Canada-Ontario Lake Erie Action Plan: 2024 Evaluation and Update Report

Canada Ontario

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EXECUTIVE SUMMARY

The Canada-Ontario Lake Erie Action Plan (LEAP) is a partnership-based effort among federal and provincial agencies and partners to reduce phosphorus loads to Lake Erie with the goal of decreasing harmful and nuisance algal blooms and zones of low oxygen (hypoxia). These conditions are impacting the lake ecosystem and well-being of Canadians, including a cost of hundreds of millions to the Ontario tourism and recreation industries, property owners and water treatment operators.

Since the LEAP was released in 2018, significant action has been taken with many positive results. However, monitoring results show there has been no discernable downward trend in phosphorus loads to Lake Erie, which reflects the challenges of undertaking collective efforts to make change in a large geographic area and the time required for the ecosystem to respond. Enhanced and sustained action is required to reduce phosphorus loads to Lake Erie.

Phosphorus is a valuable resource. Keeping it on the land, out of the waterways and available to crops and plants is a broadly recognized benefit of reducing phosphorus loads to Lake Erie. The science, monitoring and modelling work undertaken through the LEAP has confirmed our understanding that Canadian phosphorus loads to Lake Erie are largely from non-point sources (e.g., stormwater runoff from urban, rural and agricultural lands). Climate change is impacting the timing and intensity of precipitation events and drives the variability in observed phosphorus loads to the lake meaning wet years with intensive rain events produce larger annual loads. There is growing recognition that with shifting land management patterns and reserves of legacy phosphorus in the watershed, the results of improved management practices will not be observed for some time.

To support progress towards achieving the phosphorus load reduction targets, Canada, Ontario, and LEAP partners will continue to deliver programs, actions and activities guided by the following priorities (in no particular order):

- Target reductions at high-risk phosphorus loading sources, with a focus on the watersheds of the Thames River, Sydenham River, and Leamington/Kingsville.
- Prioritize efforts that address phosphorus loss through management of livestock, field crops, greenhouses, urban stormwater, natural areas, municipal and tile drainage systems, and land user behaviour and adoption of best management practices (BMPs).
- Build our understanding of how individual management practices, and combinations of practices, work to reduce phosphorus and to guide actions and investments.
- Seek out and emphasize measures that provide multiple benefits (e.g., phosphorus load reductions, cost savings, enhanced soil health and greenhouse gas mitigation).
- Expand LEAP partnership to more municipalities, agricultural organizations, and other partners.
- Actively work to support and strengthen First Nations and Métis participation in the LEAP.

As our knowledge of the lake's ecosystem improves, LEAP actions will be adjusted to increase their effectiveness using an adaptive management approach. Management actions and related investments result in benefits to the Lake Erie basin. For example, a cost-benefit analysis for the LEAP found that for every dollar invested (e.g., best management practices), there is a $25 net benefit (e.g., reduced water treatment costs).

This LEAP update shares many accomplishments to date and reflects the commitment by Canada, Ontario and implementation partners to take action to achieve phosphorus loading reductions to

Lake Erie from Canadian sources. While LEAP efforts since 2018 established strong partnerships and a governance structure that facilitated partner collaboration, coordination and actions, more is needed to address the challenges. Collective, sustained, and targeted action is required as we look ahead to reducing excess phosphorus and improving the health of Lake Erie.

Table of Contents

1.0 INTRODUCTION

For over 50 years, Canada and Ontario have worked with the United States and other partners to control the nutrient pollution that causes algal blooms in the Great Lakes, including Lake Erie. In large part, those efforts have focused on reducing the amount of phosphorus entering waterways. Phosphorus is a naturally occurring element that is essential to plant and animal life, but too much of it in lakes and rivers can result in excessive growth of algae and cyanobacteria. In Lake Erie and elsewhere, nuisance and harmful algal blooms cause significant social, economic and ecological problems including poor water quality, low oxygen (hypoxic) zones, degraded fish and wildlife populations and habitats, fouled beaches, clogged water intakes, impaired commercial fisheries and risks to human health.

Examples of algae blooms. Left: The attached algae Cladophora forms dense mats in standing water. Right: Cyanobacteria, commonly called blue-green algae. Photo credits: I. Heathcote; Government of Ontario.

Early phosphorus control efforts in Lake Erie focused on lowering phosphate levels in household detergents and enhancing municipal wastewater treatment. Those controls worked, and by the mid-1980s conditions in the lake had improved dramatically – but just a few years later, problems began to re-emerge. The causes of these problems in Lake Erie are complex. They include interactions of a changing and warming climate, altered hydrologic patterns, changes in land use and management, development and population changes, availability of substrate for algal growth, and the arrival of invasive zebra and quagga mussels. By the late 2000s, harmful algal blooms of cyanobacteria (also known as blue-green algae) were once again appearing in Lake Erie's western basin each year, and a low-oxygen zone in the central basin grew larger and lasted longer. Nuisance algal blooms (e.g., *Cladophora*) also became more frequent along the eastern basin's north shore and even on offshore shoals. In 2015 it was estimated that excessive phosphorus leading to harmful and nuisance algal blooms was having a potential economic cost of upwards of $272 million annually to the Canadian Lake Erie basin economy[1].

In 2012, Canada and the United States signed a protocol amending the Great Lakes Water Quality Agreement (GLWQA) which recognized the need for new approaches to managing phosphorus loads to the lake, including establishing phosphorus loading targets for Lake Erie. In 2016, the two countries established domestic and binational phosphorus load reduction targets for Lake Erie. The targets are: a 40% reduction from 2008 levels in spring loads of total phosphorus and soluble reactive phosphorus for priority tributaries, to minimize harmful algal blooms in nearshore areas; and a total 40% reduction from 2008 levels in phosphorus loadings to the western and central basins, to minimize the extent of the low-oxygen zone in the central basin. Together, these reductions will reduce the total annual phosphorus load from approximately 10,000 to 6,000 tonnes to the central basin. To reach this target, Canada must reduce its phosphorus loads to the lake by 212 tonnes per year, and the U.S. by 3,316

[1] Estimates are from *Estimating the economic costs of algal blooms in the Canadian Lake Erie Basin*, a 2019 paper summarizing a 2015 consultancy report authored by Midsummer Analytics (in collaboration with EnviroEconomics) and submitted to Environment and Climate Change Canada.

tonnes per year. Under the *Great Lakes Protection Act, 2015*, Ontario also adopted a target to help reduce algal blooms in Lake Erie: a 40% phosphorus load reduction by 2025 (from 2008 levels), using an adaptive management approach, for the Ontario portion of the western and central basins of Lake Erie.

Canada, Ontario, and partners are working together through the Canada–Ontario Agreement on Great Lakes Water Quality and Ecosystem Health (COA) to restore, conserve and protect the Great Lakes basin ecosystem. A key commitment of COA is the development and implementation of a domestic action plan to reduce phosphorus loads to Lake Erie.

In 2018, Environment and Climate Change Canada (ECCC) and the Ontario Ministry of the Environment, Conservation and Parks (MECP) led the development and release of the **Canada-Ontario Lake Erie Action Plan (LEAP): Partnering on Achieving Phosphorus Loading Reductions to Lake Erie from Canadian Sources**. The LEAP identified five categories of action: reduce phosphorus loadings; ensure effective policies, programs, and legislation; improve the knowledge base; educate and build awareness; and strengthen leadership and co-ordination. Also included was a commitment to review and revise the plan periodically using an adaptive management approach.

For more information about the LEAP and Canada and Ontario's phosphorus load reduction actions for Lake Erie, see the Canada-Ontario Lake Erie Action Plan (Canada). For additional information from Ontario, see the Canada-Ontario Lake Erie Action Plan (Ontario).

Since the inception of the LEAP, Canada and Ontario with partners have led and supported activities and actions within the Lake Erie basin, including on-the-ground actions, the delivery of restoration activities through direct and/or cost-share funding, contributions to outreach and education approaches, and practices to reduce phosphorus loss from the landscape. Phosphorus is a valued resource and keeping it on the land and soil, and out of waterways through agricultural conservation and stewardship also protects Ontario's agricultural soils and enhances the environmental resiliency of agricultural landscapes.

It's now time to take stock of what was done and what was learned. Section 2 of this report reviews LEAP accomplishments during the first adaptive management cycle (2018 – 2022), as well as recent updates from 2023 where available, to assess progress toward achieving phosphorus load reduction targets. Section 3 discusses how new insights gained can help to shape our plans for the future. Section 4 outlines a renewed commitment to action moving forward, and Section 5 lists LEAP partner agencies, organizations, and communities.

2.0 ASSESSING PROGRESS UNDER THE LEAP

LEAP partner agencies and organizations have undertaken hundreds of activities and engaged thousands of people to take actions to reduce phosphorus loads to Lake Erie. LEAP efforts primarily from 2018 to 2022 were reviewed and summarized to identify accomplishments, highlights and gaps that remain related to making progress in achieving the targets. The review concluded that work conducted in the first LEAP adaptive management cycle had successfully advanced the commitments made in 2018 and laid a strong foundation for the future. Those findings form the basis for the current update report and will help to inform activities for the next LEAP adaptive management cycle.

The following sections provide examples of key LEAP achievements, grouped under the five categories of action:

- reduce phosphorus loadings
- ensure effective policies, programs, and legislation
- improve the knowledge base
- educate and build awareness
- strengthen leadership and coordination

More information for each LEAP action is found in the LEAP Status of Actions table which highlights progress to date for each LEAP action, its status, implementation partner(s) involved and weblinks to more information on the action including partner programs, projects, and findings.

2.1 LEAP ACTIVITIES

Category A: Reduce phosphorus loadings

Phosphorus loads to Lake Erie come from five main sources: **point sources** (e.g., wastewater treatment plant); **diffuse, or non-point, sources** such as stormwater runoff from urban areas and rural and agricultural lands; **inputs from the atmosphere; legacy phosphorus** from the land and stream sediment; and phosphorus present in **water flowing into Lake Erie from the Huron-Erie Corridor**. In recent years the greatest proportion of phosphorus has come from non-point sources (see Figure 2). There are more than 100 separate LEAP activities focused on controlling phosphorus loads from rural and agricultural lands and urban areas, as well as protecting and enhancing natural heritage features like wetlands that can help to trap and store runoff. The COVID-19 pandemic was a difficult period but it did not have any notable overall impact on the results achieved.

Agricultural and rural areas

Each agricultural and rural site is unique in terms of its landscape, soil type, vegetative cover, and past and present land management practices. LEAP activities aimed at reducing phosphorus from the agricultural landscape therefore emphasized site- and sector-specific planning, funding, and technical support. Several major programs supported this work.

From 2018 to 2022, Canada's Great Lakes Protection Initiative (GLPI) provided over $4 million to 16 projects, including actions on 268 farms, to reduce phosphorus loads through implementation of agricultural BMPs, construction of wetlands, development of new and innovative technologies and mapping products, and adoption of watershed-scale management plans to improve phosphorus management.

The Lake Erie Agriculture Demonstrating Sustainability (LEADS) program, offered under the federal-provincial-territorial Canadian Agricultural Partnership[2], provided funding to support risk assessment

[2] The Canadian Agricultural Partnership was a five-year, federal-provincial-territorial initiative to support region-specific agriculture programs and services tailored to meet regional needs. In 2023, the partnership was renewed until 2028 as the Sustainable Canadian Agricultural Partnership, offering $1 billion in federal programs and activities and $2.5 billion in cost-shared programs and activities funded by federal, provincial and territorial governments.

activities and on-farm implementation of BMPs in the Lake Erie and Lake St. Clair watersheds. LEADS included two components, the Farmland Health Check-Up (FHCU), a field-specific risk assessment tool for farmers to identify priority actions, and an associated cost-share program to encourage voluntary adoption of on-farm BMPs. Applicants also completed an Environmental Farm Plan to assess environmental strengths and identify areas of potential concern associated with their farm operation. Through the FHCU, farmers worked one-on-one with a certified crop advisor or professional agrologist to identify soil health BMPs tailored to the specific needs of their operation. More than 500 FHCUs and over 1,100 on-farm improvement projects were completed under LEADS, reducing the risk of soil and nutrient loss on more than 81,000 hectares and leveraging $18.6 million in farmer cash contributions.

The On-Farm Applied Research and Monitoring (ONFARM) program is an applied research initiative that is being administered by the Ontario Ministry of Agriculture, Food and Agribusiness (OMAFA) and funded under the Canadian Agricultural Partnership (CAP)[2] and Sustainable Canadian Agricultural Partnership (Sustainable CAP)[2] federal-provincial-territorial agreements. A total of $12.75 million has been invested in ONFARM, with the goal of evaluating BMPs for improved soil health and water quality on Ontario farms. ONFARM is delivered by the Ontario Soil and Crop Improvement Association with support from various organizations including conservation authorities, the Soil Resource Group, and a network of participating farmers who are essential to the success of the program. Beginning in 2019, the program established 25 paired (side-by-side) field trial sites while continuing existing edge-of-field monitoring at seven sites on farms across Ontario. Most of the paired field trials and all edge-of-field sites are located within the Lake Erie watershed and are designated LEAP components. A key focus of ONFARM is to establish comprehensive long-term data sets to validate on-farm BMP performance. The program's stakeholder engagement concentrates on actively sharing evidence-based and practical solutions to advance farmers' knowledge and encourage BMP implementation. This program is anticipated to contribute to a deeper understanding of phosphorus movement, impacts of key soil health BMPs on water quality, phosphorus loss dynamics and other pertinent aspects essential for advancing agricultural practices.

OMAFA and MECP together with the Ontario Greenhouse Alliance, including Ontario Greenhouse Vegetable Growers and Flowers Canada (Ontario), are implementing the Ontario Greenhouse Environmental Strategy. The Strategy aims to demonstrate leadership, encourage compliance, and investigate technology for phosphorus reductions and water efficiencies in the greenhouse sector. Between 2018 and 2020, about $4.5 million was provided to fund approved projects with environmental stewardship outcomes or co-benefits under the Greenhouse Competitiveness and Innovation Initiative. Between 2018 and 2022, OMAFA also supported multiple greenhouse research projects with total funding surpassing $1 million. These projects primarily focused on or included environmental stewardship components and were carried out in partnership with the University of Guelph through the Ontario Agri-Food Innovation Alliance Agreement.

Conservation authorities in the Lake Erie basin have increased focus on actively managing their lands to minimize phosphorus losses. They are developing phosphorus reduction strategies for conservation and natural heritage areas, renewing agricultural leases with conservation farm leases to ensure that BMPs are implemented as intended, enhancing, and enlarging wetland areas, retiring marginal and erodible lands, naturalizing conservation lands, and planting trees. Where possible, conservation authorities also provide on-farm technical assistance and deliver financial assistance programs for landowners, which are implemented in partnership with watershed municipalities and others.

Beginning in 2021, the Chippewas of the Thames First Nation's (COTTFN) Department of Treaties, Lands, and Environment, in collaboration with the Lower Thames Valley Conservation Authority and with OMAFA funding, developed and implemented a COTTFN Agricultural Management Plan. The COTTFN Agricultural Management Plan includes a 4-year water quality monitoring program of surface waters and the Thames River (Deshkan Ziibi), event-based nutrient loading monitoring, soil sampling of agricultural lands and soil biological health assessment, natural restoration of legacy and non-productive agricultural lands, and education and outreach to farmers, farm leaseholders, and general community members about agricultural BMPs for nutrient management, EFPs, and local restoration organizations.

Nearly 2,500 farms and over 384,000 hectares are following the 4R BMPs under the 4R Certification program, to improve on-farm economic crop productivity and fertilizer efficiency. The 4R Nutrient Stewardship concept involves applying the right source of nutrient, at the right rate, to the right place at the right time, which reduces nutrient loss into the environment and to the waterways. On January 1, 2022, OMAFA entered into a Memorandum of Cooperation with Fertilizer Canada, the Ontario Agri Business Association, the Grain Farmers of Ontario, the Ontario Federation of Agriculture and the Christian Farmers Federation, which outlines the areas of collaboration on the 4R program.

Urban areas

In urban areas, phosphorus loads arise from point sources, such as municipal wastewater treatment plant effluents, and non-point sources, such as stormwater runoff. Most municipal wastewater treatment systems in the Lake Erie basin remove total phosphorus to 0.5 mg/L or lower on an annual average basis. LEAP actions related to these sources were geared to maintaining good performance. Some municipalities are building new sanitary sewers to serve areas formerly on septic systems, improving treatment and reducing the risk of nutrient losses from ageing septic tanks. In other cases, municipalities are converting older combined sewers into separate sanitary and stormwater sewer systems, reducing the load on treatment plants and the volume and frequency of combined sewer overflows. LEAP urban stormwater activities focused on slowing and storing runoff, often through green infrastructure like low impact development (LID) measures that use natural and constructed features such as rain gardens and infiltration trenches to collect, store, and treat stormwater runoff on site.

Ontario has invested in initiatives that will help better manage wastewater and stormwater across the province, including funding for municipal monitoring and public reporting of municipal sewage overflows and bypasses. The ministry has provided close to $10 million in funding to 19 municipalities, including six municipalities (Amherstburg, Leamington, London, Sarnia, Niagara Region, and Windsor) in the Lake Erie watershed, to help increase transparency around monitoring and public reporting of municipal sewage bypasses and overflows into Ontario's lakes and rivers. Municipalities are using this funding to install and upgrade monitoring equipment, acquire, and implement software approaches to model event forecasting and develop user-friendly public reporting systems.

The Grand River Conservation Authority, with MECP funding support, implemented a watershed-wide wastewater treatment optimization program as part of the Grand River Watershed Management Plan. These measures are estimated to have reduced total phosphorus loadings from urban areas in that watershed by 41% since 2012. Wastewater treatment plant bypasses and overflows also dropped in volume by 98% since 2013 in that watershed.

The Upper Thames River Conservation Authority, with the MECP, supported the implementation of

LID / green infrastructure projects within the Thames River watershed to help intercept stormwater and reduce nutrients and sediment inputs to the Thames River.

From 2017 to 2023, the City of London separated 6.86 km of combined sewer, with plans for an additional 2.47 km to be separated by 2025. Disconnection of weeping tile flows is promoted by the city through grant programs with subsidies of 90 to 100% of the cost of disconnection, depending on location and project circumstances. The disconnection of residential weeping tile connections to the sanitary sewer is important as they contribute a significant amount of wet weather flow to the sanitary sewer system which can lead to sewer overflows, phosphorus loads, and basement flooding. Disconnecting these flows at the source is a cheaper, longer-lasting solution than building larger sewers or storage tanks to accommodate the extra flows.

The City of London is undertaking a Pollution Prevention Control Plan (PPCP) Master Plan Update which is anticipated to be completed in 2024-2025. The study is an update to the 2018 PPCP Implementation Plan which has the following objectives:

- Identify an effective management strategy to limit the volume and frequency of untreated wastewater discharges into the Thames River and receiving streams;
- Consider options for how the frequency and volume of sewer system overflows can be reduced; and
- Incorporate a cost-benefit analysis to support prioritization of pollution source reduction options.

The City of London also has several LEAP-related projects underway to manage urban stormwater. Every five years, stormwater management ponds are surveyed and accumulated sediment is removed as warranted, ensuring that the phosphorus it contains doesn't become a source to downstream waterways. Under the Dingman Creek sub-watershed stormwater management strategy, the city plans to incorporate LID measures in new development and establish a "complete corridor" for safe stormwater conveyance, with engineered wetlands, natural channel expansions, and floodplain review. In 2019, the city updated its design standards to include LID systems to promote infiltration for private development and municipal projects.

During the first LEAP cycle, the Municipality of Leamington separated 4.5 km of aging combined sewers and installed 6.7 km of new sanitary and storm sewers along Point Pelee Drive and Bevel Line to collect raw sewage from residential and business properties that were previously on failing septic systems along the shore of Lake Erie. Two additional projects that are in the planning stage include the Northeast Sanitary Trunk Sewer to collect effluent from the greenhouse sector and domestic waste from worker housing and existing residential, commercial and industrial properties and the Seacliff Drive West Sewer to collect greenhouse effluent and domestic waste from residential properties along the shore of Lake Erie. Leamington continues to complete combined sewer separation projects annually to eliminate the potential for combined sewer overflows and excess storm flow volumes to the wastewater treatment plant.

The Municipality of Leamington is also undertaking a Masterplan Update for the Leamington Pollution Control Centre that is to be completed in 2024. This study is an update to the 2003 Masterplan document and will include alternatives to optimize existing infrastructure, manage excess flows during wet weather events to limit the volume and frequency of overflows to the Selkirk Drain and plan for expansion to service growth.

Leamington was the recipient of funding through the Improving Monitoring and Public Reporting of Sewage Overflows and Bypasses Program. This funding has allowed Leamington to install flow monitors in six combined sewer overflow structures to improve data quality reported to the public and provincial governments.

Natural heritage

Natural heritage features, including wetlands and riparian areas, play an important role in capturing and filtering out nutrients from overland runoff before they can enter a waterway in addition to providing other important ecosystem services such as habitat and carbon sequestration. Restoring and protecting these natural heritage features and their functionality helps reduce phosphorus loads to the lake. Since 2018, LEAP partners have carried out hundreds of natural heritage projects across the Lake Erie basin.

Ducks Unlimited Canada completed 663 projects in the Lake Erie watershed, restoring 11 hectares of upland area and 545 hectares of wetland areas, and protected over 2,630 existing hectares of natural heritage features.

The Nature Conservancy of Canada restored habitat within Pelee Island (24 hectares of coastal wetland and 8 hectares of upland habitat), the Southern Norfolk Sand Plain Natural Area (801 hectares), and the headwaters of Cedar Creek (3 hectares of wetland, 6 hectares of upland habitat).

The Ontario Eastern Habitat Joint Venture protected over 170 hectares of wetlands and 195 hectares of upland habitat and enhanced over 28 hectares of wetlands and 338 hectares of associated upland habitat in the Lake Erie watershed.

From 2020 to 2022, Ontario's Wetlands Conservation Partner Program supported conservation organizations in implementing more than 145 wetland projects to restore and enhance over 1,052 hectares of wetlands in the Lake Erie watershed.

Alternative Land Use Services Canada (ALUS) provided ongoing support to farmers and ranchers to create, enhance, and steward environmental projects on their farmland through community partnerships. Since 2018, ALUS provided expertise, resources and financial support to farmers and ranchers in Lambton, Elgin, Middlesex, and Norfolk Counties and the Municipality of Chatham-Kent. These community-developed projects created 761 hectares of new naturalized areas on marginal farmland and environmentally sensitive areas in the Lake Erie watershed. Projects include tree and shrub plantings (205 hectares), establishment of natural grassland areas (449 hectares), modified agricultural practices (202 hectares), and 107 hectares of wetlands restored with conservation authorities, in addition to farmers and others as key partners.

Multi-objective projects

Watershed management plans and strategies across the Lake Erie basin play an important role in identifying and highlighting areas needing stewardship and restoration, including wetlands, floodplains, grasslands, and other natural systems. LEAP partners developed comprehensive watershed and phosphorus management plans for four key watersheds: Thames River, Sydenham River, Essex Region, and the Grand River. Implementation of these plans is ongoing.

For more than a decade, the Thames River Clear Water Revival has brought together Indigenous peoples, three levels of government, two local conservation authorities (the Lower Thames Valley

Conservation Authority and the Upper Thames River Conservation Authority), and the local community to work toward achieving a healthy and vital Thames River. The partnership uses a Shared Waters Approach with significant involvement by First Nations whose traditional territory includes the Thames River watershed. The Thames River (Deshkan Ziibi) Shared Waters Approach to Water Quantity and Quality was completed in 2019 and highlights the positive participation and sharing of Traditional Ecological Knowledge within this framework, as well as the valued participation of the First Nations in implementation, through both cultural and technical expertise. The Shared Waters Approach focuses on learning respectfully about Indigenous perspectives of the importance of water, as well as collaborating with First Nations in technical capacities to achieve the water quality goals within the Shared Waters Action Plan.

Category B: Ensure effective policies, programs and legislation

Support and strengthen policies, programs and legislation

Effective laws and policies are essential for the reduction of phosphorus loadings. Canada and Ontario already have a strong legislative framework to support pollution control, including the federal *Canadian Environmental Protection Act, Ontario's Nutrient Management Act, Environmental Protection Act*, and *Ontario Water Resources Act*. Thirty-nine separate LEAP actions aim to strengthen existing protections and encourage compliance. Targeted programs have encouraged innovation and helped to improve the effectiveness of phosphorus reductions in the Lake Erie basin.

In 2018, Ontario released New Horizons: Ontario's Agricultural Soil and Conservation Strategy, which was developed in collaboration with multiple stakeholders (e.g., agriculture, conservation organizations, government, and academia) through the Agricultural Soil Health and Conservation Working Group. The implementation of the Soil Strategy is now being guided by a similar partnership of stakeholder organizations called the Soil Action Group. The Soil Strategy aims to improve soil health in the province through several diverse actions, including the support and promotion of agricultural soil management practices that provide economic, environmental, and social benefits to Ontario.

OMAFA continues to review and approve nutrient management strategies (NMS) to ensure manure is being managed on farms in accordance with the regulations. As of January 2022, there were approximately 7,100 farms with NMS and over 375 Non-Agricultural Source Material plans approved. OMAFA also continues to work with greenhouse growers to encourage nutrient recycling and reduction of phosphorus in discharges to watercourses, with an emphasis on the Leamington area and Thames River, and to support leadership and drive action in the greenhouse sector.

Canada continues to work on revisions to the federal *Feeds Regulations* that would enable the livestock feed industry to be more flexible and decrease the level of phosphorus in feeds (and corresponding manure) where it makes sense to do so.

Strengthen decision-making tools

OMAFA and Agriculture and Agri-Food Canada (AAFC) advanced the development of tools to assist with site-specific decision making. Ontario's modernized, cloud-based AgriSuite offers a range of decision support tools for crop nutrients, organic amendments, and fertilizer, including a new Phosphorus Loss Assessment Tool for Ontario, developed in collaboration with AAFC.

OMAFA worked with conservation authorities in the Lake Erie basin to support analysis and reporting

for decision-making. In 2020, the Grand River Conservation Authority undertook a project to engage producers in the evaluation of profitability mapping as a decision support tool for adoption and placement of BMPs. The Lower Thames Valley Conservation Authority is supporting sub watershed Soil and Water Assessment Tool (SWAT) model development and agricultural BMP verification research and providing financial incentives for BMP implementation through the McGregor and Jeannette's Creek Phosphorus Reduction Program (2018-2022). Essex Region Conservation Authority maintained a long term demonstration farm to test and highlight rural BMPs until 2024.

A coupled watershed model and economics driven cost-benefit framework was developed to support the LEAP and assess the benefit of investment in LEAP actions (e.g., BMPs). It found that for every dollar invested in the LEAP, there was a $25 net benefit[3]. Achievement of the phosphorus load reduction targets would have a substantial public value through reduced water treatment and stormwater infrastructure costs, increased carbon sequestration, and improved biodiversity and economic benefits to farmers and landowners through improved crop yields.

Municipalities also support decision making tools to help reduce phosphorus through stormwater management. For example, the City of London's Development Charges By-law includes a LID subsidy for developers who include linear municipal LID systems as part of the subdivision stormwater servicing.

Category C: Improve the knowledge base

The actions and priorities of the LEAP were developed based on more than 40 years of field data, published reports and ecosystem-level understanding. Today, our knowledge of Lake Erie phosphorus dynamics continues to steadily grow, providing support for continuous improvement of management approaches, and keeping us on the best path to achieve Canada and Ontario's loading reduction targets.

A key activity undertaken by the LEAP Implementation Team (see Category E and Section 5) during the first LEAP adaptive management cycle was to gather input and expertise from LEAP partners and 140 phosphorus management experts to identify key themes or pathways that are governing phosphorus loss from the Canadian watersheds to Lake Erie. The seven phosphorus loss pathways identified by the LEAP Implementation Team are (in no particular order):

- livestock management
- field crop management
- greenhouse management
- urban stormwater management
- municipal drainage systems
- natural areas management
- land user behaviour and adoption of best management practices

Many LEAP activities involved monitoring, modelling, or research related to phosphorus dynamics. One example is the Multi-Watershed Nutrient Study conducted by MECP and partners. Through that work,

[3] Estimates are from Implementing *the Canada-Ontario Lake Erie Action Plan: Cost / Benefit Analysis* a 2021 consultancy report authored by Greenland International Consulting Ltd. (in collaboration with University of Guelph and University of Waterloo) and submitted to Environment and Climate Change Canada.

we now understand how phosphorus losses from the land surface have changed over the last 50 years. In the 1970s, about 40 to 85% of nutrient export occurred during the spring and summer. Today, about 40 to 70% of nutrient export now occurs during winter and spring, due to altered precipitation patterns caused by a changing climate. This study confirmed that the largest proportion of phosphorus is lost during major storm events, many of which now occur outside the growing season. Stream phosphorus monitoring conducted in a sub-watershed inflowing to the Thames River also demonstrated evidence of these changing seasonal patterns.

Another example is the ONFARM applied research program, which successfully established 25 trial sites across Ontario to evaluate soil health BMPs, including cover crops, organic amendments, and tillage management. The program also focused on continuing the long-term monitoring of seven edge-of-field sites established under a preceding program to assess the effectiveness of select agricultural BMPs in improving water quality leaving the field edge. ONFARM studies have demonstrated that a farmer's management choices can make an impact on what leaves their farm. The use of BMPs that improved soil cover (e.g., leaving a cover crop in place over winter) reduced both the overall amount of runoff and the amount of nutrients in that runoff. Timing manure application to occur on drier soils, and maintaining more surface residue coverage were shown to result in lower nutrient loads that had otherwise occurred throughout the non-growing season after spreading. Incorporating phosphorus fertilizers/manure to ensure more contact with the soil resulted in less phosphorus runoff. Strip tillage for example helps get phosphorus incorporated in the soil with less soil disturbance.

Advances have also been made in new monitoring approaches and associated technology. Effective monitoring is essential to assess water quality conditions and estimate quantities of phosphorus entering the lake from tributaries. Algal blooms are particularly difficult to track because they vary so much in space and time. LEAP partners developed satellite image processing work flows for real-time bloom reporting and analysis and deployed real-time monitoring systems in Lake Erie to track the onset, severity and duration of nearshore harmful algal blooms or low oxygen zones.

Canada, Ontario, and partners also enhanced monitoring capacity through a strengthened network of flow gauges that produce essential data for the calculation of phosphorus loads. Water quality conditions are tracked at key sites through federal, provincial (e.g., Provincial Water Quality Monitoring Network (PWQMN) and Provincial Groundwater Monitoring Network), conservation authority, and partner monitoring programs.

The Farmland Health Check-up is available to assess farm risks to the environment, such as water erosion, wind erosion, and potential for phosphorus loss; it was also a prerequisite for applying for cost-share funding through the LEADS program, and continued to remain a requirement for receiving enhanced cost share funding under the Agricultural Stewardship Initiative (ASI) in 2023. As another example, the longstanding Canada-Ontario Environmental Farm Plan program has been updated with an electronic workbook and new one-day renewal workshop for farmers wanting to update their plans.

AAFC has updated background algorithms (equations) in the longstanding Indicator of Risk of Water Contamination by Phosphorus (IROWC-P), a tool used to assess the risk of phosphorus loss from agricultural lands resulting from agricultural practices. AAFC recently updated the IROWC-P algorithms to reflect current research findings, such as improved understanding of flow pathways and associated phosphorus forms through different pathways on the landscape, including tile drains. This update to the indicator reflected the latest research findings from work undertaken by AAFC researchers and others, including related to BMP effectiveness and other land management practices.

Category D: Educate and build awareness

Individuals, organizations, and agencies all play a role in reducing phosphorus loads. Building awareness of the issues facing Lake Erie – and associated social, economic, and ecological consequences – is therefore an essential component of the LEAP. This first LEAP adaptive management cycle provided an opportunity to coordinate a wide range of existing education and outreach initiatives and develop new, LEAP-specific initiatives. LEAP activities were focused on developing tools and programs to communicate BMPs to a wide audience, including school-based programs, conferences, webinars, workshops, tours, media posts, publications, instructional videos, and face-to-face interactions. For example, MECP engaged students and youth on Lake Erie issues through the Western Lake Erie Student Summit and Huron-Erie Corridor Virtual Field Trip.

OMAFA and ECCC provided funding for the agricultural sector, and other partners to provide activities such as one-on-one agronomic support to farmers, workshops, and demonstration projects to increase the adoption of BMPs in priority watersheds. For example, in 2020-2022 OMAFA supported 13 agreements and provided approximately $1.5 million in Ontario's Great Lakes funding to Lake Erie partners towards action for phosphorus reduction. OMAFA also funded Lake Erie conservation authorities to provide technical support to farmers to better understand and address farm-level risks to water quality and soil health through one-on-one support, workshops, and demonstrations. Under the federal GLPI (2018-2022), ECCC funded Lake Erie conservation authorities and non-government organizations including the Ontario Federation of Agriculture, ALUS, and Farm and Food Care Ontario to further engage farmers and promote stewardship practices in the Lake Erie watershed.

Conservation authorities continue to play a central role in communicating best practices to watershed residents through private land stewardship programs, tree planting, community partner events, school-based programs such as Children's Water Festivals, creation of educational modules, presentations at elementary schools, high schools and adult learning institutions, print and social media, locally-based videos, farmer/landowner workshops and site assessments, Lake Erie Student Conferences and delivery of the Specialist High Skills Major high school program. Conservation authorities also provide on-site consultations with rural landowners through delivery of private land stewardship programs.

The public has access to LEAP data through a variety of mechanisms. They include ECCC's Open Data portal, AAFC's semi-decadal inventory of land use in Canada, and annual crop inventory based on satellite imagery[4]. There is also data available from the ONFARM applied research program, supported through the federal-provincial-territorial agreements, CAP² and Sustainable CAP². Individual conservation authorities collect, maintain, and share a wide variety of data on surface water, groundwater, forestry, wetlands, flood parameters, benthos, and other parameters. Since 2018, Conservation Ontario has worked with the Great Lakes Observing System to make conservation authority data discoverable and accessible.

Canada, Ontario and partners regularly update the public on LEAP progress through Canada-U.S. GLWQA Nutrient Annex public webinars. These events provide an opportunity for the public to ask questions and share input and are important platforms for engagement and communication.

Ontario shared a LEAP progress update online in 2019, and in the second progress report on Ontario's

[4] Type "Lake Erie" in the search bar for these sites, and/or specify the kind of data you wish to view.

Great Lakes Strategy (released May 2023). Canada and Ontario include LEAP updates in the triennial GLWQA Progress Report of the Parties and regularly shares information with partner agencies, for example during meetings of the GLWQA Great Lakes Executive Committee and at the binational Great Lakes Public Forum.

Through the Excellence in Agriculture program (formerly the Premier's Award for Agri-Food Innovation Excellence), Ontario recognizes agri-food innovations that demonstrate leadership, product development or technology advancement that will benefit the agri-food sector, including in environmental stewardship. This program includes recognition for a farmer-led approach to address major environmental and agricultural challenges and is an important mechanism to showcase stewardship accomplishments at the farm level.

Category E: Strengthen leadership and coordination

At the beginning of the LEAP process, Canada and Ontario established a formal governance structure, the LEAP Implementation Team, to facilitate partner collaboration, co-ordination, and actions – a significant achievement with a large and diverse group of agencies, organizations, and communities. Since 2018, LEAP activities have been implemented by over 30 partners from federal and provincial government departments and agencies, municipalities, conservation authorities, First Nations, Métis, non-government organizations, and agricultural sector groups across the Lake Erie watershed. The LEAP Implementation Team, supported by topic-specific task teams, developed an overarching work plan for the first LEAP cycle and an extensive list of consensus-based actions, and are using an adaptive management approach to plan for the future. A list of LEAP Implementation Team members appears in Section 5 of this document. The Agriculture Sector Working Group was also assembled in 2016 to coordinate the development and implementation of many important agriculture-focused actions, such as the Ontario Cover Crops Strategy, the Timing Matters initiative and 4R Nutrient Stewardship, leveraging the diverse knowledge and influence of over 20 supporting partners.

Lake Erie conservation authorities are also strengthening co-ordination around data management and sharing by transitioning to KISTER's North American product, the Western Ontario WISKI (**W**ater **I**nformation **S**ystem **KI**STERS) data hub. The hub, hosted by the Upper Thames River Conservation Authority, is a network of member conservation authorities sharing a single database system for managing hydrometric (rainfall, streamflow, groundwater), water quality and ecological data beyond watershed boundaries. This initiative has allowed for cost sharing and improved data accessibility for members and provides a forum for sharing knowledge about southwestern Ontario water systems.

2.2 CANADIAN PHOSPHORUS LOADS

Phosphorus entering Lake Erie comes from many sources across the Canadian watershed. This section explains how annual phosphorus loads are estimated and summarizes current loads from the Canadian side of Lake Erie. For additional details, phosphorus load data is available on Canada's Open Data portal.

How phosphorus loads are estimated

Phosphorus loads are calculated by multiplying concentration (the amount of phosphorus present in a given volume of water, for example milligrams per litre) by the flow rate (the volume of water passing a point in a given period of time, for example litres per second). Estimating phosphorus loads uses data

on both water quality (concentrations) and water quantity (flows), collected by federal and provincial agencies and partner organizations such as conservation authorities. Along with total load, the flow-weighted-mean concentration may also be reported, which is the total phosphorus load divided by the total flow for a tributary. Canada and Ontario provide data to support the annual total load estimates for soluble and total phosphorus for the Thames River, the Sydenham River, and the Grand River for 2008 to 2022. Total and soluble phosphorus load estimates for the Leamington area tributaries are also now available for 2018 to 2022, as well as load data from seven other tributaries based on PWQMN data (see Canada's Open Data portal and Ontario Data Catalogue - PWQMN).

Phosphorus loads to Lake Erie (2008-2022)

The phosphorus load reduction target of 40% based on 2008 phosphorus load levels has not been achieved and there is no clear downward trend in annual loads with annual variability driven by precipitation events and discharge. Between 2008 and 2022, the largest contributor of phosphorus loads from Canadian sources were the Thames River and Sydenham River in the Lake St. Clair/western basin, and the Grand River in the eastern basin (Figure 1). The largest contributing types of sources each year continue to be from non-point sources (Figure 2).

The most recent load estimates reveal that together, the Thames, Sydenham, and Grand Rivers, and the Leamington area tributaries contribute over 80% of the total Canadian non-point sourced phosphorus load to Lake Erie (Figure 1). These phosphorus loads can contribute to nearshore harmful algal blooms in the western basin, hypoxia (low oxygen zones) in the central basin and nearshore nuisance algae in the eastern basin of Lake Erie.

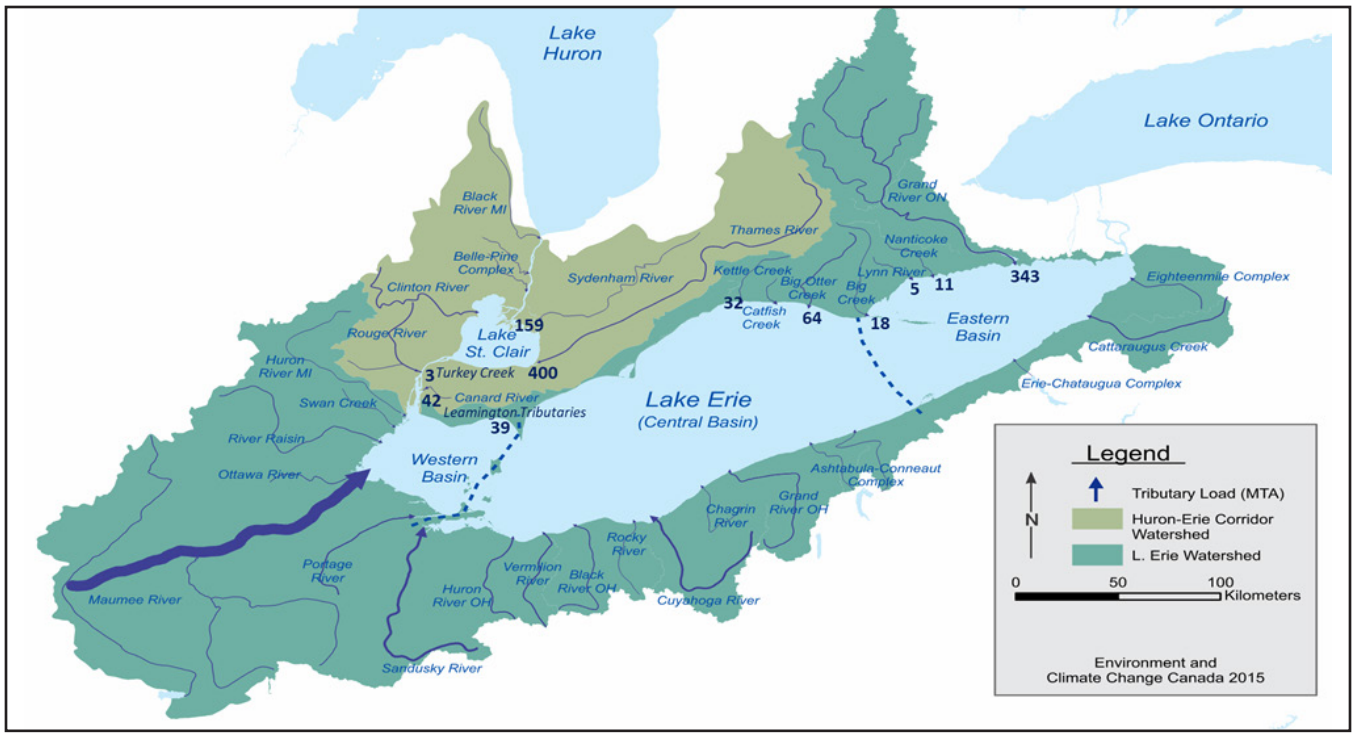


Figure 1: Mean 2008-2022 Canadian Tributary Total Phosphorus Loads to Lake Erie, metric tonnes/annum (MTA)

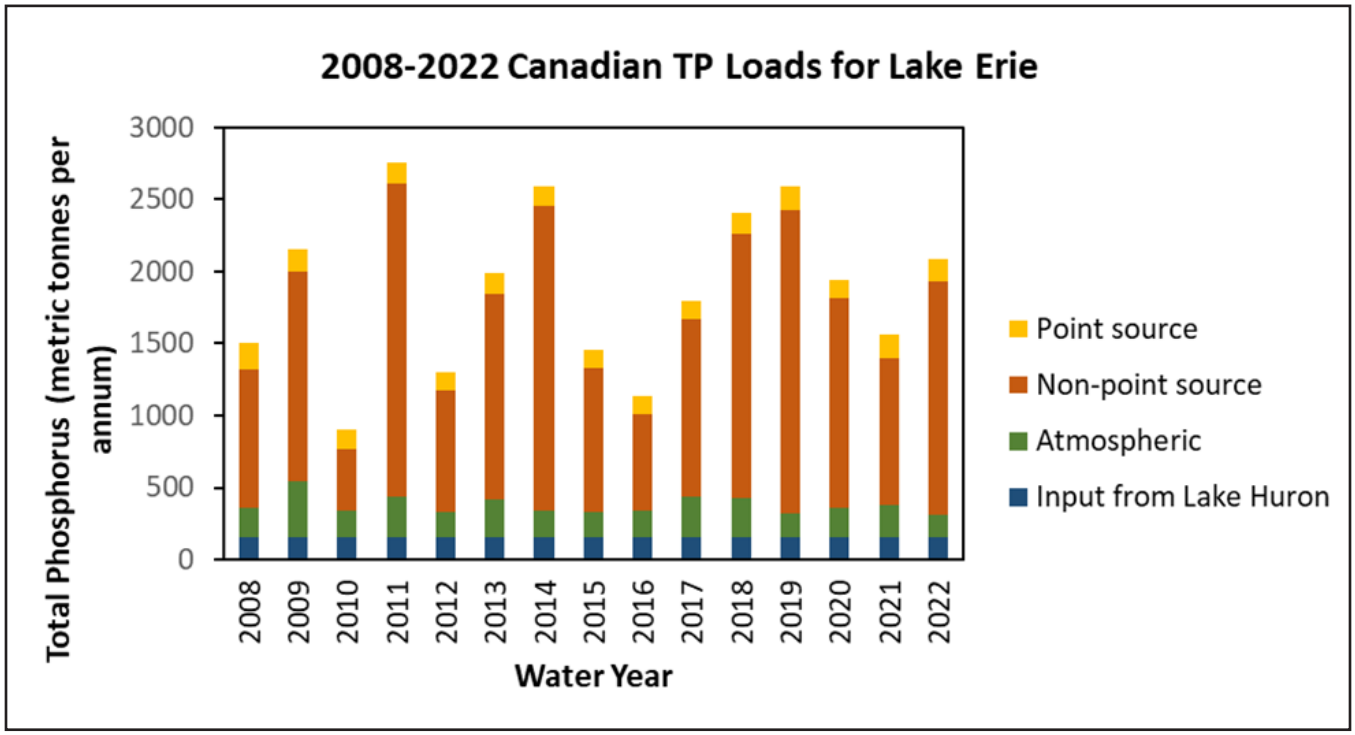
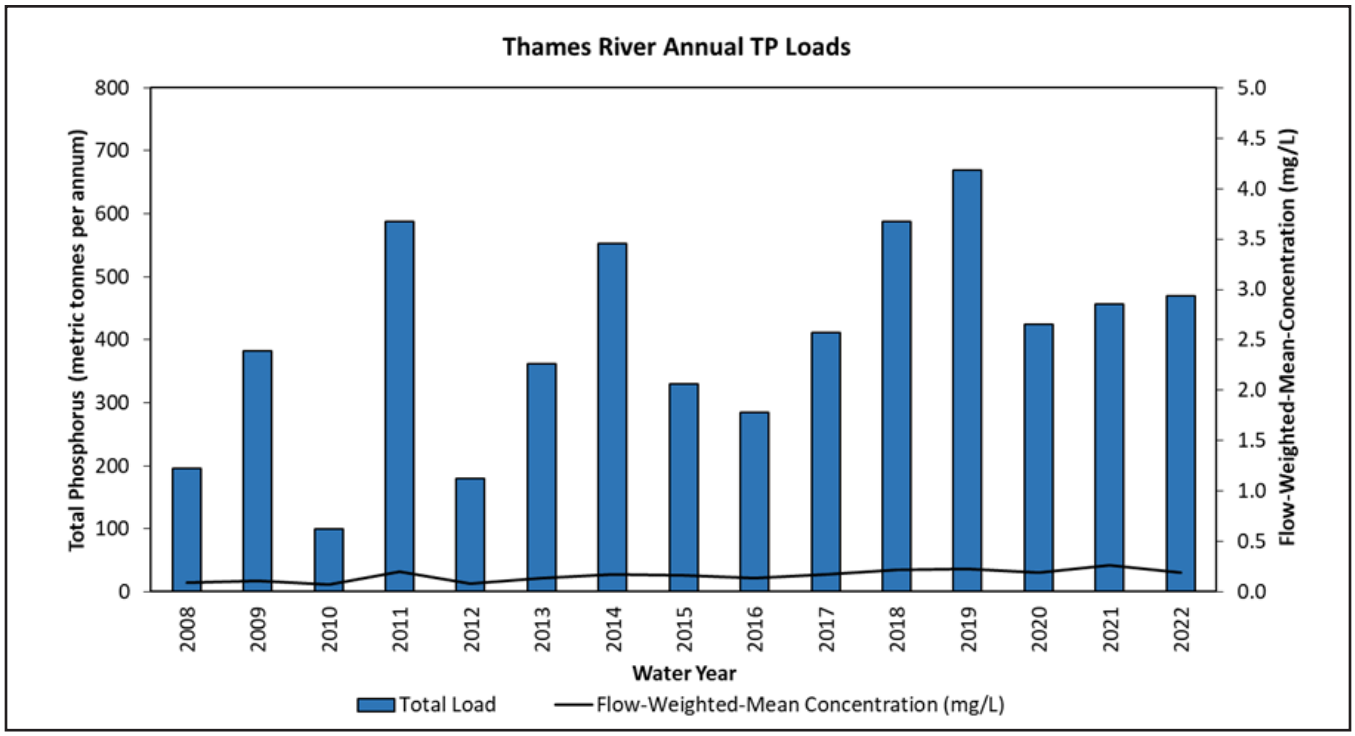


Figure 2: Total Phosphorus Loads (metric tonnes/annum) to the Central Basin Lake Erie from Canadian tributaries, 2008-2022

(A)



(B)

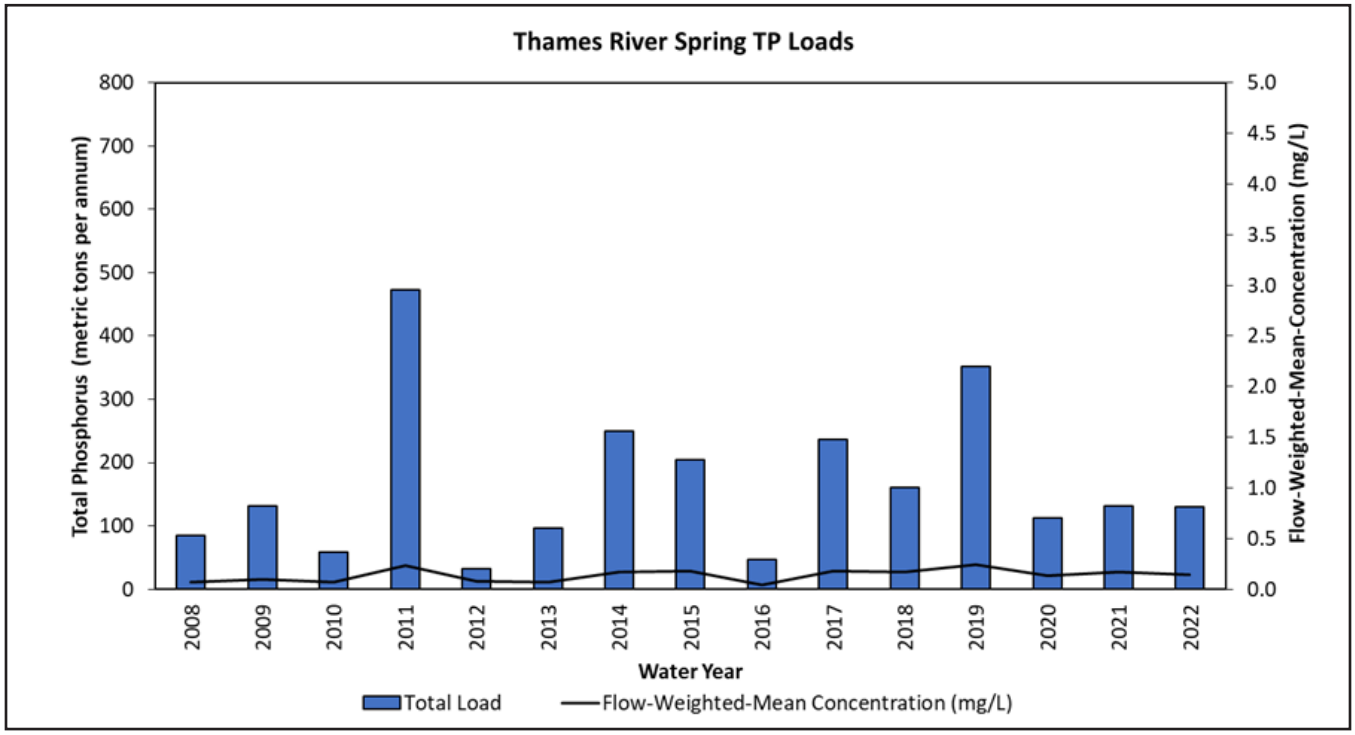
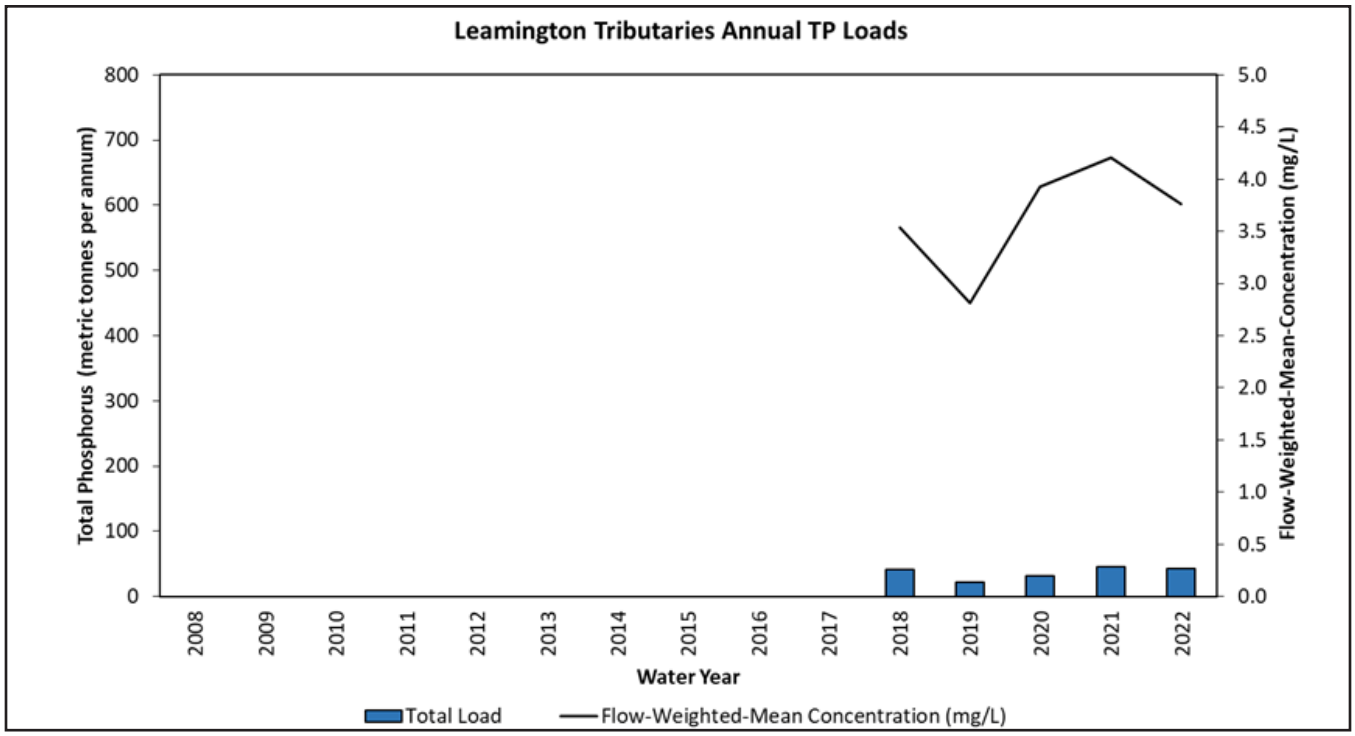


Figure 3: Thames River total phosphorus loads (metric tonnes/annum) and flow-weighted mean concentrations (mg/L) annually (A) and in the spring (B), 2008-2022

(A)



(B)

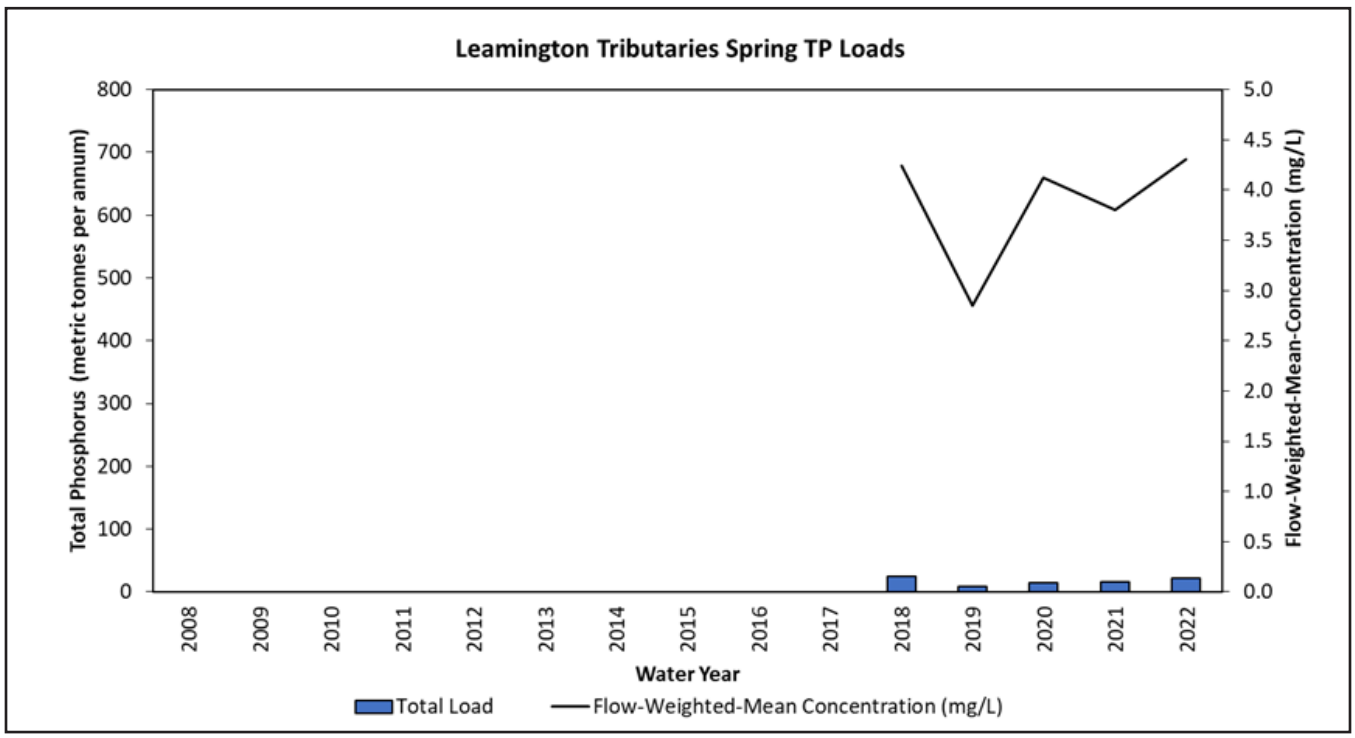


Figure 4: Leamington area tributaries total phosphorus loads (metric tonnes/annum) and flow-weighted mean concentrations (mg/L) annually (A) and in the spring (B) Spring, 2018-2022

In the Thames River, annual and spring total phosphorus loads (Figure 3) have been strongly driven by precipitation and flows, with wetter years such as 2019 being associated with higher overall loads. In Leamington area tributaries, which have been directly monitored since 2018, annual and spring loads (Figure 4) are comparatively lower than the Thames River on an annual basis, though concentrations are several times higher. Section 2.3 discusses drivers of phosphorus loads in greater detail.

2.3 NEW INSIGHTS AND OPPORTUNITIES

An adaptive management process was integrated into the LEAP approach so that management progress is assessed periodically and strategies are adjusted as necessary to improve outcomes. The process is collaborative and driven by a steadily evolving knowledge base supported by robust monitoring, research, and modelling. Considerable progress on actions on the ground, coordination and LEAP partnership was achieved in this first LEAP cycle, and continued diligence is required as the phosphorus load results have indicated. The LEAP Implementation Team made great strides in bringing together partners from across the Lake Erie basin and gained many important insights. The team significantly advanced understanding of the drivers and pathways of phosphorus loads and how they might be controlled; and continues to support the development and application of decision-making tools that can be scaled up from the field level to the entire watershed.

Improved understanding of drivers of phosphorus loads

Climate change and associated weather patterns continue to be broad scale drivers with important consequences for phosphorus loss to Lake Erie. Changes in agricultural and urban areas over the last 30 years are also important in influencing how phosphorus moves across the landscape. The following are some of the key adaptive management findings from this first LEAP cycle.

1. **Seven key phosphorus loss pathways were identified under the LEAP** with known influence on Canadian phosphorus loadings and transport to Lake Erie. These include livestock management, field crop management, greenhouse management, urban stormwater management, municipal and tile drainage systems, natural areas management and land user behavior and adoption of BMPs.

2. **Canadian phosphorus loads to Lake Erie are largely from non-point sources** and must be the primary focus of load reduction efforts. These are among the most challenging sources to manage because they arise over a wide area and reflect the land management practices of many different urban and rural landowners.

3. **Phosphorus loads vary dramatically from year to year**, driven primarily by non-point source contributions, which in turn are driven primarily by weather. In a dry year (such as 2010; see Figure 4), there is little rainfall and much less phosphorus is washed off the land surface into rivers and streams. By contrast, in a wet year like 2011 there are more frequent and larger precipitation events, generating much higher runoff carrying higher phosphorus loads. While this inter-annual variability complicates the assessment of trends, the phosphorus load response confirms our understanding of the factors, such as precipitation and discharge, that control phosphorus mobilization and transport to Lake Erie.

4. **Climate change is impacting the timing and intensity of precipitation events**. Extreme weather events have become more frequent, often occurring outside the growing season. Changes in

winter dynamics have affected timing and frequency of spring snowmelt events. Nutrient loss is higher when a major precipitation event causes runoff to flow over bare, frozen, or saturated soil, and can also challenge the capacity of urban stormwater systems. Even a relatively small spring rain event could mobilize a very large amount of sediment-bound phosphorus.

5. **Combinations of actions (e.g., types and number of BMPs) tailored to each unique location are most likely to achieve phosphorus reductions**. Priority investments and programming should be focused on supporting actions through advanced management tools, such as precision conservation, that target areas most likely to release phosphorus because of their land-use, soil type, topography, or other factors. These high-risk areas may exist at multiple scales, from the field scale to the sub-watershed.

6. **Invasive species, particularly zebra and quagga mussels, are significant in promoting the growth of attached nuisance algae species (e.g., *Cladophora*)**, by creating conditions favorable to its growth in the eastern basin of Lake Erie.

7. **Changes in land use in the Lake Erie basin over the last 30 years are changing the delivery and type of phosphorus exported from the landscape in complex ways**. Land management considerations such as changes in the types of agriculture and urban development are changing phosphorus runoff dynamics in the basin. For example, agriculture in the Lake Erie basin has seen a decline in beef production and increases in soybean and greenhouse production.

8. **Sanitary sewage and resulting phosphorus load to wastewater treatment plants will continue to increase with population growth**. While these sources are currently well controlled, plants require careful management and on-going investment to ensure continued good performance, particularly in high-growth and major urban communities.

9. **Continued urban development creates more impermeable surfaces such as roads, parking lots, and roofs, causing rainfall to be diverted to storm or combined sewers**. As it flows, stormwater picks up sediment, phosphorus and other pollutants from the land surface and carries it to the point of discharge, which is often into a lake or stream. The amount of bare soil exposed during development also results in higher soil and phosphorus loss to the environment. Protecting and restoring natural features like wetlands, and encouraging local LID measures, helps to slow stormwater flows and trap sediment and nutrients.

10. **Legacy phosphorus is phosphorus left over from many years of historical land management practices**. It remains in the lake and stream sediments and on the land surface. Legacy phosphorus can be mobilized, become a source of phosphorus loads to the lake and result in time lags in system response to actions. It will take time and possibly specialized measures to manage legacy phosphorus.

11. With a changing climate, increasingly erratic weather, and significant reserves of legacy phosphorus to draw down, **it will take time to see the effects of improved management practices and actions (e.g., agriculture, municipal, natural heritage) on phosphorus loads and Lake Erie water quality**.

Improved decision making and reporting

This first LEAP adaptive management cycle revealed several opportunities to enhance future decision making and reporting. We identified the need to support the development of a multi-scale ensemble watershed modelling framework for Lake Erie to assess potential management approaches under a range of simulated scenarios (e.g., climate and weather conditions, changing land use). We will be able to test the response to on-the-ground actions at the field scale and explore the cumulative impact of multiple actions at the sub-watershed, watershed, and regional scale. We will evaluate different combinations of management practices to see which work best, in which locations, and explore the impact of implementation timing and location on phosphorus loads. This work will start with enhanced analysis to confirm the areas most likely to generate phosphorus loading, many of which were tentatively identified in the first LEAP cycle. Then, we will focus scenario testing on the areas and management practices most likely to result in meaningful phosphorus load reductions.

Future planning will also benefit from the use of advanced management tools, such as precision conservation, which identify high risk areas of phosphorus loss and allow LEAP partners to make informed, cost-effective decisions about actions. For example, farmers may use a suite of practices (e.g, precision planting and/or tilling) or tools to determine optimal fertilizer placement and timing that are tailored to their particular field, crop, and nutrient needs while also considering farm profitability and ecological co-benefits.

With an effective LEAP governance framework in place since 2018, Canada, Ontario and LEAP partners have an opportunity to streamline and enhance the tracking of LEAP activities and share their findings with others in the Lake Erie community. Enhanced coordination benefits all by optimizing available funds and resources. Communities of practice will be enhanced, including around the seven LEAP phosphorus loss pathways, encouraging collaboration and learning amongst partners, organizations, and agencies. Enhanced tracking of LEAP activities will also help to identify implementation gaps and support the generation of robust load reduction estimates across the watershed.

3.0 LOOKING AHEAD: FUTURE PRIORITIES TO REDUCE PHOSPHORUS LOADS

The 2018 LEAP document is subtitled *Partnering on Achieving Phosphorus Loading Reductions to Lake Erie from Canadian Sources*, and that partnership approach has been a hallmark of our work. The LEAP Implementation Team has representation from federal and provincial agencies, First Nations, Chiefs of Ontario, Métis Nation of Ontario, agriculture sector organizations, municipalities, non-governmental organizations, and conservation authorities. Members contribute knowledge, experience and unique perspectives, support and implement on-the-ground actions, and spread the word about the LEAP and its activities in the broader community.

Considerable effort was already underway before the LEAP began in 2018, and over the first LEAP adaptive management cycle Canada and Ontario, with LEAP partners, have worked hard to co-ordinate and strengthen alignment of implementation of relevant initiatives. These include Canada's Great Lakes Protection Initiative and Living Laboratories Initiative; Ontario's Great Lakes program, ONFARM applied research program, and Wetlands Conservation Partner Program; and other programs under the federal-provincial-territorial Canadian Agricultural Partnership. Coordinating LEAP activities with these

other programs has allowed us to leverage the work of many and bring it to bear on the challenge of phosphorus management in Lake Erie.

The LEAP's collaborative foundation will be key to achieving continued progress under the five categories of action: reduce phosphorus loadings; ensure effective policies, programs and legislation; improve the knowledge base; educate and build awareness; and strengthen leadership and coordination. With guidance and in partnership with Indigenous partners, we will strengthen our ability to apply Traditional Ecological Knowledge and Indigenous ways of knowing as we continue to implement the LEAP. With new insights, tools, and working relationships now in place, we are well positioned to build on the momentum of the first LEAP cycle and ramp up actions to reduce phosphorus loads. Enhanced action tracking will allow us to link on-the-ground activities targeted to high-risk sources with associated phosphorus load reductions. We will maintain and strengthen actions that are working well and extend existing partnerships and engagement across the basin.

The LEAP will continue to be rooted in an adaptive management approach. The LEAP implementation team will regularly share progress and findings with the public (e.g., updates to the LEAP Status of Actions, webinars and workshops), and at the end of the next cycle we will once again review and update the action plan to respond to observed outcomes, new science and information, and evolving priorities. As we test and confirm effective management approaches, we will continue to update the plan and add actions as they emerge through the adaptive management process. Building on the actions and findings from the first LEAP cycle, our work in the next cycle will be guided by the following priorities:

- **Priority 1: Continue to target reductions at high-risk phosphorus loading sources, with a focus on the Thames River watershed, the Sydenham River watershed, and the Leamington/ Kingsville area of the Lake Erie basin**. While we will continue to implement and enhance phosphorus reduction actions across the watersheds, it is clear more work is needed, especially in these priority areas. Advanced management approaches, such as precision conservation, and multi-scale modelling tools can be used to tailor actions to site conditions, identify types of BMPs (e.g., agricultural, municipal, natural heritage), and will allow us to evaluate the cumulative effect of those actions in achieving binational and domestic phosphorus loading reduction targets.

- **Priority 2: Continue to prioritize efforts that address the seven LEAP phosphorus loss pathways:** livestock management, field crop management, greenhouse management, urban stormwater management, municipal and tile drainage systems, natural areas management, and land user behaviour and adoption of BMPs. Focusing our ongoing efforts on these seven LEAP pathways will be key to achieving phosphorus load reduction targets.

- **Priority 3: Continue to build understanding of how individual management practices, and combinations of practices, work to reduce phosphorus.** We will use the best available monitoring, modelling, science and decision support tools to guide action and investments at various scales including watershed and field scales. We will assess the performance of management practices under different conditions through monitoring and modelling. Where and how are they most effective? What might cause them to be less effective? What are the climate change considerations when implementing these practices? Are there optimal groupings or placements for such actions? How much phosphorus would be reduced if a given action, or combination of actions, was implemented?

- **Priority 4: Seek out and emphasize measures that provide multiple benefits.** We know that reducing phosphorus loads to Lake Erie has many benefits. LEAP partners support, fund and/or promote management practices to reduce phosphorus loss resulting in cost savings and co-benefits to the Canadian Lake Erie community. In this first LEAP cycle, we were able to demonstrate that management practices to reduce phosphorus loss resulted in several co-benefits, such as cost savings in water treatment, protection of stormwater infrastructure, erosion reduction, and enhanced soil health. Additional co-benefits include carbon sequestration, reduced greenhouse gas emissions and enhanced biodiversity. In the next LEAP cycle, the LEAP Implementation Team will strive to boost implementation by leveraging other initiatives and funding programs that have co-benefits in addition to reducing phosphorus.
- **Priority 5: Continue to expand the LEAP partnership to include more municipalities, agricultural organizations, and other key partners** who are committed to supporting the LEAP. Expanded LEAP partnerships will be used to prioritize and enhance opportunities for LEAP actions and to collaborate and recognize partner accomplishments and participation.
- **Priority 6: Actively work to support and strengthen First Nations and Métis participation in implementing the LEAP** through existing mechanisms and new partnerships. For example, Canada's Great Lakes Freshwater Ecosystem Initiative is working to enhance First Nations and Métis capacity to implement on-the-ground actions and plans that restore and protect Great Lakes water quality and ecosystem health, conduct science and monitoring that informs decision making, and participate in Great Lakes governance. Through its Great Lakes Program, Ontario will continue to build relationships and support on-the-ground actions led by First Nations and Métis to support the LEAP.

4.0 COMMITMENT TO ACTION

When the LEAP was released in 2018, it was evident that significant action was required across the Lake Erie basin to meet phosphorus reduction targets. This remains true today. A lot more work and sustained efforts are needed to reduce phosphorus loads to Lake Erie.

As an example of Canada's commitment, the Great Lakes Freshwater Ecosystem Initiative will greatly enhance support for on-the-ground actions following the Precision Conservation approach, which involves targeting implementation of phosphorus load reduction measures in critical source areas for nutrient loss, as well as increasing participation in the application of phosphorus load reduction measures by demonstrating innovative approaches for implementing BMPs, and filling knowledge gaps through research and science.

Ontario's Great Lakes funding program and other complementary initiatives continue to support LEAP partners in implementing key initiatives such as the LEAP Multi-scale Ensemble Watershed Framework, LID / green infrastructure installations, watershed management plans, First Nations technical programs, and First Nations Youth Stewardship programs.

As part of Ontario's 2023 Budget: Building a Strong Ontario, the Ontario government announced funding to implement the Soil Resource Inventory and the development of the Ontario Agricultural Soil Information System, which are two key actions that contribute to the implementation of the Soil Strategy and the Grow Ontario Strategy. Healthy soil helps protect water quality by retaining nutrients that may otherwise run off the land into adjacent streams and lakes. Agriculture-specific programming

will continue through the Sustainable CAP to support farmers in making agricultural lands more productive, environmentally sustainable, and resilient to the impacts of climate change. The funding includes the ASI and the Resilient Agricultural Landscape Program[5]; and support for the ONFARM program.

This first LEAP adaptive management cycle has demonstrated what effective governance, coordination and collaboration across sectors can achieve in making progress toward a common goal. It also highlighted the challenges to progress and a continued need for focused and strengthened actions to keep phosphorus on the land and out of the waterways. Equipped with improved understanding, new tools, and a broad and actively engaged network of partners, the LEAP is well positioned to guide action to further progress towards achieving its goals, including phosphorus reduction targets.

5.0 LEAP PARTNERSHIP: AGENCIES, ORGANIZATIONS AND COMMUNITIES

The implementation of the LEAP is, and will continue to be, a collective effort between Canada, Ontario and LEAP partners. The following lists agencies, organizations and communities who support LEAP partnership implementation through delivery of implementation actions, or participation on the LEAP Implementation Team or LEAP task teams. It also includes partners who have provided input and support on LEAP implementation in the past, or other LEAP-related COA and GLWQA efforts in the Canadian Lake Erie basin.

Canada

- Environment and Climate Change Canada, including the Canada Water Agency Branch
- Agriculture and Agri-Food Canada

Ontario

- Ministry of the Environment, Conservation and Parks
- Ministry of Natural Resources
- Ministry of Agriculture, Food and Agribusiness

First Nations

- Aamjiwnaang First Nation
- Bkejwanong Territory (Walpole Island)
- Caldwell First Nation
- Chiefs of Ontario
- Chippewas of the Thames First Nation
- Eelunaapeewi Lahkeewiit (Delaware Nation)
- Mississaugas of the Credit First Nation
- Munsee-Delaware Nation
- Oneida Nation of the Thames

[5] Resilient Agricultural Landscape Program is a federal-provincial-territorial program which for Ontario, includes $56.7 million in funding, over five years to support ecological goods and services provided by the agricultural sector with a focus on actions that measurably reduce greenhouse gas emissions and sequestering carbon.

- Six Nations of the Grand River

Métis

- Métis Nation of Ontario

Municipalities

- City of London
- Municipality of Leamington

Conservation authorities

- Conservation Ontario
- Essex Region Conservation Authority
- Grand River Conservation Authority
- Lower Thames Valley Conservation Authority
- Upper Thames River Conservation Authority
- St. Clair Region Conservation Authority
- Kettle Creek Conservation Authority
- Catfish Creek Conservation Authority
- Long Point Region Conservation Authority

Agricultural organizations

- Fertilizer Canada
- Grain Farmers of Ontario
- Land Improvement Contractors of Ontario
- Ontario Agri Business Association
- Ontario Federation of Agriculture
- Ontario Greenhouse Vegetable Growers
- Ontario Pork

Non-government organizations

- Alternative Land Use Services (ALUS) Canada
- Ducks Unlimited Canada
- Nature Conservancy of Canada

Interested in supporting the LEAP or joining the LEAP Implementation Team? We welcome new partners who have a shared interest and ability to support actions to reduce phosphorus loads to Lake Erie. For more information or to inquire about joining the LEAP Implementation Team please contact:

Canada: Greatlakes-grandlacs@ec.gc.ca
Ontario: GLO@ontario.ca

ACRONYMS

AAFC	Agriculture and Agri-Food Canada
ASI	Agricultural Stewardship Initiative
BMP	Best management practice
CAP	Canadian Agricultural Partnership (2018 – 2023)
COA	Canada–Ontario Agreement on Great Lakes Water Quality and Ecosystem Health, 2021
COTTFN	Chippewas of the Thames First Nation
ECCC	Environment and Climate Change Canada
FHCU	Farmland Health Check-up
GLPI	Great Lakes Protection Initiative
GLWQA	*Great Lakes Water Quality Agreement, 2012*
IROWC-P	Indicator of Risk of Water Contamination by Phosphorus
LEADS	Lake Erie Agriculture Demonstrating Sustainability
LEAP	Canada-Ontario Lake Erie Action Plan
LID	Low impact development
MECP	[Ontario] Ministry of the Environment, Conservation and Parks
NMS	Nutrient Management Strategy
OMAFA	Ontario Ministry of Agriculture, Food and Agribusiness
ONFARM	On-Farm Applied Research and Monitoring Program
PPCP	Pollution Prevention Control Plan
PWQMN	Provincial Water Quality Monitoring Network
Sustainable CAP	Sustainable Canadian Agricultural Partnership (2023 – 2028)
SWAT	Soil and Water Assessment Tool