NUTRIENT MANAGEMENT:

A SUMMARY OF STATE AND PROVINCIAL PROGRAMS IN THE GREAT LAKES – ST. LAWRENCE RIVER REGION

Prepared by the
Great Lakes Commission

In consultation with the
Great Lakes–St. Lawrence River
Phosphorus Reduction Task Force

SEPTEMBER 2012

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Preface

This briefing paper was developed at the request of the Great Lakes Commission Board of Directors. Staff was directed to prepare an "issue brief" on nutrient management and the problem of increased nutrient loadings to the Great Lakes-St. Lawrence River basin. The paper lists and summarizes the nutrient management programs and efforts of the states and provinces that fall under the representation of the Great Lakes Commission (GLC).

The GLC's involvement in nutrient management reflects its long-term interest in water quality management activities and the need for state and provincial governments' understanding of this multijurisdictional issue. While many of the nutrient management programs are common to each jurisdiction, each jurisdiction has unique and innovative initiatives that provide the opportunity for others to learn from best practices and adopt these programs of interest.

This report was prepared by the GLC staff in consultation with the Phosphorus Reduction Task Force. The GLC extends its appreciation to the Phosphorus Reduction Task Force for reviewing and editing this paper. The Task Force is composed of individuals from environmental, natural resource and agricultural agencies of each of the Great Lakes states and the provinces of Ontario and Québec. The Task Force membership roster is included as Appendix C.

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Overview

According to a report from the U.S. Environmental Protection Agency's (U.S. EPA) Nutrient Innovations Task Group,[1] 78 percent of the assessed continental U.S. coastal areas, including the Great Lakes, exhibit signs of degraded water quality conditions due to excessive nutrient loadings from activities collectively termed "nonpoint source pollution." Nonpoint source pollution – pollution that enters waterways mainly as the result of runoff from and through the landscape – is comprised of many and varied constituents. These include sediment, bacteria, organic material, pesticides, toxic chemicals, and nutrients. In particular, sedimentation from agricultural and construction activities (among others) plays a major role in the addition of nutrients and toxic chemicals to the Great Lakes system. Beyond water quality degradation, soil erosion and sedimentation reduce agricultural productivity, degrade fish and wildlife habitat, limit water-based recreation, and damage water treatment and public water supply infrastructure.

In recent years, the relationship between land-use activities and water quality has been increasingly well-documented. Federal, state and provincial governments are becoming ever more concerned about nonpoint source pollution, especially excessive nutrient loadings to the Great Lakes and St. Lawrence River, and the potentially harmful effects this can have on the ecosystem, human activities, and public health. Because of this new and increased focus on problems associated with nonpoint source pollution, new partnerships and initiatives are emerging to address what is understood to be a leading environmental problem in the Great Lakes basin.

The Nutrient Problem

There are 17 essential nutrients required for proper plant growth. Of these, carbon and oxygen are absorbed from the air, while other nutrients, including water, are obtained from a growing medium, usually soil. The three main nutrients, or macronutrients, required for plant growth are nitrogen, phosphorus and potassium, which occur naturally in terrestrial and aquatic environments. However, these also are commonly found in commercial fertilizers that are applied annually to croplands and farm fields and from properties in urban and suburban areas, additions which are required for high levels of crop production and to increase the attractiveness of lawns. The elevated concentration of these elements, due to their widespread uses in human activities, has prompted the development of the scientific objectives and practices of nutrient management.

Nutrient management, according to the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) is the management of the (proper) amount, source, placement, form and timing of the application of plant nutrients and soil amendments.[2] Nutrient sources include: soil

[1] U.S. EPA. 2009. *An Urgent Call to Action. Report of the State-EPA Nutrient Innovations Task Group.* Accessed 27 June 2012. Available online at: http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/2009_08_27_criteria_nutrient_nitgreport.pdf.

[2] U.S. Department of Agriculture. 2012. *Nutrient Management Definition.* Nutrient and Pest Management, Natural Resources Conservation Service. Accessed 27 June 2012. Available online at: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse/crops/npm.

reserves, commercial fertilizer, manure, organic byproducts, legume crops, and crop residues. The two nutrient elements of most concern for their effect on ecosystem and human health are nitrogen and phosphorus.

Nitrogen

Nitrogen, including nitrates and other chemical formulations, is soluble and easily transported by water. Due to its ease of transport, it may readily accumulate, and any that is not absorbed by plants results in residual nitrogen that can percolate down through the soil profile with rain water or snow melt. Eventually this nitrogen can reach the water table which is often used for drinking water. In the southern portion of the Great Lakes basin, where subsurface drainage of cropland is common, the downward flow is intercepted by tile drains and emptied into nearby waterways.

Nitrogen (in many formulations such as urea ($(NH_2)_2CO$), ammonia (NH_3), and animal waste) is applied to millions of acres of land annually in the Great Lakes basin. These areas include lawns, golf courses and cropland. Soybean production also is a significant source of nitrogen in the basin. The soybean plant, a legume, produces its own nitrogen through a process called nitrogen fixation. Any nitrogen not used by the soybean plants is added to the pool of available excess nutrients.

Excess nitrogen is a concern for several reasons, including the potentially high levels of nitrates (NO_3^-) in drinking water. Many towns and cities in the basin obtain their drinking water from groundwater or from the streams and rivers potentially polluted with nitrogen. The maximum amount of nitrates allowed by the U.S. EPA in finished (*i.e.,* processed) drinking water is 10 mg/l. Levels higher than 10 mg/l can affect human health, especially that of children under six months of age and the elderly. However, many rivers in the Great Lakes basin frequently exceed this standard.

Phosphorus

Like nitrogen, phosphorus also occurs naturally in the soil profile and is applied as a fertilizer to millions of acres of cropland annually in the Great Lakes basin. Phosphorus can be attached (adsorbed) to soil particles or be in a dissolved state. During runoff events, phosphorus can be transported to Great Lakes waterways by the movement of soil through the erosion process and in the runoff itself. Phosphorus in its dissolved state is (pound for pound) three times more available to plants, including aquatic algae, than phosphorus attached to a soil particle. Over the past two decades the amount of phosphorus attached to soil particles has been reduced while the amount of dissolved phosphorus has increased.

Excess phosphorus is of particular concern in bodies of freshwater, as phosphorus is a limiting factor in the growth of aquatic plants (including phytoplankton and algae) in these ecosystems. Algae need very little phosphorus for growth, and excess phosphorus causes extensive algae growth, creating algal blooms which may result in unpleasant odors, and/or may reduce the visual appeal in the coastal zone by coloring the water an unattractive green. This is the first symptom of cultural eutrophication.

Eutrophication

Eutrophication is traditionally defined as the increase in the rate of supply of organic matter to an ecosystem,[3] usually due to the land-based loading of nutrients, especially phosphorus and nitrogen (*i.e.*, phosphates and nitrates). This is a natural, slow-aging process for a water body, but one that is greatly accelerated by human activities.[4] Contributing sources of nutrients leading to eutrophication in the Great Lakes basin include urban and agricultural runoff, shorebird droppings, and leaking septic systems.[5]

One of the first, and most common, effects of eutrophication in aquatic systems is the development of algal blooms. This occurs as nutrients (phosphorus) enter a river or lake, promoting the increased growth of phytoplankton (algae). In addition to nutrient loading, several additional factors contribute to – and in some cases intensify – bloom development, including slow-moving or stagnant water, and high light availability. While phytoplankton, through photosynthesis, raise dissolved oxygen (DO) saturation during daylight hours, the high plant density of a bloom reduces DO saturation during the night because of plant respiration, which uses oxygen and releases carbon dioxide (CO_2). When phytoplankton cells die, they sink toward the bottom of the waterbody and are decomposed by bacteria, a process that further reduces oxygen in the water column. In the conditions of an algal bloom, these processes may result in hypoxia, or severe oxygen depletion. Loadings of dissolved phosphorus have been and continue to be one of the major contributors in the process of the annual occurrence of hypoxia zones in Lake Erie. As oxygen depletion progresses, adverse impacts to other organisms, such as fish, can occur.

An additional outcome of eutrophication-induced algal growth, and one that is of particular concern for human health in the Great Lakes and other coastal regions, is the development of harmful algal blooms, commonly referred to as HABs. The development of a HAB is no different from the blooms described above, in that these result from an increase in the rate of supply of nutrients to a system, leading to the excessive algal growth. HABs, however, occur when the algal communities consist of microorganisms, such as cyanobacteria (commonly termed "blue-green algae"), with inherently harmful qualities.[6] In addition to their ability to affect an ecosystem due to sheer population size (*i.e.,* DO depletion), HABs also may produce toxins that directly or indirectly affect human health and safety.[7] The toxicity of a HAB may be further intensified by filter-feeding invertebrates (*e.g.,* zebra mussels), which selectively remove the non-toxic, higher quality algal species from the water column.[8]

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[3] Nixon, S.W., 1995, Coastal marine eutrophication--A definition, social causes, and future concerns: Ophelia, v. 41, p. 199-219.

[4] The University of Michigan. 2001. *The Urban and Industrial Environment: Hydrological Effects and Waste Management.* Accessed 25 June 2012. Available online at: http://www.globalchange.umich.edu/globalchange2/current/lectures/urban2/urban_indust.html#intro

[5] Michigan Sea Grant. *Factors Influencing the Growth of Harmful Algal Blooms (*Thereafter, *Factors*). Accessed 26 June 2012. Available online at: http://www.miseagrant.umich.edu/hab/images/Harmful-Algal-Bloom-illustration-1000w.jpg.

[6] Gilbert, P.M., D.M. Anderson, P. Gentien, E. Granéli, and K.G., Sellner. 2005. *The Global, Complex Phenomena of Harmful Algal Blooms.* Oceanography 18 (2).

[7] Michigan Sea Grant. *When Blooms go Bad: Harmful Algal Blooms in the Great Lakes.* Accessed 25 June 2012. Available online at: http://www.miseagrant.umich.edu/hab/index.html.

[8] *Factors, s*upra note 5.

The impacts of excessive nonpoint source nutrient loading and eutrophication to both Great Lakes water quality and human health have become clearer over the past several decades. This realization has prompted the development of several federal, regional, and state-wide nutrient abatement and management programs aimed at both educating farmers and landowners about the impacts of their practices, and improving and maintaining the ecological integrity of the Great Lakes-St. Lawrence system.

History of Nutrient Abatement Programs in the Great Lakes Basin

In the 1950s, water quality in most of the Great Lakes, especially Lake Erie, had begun to decline due primarily to eutrophication caused by excessive phosphorus loadings. In Lake Erie algal blooms were becoming increasingly common. Anoxic (areas without oxygen) zones in the central and western basins were spreading, and taste and odor problems from public water supplies were prevalent. By the 1960s, scientists were concerned that the anoxic conditions could trigger such large nutrient releases from bottom sediments that Lake Erie would be thrown into an irreversible downward spiral of excessive eutrophication.

A series of events, including the unsightly algal blooms along the shores of Lake Erie and Lake Ontario, a massive alewife die off in Lake Michigan and the infamous scene of the Cuyahoga River catching on fire prompted new action on the part of governments in both the United States and Canada to combat pollution and protect the Great Lakes. During 1970, both the U.S. EPA and the Canadian Department of the Environment (now Environment Canada) were formed, and several federal and regional initiatives since that time have focused on restoring and protecting the health of North America's waterways, including those in the Great Lakes basin.

Federal Initiatives

Federal Water Pollution Control Act (Clean Water Act)

The U.S. Federal Water Pollution Control Act, popularly known as the Clean Water Act (CWA), is a comprehensive statute aimed at restoring and maintaining the chemical, physical and biological integrity of the nation's waters. Originally enacted in 1948, the Act was amended numerous times until it was reorganized and expanded in 1972. It continues to be amended annually. The CWA amendments in 1972 represented the nation's response to the nearly unchecked dumping of pollution into its waterways. At the time of the 1972 amendments, two-thirds of the country's lakes, rivers and coastal waters had become unsafe for fishing or swimming.

The 1987 amendments to the CWA established the section 319 Nonpoint Source (NPS) Management Program in recognition of the need for greater federal leadership to help focus state and local NPS control efforts. Since 1990, states (along with territories and Indian tribes) have been eligible to receive grant money from regional EPA offices under section 319(h). These funds support a wide variety of activities including nonregulatory or regulatory programs for enforcement, technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific NPS implementation projects. Notably, a portion of the section 319 grant funds have been used by states to support implementation of NPS controls in lake watersheds and to monitor the effectiveness of NPS best management practices

(BMPs) within watersheds.[9] To obtain funding, states must complete an NPS assessment report that identifies NPS water quality problems. States then develop NPS management programs describing what they are going to do about their nonpoint water quality problems over the next four years. As of November 1994, all states, as well as six tribal governments and six territories, had completed assessments and management programs.

U.S. Farm Bills and Agricultural Land Conservation

The first Farm Bill was passed in 1933 as the Agricultural Adjustment Act. During the Great Depression in the late 1920s and early 1930s the federal government saw a need to invest in the rural agricultural economy to help farmers facing tough economic times. Before this, the U.S. Department of Agriculture (USDA) provided research, marketing, and extension services. After the "dust bowl" of the 1930s and the Great Depression, the USDA was empowered to provide income and crop price support to the impoverished American farmer. These commodities programs continued to evolve over the decades, gradually changing from a vehicle of income, price, and supply control to include an environmental resource management component.

The federal farm policy of the 1980s showed a change in environmental concern and a greater awareness of the need for farm conservation. Until this time, two major themes had dominated the conservation debate: 1) reducing high levels of erosion; and 2) providing high quality water to agriculture in quantities that enhanced production. Public awareness about the deleterious effects farming had on not only soil quality, but also on water and air quality and wildlife habitat, increased. The 1985 Farm Bill was the first to have a specific title devoted to conservation. The true breakthrough of the 1985 legislation can be found in the change in the language used to describe the importance of soil conservation for reasons other than productivity gains. It added new programs: Sodbuster, Swampbuster, Conservation Compliance, and the Conservation Reserve Program (CRP). New programs such as the Environmental Quality Incentives Program (EQIP), introduced in the 2002 Farm Bill, and the Conservation Reserve Enhancement Program (CREP), introduced in the 1996 Farm Bill, were created to address the environmental issues of soil erosion, water quality improvement, and wildlife habitat protection and enhancement.

Regional Initiatives

Great Lakes Water Quality Agreement

Within the backdrop of public awareness and greater scientific evidence of the damaging effects of pollution to the water quality of the Great Lakes, a joint U.S.-Canada working group was formed to study the need for binational action to clean up the Great Lakes. Several years of study and two years of intense negotiation led to the signing of the Great Lakes Water Quality Agreement on April 15, 1972. In this landmark agreement, the United States and Canada agreed to initiate phosphorus reduction programs for municipal sewage treatment plants in the Lake Erie and Lake Ontario basins. Controls were also agreed upon for industrial discharges and for large, concentrated livestock operations.

The role of different land uses, especially row crop agriculture as a major contributor of phosphorus to the Great Lakes, also became more apparent in the 1970s as a result of two major studies. In

[9] U.S. EPA. *Clean Water Act Section 319*. Background and Reports Summaries. Wetlands, Oceans and Watersheds. Accessed 25 June 2012. Available online at: http://www.epa.gov/owow_keep/nps/cwact.html.

1972, the governments of the United States and Canada requested that the International Joint Commission (IJC) initiate a reference study to determine the nature, extent and possible remedies for nonpoint source pollution. The resulting binational research effort, organized under the Pollution from Land Use Activities Reference Group (PLUARG), produced a series of reports that essentially launched nonpoint source pollution research in both countries. These studies also represented the first truly comprehensive effort to address the connection between land use and water quality in the binational Great Lakes region.

State and Provincial Responses to Nutrient Abatement and Nonpoint Source Pollution

As an outgrowth of the CWA and the Great Lakes Water Quality Agreement of 1972 (renewed in 1978; amended by protocol in 1987), many nutrient management programs, especially for the control of phosphorus, were developed by the states and provinces in the 1980s and 1990s. The programs provide technical and financial assistance to regulate, educate and implement nutrient reduction efforts. Some of the programs are specific to the Great Lakes basin while most are state-wide or province-wide programs.

Many programs are multifunctional and have purposes that are not primarily for the management of nutrients but also contribute to the reduction of nutrient runoff. For example, sediment and erosion control activities also control phosphorus and nitrogen runoff. Tax abatement programs for open spaces may remove lands that were previously subject to intense land use and excessive nutrient runoff and convert them to a more natural, less polluting use.

The state/provincial programs described below can be grouped into six broad categories: regulatory, education/ information, technical and financial assistance, watershed management, special/pilot projects, and research. Many of the programs overlap into several categories. An example of each type of program is provided for each category. Appendices A and B also provide a more detailed list and a synopsis of programs offered in each of the states and provinces.[10]

1. Nutrient Management Regulatory Programs

Regulatory programs legally require individuals or entities to take action, either positive or negative, to curb erosion and associated nutrient runoff. These include implementing erosion control practices on development sites (positive action), or actively refraining from applying rates of nutrients above a certain level (negative action). The management of animal wastes is a regulatory initiative common to all states, including those in the Great Lakes region.

All states regulate concentrated animal feeding operations (CAFOs), which are agricultural settings where animals (*e.g.,* livestock) are kept and raised in confined situations, resulting in concentrated amounts – and potential releases of – animal feed, urine, and solid wastes. The National Pollutant

[10] Appendix A provides a listing of state and provincial programs along with links to further information about each program. Appendix B provides a more detailed description of each of the programs listed in Appendix A. Note that section 6, "Nutrient Management Research," which encompasses a broader range of participants than Great Lakes states and provinces, only occurs in Appendix B.

Discharge Elimination System (NPDES) for CAFOs[11] ensures that the largest of these operations are required to apply for an NPDES permit. Among other things, CAFOs develop and implement a nutrient management plan as a condition of their NPDES permit. The U.S. EPA expects that the requirement to develop and implement a nutrient management plan (NMP or plan) will generally be fulfilled where a CAFO has developed and is implementing a comprehensive nutrient management plan (CNMP) in accordance with U.S. Department of Agriculture (USDA) guidance, although it is not the only way to fulfill the NMP requirement. Plans developed and implemented as a condition of an NPDES permit need to be based on the applicable nutrient management technical standard established by the permitting authority.[12]

2. Nutrient Management Information and Education Programs

Information and Education programs primarily provide local governments, individuals and companies with information and education about nutrient management. Many information and education programs are carried out by the states' land grant colleges through cooperative extension service offices. Information and education programs range from publishing general brochures on nutrient management to technical training on prescription fertilizer application.

One of the more intensive information efforts is Michigan State University's Nutrient Management Program (MSUNM). The MSUNM is a Decision Support System (DSS) that incorporates strategic planning, tactical planning and record keeping of key activities that affect whole-farm nutrient management. The DSS provides options for incorporating "tailor made" technical attributes into nutrient management planning, and provides farm operators tools to implement Generally Accepted Agricultural and Management Practices (GAAMPS) and/or to develop a Comprehensive Nutrient Management Plan (CNMP). The DSS software also allows for reduction in critical nonpoint pollution from excessive nutrient application by calculating fertilizer application rates based on soil testing results and record keeping.

3. Nutrient Management Technical and Financial Assistance Programs

Many state programs provide both technical assistance (*e.g.,* engineering and planning) and funding to landowners, other units of government, and organizations. Conservation districts, which are either entities of the state or part of the local county government, provide technical assistance to land users to assist them in nutrient management. Also, all states have some form of financial assistance programs to help defray the cost of implementing nutrient management plans. Funds are in the form of grants and loans, and most have a match requirement on the part of the receiving entity.

Ohio's Nonpoint Source Pollution Control Program is an example of a financial assistance program that provides Clean Water Act section 319 grants to local entities to install nutrient management among other nonpoint practices. Ohio EPA is the designated water quality agency responsible for administering the Ohio 319 program. Since 1990, Ohio EPA has annually applied for, received, and distributed Section 319 grant funds from the U.S. EPA to correct NPS-caused water quality impairment to Ohio's surface water resources. Section 319(h) implementation grant funding is targeted to Ohio waters where NPS pollution is a significant cause of aquatic life use impairments.

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[11] Published in the Federal Register on February 12, 2003

[12] U.S. EPA. *Concentrated Animal Feeding Operations (CAFO) – Final Rule.* Accessed 25 June 2012. Available online at: http://cfpub.epa.gov/npdes/afo/cafofinalrule.cfm.

The cornerstone of Ohio's Section 319 program is working with watershed groups and others who are implementing locally developed watershed management plans and restoring surface waters impaired by NPS pollution.[13]

4. Watershed Management Programs

The "watershed" has become the dominant implementation area in the nutrient management arena. The main purpose for having nutrient management programs is to reduce the amount of nutrients exiting the landscape into the waters of the basin. Once a waterbody is identified as being impaired by nutrients, the area draining to that waterbody (the watershed) can be identified and managed. This provides a specific area, identifiable by any interested party, to plan and implement nutrient reduction management practices that will reduce the nutrient runoff to the system at risk.

Many of the states in the Great Lakes, such as Indiana, Ohio, Michigan and Wisconsin, require state-approved watershed management plans in order for those watersheds to be eligible for certain types of funding and other assistance. All states have some nutrient management programs based on watershed boundaries.

5. Special Projects/Pilot Programs

Many states have specialized projects or pilot programs dealing with nutrient management. These generally deal with a specific geographical area or a narrower aspect of the nutrient management spectrum, and range from statewide special initiatives like Michigan's limitation of phosphorus in cleaning agents and laundry detergent to Indiana's checklists for watershed groups to identify water quality parameters of concern.

Indiana's checklist for watershed groups requires groups to identify targets for desired measurement levels based on a defined list of water quality and/or habitat/biological conditions of concern. These include Total Maximum Daily Loads (TMDL) for pollutants such as nitrates, ammonia, *E. coli*, and suspended solids, among others. While many of the listed parameters have standards in place (set, for example, by the U.S. EPA), some do not. For these, the watershed groups are at liberty to devise and set an appropriate target.[14]

6. Nutrient Management Research

Research into nutrient management is carried out by all land grant universities as well as other institutions of higher learning. The USDA has several research agencies, such as the Agricultural Research Service (ARS), that also conduct extensive research into nutrient management, some of which is directly related to nutrient management in the Great Lakes basin. While the research is comprehensive in scope and breadth, it is scattered across the basin and the country as well as across the research system. Still, several notable organizations and initiatives within the Great Lakes region stand out.

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[13] Ohio Environmental Protection Agency. *319 Grant Program Documents*. Accessed 25 June 2012. Available online at: http://www.epa.ohio.gov/dsw/nps/319Program.aspx.

[14] Indiana Department of Environmental Management. *Water Quality Targets*. Accessed 25 June 2012. Available online at: http://www.in.gov/idem/6242.htm.

Ohio is home to the National Center for Water Quality Research on the campus of the University of Heidelberg in Tiffin, Ohio. Founded in 1969, the Center is a leader in surface water and groundwater research in the Great Lakes region and beyond. Chemical analysis of freshwater samples as well as biological assessment of aquatic communities is performed at the Heidelberg's laboratory facilities. Additionally, Wisconsin has a unique research system composed of a network of working farms, called Discovery Farms, which conduct research and outreach activities on a wide variety of agricultural issues including nutrient management. Other recent research efforts include investigations of the effects on invasive species on the nutrient management programs in Lake Erie,[15] and simulated algal growth models to guide nutrient application and management in the Lake Michigan basin,[16] among others.[17]

Efforts in Canada

Canada-Ontario Agreement

The Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem (COA) provides the longstanding mechanism through which Ontario works with the federal Government of Canada to protect the Great Lakes basin ecosystem. The first COA was signed in 1971, in advance of the signing of the 1972 U.S.-Canada Great Lakes Water Quality Agreement (GLWQA). Unlike the GLWQA, COA has been continually updated, with six COAs having been signed since the inaugural agreement. Each revised agreement builds upon actions taken through previous agreements, and focuses future priorities and actions on current issues.

The 1971 COA focused on addressing eutrophication through phosphorus control and sewage treatment in the lower lakes. The agreement contained funding commitments from Canada and Ontario to support sewage treatment plant construction and to transfer funds from Canada to Ontario to conduct research on Great Lakes water pollution. The second agreement, signed in 1976, continued to focus on improving municipal wastewater treatment, as well as on controlling phosphorus. The third and fourth COAs, signed in 1982 and 1986, respectively, also continued to focus on Canadian funding contributions through the Government of Ontario to municipalities needing sewage treatment construction and funding for the implementation of the Canadian Phosphorus Management Plan. Recent COAs have included commitments to work with the agricultural sector to implement environmental farm planning and beneficial land and water management practices by providing technical advice, workshops, education and outreach materials, and cost-share funding for land owner contact programs, environmental stewardship projects and beneficial management practices.

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[15] Roy, E.D., J.F. Martin, E.G. Irwin, J.D. Conroy, and D.A. Culver. 2010. Transient Social-Ecological Stability: the Effects of Invasive Species and Ecosystem Restoration on Nutrient Management Compromise in Lake Erie. Ecology and Society 15 (1): 20. Accessed 25 June 2012. Available online at: http://www.ecologyandsociety.org/vol15/iss1/art20/.

[16] Tomlinson, L.M., M.T. Auer, H.A. Bootsma, and E.M. Owens. 2010. *The Great Lakes Cladophera Model: Development, Testing, and Application to Lake Michigan.* Journal of Great Lakes Research 36: 287-297. Accessed 25 June 2012. Available online at: http://techalive.mtu.edu/gradfaculty/mtauer/documents/Tomlinsonetal2010.pdf.

[17] See Appendix B, section 6 for a summary of research efforts across the United States.

In 1985, in response to numerous beach closings in 1983 and 1983 that drew public and government attention,[18] Ontario formulated the Provincial Rural Beaches Strategy Program, which identified and quantified agricultural bacterial and phosphorus sources upstream of recreational water bodies. In 1991, the Clean Up Rural Beaches (CURB) Program was announced to develop a course of action leading to the restoration and long-term maintenance of acceptable water quality at provincial rural beaches. CURB was a technical assistance and financial incentive program to encourage improved rural land management practices to reduce the impact from upstream pollution sources. Eligible items for grant assistance included private sewage disposal systems, livestock access restriction and alternate watering systems, manure storage and handling and milkhouse washwater disposal systems. Funds were also used to address education, extension, and local awareness programs, and on-site research and demonstration of new and innovative technologies. The CURB Program addressed water quality problems in 150 subwatersheds in southern Ontario. Approximately $15 million was distributed as grants for 3,650 projects, and preliminary analysis of site-specific program water quality monitoring data indicated significant local water quality improvements as a result.

All of these phosphorus reduction efforts successfully reduced algal pollution in the Great Lakes throughout the 1970s and 1980s. By the early 1990s, reductions in annual phosphorus loadings had been achieved in the lakes, with loads well below the target loads for Lakes Superior and Huron, and at or near the target limits for Lakes Erie and Ontario. The control of excessive phosphorus loadings to the Great Lakes, through the combination of point and non-point source phosphorus management actions, seemed to be working and the positive response to these control measures was viewed as a success.

While open-lake data suggested that the phosphorus control efforts of past decades were successful, the nearshore zones started to tell a different story, particularly in the lower lakes (Erie and Ontario). In the past decade, there has been a resurgence of algae problems with the most visible signs of eutrophication — potentially toxic blooms of cyanobacteria (blue-green algae) and rotting piles of the green macro-alga, *Cladophora* — returning to the shorelines of all of the Great Lakes except Lake Superior. Thus, the current COA includes several action items to address the present nutrient-related issues in the Great Lakes basin:

reduce excessive nutrients inside and outside Areas of Concern from point and non-point sources (Annex 1, Goals 1 & 2; Annex 3, Goal 2)
encourage and enhance Great Lakes sustainability to achieve social, economic and aquatic ecosystem well-being (Annex 3, Goal 1)
improve water quality in each Great Lake by making progress on virtual elimination of persistent bioaccumulative toxic substances and the reduction of other pollutants (Annex 3, Goal 2)
reduce the threat of aquatic invasive species[19] to Great Lakes aquatic ecosystems (Annex 3, Goal 4)

In 2011 Canada and Ontario made amendments to update and refresh some specific commitments under the current COA. In doing so they made a new commitment to undertake environmental and

[18] Watershed studies found that multiple sources of pollution were affecting beaches in Ontario. These included urban sanitary and stormwater runoff, direct livestock manure access to watercourses, inadequate manure management practices, direct discharge of milkhouse wastes (wastewater from dairy farm operations), contaminated field tile systems, and faulty septic systems.

[19] Certain non-native species are known to exacerbate the effects of nutrient-loading to water bodies. For example, upon eutrophication and algal bloom development, the invasive zebra mussel may selectively filter high-quality phytoplankton from the water column, resulting in an abundance of poor-quality, or even toxic, microorganisms.

economic evaluations of agricultural non-point source best management practices, including an assessment of actions at the farm and watershed scale (under Annex 3, Goals 1 and 2 of the current COA). This commitment is a next step toward the development and implementation of more effective and efficient best management practices for the Great Lakes.

Nutrient Management Act

In 2002 the Ontario government passed the Nutrient Management Act*,* which enables legislation that supports the implementation of a comprehensive and integrated regulatory framework governing nutrient management and other related farm practices in Ontario. This legislation provides for oversight and administration for the management (storage, treatment, land application, disposal) of on- and off-farm nutrients. The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and the Ontario Ministry of the Environment (MOE) are responsible for implementing the legislation and any regulations made under it.

The Act:

- provides authority to establish province-wide standards for the management of materials containing nutrients and sets out requirements and responsibilities for farmers, municipalities and others in the business of managing nutrients;
- provides the government with authority for inspections and a range of tools to support compliance, including the authority to issue orders; and sets out provisions for provincial enforcement, and the authority for a range of penalties for the contravention of the act, regulations or orders; and
- addresses gaps in current legislation and provides clarity to municipalities administering their responsibilities under the *Municipal Act,* the *Planning Act* and the provincial and federal building codes, by establishing new and enhanced nutrient management-related standards for planning and approvals

The General Nutrient Management Regulation (Ontario Regulation 267/03 as amended by Ontario Regulation 338/09) outlines requirements for land application, preparation, and approval of nutrient management plans and strategies and non-agricultural source material plans. There are also requirements for siting and construction of nutrient storages, and certificates and licensing for brokers and land applicators.

The keystones of the requirements in the regulation are the development of a farm nutrient management plan and strategy. The nutrient management strategy (NMS) outlines how to manage all nutrients that are generated on a farm and examines the housing capacity of barns relative to the size of the manure storage that is needed. The nutrient management plan (NMP) identifies how much and where the nutrients will be applied on the land. These documents, when required by the regulation, are anticipated to manage water quality concerns associated with the application of agricultural source material (ASM) to land. In addition to the strategy and plan requirements the regulation includes requirements for constructing manure storages with two levels of protection between the manure and the groundwater; land application standards; outdoor confinement areas; milking center washwater; anaerobic digestion; vegetated filter strip systems; sampling and analysis; education and training and record keeping.

Ontario has many other acts, regulations, agreements, research initiatives and pilot projects, as well as stewardship, funding and public outreach programs in place to address nutrient management in

the Great Lakes basin. For example, the Ontario Water Resources Act prohibits the discharge of polluting materials that may impair water quality. The Canada-Ontario Farm Stewardship Program is a cost-share program available province-wide to assist producers with implementing environmental improvement projects identified through the Environmental Farm Plan educational process. Ontario has introduced a Phosphorus Index as a means to assess the risk of surface water contamination from a field, and identifies where measures to reduce phosphorus losses are needed. Research and monitoring activities carried out by the government of Ontario include annual nearshore monitoring and assessment on a lake-by-lake cycle. For more details regarding Ontario's nutrient reduction policies and activities, see Appendices A and B.

Appendix A

The following is a selected list of nutrient abatement programs in the Great Lakes basin. To the extent possible, the programs below have been organized according to the six categories listed for the Great Lakes state programs (above): 1) Nutrient Management Regulatory Programs; 2) Nutrient Management Information and Education; 3) Nutrient Management Technical and Financial Assistance; 4) Watershed Programs; 5) Special Projects/Pilot Programs; and 6) Nutrient Management Research. Because the Canadian Federal government and provinces of Ontario and Québec share the Great Lakes with the United States, their nutrient management programs also are included. A more detailed description of each program can be found in Appendix B.

* denotes a program that is common to all states
** denotes a program administered by the Canadian federal government

1. Nutrient Management Regulatory Programs

State/Province	Program	Website
Illinois	Division of Water Pollution Control	http://www.epa.state.il.us/water/index-wpc.html
	Stormwater Runoff Pollution (IDOT) *	http://www.dot.state.il.us/pollution/idotdoing.html
Indiana	Confined Animal Feeding Operations (CAFO) *	http://www.in.gov/idem/4994.htm
Michigan	Biosolids	http://www.michigan.gov/deq/0,4561,7-135-3313_3683_3720-9567--,00.html
	Michigan Agriculture Environmental Assurance Program (MAEAP)	http://www.maeap.org/
	Municipal Stormwater Permitting	http://www.michigan.gov/deq/0,4561,7-135-3313_3682_3716-24995--,00.html
	National Pollutant Discharge Elimination System (NPDES) *	http://www.michigan.gov/deq/0,4561,7-135-3313_3682_3713-10197--,00.html
	Right to Farm	http://legislature.mi.gov/documents/mcl/pdf/mcl-Act-93-of-1981.pdf
	Septage Waste Program	http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3717---,00.html
	Soil Erosion and Sedimentation Control Program	http://www.michigan.gov/deq/0,4561,7-135-3311_4113---,00.html
Minnesota	Permitted Activities	http://www.pca.state.mn.us/index.php/water/permits-and-rules/index.html
	Restricted Use of Phosphorus Fertilizer on Lawns and Turf	http://www.mda.state.mn.us/phoslaw
New York	A Comprehensive Nutrient Management Plan (CNMP)	http://www.nys-soilandwater.org/aem/cnmp.html.

	Dishwater, Detergent, and Nutrient Runoff Law	http://www.dec.ny.gov/chemical/67239.html.
	SPDES Permits	http://www.dec.ny.gov/chemical/8468.html.
	Vessel Waste No Discharge Zones	http://www.dec.ny.gov/chemical/73875.html.
Ohio	Enforcement Program	http://www.epa.ohio.gov/dsw/enforcement/enf.aspx
	Ohio EPA Biosolids Program	http://www.epa.ohio.gov/dsw/sludge/biosolid.aspx
Pennsylvania	Agriculture Erosion and Sediment (E&S) Control Plans	http://www.pacode.com/secure/data/025/chapter102/s102.4.html
	Manure Management Plans	http://panutrientmgmt.cas.psu.edu/pdf/rp_manure_mgmt.pdf
	NPDES Program-General	http://www.dep.state.pa.us/dep/deputate/waterops/redesign/subpages/npdes.htm
	NPDES Program-Municipal Separate Storm Sewer Systems	http://www.elibrary.dep.state.pa.us/dsweb/View/Collection-9456
	NPDES Program-Stormwater Discharges Associated with Construction Activities	http://www.elibrary.dep.state.pa.us/dsweb/View/Collection-9451
Wisconsin	Reducing Phosphorus to Clean Up Lakes and Rivers	http://dnr.wi.gov/news/mediakits/mk_phosphorus.asp
	Turf Nutrient Management	http://dnr.wi.gov/topic/stormwater/standards/turf_nutrient.html
Ontario	Ontario Water Resources Act, 1990	http://www.ene.gov.on.ca/environment/en/legislation/ontario_water_resources_act/index.htm
	Farming and Food Production Protection Act, 1998	http://www.omafra.gov.on.ca/english/engineer/facts/05-013.htm
	Nutrient Management Act	http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_02n04_e.htm
	Ontario Clean Water Act, 2006	http://www.ene.gov.on.ca/environment/en/legislation/clean_water_act/index.htm
	Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem (COA)	http://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=B903EE0D-1
	Lake Simcoe Protection Act, 2008 and Lake Simcoe Protection Plan, 2009	http://www.ene.gov.on.ca/environment/en/resources/STD01_076301.html
	Lake Simcoe Phosphorus Reduction Strategy, 2010	http://www.ene.gov.on.ca/environment/en/resources/STD01_078834
	Water Opportunities Act, 2010	http://www.ene.gov.on.ca/environment/en/legislation/water_opportunities/index.htm
	Septic System Regulation under the Municipal Building Code	http://www.ene.gov.on.ca/environment/en/subject/septage/STDPROD_078938
Québec	Adoption of Environmentally and Economically Sustainable Beneficial Management Practices	http://www.cropnutrientscouncil.ca/_documents/pdf/CNC_final_planning.pdf

	Quebec Regulation Respecting Agricultural Operations (RRAO)	www.mddep.gouv.qc.ca/milieu_agri/agricole/index.htm; www.mapaq.gouv.qc.ca/aeroaspersion

2. Nutrient Management Information and Education Programs

State/Province	Program	Website
Illinois	Nonpoint Source Unit	http://www.epa.state.il.us/water/watershed/nonpoint-source.html
	Partners for Conservation	http://www.dnr.illinois.gov/conservation/pfc/Pages/default.aspx
Indiana	Clean Water Indiana	http://www.in.gov/isda/2379.htm
	Indiana's Conservation Cropping Systems Initiative	http://www.in.gov/isda/ccsi/
	Indiana State Department of Agriculture (ISDA)	http://www.in.gov/isda/
Michigan	Environmental Assistance Program (EAP)	http://www.michigan.gov/deq/0,1607,7-135-3307_36106---,00.html
	Michigan Agriculture Environmental Assurance Program (MAEAP)	http://www.maeap.org/
	Michigan State University (MSU) Nutrient Management Program	http://www.egr.msu.edu/age/documents/news_archives/eco/nutrientmanagement.pdf
	Nonpoint Source Program	http://www.michigan.gov/deq/0,4561,7-135-3313_3682_3714-13061--,00.html
	Nutrient Reduction Framework	http://www.michigan.gov/deq/0,4561,7-135-3313-264525--,00.html
	Soil Surveys	http://www.michigan.gov/documents/deq/deq-whm-hwp-Michigan-Background-Soil-revJuly2005_248097_7.pdf
	Sustainable Soil and Water Quality Practices on Forest Land Manual	http://www.michigan.gov/documents/dnr/IC4011_SustainableSoilAndWaterQualityPracticesOnForestLand_268417_7.pdf
Minnesota	MN website tools	http://septic.umn.edu/; http://www.mda.state.mn.us/protecting/waterprotectioNone Reportedwqcprogram/awqcprogramfaq.aspx
	Surface water data collection and reporting	http://www.pca.state.mn.us/index.php/topics/environmental-data/eda-environmental-data-access/eda-surface-water-searches/eda-surface-water-data-home.html
New York	Nutrient Management Spear Program	http://nmsp.cals.cornell.edu/
Ohio	Manure and Nutrient Management Training	http://ohiodnr.com/tabid/10630/Default.aspx
	Nonpoint Source Water Pollution Education	http://www.dnr.state.oh.us/tabid/21817/Default.aspx

	Surface Water Enhancement, Restoration and Protection (SWERP) Clearinghouse	http://www.epa.state.oh.us/dsw/swerp/index.aspx
Pennsylvania	Education Program Introduction	http://panutrientmgmt.cas.psu.edu/
	Pennsylvania Department of Environmental Protection (PADEP) - Bureau of Watershed Management	http://www.portal.state.pa.us/portal/server.pt/community/watershed_management/10593
Wisconsin	Discovery Farms Network	http://uwdiscoveryfarms.org/
	Nutrient Management Team - University of Wisconsin Extension	http://www.uwex.edu/ces/ag/teams/nutrient/
Ontario	Agricultural Erosion Control	http://www.omafra.gov.on.ca/english/engineer/facts/erosion_p832.htm
	Canada-Ontario Environmental Farm Plan (EFP)	http://www.omafra.gov.on.ca/english/environment/efp/efp.htm
	Nutrient Management Strategy/Plan Preparation	http://www.omafra.gov.on.ca/english/nm/buildev/nms.htm
	Soils Ontario	http://www.omafra.gov.on.ca/english/landuse/gis/soils_ont.htm
	The Phosphorus (P) Index	http://www.omafra.gov.on.ca/english/engineer/facts/05-067.htm
Québec	Manure Management in Canada	http://dsp-psd.pwgsc.gc.ca/Collection/Statcan/21-021-M/21-021-MIE2004001.pdf

3. Nutrient Management Technical and Financial Assistance Programs

State/Province	Program	Website
Illinois	Agricultural Loan Program	http://www.treasurer.il.gov/programs/ag-invest/annual-loans.aspx
	Conservation Practices Cost-Share Program	http://www.dnr.state.il.us/orep/pfc/incentives.htm#CPP
	Forest Management Assistance Program	http://www.dnr.state.il.us/orep/pfc/incentives.htm#FMAP
	Lake Education Assistance Program (LEAP)	http://www.epa.state.il.us/water/conservation/leap.html
	Sustainable Agriculture Grant Program Partners for Conservation	http://www.dnr.state.il.us/orep/pfc/incentives.htm#SAGP
	Tax Certification Program for Livestock Waste Management Facilities	http://www.epa.state.il.us/water/watershed/forms/livestock-tax-cert.pdf
	Vegetative Filter Strip Assessment	http://www.dnr.state.il.us/orep/pfc/incentives.htm#VFSA
Indiana	Clean Water Indiana	http://www.in.gov/isda/2379.htm
	Indiana State Department of Agriculture, Division of Soil	http://www.in.gov/isda/

	Conservation (ISDA-DSC)	
	Indiana State Revolving Fund (SRF) Program *	http://www.in.gov/ifa/srf/
	Lake and River Enhancement (LARE) Program	http://www.in.gov/dnr/fishwild/2364.htm
	Section 205 Grants	http://www.in.gov/idem/4103.htm#205j
	Section 319 Grants *	http://www.in.gov/idem/4103.htm#319h
Michigan	Clean Michigan Initiative (CMI)	http://www.michigan.gov/deq/0,4561,7-135-3307_31116---,00.html
	Conservation Reserve Enhancement Program (CREP)	http://www.michigan.gov/mdard/0,4610,7-125-1567_1599_1603---,00.html
	Intercounty Drains	http://www.michigan.gov/mdard/0,4610,7-125-1572_2875_31944---,00.html
	Landscape Level Wetland Functional Assessment (LLWFA)	http://www.fotsjr.org/Resources/Documents/LLWFA_Brochure_VBCD_Draft.pdf
	Michigan Agricultural Environmental Assurance Program (MAEAP) -- Residential Program	http://www.miwaterstewardship.org/
	MAEAP – Technical Assistance Grant Program	http://www.michigan.gov/deq/0,1607,7-135-3307_4132---,00.html
	Michigan Biosolids Land Application Program	http://www.michigan.gov/documents/mdard/2011_Annual_Report_377587_7.pdf; http://www.michigan.gov/mdard/0,4610,7-125-1572_2875_31944---,00.html
	Michigan Coastal Management Program	http://www.michigan.gov/deq/0,1607,7-135-3313_3677_3696---,00.html
	Michigan Turfgrass Environmental Stewardship Program	http://www.michiganturfgrass.org/mtesp-initiative-program-87/
	Nonpoint Source Program	http://www.michigan.gov/deq/0,4561,7-135-3313_3682_3714-13061--,00.html
Minnesota	Best Management Practices for Nitrogen	http://www.mda.state.mn.us/protecting/bmps/nitrogenbmps.aspx
	Clean Water Fund	http://www.cleanwaterfund.org/minnesota
	Clean Water Partnership Program (CWP)	http://www.pca.state.mn.us/index.php/water/water-types-and-programs/water-nonpoint-source-issues/clean-water-partnership/more-about-the-clean-water-partnership-program.html
	Coastal Nonpoint Program	http://www.dnr.state.mn.us/waters/lakesuperior/cnp/index.html
	Minnesota Board of Water and Soil Resources	http://www.bwsr.state.mn.us/
	Nonpoint Source Management Program Plan (NSMPP)	http://www.pca.state.mn.us/index.php/water/water-types-and-programs/water-nonpoint-source-issues/minnesota-nonpoint-source-management-program-plan-

		nsmpp.html?menuid=&redirect=1
	Sustainable Agriculture Demonstration Grant	http://www.mda.state.mn.us/grants/grants/demogrant.aspx
New York	Agricultural Environmental Management (AEM)	http://www.agmkt.state.ny.us/soilwater/aem/.
	NYS Conservation Reserve Enhancement Program (NYS CREP)	http://www.nys-soilandwater.org/crep/index.html
Ohio	Agricultural Pollution Abatement Cost-Share Program	http://www.dnr.state.oh.us/tabid/8856/Default.aspx
	Compliance Assistance Unit	http://www.epa.ohio.gov/dsw/compl_assist/compasst.aspx
	Lake Erie Programs	http://www.epa.ohio.gov/dsw/lakeerie/index.aspx
	Ohio Nonpoint Source Pollution Control Program	http://www.epa.ohio.gov/dsw/nps/index.aspx
	Source Water Protection Program	http://www.epa.ohio.gov/ddagw/swap.aspx
	Statewide Biological and Water Quality Monitoring & Assessment	http://www.epa.ohio.gov/dsw/bioassess/ohstrat.aspx
Pennsylvania	Act 38 of 2005	http://panutrientmgmt.cas.psu.edu/
	Act 167: Pennsylvania Stormwater Management Act	http://www.stormwaterpa.org/assets/media/regulatory/3930-FS-DEP4101.pdf
	Act 537: Sewage Facilities Planning Act	http://www.dep.state.pa.us/dep/deputate/watermgt/wqp/wqp_wm/537Map/537Plan.htm
	Conservation Plans	http://www.pa.nrcs.usda.gov/technical/Conservation_Planning/ConservationPlanning.htm
	DEP Growing Greener Grant Program	http://www.portal.state.pa.us/portal/server.pt/community/growing_greener/13958
	Financial Assistance Programs	http://panutrientmgmt.cas.psu.edu/main_financial_assist.htm
	Nutrient Management Specialist's Certification Program	http://www.agriculture.state.pa.us/portal/server.pt/gateway/PTARGS_0_2_24476_10297_0_43/AgWebsite/ProgramDetail.aspx?name=Nutrient-Management-Certification-Program-&navid=12&parentnavid=0&palid=74&
	PENNVEST: Pennsylvania Infrastructure Investment Authority	http://www.portal.state.pa.us/portal/server.pt/community/pennvest/9242/
	Resource Enhancement and Protection Program (REAP)	http://www.agriculture.state.pa.us/portal/server.pt/gateway/PTARGS_0_2_24476_10297_0_43/AgWebsite/ProgramDetail.aspx?name=Resource-Enhancement-and-Protection-(REAP)&navid=12&parentnavid=0&palid=22&
Wisconsin	Priority Watershed and Priority Lake Program	http://dnr.wi.gov/runoff/watershed.htm

Ontario	Canada-Ontario Farm Stewardship Program (COFSP)	http://www.ontariosoilcrop.org/en/programs/canada_ontario_farm_stewardship_program_cofsp.htm
	Great Lakes Sustainability Fund **	http://www.ec.gc.ca/raps-pas/default.asp?lang=En&n=F328E319-1
	Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA)	http://www.omafra.gov.on.ca/english/index.html
	Other Local Stewardship Programs	http://www.conservation-ontario.on.ca/about/cas.html
Québec	Great Lakes Sustainability Fund **	http://www.ec.gc.ca/raps-pas/default.asp?lang=En&n=F328E319-1

4. Watershed Management Programs

State/Province	Program	Website
Illinois	None reported	N/a
Indiana	Water Quality Targets	http://www.in.gov/idem/6242.htm
Michigan	Areas Of Concern (AOC)	http://www.michigan.gov/deq/0,1607,7-135-3313_3677_15430-35544--,00.html
	Clean Lakes Management Program (CLMP)	http://www.micorps.net/lakeoverview.html
	Lake Allegan Phosphorus TMDL and Cooperative Agreement	http://www.epa.gov/waters/tmdldocs/deq-swq-gleas-tmdlallegan.pdf
Minnesota	Major Watershed Restoration and Protection Projects	http://www.pca.state.mn.us/index.php/water/types-and-programs/watersheds/map.html
	Watershed Assessment Tool (WAT)	http://www.dnr.state.mn.us/watershed_tool/index.html
New York	604(b) Funds – Watershed Restoration	http://www.ceinfo.org/index.php/water/94-water-loci/water-current-work/120-tmdl-project-water-quality-restoration-strategy
	Agricultural Environmental Management (AEM)	http://www.dec.ny.gov/chemical/23835.html.
Ohio	The Stillwater River Watershed TMDL	http://www.epa.ohio.gov/dsw/tmdl/StillwaterRiverTMDL.aspx
Pennsylvania	EPA Clean Water Act Section 319 Funding	http://www.epa.gov/owow_keep/NPS/cwact.html
	Total Maximum Daily Load (TMDL) Program *	http://www.dep.state.pa.us/dep/deputate/watermgt/wqp/wqstandards/Facts/fs2248.htm
Wisconsin	Total Maximum Daily Load (TMDL) Development and Implementation *	http://dnr.wi.gov/org/water/wm/wqs/303d/TMDL.html
	Watershed Management Plans	http://dnr.wi.gov/org/water/wm/glwsp/
Ontario	Ontario Conservation Authorities	http://www.lsrca.on.ca/leap/index.html
	Stormwater Management	http://www.ene.gov.on.ca/environment/en/s

		ubject/stormwater_management/index.htm
Québec	None Reported	N/a

5. Special Projects/Pilot Programs

State/Province	Program	Website
Illinois	None Reported	N/a
Indiana	None Reported	N/a
Michigan	Special Initiatives (Phosphorus bans, etc.)	N/a
Minnesota	Field Scale Drainage Water Quality Demonstrations	http://www.mda.state.mn.us/protecting/bmps/drainagedemos.aspx
	Manure Testing Laboratory Certification Program	http://www2.mda.state.mn.us/webapp/lis/manurelabs.jsp
	University of Minnesota Precision Agriculture Center	http://www.precision.agri.umn.edu/
New York	Phosphorus Runoff Index	http://nmsp.cals.cornell.edu/publications/pindex.html
	Precision Feed Management (PFM)	http://nmsp.cals.cornell.edu/publications/.
	Variable Source Area (VSA)	http://soilandwater.bee.cornell.edu/Research/VSA/extension.html
Ohio	None Reported	N/a
Pennsylvania	Act 15	N/a
Wisconsin	The Wisconsin Phosphorus Index (P Index)	http://wpindex.soils.wisc.edu/
Ontario	Agricultural Resource Inventory Mapping Project and LiDAR Data Acquisition	http://www.omafra.gov.on.ca/english/landuse/gis/ari_1983.htm
	Investment in Municipal Sewage Infrastructure	http://www.infrastructureontario.ca/
	Rural Nonpoint Source Work in the Areas of Concern	http://www.ec.gc.ca/raps-pas/default.asp?lang=En&n=A0270A32-1
	Sewer Use Best Management Practices (BMPs)	http://www.ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTAxMDU1&statusId=MTUwOTYz
	Targeted Compliance Initiatives	http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/std01_079341.pdf
Québec	None Reported	N/a

Appendix B

1. Nutrient Management Regulatory Programs

All states regulate wastewater treatment plants, confined animal feeding operations, stormwater runoff, and land development projects Below are examples of state regulatory programs showing how the various states handle common issues. Also shown are additional regulatory practices unique to each Great Lake state.

Illinois

Division of Water Pollution Control
The water pollution control program is designed to identify sources of water pollution and implement steps to abate the pollution. Pollution can come from municipal, industrial, and commercial discharges as well as non-point sources from urban and agricultural runoff.

Stormwater Runoff Pollution
(common to all states)
IDOT ensures that highway construction projects and highway separate storm sewer systems in urbanized areas comply with the National Pollutant Discharge Elimination System (NPDES). This is a permitting program, under the Federal Clean Water Act, which regulates construction, industrial activities and both large and small metropolitan separate storm sewer systems.

Indiana

Confined Animal Feeding Operations (CAFO) (common to all states)
Indiana law defines a confined feeding operation as any animal feeding operation engaged in the confined feeding of at least 300 cattle, 500 horses, or 600 swine or sheep, or 30,000 fowl, such as chickens, turkeys or other poultry. Requirements for the Indiana Department of Environmental Management (IDEM) regulation of these operations include the development and implementation of a nutrient management plan as part of the permitting process.

Michigan

Biosolids
The Department of Environmental Quality (DEQ) encourages the use of Biosolids (also known as sewage sludge) to enhance agricultural and silvicultural production in Michigan. Almost all Biosolids that are land-applied in Michigan are used to grow crops on sites at agronomic application rates approved by the DEQ. Biosolids are also used to provide nutrients and soil conditioning in mine reclamation programs, tree farms, and forest lands.

Michigan Agriculture Environmental Assurance Program (MAEAP)
MAEAP is a voluntary, pro-active program, initially designed by a coalition of farmers, agricultural commodity groups, state and federal agencies, and conservation and environmental groups to reduce producers' legal and environmental risks. To become MAEAP verified, farmers must complete three comprehensive steps: educational seminars, a thorough on-farm risk assessment, and development and implementation of an action plan addressing potential environmental risks. MAEAP Standards are reviewed annually and are adopted by the Michigan Commission of Agriculture and Rural Development.

Municipal Stormwater Permitting

The Municipal Separate Storm Sewer System (MS4), a system of drainage (including roads, storm drains, pipes, and ditches, etc.) that is not a combined sewer or part of a sewage treatment plant, aims to reduce the discharge of pollutants to state surface waters. The MS4 program requires a permit to discharge from an MS4 located in an urbanized area with a qualifying population to surface waters in Michigan.

National Pollutant Discharge Elimination System (NPDES)

Michigan has been regulating total phosphorus in NPDES discharges since the 1970s. By 1986, 1 mg/l became an effluent standard in Michigan's Water Quality Standards (WQS) and a requirement in NPDES permits for wastewater treatment plants and many industrial discharges. Throughout the 1990s to the present, phosphorus limitations below the 1 mg/l effluent standard have been routinely included in NPDES permits following a narrative nutrient WQS.

Right to Farm

Michigan has one of the most effective Right to Farm laws in the nation. The legislation directs the Michigan Commission of Agriculture and Rural Development to adopt Generally Accepted Agricultural Management Practices and review them annually. These science-based practices include complaint-response, which conducts on-site inspections to investigate and resolve complaints of non-point-source pollution and nuisance conditions on farms, and help farmers protect the environment.

Septage Waste Program

Since 2004, Michigan has been regulating the septage waste industry and disposal of septage waste to ensure that land application is conducted within the accordance of state and federal law. Beyond protecting human health, a goal of the program is to protect the environment and ensure that nutrients are not applied to frozen agricultural land or at rates that are excessive to demand.

Soil Erosion and Sedimentation Control Program

The Soil Erosion and Sedimentation Control Program was implemented to regulate the pollution of Michigan waters by improper construction site management practices.

Minnesota

Permitted Activities

The Minnesota Pollution Control Agency (MPCA) administers and enforces all laws relating to the pollution of any waters of the state. Programs include NPDES and Sewer Discharge Station (SDS) discharge permits, NPDES stormwater permits, animal feedlots, and municipal and individual wastewater permits. Among these permitted programs, stormwater and wastewater have special emphasis areas which target the Lake Superior basin and its waters. The MN DNR and local governments also manage a specialized shorelands ordinance (North Shore Management Plan) which provides development thresholds for nearshore areas of Lake Superior.

Restricted Use of Phosphorus Fertilizer on Lawns and Turf

Fertilizers containing phosphorus cannot be used on lawns and turf in Minnesota unless one of the following situations exists:

- A soil test or plant tissue test shows a need for phosphorus.
- A new lawn is being established by seeding or laying sod
- Phosphorus fertilizer is being applied on a golf course by trained staff
- Phosphorus fertilizer is being applied on farms growing sod for sale

New York

A Comprehensive Nutrient Management Plan (CNMP)

A CMNP unique to animal feeding operations, evaluates all aspects of farm production and offers conservation practices that help achieve production and natural resource conservation goals. CNMPs are the foundation for the New York State Department of Environmental Conservation's (NYSDEC) environmental regulatory program to control potential water pollution from Concentrated Animal Feeding Operations (CAFOs). New York's program includes requirements for medium CAFOs to implement CNMPs and has a certification program for nutrient planners.

Dishwater, Detergent, and Nutrient Runoff Law

The Dishwasher Detergent and Nutrient Runoff Law prohibits the use of phosphorus-containing lawn fertilizer unless a new lawn is being established, or unless a soil test shows that the lawn is phosphorus-deficient. Retailers that sell lawn fertilizers are required to place those containing phosphorus in a separate section with an educational sign. The application of any lawn fertilizer is prohibited between December 1st and April 1st, and the application of lawn fertilizer to impervious surfaces (such as driveways or sidewalks) is prohibited.

SPDES Permits

The NYS State Pollution Discharge Elimination System (SPDES) controls point source wastewater and storm water discharges in accordance with the federal Clean Water Act. SPDES permits apply to discharges from municipal wastewater treatment facilities, industrial outfalls, construction sites, medium or large concentrated animal feeding operations (CAFOs), and other private/commercial/institutional sources. Municipal Separate Storm Sewer Systems (MS4s) in Urbanized or Additionally Designated Areas ("regulated MS4s") discharging into 303(d) listed waters must ensure no increase in the listed pollutant of concern to the listed water.

Vessel Waste No Discharge Zones

NYSDEC, in collaboration with the NYS Department of State (DOS) and Environmental Facilities Corporation (EFC), is actively petitioning EPA to establish a vessel waste No Discharge Zones (NDZ) covering the open waters, tributaries, harbors and embayments along the NYS portions of Lake Erie. No Discharge Zones, as defined under Clean Water Act Section 312, prohibit the discharge of sewage from all vessels into the defined waters.

Ohio

Enforcement Program

Ohio provides technical assistance, conducts inspections of wastewater treatment plants, reviews operation reports, oversees land application of biosolids and manure from large concentrated animal feeding operations, and investigates complaints regarding malfunctioning waste water treatment plants and violations of Ohio's Water Quality Standards. The Ohio EPA's Division of Surface Water (DSW) strives to ensure that permitted facilities comply with their National Pollutant Discharge Elimination System (NPDES) permits. DSW also assists small communities with inadequate means of waste water treatment in seeking alternatives to help abate pollution to waters of the state. Although small and medium AFOs are not typically permitted in Ohio, Ohio's Agricultural Pollution Abatement Program administered by ODNR Division of Soil and Water Resources requires AFOs to meet state regulations for the safe handling of animal waste.

Ohio EPA Biosolids Program
The program involves the regulation and monitoring of the land application and disposal of biosolids, sewage material that contains nitrogen and phosphorus.

Pennsylvania

Agriculture Erosion and Sediment (E&S) Control Plans
Administered by PA State Conservation Commission, this program focuses on implementing E&S controls for all agricultural operations that create earth disturbance from plowing, tilling or heavy-use animal areas. Operations that disturb 5,000 square feet or greater must have and implement a written E&S plan that meets the requirements of the regulations.

Manure Management Plans
Administered by PA State Conservation Commission**,** this program is designed so that agricultural operations that mechanically apply manure must design and implement a written manure management plan that meets the requirements of the Manure Management Manual.

NPDES Program-General
This program is administered by the Pennsylvania Department of Environmental Protection (PADEP) and Erie County Department of Health to protect surface water through the permitting of discharges. This includes implementation of the state Great Lakes Initiative. The effectiveness of this program is based on the compliance with permit conditions and number of enforcement actions related to those conditions.

NPDES Program-Municipal Separate Storm Sewer Systems
This authorized permit is regulated by the PADEP and requires that urban municipalities address stormwater management through six control measures, including a stormwater management ordinance.

NPDES Program-StormwaterDischarges Associated with Construction Activities
This permit is administered by PADEP to persons conducting earth disturbances. Activities that disturb over 1 acre of land are to be outlined with erosion and sediment control measures, while including a Post Construction Stormwater Management component that limits the rate, volume, and pollutant load to preconstruction levels. Erosion and sediment complaints, and general permits are delegated to the Erie County Conservation District.

Wisconsin

Reducing Phosphorus to Clean Up Lakes and Rivers
The Wisconsin Administrative Code sets the highest allowable levels of phosphorus for lakes, rivers and the Great Lakes that would still allow for the sustained health of fish and other aquatic life. Different numerical levels are set for five categories of lakes and reservoirs, for rivers and streams, and for the Great Lakes. Farmers are required to curb phosphorus potentially coming off their fields to an eight-year average that factors in land slope, phosphorus levels in their soil and average precipitation levels.

Turf Nutrient Management
This regulation applies where nutrients are applied on five or more acres. Operators must fertilize according to a nutrient management plan, and soil testing is needed when applying phosphorus. The plan identifies the amount of nitrogen that can be applied in a growing season and sets an

application limit of usually no more than 1 lb/1000 ft^2 per application. The plan also sets limitations on nitrogen application under wet or frozen soil conditions, on highly permeable soils and near bedrock, and delineates limitations on phosphorus application on wet soils and areas near wetlands, streams or lakes.

Ontario[20]

Ontario Water Resources Act, 1990

The Ontario Water Resources Act is designed to conserve, protect and manage Ontario's water resources for efficient and sustainable use. The act focuses on both groundwater and surface water throughout the province. The act regulates sewage disposal and "sewage works" and prohibits the discharge of polluting materials that may impair water quality. The act is also designed in part to protect the province's water resources by regulating water takings from ground or surface water sources.

Farming and Food Production Protection Act, 1998

This legislation has two main themes: farmers are protected from nuisance complaints made by neighbours provided they are following normal farm practices; and no municipal by-law applies to restrict a normal farm practice carried on as part of an agricultural operation. Seven nuisances are listed in the Act, including odour, light, vibrations, smoke, noise, flies and dust. The Act outlines that in agricultural areas, agricultural uses and normal farm practices should be promoted and protected in a way that balances the needs of the agricultural community with provincial health, safety and environmental concerns.

Nutrient Management Act

The Ontario government introduced the Nutrient Management Act in 2002 and the General Nutrient Management Regulation in 2003. Under the Regulation, phased-in farms must develop nutrient management strategies and/or plans to manage materials containing agriculturally sourced nutrient (*e.g.,* manure) and non-agriculturally sourced nutrients (*e.g.,* pulp and paper mill biosolids) in ways that will enhance the protection of the natural environment and provide a sustainable future for agricultural operations and rural developments. The Regulation also outlines requirements for land application such as setbacks from surface water, and a crop's nutrient needs, and contains standards for construction and siting of nutrient storages.

Ontario Clean Water Act, 2006

The Ontario Clean Water Act aims to protect drinking water from source to tap with a multi-barrier approach that stops contaminants from entering sources of drinking water. The act establishes a watershed-based, locally driven program that uses a science-based approach to assessing risks to drinking water, and decision-making that emphasizes the involvement of interested members in the watershed communities. Nutrient-related threats to municipal drinking water include wastewater discharges, combined sewer overflows, sewage bypasses, stormwater outfalls and industrial discharges.

Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem (COA)

COA outlines Canada and Ontario's commitment to the Great Lakes, and is the primary mechanism through which Canada meets its commitments under the Canada-U.S. Great Lakes Water Quality Agreement. The first COA was signed in 1971 and has been continually updated since that time. It has evolved from a focus on excessive nutrients and persistent toxic substances to include biodiversity, invasive species, climate change and source protection. The

[20] While programs throughout the appendices are listed alphabetically, Ontario's regulatory initiatives are listed in chronological order of implementation.

current COA, signed in 2007, includes commitments to reduce excessive nutrients from point and non-point sources.

Lake Simcoe Protection Act, 2008 and Lake Simcoe Protection Plan, 2009

The Lake Simcoe Protection Act and Plan together represent a legal framework for the protection and restoration of Lake Simcoe's aquatic resources. The Plan has established a common objective for the watershed (late-summer, hypolimnetic oxygen concentration, phosphorus loading target), put structures into place to implement and advise (Ontario Ministry of the Environment as a leading role, Science and Coordinating committees), and set out legally binding policies for certain activities, including effluent load caps for municipal sewage treatment plants and stormwater best management practices as well as voluntary strategies that address all land uses.

Lake Simcoe Phosphorus Reduction Strategy, 2010

The Lake Simcoe Phosphorus Reduction Strategy outlines an adaptive management approach to watershed reduction of P loads through source-specific actions for sewage treatment plants, urban and stormwater runoff, rural and agricultural sources of phosphorous, the Holland Marsh and Smaller Polders, on-site sewage systems within 100m of Lake Simcoe, and atmospheric deposition of phosphorus. The strategy outlines monitoring and compliance requirements and future research modelling and innovation.

Water Opportunities Act, 2010

In 2010, the Water Opportunities Act was implemented to encourage a new innovative approach to planning for municipal water infrastructure. The Act enabled the development of a regulation that would require municipalities to develop Municipal Water Sustainability Plans, which would involve assessing the performance of existing infrastructure (including sewage treatment plants, sewage collection systems and lagoons), evaluating risks such as algae blooms and climate change impacts, and planning for the appropriate operational improvements or upgrades.

Septic System Regulation under the Municipal Building Code

The Ontario Building Code was amended in 2011 to establish and govern mandatory and discretionary on-site sewage system maintenance inspection programs to be administered by principal authorities (municipalities, conservation authorities) in specific areas. The program is intended to support the implementation of the Clean Water Act (2006) and the Lake Simcoe Protection Plan. To date, mandatory septic re-inspection areas are limited to certain "vulnerable areas" approved under the Clean Water Act and "priority areas" in the Lake Simcoe watershed.

Québec

Adoption of Environmentally and Economically Sustainable Beneficial Management Practices

The Crop Nutrients Council (CNC) is an industry-led initiative founded in 2003 in response to rising public interest regarding nutrient use in Canada. The establishment of the CNC brings together various stakeholders in the agriculture and agri-food chain from all regions across the country. The CNC's mission is to promote science-based Beneficial Management Practices (BMPs) for crop nutrients that enhance both the economic and environmental sustainability of agriculture.

Quebec Regulation Respecting Agricultural Operations (RRAO)

The main objective of the Regulation Respecting Agricultural Operations (RRAO) is to protect the environment, particularly water and soil against pollution caused by certain agricultural activities. Article 31 of

the RRAO further says that fertilizers may be spread after 1 October on ground that is not frozen or covered with snow if the agrologist who designed the agroenvironmental fertilization plan specifies a new prohibition period.

2. Nutrient Management Information and Education Programs

Information and Education (I&E) programs primarily provide local governments, individuals and companies with I & E about nutrient management. Many I & E programs are carried out by the state's land grant colleges through the cooperative extension service offices. Each Great Lake state also has some form of local soil and water conservation governmental unit which provides I & E on nutrient management to its constituents. I & E programs range from publishing general brochures on nutrient management to technical training on prescription fertilizer application.

Illinois

Nonpoint Source Unit

The Illinois Environmental Protection Agency (EPA) Nonpoint Source Unit (NPS Unit) works to protect rivers, lakes, streams, groundwater and wetlands from pollutants from sources such as urban and construction site runoff, agricultural runoff, hydrologic modification, and resource extraction. Staff works with citizens, citizen groups, local, state, and federal organizations (including government agencies) to develop and implement NPS pollution control projects. Projects range from educational programs (storm drain stenciling) to diverse watershed management projects in urban and rural areas (citizen-led projects for watershed-based planning and implementation of best management practices, or "BMPs," to protect water quality).

Partners for Conservation

The Water Resources and Land Use Priorities Task Force and Illinois' First and Second Conservation Congresses developed realistic, goal-driven recommendations, through public involvement. Participants in the public involvement processes believed that it was possible to have and preserve the natural resources of Illinois through ecosystem-based management and through protection and enhancement strategies that are matched to each ecosystems scale.

Indiana

Clean Water Indiana

The Clean Water Indiana (CWI) Program was established to provide educational, technical and financial assistance to landowners and conservation groups. The CWI fund is administered by the ISDA Division of Soil Conservation under the direction of the State Soil Conservation Board. CWI funds are used by soil and water conservation districts to help cover costs of educational workshops, field days, on farm demonstrations, etc., focused on sediment and nutrient reduction.

Indiana's Conservation Cropping Systems Initiative

The Indiana Conservation Cropping Systems Initiative (CCSI) is a statewide educational effort to promote the adoption of continuous no-till/strip-till, cover crops, conservation buffers and precision farming for nutrient and pest management. This special initiative is funded by USDA Natural

Resources Conservation Service and Indiana's Clean Water Indiana Program administered by the State Soil Conservation Board and IN State Dept. of Agriculture.

Indiana State Department of Agriculture (ISDA)

The Indiana State Department of Agriculture, Division of Soil Conservation (ISDA-DSC) focuses on enhancing the stewardship of natural resources on agricultural land, and strengthening the capacity of local Soil and Water Conservation Districts to ensure that constituents have a local resource for conservation assistance.

Michigan

Environmental Assistance Program (EAP)

The EAP is a one-stop shop for environmental regulatory compliance needs. Services include direct one-on-one telephone assistance, and producing training events or assistance in developing plain English publications. Under this program, Michigan state staff provides timely and accurate information and assistance on a wide array of environmental topics.

Michigan Agriculture Environmental Assurance Program (MAEAP)

The MAEAP is latest tool to assist in the implementation of agricultural pollution prevention practices on farms. MAEAP is a voluntary, pro-active program designed by a coalition of farmers, agricultural commodity groups, state and federal agencies, and conservation and environmental groups to reduce producers' legal and environmental risks. MAEAP teaches effective land stewardship practices that comply with state and federal regulations and show producers how to identify and prevent agricultural pollution risks on their farms.

Michigan State University (MSU) Nutrient Management Program

MSU's Nutrient Management Program is a dynamic Nutrient Management Decision Support System (DSS). It incorporates the capability of strategic planning, tactical planning and record keeping of key activities that affect whole farm nutrient management.

Nonpoint Source Program

Michigan's Nonpoint Source Program assists local units of government, non-profit entities, and numerous other state, federal, and local partners to reduce nonpoint source pollution statewide. The basis of the program is watershed management and the program works with stakeholders to develop and implement plans to protect the watersheds of the state.

Nutrient Reduction Framework

Following the directives put out in 2011 guidance from U.S. EPA, Michigan has begun putting its nutrient reduction efforts on the Department of Environmental Quality's (DEQ) water website to show the historic and current efforts in the state to reduce the loading of nutrients to Michigan's surface waters.

Soil Surveys

Technical soil maps provide information on soil types and management options to provide the basis for production and resource management decisions.

Sustainable Soil and Water Quality Practices on Forest Land Manual

This Manual describes a set of voluntary Forestry Best Management Practices (BMPs) that protect our soil and water resources while allowing appropriate use of our forest resources.

Minnesota

MN website tools
Several websites provide assistance to Minnesotans for managing nutrients on their property. The University of MN wastewater management website provides homeowner manuals, worksheets, contractor and installer guidance, small community planning, and project development support. The MN Dept of Agriculture provides information via their Water Quality Certification program, which includes an interactive map function, rules and worksheet guidance for managing nutrients on farms and feedlots, rotational grazing guidance and links to animal producer websites. The MN Phosphorus Index tool helps landowners assess risk of phosphorus loss from farm fields.

Surface water data collection and reporting
This program features data from surface water monitoring sites around the state. Where available, the data allow a user quickly access statewide water quality data on a site-by-site basis, display site-specific data by specifying the name of a lake, river, or other related location, and view the degree of impairment and how impairment affects the use of assessed lakes and streams on a map. These data are also available via watershed web pages that help citizens understand the larger picture at the watershed scale.

New York

Nutrient Management Spear Program
Cornell University's Nutrient Management Spear Program assesses current knowledge, identifies research and educational needs, conducts applied, field and laboratory-based research, facilitates technology and knowledge transfer, and aids in the on-farm implementation of strategies for field crop nutrient management, including timely application of organic and inorganic nutrient sources to improve profitability and competitiveness of New York State farms while protecting the environment.

Ohio

Manure and Nutrient Management Training
These programs provide training, career development and demonstrations used to address manure pollution problem areas identified by Soil and Water Conservation Districts.

Nonpoint Source Water Pollution Education
Education and outreach are conducted by a variety of agencies. The Ohio Department of Natural Resources Division of Soil and Water Resources provides Resource Management Specialists to work with landowners on developing management plans; watershed groups target specific areas of concern; and Soil and Water Conservation Districts employ technicians and coastal education specialists to develop outreach materials and conduct workshops and field days focusing on nutrient management.

Surface Water Enhancement, Restoration and Protection (SWERP) Clearinghouse
SWERP Clearinghouse is intended to facilitate the process of identifying potential projects that may be selected as compensation for environmental impacts to surface waters throughout Ohio. It includes options submitted by land owners, government agencies, watershed coordinators and others that may result in improvement and/or protection of streams, wetlands and lakes.

Pennsylvania

Education Program Introduction
This component of the nutrient management program is coordinated by the

PA Department of Agriculture in cooperation with the State Conservation Commission, Penn State Cooperative Extension, PADEP, and USDA Natural Resource Conservation Service. This education program provides opportunities for nutrient management specialists to attend mandatory certification courses as well as a variety of other courses and workshops focused on nutrient management topics.

Pennsylvania Department of Environmental Protection (PADEP) - Bureau of Watershed Management

The PADEP Bureau of Watershed Management's mission is to restore and protect Pennsylvania's watersheds through: proper planning and management of water resources and their uses; reducing the impacts of nonpoint sources of pollution on water resources; regulating activities for soil conservation and waterway and wetlands protection; forming partnerships and building local capacity to restore and protect water resources, including drinking water sources; and educating Pennsylvania citizens about watersheds and watershed management.

Wisconsin

Discovery Farms Network

The Discovery Farms program develops on-farm and related research to determine the economic and environmental effects of agricultural practices on a diverse group of Wisconsin farms. Program staff also educates and improve communications among the agricultural community, consumers, researchers and policy-makers to better identify and implement effective environmental management practices that are compatible with profitable agriculture.

Nutrient Management Team - University of Wisconsin Extension

The Nutrient Management Team addresses nutrient management issues for Wisconsin's agricultural communities. The team vision is to develop an integrated approach to provide nutrient management education programs for sustainable nutrient management on Wisconsin farms. Also they will combine the interests and skills of UW-Extension, government agencies and the private sector to develop a comprehensive statewide educational program for nutrient management.

Ontario

Nutrient management education, training and certification opportunities are offered to support implementation of the Nutrient Management Act and to promote environmentally responsible use of nutrients on farms in Ontario including the following:

- Agricultural Operation Strategy of Plan Development Certificate
- Agricultural Operation Planning Certificate
- Broker Certificate
- Prescribed Material Application Business License
- Non-Agricultural Source Material Plan Development Certificate and;
- Nutrient Application Technician License.

The provincial government also provides support for the review and approval of Nutrient Management Strategies (NMS) and Nutrient Management Plans (NMP), and the development of educational materials to encourage adoption of nutrient management planning and nutrient management practices. Educational materials in addition to course materials include Factsheets and Best Management Practice books.

Agricultural Erosion Control

The provincial government provides support for farmers to address issues of soil

erosion and to reduce sediment loss to watercourses. This is achieved through the development of guidance documents for farmers to properly design and construct agricultural erosion control structures, and by offering training for the industry for design and installation (Certified Soil Erosion Control Contractors), as well as through general technology transfer materials.

Canada-Ontario Environmental Farm Plan (EFP)

EFP is a confidential, voluntary self-assessment farmers undertake to review potential environmental risks associated with their farm operations. Farmers attend an EFP educational workshop, complete a review of their operation, and develop an individualized Action Plan to address identified concerns. A peer-reviewed EFP Action Plan is required to access environmental cost-share funding from the associated cost-share program, the Canada-Ontario Farm Stewardship Program.

Nutrient Management Strategy/Plan Preparation

Computer software (*NMAN*) and paper-based guidance documents developed by the provincial government are available to assist agricultural producers in preparing NMSs and NMPs as required under the provincial legislation.

Soils Ontario

Information management and custody of the digital soils layer is shared with the federal agriculture department, AAFC. Accurate soils information is an important component of developing nutrient management plans and managing agricultural landscapes to reduce soil erosion and sediment loss.

The Phosphorus (P) Index

The P Index was introduced into Ontario as a means to assess the risk of surface water contamination from a field, and identifies where measures to reduce phosphorus losses are needed. A Best Management Practices Factsheet, "A Phosphorus Primer," is available that details measures that can be taken to reduce phosphorus from agricultural sources. The Factsheet also discusses the use of the P index.

Québec

Manure Management in Canada

There are several characteristics of manure management in Canada. The 2001 Farm Environmental Management Survey (FEMS) was conducted to gain perspective on farming practices in Canadian provinces that may impact the environment. FEMS results provided insight into methods for adopting environmentally sound farming practices, and for assisting governments, farmers, and non-governmental organizations in the promotion of new farm programs and practices.

3. Nutrient Management Technical and Financial Assistance Programs

Many state programs provide technical assistance, such as engineering and planning, to landowners, other units of government and organizations. State programs also provide funding to landowners and other units of government and organization. Funds are in the form of grants and loans. Most have a match requirement on the part of the receiving entity. All states have a form of conservation districts which are either entities of the state or part of the local county government. The conservation districts provide technical assistance to landusers to assist them in nutrient management. All states have some form of financial assistance programs. Ohio's Nonpoint Source Pollution Control Program is an example of a financial assistance program that provides Clean Water Act section 319 grants to local entities to install nutrient management among other nonpoint practices.

Illinois

Agricultural Loan Program
This program provides low-interest loans to Illinois farmers who wish to make improvements to their farming techniques to conserve soil and water resources. Loans are available to farmers statewide through over 1,000 financial institutions. Funds may be used for the following expenditures: soil and water conservation practices and new and used farm equipment, including conservation implements.

Conservation Practices Cost-Share Program
This program provides cost-share assistance for conservation practices that conserve soil and protect other natural resources. Eligible landowners may receive up to 60% cost-share on the construction of eligible soil and water conservation practices. County Soil and Water Conservation Districts (SWCD) administer the program locally. SWCDs establish cost-share rates, eligible conservation practices and maximum cost-share payments. Cost-share payments are based on locally established average costs for similar conservation practices.

Forest Management Assistance Program
This program's goal is to manage, protect, develop and enhance the private and public rural and urban forest resources for the following benefits:
to improve the quality and quantity of that resource;
to improve wildlife habitat;
promote soil and water conservation; and
improve the quality of life for Illinois residents.

Lake Education Assistance Program (LEAP)
This program provides assistance to teachers, youth, not-for-profit organizations, and others to carry out inland lake and lake watershed information/education programs and activities. Programs and activities must have stated goals and involve the enhanced lake/watershed education of teachers, students, organizations, and/or communities.

Sustainable Agriculture Grant Program Partners for Conservation
The purpose of this program is to carry out research, education, and on-farm demonstration projects which support sustainable agriculture or agricultural management systems that maintain farm profitability while protecting the

environment. Grant monies are available in four program areas: on-farm research and demonstration; outreach and education; university research; and training and education.

Tax Certification Program for Livestock Waste Management Facilities
As an incentive for livestock producers to construct waste storage structures and other structures which prevent water pollution, the EPA administers a tax certification program, which reduces the property tax value for many pollution control improvements. In order to recognize this tax reduction, the producer must have the improvement certified by the Illinois Environmental Protection Agency (Illinois EPA) as a pollution control facility.

Vegetative Filter Strip Assessment
The goal of this program is to protect the water quality of lakes, rivers, streams, creeks or other water bodies, by providing a property tax reduction incentive to landowners who install vegetative filter strips between farm fields and the water body to be protected. Interested landowners may contact the Soil and Water Conservation District (SWCD) for the county in which they reside. SWCD staff will provide technical assistance in the design, surveying and certification of vegetative filter strips.

Indiana

Clean Water Indiana
The Clean Water Indiana (CWI) Program was established to provide educational, technical and financial assistance to landowners and conservation groups. The financial assistance supports the implementation of conservation practices which will reduce nonpoint sources of water pollution. The CWI fund is administered by the IN State Department of Agriculture's Division of Soil Conservation under the direction of the State Soil Conservation Board.

The (CWI) Program is responsible for providing local matching funds as well as grants for sediment and nutrient reduction projects through Indiana's Soil and Water Conservation Districts. CWI also contributes critical state matching funds for Indiana's Conservation Reserve Enhancement Program, an initiative which utilizes federal funds to encourage landowners to conserve environmentally sensitive land.

Indiana State Department of Agriculture, Division of Soil Conservation (ISDA-DSC)
ISDA-DSC focuses on enhancing the stewardship of natural resources on agricultural land, and strengthening the capacity of local Soil and Water Conservation Districts to ensure that constituents have a local resource for conservation assistance. In addition, ISDA-DSC provides conservation technical assistance to implement federal, state, and local conservation projects. It employs Resource Specialists to assist directly landowners with the planning and implementation of conservation practices addressing specific soil and water resource concerns.

Indiana State Revolving Fund (SRF) Program (common to all states)
The SRF program finances projects that abate or prevent nonpoint source pollution of Indiana's waters. The SRF program has traditionally provided low interest loans to Indiana communities for projects that improve wastewater and drinking water infrastructure. The program has been expanded to fund projects that meet the objectives in the Indiana Nonpoint Source Management Plan. The money loaned to these nonpoint source projects is also documented as match, when applicable, for the state Section 319 Grant Program. Eligible nonpoint source projects must

provide water quality benefits to their respective communities.

Lake and River Enhancement (LARE) Program

The LARE program in IDNR's Division of Fish and Wildlife charges the Department with the responsibility to do the following: (A) Control sediment and associated nutrient inflow into lakes and rivers, and (B) Accomplish actions that will forestall or reverse the impact of that inflow and enhance the continued use of Indiana's lakes and rivers. LARE funds come from user fees collected by IDNR. The program overlaps with many of IDEM's goals, funding both lake and watershed management plans as well as the implementation of BMPs.

Section 205 Grants

The Section 205(j) program provides for projects that gather and map information on nonpoint and point source water pollution, develop recommendations for increasing the involvement of environmental and civic organizations in watershed planning and implementation activities, and develop and implement watershed management plans. Projects are administered through grant agreements that spell out the tasks, schedule, and budget for the project.

Section 319 Grants (common to all the Great Lakes states)

The Federal Clean Water Act Section 319(h) provides funding for various practices that reduce nonpoint source water pollution. Section 319 grant projects in Indiana that are implementing best management practices (BMPs) are required by Indiana's Nonpoint Source Program to develop a cost-share program. Details of the cost-share program must be submitted to the Indiana Department of Environmental Management (IDEM) Project Manager prior to implementing the program, including information requested in the Section 319 Cost-Share Program Development Guidelines. The approved cost-share program allows Section 319 funds to be used to pay a portion of the cost of implementing BMPs that reduce sediment, nutrients and other pollutants from nonpoint sources in the watershed.

Michigan

Clean Michigan Initiative (CMI)

The CMI is a $675 million bond approved in 1998 to improve and protect Michigan's water resources. Funding from this bond is used, in part, for pollution prevention, nonpoint source projects, water pollution control projects, and surface water quality monitoring.

Conservation Reserve Enhancement Program (CREP)

Michigan's CREP was created to help protect the soil and water resources and wildlife habitat. Michigan is partnering with the federal government *(i.e.*, USDA-NRCS) to implement conservation practices of great significance to the state.

Intercounty Drains

The Michigan Department of Agriculture and Rural Development, Environmental Stewardship Division (ESD) staff provides direction for more than 1,100 intercounty drains with a combined length of over 6,000 miles. ESD provides direction, holds public hearings, and oversees construction and financing of intercounty drain work.

Landscape Level Wetland Functional Assessment (LLWFA)

Michigan endorses the use of a LLWFA as a means to prioritize areas for wetland restoration and protection. The LLWFA methodology is based on an inventory of existing wetlands, and a determination of the functions that they are performing, including acting as nutrient sinks. The Nonpoint Source and Wetland programs are working together to complete LLWFA

for all funded 319 watershed management plans.

Michigan Agricultural Environmental Assurance Program (MAEAP) – Residential Program

The MAEAP Residential Program, also known as the Michigan Water Stewardship Program, provides technical assistance through web-based interactive education and outreach materials. The web site targets both urban and rural residents to assist their adoption of stewardship practices that reduce environmental risks (including fertilizer usage) to surface and groundwater and other related natural resources.

MAEAP – Technical Assistance Grant Program

Through pesticide and nitrogen fees collected under Part 87, Michigan Natural Resources and Environmental Protection Act, over $2.5 million are sent annually to conservation districts to fund conservation district technicians to assist farmers with adopting MAEAP Standards and linking to Farm Bill dollars when appropriate and as available.

Michigan Biosolids Land Application Program

ESD staff provides education and technical assistance to encourage the proper land-application and use of biosolids as nutrients for crop production. This program works with about 160 publically-owned wastewater treatment plants to recycle biosolids to over 18,000 acres of cropland delivering millions of dollars-worth of nutrients to private land-owners for their crop production. ESD staff provides education and assistance to encourage the increased use of biosolids recycling and application.

Michigan Coastal Management Program

The Coastal Zone Management Act (CZMA), originally passed in 1972, enables coastal states, including Great Lakes states, to develop a coastal management program to improve protection of sensitive shoreline resources, to identify coastal areas appropriate for development, to designate areas hazardous to development and to improve public access to the coastline. The coastal program has allowed the MIDEQ to improve the administration of state coastal regulatory programs and provide financial and technical assistance to local units of government to address shoreline issues and improve their coastal resources.

Michigan Turfgrass Environmental Stewardship Program

In 1998, Michigan became the first state to launch a voluntary environmental evaluation program for golf courses. Golf courses helped develop the program, which seeks to lower risk of groundwater contamination and support wildlife habitat through pesticides and nutrients management.

Nonpoint Source Program

This program assists local units of government, non-profit entities, and numerous other state, federal, and local partners to reduce nonpoint source pollution statewide. The program works with stakeholders to develop and implement plans to protect the watersheds of the state.

Minnesota

Best Management Practices for Nitrogen

Voluntary Best Management Practices (BMPs) form the core of the 1990 Nitrogen Fertilizer Management Plan. BMPs are organized according to five regions of the state and for nitrogen use on coarse-textured soils and irrigated crops. The BMPs include such practices as accounting for all sources of nitrogen when setting rates, timing nitrogen applications for optimum use, and use of nitrification inhibitors.

Clean Water Fund
The Clean Water, Land and Legacy
Amendment to the state constitution protects drinking water sources and restores lakes, rivers, streams, and groundwater. The Amendment increases the sales and use tax rate by three-eighths of one percent on taxable sales. Of those funds, approximately 33 percent will be dedicated to a Clean Water Fund to protect, enhance, and restore water quality in lakes, rivers, streams, and groundwater, with at least five percent of the fund targeted to protect drinking water sources.

Clean Water Partnership Program (CWP)
This program focuses on the control of nonpoint sources of pollution through watershed management to protect and improve surface and ground water in Minnesota. The CWP Program provides financial assistance through matching grants and loans and technical assistance to local units of government to lead pollution control projects.

Coastal Nonpoint Program
The Coastal Nonpoint Program is a partnership and is administered through Minnesota's Lake Superior Coastal Program (facilitated by the Minnesota DNR) and the Lake Superior Basin Plan (facilitated by the Minnesota Pollution Control Agency). Implementation of Coastal Nonpoint Management Measures is supported by distributing pass-through grants to Lake Superior watershed partners to help achieve the goals of Soil Water Conservation District Plans, Local Water Plans, and the Lake Superior Basin Plan.

Minnesota Board of Water and Soil Resources
BWSR is the state soil and water conservation agency, and it administers programs that prevent sediment and nutrients from entering lakes, rivers, and streams; enhance fish and wildlife habitat; and protect wetlands.

Nonpoint Source Management Program Plan (NSMPP)
The Nonpoint Source Management Program Plan (NSMPP) is a requirement for Minnesota to remain eligible to receive NPS grant funds from the US Environmental Protection Agency (U.S. EPA) under Section 319 of the Clean Water Act. The NSMPP is also intended to reach beyond this purpose by setting Minnesota's Statewide NPS goals and to layout out a statewide multi-year approach for addressing water quality problems from NPS pollution.

Agriculture BMP Loans & Sustainable Agriculture Demonstration Grants
These programs provide funds in the form of grants or loans for residential and commercial wastewater management, feedlot improvements and manure management.

New York

Agricultural Environmental Management (AEM)
New York State's AEM program is a voluntary, incentive based program which helps farmers develop comprehensive farm plans. Farmers may obtain technical and financial assistance through County Soil & Water Conservation Districts. Many agricultural Best Management Practices (BMPs) are aimed at keeping nutrients out of runoff and reducing agricultural runoff, protecting water resources and preserving agricultural soil resources. AEM has five levels or "Tiers" of planning and assessment to focus the farmer's attention on solving agriculture-related problems: farm inventory/summary; assessment; development of a CNMP; implementation of BMPs; and follow-up and evaluation.

NYS Conservation Reserve Enhancement Program (NYS CREP)
The NYS CREP facilitates the reduction of pollution in streams by helping agricultural landowners to voluntarily plant trees, shrubs, and grasses on streambanks to trap sediment, pesticides and fertilizers in runoff. Cost-share funding up to 50% with an additional 40% in incentive payments is available for planting materials, fencing, watering facilities, and stream crossings.

Ohio

Agricultural Pollution Abatement Cost-Share Program
Cost share monies from the state are made available to assist landowners in installing needed best management practices which abate animal manure pollution, soil erosion or degradation of the waters of the state by soil sediment including pollutants attached thereto. Eligible landowners may receive up to 75% cost-share on the construction of eligible soil and water conservation practices. County Soil and Water Conservation Districts (SWCDs) assist ODNR in administering the program.

Compliance Assistance Unit
The goal of the Compliance Assistance Unit (CAU) is to improve the water quality of streams, rivers, and lakes by assisting WWTPs that need help in meeting their National Pollution Discharge Elimination System (NPDES) permit. The CAU is a voluntary evaluation and training program for wastewater treatment facilities that want to improve their effluent and/or increase their plant efficiency, which could result in increased phosphorus removal from the facilities.

Lake Erie Programs
The Ohio EPA Division of Surface Water, Lake Erie Unit, participates in many Lake Erie- and Great Lakes-related issues and efforts. The Ohio Lake Erie Phosphorus Task Force reviews phosphorus loading data from Ohio tributaries to Lake Erie to consider possible relationships between trends in dissolved reactive phosphorus loading and in-lake conditions; to determine possible causes for increased soluble phosphorus loading; and to evaluate possible management options for reducing soluble phosphorus loading.

Ohio Nonpoint Source Pollution Control Program
Programs such as the CWA Section 319(h) grants program administered by Ohio EPA are actively engaged in assisting local governments and watershed groups by providing much needed funding for local restoration projects. Equally important are the funds provided by Ohio EPA's Water Resources Restoration Sponsor Program (WRRSP) and other programs within Ohio's Department of Natural Resources to protect against further water quality degradation.

Source Water Protection Program
Also known as "Wellhead Protection" and "Drinking Water Source Protection," source water protection is a program to assist public water suppliers with protecting sources of drinking water (streams and aquifers) from contamination. Source Water Protection addresses the more than 5,000 public water systems in Ohio.

Statewide Biological and Water Quality Monitoring & Assessment
Ohio EPA bio-survey is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. The data gathered by a bio-survey are processed, evaluated, and synthesized in a biological and water quality report. The findings and conclusions of each biological and water quality study may factor into regulatory actions taken by Ohio EPA and are

incorporated into Water Quality Permit Support Documents (WQPSDs), State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the Ohio Water Resource Inventory (305[b] report). This information also provides the basis for the list of impaired and threatened waters required by Section 303(d) of the Clean Water Act.

Pennsylvania

Act 38 of 2005
The Pennsylvania State Conservation Commission and the Erie County Conservation District are responsible for administering this act which demands that certain agricultural operations develop a nutrient management plan that addresses nitrogen and/or phosphorus application on agricultural operations. The Act also requires the implementation of best management practices for nutrient application and potential non-point source pollution

Act 167: Pennsylvania Stormwater Management Act
This act mandates counties to complete a stormwater management plan for all watersheds within their political boundaries. After approval of the plan, municipalities are required to adopt stormwater management ordinances that govern new development. Within Act 167, a component examines the creation of a multi-municipal entity known as a Qualified Local Program for 11 MS4 municipalities, also providing stormwater management, floodplain management, and source water protection services for all municipalities in Erie County.

Act 537: Sewage Facilities Planning Act
This program was established to protect ground and surface water through the implementation of the PA Sewage Facilities Act (Act537). The focus of this program includes working with local governments to address existing sewage disposal problems, permitting environmentally sound on-lot sewage disposal systems, planning for adequate sewage treatment during new land development projects, and providing oversight and support to local agencies administering the provisions of Act 537. The Erie County Department of Health is responsible for the on-site testing associated with this program.

Conservation Plans
Administered by the NRCS and Erie County Conservation District, soil conservation "compliance plans" are required of federal Farm Bill participants. These plans specify a tolerable limit for soil loss in a given area (thereby reducing phosphorus loading).

DEP Growing Greener Grant Program
This program provides grants to eligible entities for watershed, water quality and flood control projects. The target audience for this project is widespread and includes counties, municipalities, 501c3 non-profit groups and educational institutions.

Financial Assistance Programs
Several financial assistance programs are available under the Nutrient Management Act for the development of or implementation of an approved Act 38 nutrient management plan. These programs provide funding in the form of grants to offset the cost of nutrient management plan development and grants or low interest loans for the implementation of best management practices identified in an approved nutrient management plan. The PA Department of Agriculture assists the State Conservation Commission in the administration of these programs.

Nutrient Management Specialist's Certification Program

The certification program is administered by the Pennsylvania Department of Agriculture in consultation with the State Conservation Commission. The program certifies nutrient management specialists to write and review nutrient management plans which meet the requirements of the Nutrient Management Law.

PENNVEST: Pennsylvania Infrastructure Investment Authority
This program offers a revolving loan fund that issues grants and low interest loans of water, wastewater and stormwater infrastructure improvements.

Resource Enhancement and Protection Program (REAP)
This program is administered by the PA State Conservation Commission and serves as a tax credit program, where tax credits are earned by agriculture producers for the implementation of BMPs, including the development and implementation of nutrient management plans that address the application and non-point source reduction of nitrogen and phosphorus.

Wisconsin

Priority Watershed and Priority Lake Program
The Priority Watershed and Priority Lake Program provides financial assistance to local units of government in selected watersheds to address land management activities that contribute to urban and rural runoff. The Wisconsin Department of Natural Resources issues grants for the implementation of watershed and lake projects through a cost-share approach. The grantees use the funds to reimburse costs to landowners for installing voluntary BMPs including reductions in sediment/soil loss from uplands, streams, gullies, and phosphorus reductions from barnyards and croplands.

Ontario

Canada-Ontario Farm Stewardship Program (COFSP)
This cost-share program, available province-wide, assists producers with implementing environmental improvement projects identified through the EFP educational process. COFSP provides 30% or 50% cost-share funding to eligible producers to support projects in 27 best management practice categories, including projects targeting nutrient management issues such as storage, handling and application.

Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA)
OMAFRA staff provides technical assistance related to nutrient management to help producers address on-farm risks and in the development of nutrient management plans and strategies.

Other Local Stewardship Programs
Cost-share funding and technical assistance may be available from other sources on a more localized basis, including from the network of Conservation Authorities located across the province.

Canadian Federal Government

Great Lakes Sustainability Fund

Administered by Environment Canada, this program provides financial support to initiatives that rehabilitate key habitats in Canadian Great Lakes Areas of Concern. Project priorities include habitat rehabilitation, contaminated sediment clean up, stewardship, and the control of runoff in both urban and rural settings.

4. Watershed Management Programs

Many Great Lakes states, such as Indiana, Ohio, Michigan and Wisconsin, require state-approved watershed management plans in order for those watersheds to be eligible for certain types funding and other assistance. All states have some nutrient management programs based on watershed boundaries. Below are examples of a few of those programs.

Indiana

Water Quality Targets

The IDEM Watershed Management Plan (WMP) Checklist requires groups to identify targets for water quality parameters of concern. A target is defined as the desired measured level of a water quality or habitat/biological parameter that a group has decided streams in the watershed should meet. Where an Indiana Water Quality Standard or TMDL exists for a parameter of concern, the watershed group must, at a minimum, set the target to meet the respective standard or the loading limit set in the TMDL. Many of the water quality parameters watershed groups are concerned with do not have a standard. In these instances groups are free to set whatever target they deem appropriate (though these often are based on suggested standards).

Michigan

Areas Of Concern (AOC)

Annex 2 of the Great Lakes Water Quality Agreement (GLWQA) included a list of AOCs within the Great Lakes that had serious water quality problems known to cause beneficial use impairments (BUI). Of Michigan's 14 AOCs, seven continue to have impairments due to 'eutrophication or undesirable algae.' Michigan is reevaluating BUIs and is in the process of removing the 'eutrophication of undesirable algae' BUI from the White Lake AOC.

Cooperative Lakes Management Program (CLMP)

The primary purpose of the CLMP is to help citizen volunteers monitor indicators of water quality in their lake and document changes in lake quality over time. The program also 1) educates lake residents, users, and interested citizens in the collection of water quality data, lake ecology, and lake management practices, 2) builds a constituency of citizens to practice sound lake management at the local level and build public support for lake quality protection, and 3) provides a cost-effective process for the DEQ to increase baseline data for lakes state-wide.

Lake Allegan Phosphorus TMDL and Cooperative Agreement

This agreement is between the Michigan Department of Environmental Quality and other signatories, representing both point source and nonpoint source stakeholders (*e.g.*, municipalities) in the Kalamazoo River/Lake Allegan watershed. The primary purpose of the agreement is to create a process to cooperatively reduce phosphorus loading in the Kalamazoo River/Lake Allegan watershed to meet the goals of the Total Maximum Daily Load.

Minnesota

Major Watershed Restoration and Protection Projects

Minnesota Pollution Control Agency (MPCA) assessment system for streams and lakes is systematically organized by the 81 eight digit (HUC) watersheds in the state. Watershed streams and lakes are monitored, evaluated for healthy or impaired conditions, and moved toward restoration or protection

plans based on collected data. Efforts are made to enlist the participation and support of watershed residents and local governments throughout the process. Watershed web pages organize information about the watersheds, status of work projects in the watersheds, and provide links to monitoring data, TMDLs in progress, impaired waters lists and more.

Watershed Assessment Tool (WAT)

The WAT is a web-based tool for use by resource managers and others interested in the ecological health of Minnesota's watersheds. Five components are used to describe the similarities and differences between watersheds.

The five components are:

- Hydrology
- Connectivity
- Biology
- Geomorphology
- Water Quality

By describing, quantifying and comparing watershed health based on each of these components, the user will gain appreciation and understanding of the context and constraints faced by natural resource systems.

New York

604(b) Funds – Watershed Restoration

New York has provided 604(b) pass through funds to the Great Lake Commission and a local contractor to develop watershed restoration strategies that outline practices and funding needed to restore several streams impaired by phosphorus.

Agricultural Environmental Management (AEM)

The AEM was created to provide a coordinating framework to target the limited technical and financial resources available from all levels of government toward the watersheds, issues, pollutants, farms, practices, and BMPs that are of the greatest concern and where the most significant water quality benefits will occur. County Soil and Water Conservation Districts are required to form an AEM Steering Committee to develop a Strategic Plan identifying priority water bodies/watersheds, associated water quality impairments, pollutants of concern from agricultural sources, BMPs to address the identified pollutants, and potential sources of technical and financial assistance. The County AEM Strategic Plan then prioritizes all waterbodies/watersheds within the County, identifying the impairment associated with agriculture, the priority agriculturally generated pollutants, and the appropriate BMPs generally needed to address the priority pollutants.

Ohio

The Stillwater River Watershed TMDL

The Stillwater River flows 67 miles from its headwaters in Indiana and northern Darke County to a confluence with the Great Miami River in Dayton, OH. The watershed covers approximately 673 square miles (about 32 square miles in Indiana) and is drained by 280 miles of streams. Agriculture composes over 80 percent of the landuse, and Darke County has the second highest concentration of animal feeding operations (AFOs) in Ohio. Ohio EPA has completed two TMDL reports based on monitoring completed in 1999. The Stillwater TMDL addresses total phosphorus, biochemical oxygen demand, and habitat.

Pennsylvania

EPA Clean Water Act Section 319 Funding

These federal funds are distributed by the Commonwealth through grants that address non-point source pollution impairments within streams.

Total Maximum Daily Load (TMDL) Program

This program is administered by the PADEP and Erie County Department of Health. The program consists of stream and lake assessments, listings of a water body's attainment status as required by the U.S. Clean Water Act, and development of TMDLs to mitigate water quality problems.

Wisconsin

Total Maximum Daily Load (TMDL)

Development and Implementation
Clean Water Act Section 303(d) requires all states to develop TMDLs for waters on the Impaired Waters List. TMDLs are established based on Wisconsin's numeric water quality standards, or by applicable targets based on narrative water quality standards.

Watershed Management Plans

Wisconsin develops water quality plans based on watersheds. Plans include: 1) a summary of ecological landscapes and landuse; 2) an assessment of water quality based on available data; and 3) next recommended actions including grants/projects and planned monitoring. Data summaries and interpretation range, topically, from wetlands to invasive species risk to private wells.

Ontario

Ontario Conservation Authorities

Conservation Authorities (CAs) are local watershed management agencies established under the Conservation Authorities Act of 1946. CAs deliver services and programs that protect and manage water and other natural resources in partnership with government, landowners and other organizations. CAs implement municipally and privately funded programs that support septic system upgrades, well capping and a variety of agricultural BMPs. Examples include the Clean Water Program in the South Nation Conservation and the Landowner Environmental Assistance Program in the Lake Simcoe Region Conservation Authority.

Stormwater Management

Stormwater management in Ontario is governed by the Ministry of the Environment (MOE) through a series of guidelines and regulations, the most significant of which is the Stormwater Management Planning and Design Manual. This describes how stormwater management systems are to be designed and establishes water quality criteria. As part of this process, the MOE issues certificates of approval for urban stormwater sewer systems. Other significant government policies related to stormwater management include the Provincial Policy Statement (2005) which requires municipalities to ensure that stormwater volumes and contaminant loads are minimized and that the extent of vegetative and pervious surfaces is maintained or increased.

5. Special Projects/Pilot Programs

Most Great Lake states have specialized projects or pilot programs dealing with nutrient management. They generally cover a specific geographical area or a narrower aspect of the nutrient management spectrum. These range from statewide special initiatives such as Michigan's limitation of phosphorus in cleaning agents and laundry detergent to Minnesota's Precision Agriculture Center's nitrogen application timing modeling effort.

Michigan

Michigan Special Initiatives

In 1971, Michigan enacted a phosphorus limitation of 8.7% by weight on all cleaning agents. Michigan's phosphorus detergent ban was implemented in 1977, restricting the phosphorus content of household laundry detergents to no greater than 0.5% by weight. In July, 2010 Michigan restricted the phosphorus content of dishwasher detergent to no greater than 0.5% by weight and as of January 1, 2012 Michigan has placed limitations on when phosphorus can be used in lawn fertilizers.

Minnesota

Field Scale Drainage Water Quality Demonstrations

Two separate field scale water quality demonstration sites are currently in operation in southern-Minnesota to evaluate and demonstrate best management practices (BMP's) and impacts to water quality both at the field scale and the larger watershed.

Manure Testing Laboratory Certification Program

The Minnesota Department of Agriculture (MDA) implemented "FAQs" about the Manure Testing Laboratory Certification Program in 1996 to assist laboratories in ensuring the accuracy and credibility of manure test results, and to promote voluntary adoption of manure testing practices and use of test results in nutrient management planning by livestock producers.

University of Minnesota Precision Agriculture Center

Research at the University of Minnesota Precision Agriculture Center focuses on determining whether vegetation and topographic indices computed from Remote Sensing data and terrain models can improve prediction of crop nitrogen status, and whether these indices can be used to predict the crop yield or crop quality response to late season nitrogen application.

New York

Phosphorus Runoff Index

Cornell University and partners have jointly developed the New York Phosphorus Runoff Index (P Index), a water quality tool designed to estimate the relative risk of generating phosphorus runoff from agricultural fields. The index includes transport (soil drainage class, flooding frequency, distance to the stream and stream type, concentrated flows) and source factors (soil test P, fertilizer and manure P application rate, timing and method).

Precision Feed Management (PFM)

Precision Feed Management (PFM) is the providing of adequate, not excess, nutrients to the animal to maintain or improve environmental and economic sustainability through the integration of feeding and crop management. PFM is a continuous improvement process, voluntarily adopted and directed by the farm management. Cornell Cooperative Extension and Cornell University have developed software tool

applications to aid in generating PFM implementation on farms and to assist in the quantification of economic and environmental impacts.

Variable Source Area (VSA)
Targeting implementation sites using a "Variable Source Area" (VSA) hydrology concept may further increase success in watershed management efforts. This concept, which is employed at Cornell University, asserts that a relatively small portion of the watershed influences a majority of runoff exiting a watershed. By implementing practices in these areas, substantial water quality improvements can be accomplished in a more cost effective manner.

Pennsylvania

Act 15
Act 15 bans phosphorus in dishwashing detergents as of July 1, 2010. Note that commercial dishwashing remains exempt from this act. It is implemented in coordination with other Great Lakes states.

Wisconsin

The Wisconsin Phosphorus Index (P Index) The P index is a runoff phosphorus loss risk assessment tool for cropland management planning. It uses information that is readily available to farmers and agricultural consultants to evaluate the potential for phosphorus in runoff from a specific field entering a nearby stream. The P Index currently has two types of uses: nutrient management planning and water quality improvement planning.

Ontario

Agricultural Resource Inventory Mapping Project and LiDAR Data Acquisition
This work involves collection of field-level information on crop and tillage management in selected watersheds across the province, with digitization of landscape features and use of Geographic Information System (GIS) for modeling potential nutrient sources and mitigation strategies.

Investment in Municipal Sewage Infrastructure
Since 2003, the province has committed approximately $1.8 billion in funding, as well as almost $1.7 billion in loans through Infrastructure Ontario, to help local municipalities with their water and wastewater infrastructure including upgrades to sewage treatment and collection systems. Actions resulting from Ontario's commitment to wastewater and stormwater infrastructure in the Great Lakes basin since 2007:

- upgrading the province's remaining Great Lakes primary sewage treatment plants to secondary treatment;
- taking significant steps forward in other Areas of Concern and priority coastal areas; and
- leveraging federal investments in municipal wastewater infrastructure in the Basin.

Rural Nonpoint Source Work in the Areas of Concern

Bay of Quinte

- Over 27,000 hectares (ha) of farmland have been converted from conventional to conservation tillage, and phosphorus inputs from rural sources have been lowered at source by more than 16,000 kg annually
- At sewage treatment plants bordering directly on the Bay of Quinte, phosphorus loads have been greatly reduced as a result of sewage treatment

plant optimization for four facilities within the watershed
- Over 40 kilometers (km) of shoreline have been planted with native trees, shrubs and grasses to reduce erosion and improve habitats
- Looking ahead, work is underway to develop and implement a long-term phosphorus management strategy to ensure protection of the bay into the future from excess nutrient loading

Detroit River

- Conservation tillage techniques have been implemented on more than 15,000 ha of agricultural lands to reduce the runoff of nutrients, sediments and chemicals into local waterways.

Niagara River

- The Welland River watershed strategy has been developed, and a rural watershed heritage strategy is being implemented. The latter has resulted so far in the planting of more than 96,000 tress, and the installation of over 18 km of fencing to protect riparian habitat adjacent to watercourses, which reduces phosphorus entering local watercourses by more than 1,500 kilograms (kg) per year

St. Lawrence River (at Cornwall)

- Environmental farm plans and a tributary restoration program have been implemented to reduce agricultural runoff. This work involved fencing to restrict cattle from watercourses, upgrades to milkhouse washwater facilities, manure storage facilities and rural septic systems, and tree planting along riverbanks.

Wheatley Harbour

- Since 1988, erosion control measures have been implemented, and septic system upgrades and naturalization of riparian areas have been conducted through a rural non-point source remediation program in the Muddy Creek watershed

Sewer Use Best Management Practices (BMPs)

In August 2007, Ontario released ten sewer use BMP documents for various industrial, commercial, and institutional sectors focusing on prevention and treatment to minimize the discharge of harmful substances into municipal sewers.

Targeted Compliance Initiatives

In 1997 the MOE released Procedure F-5-5 which outlines expectations for municipalities to manage combined sewer overflows (CSOs). In 2006 the MOE completed a compliance review initiative to assess the status of municipal compliance with F-5-5. The review found that a high number of municipalities are monitoring and reporting overflows; that updates are being made to inspection processes to place a greater emphasis on overflows; and that direction has been given to staff at municipalities with combined sewers that they are to complete studies related to the systems and prepare comprehensive Pollutions Prevention and Control Plans, if required.

6. Nutrient Management Research

Research into agricultural nutrient management is carried out by almost all land grant universities located not only in the Great Lakes states but in states all over the country. The USDA has several research agencies, such as the Agricultural Research Service, which also conduct extensive research into nutrient management, some directly related to nutrient management in the Great Lakes basin. While the research is comprehensive in scope and breadth, it is scattered across the basin and the country as well as across the research system. Below is a selected list of research efforts and programs developed in and beyond the Great Lakes region.

Agricultural Research Service: Ditching Phosphorus Runoff

An innovative buffer system has been developed to mitigate phosphorus discharge by digging auxiliary ditches that parallel existing draining ditches and that are filled with synthetic gypsum, a byproduct produced by the process of scrubbing sulfur from the smokestacks of coal-fired power plants. Results show that the gypsum trench could treat the water draining from a field and reduce soluble phosphorus in subsurface drainage by at least 50 percent.

Brace Center for Water Resources Management

Research from the in Ste-Anne-de-Bellevue, Québec highlights results from a field study that examined phosphorus concentrations and loads in surface runoff and drainage waters from a tile drain system. More information is available at: http://www.engr.usask.ca/societies/csae/protectedpapers/c0208.pdf .

Conservation Technology Information Center (Indiana): A Review of BMPs for Managing Crop Nutrients and Conservation Tillage to Improve Water Quality

Research conducted over many decades has aided farmers in the efficient use of added nutrients through techniques such as soil testing and nutrient placement and timing. Until recently, most research and education was aimed at helping farmers determine economically optimal nutrient application amounts and methods. Today, we are more aware of the adverse off-site impacts that nutrients may have when they leave agricultural fields with surface runoff or leaching and enter surface or ground water in excessive amounts. The following presents a review of Best Management Practices (BMP) for nutrient and tillage management: http://www.ctic.purdue.edu/media/pdf/A%20Review%20of%20BMPs%20For%20Managing%20Crop%20Nutrients.pdf.

Cornell University

A variety of research efforts related to nutrient management have been conducted, and are currently being conducted, through the Cornell University Nutrient Management Spear Program. Examples include the following projects: "Whole Farm Nutrient Mass Balance;" "N and P Availability and Losses as Affected by N Requirement and P Removal Based Liquid Dairy Manure and Composted Separated Dairy Solids;" "New York Phosphorus (P) Starter Project;" "Phosphorus Buildup With Fertilizer and Manure P Addition;" and "Statewide Phosphorus and Nitrogen Balances for New York." Additional information on these and other research programs can be found at: http://nmsp.cals.cornell.edu/projects/index.html

Everglades Foundation: Phosphorus run-off assessment in a Watershed

The Watershed Assessment Model was used to simulate the runoff volume, peak flows, and non-point source phosphorus loadings from the 5870 km^2 Lake Okeechobee watershed as a case study. Land parcels with P oversaturated soil as well as the land parcels with high phosphorus

assimilation and high total phosphorus contribution were located. The most critical sub-basin was identified for eventual targeting by enforced agricultural best management practices. Phosphorus load, including stream assimilation, incoming to Lake Okeechobee from two selected dairies was also determined.

Great Lakes Protection Fund

The Great Lakes Protection Fund was created in 1990 through legislation that allows New York to use a portion of the earned interest on an endowment (the Fund) created by seven of the eight Great Lakes states. The Fund supports projects between government, academia, non-governmental and environmental groups to conduct research and exchange/apply information about remediating and sustaining the health of the plant, animal, and human elements of New York's Great Lakes ecosystem. Additional information can be found at: http://www.dec.ny.gov/lands/25582.html.

Government of Ontario

The explosive growth in the numbers of non-native mussels has greatly altered the movement and role of phosphorous in the system, a phenomenon known as the "nearshore shunt." The Ontario government is continuing to research this phenomenon and is working with its Great Lake partners on developing mitigation and management strategies. Climate change also poses a new challenge to the Great Lakes, and Ontario is examining the potential relationships between more frequent intense storms and the nutrient cycle.

Iowa State University Extension Nutrient Management Education in a Priority Watershed

This program was developed by Iowa State University Extension water quality specialists as an alternative approach for public assistance to producers in nutrient-impaired watersheds. It includes an education model, used to deliver the nutrient management incentive program and helps participants to evaluate the economic outcome of refined practices under the guidance of an extension crop production specialist (or other qualified educator). Concurrent field demonstrations on cooperator farms provide tangible evidence and local validity to the education program.

National Center for Water Quality Research

Founded in 1969, the National Center for Water Quality Research (NCWQR) is a leader in surface water and groundwater research in the Great Lakes region and beyond. Chemical analysis of fresh water samples as well as biological assessment of aquatic communities is performed at Heidelberg University's laboratory facilities.

North Carolina State University

North Carolina State University developed and maintains nutrient decision support systems that both function at the watershed-scale and are applicable to field-scale soil fertility issues.

Ontario Ministry of Agriculture, Food, and Rural Affairs

The Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA) provides funding for research both under the OMAFRA/University of Guelph Partnership Agreement and through other programs. Priorities are established annually for research funding. Other research related to nutrient management is conducted provincially and federally by Agriculture and Agri-food Canada, through CanAdapt and OMAFRA's New Directions Research Program.

Ontario Ministry of the Environment

Ontario's Ministry of the Environment (MOE) also participates in nutrient management research and works closely with government and academic partners. The MOE conducts an annual nearshore monitoring and assessment program on a lake-by-lake cycle. Through this program, the MOE collects data on water, sediment, and biota in order to define the impact of contaminant discharges, identify emerging issues and trends, and assess the effectiveness of control measures. The program includes both ambient monitoring (to characterize long-term, background conditions) and investigative monitoring in support of regulatory needs for the MOE's operations and for partnerships (*e.g.,* Remedial Action Plans).

Swedish Univ. of Agricultural Sciences, Division of Water Quality Management: A Decision Support System for Phosphorus Management at a Watershed Scale

A decision support system (DSS) consisting of the Maryland Phosphorus Index (PI), diagnosis expert system (ES), prescription ES, and a nonpoint-source pollution model, Ground Water Loading Effects of Agricultural Management Systems (GLEAMS), was developed and applied to an agricultural watershed in southern Sweden.

USDA – ARS Potato Rotation Systems: Nutrient Management

Specific research objectives are: 1) to determine the optimal nitrogen (N) management for potatoes under conventional and reduced tillage to minimize N losses and maximize N uptake efficiency; 2) to determine the annual N mineralization from crop residues in a potato rotation system; 3) application of continuous and real time monitoring the soil water content to fine tune irrigation scheduling to minimize water leaching below the root zone; and, 4) to evaluate the soil and plant growth parameters of a potato growth model, and validate the model for different production systems.

University of Idaho

The State of Idaho and the USDA offer the software and training for individuals to become Certified Nutrient Management Planners. This decision support tool (Idaho OnePlan Nutrient Management Planner) was a collaborative effort developed by the University of Idaho, NRCS, U.S. EPA and the Idaho Associate of Soil Conservation Districts.

University of Maryland: Crop rotations for phytoremediation of phosphorus over-enriched soils.

The objective of this project is to evaluate the effectiveness of grain-based and forage-based crop rotations in reducing soil phosphorus levels.

University of Wisconsin

Researchers at the University of Wisconsin are developing a Precision Ag-Landscape Modeling System (PALMS) and using it to quantify phosphorus losses from fields. PALMS is a combination of several models that simulate the flow of energy, water, and some chemicals in the air-plant-soil system.

Appendix C

Phosphorus Reduction Task Force Membership

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