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Division of Surface Water

Ohio Lake Erie Phosphorus Task Force Final Report

Executive Summary

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Acknowledgements

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Executive Summary

Introduction

Following extensive phosphorus reduction efforts initiated in the 1970s, algal blooms in Lake Erie had been largely absent. However, blue-green algae (cyanobacteria) blooms began to reappear in the western basin of Lake Erie in the mid 1990s. A particularly massive bloom of *Microcystis aeruginosa* occurred in 2003 and in 2006, the benthic mat-forming blue-green alga *Lyngbya wollei* began growing profusely in Maumee Bay and washing up along the shoreline. Many shoreline areas around Lake Erie are again experiencing nuisance growths of the filamentous green algae *Cladophora*. Coincidental to the increasing degradation of the lake, Heidelberg University's long term tributary monitoring program noted an increasing trend in the concentration and load of dissolved reactive phosphorus (DRP), also beginning in the mid-1990s.

In consultation with Heidelberg University, Ohio EPA convened the Ohio Lake Erie Phosphorus Task Force in 2007 to review and evaluate the increasing DRP loading trends and the connection to the deteriorating conditions in Lake Erie. The Task Force was charged to identify and evaluate potential point and nonpoint sources and related activities that might be contributing to the increasing trends in DRP. The Task Force included a wide range of participants and presentations by invited experts in a variety of disciplines. This report presents the findings of the Task Force along with recommendations for future management actions for Ohio.

Background

The algal bloom situation in Lake Erie has gotten noticeably worse since the Ohio Lake Erie Phosphorus Task Force was convened in 2007. The *Microcystis* blooms in the western basin in 2007, 2008 and 2009 were extensive. In 2009 the blooms extended into the central basin by September. The increasing eutrophic conditions appear to also be affecting the fishery as walleye and perch hatches were well-below average in all but one year from 2004 through 2009. Initially, increased total phosphorus (TP) concentrations were restricted to the nearshore area. However, over the last five years, TP concentrations have been increasing in the open lake as well. Algal bloom problems have been increasing in the bays of Lakes Michigan, Huron and Ontario as well as in a number of inland lakes across the state and the country. Although it is not clear as to why these blooms are increasing, one commonality appears to be excess nutrients, particularly phosphorus.

The Great Lakes Water Quality Agreement between the United States and Canada established an 11,000 metric tonnes per annum (MTA) total phosphorus load target for Lake Erie to minimize algal blooms in the lake and anoxia in the central basin. To support this goal targets were set at 15 µg/l for the western basin and 10 µg/l for the central and eastern basins.

Rapid implementation of the phosphorus removal programs at sewage treatment plants beginning in the late 1970s led to major reductions of phosphorus entering Lake Erie. The target load was met for the first time in 1981. At that time, agricultural nonpoint sources became the major contributor of phosphorus to Lake Erie and needed to be reduced to consistently reach the target load. Estimates at the time indicated 75 to 90% of the agricultural phosphorus load was attached to sediment particles. The use of no-till and reduced till conservation practices became the dominant cropping practices in northwest Ohio through the late 1980s and early 1990s, especially for soybean and wheat production. Increasing use of streamside buffers and set-aside programs for highly erodible land under the Ohio Lake Erie Conservation Reserve Enhancement Program contributed to reductions in the sediment and associated particulate phosphorus load. By the late 1980s, conditions in Lake Erie had dramatically improved. Phosphorus reduction programs were viewed as a major success story in large scale environmental management (Matisoff and Ciborowski, 2005).

Phosphorus entering Lake Erie occurs in two basic forms: dissolved phosphorus and particulate phosphorus. Together, these forms comprise total phosphorus (TP). Most of the dissolved phosphorus is 100 percent bioavailable, meaning it is readily available to support algal growth. Particulate phosphorus adheres to sediment particles or settles to the bottom and is only about 30 percent bioavailable. Throughout this report, dissolved phosphorus is referred to as dissolved reactive phosphorus, or DRP.

Loading and concentration targets for phosphorus are based on total phosphorus, and most of the available data are a measurement of TP, although the increasing proportion of DRP is likely the primary cause of the algal resurgence. Since 1995, the dissolved phosphorus fraction of total phosphorus has been increasing (Baker, 2007). The long term tributary loading program conducted by Heidelberg University provides the information that the DRP loads and concentrations are increasing. Examination of pollutant loading data for the Lake's major U.S. tributaries suggests that the problem stems not from any increase in the total amount of phosphorus entering the Lake, but instead from changes in the forms of phosphorus entering the lake from its large agricultural watersheds. The Maumee and Sandusky Rivers have the highest DRP loads under high flow conditions, suggesting that nonpoint sources are the most important in these watersheds. In all areas, peak DRP concentrations coincide with peak storm water runoff, particularly in the winter months. In the Maumee and Sandusky Rivers over a 20-year period, 90% of the sediment and phosphorus load was delivered during storm events.

The Ohio Lake Erie Phosphorus Task Force

The Task Force included State program personnel from Ohio EPA, the Ohio Department of Natural Resources, the Ohio Department of Agriculture and the Ohio Lake Erie Commission. Federal agency participation included USDA-Natural Resources Conservation Service, the USDA-Agricultural Research Station, the U. S. Geological Survey and the USEPA-Great Lakes National Program Office. Agricultural interests included the Ohio Farm Bureau and the Conservation Action Project, a not for profit agricultural organization in northwest Ohio. Lake Erie researchers from four Ohio universities also participated as did a representative from the Ohio Academy of Sciences. In addition, the Task Force included a representative from the Northeast Ohio Regional Sewer District. Experts in a variety of disciplines were invited to provide additional insight into issues beyond the expertise of Task Force members. The Task Force also sought out data and information from peer-reviewed publications.

The goals of the Task Force were to:

- identify and evaluate potential point and nonpoint sources of phosphorus;
- identify possible changes since the mid 1990s that could increase DRP loads;
- consider the impacts of zebra and quagga mussels in altering the internal cycling of phosphorus in the lake;
- compare *relative contributions* from possible sources;
- identify research and monitoring needs; and
- recommend management actions.

The Task Force took a broad-based approach in analyzing potential contributing factors related to the observed increasing dissolved phosphorus and the resurgence of algal blooms in the western basin of Lake Erie. The complexity of the dynamics of phosphorus as it moves over and through the land surface and its transport through water systems became readily apparent to the Task Force. While no modeling or monitoring efforts were undertaken on behalf of this analysis, the Task Force was able to assess different sources utilizing existing data and information to identify their relative contributions.

The list of potential sources of phosphorus contributions include:

- Point sources
    - Wastewater treatment plants, combined sewer overflows and bypasses, industrial discharges, home sewage treatment systems
- Urban/residential
    - Lawn care fertilizers, storm water, orthophosphate in treated water, dishwasher detergent
- Agriculture
- Transport mechanisms
    - Subsurface drainage, surface runoff
- Internal loading and recycling processes

Point Sources

These sources include loading data from permitted municipal and industrial discharges, estimates of combined sewer overflow (CSO) loads and home sewage treatment systems. Overall, annual point source phosphorus contributions from Ohio to Lake Erie are approximately 796 MTA. These estimated loads are significant, considering the fact that most of the phosphorus from point source loads is DRP and thus bioavailable. However, this load has remained fairly consistent since 1981 and is not considered to be a significant contributor to the recent increases in DRP loads measured in Ohio's Lake Erie tributaries.

Recommendations for future actions relative to phosphorus point source loads include: 1) maintain an effective permit compliance and enforcement program for NPDES-permitted facilities of all types; 2) maintain timely issuance of discharge permits; 3) support implementation of Long Term Control Plans to eliminate CSOs, sanitary overflows and bypasses; and 4) evaluate the need to further reduce phosphorus concentrations in effluents based on the findings of TMDL studies, watershed plans, and the Lake Erie Lakewide Management Plan (LaMP).

Specific recommendations for home sewage treatment systems include: 1) Establish statewide rules for home sewage treatment system management to provide program continuity across the state; 2) design systems for proper treatment (not off-site disposal) of household sewage; 3) ensure proper design and siting of systems based on soil and site characteristics combined with an inspection and maintenance program; 4) minimize the use of off-lot discharge; and 5) develop training and continuing education programs for system designers, installers, inspectors, regulators, and operators.

Nonpoint Sources: Urban/residential

Urban and residential sources considered by the Task Force included storm water runoff, lawn care fertilizers and orthophosphate in treated drinking water. Overall, urban land accounts for a small percentage of land area in northwest Ohio (8 to 14 percent).

Storm water runoff from urban areas is a source of phosphorus loading that can be locally significant. Phosphorus in urban runoff is generated from multiple sources including sediments from erosion, fertilizers, detergents, leaves and other detritus, lubricants, animal waste (e.g., from Canada geese and pets) and organic and inorganic chemical decomposition (Carpenter et al., 1998; and Burton and Pitt, 2001). The Task Force concludes that any phosphorus contribution from urban runoff may have localized impacts, but is likely not a significant contributor to the algal blooms in the western basin. Targeting strategies to address local impacts will best be realized with existing permitting programs supported by more comprehensive monitoring on the use of storm water BMPs.

Turf or sod, is defined as the managed surface layer of soil, grass and the matted roots of the plants. Turf includes home lawns, roadsides, park areas, golf courses, schools, sports fields, sod farms, airports, cemeteries, churches, commercial properties and other general areas. Phosphorus runoff losses from turf have been found to vary directly with application rate (e.g., lbs. of product/1000 ft2) (Shuman 2001; 2003). Typical commercial fertilizers for lawns contain low concentrations of inorganic phosphorus, but is highly soluble.

Given the low ratio of turf land area to row-crop agriculture land area in the Ohio Lake Erie basin, the relative contribution of DRP load to Lake Erie from turf is likely to be low. The Task Force recognized the importance of BMP education for citizenry in urban settings, and also recognized recent efforts between the home and garden fertilizer industry and various states (e.g., Florida and Minnesota) to lower or eliminate phosphorus from home lawn products. Lawns or other turf systems located close to surface waters or Lake Erie could be the cause of localized impairment and algal blooms and should be the primary focus of outreach to citizenry.

In the mid 1990s new rules for public water supplies mandated the use of anti-corrosive agents to prevent lead and copper from leaching out of the pipes at levels potentially harmful. These agents work by forming a protective coating on the pipes. Most public water supplies began adding phosphate-based inhibitors (phosphate, orthophosphate, polyphosphates, and zinc orthophosphate) to accomplish this starting in the mid-1990s.

The service area for wastewater treatment plants (WWTPs) can generally be assumed as the same for public water supplies. In general, approximately 80% of the water distributed from a public water supply will end up at a WWTP. An assessment of total phosphorus effluent concentrations at WWTPs across the basin indicates that there has been no significant increase in the overall loading from these plants in the time period following the addition of phosphates to drinking water. Based on the estimates for WWTP effluent loads and the direct contribution to Lake Erie from losses in the distribution system, the addition of orthophosphate to drinking water is considered to be a low-magnitude source.

Agricultural

The majority of annual phosphorus loading to Lake Erie has been documented to be from the storm-pulsed runoff from the landscape into the tributaries that drain to Lake Erie. The connection to weather events makes these loads highly variable from week to week and year to year. The high percentage of agricultural land use in the western basin of Lake Erie (60-80%) in conjunction with the high DRP loads from the Maumee and Sandusky River basins led the Task Force to review available information and data on the following agriculture sources and practices to evaluate the relative contribution of phosphorus loading to Lake Erie:

- Historical trends
- Fertilizer management in row crop agriculture
  - Commercial inorganic phosphorus fertilizer
  - Manure phosphorus fertilizer
  - Biosolids as fertilizer
- Glyphosate
- Soil tests and the Phosphorus Index
- Fall and winter fertilizer application

An interesting finding of the Task Force is the observation that phosphorus inputs from both commercial fertilizer and animal waste roughly equal phosphorus outputs (e.g., removal) by crop production, based upon current estimates of crop acres and productivity, state-wide fertilizer sales trends, and manure generated from animal production in the state of Ohio. This “phosphorus balance” has not existed in Ohio historically and is likely the result of several factors, including higher fertilizer prices, decreased animal numbers, improved crop productivity, newer crop varieties and hybrids, and increased awareness of nutrient management.

Despite this net balance of TP, the DRP load to Lake Erie continues to increase, suggesting that changes in agriculture are having an effect on the delivery of DRP to Lake Erie. Given that the land use in northwest Ohio is predominantly agricultural (60-80%), nutrient inputs to the Lake Erie watersheds need to be managed carefully to minimize the runoff potential and delivery to the Lake Erie ecosystem.

The Task Force compiled estimates on the usage of fertilizers in row crop agriculture in the Ohio Lake Erie watershed. These estimates indicate that commercial inorganic fertilizers contribute about 66%, animal manure about 27%, and biosolids from WWTPs about 7% of the total amount of fertilizers being applied in the watershed in recent years.

A key observation for the Task Force was that soil-nutrient interactions are critical to understanding nutrient movement. Phosphorus in soil fluctuates between dissolved and solid forms as it continually strives to reach chemical equilibrium. The mineralogy of the soils is the primary driver influencing the solubility of phosphorus. The addition of soluble phosphorus minerals (e.g., fertilizer), as well as plant uptake of soluble phosphorus, all serve to disturb the chemical equilibrium, resulting in variable phosphorus solubility in the soil.

The Task Force considered these dynamics as it analyzed factors that influence relatively low soil test phosphorus levels while tributary loading data for soluble phosphorus can be high, particularly during high flow events. Many factors can influence this scenario, including surface application of fertilizer without incorporation, soil tests from composite samples that are taken at a depth below the zone of effective run-off, and the timing of significant rain events shortly after fertilizer application, particularly on frozen ground.

Part of the charge to the Task Force was to evaluate what has changed since the mid-1990s that may be drivers to the increases in DRP. The Task Force identified a number of recent trends in agriculture that may be influencing nutrient movement. While none of these trends can be directly linked to the mid-1990s, the Task Force believes that in the aggregate, they contribute to the change in the annual increases in DRP loading.

Some of the aspects that may be influencing changes in nutrient movement include:

- More fall preparation of seedbeds for spring planting (also known as stale seedbeds).
- Larger farms and larger fields have resulted in changes in the type and size of equipment used. Planters and tillage equipment range from 30 to 120 feet in width compared to those 12 to 24 feet in width used in the 1970s. Larger equipment may increase soil compaction and run-off. Larger farms also require spreading the work load over the year to optimize labor and equipment availability, increasing the tendency of applying fertilizer after crop harvest (fall and winter).
- Changes in drainage and runoff related to installation of surface drainage systems, installation of additional subsurface drainage on closer spacing, enlarging fields and removing fencerows, and utilizing tillage practices that minimize surface roughness.
- Changing methods, amount, form, placement and timing of nutrients, such as more surface application of nutrients with less incorporation, instead of using row fertilizers.
- Unknown and uncertain use of soil testing to assess field nutrient levels prior to application, and unknown and uncertain adherence with nutrient application recommendations.
- Changes in soil quality, such as decreasing soil organic matter content, soil tilth and infiltration rates, and increasing compaction, soil densities and aggregation.
- Phosphorus build-up (stratification) in the upper two inches of the soil may result in increased DRP concentrations in runoff water. Stratification can result from surface application of fertilizer and manure and the phosphorus releases from the breakdown of crop residues in the soil surface. Further study is needed on the extent of stratification and its potential role in DRP in runoff.

Positive changes in nutrient management include utilizing precision farming and grid sampling, which result in more detailed specificity in the application of fertilizers designed to meet agronomic needs. However, these practices have not been adopted at a scale sufficient to counteract excessive nutrient movement.

Task Force participants readily acknowledge that these trends are having significant impact on agricultural management. Agricultural producers, as well as the consultants and fertilizer dealers that advise producers, all face challenging demands that affect field management decisions on an annual basis. Costs, product availability and inventory limitations affect both dealers and farmers decisions on when to apply fertilizer to meet upcoming crop needs.

These trends are nearly impossible to quantify in terms of their contribution to nutrient movement from fields to the western basin of Lake Erie. The research recommendations presented in the full report will address many of the knowledge gaps. But the Task Force also acknowledges that much needs to be done to address nutrient management in the near term to address the issue of algal blooms.

The ability of soils to adsorb phosphorus and the soil nutrient interactions for many of the over 400 soil types in Ohio (especially the lakebed soils of the Lake Erie basin) are not well known and will require additional research. Current tools to assist agricultural managers with nutrient management include the use of soil tests and other screening tools to predict nutrient loss from a given field. These tools provide managers with the data and assessment of field-based conditions to guide nutrient inputs to agricultural fields. While these tools have been in use for many years, their application needs to increase significantly to adapt nutrient management practices to highly variable and frequently changing conditions.

While recognizing the dynamic, highly weather-related, complexities of managing soil nutrients in run-off, we nonetheless recommend several Best Management Practices (BMPs) for near-term implementation:

- Base nutrient applications on accurate soil testing according to Ohio State University recommendations for frequency and sampling methodology;
- Follow Tri-State Fertility recommendations for application of nutrients to attain targeted crops and yields;
- Apply fertilizer and manure to a growing crop or cover crop whenever possible.
- Minimize nutrient movement off site by avoiding frozen and snow-covered ground applications and incorporating nutrients into soil when/where possible;
- Utilize and install more effective hydraulic buffers (such as filter areas, wetlands, controlled drainage, cover crops and other recommended practices: see Appendix B) designed to reduce the rate and amount of water leaving the landscape and to filter and treat nutrients moving from the field to and through surface and subsurface drainage systems, waterways, streams, and rivers, and
- Encourage and promote other recommended BMPs for nutrient management (Appendix B).

Transport Mechanisms

In addition to identifying sources of phosphorus to the aquatic system, the Task Force evaluated how phosphorus moves into a stream before it reaches Lake Erie via subsurface drainage, surface drainage, and channelized streams and ditches. The successful transition to reduced and no-till farming is highly dependent upon effective water management within the soil profile by using these practices. An agriculture census survey conducted in 1992 by the U.S. Department of Agriculture shows that northwest Ohio had the highest percentage of drained cropland in the Midwest region. All northwest Ohio counties, as well as those Indiana counties that drain to Lake Erie, are shown to have between 60.1% and 100% of cropland drained by subsurface tile. The lack of available data on surface and subsurface drainage practices however, prevents any more thorough analysis of the scale of this contribution to the increases in DRP loading to the western basin of Lake Erie.

The Task Force recommends that complementary practices (such as tile drainage control structures and management, and other hydraulic/treatment buffers) be promoted to facilitate more widespread adoption of BMPs that ameliorate water quality impairments attributable to subsurface drainage. The Task Force also recommends that all surface drainage systems be evaluated to determine which complementary BMPs can best ameliorate the water quality issues caused by pollutants carried by surface drainage systems. Lastly, the Task Force recommends that more extensive research be conducted on sampling discharges from tile drain systems, incorporating data on the land management variables that contribute to the quality of tile drain discharges.

Internal Loading and Recycling Processes in Lake Erie

Once phosphorus is delivered into Lake Erie, it is subject to a complex series of in-lake processes, including physical transport, biological uptake, and chemical transformations and reactions before deposition onto the sediment.

There are three types of internal phosphorus cycling in Lake Erie. First, much of the phosphorus that is loaded to the Lake is delivered to the western basin, where it undergoes cycling and transport eastward. Second, there are various biological transformations and food chain transfers of phosphorus that recycle the highly bioavailable DRP to organic phosphorus in various trophic levels and the water column, and to organic phosphorus in the sediment. The third type of internal lake phosphorus cycling is regeneration of sediment phosphorus and its transport back into the water column.

About half of the phosphorus that is deposited as particulate organic phosphorus on the sediment surface is regenerated and returned to the water column as phosphate (inorganic phosphorus), especially under anoxic conditions. This is a significant amount of phosphorus and is quantitatively important in the overall phosphorus budget of Lake Erie. Additional research is still needed to better understand factors that affect internal phosphorus cycling in Lake Erie. More importantly, however, is the realization that phosphorus in Lake Erie cannot be managed. The focus of any phosphorus management work must target actions in the watershed to reduce phosphorus sources and loads.

The Task Force acknowledges that phosphorus alone may not fully explain notable increases in algal populations over the past decade in Lake Erie. Other nutrients, such as nitrogen, have been steadily increasing over the years and can be limiting to certain algae.

Summary

The following is a synopsis of key observations made by the Task Force to support the conclusions and recommendations included within this report. The list includes those elements believed to be critical to understanding the current situation and those elements that will have the greatest impact in reducing the delivery of DRP into the western basin of Lake Erie.

Relative Contributions

1. Point source discharges have remained consistent after a rapid drop in the 1970s. Historical discharge monitoring reports do not indicate any increases in phosphorus loadings. Point source loadings are not a major contributor to the increase in DRP.
2. Certain garden care products can contain high sources of phosphorus that can be potentially available to runoff to streams and watercourses. However, most products designed for lawn care have relatively low phosphorus levels. The runoff potential from any of these products is also highly dependent on management practices. Industry reductions in phosphorus content, better package labeling and improved application devices are all serving to minimize this potential even further. Lawn care products may be a contributing source with the potential for local impacts, but overall are not a significant contributor to algal blooms.

3. The invasive species of zebra and quagga mussels have altered the internal phosphorus cycle in the lake. Research continues to quantify this impact as models are being revised to account for the influence of mussels in the lake. While mussels may be having an influence on the internal cycling, the mussels are processing phosphorus input coming in from the rivers draining into Lake Erie. Once reductions in phosphorus loadings are realized, mussels may delay the response in the Lake, but researchers expect their influence will be short-lived.
4. While there are multiple contributors to phosphorus loading, the most significant is the result of runoff from agricultural nutrient applications. There is a lack of evidence that differentiates the relative contribution of commercial fertilizers and the land application of manure. Commercial fertilizer usage varies from year to year and its use outweighs the land application of manure or biosolids by a factor of two to one.

Agriculture

1. Overall, agricultural inputs are down (total number of animal units and lower sales of commercial fertilizer) yet increases in DRP suggest that these inputs must be managed differently. There have been many changes in agriculture that influence the methods, amount, form, placement and timing of nutrient applications. The Task Force concludes that management practices that focus on the application of nutrients will have the greatest potential for reducing the algal blooms in the western basin.
2. Although there are agronomic standards for the amount of phosphorus that soils need for fertility and crop yields, it is not apparent that soil tests are done on a regular basis or that the results are used to guide fertilizer application rates. The Task Force concludes that tools and indices need to be refined to account for crop fertility needs as well as environmental risk. Strategies that will improve nutrient management and reduce the runoff potential include improved soil test methodology, use of precision nutrient management technology, education, consistent recommendations to producers, and better follow-through on the recommendations made for phosphorus application.
3. Precision nutrient management, utilizing management zones prepared from geo-referencing of crop production yield maps, soil maps, and soil testing data, has the potential to more accurately apply phosphorus where needed and to minimize over-application of phosphorus fertilizer, than with current standard practices.
4. Applying nutrients to a growing crop or cover crop significantly increases the chances for nutrients to be taken up and temporarily stored in plant tissue. The growing crop would also reduce soil erosion and increase water infiltration. This would help reduce DRP as well as particulate phosphorus.
5. There is no single agricultural practice that will result in a lowering of nutrient runoff. The reduction of DRP will require a system of best management practices that address the methods of application of commercial fertilizers and manures applied to fields, the amount, form and placement of those fertilizers, and practices that inhibit runoff delivery to local streams. The Task Force has developed a list of recommended BMPs that have been identified as pivotal to reducing phosphorus in Appendix B of the report.

Other

1. DRP loading to Lake Erie has been increasing by large amounts since the mid-1990s and is now reaching historical highs, after dropping substantially during the late 1980s and early 1990s. While there has not been any significant change in average annual rainfall, there have been significant increases in fall and winter runoff. Reductions in snowfall over this period may be contributing to significant runoff, as a result of frozen ground and little to no plant uptake, even under moderate winter rains. Changing seasonal patterns of rainfall and runoff have thus contributed to the increased runoff of dissolved phosphorus to Lake Erie.

2. Stream corridors can provide assimilative capacity for the uptake of in-stream nutrients in stream runoff, but benefits are primarily localized to stream condition. There are no specific recommendations on developing the assimilative capacity through the restoration of stream corridors. The focus of the Task Force was to address phosphorus as a contributor to the increase in algal blooms and the Task Force has concluded that addressing upland measures will yield the most beneficial results.
3. Although DRP is increasing in other monitored tributaries in Ohio (e.g., the Cuyahoga and Grand Rivers), the much higher loads from the Maumee and Sandusky make them higher priority watersheds for reducing impacts to Lake Erie. The concentrations and loads from the Maumee and Sandusky are higher than most other monitored tributaries in the entire Midwest region.
4. Based on past experiences following implementation of the Great Lakes Water Quality Agreement, we believe that reductions in DRP loads into Lake Erie will have expected and desirable benefits. Reductions in DRP inputs could result in near-term responses in ecosystem condition, particularly in the nearshore. Open lake responses may take longer (up to 10 years).

Recommendations

The Task Force developed a variety of recommendations to address nutrient reductions, particularly to the western basin of Lake Erie. The Task Force acknowledges that there are many sources of phosphorus to Lake Erie and much is still unknown to quantify respective loadings. The Task Force opted to include recommendations for all of the sources examined, but the major focus is on upland measures that will influence agricultural practices. In particular, the Task Force recommends a discrete list of recommended best management practices designed to reduce phosphorus, nitrogen and sediment loading. These practices are extracted from the Field Office Technical Guide (U.S. Department of Agriculture – Natural Resources Conservation Service). While these practices have been available for years, the Task Force recommends that new incentives be developed to promote and to encourage their adoption by agricultural producers.

The Task Force has begun the diagnosis of the array of potential sources from Ohio contributing to the algal blooms in the western basin, yet more needs to be fully understood to effectively manage the critical natural resources of Lake Erie. Scientific analyses are needed to: understand the movement of sediment and nutrients through stream systems; target remedial measures to critical pollutant source areas at the watershed level; improve the science of watershed modeling relative to both predicting the extent of agricultural nonpoint pollution and estimating the benefits of targeted BMP adoption; and expand our understanding of the sociology of agricultural pollution abatement. More information is also needed relative to the transport and effects of nutrients and sediments as they move through estuaries, bays, nearshore zones and open lake waters during and following storm runoff events. These analyses are needed so that results can be applied to the most effective melding of modern soil conservation methods with advanced nutrient management measures and agricultural water management measures.

The full report includes a research agenda to focus future efforts in answering the critical questions raised by the Task Force's inquiry into the causes and sources of increases to DRP loading into Lake Erie and the corresponding algal blooms. The matrix of recommendations developed by the Task Force is presented as follows. The full report of the Ohio Lake Erie Phosphorus Task Force can be found at *www.epa.ohio.gov/dsw/lakeerie/ptaskforce/index.aspx*.

	TOPIC	ISSUE	RECOMMENDATION	IMPLEMENTATION
Point Sources				
1	Point Source Dischargers	Point source dischargers are required to meet discharge limits under the provisions listed in NPDES permits. Ohio EPA issues the NPDES permits by Water Quality Standards, reviewing discharge data, reviewing records, doing inspections, considering the targets set in the GLWQA (0.5 to 1 mg/l TP), and the recommendations in TMDL reports.	A. Maintain effective permit compliance and enforcement program for NPDES permitted facilities. B. Continue to pursue progress with regard to Long Term Control Plans (LTCP) for Combined Sewer Overflows (CSOs) and Sanitary Sewer Overflows (SSOs). C. Maintain timely issuance of discharge permits. D. Evaluate need to reduce Phosphorus concentration limits in individual NPDES permits based on findings in TMDL reports or other action plans (WAP, RAP, LaMP).	Ohio EPA
2	Home Sewage Treatment Systems	Data collected by the Ohio Department of Health in 2008 indicate that 23% of the household sewage treatment systems are failing with an additional 13% projected to fail within the next 5 years. Soil limitations, substandard or poor designs, space limitations, system age, shallow seasonal water tables and poor operation and maintenance were reported as most common reasons for system failure.	A. A successful household sewage treatment system program for Ohio should be based on the establishment of statewide minimum standards/rules to provide program continuity across all 88 counties in Ohio. B. To protect public health and the environment, household sewage treatment systems must be designed to ensure the proper treatment (not disposal) of household sewage. C. Proper household sewage treatment system siting, design (based on the soil and site characteristics) and installation combined with an inspection and maintenance program will ensure system long-term sustainability and protect public health and the environment. D. The use of off-lot discharge for household sewage treatment systems should be minimized. E. A training and continuing education program for household sewage treatment system designers, installers, inspectors, regulators, maintainers and operators must be established.	Ohio Department of Health and Local Health Districts

	TOPIC	ISSUE	RECOMMENDATION	IMPLEMENTATION
Nonpoint Sources: Agriculture				
3	Current agronomic recommendations (Vitosh et al. 1996).	The current agronomic recommendations for rates of P usage are considered to be valid; however, it is apparent that some fraction of the farming community is either over- applying or applying P without proper consideration to timing or methods of application, contrary to Tri-state fertilizer recommendations for corn, soybeans, wheat, and alfalfa (Vitosh et al., 1996).	A. Agricultural agencies and crop consultants need to emphasize (and producers need to follow) the prescriptions called for in the Tri-State recommendations (Vitosh et al. 1996). B. Reinforce through increased training of agency staff, producers, crop consultants, etc. C. Update recommendations as needed, with special emphasis on timing and method application.	ODA, NRCS, OSU, Fertilizer dealers, Crop Advisors, producers
4	Soil Tests – increase usage	There is limited usage of soil tests for environmental purposes. Insufficient use of soil tests for agronomic purposes results in uncertainty as to how much cropland in Ohio is regularly soil tested.	A. Develop incentives to encourage more soil testing. B. Promote wider adoption of soil testing with a goal of getting a higher % of cropland tested C. Expand soil test procedures to include water extractable solubility, P-saturation and stratification in order to expand the base of knowledge and gain additional data sets to understand risks of P transport.	• Conservation Stewardship Program (CSP) • Special projects to emphasize nutrient management (e.g., EQIP) • Broader outreach (watershed groups, SWCDs, Extension, CCAs)
5	Linkage of soil test results to fertilizer recommendations and actual application.	Basis for recommendations from soil labs and crop consultants to guide decisions by producers with respect to P application rates and methods are currently unknown.	Conduct needs assessment of the soil labs, CCAs and others (Extension, landowners, unaffiliated consultants) to learn the basis of P recommendations given with soil test results	Currently funded by the Lake Erie Protection Fund

	TOPIC	ISSUE	RECOMMENDATION	IMPLEMENTATION
6	Reliability, availability and comparative usefulness of soil test laboratory results	Reliability of some soil test results remains questionable in the absence of sampling technique standardization • In order to validate program effectiveness, we need more access to soil test data from laboratories • We also need access to collection methods data to analyze them as one factor in soil test reliability	Encourage and support development and implementation of a soil P analytical lab certification program A. Establish a central clearinghouse of soil test results to: • analyze trends and levels • identify number and location by watershed of tests taken utilizing GIS capabilities • identify problem areas and targeted watersheds B. Standardize collection methods C. Standardize analytical methods D. In the absence of a state-sponsored certification program, the agencies should consider requiring data come from certified labs allowing the industry (laboratories) the flexibility of implementing their own certification requirements. E. Review the Wisconsin "discovery farm" experience (*www.uwdiscoveryfarms.org*) and the Ontario example.	TBD
7	P-runoff risk screening tool for farmers (expansion of Soil Test Risk Assessment Procedure in the NRCS *Section 1, Field Office Technical Guide*)	There is a need for development of a simple tool to be used in the field for a rapid determination of risk of P transport to surface water. A screening tool would serve as a precursor to the more detailed analysis of the P Index.	Develop and implement a P-Risk Screening Tool that includes: • potential for off-site P transport; • seasonality/weather conditions; • runoff and erosion potential to surface waters; • distance/connectivity to surface inlets and subsurface drainage systems to surface waters; • P solubility; and • soil test data (including stratified data where available).	USDA NRCS Recommendations #6 and #7 are to be considered together for purposes of developing and providing the most effective tools for consultants and landowners to make field application decisions that address crop yields and environmental concerns

	TOPIC	ISSUE	RECOMMENDATION	IMPLEMENTATION
8	Phosphorus Index (as defined in the NRCS *Section 1, Field Office Technical Guide*	The current phosphorus index in use by the NRCS is a comprehensive tool that is in need of updating.	A. Recommend revisions as needed to the P Index to NRCS if warranted based upon: • data from last 10 years • the need to make the P-Index more quantitative to risk of P runoff from site • include a dissolved P component B. Validate as specific to Ohio	USDA NRCS; project team underway
9	Promotion of phosphorus management using improved assessment tools	How to get P runoff assessment tools used more often and to be more useful.	A. Emphasize incorporation of fertilizer and manure B. Discourage application of manure and P-containing fertilizer unless P-Index/Soil Test Risk Assessment Procedure score is below a value that is determined to be acceptable. C. Promote the use of the P runoff risk assessment tools in nutrient management plans D. Promote potential economic benefit of Phosphorus management E. Develop incentives in State and Federal programs to increase usage of updated assessment tools such as: • Tax/rebates associated with P sales • Incentives directed at crop consultants	
10	Promotion of Recommended BMPs (see Appendix B)	Priority practices for nutrient management are currently available with existing cost share programs. However, these BMPs are not fully optimized by producers. Recommended BMPs for nutrient management need to be more strongly advocated with alternative approaches.	Recommend that cost-share agencies develop innovative approaches to agricultural programs such as: • linking the use of the P Index and/or a screening tool to allocating funds for adoption of BMP practices • explore on farm challenge projects (e.g., American Farmland Trust BMP Challenge Program) • identify options to more fully support Recommended BMPs that address nutrient management	Cost-share agencies and other technical assistance entities include: FSA, USDA-NRCS, DNR-DSWC, TSPs, CCAs, OSU-Extension Available agricultural agency resource concerns are significant. Other financial mechanisms to promote implementation of Recommended BMPs in targeted areas.

	TOPIC	ISSUE	RECOMMENDATION	IMPLEMENTATION
Nonpoint Sources: Urban and Residential				
11	Contributions of P from dishwasher detergent	SB 214 has been introduced to the Ohio legislature. If adopted, SB 214 would ban phosphorus from dishwasher detergents.	The P Task Force recommends passage of this legislation.	Legislation passed in 2009, effective as of July 1, 2010
12	Lawn care fertilizers	The Task Force considers P contributions to increasing algal blooms in Lake Erie from lawn care fertilizers to be low, but contributions could be locally significant as a result of the misapplication of lawn care products.	Identify opportunities to support low-P lawn care products and proper stewardship of product recommendations. A. Develop an MOU between the State of Ohio and lawn care manufacturers and service providers to achieve a reduction in pounds of phosphorus applied in lawn care products for all 88 Ohio counties. B. Support education and outreach targeted to homeowners to implement appropriate stewardship practices in the use of lawn care fertilizers.	Recommended Lawn-Care BMPs 1) Select low or no P fertilizer: Apply a product with an N-P-K formulation of 26-0-3. 2) Choose fertilizer designed for lawns**.** The word “lawn or turf” should be on the label. “All purpose” formulations should be avoided for lawn use. 3) Read and follow label directions**.** Reduce spreader setting to that recommended on product label. Over application can harm water quality and the lawn health. 4) Keep fertilizer off of walks and driveways to reduce loss to storm sewers and streams. Use drop spreader with deflector to keep fertilizer on lawn. 5) Mow lawn at the highest setting and leave the grass clippings on the lawn. Mowing high allows the grass to develop a deep root system that retains and uses water more efficiently. Returning clippings recycles nutrients. 6) Fertilize in spring after first cutting and in the fall after Labor Day and before Halloween**.** Only apply fertilizer when grass is growing enough to be mowed, and before dormancy. 7) Soil tests can help determine if other nutrients are needed.

	TOPIC	ISSUE	RECOMMENDATION	IMPLEMENTATION
13	Transport Mechanisms	Subsurface drainage, surface drainage and channelized streams and ditches -are contributing factors to the transport of DRP. Lack of available data prevents a thorough analysis of the relative contribution.	A. Support the recommendations of the Ohio Rural Drainage Committee. B. Promote/encourage complementary practices to surface and subsurface drainage practices to address potential delivery of DRP to streams. C. Conduct data collection on drainage intensity via the ag census and/or survey. D. Conduct research on sampling discharges from tile drain systems. E. Further develop BMP effectiveness analysis to guide BMP selection.	State and federal agricultural agencies
Other				
14	Public Education and Involvement	Education of residents about harmful algal blooms and local actions needed to address this problem on a long term basis.	A. Ohio EPA should work with sister agencies to coordinate the delivery of Phosphorus Task Force recommendations for public outreach and education utilizing current programs to the extent possible. Where gaps exist, funding should be sought to fulfill identified needs. B. Ohio EPA and ODNR should seek funding that will result in the development and implementation of new Watershed Action Plans and updates to existing plans to fully address Phosphorus Task Force recommendations in the Lake Erie basin.	Ohio EPA and ODNR; other state, academic and local partners

	TOPIC	ISSUE	RECOMMENDATION	IMPLEMENTATION
15	Research agenda for Ohio	Current research projects underway will yield valuable results in understanding the science and mechanisms in the movement of phosphorus and its impact to Lake Erie. The Task Force recommends an integrated, interdisciplinary approach to current and future projects to maximize the application of results to an adaptive management approach in addressing phosphorus delivery to Lake Erie.	A. Develop a research agenda designed to: • identify specific P reduction targets for the western basin; • identify nearshore targets; • identify potential linkages of DRP levels with rainfall intensity; • identify (any) direct linkages of DRP and harmful algal blooms; • determine extent of contributions of P from internal cycling; and • impacts of P stratification in soil. B. Develop a Discovery Farm and/or Watershed in Ohio (based upon the Wisconsin model) to demonstrate results from research (both agricultural and environmental) and linkages between land and water. C. Expand soil test procedures to include water extractable solubility, P-saturation and stratification in the soil to expand base of knowledge and data set to estimate the risk of P transport from a given site. D. Develop and implement a P-Risk Screening Tool (as described in #6). E. Validate the P-Index (as developed in #7). F. Develop new BMPs to minimize Phosphorus movement from the landscape where risk of P transport is known to be high.	See Section 10
16	Phosphorus Water Quality Standards for streams	Need WQ standards for TP and DRP; Need to consider loading standards vs. concentration standards.	A. Ohio EPA should monitor or require monitoring for dissolved phosphorus. B. Adopt and update nutrient standards for water quality. C. Develop standard operating procedures for dissolved phosphorus samples in runoff.	Ohio EPA and U.S. EPA
17	Create an Ohio Research Advisory Committee	The State of Ohio would benefit from a coordinated effort among researchers and program managers to assess research needs in Ohio	Form a committee of applied interdisciplinary researchers (including managers, users, academia).	This committee would address the research needs identified in Recommendation #15 above

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