading. One example of this is the attempt to measure the impact of carcinogens in dollar terms. Also, an analysis might indicate that an environmental program is not desirable from the viewpoint of economics; nevertheless, the analysis is still of value, as long as other considerations that are not included in the economic analysis are also eventually taken into account. At the least, there is some measure of the benefits foregone, perhaps in another economic sector - this is the concept of "opportunity cost", i.e. the foregone values due to taking or failing to take a certain action. In many instances, the information gained could assist in achieving acceptance and implementation of environmental programs, even if only some of the benefits can be readily demonstrated. At the present time, for much of the Great Lakes pollution control program, only limited case studies are available on which to judge the potential magnitude of benefits. The Great Lakes Research Advisory Board (now Science Advisory Board) concluded in its 1978 Report: Canada-United States Research Programs Pertinent to the Water Quality of the Great Lakes, which report resulted from the 1976 Research Needs Workshop and follow-up assessment of existing agency programs, that:

> "The scope of effort pertaining to identified socio-economic and political issues appears limited. Little program focus or co-ordination is evident, with studies being scattered and directed to specific research topics.
>
> "The aggregated research programs which were monitored (in all areas of Great Lakes environmental research covered by the study) identify a research budget allocation of approximately 100 million dollars with some 13 to 15 million dollars committed to efforts specific to the Great Lakes. Programs addressing ecological and technological issues account for some 98 percent of the aggregated budget with an allocation of approximately 50 percent to each of the issue areas. The remaining 2 percent is directed to the social-economic-political area."

The Commission believes that both the value and limitations of assessing benefits and costs as a means of developing the most effective pollution control strategy should be recognized. This activity will be a long term and gradual effort. Because of the need to develop and implement management plans, and to proceed without delay with nonpoint pollution control as well as other aspects of the 1978 Great Lakes Water Quality Agreement, the Commission does not suggest that the latter should be delayed until the socio-economic consequences are better known. On the contrary, the Commission recommends that a program of assessment of the social and economic implications of pollution control, including the monitoring and evaluation of the effectiveness of remedial measures adopted as a result of this Report, be

initiated concurrently with the development of comprehensive management strategies. Furthermore, since certain benefits and indirect costs may lie outside the individual jurisdictions undertaking remedial action as part of a national or international obligation, this program should be coordinated or perhaps even conducted, at least in part, at the highest level of the management framework, that is at the international level, much as has occured with various scientific programs.

Furthermore, in developing management strategies and the analysis of cost-effectiveness therein, it is the recommendation of the Commission that responsible agencies institute procedures for ensuring that all alternatives for controlling particular pollutants, and their local, regional and national implications, are considered consistent with the ecosystem approach. This would include the whole range of point, nonpoint and source-reduction controls to the extent that they are relevant, and alternate practicable technologies for achieving these controls.

6. Administrative and Legislative Requirements

The planning and implementation of nonpoint pollution management programs within the general framework provided would require a detailed review of and adjustments to specific administrative mechanisms, including agency responsibilities and procedures, and the legislative basis of environmental, land and resource management policies.

Much testimony at the Public Hearings and several reports from the various PLUARG Panels emphasized the desirability of improving the mandate and operations of existing government agencies rather than creating new ones. In effect PLUARG had taken this viewpoint also, in its recommendations that better use be made of existing planning mechanisms in implementing nonpoint source control programs, that the adequacy of existing and proposed legislation be assessed to ensure a suitable legal basis for enforcement and that the greater emphasis be placed on the preventive aspects of laws and regulations. PLUARG suggested that governments "review the adequacy of their present voluntary programs and consider other inducements or regulation alternatives where these programs are found lacking ... determine if more specific guidelines are needed. *Wherever possible, governments should maximize the utility of existing programs rather than creating new ones.*"

While the Commission supports, in principle, the concept of simplifying and minimizing the amount and complexity of government, and indeed of using existing legislation and administrative mechanisms more effectively, it is apparent from the review of the existing status of nonpoint pollution control, and of government policies and programs, that the review and revisions to current mechanisms noted above will be required and that this may well indicate the need for new initiatives or programs rather than merely adjusting old ones. Thus, while existing agencies and programs may well be retained and enhanced, where possible and desirable, this should not unduly inhibit their supercession or replacement by new structures, where they are required for effectively addressing nonpoint pollution problems.

Three additional elements should be considered in the legislative-administrative review, all within the context of the ecosystem approach and the comprehensive management strategy concept.

A. VOLUNTARY VS. REGULATORY ACTION

A concern expressed frequently during the Public Hearings was the extent to which the remedial strategies should rely on voluntary efforts as opposed to government regulation. The realities of government funding, the reaction of land owners, particularly farmers who are highly independent by nature, and the general trend of social opinion, all point towards a reaction against further layers and complexities of government regulation in favour of encouraging voluntarism and a more efficient and effective application of existing measures . A significant danger of increasing restrictions on individual behaviour is backlash, which is known to occur in other regulated areas, so that the object becomes one of contravening the regulations rather than the cooperative achievement of social and environmental goals. The basic philosophy of those supporting the voluntary approach is that the vast majority of individuals will change their undesirable practices if they are brought to recognize the problem and their contribution to it, are provided with technical support, and given protection from the severe economic hardship that might result from the required actions.

There was also a strong body of opinion expressed at the Hearings that further regulation is required, along with effective legislation and monitoring, to ensure consistent and equitable implementation of environmental programs. This attitude is based on experience with resistance against environmental controls, the failure of many corporations and individuals to recognize their impact on water quality and to adopt "best management practices", even when they have been provided with the proper procedures, and the very limited success of public exhortation programs such as those concerning energy conservation and resource recovery (recycling), among other things.

An example of the failure to take voluntary action from the PLUARG studies, is the reaction of many Ontario farmers to the free soil testing service of the Ontario Ministry of Agriculture and Food, with respect to fertilizer requirements. A survey of some 1,500 farmers, selected randomly, showed that whereas 90 percent of farmers were aware of the service, only 60 percent had ever availed themselves of it. Of this 60 percent, 17 percent had not been tested in five years and only 14 percent had been tested every year. Furthermore, a sub-sample of tested respondents indicated that 90 percent of those who had soil tests done made changes to the recommended application amounts, over half of which were considered to be ill-advised.

In the survey of United States farmers, which did not ask about the use of soil tests, nearly 90 percent of farmers followed some kind of soil conservation practice (especially crop rotation and leaving residues over winter) and half stated that they followed a conservation plan. Most farmers, however, were not aware that the major farm nutrient-pollution problems identified by PLUARG existed. Only a third (32%) of all farmers felt that pesticides and fertilizers contributed to Great Lakes pollution, and less than a quarter (22%) that manure did so. Almost half (49%) of the farmers surveyed recognized the pollution hazard from soil erosion, however. The major source of their information on these matters was the public media, especially newspapers and magazines, rather than governmental agencies or farm organizations; three quarters (77%) of the

United States Great Lakes farmers agreed that more information on how to control water pollution was needed. Doubtless other examples of the need to inform and encourage individuals to adopt environmentally-sound practices can be derived from experience in other jurisdictions and other sectors of economic and social activity.

PLUARG's conclusions on this question was that a mixed approach would be required: it stressed voluntary action as desirable and indeed stated that the success of nonpoint pollution control "will have to rely heavily on the interest and concern of individual members of society". Nevertheless regulation will also be required, since reliance on voluntary compliance will not always be effective, most notably in instances when the environment and the activities of people are subject to competing goals. PLUARG thus concluded that all levels of government should review the adequacy of existing voluntary programs and consider other incentives or regulations where voluntary measures do not produce the desired results.

The Commission recognizes the value of using and improving on voluntary programs, particularly when they can be conducted by established organizations and when they are likely to be effective. This approach has merit in its own right, by increasing public participation and commitment, and also allows governments to concentrate limited public funds in areas where they will be required most. It must be emphasized, however, that the success of the voluntary approach will be highly dependent on the amount of guidance and effort given to it by the agencies of the government. The Commission agrees with PLUARG and its Public Consultation panels, that the achievement of Great Lakes water quality goals will require a greater emphasis on developing an informed public, and that concrete efforts to provide planners and land managers with relevant technical information and assistance is the key to the success of the voluntary approach. In some instances, information can be made available that will demonstrate economic advantages, at least in the long term such as erosion control, to adopting environmentally-sound practices. The Commission's more specific views on public education and participation are contained later in this Report.

Notwithstanding the potential for voluntary action, the Commission concludes that there is a need for regulation in some instances. The Commission recommends that regulations be adopted where needed to ensure consistent and equitable implementation of required remedial measures. Three specific areas that the Commission has identified as requiring such regulation are: the prohibition of winter spreading of manure on frozen ground, the regulation of sediment runoff from urban areas under construction, and the regulation of industrial wastes management to prevent environmental contamination. Regulation could take the form of enforceable guidelines to be applied first by the individuals and then, if required, enforcement by local agencies or State, Provincial or Federal authorities as relevant.

B. FUNDING

Adequate legislation and mechanisms for nonpoint pollution control can be rendered ineffective by the failure to ensure sufficient funding or manpower to carry out technical and financial assistance programs, or monitoring and enforcement activities.

Within existing financial assistance programs, in both countries, total appropriations may be too small to deal with all or many of even the most severe cases of pollution. Particular grant programs may be too restrictive with respect to incorporated conditions on location, economic sector or type of investment, to apply to the proper priorities of a wide-range of nonpoint situations, or they may place ceilings on the funding of individual applications that are too low to provide sufficient incentive for their wide-scale use. Agencies in both countries having roles in technical assistance, inspection and enforcement are generally too constrained as to operating funds and manpower to carry out a sufficiently intensive program within a reasonable time period for example feedlot inspection programs, sewage sludge management and private sewage disposal system inspections. Two examples of grant programs that have been inadequately funded are: (a) The United States Rural Clean Waters Act, which has the potential to help control pollution from farmlands in the high priority areas which are identified by 208 plans, but which received very little funding during Fiscal Year 1979. In any event, given the likely distribution of authorized funds (even if appropriated), considerably more funds will be required to remedy a significant portion of the problems in the United States Great Lakes Basin to which it might be applied, and (b) the Province of Ontario's capital grants program, under which 40 percent of the capital costs of farm improvements relating to erosion control, manure management and similar matters has been available to farmers from the Province, but grants have had a maximum limit of $3,000, although the entire provincial capital grants program has been under review. This amount certainly would not act as a major incentive for farmers to undertake specific projects to reduce pollution.

While recognizing the general constraints placed on the expansion of government employment and expenditures at all levels in both countries, as well as the competing needs of all governmental programs, the Commission urges the governments to give careful consideration to the sufficiency of financial assistance and personnel, particularly with respect to nonpoint pollution control but also including related programs now in place or planned for the Great Lakes Basin. This review is needed to assess the likelihood of effective implementation and monitoring of these programs, and in order to make suitable provision, (to the extent possible), for greater resources or for more efficient utilization of those now available.

C. LOCAL RESPONSIBILITIES

Despite the view expressed earlier that comprehensive environmental coordination should rest with mechanisms in the senior levels of government, there is considerable merit in allowing a large degree of responsibility for implementation and management-planning input to fall at the local level of jurisdiction. Land-based problems have a variety of site-specific factors that should be addressed in a manner responsible to local natural and human needs, while maintaining a primary thrust of solving problems that may lie outside the local area in their impact. In order for the definition of specific remedial requirements to be practicable and for their implementation to be effective, a high degree of local knowledge, involvement and contact with individuals ultimately causing the pollution problems, are necessary.

At the same time, local institutions are usually lacking in sufficient technical and financial resources to carry out this function alone, even within guidelines. There is a need therefore, to reinforce or establish mechanisms to provide for a local, state, provincial and, in some instances perhaps federal partnership, on a county but preferably watershed basis, in order to address adequately the entire sphere of land management problems from an environmental as well as a traditional viewpoint. Again, it would appear that the basic mechanisms are in place and have indeed been evolving towards an environmental perspective.

In Canada, the Conservation Authorities have a long history of provincial and local partnership in watershed management that could form the basis for an effective implementation of nonpoint pollution control in areas where they exist. These include most of the developed tributaries of the Great Lakes Basin. Operating under provincial legislation that gives them a broad mandate over renewable resource planning and management, in particular water resources, and with a high degree of local involvement, the Conservation Authorities could, with a change in focus from that traditionally maintained, implement most non point controls relating to soil and water conservation, and land use planning in flood plains. For the most part, their efforts have been directed at flood management and recreational developments in designated management areas, although some authorities have recently been moving towards greater efforts in water quality protection, erosion control, and environmental education. The furthering of this trend should be encouraged by firm guidelines and technical assistance in this area from the province, in the same manner as it has been provided by the Ministry of Natural Resources in areas such as water and forest resource management. Further, greater power to regulate land use and potential polluting activities should be provided throughout the watersheds covered.

Also in the Province of Ontario, the well-established mechanism of urban planning, with shared responsibilities between the Province, regional government and municipalities could provide a further institutional foundation for urban nonpoint pollution prevention. This procedure, based on the Planning Act can influence both regional and urban plans including zoning uses and the designation of hazard lands where development cannot occur, as well as individual subdivision plans including infrastructure and overall design. While the statute has sufficiently broad powers to incorporate environmental concerns, there is no requirement to do so, and many local plans have been silent in this regard. Environmental agencies and Conservation Authorities have a largely advisory role, unless specific provisions are made otherwise. The coordination of governmental programs, proposed above, should extend to the Planning Act in those aspects relating to water quality. In their areas of responsibility, Conservation Authorities should be assured a greater role and expertise in assessing the suitability of proposed plans or subdivision agreements with respect to flood and erosion control, throughout their areas of responsibility.

In the United States, the area-wide water quality management planning process under Section 208 of PL 92-500 involves local planning and approval, state pollution control responsibility and technical assistance, and federal certification and funding, all in a structured manner. Designated area or state planning agencies are required to develop controls over land runoff as part of the Plans, on the basis of guidelines

provided by EPA to ensure consistent action towards improving water quality. This process is a good example of comprehensive environmental planning, carried out at the local or regional level in some 30 locations in the United States Great Lakes Basin, in a generally successful manner. Several problems have emerged, however, as was identified at the Commission's Public Hearings and in the Great Lakes Basin Commission's "Post-PLUARG Evaluation of Great Lakes Water Quality Management Studies." Problems include the lack of EPA action to ensure implementation of nonpoint aspects of approved plans, resulting in a reliance on the interest and commitment of local governments to take action. Problems in the planning process itself include the need for: greater coordination, communication and technical information flow between the 208 agencies, and basin-wide environmental and other resource management programs concerning the Great Lakes; clear goals and objectives for the Great Lakes on which planning can be based; and more area-specific basic data on links between land use practices and pollution. The Commission recommends that measures should be taken to improve linkages between the 208 agencies and other environmental and resource decision-making bodies, and to strengthen the powers of implementation at the local or regional level within the context of overall objectives and guidance from the State and/or Federal level.

The U.S. Soil Conservation Service with its locally-based Soil Conservation Districts or Soil and Water Conservation Districts, and similar structures at the state level, provide a strong basis for implementing various nonpoint pollution control measures, relating to the agricultural sector. The local districts have a wide range of planning and implementation powers, but the extent to which these are enforced, either due to mandate or the fervor of local districts, and especially with regard to water quality, varies both between states and within states. As a mechanism somewhat similar to the Conservation Authorities in Ontario, including the concept of Federal-State-Local partnership, they could perform a comparable role in the agricultural area.

With respect to developing areas, SCS, county and local development and regulatory bodies have varying degrees of institutional experience and expertise in regulating runoff. Those agencies could play significant roles in implementing nonpoint remedial programs.

While the institutional basis may be largely present, it will be necessary for governments to assess in detail the improvements that are needed within their mandate and within the general context outlined above, in particular to provide sufficient powers of implementation, and to determine the need for incentives and resources on the part of these mechanisms to carry out their ultimate responsibilities that may be assigned within the overall management strategy. A shift in emphasis from the past or further financial and technical resources, would appear to be required in many instances.

7. Public Involvement and Information

The PLUARG Public Hearings and the Public Consultation Panels which preceded them demonstrated that most people are unaware of the extent to which urban and rural land use activities affect the water quality of the Great Lakes, and of the fact that they themselves may be directly involved and

responsible for deteriorating ecosystem quality. The lack of awareness of the effect of the various land use activities on water quality was attributed mainly to the fact that there has been little or no public education with respect to these diffuse sources of pollution. It was also recognized that the acceptance and successful implementation of PLUARG's recommendations would be possible only if there were an informed public. A stronger educational program was recommended by many witnesses at the public hearings as being the best way to create this informed public. An informed and active public would also assist Governments in reaching acceptable solutions to nonpoint pollution problems and should be encouraged for this reason also. In this regard, the Commission notes that each jurisdiction has an environmental information program, and Governments have provided for a basin wide program in Article VII of the 1978 Great Lakes Water Quality Agreement.

The Commission believes that in addition to existing public information programs, there is a need for a general environmental- education program, and recommends that the governments consider the following measures.

First, people must be made aware of the existing local problems and their impact on the Great Lakes ecosystem, and be encouraged to participate in solving these problems. Comments received at the public hearings were strongly in favour of giving people the opportunity to participate voluntarily in the implementation of remedial measures. An educational program for the general public could use such local civic and environmental organizations to explain the significance to the PLUARG findings and to encourage program development. Feed-back from these groups could be used as an input into the development of an educational program. The same community groups could also be the vehicle for encouraging the development of practical demonstration programs at the local level, geared to the needs of specific areas. The emphasis should be on consulting people to meet their particular needs rather than presenting them with a fixed program.

Secondly, efforts should be made to familiarize government officials at all levels with the issues concerning both ecosystem management in general and nonpoint pollution in particular. Officials should be encouraged to cooperate with environmental and resource management agencies, and to allocate funds in order to include the relevant preventative or remedial measures in their own programs.

Thirdly, the successful implementation of the various remedial measures will depend upon the skill and knowledge of program managers and field personnel, notably at the local level. These should be provided the opportunity to acquire the necessary technical information and the skills to implement their specific program or tasks properly.

Fourthly, a solid community base must be established to provide continuity once nonpoint remedial measures are implemented. This can best be achieved by making information more accessible to the public education systems and by assisting schools in developing the appropriate programs.

Public involvement in the solution of local problems should be developed within the perspective of the overall Great Lakes ecosystem. It is important for the public to be aware of the fact that the water quality problems of the Great Lakes are to a large part the cumulative effect of many small or local problems. This awareness is necessary for the recommended voluntary approach

to work, and hence the requirement for regulations to enforce environmentally-appropriate behavior might be minimized.

The Commission recommends that such a program be incorporated into the jurisdictional management strategies.

8. Monitoring and Review of Management Plans and Remedial Programs

The success of the recommended comprehensive management strategy will depend in part upon the ability of the various jurisdictions to adopt and implement the various elements outlined in the preceding sections. The Commission is of the opinion, however, that there is a necessity for the establishment of some mechanism to review and evaluate the overall success of the various management plans. This evaluation should consist of three basic components. First, there should be a general review of the adequacy of all state, provincial, and federal management plans. The second component should be an enhanced continous monitoring program within the surveillance program developed under the Great Lakes Water Quality Agreement, including nearshore, river mouth and tributary monitoring to evaluate the success or achievement of the various remedial programs that are in place. Finally, there should be a review of the accomplishments of the overall management strategy to determine whether the provisions of Article VI of the 1978 Water Quality Agreement are being adequately fulfilled.

VI. THE COMMISSION'S CONSIDERATIONS AND CONCLUSIONS REGARDING REMEDIAL MEASURES AND PROBABLE COSTS: SPECIFIC POLLUTION PROBLEMS AND REMEDIAL MEASURES

VI. THE COMMISSION'S CONSIDERATIONS AND CONCLUSIONS REGARDING REMEDIAL MEASURES AND PROBABLE COSTS: SPECIFIC POLLUTION PROBLEMS AND REMEDIAL MEASURES

INTRODUCTION

Within the context of the proposed management strategy, the Commission has reviewed the applicability of various nonpoint and other remedial measures, in order to provide advice on some specific practicable measures that can be taken. To the extent that these measures are environmentally-sound and applicable throughout the Basin (as discussed in Chapter V), they should be encouraged by governments by all means at their disposal. The more costly programs should be considered as options in developing management plans for specific sub-basins and priority pollution management areas, including locations contributing to nearshore problem areas which are not taken into account in the overall assessment. Not all problems or remedies reviewed need to be applicable to all areas nor would the required intensity of implementation be identical everywhere. In any event, programs having clear applicability to current problems should not wait for the full development of the management strategy described above despite its importance, since the latter may well be some time in being brought about. These programs should in the meantime, however, be implemented within the spirit of the overall management strategy.

1. Phosphorus

As phosphorus enters the Great Lakes System from a variety of sources, in varying quantities and forms, a holistic management strategy should be used to address the most cost-effective means of reducing exessive loading levels. In taking this approach, PLUARG concluded that the whole lake target loads recommended in its Report could be met by point source controls on all but Lakes Erie and Ontario, although nonpoint measures would be required to resolve local water quality problems in southern Lake Huron and Saginaw Bay.

Present phosphorus loads could be reduced to target levels, according to PLUARG, by municipal sewage treatment plant effluent limitations of 1 mg/L on Lake Superior and Michigan, and 0.5 mg/L on Lake Huron. PLUARG also concluded that projected future loads (to the year 2020) on Lakes Michigan and Huron would require more restrictive but achievable limitations. Projected target loads on Lakes Superior and Michigan could be reached by point source controls alone although local nearshore problems may require specific nonpoint control action. Southern Lake Huron would in the future require some nonpoint phosphorus control for acceptable main-lake levels, even with a 0.3 mg/L limitation of municipal sewage treatment plant effluents.

Both present and future loads would exceed target loads on Lakes Erie and Ontario, even at the 0.3 mg/L municipal point source limitation, without effective nonpoint phosphorus control programs.

PLUARG concluded that of the options it considered, the most cost-effective measure for controlling phosphorus was a 0.5 mg/L limitation on municipal sewage treatment plants, discharging over one million gallons per day. The incremental cost of a 0.3 mg/L municipal point source effluent limitation was evaluated for conventional treatment plants and found to be very costly, equivalent in cost to some of the most expensive agricultural programs. PLUARG also indicated that a comprehensive nonpoint source program in Lake Erie Basin and selective nonpoint controls for Lake Ontario, southern Lake Huron and Saginaw Bay areas, along with the 0.5 mg/L limitation would be required parts of the minimum cost programs for achieving their respective target loads.

The indicated nonpoint controls include "Level 2"* rural and "Level 1"* urban remedies for Saginaw Bay in Michigan and for southern Lake Huron in Canada. Lake Ontario would require "Level 1*" rural and "Level 2" urban programs, while even more intensive efforts are required in the Lake Erie Basin. The total annual cost of nonpoint controls, including sound management of 112,000 km^2 (27.4 million acres) of agricultural land at a cost not quantified but estimated to be "minimal", was estimated to range from $26.5 to $57.0 million annually, depending on the level of control applied. Close to 40 percent of the above agricultural land would require treatment exceeding "Level 1". In addition, the total incremental annual costs (above 1975 levels) of achieving the 0.5 mg/L point source limitation was estimated at $13.0 million for the United States and $5.0 million for Canada. A breakdown of costs is provided in the PLUARG Executive Summary, (Appendix II), and the various options are outlined in Table 6 of this Report.

In subsequent analysis of the accuracy of its phosphorus loading estimates with respect to climatic variability and assuming that a possible lower mean annual load can be maintained, the PLUARG members concluded that it may be possible to maintain target loading for all lakes with municipal phosphorus discharge limitations of 0.5 mg/L phosphorus alone for some time into the future, and that the degree or mix of application of the various alternate programs may need further consideration. It was maintained, however, that the cost estimates of the alternatives remained valid.

With respect to the accuracy of the cost estimates per se, the Commission has noted several suggestions that the costs are either too high or too low, including one by the United States Corps of Engineers Lake Erie Waste Water Management study which suggests lower costs and greater success potential for second level agricultural measures, notably the practice of zero tillage. Furthermore, the Great Lakes Water Quality Board has questioned, in its review of the PLUARG Report, the feasibility of consistently achieving a 0.5 mg/L phosphorus effluent level at municipal treatment plants. PLUARG has

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*Level 1 nonpoint controls include:
- Rural - sound management practices such as proper nutrient application, minimum tillage, mulching, avoiding slopes near streams, believed achievable at minimal cost
- Urban - reduction of pollutants and stormwater at source including development controls, use of natural storage capacities, street-cleaning.

Level 2 nonpoint controls include Level 1 plus:
- Rural - conservation tillage, contour strip cropping, use of cover crop
- Urban - artificial detention and sedimentation of stormwater runoff

Level 3 (Rural only) is Level 2 measures at greater intensity of effort.

TABLE 6

PRESENT AND FUTURE GREAT LAKES PHOSPHORUS LOADS
UNDER SEVERAL PHOSPHORUS REDUCTION SCENARIOS

	metric tons/yr									
	Lake Superior		Lake Michigan		Lake Huron		Lake Erie		Lake Ontario	
Existing 1976 Total Load (excluding shoreline erosion)	4,207		6,350		4,857		17,474		11,755	
Existing 1976 Nonpoint Load[a]	2,238		1,891		2,444		8,445		3,581	
Recommended Target Loads[b]	4,000		4,900		4,400		11,000		7,000	
Reduction Scenarios[c]:	Present (1976)	Futured (2020)	Present (1976)	Futured (2020)	Present (1976)	Futured (2020)	Present (1976)	Futured (2020)	Present (1976)	Futured[d] (2020)
Scenario 1 (STPs at 1 mg/L) Total Load	4,000	4,000	4,900	5,300	4,500[e]	4,700[e]	13,400	14,700	9,400	11,000
Additional Reduction Required to Meet Target Load	0	0	0	300	100	300	2,400	3,700	2,400	4,000
Percent of Existing Nonpoint Load	0	0	0	16	4	12	28	44	67	112
Scenario 2 (STPs at 0.5 mg/L) Total Load	4,000	4,000	4,400	4,700	4,400[e]	4,500[e]	12,000	12,600	8,200	9,000
Additional Reduction Required to Meet Target Load	0	0	0	0	0	100	1,000	1,600	1,200	2,000
Percent of Existing Nonpoint Load	0	0	0	0	0	4	12	19	34	56
Scenario 3 (STPs at 0.3 mg/L) Total Load	← Not considered Because Target Loads are Achieved in Either Scenario 1 or 2 above →						11,500[f]	11,900[f]	7,800[g]	8,300[g]
Additional Reduction Required to Meet Target Load							500	900	800	1,300
Percent of Existing Nonpoint Load							6	11	22	36

Explanation of Table 6

[a] includes tributary diffuse and municipal nonpoint direct phosphorus loads; does not include direct atmospheric and upstream lake loads.
[b] modified from Task Group III recommended phosphorus loads for Great Lakes (see chapter 1.2 for rationale of recommended loads).
[c] only sewage treatment plants with flows ≥ one million gallons per day are reduced to the indicated effluent standards.
[d] sewage treatment plants and upstram lake loads have been projected on the basis of population trends. All other lake inputs were kept constant in these scenarios.
[e] loading reduction may be applied to Saginaw Bay
[f] based on assumption that phosphorus concentrations in Lake Huron sewage treatment plant effluent (> one million gallons per day) are reduced to 0.5 mg/L.
[g] based on assumption that phosphorus concentrations in Lake Erie sewage treatment plant effluents (> one million gallons per day) are reduced to 0.3 mg/L.

maintained that its modelling procedure led to cost estimates that are as accurate as possible at the gross level of calculation and within a range of ± 30%, more probably over-estimated than under-estimated due to conservative assumptions. Refined cost estimates require a more detailed level of study, such as achievable through pilot programs for specific types of site and land use practices.

The Commission has reviewed the conclusions of the Reference Group concerning phosphorus management strategies, and believes that they represent a major step forward in addressing the probable costs and loading reductions with respect to nonpoint pollution from various sources. These estimates establish a firm basis for developing the broad remedial strategies for land use activities, and indeed for specific corrective programs, at least until such time as better information becomes available. These values may be better tuned once the United States Corps of Engineers' Lake Erie Waste Water Management Study results become available publicly, and as actual experience can be used as a guide. There is no basis to assume that the PLUARG conclusions in this regard are seriously in error. Indeed, many Section 208 planning agencies, and at least one major Conservation Authority in Ontario, have indicated that the PLUARG Report will form a basis for remedial programs.

The Commission does not consider it possible at the present time, however, to make a recommendation on controlling municipal treatment plant effluents to a level of 0.5 mg/L. The Commission supports the need for further phosphorus reductions, beyond those to be achieved by the present programs in order to achieve Agreement objectives. It is not clear, however, that achieving 0.5 mg/L is either feasible (technically and economically), for the majority of existing sewage treatment plants, nor with respect to Lake Erie at least, desirable on the basis of relative cost-effectiveness. Other alternatives should be investigated further before embarking on another major public investment program. These include the consideration of other effluent limitations (e.g. between 1.0 and 0.5, or even lower in specific plants where this is possible and cost-effective), and of alternate technologies for the disposal of municipal effluents such as land application which can reduce phosphorus concentration from municipal treatment plants under appropriate conditions to as low as 0.1 mg/L. The strategy question of whether all plants should be required to reach identical effluent levels, without regard to relative efficiencies in being able to reach total loading reductions, should be addressed in the light of the selective application of these technologies. The Commission also notes the view of the Great Lakes Basin Commission that a complete achievement of the 1.0 mg/L effluent standard, and Level 1 nonpoint controls, is the best approach. This Commission observes, however, that the strategy proposed by the Great Lakes Basin Commission is not predicated on achieving the target loads tentatively recommended in this Report. The IJC, therefore, does not endorse the views of the GLBC at this time.

The Commission is thus not in a position at the present time to recommend specific phosphorus management strategies which would achieve the target loads.

The Commission's Task Force on Phosphorus Management Strategies is expected to address this entire matter in its Final Report. The interim report, noted above, did not deal with this subject as its purpose was to address specific technical issues. The Commission is planning to provide a separate, supplementary report to the Governments on a proposed phosphorus management strategy, after the final Task Force Report is available in 1980,

after considering the advice of the Great Lakes Water Quality Board and Science Advisory Board. In view of uncertainty concerning appropriate phosphorus management strategies, the Commission recommends that Governments exercise caution when approving sewage projects to ensure that such projects would not inhibit later upgrading to accommodate new phosphorus management strategies that may be considered following the Commission's further report on this matter.

2. Agricultural Programs

There is a variety of practices that can be undertaken by farmers to reduce the load of pollutants from their land. While these have general applicability, the degree of implementation and precise methods taken, may have to be tailored to the site and practice concerned. To the extent that such controls may be required, rather than being generally desirable, farm-specific plans should be developed with the assistance of agricultural extension services of government agencies.

Soil Erosion causes not only high sediment and phosphorus loads to enter the Great Lakes, but also other nutrients, pesticides and herbicide residues, as well as being a loss of a valuable resource in its own right. The loss of soil has been tied, in large part, to farming practices, although the problem is more severe on fine-grained soils and steep slopes. All farmers, and particularly those in susceptible areas, should adopt sound soil conservation practices. These include identifying the minimal amount of plowing consistent with maintaining crop yields, maintaining the stability of stream banks by avoiding their disruption, the maintenance of organic materials in the soil and mulching, both utilizing crop residues. The expected reduction of sediment is not large; probably about 10 percent of that currently lost, but the costs are also minimal, and the reduction would assist in reaching target loads.

As these measures relate to changes that may well be beneficial to individual farmers, a major requirement would be to inform and educate farmers about the more appropriate practices.

A program of education and technical assistance could be tied to existing farm programs, and in so doing provide a further incentive for farmers to develop soil conservation plans. The development and implementation of such plans could be linked to any of a range of fiscal or administrative programs. An important element in this process would be the clear demonstration to farmers that their activities are causing pollution, and hence significant social and ecological harm, and also in many cases that soil conservation can have a positive impact on long term agricultural productivity, and hence be of economic benefit to the farmers themselves.

In areas where more intensive action is required to prevent erosion, such as the hydrologically active lands having fine-textured soil, a higher degree of financial incentive, regulation and perhaps even land use control may be required. Buffer strips of vegetation to reduce soil movement into streams, strip cropping, and improved drainage designed so as to minimize environmental damage rather than costs, are potentially useful methods of reducing sediment and phosphorus pollution. Another measure which can reduce the exposure of loose soil to long periods of precipitation and thus erosion potential, is the implementation of spring rather than fall plowing and/or the planting of

winter cover crops. While capital investment is not involved, higher field preparation costs and reduced productivity due to wet field conditions in the spring (with drying further delayed by the winter vegetative cover) and hence more difficult or delayed spring planting. This would be particularly critical and costly in the more northern areas where the growing season is limited.

In the United States, the federal Soil Conservation Service, with its local soil or Soil and Water Conservation Districts, noted above, has a long history of assistance to farmers. The Soil Conservation Districts will prepare a conservation plan for a farm if a cooperative agreement is undertaken between the farmer and the District. Both the agreement and implementation are voluntary, although the SCS and other state and federal programs provide financial and technical assistance. In several states, municipalities have the power to pass sediment control ordinances which may, or may not, be in accord with the concerns of the Districts. While this program has in the past been primarily directed at maintaining agricultural productivity, environmental benefits do result and the emphasis of this type of program is shifting to incorporate explicit provision for protecting water quality. State governments, in consultation with the Federal EPA and Soil Conservation Service, and the District Boards themselves, should review the specific powers of these agencies, with an objective of ensuring that they have sufficient guidance, initiative, coordination, funding and authority to serve effectively as a local arm of the management planning and implementation process.

In addition to the SCS program, the United States Agricultural Stabilization and Conservation Service with its network of state and local policy units has a similar function with respect to cost-sharing programs for soil and water conservation and pollution abatement practices in accordance with specified standards, and long term agreements covering 50-75 percent of the cost of establishing the conservation practices, but with an annual maximum of only $2,500. The U.S. Federal Government should consider the respective roles and practices of this program and that of the Soil Conservation Service, to avoid the duplication of effort and ensure an efficient approach to this area of responsibility in the Great Lakes Basin. The Federal and State Governments should also ensure that these programs have adequate manpower, funding, and eligibility criteria to provide a basis and adequate incentive for controlling the erosion of agricultural soils.

In Ontario, approvals are not required for agricultural soil-disturbing practices, and advisory programs are not as well developed as in the United States. To the extent that they exist, they tend to be productivity oriented. Some Conservation Authorities have assisted farmers with stream bank erosion problems, and while erosion-prevention progams have very recently received more emphasis, they are generally constrained by the lack of funding and manpower, and the lack of interest or initiative among farmers.

Active use and sufficient appropriations to programs already in existence should be assured, including, in the United States, those to the Soil Conservation Service, the Agricultural stabilization and Conservation Service, and the Rural Clean Water Act. In Canada, the Ontario Drainage Act and the federal Agricultural Rehabilitation Development Act, Farm Credit Act and Farm Syndicates Act, all have potential to encourage, but at present and for various reasons, have not been encouraging farmers to implement soil

conservation activities. Where such programs are now in place, there would appear to be a need for taking better account of the environmental requirements of the receiving water bodies, including the need for maintenance as well as capital costs, where relevant.

In addition to controlling sedimentation and phosphorus pollution problems, proper soil conservation practices can have some impact on the reduction of organic pesticides and herbicides. The presence of persistent chemicals in this category are largely residual from use prior to the early 1970's, and are declining in concentrations. Other pesticides and herbicides have a shorter life in the environment, and are generally closely regulated. Their application and their use in controlling pests and weeds, however, still lead to some runoff from agricultural lands and thus the potential for at least short term, local harm to the ecosystem. The programs that reduce sedimentation can also minimize these impacts. It should be noted, however, that some soil conservation practices such as zero tillage, one potential but controversial measure for minimizing erosion whereby the soil between crop lines is not disturbed, can result in the need to apply greater quantities of selective herbicides to prevent weed growth. The relationship between these additional applications, and the reduction of runoff, in terms of the eventual amount of toxic chemical substances entering the Great Lakes system, is not well known but should be a consideration in the development of individual management plans.

Fertilizer Application, while it is not one of the largest contributors to overall Great Lake phosphorus loadings, the runoff of nutrients from fertilizer applications can, as noted earlier, have a significant effect in certain locations and at certain times. Its effects on water quality can be controlled by proper application procedures.

The major factors associated with both the environmental and productivity effects of the application of commercial fertilizers are time of application, quantity and type applied, and fertilizer placement including the degree of incorporation into the soil. The spreading of fertilizers too close to or even in watercourses, notably during "broadcast" spreading can result in its direct entry into the Lake system.

Guidelines should be developed for general principles of nutrient application and basic standards under a variety of site and crop conditions, backed up by direct technical assistance and soil testing. While no jurisdiction in the Great Lakes requires approvals or licences for fertilizer application (Minnesota has the authority to regulate usage but has not developed regulations), the Province of Ontario and the States have voluntary informational programs for individual farmers on the amount and types of fertilizers required for their sites. The State programs are generally administered through the Agricultural Co-operative Extension Services, providing soil test and technical advice. A similar program is available in Ontario through the Ministry of of Agriculture and Food, and the University of Guelph.

The availablity of technical assistance does not mean that all farmers either avail themselves of it or apply the resulting information. The PLUARG survey of Ontario farmers indicated that the majority of farmers, while being aware of the Ontario Ministry of Agriculture and Food soil testing program, either did not utilize it adequately, or made ill advised amendments to

recommended fertilizer application programs. Most American farmers surveyed in the Great Lakes Basin did not realize the water quality impacts of farm fertilizers. There is a need for a determined educational and training program to encourage the use of soil tests and best management practices. Extension services, in cooperation with agricultural organizations, should be developed or expanded in all State/Provincial jurisdictions as required for the consideration of environmental as well as productivity impacts. The requirement for further incentives should be assessed and implemented on the basis of need.

There would be value in the Commission's view, in an effective training and information program to further back up the technical assistance now available. It has been suggested that this might be encouraged by requiring a certificate showing completion of an applicator training course in order to purchase fertilizers in bulk quantities. Another mechanism might be to make any governmental assistance programs that apply to fertilizer costs, such as the Farm Credit Act in Canada, contingent on proof of a course having been taken, or on the use of soil tests.

The manufacture and marketing of commercial fertilizers is controlled at the federal level in Canada under the Fertilizer Act and in some States (all aspects of distribution are controlled in Michigan), while certain constituent compounds are regulated at the United States federal level. The Commission recommends that all jurisdictions ensure that existing registration and approval programs take into account environmental as well as productivity and public health criteria. The labelling of all fertilizer packaging, or notices accompanying bulk sales, with respect to potential environmental damage and the desirability of application in accordance with soil tests may be a useful information mechanism.

A problem related particularly to the application of natural fertilizer (animal manures) is their spreading on the land during the winter. This is a widespread practice that leaves the manure exposed, while on top of frozen soil, and can result in high nutrient loads into watercourses during rain events and spring melt. The alternative is the storage of manure during the periods when spreading in the land is undesirable. The Commission notes that the storage of manure can itself lead to runoff problems, and recommends that farmers be encouraged to store it in an environmentally-sound manner. Such systems may lead to great expense for individual farm operations which may require improved provisions for financial assistance to those affected.

As noted in Chapter V, the Commission recommends that the practice of winter spreading of manure on frozen ground be prohibited and that provision be made for technical assistance and financial aid to cover increased costs.

A specialized but related problem is the application of sewage sludge from municipal treatment plants onto agricultural land. At present, this is a localized concern that does not appear to have caused pollution of the boundary waters. A large volume of sludge is generated in the Basin, however, and the amount that will be disposed on land will undoubtedly grow as the population increases and alternative means of disposal of sewage sludge and effluents (into the water and by incineration) are more severely restricted. Increased application to the land could well lead to an environmental problem if inadequately controlled, having effects similar to indiscriminate animal manure application as well as the potential for heavy metals and other toxics entering the lakes by leaching from sludges containing such materials.

The application of sewage sludge and effluents to rural lands is a practice that will require increasing attention to its overall management. It will be necessary to ensure that an adequate number of sites meet known environmental criteria and that all such material is applied at those locations in an environmentally sound, as well as safe manner. In Ontario, the province controls the handling and application of sewage sludge to agricultural land with site approvals and regulations, and regional governments may acquire and use land for this purpose. The number of approved sites does not appear to be commensurate, however, with the amount of sludge being generated. In the United States, there has been an inadequate number of sites and difficulty in approving new ones. Sludge disposal is largely a function of municipal agencies, with a wide variation in its control, although some states require permits or provide guidelines. Further attention must be given to these matters by governments within their pollution management strategies as the practice of sludge disposal on land increases.

The Commission wishes to emphasize, however, that the utilization of both agricultural and domestic "wastes" is a practice that is, in principle, ecologically sound. The recognition that they are a valuable resource that can replace other, perhaps non-renewable or unnecessary capital and energy-intensive commodities, at the same time, (if properly used), alleviating related disposal problems, is a major advance over traditional disposal practices. Their use is not without limitations, however, that must be taken into account.

Livestock Operations. All concentrations of livestock and poultry, in particular intensive feedlot operations, have a potential for water pollution if not properly designed and operated. Unlike crop practices and general farming, major livestock operations are both more amenable to and may require regulatory action, if measures cannot be developed to encourage the implementation of strict voluntary guidelines.

In the United States, the National Pollutant Discharge Elimination System (NPDES) requires permits for all feedlots handling over 1000 animal units at a time and in some cases those handling 300-1000 animal units. Some 95 percent of feedlots in the Great Lakes Basin are not covered by these criteria (although there is provision that individual operations may be required to have a permit if they are a problem), although cumulatively they may produce a significant load of pollutants. While states have the authority to develop more stringent requirement, not all have done so. Some States, notably Indiana, Ohio, Pennsylvania and Wisconsin, have identified pollution from feedlots as a pollution problem, while the other do not see it as a serious problem. The Commission recommends that all states develop programs to deal with pollution from feedlot operations not covered by NPDES regulations.

In Ontario, an Agricultural Code of Practices has been issued which has been very successful in reducing odor problems since it has been applied in conjunction with municipal by-laws based on separation distances from residential areas. It also provides management recommendations on controlling water pollution from feedlot and field runoff as well as stock watering. This guideline program although encouraged, is voluntary, and there is no requirement for approval or permits for feedlots or animal waste handling systems. Its use for enforcing water pollution problems is in doubt since, as they are less manageable by distance regulations, municipal by-laws may be an inappropriate and insufficient legal basis for denying building permits when the siting requirements may vary between individuals.

The agricultural community and Ministry extension services in Ontario have been active in resolving pollution problems. However, less than a third of Ontario's livestock operators were familiar with the provisions of the Code of Practice in PLUARG's agricultural survey. This indicates the need for a more vigorous effort to ensure knowledge of and compliance with the Code of Practice. Information and technical advice concerning the siting, design and construction of animal and manure management systems should be made available to farmers, and where the need arises, provision made for loans or cost-sharing in an amount that will act as a real incentive or that will prevent undue economic hardship to existing operations.

The Commission recommends that the Code be reviewed as to its adequacy for dealing with water pollution problems, that emphasis be given to these aspects in a more intensive informational program, and that financial assistance programs be developed and adequately funded. After a reasonable period of time, the implementation success should be reviewed to determine whether provisions for mandatory controls and regulations are required to ensure proper siting and operating practices.

In some areas, it is a common practice to allow livestock to utilize streams for watering. This can lead to the destabilization of the banks and consequently increased erosion. While this is not a major problem, an awareness program and, in particular areas where water quality problems result, the encouragement by incentives or other means for developing alternative methods of stock watering (such as by pumping) should be considered.

3. Urban Programs

The major problems of urban nonpoint pollution, with the exception of combined sewer overflows, relate to the control of sediment and associated pollutants. To a large degree, these problems can be prevented or alleviated by greater awareness, planning and proper design of urban developments and infrastructure, and the preventative approach should be universally adopted for new urban development. Application of structural remedies to existing urban areas will be expensive and more difficult to achieve, and should be assessed on a case-by-case basis.

Erosion and Stormwater Runoff. The inflow of sediment, phosphorus, toxics and other pollutants results from erosion and the suspension of loose particulate matter entering streams either directly or through storm sewers. In the past urban design has concentrated on utilizing land most easily developed and on highly intensive use of land in order to minimize both direct land and infrastructure costs, but without sufficent regard for environmental implications. Further, in all jurisdictions the direct responsibility for land development approval rests at the municipal level, subject to guidelines, approval and/or appeal. The technical expertise, awareness and concern for implications external to the municipality have often been lacking to ensure that water quality as well as water quantity aspects of stormwater control are taken into account. This localized approach may also result in a narrow view of the problem and solutions, with insufficient regard for impacts on the Great Lakes ecosystem as a whole.

Urban planning should incorporate to the degree possible natural systems for the retention and settling of stormwater runoff, and retain natural streamflow characteristics. The use of surface retention ponds incorporated into development design, proper drainage grading and strategically located open areas are preventative measures having costs that can be intergrated into overall development costs rather than result in expensive remedial programs later. As these concepts have not been extensively used in the past, there is a need for drainage guidelines and their understanding and acceptance by not only municipal planners but also by elected officials and the public.

In Ontario, a "Manual of Practice of Urban Drainage" has been developed under the Canada/Ontario Agreement on Great Lakes Water Quality which attempts to address the problem in a coordinated way. In the United States, consideration of urban stormwater problems is part of the 208 planning process, and considerable technical and informational material has been provided by EPA, SCS and some state agencies. There is a need, however, for further encouraging implementation of the resulting prescriptive measures by education, technical assistance and financial incentives. The wider application of grant and loan programs to stormwater control should be considered. These might include funds available under the United States Clean Water Act of 1977, and the use of Central Mortgage and Housing Authority funding programs under the National Housing Act in Canada, both of which might apply to or if not already the case, could be made conditional on approved stormwater management plans, should be considered. Other relevant programs include the Federal-State Coastal Zone Management programs in the United States, and the regulatory activities of the Conservation Authorities in Ontario, in addition to other state and provincial planning procedures.

The Commission recommends that all jurisdictions ensure the adequacy of procedures for requiring the proper design of new urban developments in order to minimize the adverse effects of excessive runoff of pollutants, at least to the level of control identified by PLUARG as "Level 1 Urban" (See footnote, p. 74).

Extremely high levels of sediment and phosphorus enter the Great Lakes at sites under construction. The massive scale of earth moving in subdivision, industrial and road construction result in large quantities of disturbed soil, which can be carried in suspension in stormwater runoff. It has not been a normal practice to take steps to prevent such erosion, and in no jurisdictions, except Pennsylvania and Michigan, have effective regulations been adopted for the widespread control of sediment transport from private construction sites. While in Ontario, the Planning Act allows municipalities to control land development activities, such as through subdivision agreements with developers, there is no requirement and often little local incentive to enforce such measures which might add to development costs. Some States, such as Ohio, have similar permissive but not mandatory legislation. The federal role is limited (except on Federal land) to funding programs, such as that under Canada's National Housing Act. These have not generally but presumably could be amended to require acceptable sediment control programs. Education is a possible route, but may not be effective where developers are caught in a cost-price squeeze and municipalities anxious to encourage development to broaden the local tax base. The Commission therefore recommends that mandatory regulation be applied to the control of sediment erosion from urban areas under construction.

Such regulations on future urban development should be readily enforceable by the jurisdictions that maintain supervisory authority over urban development. Their costs could be incorporated by developers into overall construction costs, of which they would be a minor component.

A special problem, especially in large, older centers such as Cleveland, Milwaukee and Toronto, is that of combined sewer overflows. While the impacts vary on local conditions, they occur intermittently and in large quantities which can result in a "shock" effect to local waters, as well as increasing total lake loadings over time. Typically, from 1-10 percent of the annual sewage volume may escape in this manner, and it may be a high proportion of total local phosphorus loads. This is now widely recognized as a significant contributor to pollution by nutrients, organic matter, toxic materials and bacteria. The worst instances are often the most difficult and expensive to solve, however, due to the tremendous cost of sewer separation. Governments should ensure that further urban expansions do not add this problem, and that all feasible means, particularly non-structural measures, be undertaken in existing areas to reduce potential pollutants at source.

Reducing Pollutants at Source. In developed urban areas, the only practicable measures for immediate implementation, may be the reduction of pollutants exposed to surface runoff and direct input to the drainage systems. A number of nutrients, heavy metals and other toxic materials are associated with loose particulate matter lying in yards and streets, resulting from human and natural sources. Fugitive dust from a large number of sources, including wind and water erosion, combustion and other atmospheric emissions, are deposited in urban areas, and can be washed off during storm events.

A measure that was addressed by PLUARG in one of its technical reports as an effective means of controlling water pollution in urban areas was the removal of pollutants by street cleaning with mechanical or vacuum sweepers. Traditionally employed for aesthetic reasons, street cleaning has only recently been recognized as a water pollution control measure. Costs vary with the type and frequency of measures employed, and tend to increase with the amount of pollutants removed. The Commission recommends that street cleaning in urban areas be instituted or expanded to a level commensurate with water quality objectives.

Other measures are available to control pollutants at source. These include public education to avoid disposal of toxic and oil-based substances into sewer systems, accidental or intentional spills and reduced usage of non-biodegradable materials. Lead was identified by PLUARG as a potential pollution problem for the Great Lakes, with the urban concentration of automotive exhausts being a major contributor. The removal of lead from gasoline could help alleviate this problem. There is presently an economic disincentive for motorists to use more expensive non-leaded gasoline in older vehicles. This might be rectified by a special tax on leaded gasoline to remove or preferably reverse the price differential between leaded and unleaded gasoline.

One additional component of urban pollution should be mentioned. Much particulate matter, incorporating a range of pollutants, is deposited in urban areas from the air, a result of emissions from industries, utilities, low temperature waste incineration and transportation vehicles. An example of this problem, and how it can be controlled or elude control, is the situation

in Detroit- Windsor, the subject of another Reference to the International Joint Commission and annual reports from the Commission. By reducing these sources, there is a decrease not only in air pollution, but also indirectly in the availability of pollutants which can be washed off in storm events into the water of the Great Lakes system.

4. Hazardous Waste Disposal

An overview of the problems concerning the management of toxic and hazardous wastes in the Great Lakes Basin reveals that current practices are generally inadequate to ensure the long term protection of human health and the environment from such wastes. Moreover, problems concerning waste disposal will continue in the short term either because legislation relating to overall control of toxic and hazardous substances is incomplete or because of the difficulties in implementing regulations or of establishing acceptable disposal sites and procedures. Although governments are attempting to respond to such problems, the current evolution of control programs is generally still in a state of flux. Several programs are mainly frameworks for future actions that have yet to be implemented. It may be some time before their full provisions are put into effect.

The most desirable response to the hazardous waste problem in the Great Lakes Basin is a comprehensive hazardous waste management program which would provide for all aspects of the problem to be addressed, from the production (and alternatives to) such wastes to their ultimate destruction or long term disposal.

As a minimum, the following major areas should be considered as a part of any comprehensive program for management of hazardous wastes. It is noted that the following elements refer to an overall management plan for disposal of hazardous wastes. Discussions will, however, be limited to waste disposal sites themselves in a following section.

A. Waste reduction and recovery

The reduction of waste generation at the source through the development of conservation technologies should receive a high priority. Mandatory provisions should be made for reclamation, re-use and recovery of hazardous wastes, wherever feasible, or for the complete prohibition of the manufacture, import, transport, sale, and use of specific substances. Process or product component changes and plant modifications should be encouraged through taxes or other economic incentives for new technology wherever feasible. Reduction and recovery possibilities should be an integral and prominent part of any hazardous waste management program. The production, sale, transport or use of persistent synthetic organic compounds with known highly toxic effects whose use will result in their entry into the environment should be prohibited.

B. Waste identification and classification

Various methodologies can be developed for identifying and classifying hazardous wastes. In order to provide a consistent and comprehensive management program, however, common approaches should be adopted between jurisdictions within the Great Lakes Basin and even beyond if possible.

C. Waste transportation

The nature of hazardous wastes and the possibility of serious transportation accidents, such as those at Mississauga, Ontario and at several places in the United States in late 1979, require appropriate container construction, maintenance standards, and labelling procedures. A manifest system for hazardous wastes, from the generator to disposal site operator, should be mandatory in the Basin. Compatible manifest systems throughout the entire Basin are clearly required. When benefits can be mutual or exchanged, cooperative programs between jurisdictions for reduction of the hazards associated with waste disposal should be pursued.

D. Waste disposal facilities

Problems relating to hazardous waste disposal sites themselves are the focus of the remainder of this section. Site selection and operation, and public acceptance of such sites, pose serious difficulties for authorities. Site selection and operation will have to be based on the best scientific and technological information available. The socio-political issue of public acceptability of such sites, however, will not disappear until the public has confidence in the ability of the jurisdictions to assure safe operation of such sites . There is an urgent need for governments to address this problem. This acceptance will as a minimum require stringent standards and permit systems for the siting, construction, operation and closure of waste treatment and disposal facilities to assure that such facilities are safe, and public confidence that governments can and will enforce such standards. It will also require that adequate information and opportunity for input by the public into the decision-making process be provided. Adequate, long term monitoring/surveillance of the facilities is also essential to insure against problems during operation or problems which may emerge after site closure (e.g., Love Canal).

A "perpetual care" program for hazardous waste disposal sites will be required. It must encompass standards for the active operation of the site, including enforceable mechanisms for identifying the wastes being placed in the sites, as well as provisions for dealing with problems arising after closure of a site. Necessary funding for clean-up operations must be included. The funding aspect has attracted considerable debate in recent months and adequate provision for it must be made. The Commission, consistent with the polluter pays principle, endorses the concept that industrial producers of hazardous wastes should pay the costs of handling and caring for these wastes. In addition, if the private sector is unable or unwilling to assume the burdens associated with proper waste management, or if the public remains unsatisfied as to the adequacy of such programs, then governmental participation will be required. In any event, government will have to have a strong role in the administration of any perpetual care system for hazardous wastes.

Regulations for hazardous waste disposal sites vary greatly among jurisdictions in the Basin. It is possible to highlight the differences in relevant rules among the jurisdictions. To decide, however, whether a given set of rules is adequate to meet the problem of hazardous waste disposal in the Great Lakes Basin is a very complex question. A logical first step is to establish the desired general standard for hazardous

waste disposal facility siting, construction, operation and closure. This general standard could be whatever is necessary to assure a minimal or no risk of injury to the surrounding environment, whatever is possible based on Best Available Technology; or some other criterion. But whatever it is, it will become the reference point against which "adequacy" is assessed.

Once a general standard is determined, the next step is to determine what is required to meet the standard. If it was decided, for example, that the specific standards for identification of hazardous wastes, and for siting, construction, and operation in the United States Resource Conservation Recovery Act (RCRA) regulations fulfill the general standard, and then measure the adequacy of state and provincial legislation by determining how closely they follow those regulations. Another possibility is to compare the laws of each jurisdiction against their actual success in meeting the desired general standard. Either approach presents an awesome task, but one that should be undertaken at the earliest opportunity.

This report does not address in detail questions of general and specific standards. There are, however, several major issues concerning hazardous waste disposal sites, as a land use activity, which should be addressed in any management program for hazardous wastes. These issues are the identification (definition) of hazardous wastes, siting of disposal facilities, site construction standards, site operation standards, site groundwater and leachate monitoring, and site closure and long term liability. This list does not cover the entire spectrum of issues pertinent to the management of hazardous wastes. Other topics, such as alternative product components or manufacturing processes, reduction of waste generation at the source, transportation of wastes, a comprehensive manifest system, and destruction or neutralization of wastes, must also be part of a comprehensive control program. Further discussion, however, is primarily restricted to the disposal sites themselves.

The following paragraphs in this section provide a descriptive discussion of whether the various jurisdictions have addressed the above major issues. It does not address the adequacy of efforts to address these issues, but rather points out where jurisdictions have at least in part considered them in their programs to manage hazardous and toxic wastes in the Great Lakes Basin ecosystem.

United States: A comprehensive federal program addressed to many of these items has been developed in the United States under Subtitle C of the Resource Conservation and Recovery Act (RCRA). The U.S. Council for Environmental Quality in its 9th Annual Report described RCRA as follows:

> "RCRA requires comprehensive ("cradle to grave") regulation of hazardous wastes. The key provisions are for development of criteria for identifying hazardous wastes, publication of characteristics of hazardous wastes and of lists of particular hazardous wastes, institution of a manifest system to trace wastes from the point of generation to the point of disposal, and organization of a permit system based on performance and management standards for hazardous waste treatment, storage, and disposal facilities. With these

controls all individuals or industries generating waste will determine whether the waste is hazardous. Accordingly, they must either obtain a permit to manage it on their property or ship it to a permitted treatment, storage, disposal facility. In the latter case, a manifest containing basic information about the waste must accompany the shipment. In either case, all treatment, storage, and disposal operations must meet the minimum standards developed."

Under RCRA, the U.S. Environmental Protection Agency was directed to promulgate regulations establishing the standards for treatment, storage, and disposal of hazardous wastes by 1978. Such regulations have not yet come into effect.

The Act defines hazardous wastes as those wastes which because of quantity, concentration, or physical, chemical, or infectious characteristics, may cause an increase in mortality or irreversible illness, or which may pose a substantial threat to human health or the environment. The definition does not, however, provide specific criteria by which to determine these properties. Therefore, the proposed regulations themselves set out extensive criteria, characteristics, and lists of substances identified as hazardous that must be managed according to Subtitle C regulations.

Sites for disposal of "hazardous" wastes must meet several requirements: they must not be in a floodplain, wetland, near a sole source aquifer, or where they would jeopardize the continued existence of endangered animal species; they must also be located so as to prevent direct contact with navigable waters. A liner meeting specific criteria should be included in construction of the site. Other construction standards for liners apply to cover material and to collection of gas, leachates, and surfacewater.

The regulations also provide for operation standards as they relate to security, training of facility personnel, site inspection, and contingency plans for emergencies. There are also requirements for a contingency plan which must be filed with the Regional EPA Administrator, the local police and fire departments, and the local hospitals to prevent human health or environmental damage in the event of leakage of hazardous wastes.

Regulations provide for both leachate and groundwater monitoring systems. Both systems must establish a baseline ("background") level of water quality by means of analyses specified in the regulations. Significant differences between levels of contaminants noted during operation and the background level must be reported to the Regional Administrator.

The regulations also contain specific requirements for the final cover of the landfill, and provide for post-closure care. The site operator is responsible for the maintenance and monitoring of the landfill for twenty years following closure.

Until the RCRA regulations come into effect, states can implement their own hazardous waste disposal program. In general, the major issues cited earlier are banded by the various jurisdictions either by regulations, or by intra-departmental guidelines that serve as a basis for determining the conditions normally included as a part of hazardous waste disposal permits. Once the RCRA regulations are in effect, EPA will assist states not having such programs to develop them, consistent with RCRA and subject to the

Agency's approval. States with programs may receive interim authorization from EPA if their programs are "substantially equivalent" to the federal program. It is noted, however, that the slow implementation of rules under RCRA has meant that the states have been reluctant to update their own laws until the RCRA implementation is complete. Further, the problems relating to the environmental and health effects of abandoned waste disposal sites are not covered under present regulations. The proposed "SUPERFUND" concept for such sites, if implemented, represents a substantial step in this direction.

In addition to the provisions of RCRA relating to the generations and disposal of hazardous wastes, the Toxic Substances Control Act (TOSCA) gives EPA broad discretionary substances (except for pesticides) in the United States, including the requirement for health assessments of chemicals prior to regulation. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) contains provisions relating to the entry of pesticides into the water environment. In addition, the discharge of toxic and hazardous substances into water is controlled by discharge permits under the provisions of Public Law 92-500. The transportation in commerce of hazardous materials by all modes is regulated under the Hazardous Materials Transportation Act.

The Great Lakes Basin Commission has noted that a major shortcoming in the management of hazardous wastes is the lack of sufficient coordination and integration among state and federal programs.

State Programs: The first issue identified above is that of definition and identification of hazardous wastes. While all the jurisdictions in the Basin have a general definition of hazardous waste in their respective rules, only the State of Minnesota has criteria in effect for specific identification of hazardous wastes. Pennsylvania maintains a list of wastes deemed hazardous by the administering agency based on its own "experience, investigation, and literature". The intradepartmental guidelines are not, however, standardized in the regulations.

There is somewhat more regulatory attention given to siting of disposal facilities. While few people believe that hazardous waste can be disposed of anywhere, agreement does not exist as to which locations are the most desirable. Most jurisdictions handle this problem on a site-by-site basis. Illinois, Minnesota, New York, Ohio, Pennsylvania and Wisconsin have some general prohibitions against sites in such locations as floodplains, or where the geology, hydrology, topography, or soil is unsuitable to protect ground and surfacewater. The State of Michigan has recently provided a mechanism for public input into the hazardous waste management process as part of its Hazardous Waste Management Act. This Act provides that both siting and construction permits must be approved by a state planning committee, appointed by the governor, whose membership includes both local officials and members of the general public.

Most jurisdictions decide the issue of construction standards for hazardous waste facilities on the basis of individual construction permits. Applicants indicate their proposed construction plans in permit applications which the authorizing body will approve or modify. An increasing number of jurisdictions, particularly, New York and Pennsylvania, now prescribe such specific standards as the thickness and material required for the liner and cover of the facility. The provision for citizen input in this process in Michigan was noted above.

Similarily, the standards for operation of the facility, including the requirements for training of personnel and emergency procedures are generally prescribed by the administering agency in individual permits, or else the facility operator must propose operation procedures in his permit application which the agency must approve. New York, Ohio, Pennsylvania and Wisconsin regulations provide for a number of operation standards. Training of facility personnel and emergency procedures are required only in Minnesota, New York, Ohio and Wisconsin.

Concerning monitoring of ground and surfacewater, and leachates in and adjacent to the facility, only Illinois and Indiana do not require some sort of monitoring in their regulations.

Those few jurisdictions which address the problem of closure have specific requirements, namely procedures for covering and fencing the site, and a requirement for monitoring of groundwater and leachates. Minnesota, New York, Ohio and Pennsylvania all have such requirements. Of these jurisdictions only Minnesota provides for long term post-closure maintenance and monitoring of the site.

A more detailed description of state programs concerning these various aspects of hazardous waste management programs is provided in Appendix V.

Canada: Federal/Provincial Legislation. There is a difference in the jurisdictional lead role for hazardous waste management programs between Canada and the United States. In the United States, the federal EPA takes the lead role with the States adopting the EPA regulations, or the EPA imposing such regulations in the absence of state action. In Canada, jurisdiction for controlling waste disposal into or onto land has rested primarily in the hands of the provinces. However, insofar as the Great Lakes Basin is concerned the international and certain other transport and trade aspects are a federal responsibility. The development of a comprehensive Canadian package is not as readily apparent as the RCRA model in the United States, due to this division of interests and responsibilities.

The Canadian approach to developing a comprehensive program is a loosely-knit fabric of provincial initiatives some limited federal programs, and mechanisms for technical assistance and information exchange. One mechanism that has been active in the area of hazardous wastes is the Canadian Council of Resource and Environmental Ministers (CCREM). Bilateral federal-provincial arrangements are also important.

The federal role in hazardous waste management has focused primarily on technology development and transfer, demonstration projects, and on funding. The principal federal legislative mechanism for addressing toxic and hazardous substances is the Environmental Contaminants Act. The Act, somewhat analogous to the United States Toxic Substances Control Act, is directed to controlling by prohibition, the manufacture, import and use of new hazardous substances (chemicals) and existing designated substances on a case-by-case basis. It is not, however, a hazardous waste management law. However, limitations on the effective administration of this Act are related to the lack of information on chemicals of concern. This information is available through Statistics Canada and the Customs and Excise Tax Department. These agencies, however, are not obliged to identify manufacturers of hazardous substances for purposes of implementing the Environmental Contaminants Act. These conflicting goals

diminish the ability of Environment Canada and Health and Welfare Canada to identify and quantify hazardous chemicals, as mandated in the Environmental Contaminants Act.

Under the Ontario Environmental Protection Act, regulations to define "liquid industrial wastes" have been issued. The definition and criteria, however, for identifying "hazardous wastes" are still under review by a CCREM Task Force, and consequently neither a definition nor criteria for identifying hazardous wastes exist at present.

Waste transportation is controlled in Ontario under its Waybill legislation, wherein a waste-hauler manifest system is in operation. The interprovincial and international regulation of the transport of hazardous wastes continues to await passage of the proposed federal Transport of Dangerous Goods Act, although the Canada Shipping Act may also play a limited role. A compatible manifest system between the jurisdictions has yet to be developed.

Standards for the construction, operation and maintenance of hazardous waste treatment and disposal sites do not yet exist. Site selection criteria are a responsibility of the Province. It is noted that in October, 1978, the Ontario Ministry of the Environment announced a seven-point program to address these and related concerns as applied to liquid industrial wastes. This program is one that charts the course of intended action, but is yet largely uncompleted in terms of regulations and their implementation. The philosophy behind the program is that it is a private sector problem requiring the development of efficient and safe waste disposal technology and practices, and that governmental encouragement, leadership and regulation are necessary to ensure that threats to environmental and human health are minimized. Provisions in this seven-point program relating to hazardous waste disposal sites include: 1) a new waste classification system identifying treatment and disposal requirements for various substances; 2) guidelines on the handling, treatment and disposal of wastes, including a policy of banning the direct landfilling of untreated wastes; 3) regulations concerning required disposal methods; 4) requirements for a fund to provide for long term surveillance, and clean-up of any resulting long term problems from certain toxic wastes; and 5) siting and establishing safe waste disposal facilities, including interim sites, until permanent treatment or disposal sites are available. Other aspects of the seven point program relate to waybill monitoring, generated waste registration and transboundary shipment of wastes.

The Commission recommends that Governments accelerate implementation of existing and proposed programs and that a comprehensive and coordinated review with the following elements be completed:

- A complete inventory of hazardous and toxic waste disposal sites in the Great Lakes Basin, including nature and quantities of wastes handled should be conducted.

- The adequacy of the inventoried sites to properly and safely handle the wastes disposed of should be determined (including monitoring of groundwater flows at or near such sites), on the basis of criteria such as those contained in RCRA. Steps should be taken to provide necessary alterations to the sites if their present construction is inadequate to handle the wastes contained therein.

- In concert with evaluation of the technical questions, Governments on all levels should carefully review the adequacy of legislation and regulations concerning the establishment, operation and closure of hazardous waste disposal sites, including presently operating sites; and long term liability for damages and care.

- Every effort should be made to determine the presence of abandoned hazardous waste disposal sites in the Great Lakes Basin, as these sites represent potentially severe problems to groundwaters and surface waters of the Great Lakes Basin ecosystem.

- Special attention should be given to the establishment of safe waste disposal sites, including involving the public and educating it as to the need of such sites and the ability to insure that safe sites are feasible. Public lands should be explored for their potential for containing such sites if inadequate sites are otherwise available.

- Efforts should be accelerated to establish a compatible manifest system between all jurisdictions within and beyond the Basin in order to enable ready identification and tracing of hazardous wastes which may be transported across boundaries, including the international boundary.

The Commission believes that these recommendations will aid in the implementation of Article VI and related Annexes of the 1978 Great Lakes Water Quality Agreement, particularly the desire expressed therein that every effort should be made to develop, adopt and implement joint programs for the proper transportation and disposal by 1980.

The Commission will be preparing one or more special reports to Governments on toxics and hazardous substances, including a comprehensive assessment of hazardous waste management programs, in order to formulate further recommendations to Governments on these topics.

5. Private Waste Disposal

While private waste disposal systems are not a major source of Great Lakes pollution, leaching of septic tank effluent and occasional surface ponding of the effluent have contaminated groundwater in some local areas. However, only where there was a failure to properly implement appropriate guidelines, or where private waste disposal systems were installed under unsuitable soil conditions (e.g., impermeable with high clay content soils, or soils with a low sorptive capacity for phosphorus) did water quality problems generally arise.

Several simple remedial options identified by PLUARG are endorsed by the Commission as solutions to the localized private waste disposal problems. Unsatisfactory old systems should be corrected, and new ones constructed according to current regulations, including more strict inspections and approvals on the part of the regulatory agencies.

Proper evaluations of soil conditions in areas proposed for such systems should be conducted. Suitable soil for a tile field should be imported if the on-site soil is not suitable or is not present in sufficient quantity. In

areas where there is inadequate removal of phosphorus because of the low sorptive capacity of the particular soil for phosphorus, addition of soil additives or clay soils to the soil systems, or even phosphorus - precipitation compounds (e.g. alum) to the septic system itself, might be considered. In areas where conditions are such that remedial measures cannot overcome problems created by the particular soil conditions, development should be prohibited or severely restricted unless the removal of sewage by tank trucks can be assured.

6. Other Nonpoint Remedial Programs

Several other nonpoint sources, which by themselves do not constitute lakewide pollution problems, also warrant mention because they represent areas where additional nonpoint remedial programs may be applied, if desirable or necessary as a component of an overall control program. These additional nonpoint sources include forestry, transportation corridors and extractive operations (i.e. mining).

Forested lands, as noted earlier, may be the source of sufficiently high concentrations of pollutants, mainly phosphorus, sediments and occasionally pesticides, to cause a deterioration of local surface waters. Factors influencing the contribution of such pollutants to the lakes include the intensity of operations, harvesting techniques, road design, steepness of terrain, rates and application methods of pesticides, precipitation and reforestation practices. Accelerated erosion caused by poor road construction and logging techniques and the improper use of machines is probably the worst threat to water quality. Regulatory mechanisms encouraging land stewardship through use of management practices appropriate to water quality protection are generally adequate to control pollution from forested lands, although problems do arise where current regulations are inadequate, or where insufficient resources and manpower inhibit their enforcement.

Transportation corridors include highways, roads, railroads, airports, and pipeline and utility corridors. Sediments, pesticides, deicing chemicals, vehicle emissions, roadside littering and spills are all localized pollution problems resulting from transportation corridors, with deicing salts perhaps the most significant pollutant. The general lack of regulatory controls related to transportation corridors makes it virtually impossible for environmental agencies to know the degree of adherence to recommended guidelines. Many jurisdictions apply excessive quantities of road deicing salts. It is likely that pollutants from transportation corridors will be dealt with successfully only when there is a significant movement from agency self-regulation to external environmental review and approval.

Extractive operations (pits, open-pit mines and underground mines) are generally carried out under considerable regulatory controls including provisions to preventing pollution problems. There is a problem, however, of compliance by operations with permit requirements. Identification of violations and follow-through on enforcement are difficult because of insufficient manpower for site inspections. There is a need, therefore, for the development and implementation of adequate enforcement provisions including more enforcement staff, and tightening the length of time given to existing mine operations for compliance with permit requirements.

VII. SPECIAL CONSIDERATIONS REGARDING LAND MANAGEMENT AND POLLUTION

VII. SPECIAL CONSIDERATIONS REGARDING LAND MANAGEMENT AND POLLUTION

During the Commission's review of the PLUARG Report, three issues fundamental to land management and pollution were identified which, while not strictly part of the analysis and control of nonpoint pollution, merit consideration by governments in the development of management strategies. These issues are the need:

- o for a conservation ethic in modern society;
- o to preserve prime agriculture land; and
- o to protect wetland areas.

They are presented here to highlight their importance and indicate some relevant considerations.

In addition, the Commission draws attention to the recommendations of PLUARG concerning further research needs and identifies some of the aspects of further research deserving of priority attention. This is not to divert concern from the early implementation of control action in favor of further study, but rather to suggest a concurrent initiation of the additional work required to refine management strategies.

1. The Need for a Conservation Ethic

Much of the pollution occurring in the Great Lakes is a mirror image of the waste of resources. By allowing or causing the release of substances such as nutrients, soil, metals, and organic pollutants into the environment, society is in effect discarding materials that could possibly be further utilized for productive purposes. At the same time, the ecosystem is harmed. The reasons for this occurrence are basic to our economic and resource management system - it is cheaper, or less trouble, to dispose of these commodities and use new materials than to recover them for further use or make them more durable. This is the case with industrial effluents, industrial by-products, packaging materials, used consumer goods and the like. Resource policies may encourage the use of virgin rather than recycled raw materials. The throw-away and planned-obsolescence attitudes of modern consumers (of both household and industrial products) encourage, or may be encouraged by, the purveyors of products that are wasteful of resources, including non-renewable resources such as metals and fossil energy. The environmental implications, both in the production and disposal of such commodities, are pervasive, severe and often long-lasting.

The Commission recommends that governments continue and enhance efforts, such as through the Resource Recovery and Recovery Act in the United States and Ontario's efforts in recycling and resource recovery, to find innovative and effective means of encouraging or regulating resource conservation in production, longer product life, and the re-use of materials. The mechanisms are several, and include regulation of material flows, pricing mechanisms to encourage, rather than discourage, resource recovery, the development of "reverse" distribution systems for collecting recyclable materials (society has developed sophisticated systems for distributing commodities but not the

reverse), and economic incentives or regulations that force the internalizing of the ultimate costs of pollution to pollutors, rather than to society as a whole. If discarding residuals is necessary, they should be handled in an environmentally safe and rational matter and, if possible, consist of non-toxic materials that can be readily assimilated by the natural environment.

The PLUARG study has provided valuable information to demonstrate the widespread occurrence, severity of, and some of the alternatives to, the loss of resources via pollution. The Commission suggests that the findings should provide additional incentive to develop a long term program for resource conservation and recovery in a serious way.

2. The Need to Preserve Prime Agricultural Lands

PLUARG drew attention, in its recommendations, to the need for retaining high quality agricultural lands for agricultural production. The trend of losing agricultural land to urban or industrial uses is a problem of almost universal concern in North America, particularly near expanding urban centers. While the economic and social debate concerning the advantages and disadvantages of stricter agricultural land use controls has received much attention, it is important to consider the environmental implications as well.

Despite the pollution problems from agricultural land noted in this report, it has been concluded that by preserving for agricultural purposes the best lands suited for farming, the amount of pollutants generated by agricultural practices would be minimized, due to both the natural characteristics of the land and its ability in economic and physical terms to support remedial measures. If these lands are preserved and properly managed, from both the production and environmental viewpoint, pollution problems are reduced. Further, there would be less of a tendency or need for farming to move to, or intensify on, less productive lands. This is important since, as more low grade farmlands become farmed more intensively, with a narrow or nonexistent profit margin, there is a decline in the ability of the agricultural community as a whole to afford to, as well as a decreased likelihood of being willing to, implement environmentally-appropriate farming practices. Marginal lands may in themselves be more prone to pollution-generation, due to slope, poor drainage and possible susceptibility to flooding. At the same time, the scattered, unplanned or even officially sanctioned development of agricultural lands for urban (usually residential) purposes leads to intensive pollution of its own, as discussed in earlier sections dealing with urban pollution

Thus, the Commission believes that the problem of nonpoint pollution adds to the many other concerns about the disadvantages of the continued loss of prime agricultural land to other uses.

3. Preservation of Wetlands

It is also important in the planning of land use activities to be aware of the location of, and the need to protect, wetland areas. These are areas which are saturated or covered with water at a frequency and duration sufficient such that they normally support a prevalence of vegetation typically adopted to saturated or flooded soil conditions. Flooded

periodically, and perhaps more or less permanently, they can be natural pollution control mechanisms in themselves.

Coastal wetlands, particularly at tributary mouths, tend to act as at least temporary traps for nutrients, sediments and other chemicals. Their disruption, by development or intensive use, can reduce their effectiveness as sediment traps and in the redistribution of nutrients within the annual cycle. In addition, a new direct source of pollution would be caused by erosion, siltation and pollutants emanating from the new land use, problems which would be intensified by the location on a flood plain.

Upland wetlands can also reduce the transmission of pollutants particularly sediment from other lands to the Great Lakes by acting as a buffer between polluting or soil-disturbing activities and watercourses to the lakes.

In addition, and perhaps more important, both coastal and upland wetland areas normally support very rich, productive and diverse biological communities which should be preserved. The protection and careful management of wetland areas should be done in order to maximize their functions as highly productive ecosystems.

4. Research Needs

The PLUARG study marked a substantial advancement in our knowledge of the generation of pollutants as a result of man's activities in the Great Lakes Basin. There are, however, still large areas of uncertainty in our understanding of nonpoint pollution and its effects on the Great Lakes. The Commission endorses the recommendations for future research needs for the Great Lakes Basin ecosystem presented in the PLUARG Report and wishes to emphasize several as being of particular importance.

The Commission believes that the holistic view should be the guide in designing and carrying out Great Lakes pollution studies. This is a re-endorsement of the ecosystem approach originally presented by the IJC's Science Advisory Board. No component of the Great Lakes Basin should be viewed in isolation of its interactions with, and potential effects on, other Basin components. As noted by the Science Advisory Board, "an ecosystem is any unit of nature in which living organisms and nonliving substances interact with an exchange of materials between the living and nonliving parts." The land area within the Great Lakes Basin is part of the Great Lakes Basin ecosystem and as such influences, both by natural processes and as a result of man's activities, the character and quality of other parts of the ecosystem, including the waters and biological organisms contained therein. Research efforts conducted with this guiding principle in mind will be of greater value in our efforts to consider pollution impacts within the Great Lakes.

Attempting to control pollution in the Great Lakes requires that we can define it adequately. PLUARG reported difficulty in several instances in evaluating the effects of nonpoint pollution because traditional definitions of pollution were inadequate. This was particularly true when individual nonpoint sources, although they could not be strictly defined as "violators" themselves, produce pollution in the Great Lakes. It was also noted that defined loading criteria existed only for phosphorus. The manner in which

other materials being contributed to the lakes could be defined as pollutants was only determined by their exceedance of guideline levels in biota or in the waters themselves. Such an approach creates difficulty in designating specific nonpoint sources as causes of pollution.

Concerning quantification of pollutant inputs, PLUARG noted, its own study notwithstanding, that adequate determination of pollutant inputs from specific land use activities and the atmosphere required further attention. While general unit area loads compiled from several sources were used in the overview modeling exercise, the pilot watershed study results illustrate a wide range of unit area loads for a given pollutant from the same land use activities in different watersheds. Ranges of a factor of ten or more were not uncommon for a single land use activity. The natural and man-associated factors which serve to produce this range are not yet clearly defined for any pollutant. The atmosphere is also a component of the Great Lakes Basin ecosystem whose significance in transporting and transforming pollutants is acknowledged, yet remains largely unquantified, both in terms of pollutant source or magnitude. The question of the biological availability of any material inputs is also an area of little knowledge, but can have a significant effect in establishing necessary control efforts. The impact of variability of pollutant loads, especially phosphorus, due to streamflow and climate variability, and the interconnections or dynamics of nearshore vs. open lake concentrations and their effects, all merit further scientific investigation. There are a number of elements in the ecosystem, including sediments and wetlands, whose interactions with pollutants require further clarification. These concerns need additional research attention in order to allow the refinement of strategies for nonpoint source pollution control measures, as well as the overall most effective remedial strategy.

Although many alternative nonpoint source pollution remedial measures were explored by PLUARG, it is also clear that neither the short nor the long term effectiveness of many of these measures is clearly known at present. In addition, the socio-economic tradeoffs involved in choosing the most cost-effective remedial measure for a given nonpoint source requires further study. "Cost-effectiveness" may require an expanded meaning in view of the lack of adequate pollution yardsticks so that effects which are not easily expressed in traditional economic terms, particularly biological effects, can be considered in choosing the "best" remedial measure for a given nonpoint source.

The Commission also wishes to emphasize its concern with the potentially significant environmental damage associated with the disposal of hazardous and toxic wastes in the Great Lakes Basin ecosystem. This topic has become one of considerable national and international concern in recent months, especially in the Great Lakes region because of its large concentration of industrial and municipal waste disposal sites. The whole question of the adequacy and coordination of present United States and Canadian regulations concerning the siting, operation and closure and rehabilitation of such sites is one which warrants a thorough review by the Governments.

VIII. RECOMMENDATIONS

VIII. RECOMMENDATIONS

The Reference Group made a number of recommendations to the Commission concerning nonpoint pollution in the Great Lakes Basin Ecosystem. These recommendations are included in the Executive Summary of the report of the Reference Group, attached as Appendix III of this Report.

Based on consideration of the Reference Group's report and recommendations, the information gained from the efforts of the public panels organized by the Reference Group, and the Commission's public hearings, and in response to the Reference dated April 17, 1972, from the Government of the United States and Canada, the International Joint Commission recommends that:

1. The Commission recommends that the Governments of Canada and the United States, in partnership with the state and provincial governments, and local jurisdictions where relevant, undertake to develop a comprehensive strategy of pollution control for the Great Lakes which would be specifically directed at but not restricted to nonpoint pollution. The Commission further recommends that such a strategy have sufficient flexibility to permit individual jurisdictions to maintain their resource and land management prerogatives to the extent that they are consistent with the Great Lakes Water Quality Agreement of 1978. This flexibility should also ensure that the strategy can be responsive to future scientific, technological and socio-economic developments concerning the pollution control.

2. Ongoing and priority programs be pursued without awaiting complete development of the comprehensive management strategy.

3. As part of the management strategy Governments develop and implement remedial plans for achieving the reductions in nonpoint pollution from priority areas. These priority areas should be selected on the basis of the most severe whole lake and nearshore water quality problems, present land use activities and areas with a high potential or demonstrated ability to contribute pollutants, especially hydrologically active areas. Such areas are identified in Figures 1-3 of this report. In accordance with the ecosystem concept, selection of remedial programs should also include consideration of the principle of non-degradation of higher quality waters (further to the Commission's Report on Water Quality of the Upper Great Lakes), impacts on other environmental components, including plankton, fish stocks and wildlife, occurrence of severe local problems (especially the nearshore areas and tributary mouths), and the impacts to be realized in downstream lakes in the Great Lakes System via connecting channels.

4. Governments implement low cost but generally beneficial measures throughout the Basin. Thus, certain measures to reduce pollutant loadings, to at least PLUARG level 1 agricultural and urban control measures, be applied throughout the Basin without regard for the criteria suggested above for establishing priorities.

5. Nonpoint source pollution control not be considered in isolation of point source pollution or the relative cost-effectiveness of further control thereon. The economic and social impacts of remedial programs in individual areas should be considered in the development of such programs and efforts should be made to include elements in the program which would alleviate such undesirable side effects. All alternatives for controlling particular pollutants, and their local, regional and national implications should be considered consistent with the ecosystem concept, including the full range of all relevant point, nonpoint and source-reduction controls and alternate practicable technologies for achieving these controls. The Governments initiate a program of assessment of the social and economic implications of nonpoint and point source pollution control.

6. Jurisdictions, in formulating their management plans, recognize and consider the need for strengthening coordination within and between jurisdictions in developing and implementing required remedial programs. That senior levels of government as relevant within each country assume broad overview and basic control and monitoring of nonpoint pollution control measures, centered in a lead agency or coordinating mechanism, while recognizing that effective implementation of such measures will be done at least in part at a local level. The Governments review existing legislative and administrative measures to ensure the adequacy of nonpoint pollution control programs and sufficient coordination.

7. In this regard, Governments could consider the utilization of such existing mechanisms as:
   a) at the Canadian Federal level, the coordinating and environmental review roles of Environment Canada,
   b) at the United States Federal level, a coordinating mechanism to focus the concerns of agencies whose programs are related to Great Lakes water quality,
   c) at the Canadian provincial level, the systematic use of the Planning Act and the Environmental Assessment Act,
   d) at the United States State level, the Section 208 agencies and the environmental or "little-NEPA" agencies.

   These mechanisms could, if strengthened, provide the needed coordination of environmental perspectives in other policy areas such as development and energy programs. While existing programs would be used where possible and appropriate, new or revised programs should also be developed where necessary to address nonpoint pollution problems.

8. The Governments use and accentuate voluntary mechanisms and approaches where possible in implementing pollution control programs. Since public interest in, and acceptance and support of such programs is of paramount importance, Governments insure adequate environmental information, education and technical support is supplied to the public, and that provisions are made for their involvement.

9. For certain measures that are universally desirable, but for which voluntary compliance is not likely, Governments adopt regulations in order to insure their consistent and equitable implementation. Specific measures identified by the Commission requiring regulation are: prohibit winter spreading of manure on frozen ground, with financial assistance to farmers who incur expenses by doing so; regulate sediment runoff from urban areas under construction; and regulate industrial waste management

to prevent environmental contamination. Other regulatory measures should be considered to deal with nonpoint pollution problems when voluntary approaches are found inadequate.

10. The Governments assure that adequare financial support for small scale agricultural operations and local municipalities is provided to adequately address the nonpoint pollution problems outlined in this Report. Governments also assure that relevant agencies be given sufficient technical and manpower support to address these problems.

11. In recognizing the need for an informed public, the Governments institute a general environmental education program. The program should be designed to make the public aware of existing local pollution problems, as well as providing for public input into the solutions to such problems. Local civic and environmental groups should be used to the extent possible. Further, Government officials at all levels should be made familiar with both ecosystem management in general, and nonpoint pollution in particular, and with the agencies which address such problems. In addition, remedial program managers and field personnel should be given all necessary technical information and skills necessary to properly implement their specific remedial programs or tasks. Finally, efforts should be made to provide environmental education and information at the public school levels.

12. As a follow-up to any management framework or strategy, the Governments establish some mechanism to review and evaluate the overall success of the various management plans. This evaluation should include a general review of the adequacy of all state, provincial and federal management plans; an enhanced continuous monitoring program within the surveillance program developed under the 1978 Great Lakes Water Quality Agreement, including nearshore, rivermouth and tributary monitoring to evaluate the effects of the various remedial programs in place or planned; and a determination of the ability of the overall management strategy to adequately fulfill the provisions of Article VI of the Agreement.

13. The Governments implement the pollution controlled measures presented in Chapter VI of this report to the maximum extent possible, to address the specific identified pollution problems regarding soil erosion, application of fertilizer, and control of runoff from livestock operations in agricultural areas; street sweeping and combined sewer systems in urban areas; and erosion control in construction areas, described in detail in pages 77-86 of this Report. The Conservation Authorities in Canada and the Soil Conservation Service in the United States could play a major role in these functions.

14. Governments urgently bring hazardous waste disposal priorities under control. To this end, the Governments:
    a) prepare a complete inventory of operating and abandoned waste disposal sites in the Basin, including nature and quantities of waste handled where possible;
    b) the adequacy of such sites, and any proposed sites, to properly and safely handle the wastes disposed of be thoroughly assessed and necessary measures to correct any deficiencies found be implemented;
    c) a comprehensive review of all existing legislative and regulatory

mechanisms also be conducted and alterations made where necessary to assure the safe transportation and disposal of hazardous wastes in the Basin;

d) a compatible manifest system for hazardous wastes between all jurisdictions within and beyond the Basin be established;

e) Governments embark on a long term effort to reduce or eliminate pollutants at their sources, including increased resource recovery efforts and alterations in the manufacturing process;

f) because siting of hazardous waste facilities depends in part on public acceptance of such sites, the Governments make efforts to demonstrate that safe disposal sites are technically possible, or that associated risks can be held to a minimum.

15. The production, sale, transport or use of persistent synthetic organic compounds with known highly toxic effects whose use will result in their entry into the environment be prohibited.

16. The Governments continue to enhance efforts to find innovative and effective means of encouraging resource conservation, recovery and recycling efforts.

17. The Governments recognize the values of preserving prime agricultural and wetland areas in the Basin.

18. In regard to phosphorus control, and pending the final report on the Commission's Phosphorus Management Strategies Task Force, the Governments accept the 1976 phosphorus load estimates presented in Table 5 of this report as the best estimates of "present" loads. Further, the proposed phosphorus target loads in the 1978 Great Lakes Water Quality Agreement should be taken as valid minimum goals for phosphorus control programs. The Commission has pointed out that recent work and interpretation of the Agreement indicates that lower target loads may be indicated for Lake Erie and Saginaw Bay if more restrictive interpretation of the phosphorus control goals, as outlined in this Report, are adopted. In view of uncertainty concerning appropriate phosphorus management strategies, Governments exercise caution when approving municipal sewage projects to insure that such projects would not inhibit later upgrading to accommodate new phosphorus management strategies that may be considered following the Commission's further report on this matter.

Signed this seventh day of February 1980, as the Commission's response to the Reference from the Governments of Canada and the United States, dated April 15, 1972, on the question of pollution of the boundary waters of the Great Lakes System from land use activities.

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APPENDICES

I. Text of Reference

II. PLUARG Executive Summary

III. Listing of PLUARG Technical Reports

IV. Listing of PLUARG Membership

V. Overview of Hazardous Waste Management Issues in State Jurisdictions

APPENDIX 1

TERMS OF REFERENCE

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.

EXECUTIVE SUMMARY

INTRODUCTION

The Canada-United States Agreement on Great Lakes Water Quality signed at Ottawa, April 15, 1972, by the President of the United States and the Prime Minister of Canada, requested 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. As a result, an intensive inquiry was conducted by the International Reference Group on Great Lakes Pollution from Land Use Activities (PLUARG), established by the International Joint Commission.

The scope of this inquiry was broader than previous Great Lakes studies conducted under the sponsorship of the Commission in that the entire land area, as well as the water, in the Basin was studied. The Basin totals 755,200 km^2 (292,000 mi^2) in area, with 538,900 km^2 (208,000 mi^2) of land and 216,300 km^2 (84,000 mi^2) of water surface area. The Great Lakes contain approximately 20 percent of the world's fresh surface water supply.

The Basin, with 37 million residents of Canada and the United States, is the industrial heartland of both countries. A major portion of their gross national product is generated here.

Until recently, the Great Lakes have been viewed as a virtually inexhaustible supply of high quality water. However, increasing population, advancing technological innovation and intensification of water and land use in the Basin have resulted in a continuing degradation of the lakes.

Eutrophication, due to elevated nutrient inputs, particularly in the lower lakes (Erie and Ontario), and the increasing contamination of these water bodies by toxic substances, have been identified as the major pollution problems in the Basin. It has also become apparent that while the Great Lakes themselves are a focal point of concern, they are but a part of a complex system in which interaction of the climate and the land and its use have a major influence on the lakes.

Past studies ("Report to the International Joint Commission on the Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River, 1969") indicated that current conditions in the lakes could not be related entirely to pollutant loadings from readily identifiable point sources. These studies indicated that 30 and 43 percent of the total phosphorus load for Lakes Erie and Ontario, respectively, were due to sources other than municipal sewage treatment plant and industrial effluents. In attempting to quantify and describe nonpoint sources of pollution, PLUARG reviewed and studied the pollution potential of several land use activities, including agriculture, urban, forestry, transportation and waste disposal, as well as natural processes such as lakeshore and riverbank erosion. PLUARG also examined atmospheric deposition of materials on land and water surfaces. Pilot watershed studies were established and monitoring programs initiated to further define the relationship between land use activities and water quality. While these studies shed considerable light on this relationship, the complexity of the problem makes a quantitative interpretation difficult.

Although the Great Lakes are an interconnected system, each basin is unique in terms of its limnology, the socio-economic characteristics of its communities, the type and degree of pollution and the kinds of required control measures. Diffuse source pollutants are not derived uniformly from whole watersheds or even sub-basins. Problem areas may represent only a small proportion of a drainage basin area. As a result, PLUARG has developed criteria for the identification of potential contributing areas and within these, the most hydrologically active areas, which are the zones most likely to produce water pollution from land use activities.

It is important to recognize: (1) the long term nature of the solutions to most problems of pollution from land use activities; (2) their ramifications through most sectors of society; (3) the involvement of many agencies in the implementation of these solutions; and (4) their public consequences in such policy areas as food production, housing and public health. Population growth and location, industrial development and technological innovation will all have impacts on the loadings of pollutants to the lakes from land use activities. These factors will affect both the need for nonpoint source control and the ability to control some of these sources. As populations grow and industrial development continues, given current technology, pollutant inputs from point sources will undoubtedly continue to grow. However, the finite capacity of the lakes to accept these inputs must be recognized, appropriate pollutant loading targets established and proper monitoring programs undertaken to quantify these loads so as to insure that the capacity of the lakes is not exceeded.

Effective strategies at the international, national and local level must be developed to cope with these factors, since they transcend jurisdictional and political boundaries. Flexible management systems and control measures capable of incremental adjustments in response to a changing environment will be required. As well, questions of equity must be taken into account and a formula arrived at for the reasonable allocation of responsibility between governments, institutions and individuals. Above all, it is essential to recognize that the management of nonpoint sources will require a dramatic departure from the traditional approach followed for the control of point sources.

CONCLUSIONS

The International Joint Commission instructed the International Reference Group on Pollution of the Great Lakes from Land Use Activities to inquire into and report on the following questions:

> *"Are the boundary waters of the Great Lakes System being polluted by land drainage (including ground and surface runoff and sediment) from agriculture, forestry, urban and industrial land development, recreational and parkland development, utility and transportation systems and natural sources?"*

PLUARG finds that the Great Lakes are being polluted from land drainage sources by phosphorus, sediments, some

GREAT LAKES WATER QUALITY POLLUTANTS

I. Parameters for which a Great Lakes water quality problem has been identified

POLLUTANT	PROBLEM		SOURCES				REMARKS
			DIFFUSE			POINT	
	Lakewide	Nearshore or Localized	Land Runoff	Atmosphere	In-Lake Sediments		
Phosphorus[1]	Yes	Yes	Yes	Yes	Yes[a]	Yes	[a] percentage unknown; not considered significant over annual cycle
Sediment[b,1]	No	Yes	Yes[c]	Negligible	Under some Conditions	Negligible	[b] may contribute to problems other than water quality (e.g., harbor dredging) [c] including streambank erosion
Bacteria of Public Health Concern	No	Yes	Minor[d]	No	No	Yes	[d] land runoff is a potential, but minor source, combined sewer overflows generally more significant
PCBs[1]	Yes	Yes	Yes	Yes	Yes	Yes	
Pesticides[1] (Past)	Yes[e]	Yes[e]	Yes	Yes	Yes	No	[e] some residual problems exist from past practices
Industrial Organics[1]	Yes	Yes	Yes	Yes	Yes	Yes	
Mercury[1]	Yes	Yes	Minor	Yes	Yes	Yes	
Lead[1]	Potential[f]	Potential[f]	Yes	Yes	Yes	Yes	[f] possible methylation to toxic form

II. Parameters for which no Great Lakes water quality problem has been identified, but which may be a problem in inland surface waters or groundwaters

Nitrogen	No	No[g]	Yes	Yes	Minor	Yes	[g] some inland groundwater problems
Chloride	No	No[h]	Yes	Negligible	No	Yes	[h] some local problems exist in nearshore areas due to point sources
Pesticides[i] (Present)	No	No	Yes	No	No	Yes	[i] new pesticides have been found in the environment; continued monitoring is required
Other Heavy Metals	Potential[f]	Potential[f]	Yes	Yes	Yes	Yes	
Asbestos[j]	No	Yes	No	?	Yes	Yes	[j] see Upper Lakes Reference Group Report[37]
Viruses[k]	← No Data Available →					Yes	[k] better detection methods needed
Acid Precipitation	No	No[m]	No	Yes	No	No	[m] a potential problem for smaller, soft water, inland lakes

[1] Sediment *per se* causes local problems, phosphorus and other sediment-associated contaminants have lakewide dispersion.

industrial organic compounds, some previously-used pesticides and, potentially, some heavy metals, as indicated in the following table.

Phosphorus loads from land drainage and atmospheric deposition contribute to both offshore and nearshore water quality problems related to eutrophication. Depending on the magnitude of the point source loads PLUARG estimated that the combined land drainage and atmospheric inputs to individual Great Lakes ranged from 32 percent (Lake Ontario) to 90 percent (Lake Superior) of the total phosphorus loads (excluding shoreline erosion). Phosphorus loads in 1976 exceeded the recommended target loads in all lakes. Point source control programs alone will be sufficient to meet the target loads only in Lakes Superior and Michigan.

Toxic substances such as PCBs have been found to gain access to the Great Lakes System from diffuse sources, especially from atmospheric deposition.

Residues of previously used organochlorine pesticides (e.g., DDT) are still entering the boundary waters through land drainage in substantial quantities, although in significantly declining amounts, as shown by declining levels in fish tissues.

Mercury has been detected in fish tissues in all the lakes. A continuous buildup of lead in the sediments of the Great Lakes has also been noted. In light of the potential for the methylation of lead, this poses a potential problem of unknown dimensions. Lead enters the Great Lakes System in substantial quantities through atmospheric deposition. It is believed mercury enters the system in a similar manner, although this has not been verified.

Sediment affects the Great Lakes System primarily as a carrier of phosphorus and other pollutants, contributing to the overall pollution of the lakes. Sediment affects nearshore areas through siltation of fish habitat and siltation of drainage channels, harbors and bays, necessitating expensive dredging.

Microorganisms enter the Great Lakes System from diffuse sources, resulting in localized problems affecting some nearshore waters.

While in many cases it is difficult to ascribe pollution (i.e., violation of a specific existing or proposed water quality objective) to any particular land use, it is important to note that it is the cumulative effect of a variety of land use activities that ultimately contributes to pollution of the Great Lakes.

"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?"

PLUARG finds that the lakes most affected by phosphorus and toxic substances are Erie and Ontario. Local problems associated with phosphorus, microorganisms and sediment are seen in such areas as Green Bay, Saginaw Bay, southern Georgian Bay, Lake St. Clair, the Bay of Quinte, and the south shore red clay area of Lake Superior.

Intensive agricultural operations have been identified as the major diffuse source contributor of phosphorus. The following table indicates the relative loading of phosphorus to each lake from the indicated land uses.

Erosion from crop production on fine-textured soils and from urbanizing areas, where large scale land developments have removed natural ground cover, were found to be the main sources of sediment. Urban runoff and atmospheric deposition were identified as the major contributors of toxic substances from nonpoint sources.

The most important land-related factors affecting the magnitude of pollution from land use activities in the Great Lakes Basin were found to be soil type, land use intensity and materials usage. For example, intensive agricultural activities such as row cropping (e.g., growing corn, soybeans and vegetables) on soils with fine textures (i.e., high clay content) contributed the greatest amounts of phosphorus. Areas of high phosphorus loading from intensive agricultural activities include northwestern Ohio and southwestern Ontario.

Mercury in the Great Lakes is associated with sediment and, in large measure, reflects "in-lake" redistribution of this material from past industrial point sources. Other sources include municipal and industrial waste water discharges and atmospheric deposition of unknown dimensions, which have resulted in significant tributary loadings throughout the Great Lakes watershed. Highest loadings were observed in Lake Erie.

Eighty-five to ninety-nine percent of the lead that enters the Great Lakes comes from nonpoint sources, with the highest loadings being found in Lakes Erie and Michigan. Lead is

GREAT LAKES PHOSPHORUS LOADS

Lake	Total Load[a] (metric tons/yr)	Atmospheric Load (percent of total load)	Total Diffuse Tributary Load (percent of total load)	Estimated Contributions of Major Land Uses to Diffuse Tributary Loads (percent of diffuse load)		
				Agriculture	Urban	Forest & Other
Superior	4,200	37	53	7	7	86
Michigan	6,350	26	30	71	12	17
Huron	4,850	23	50	68	12	20
Erie	17,450	4	48	66	21	13
Ontario	11,750	4	28	66	19	15

[a]1976 load rounded off to nearest 50 metric tons

mainly associated with vehicular emissions and enters the Great Lakes through tributary and atmospheric inputs.

Loadings of organic substances (e.g., PCBs) enter the Great Lakes via tributaries and atmospheric deposition. Main sources are atmospheric emissions, industrial and municipal point sources and urban diffuse sources.

"If the Group should find that pollution of the character just referred to is taking place, what remedial measures would, in its judgement, be most practicable and what would be the probable cost thereof?"

PLUARG finds that the remedy of nonpoint source pollution will not be simply nor inexpensively accomplished. Nonpoint sources of water pollution are characterized by their wide variety and large numbers of sources, the seemingly insignificant nature of their individual contributions, the damaging effect of their cumulative impact, the intermittent nature of their inputs, the complex set of natural processes acting to modify them and the variety of social and economic interactions which affect them.

PLUARG does not favor across-the-board measures for nonpoint source pollution control, but rather recommends a methodology whereby problem areas are defined on a priority basis to which the most practicable control means for a particular source are then applied. Management plans must be formulated which include a number of considerations which have not be comprehensively addressed in past point source control programs. Four major components have been identified: (1) planning; (2) fiscal arrangements; (3) information, education and technical assistance; and (4) regulation.

In addition, the successful implementation of these management plans will rely heavily on the interest, concern and action of individual members of society.

Differences in water quality between and within lakes are the basis for requiring different degrees of management in different watersheds. As a result, implementation programs should be emphasized in those areas of the Basin where water quality is the most degraded, or where a need to preserve high quality waters is identified. Remedial program priorities must then be based on the degree to which the pollutant can be controlled.

A basic tool for estimating the level and location of management required in potential pollutant contributing areas is the identification of the most hydrologically active areas (HAA). These are land areas that contribute directly to ground and/or surface waters, even during minor precipitation and snow-melt events, because of their proximity to streams or aquifer recharge areas. The size of hydrologically active areas varies, being a function of land use and management, slope, infiltration rates and soil moisture content.

Developed urban areas, because of their highly impervious, connected surface area and the extensive alteration of their natural hydrology, have large hydrologically active areas. Many developing urban areas are either within a hydrologically active area or tributary to one, and thus special attention must be given to these areas to insure the control of sediment and associated pollutants.

In agricultural areas, soil conservation techniques reduce erosion, and resulting sediment and associated contaminants, from hydrologically active areas.

In some timber and pulpwood harvesting operations, it is necessary to protect the most hydrologically active areas in order to avoid water quality problems. A common practice has been the maintenance of buffer strips along open water courses. Location of the most hydrologically active areas is important for siting solid and liquid waste disposal facilities. This is pertinent not only in consideration of surface water delivery, but also groundwater contamination. Similar concerns are important for locating disposal areas for mine tailings.

The minimum estimated annual costs to achieve recommended phosphorus target loads are presented in the following table. *These estimated costs are in addition to those of established Water Quality Agreement programs and are based only on economic estimates.* It is noted that population growth and other events will require continual adjustments of programs in order to adhere to the target loads.

In addition to the foregoing conclusions, the International Reference Group on Great Lakes Pollution from Land Use Activities concludes the following as to:

"the adequacy of existing programs and control measures"

While broad legislative authority, which may be construed as covering pollution from diffuse sources, exists at state, provincial and local levels, specific legislation or rules may be necessary in the implementation of remedial programs. Some states have already enacted such specific legislation, while others are currently attempting enactment. In the U.S., the 1972 and 1977 amendments to the Federal Water Pollution Control Program provide the mechanism for the planning and fiscal aspects of nonpoint source pollution control. The 1977 amendments also improve the sediment control programs by providing assistance on a priority water quality related basis.

Federal pesticide control legislation in both countries is deemed to be adequate at present.

Federal legislation and control programs in development appear to be adequate at present to reduce and eventually eliminate discharges of toxic substances.

The legislation and/or control programs and measures concerning landfills, deep well disposal and forestry operations, where boundary waters are affected, are considered adequate at present. These land uses are not deemed to contribute significantly to the pollution of the Great Lakes. However, local problems related to these activities can occur.

Atmospheric inputs constitute a substantial portion of the total loads of phosphorus and other pollutants directly to the lakes. The quantities of these pollutants being deposited on land, and subsequently reaching the lakes as a result of migration over or through the soil, are, however, only partially known at present.

ESTIMATED MINIMUM ANNUAL COSTS
TO ACHIEVE PHOSPHORUS TARGET LOADS

Lake	millions of dollars						
	United States			Canada			
	Point Source	Urban Nonpoint Source	Rural Nonpoint Source	Point Source	Urban Nonpoint Source	Rural Nonpoint Source	Total Costs
southern Huron	1.5	7.5	2.5	1.0	0.5	1.5	14.5
Erie	9.0	34.0	12.5	1.5	2.5	10.0	69.5
Ontario[a]	2.5	7.5*	Minimal	5.0	6.5*	Minimal	21.5
TOTAL	13.0	48.0	15.0	7.5	10.5	11.5	105.5

[a] Conditional on Lake Erie target load being met, in order to reduce the annual Niagara River phosphorus input by 1200 metric tons.

* Value revised from first printing of this report.

The level of awareness among Great Lakes Basin residents, with respect to pollution from nonpoint sources, is inadequate at present. Control of nonpoint sources will require all Basin residents to become involved in reducing the generation of pollutants, through conservation practices. Improved planning and technical assistance are prerequisites to long-term solutions of land drainage problems.

A better definition of pollution in the Great Lakes is required. PLUARG found that traditional yardsticks, such as water quality objectives or standards, were insufficient for adequately evaluating the impact of diffuse or nonpoint sources to the Great Lakes. These sources may not in themselves produce violations of water quality objectives. However, in combination with other sources, they can contribute to the overall pollution of the Great Lakes.

The public consultation panels were concerned that additional layers of government not be introduced and that present governments should better define their objectives regarding pollution control. A renewed commitment and better definition of roles of agencies are required in order to maximize the utility of existing measures.

A wealth of data currently exists in various institutions throughout the Basin. Increased efforts must be made to assess and analyze these data. Due to its dispersal, its availability and potential usefulness is restricted. Current data storage and retrieval mechanisms have been found to be inadequate and require substantial improvement to insure efficient access.

Past Great Lakes research efforts have, for the most part, been piecemeal and without unifying objectives. Future studies on the Great Lakes would be of greater value if they were more holistic in nature. The relationship to the Great Lakes System should be considered as an integral part of new studies.

Greater emphasis must be placed on the study of the nearshore areas and coastal zones of the Great Lakes. Few comprehensive studies have been completed in these areas; yet, they are most affected by man's activities.

PLUARG has contributed new information on the biological availability of phosphorus, but has not been able to satisfactorily resolve all questions concerning availability of phosphorus, heavy metals and toxic organic substances, and their transmission from different land use activities to the Great Lakes.

Immediate attention must be given to determining whether the Great Lakes ecosystem will maintain desirable characteristics of diversity, resilience and stability under man-made perturbations. Knowledge of the capacity of the Great Lakes System to handle waste loads is required so that tolerable loads can be prescribed.

The most hydrologically active areas in the Great Lakes Basin must be more clearly identified. Future protection of such areas must be provided for through proper land use management, and remedial measures applicable to such areas must be developed.

The potential for Great Lakes pollution from the disposal of radioactive and other toxic wastes is of concern. Unless safe, permanent disposal systems are found for the increasing quantities of exotic and radioactive wastes being produced, this may constitute a major future problem in the Great Lakes Basin.

RECOMMENDATIONS

Development of Management Plans

PLUARG RECOMMENDS MANAGEMENT PLANS, STRESSING SITE-SPECIFIC APPROACHES, TO REDUCE LOADINGS OF PHOSPHORUS, SEDIMENTS AND TOXIC SUBSTANCES DERIVED FROM AGRICULTURAL AND URBAN AREAS, BE PREPARED BY THE APPROPRIATE JURISDICTIONS WITHIN ONE YEAR AFTER THE INTERNATIONAL JOINT COMMISSION'S RECOMMENDATIONS ARE TRANSMITTED TO THE GOVERNMENTS. PLUARG FURTHER RECOMMENDS THAT A MUTUALLY SATISFACTORY SCHEDULE FOR THE REDUCTION OF NONPOINT SOURCE LOADINGS BE ANNEXED TO THE REVISED GREAT LAKES WATER QUALITY AGREEMENT.

MANAGEMENT PLANS SHOULD INCLUDE:

(i) A TIMETABLE INDICATING PROGRAM PRIORITIES FOR THE IMPLEMENTATION OF THE RECOMMENDATIONS;

CONTROL OF PHOSPHORUS

PLUARG RECOMMENDS THAT PHOSPHORUS LOADS TO THE GREAT LAKES BE REDUCED BY IMPLEMENTATION OF POINT AND NONPOINT PROGRAMS NECESSARY TO ACHIEVE THE INDIVIDUAL LAKE TARGET LOADS SPECIFIED BY PLUARG.

IT IS FURTHER RECOMMENDED THAT ADDITIONAL REDUCTIONS OF PHOSPHORUS TO PORTIONS OF EACH OF THE FIVE GREAT LAKES BE IMPLEMENTED TO REDUCE LOCAL NEARSHORE WATER QUALITY PROBLEMS AND TO PREVENT FUTURE DEGRADATION.

CONTROL OF SEDIMENT

PLUARG RECOMMENDS THAT EROSION AND SEDIMENT CONTROL PROGRAMS BE IMPROVED AND EXPANDED TO REDUCE THE MOVEMENT OF FINE-GRAINED SEDIMENT FROM LAND SURFACES TO THE GREAT LAKES SYSTEM.

CONTROL OF TOXIC SUBSTANCES

PLUARG RECOMMENDS THE FOLLOWING ACTIONS BE TAKEN TO REDUCE INPUTS OF TOXIC SUBSTANCES TO THE GREAT LAKES:

(i) CONTROL OF TOXIC SUBSTANCES AT THEIR SOURCE;

(ii) CLOSER COOPERATION OF BOTH COUNTRIES IN THE IMPLEMENTATION OF TOXIC SUBSTANCES CONTROL LEGISLATION AND PROGRAMS;

(iii) PROPER MANAGEMENT AND ULTIMATE DISPOSAL OF TOXIC SUBSTANCES PRESENTLY IN USE;

(iv) IDENTIFICATION AND MONITORING OF HISTORIC AND EXISTING SOLID WASTE DISPOSAL SITES WHERE THERE IS AN EXISTING OR POTENTIAL DISCHARGE OF TOXIC SUBSTANCES, AND THE IMPLEMENTATION OF CONTROL PROGRAMS AT THOSE SITES AS NEEDED; AND

(v) JOINT EXPANSION OF EFFORTS TO ASSESS THE CUMULATIVE AND SYNERGISTIC EFFECTS OF INCREASING LEVELS OF THESE CONTAMINANTS ON ENVIRONMENTAL HEALTH AND THE RAPID TRANSLATION OF THESE ASSESSMENTS INTO REFINED WATER QUALITY OBJECTIVES, OTHER ENVIRONMENTAL OBJECTIVES AND, WHEREVER POSSIBLE, TOLERABLE LOADS. FOR CERTAIN TOXIC SUBSTANCES, A ZERO LOAD WILL BE NECESSARY.

CONTROL OF MICROORGANISMS

PLUARG RECOMMENDS THAT EPIDEMIOLOGICAL EVIDENCE BE EVALUATED TO ESTABLISH APPLICABLE MICROBIOLOGICAL CRITERIA FOR BODY CONTACT RECREATIONAL USE OF WATERS RECEIVING RUNOFF FROM URBAN AND AGRICULTURAL SOURCES.

AGRICULTURAL LAND USE

PLUARG RECOMMENDS THAT AGENCIES WHICH ASSIST FARMERS ADOPT A GENERAL PROGRAM TO HELP FARMERS DEVELOP AND IMPLEMENT WATER QUALITY PLANS.

THIS PROGRAM SHOULD INCLUDE:

(i) A SINGLE PLAN DEVELOPED FOR EACH FARM, WHERE NEEDED;

(ii) CONSIDERATION OF ALL POTENTIAL NONPOINT SOURCE PROBLEMS RELATED TO AGRICULTURAL PRACTICES, INCLUDING EROSION, FERTILIZER AND PESTICIDE USE, LIVESTOCK OPERATIONS AND DRAINAGE; AND

(iii) A PLAN COMMENSURATE WITH THE FARMERS' ABILITY TO SUSTAIN AN ECONOMICALLY VIABLE OPERATION.

URBAN LAND USE

PLUARG RECOMMENDS THE DEVELOPMENT OF MANAGEMENT PLANS FOR CONTROLLING URBAN STORMWATER RUNOFF. THESE PLANS SHOULD INCLUDE:

(i) PROPER DESIGN OF URBAN STORMWATER SYSTEMS IN DEVELOPING AREAS SUCH THAT THE NATURAL STREAM FLOW CHARACTERISTICS ARE MAINTAINED; AND

(ii) PROVISION FOR SEDIMENT CONTROL IN DEVELOPING AREAS, AND CONTROL OF TOXIC SUBSTANCES FROM COMMERCIAL AND INDUSTRIAL AREAS.

WETLANDS AND FARMLANDS

PLUARG RECOMMENDS THE PRESERVATION OF WETLANDS, AND THE RETENTION FOR AGRICULTURAL PURPOSES OF THOSE FARMLANDS WHICH HAVE THE LEAST NATURAL LIMITATIONS FOR THIS USE.

LOCAL PROBLEM AREAS

PLUARG RECOMMENDS THAT THE INTERNATIONAL JOINT COMMISSION, THROUGH THE GREAT LAKES REGIONAL OFFICE, INSURE THAT LOCAL LEVELS OF GOVERNMENT ARE MADE AWARE OF THE AVAILABILITY OF PLUARG FINDINGS, ESPECIALLY AS THEY RELATE TO LOCAL AREA PROBLEMS, TO ASSIST THEM IN DEVELOPING AND IMPLEMENTING NONPOINT SOURCE MANAGEMENT PROGRAMS.

Review and Evaluation of Management Plan Implementation

REVIEW OF IMPLEMENTATION

PLUARG RECOMMENDS:

(i) THE INTERNATIONAL JOINT COMMISSION INSURE REGULAR REVIEW OF PROGRAMS UNDER-

(ii) AGENCIES RESPONSIBLE FOR THE ULTIMATE IMPLEMENTATION OF PROGRAMS DESIGNED TO SATISFY THE RECOMMENDATIONS;

(iii) FORMAL ARRANGEMENTS THAT HAVE BEEN MADE TO INSURE INTER- AND INTRA-GOVERNMENTAL COOPERATION;

(iv) THE PROGRAMS THROUGH WHICH THE RECOMMENDATIONS WILL BE IMPLEMENTED BY FEDERAL, STATE AND PROVINCIAL LEVELS OF GOVERNMENT;

(v) SOURCES OF FUNDING;

(vi) ESTIMATED REDUCTION IN LOADING TO BE ACHIEVED;

(vii) ESTIMATED COSTS OF THESE REDUCTIONS; AND

(viii) PROVISION FOR PUBLIC REVIEW.

PLANNING

PLUARG RECOMMENDS THAT GOVERNMENTS MAKE BETTER USE OF EXISTING PLANNING MECHANISMS IN IMPLEMENTING NONPOINT SOURCE CONTROL PROGRAMS BY:

(i) INSURING THAT DEVELOPMENTS AFFECTING LAND ARE PLANNED TO MINIMIZE THE INPUTS OF POLLUTANTS TO THE GREAT LAKES; AND

(ii) INSURING THAT PLANNERS ARE AWARE OF AND CONSIDER PLUARG FINDINGS IN THE DEVELOPMENT AND REVIEW OF LAND USE PLANS.

FISCAL ARRANGEMENTS

PLUARG RECOMMENDS THAT A REVIEW OF FISCAL ARRANGEMENTS BE UNDERTAKEN TO DETERMINE WHETHER PRESENT ARRANGEMENTS ARE ADEQUATE TO INSURE EFFECTIVE AND RAPID IMPLEMENTATION OF PROGRAMS TO CONTROL NONPOINT POLLUTION. SUCH A REVIEW SHOULD INCLUDE:

(i) DETERMINATION OF THE AVAILABILITY OF GRANTS, LOANS, TAX INCENTIVES, COST-SHARING ARRANGEMENTS AND OTHER FISCAL MEASURES;

(i) DETERMINATION OF WHETHER OR NOT THE TERMS OF FINANCIAL ASSISTANCE PROGRAMS ARE SUFFICIENT TO ENCOURAGE WIDESPREAD PARTICIPATION; AND

(iii) DETERMINATION OF THE EXTENT TO WHICH VARIOUS FINANCIAL ASSISTANCE PROGRAMS ARE CONDITIONAL UPON THE IMPLEMENTATION OF NONPOINT SOURCE REMEDIAL MEASURES.

INFORMATION, EDUCATION AND TECHNICAL ASSISTANCE

PLUARG RECOMMENDS THAT GREATER EMPHASIS BE GIVEN TO THE DEVELOPMENT AND IMPLEMENTATION OF INFORMATION, EDUCATION AND TECHNICAL ASSISTANCE PROGRAMS TO MEET THE GOALS OF THE GREAT LAKES WATER QUALITY AGREEMENT. THIS EMPHASIS SHOULD INCLUDE:

(i) DEVELOPMENT OF BROAD PROGRAMS, THROUGH SCHOOL SYSTEMS, THE MEDIA AND OTHER PUBLIC INFORMATION SOURCES, DESCRIBING THE ORIGINS AND IMPACTS OF POLLUTANTS ON THE GREAT LAKES AND ALTERNATIVE STRATEGIES THAT SHOULD BE FOLLOWED BY THE PUBLIC AND GOVERNMENT AGENCIES TO PREVENT WATER QUALITY DEGRADATION;

(ii) INITIATION OF MORE SPECIFIC PROGRAMS TO IMPROVE THE AWARENESS OF IMPLEMENTORS AND THOSE WORKING IN AND FOR GOVERNMENT, EMPHASIZING THE NEED FOR THE FURTHER CONTROL AND ABATEMENT OF NONPOINT POLLUTION; AND

(iii) STRENGTHENING AND EXPANDING EXISTING TECHNICAL ASSISTANCE AND EXTENSION PROGRAMS DEALING WITH THE PROTECTION OF WATER QUALITY, INCLUDING RURAL AND URBAN LAND MANAGEMENT PRACTICES.

REGULATION

PLUARG RECOMMENDS:

(i) THAT THE ADEQUACY OF EXISTING AND PROPOSED LEGISLATION BE ASSESSED TO INSURE THERE IS A SUITABLE LEGAL BASIS FOR THE ENFORCEMENT OF NONPOINT POLLUTION REMEDIAL MEASURES IN THE EVENT THAT VOLUNTARY APPROACHES ARE INEFFECTIVE; AND

(ii) THAT GREATER EMPHASIS BE PLACED ON THE PREVENTIVE ASPECTS OF LAWS AND REGULATIONS DIRECTED TOWARD CONTROL OF NONPOINT POLLUTION.

Implementation of Management Plans

REGIONAL PRIORITIES

PLUARG RECOMMENDS THAT REGIONAL PRIORITIES FOR IMPLEMENTING MANAGEMENT PLANS DEVELOPED BY THE JURISDICTIONS BE BASED UPON:

(i) THE WATER QUALITY CONDITIONS WITHIN EACH LAKE;

(ii) THE POTENTIAL CONTRIBUTING AREAS (PCA) IDENTIFIED BY PLUARG; AND

(iii) THE MOST HYDROLOGICALLY ACTIVE AREAS (HAA) FOUND WITHIN THESE POTENTIAL CONTRIBUTING AREAS.

MENDATIONS ARISING FROM THIS REFERENCE, AND

(ii) THAT NONPOINT SOURCE INTERESTS BE REPRESENTED DURING THESE REVIEWS.

SURVEILLANCE

PLUARG RECOMMENDS THAT TRIBUTARY MONITORING PROGRAMS BE EXPANDED TO IMPROVE THE ACCURACY OF LOADING ESTIMATES OF SEDIMENT, PHOSPHORUS, LEAD AND PCBs. SAMPLING PROGRAMS:

(i) SHOULD BE BASED ON STREAM RESPONSE CHARACTERISTICS, WITH INTENSIVE SAMPLING OF RUNOFF EVENTS, WHERE NECESSARY; AND

(ii) SHOULD BE EXPANDED TO INCLUDE TOXIC ORGANIC COMPOUNDS, TOXIC METALS AND OTHER PARAMETERS AS MAY BE DEFINED IN THE FUTURE.

FURTHER, THE ROLE OF ATMOSPHERIC INPUTS SHOULD BE CONSIDERED IN THE EVALUATION OF GREAT LAKES POLLUTION, WITH SPECIAL CONSIDERATION GIVEN TO DETERMINATION OF THE SOURCES OF MAJOR ATMOSPHERIC POLLUTANTS.

EFFORTS SHOULD BE MADE TO IMPROVE THE COORDINATION BETWEEN DATA COLLECTION AND DATA USER GROUPS, AND AGREEMENTS ESTABLISHED REGARDING DATA COLLECTION STANDARDS AND ACCESSIBILITY.

PLUARG FURTHER RECOMMENDS THAT THE ADEQUACY OF U.S. GREAT LAKES NEARSHORE AND OFFSHORE WATER SURVEILLANCE EFFORTS BE EXAMINED.

Role of the Public

PLUARG RECOMMENDS THAT THE INTERNATIONAL JOINT COMMISSION ESTABLISH A COMPREHENSIVE PUBLIC PARTICIPATION PROGRAM AT THE OUTSET OF FUTURE REFERENCES.

APPENDIX III

PLUARG TECHNICAL REPORTS
(See explanation of symbols
at end of Appendix 7)

Report No.†

PLUARG FINAL REPORT

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Drynan, W.R. Relative Costs of Achieving Various Levels of Phosphorus Control at Municipal Wastewater Treatment Plants in the Great Lakes Basin. Technical Report to the International Reference Group on Great Lakes Pollution from Land Use Activities of the International Joint Commission. July 1978, 59 pp. 004

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International Reference Group on Great Lakes Pollution from Land Use Activities Task Group A (U.S. Section). Management Programs, Research and Effects of Present Land Use Activities on Water Quality of the Great Lakes. 2 vols. Windsor, Ontario, November 1974, 1052 pp. 010

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* Coleman, D. E. Ontario Recreation: A Forecast to 2020. (Unpublished). Submitted to PLUARG Task Group B-5. December 1976, 23 pp. 033

* Sudar, A. and P. Deutscher. Land Use Change in the Canadian Great Lakes Basin, 1971-2020. (Unpublished). Prepared for PLUARG Task Group B-5 Land Use Forecasts. May 1976, 46 pp. 034

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Nicholson, J.A. Forested Watershed Studies, Summary Technical Report. Submitted to PLUARG Task Group C, Activity 2. Windsor, Ontario. December 1977, 23 pp. 049

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Frank, R. et al. Stream Flow Quality-Pesticides in Eleven Agricultural Watersheds in Southern Ontario, Canada, 1974-1977. Submitted to PLUARG Task Group C (Canadian Section) Activity 1. Windsor, Ontario. 1978, 174 pp. 052

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APPENDIX V

OVERVIEW OF HAZARDOUS WASTE MANAGEMENT
ISSUES IN STATE JURISDICTIONS

Illinois

Under the authority of the Environmental Protection Act of Illinois, the Illinois Pollution Control Board may adopt regulations to prescribe standards for the disposal of hazardous waste. Up to the present, the state has promulgated only a few regulations. Although hazardous waste is defined in the regulation, there are no criteria or list to more precisely identify such waste. At present, the Board determines which wastes are hazardous based on individual cases. Once it determines that a waste is hazardous, the Board must give special authorization to dispose of it in the landfill. The new Environmental Protection Act, effective January 1, 1980 provides a more extensive definition of hazardous wastes, but no specific criteria for identification will be in effect until the regulations are finalized. Once finalized the RCRA criteria and listing will be applied by Illinois. The new Act does, however, contain specific standards for siting hazardous waste disposal facilities. Sites cannot be located in counties with populations exceeding 225,000, within two miles of an active fault, or within 1000 feet of an existing well or lake.

There are no standards prescribed in the regulations for construction, operation, and closure, although the new Act does grant authority to adopt standards. The Board prescribes individual standards to be met as conditions in the Development and Operating Permits. Operators and owners of hazardous waste disposal sites are responsible for maintenance and monitoring of the sites for 20 years following closure.

Indiana

Indiana follows Illinois insofar as hazardous waste is regulated as part of the solid waste management program. The Indiana Solid Waste Management Permit regulations under the authority of the Refuse Disposal Act defines hazardous wastes but contains no criteria or lists for specific identification. Disposal of hazardous waste must be authorized by the Stream Pollution Control Board in the Solid Waste Management Permit. Construction and operation standards are described by the permit applicant in the application and approved by the Board which may add conditions of its own. The regulations provide the general standard that the sanitary landfill must conform to minimum water quality standards. There are more specific construction and operation standards in the regulations, but they are relevant to the disposal of nonhazardous waste. There are no provisions for groundwater monitoring. Under the Environmental Management Act, the site must be closed with a two-foot cover.

Michigan

Effective January 1, 1980 is the Hazardous Waste Management Act. The Act contains a definition of hazardous wastes and authorizes the Director of the Department of Natural Resources to propose specific guidelines for identification of such wastes. These are not yet promulgated.

Planned disposal facilities for hazardous waste require a construction permit from the Director. The permit must conform to the state hazardous waste management plan, a plan to be created by a state planning committee. The committee will be composed of state and local officials, engineers, and (among others) three members of the general public. This is the first law in the hazardous waste area whose administration includes direct citizen input.

Citizens also participate on the Site Approval Board. Hazardous waste generators must apply to the Director for a construction permit. If the Director approves the proposed facility, he or she will submit the application to the Board for final rejection or approval. In considering the application the Board shall examine such things as the impact of contamination of ground and surfacewater by leaching and runoff from the proposed facility.

At present, no rules have been promulgated under the Act to establish specific standards for siting, construction, operation and closure of hazardous waste facilities. Standards for a proposed facility are assigned by the Director in the operating license on a case-by-case basis.

It is worthy of note that in addition to the above, the Act also establishes a one million dollar hazardous waste service fund to cover hazardous waste emergencies.

Minnesota

The Minnesota Pollution Control Agency has recently released an extensive set of rules on hazardous waste. The rules contain lists, general criteria, and test by which the Agency can identify hazardous waste. If a waste is identified by the Agency as hazardous, the generator must obtain a Hazardous Waste Facility Permit for construction and operation of a disposal facility.

Guidelines are provided in the Rules for siting of disposal facilities insofar as they prohibit establishment of a facility in a wetland, floodplain or shoreland where the topography, geology, hydrology or soil is unsuitable for the protection of ground and surface water or where emissions from the activity would result in a violation of state ambient air quality standards. Beyond meeting these guidelines, the permit applicant must describe specific features of the proposed site in the application.

The rules do not as yet provide construction standards. Permit applications must disclose their construction plans which must answer such specific questions provided in the rules as a report on the subsurface conditions at the proposed facility, placement and construction of monitoring wells, and engineering report that addresses questions of the liner specifications, and preliminary specifications for a leachate collection system. The Agency bases its approval on the proposed plans.

Although specific procedures for operation of the plant are not named, the rules require that procedures exist for spills, fires, control of access, and prevention of discharge of hazardous waste to surface or groundwaters. The facility must have an operations manual which includes daily maintenance, inspection, monitoring, and emergency procedures. This manual must also make specific references to the training that the facility personnel shall receive, as such training is required by the Rules.

Quarterly monitoring is required to determine the effect of the facility on soil, groundwater, and air.

Finally, the rules lay out general procedures for the closure of the facility. The facility operator must perform such duties as covering the hazardous waste with an adequate amount of cover material to minimize leachate production, construction of a ground and surfacewater monitoring system, and the establishment of a final grade that promotes surface water runoff without excessive erosion. Further, the operator must provide long term maintenance of the impervious liner and final cover and treat contaminated surface water runoff.

New York

The New York Solid Waste Management Facilities Rules provide that hazardous wastes shall be accepted only at facilities which the Department of the Environmental Conservation has approved for disposal. The rules define hazardous wastes, but give no specific guidelines for identification. Legislation (Title 9 of the Solid Waste Management Law) requires that the Commissioner of the Department promulgate regulations for identification of hazardous wastes that are consistent with the RCRA regulations.

All hazardous wastes shall be landfilled only in accordance with the provisions for a "secure landburial facility." This facility must not be located over groundwater recharge areas serving public water supplies, closer than ten feet to the groundwater table or bedrock, or less than five feet above a floodplain. The soil beneath the facility must have a hydraulic conductivity specified in the Rules. These provisions are likely to change once regulations are promulgated under Title 9.

Construction standards for landburial facilities are very specific. The rules require that the liner and cap have a permeability given in the rules. There is also the requirement for leachate and surface water collection.

Operation standards are extensive and range from attendance of facility entrance to the maintenance of records. Personnel must attend and complete a training course given by the Department. Emergency procedures must also exist and be approved by the Department.

The operator must monitor the groundwater and surfacewater where the Department requires it.

At present, the Department prescribes conditions for closure in the permit. The length of term for which the operator is responsible for maintenance and monitoring of the facility after closure is determined also on a case-by-case basis. As with siting standards, Title 9 authorizes the Commissioner to promulgate regulations for long term maintenance.

Ohio

The Ohio Solid Waste Disposal Regulations under the authority of the Ohio Waste Disposal Law contain little direct reference to hazardous waste disposal. The Ohio Environmental Protection Agency treats hazardous waste disposal primarily on a case-by-case basis. As in several other jurisdictions, hazardous waste is defined but there are no specific

identification guidelines. Persons wishing to establish a solid waste disposal facility should submit to the Director of the Agency detail plans of the types of waste materials received, including hazardous, the proposed construction and the proposed site. Specific issues that should be addressed by an applicant for a facility are included in the regulations.

Siting and construction of the facility must conform to the approved detail plans. There are some specific conditions in the regulations for siting. A landfill cannot be in a floodplain outside of the floodway, in a limestone or sandstone quarry, within 1,000 feet of a well, 200 feet of a lake or stream, or less than five feet from the seasonal high groundwater table.

Operation of the facility must also conform to the detail plans and to conditions prescribed by the Director in a solid waste disposal license. The rules provide few specific operation procedures. They require that all operations be carried out by facility personnel thoroughly familiar with procedures laid out in the detail plans. There is the general operation standard that the facility shall not be operated in such a way so as to create a nuisance, health hazard or water pollution. There are also more specific requirements for a daily log of operations, adequate fire control equipment, and operable facility equipment. A contingency plan should exist to meet possible breakdowns in equipment.

Ground and surfacewater monitoring is generally required as a condition of the permit.

The rules provide specific procedures for closure including thickness of the cover, grading of the slope, and monitoring of leachates. Long term monitoring and maintenance are determined on a case-by-case basis.

Pennsylvania

The Pennsylvania Solid Waste Regulations define hazardous waste. A list of wastes identified as hazardous is also maintained by the Department of Environmental Resources, the administrating agency. Waste disposal facilities can be built and operated only at those sites which conform to the solid waste management plan of the municipality of the proposed site. Applications for Processing and Disposal Area Permits shall include design plans set forth in the regulations for Sanitary Landfills and Industrial and Hazardous Waste Disposal Sites. The latter standards require a leaching analysis of the waste, and a report on the soils, geology and groundwater in the application for the permit. Where the disposal site is to be constructed without a liner, renovating soil must be placed between the waste and any sidewall with a slope less than 110 degrees as measured from the horizontal bottom of the fill area. Furthermore, where there is no liner, the site must have renovating soil beneath the waste and above the high groundwater table or bedrock. Manufactured membranes must meet standards prescribed in the regulations which are very detailed as to allowable concentrations of leachates and thickness.

Standards exist for plant operation of sanitary landfills, but these apply primarily to nonhazardous wastes. Standby equipment is required in the event of emergencies. Groundwater monitoring is also required.

Standards also exist for closure, although there is no provision for long term post-closure monitoring and maintenance.

The Pennsylvania legislature is presently considering a cradle-to-grave hazardous waste bill. There is no prediction, however, as to when or if it will pass.

Wisconsin

At present, the Solid Waste Disposal Rules provide some coverage of hazardous wastes. As with other state legislation, there is a definition but no guidelines for identification of hazardous wastes. Persons wishing to dispose of hazardous wastes must apply for a solid waste disposal license. The application must inlcude the names of the toxic or hazardous wastes to be disposed, information on the site plot plan, and a description of signs, gates, fences, and methods of waste unloaing. The Department of Natural Resources as the administrating agency holds the authority to approve license applications and to prescribe conditions of siting, construction and operation on a case-by-case basis, in addition to standards in the Rules. The Rules prohibit siting of disposal facilities within 1,000 feet of any navigable lake, pond or flowage, 300 feet of a navigable stream or flood plain or a wetland. Boundaries of the facility must be fenced and the entrance guarded by an attendant. The Department shall also specify that samples of groundwater be taken on a calender quarterly basis, that the material be compacted and covered at a frequency of 100 days, and rules of closure of the site.

Wisconsin has passed a Hazardous Waste Management Act which is in conformity with RCRA. Rules for the six issues under discussion have been drafted, but are not yet in effect.