Phosphorus Reduction Implementation Plan for Strawberry Lake

October 2011 — September 2016

For the purpose of achieving the Total Maximum Daily Load (TMDL) and removing the nutrient impairments of Strawberry Lake

Developed by and for the Livingston Watershed Advisory Group (WAG).

October 2011

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TABLE OF CONTENTS

1. Background

The drainage area which provides water to Strawberry Lake is located in the upper Huron River Watershed in Livingston County (Figure 1). This 257 acre (104 ha) lake is the upmost lake in a chain of other lakes including Strawberry, Gallagher, Whitewood, and Baseline Lakes. Strawberry Lake is also situated downstream of four other lakes including Brighton, Kent, Limekiln, and Ore Lakes.

Problem Definition

Based on water quality studies performed on Strawberry Lake in the 1970s and 1990s, MDEQ determined that that although the lake had improved water quality from 1970s levels due to reallocations of phosphorus discharge by point sources, increased nonpoint source loading is threatening to negate these improvements. According to the MDEQ studies, nonpoint source phosphorus loads account for about 85 to 90% of all total phosphorus loads to Strawberry Lake (Alexander, 1998).[1]

In response to these findings, MDEQ listed Strawberry Lake as *threatened* on the State's 1998 303(d) list of impaired waters requiring Total Maximum Daily Load (TMDL) establishment due to excess nonpoint source phosphorus loading from upstream sources. A TMDL is the maximum amount of a particular pollutant a water body can assimilate without violating numerical and/or narrative water quality standards.

The threatened status was assigned to Strawberry Lake because of the increased developmental pressures in the subwatershed that threaten to increase the contribution of nonpoint source pollution, resulting in an expected violation of the State's narrative water quality standards. As a result of extensive field studies, MDEQ established a TMDL of 25 micrograms per liter (μg/L) phosphorus concentration to assure satisfactory water quality for Strawberry Lake (Alexander, 2000).[2]

The Nature and Sources of Phosphorus[1]

Phosphorus (P) is an essential nutrient for all life forms, and is the eleventh-most abundant mineral in the earth's crust. In surface waters, phosphorus is usually present as phosphate (PO_4-P). Phosphorus is needed for plant growth and is required for many metabolic reactions in plants and animals. Organic phosphorus is a part of living plants and animals, their by-products, and

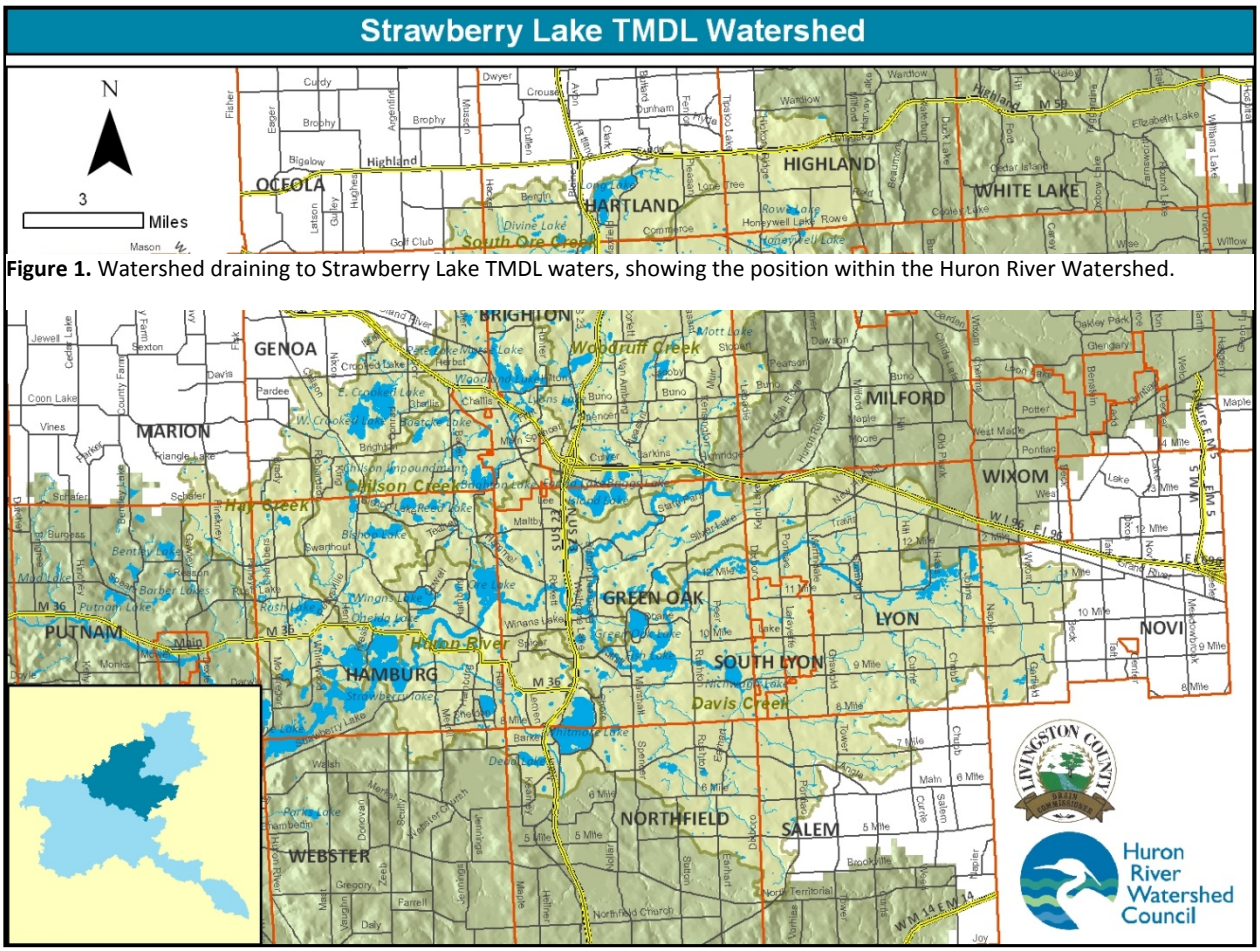


Figure 1. Watershed draining to Strawberry Lake TMDL waters, showing the position within the Huron River Watershed.

their remains.

Generally, phosphorus is the limiting nutrient in freshwater aquatic systems. That is, if all phosphorus is used, plant growth will cease, no matter how much nitrogen is available. Phosphorus typically functions as the "growth-limiting" factor because it is usually present in very low concentrations. The natural scarcity of phosphorus can be explained by its attraction to organic matter and soil particles. Any unattached or "free" phosphorus is quickly removed from the aquatic system by algae and larger aquatic plants.

Excessive concentrations of phosphorus can quickly cause extensive growth of aquatic plants and algal blooms. Several detrimental consequences may result. Surfeit algae and plant growth can lead to depletion of the oxygen that is dissolved in the water. Water can hold only a limited supply of dissolved oxygen (DO), and it comes from only two sources — diffusion from the atmosphere and as a byproduct of photosynthesis. Excessive growth leads to depletion of DO because of nighttime respiration by living algae and plants and because of the bacterial decomposition of dead algae/plant material. Extensive bacterial decomposition of detritus can create “dead-zones”, or areas of anaerobic conditions, especially near the bottom of the water column. Depletion of DO adversely affects many animal populations and can cause fish kills due to a dearth of this metabolic necessity.

In addition to low DO problems, excessive plant growth can increase the pH of the water because plants and algae remove dissolved carbon dioxide from the water during photosynthesis, thus altering the carbonic acid-carbonate balance. Because plants and algae provide food and habitat to animals, the relative abundance shifts of the different species affects the composition of the animal community. Drinking water supplies may experience taste and odor problems, and the costs of treating drinking water can increase.

Finally, high nutrient concentrations interfere with recreation and aesthetic enjoyment of water resources by causing reduced water clarity, unpleasant swimming conditions, pungent odors, blooms of toxic and nontoxic organisms, interference with boating, and "polluted appearances." The economic implications are significant for many communities. Phosphorus may accumulate in sediment, both in deposited clays and silts and deposited organic matter. In such cases, phosphorus and other nutrients may be released from the sediment in the future. This feedback loop results in internal phosphorus loading that may have originally been deposited in lake bottoms over a period of many years. Subsequently, a reduction in phosphorus input from the nearby streams and larger watershed may not be effective in reducing algal blooms for a number of years.

Phosphorus enters surface waters from both point and nonpoint sources. The primary point source of phosphorus is sewage treatment plants. A normal adult excretes 1.3 - 1.5 g of phosphorus per day. Additional phosphorus originates from the use of industrial products, such as toothpaste, detergents, pharmaceuticals, and food-treating compounds. Primary treatment removes only 10% of the phosphorus in the waste stream; secondary treatment removes only 30%. Tertiary treatment is required to remove additional phosphorus from the water. The amount of additional phosphorus that can be removed varies with the success of the treatment technologies used. Available technologies include biological removal and chemical precipitation.

The cost of subsequent levels of treatment generally increases dramatically as incremental increases in phosphorus removal get smaller.

Nonpoint sources of phosphorus include both natural and human sources. Natural sources include: 1) phosphate deposits and phosphate-rich rocks which release phosphorus during weathering, erosion, and leaching, and 2) sediments in lakes and reservoirs which release phosphorus during seasonal overturns. The primary human nonpoint sources of phosphorus include runoff from: 1) land areas being mined for phosphate deposits, 2) agricultural areas, and 3) urban/residential areas. Because phosphorus has a strong affinity for soil, generally little dissolved phosphorus will be transported in runoff. Instead, the eroded sediments from mining and agricultural areas carry the adsorbed phosphorus to the water body. However, if excessive fertilizer application or other phosphorus amendment is added, dissolved phosphorus can runoff in large amounts. Additional sources are the overboard discharge of phosphorus-containing sewage by boats, and runoff from parking lots and roadways where phosphorus in fuels and oils may wash into storm drains.

TMDL Mandate and Applicable Water Quality Goals and Regulation

Section 303(d) of the federal Clean Water Act and the U. S. Environmental Protection Agency's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop TMDLs for waterbodies that do not meet Water Quality Standards (WQS). Michigan law (R323.1100 of Part 4, Part 31 of PA 451, 1994, revised 4/2/99) mandates that all surface waters be protected for the full range of designated uses. The uses are:

- Agriculture
- Industrial water supply
- Public water supply at the point of intake
- Navigation
- Warm water fishery (or cold water fishery, where applicable)
- Other indigenous aquatic life and wildlife
- Partial body contact recreation
- Total body contact recreation between May 1 and October 31

The designated uses that were originally threatened for Strawberry Lake are total body contact recreation and partial body contact recreation. Rule 100 of the Michigan WQS requires that these waterbodies be protected for total body contact recreation between May 1 and October 31.

The Clean Water Act requires that these water bodies be returned to meeting all designated uses through the TMDL development process. A TMDL quantifies the maximum amount of a pollutant a water body can accept without violating water quality standards. TMDLs are tools for achieving water quality safeguards and assessing the impact of improvements. The MDEQ is required, under Section 303(d) of the federal Clean Water Act, to determine the health of the waters of the state. Those waters not meeting water quality standards are included in the Integrated Report. This report includes the waters that require a TMDL and sets forth a schedule for establishment. TMDL development methodology varies based on the type of pollutant causing impairment.

Rule 60 of the Michigan WQS (Part 4 of Act 451) limits phosphorus concentrations in point source discharges to 1 mg/l of total phosphorus as a monthly average. The rule states that other limits may be placed in permits when deemed necessary. The rule also requires that nutrients be limited as necessary to prevent excessive growth of aquatic plants, fungi or bacteria, which could impair designated uses of the surface water.

According to the MDEQ, phosphorus limits are placed in NPDES permits for all discharges which have the potential to contain significant quantities of phosphorus. The limit of 1 mg/l is contained in permits for discharges to surface waters which do not have substantial problems with high levels of nutrients. More stringent limits are required for discharges to surface waters which are very sensitive to nutrient inputs. Many of these surface waters are in developed areas with substantial point source and nonpoint source phosphorus inputs. In such areas, a waste load allocation may be necessary. The DEQ must determine the total amount of phosphorus (in pounds per day) which can be assimilated into the particular surface water. The DEQ then works with the dischargers to decide on appropriate phosphorus limits for each permit, without exceeding the total assimilative capacity of the surface water.

Phosphorus TMDL for Strawberry Lake

In April of 1998, a 12-month phosphorus loading analysis was initiated by the MDEQ to investigate the water quality of Strawberry Lake and its upstream sources. The analysis showed that Strawberry Lake was threatened to meet water quality standards due to phosphorus enrichment. Based on water quality sampling and accepted mathematical models, a phosphorus TMDL of 25 µg/L for Strawberry Lake was established. According to MDEQ, this value should assure the attainment of water quality standards for the lake in addition to meeting the requirements of Water Quality Standard R 323.1060(2) which states “nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended, and floating plants, fungi, or bacteria which are or may become injurious to the designated uses of the waters of the state.”

Based on two years of scheduled monitoring and the employment of the Reckow methodology of lake trophic assessment, the TMDL estimated that the annual phosphorus load was 14,822 lbs/year, most of which was from nonpoint sources. Nonpoint source loadings increased from about an estimated 50% in the 1970’s to almost 90% in the 1990’s. It was determined that Strawberry lake has an assimilative capacity for phosphorus of 17,100 lbs/yr. Eight waste water treatment plants or other point sources were identified upstream of Strawberry Lake, with a permitted load of 5,877 lbs/yr. Table 1 specifies these point source allocations by facility. Unspecified non-point sources were allocated the remainder of the load (minus a margin of safety) or 11,000 lbs/yr.

The phosphorus TMDL for Strawberry Lake was approved by the USEPA in 2000. See Appendix A for the federally approved Strawberry Lake TMDL.

Facility	Current Limits (lbs/yr)	Percent Retention in Upstream Lake*	Waste Load Allocation to Strawberry Lake (lbs/yr)
Brighton WWTP	600	40	360
Brighton Twp WWTP	525	0	525
GM Proving Grounds Milford	340	0	340
Milford WWTP	900	22	702
Northfield Twp WWTP	1,826	0	1,826
South Lyon WWTP	1,387 (800)**	50	400
Vision Metals	840 (640)**	50	320
Wixom WWTP	1,800	22	1,404

*Based on retention factors of 22 percent for Kent Lake, 50 percent for Nichwagh/Limekiln/Sandy Bottom Lakes (combined), and 40 percent for Ore Lake. These retention factors are based on the average retention of the Ore Lake and Kent Lake 1978 and 1999 data (Tierney and Massey, 1975 and Alexander, 1999). The 50 percent retention for Nichwagh Chain of Lakes was selected due to the uncertainty associated with the loading data collected during the two sampling periods.

**These are the proposed new annual phosphorus permit limits of 800 pounds per year for South Lyon WWTP and 640 pounds per year for Vision Metals. The column for Waste Load Allocation to Strawberry Lake depicts potential loading to Strawberry Lake with the new permit limits for South Lyon and Vision Metals.

Table 1. Current permit limits and waste load allocations for facilities discharging upstream of Strawberry Lake.

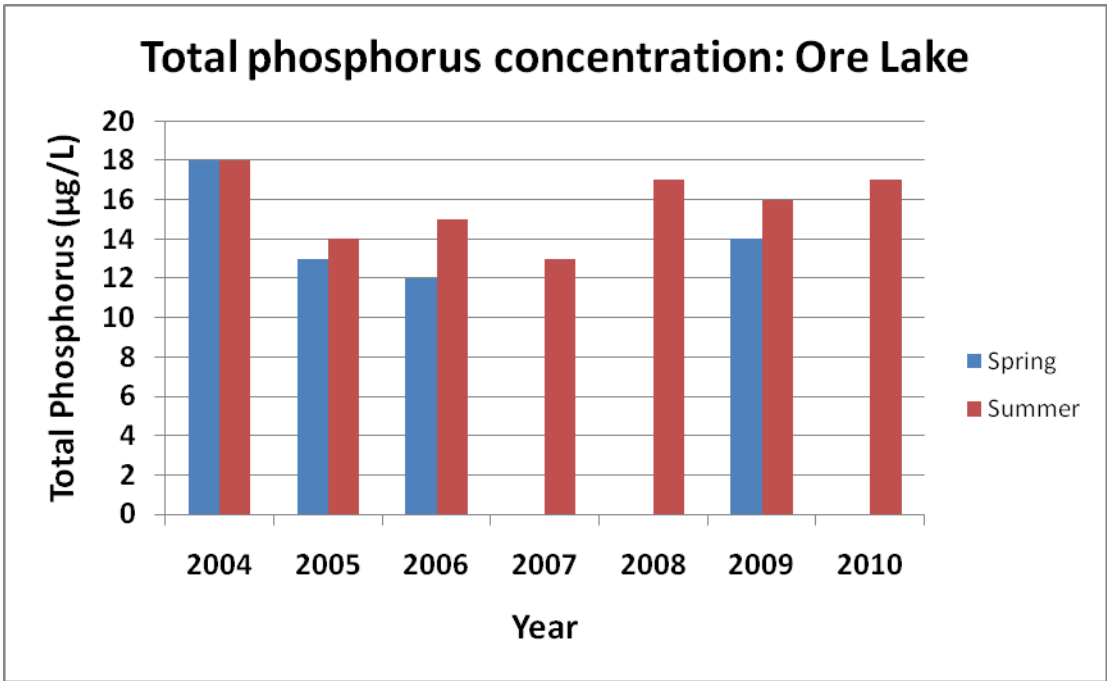
Water Sampling Data Summary

Additional water quality data has been collected since the original TMDL development in 2000. Strawberry Lake was sampled twice per year from 2004 to 2007 by volunteers with the Cooperative Lakes Monitoring Program – a state-sponsored program to monitor inland lakes. The mean total phosphorus concentration over this period was 18 µg/L, which is substantially lower than the MDEQ estimate from 10 years pervious. Monitoring by HRWC from 2008-11 from two major branches draining to Strawberry Lake showed mean concentrations of 36 µg/L in the mainstem Huron River and 32 µg/L in Davis Creek. Accounting for daily stream flow, and factoring in results from wet weather sampling in Davis Creek, these concentrations translate into loading of 33 lbs/yr of phosphorus from the Huron River mainstem and 7 lbs/yr from Davis Creek, for a total of 40 lbs/yr entering Strawberry Lake from these two tributaries. This total load is well below the load estimated for TMDL development. Similarly, continued sampling of Strawberry and Ore Lakes from 2008-10 showed similar phosphorus levels as 2004-2007 sampling (Figure 2).

Generally, these results suggest that Strawberry Lake remains well below TMDL targets and remains unimpaired. Only one sample from Strawberry or Ore Lakes exceeded the 25 µg/L threshold during the sampling period. The authors and contributors were not aware of any reports of algae blooms in Strawberry or Ore Lakes. It should be noted that the data represent samples taken at single points in time. Although there have not been any reports of algal blooms in Strawberry Lake which can be indicative of surfeit phosphorus loading in the lake, HRWC has received complaints of excessive aquatic plant growth in neighboring lakes in the Chain of Lakes.

In 2008, HRWC expanded their Water Quality Monitoring Program to include two other sites in the Huron Chain of Lakes in Livingston County, located upstream and downstream of Strawberry Lake. Volunteers in that program collect samples for water quality analysis and measure stream flow at river and tributary stream sites to help characterize water quality dynamics in the Huron River Watershed. In 2010, HRWC expanded monitoring to six additional sites, including sites just upstream and downstream of Brighton Lake. Sites are sampled twice per month between April and September. To date, results have been received for fifteen samples at each site, spanning from August 2010 through September 2011. See Appendix B for a monitoring report.

Further analysis is needed to include data from additional stormwater runoff events, estimate stream flows over a longer period of time and improve phosphorus loading estimates.



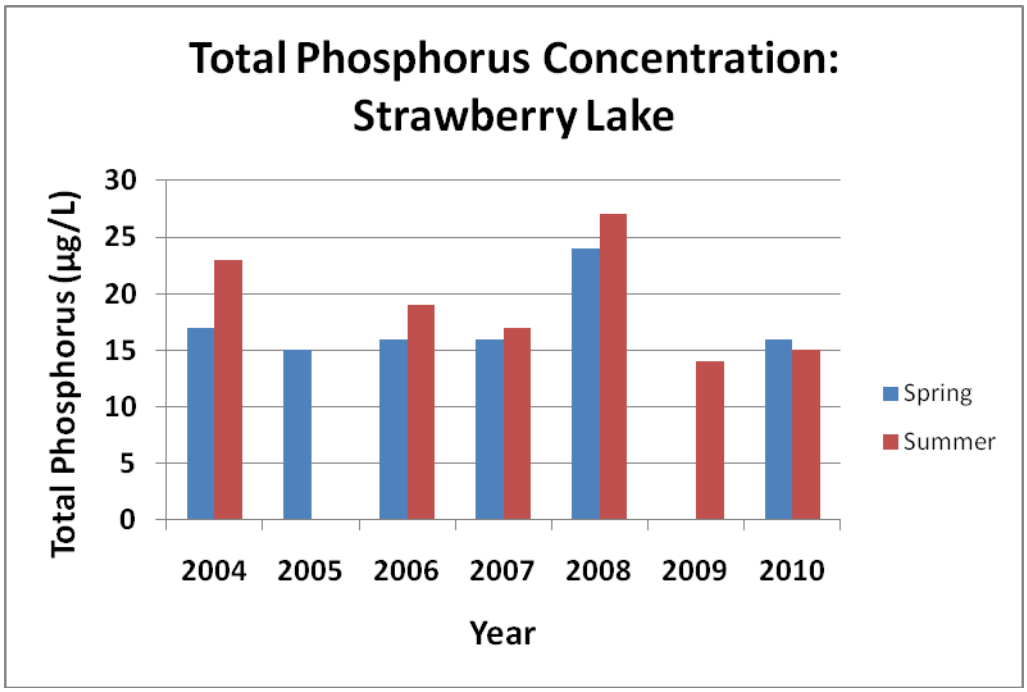


Figure 2. Spring and summer total phosphorus concentrations for Ore Lake (top) and Strawberry Lake (bottom) from 2004-10. Note that phosphorus was sometimes not measured for certain seasons (i.e. summer of 2005 for Strawberry Lake). Total phosphorus concentrations were similar between the two lakes, and over the years of study. Phosphorus levels fluctuated between about 12 and 30 µg/L over this time frame, and were predominately below the TMDL target.

Strawberry Lake Stakeholders

The Strawberry Lake Watershed lies within southeastern Livingston County and comprises portions of the municipalities Brighton, Genoa, Green Oak, Hamburg, Hartland, Highland, Lyon, Milford, Northfield, Novi and Oceola Townships and the Cities of Brighton and South Lyon (Figure 1). In addition, the Livingston County Drain Commissioner has jurisdiction over those tributaries (or portions thereof) designated as county drains, and Livingston County Road Commission manages drainage from county road right-of-ways. Other jurisdictions that may impact nonpoint source contributions of phosphorus and other pollutants are Brighton Area Schools, and Hartland Consolidated Schools.

Working with the guidance of statewide procedures, townships and other jurisdictions have the power to formulate land management, land use and development policy, amongst other important activities. Land and water regulation, management, and protection within the Strawberry Lake Subwatershed are the responsibility of the state, county, and local governments. Private residents undertake specific unregulated actions such as yard maintenance, landscaping, and waste disposal on a daily basis.

Although state and county governments take an active role in many local policies, local governments at the city, village, and township level take a significant leadership role in land and water management by passing and enforcing safeguards that can be more protective than state laws. Working under numerous established procedures, local governments may enact ordinances

to control stormwater runoff and soil erosion and sedimentation, protect sensitive habitats such as wetlands and woodlands, and establish watershed friendly development standards and lawn care and landscaping practices and so forth. Under these circumstances the local government oversees enforcement.

The stakeholders made the conscious decision to gain active involvement from the entities with more significant land ownership in the TMDL areas. This decision reflects the understanding that stakeholders with jurisdiction over minute portions of the TMDL are having little motivation to be engaged in the planning process. Many of the stakeholders meet regularly as part of the Livingston Watershed Advisory Group (WAG). All stakeholders have been invited to participate in meetings and other events pertaining to the TMDL, and programs to control phosphorus sources.

Goals for Strawberry Lake

The Strawberry Lake Phosphorus Management Implementation Plan sets forth a comprehensive, long-term effort to restore and protect water quality of the area with the goal of attaining the Total Maximum Daily Load for Strawberry Lake. To achieve this, the plan includes efforts to reduce the most likely phosphorus sources to the lake and ensure that future activities do not add new sources.

II. Significant Progress Since TMDL Development

Eleven years have passed since original TMDL for Strawberry Lake was developed and it has been four years since the *Huron Chain of Lakes Watershed Management Plan* was last updated. The Chain of Lakes plan provided several key pieces of information to provide stakeholders with direction for their efforts toward phosphorus reduction for the Strawberry Lake Watershed and downstream to Portage Lake. The plan defined critical areas (priority sub-basins) for focus actions, identified probable sources and causes and developed an initial strategy to achieve water quality targets. The plan's key elements are summarized below along with a brief assessment of progress.

Assessment of the *Huron Chain of Lakes Watershed Management Plan*

In 2003, the Phase II stormwater program was launched and a new stakeholder group was formed to address stormwater requirements within the Watershed General Permit. The Huron Chain of Lakes Steering Committee, with guidance and assistance from HRWC, developed the *Huron Chain of Lakes Watershed Management Plan.* This plan applied to a section of the Huron River watershed downstream of Kent Lake and ending in Portage Lake. It was approved in 2006 and then revised and approved in 2007.

The Chain of Lakes plan was a general watershed plan that focused on stormwater sources and management practices. The plan divided the watershed into 35 sub-basins that were used for analysis of watershed threats and their potential causes and sources. Using several modeling approaches and field surveys, phosphorus and sediment loading was also estimated based on land uses. Eleven of the 35 sub-basins were identified as higher priority sub-basins, or critical areas (see Figure 3). Using the model results, the plan concluded that the Brighton Lake catchment up to Woodland Lake was the highest priority critical area for management actions to control pollutants in runoff, and several other catchments were identified as secondary critical areas (see Figure 3).

The plan included an extensive set of over 100 management activities that were categorized into eight sets:

- Managerial actions:
    - Ordinances and Policies
    - Practices
    - Studies and Inventories
    - Public Information and Education
    - Illicit Discharges Elimination
    - Coordination and Funding
- Vegetative BMPs

- Structural BMPs

Each municipality or agency that contributed to the plan committed to engaging in a set of the outlined actions. None of the recommended actions, however, was geographically specific.

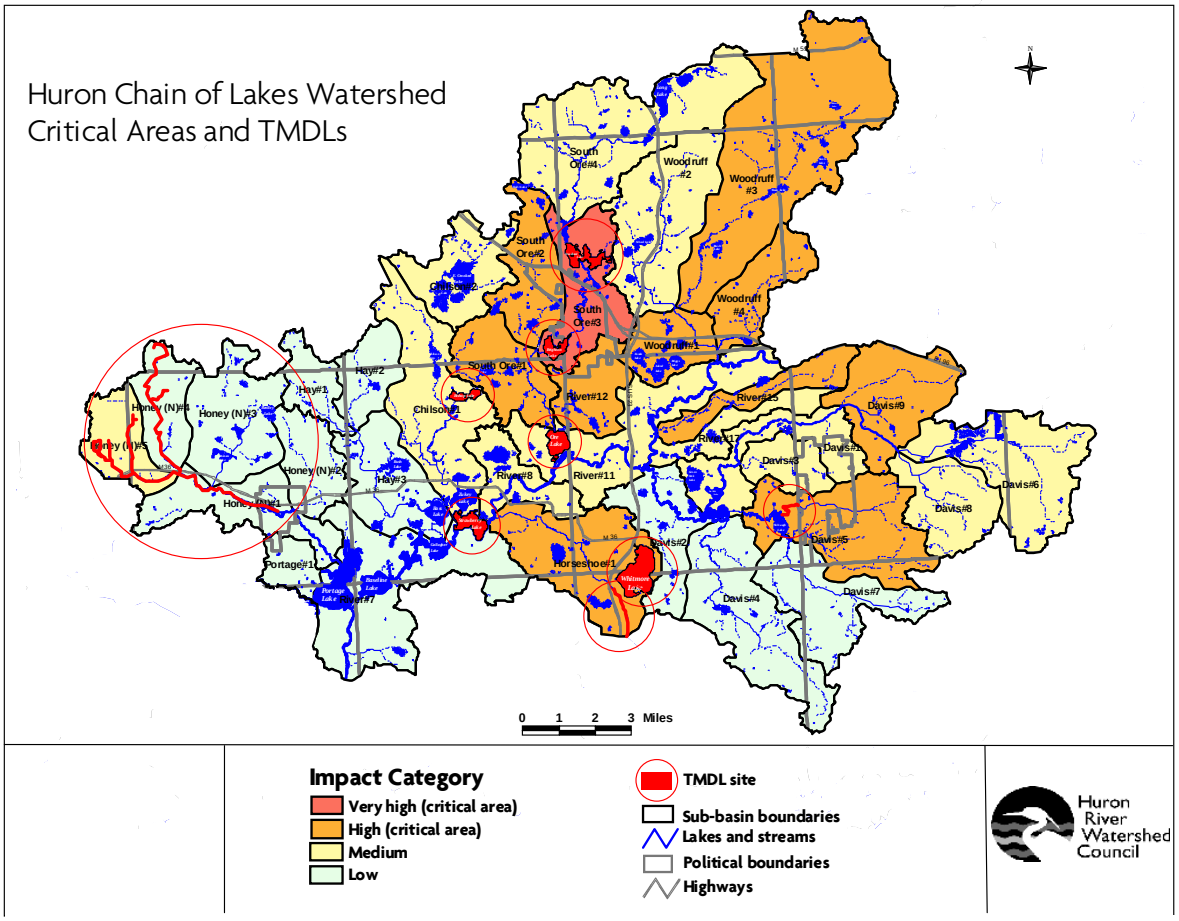


Figure 3. Chain of Lakes Watershed showing critical areas for reducing impairments.

Stormwater Programs

In 1995, implementation of the federal stormwater program began with Phase I being applied to large metropolitan areas. This did not include any municipalities in the Strawberry Lake area. In 2003, many municipalities and two Livingston County agencies were added to the program in Phase II, including the Cities of Brighton and South Lyon, and most of the townships in the watershed. All agencies with municipal stormwater discharges were provided with discharge permits and required to engage in six minimum measures to reduce stormwater pollution. Many of these required activities were designed to reduce nutrient runoff and therefore helped to reduce phosphorus loading into the Strawberry Lake catchment. Most of these agencies, along with others joined together to form the Livingston Watershed Advisory Group (WAG) to work collectively to manage stormwater and improve conditions in county water resources.

In 2007, following a legal challenge, DEQ allowed many municipalities to withdraw their stormwater permit coverage. In the Strawberry Lake drainage, only the county agencies, the

Cities of Brighton and South Lyon, and Brighton, Hamburg, Hartland, Lyon, Milford and Northfield Townships remain as permitted MS4s. However, some of the municipalities have continued to participate in the activities of the Livingston WAG.

Program and Project Summary

Point Source Upgrades and Investments

The following Waste Water Treatment Plants and other direct point sources are permitted to discharge to the watershed:

- *City of Brighton Waste Water Utility*
- *Brighton Township Waste Water Utility*
- *GM Proving Grounds Milford*
- *Milford WWTP*
- *Northfield Township WWTP*
- *South Lyon WWTP*
- *Vision Metals*
- *Wixom Waste Water Utility*

A summary of each source's capacity and activities to invest in technologies to minimize phosphorus discharge is needed.

Stormwater and Non-point Source Programs and Projects

Stormwater Programs

Public Education
The Phase II stormwater permittees fund a Public Education Plan (PEP) that includes numerous activities to educate and inform residents and other target groups about their involvement with stormwater and how to minimize their impact on water resources. Messaging specifically targets phosphorus reduction. Partners conduct some activities individually, but also contribute to several large joint efforts that include a biannual calendar, news media ads and involvement in events.

Illicit Discharge Elimination Programs
All stormwater permittees have developed IDEP programs to inspect their stormwater system to find suspected sources of contamination, determine the ultimate sources and eliminate any illicit connections or dumping. These programs require significant investment of time and resources, and those conducting the investigations reported few discoveries in past annual reports. However, IDEP investigations have not been completed for all parts of the stormwater system in the watershed and national and statewide evidence suggests that it remains an effective way to reduce contaminant sources.

Construction Runoff Control
All permittees have established programs for soil erosion and sediment control from new or redevelopment construction. Such developments require permits and inspections for practices to keep exposed soils on site or controlled from runoff. This has reduced a significant potential source of phosphorus.

Post-Construction Stormwater Ordinances
The City of Brighton and Brighton Township both passed post-construction stormwater ordinances that require that all new and re-development projects capture and treat the first flush of stormwater runoff and protect stream channels from erosion due to peak flow runoff. The Livingston County Drain Commissioner has established stormwater standards for construction that municipalities within the county reference. These standards are being reviewed for potential revisions. While the ordinances do not address pre-existing developments, they will help prevent additional loading when new development occurs.

Pollution Prevention and Good Housekeeping
MS4s have all engaged in activities to educate internal staff on the state-of-the-art in pollution prevention practices and develop good housekeeping practices to reduce or eliminate pollution sources on their own properties and operations. Practices like spill prevention and clean-up, fertilizer reduction or elimination, vehicle maintenance and washing, have all improved since permits were originally issued, resulting in reduction in phosphorus sources.

Other Significant Programs and Projects
Beyond the required stormwater programs and projects, some partners have engaged in activities that have had a positive impact on reducing existing phosphorus sources or protecting against future sources.

City of Brighton
Street and Catch Basin Cleaning: The city regularly sweeps city streets and parking lots on a rotational basis from May through October. The sweeper is active 5 days a week during this period. The city also cleans out city catch basins once per week. This high frequency cleaning removes phosphorus sources from otherwise untreated road runoff.

Yard and Leaf Collection: The city collects yard waste every other week from April through September and once per week in October and November. Additional leaf collection is done twice in the fall. This helps to remove residential sources of phosphorus from stormwater runoff.

Mill Pond Dredging: The city dredges the Mill Pond created by a dam on South Ore Creek. This pond accumulates sediment behind the dam before releasing flow downstream to Brighton Lake. Removing the sediment reduces the potential of its inclusion in outflow during high flow periods. Dredging also increases future sediment storage capacity.

Green Oak Township

Protective ordinances: The township passed a unique stormwater ordinance that encourages low impact development by allowing distribution of practices across development sites. They also passed a Riparian Buffer ordinance that protects areas within close proximity to streams from impactful developments. These ordinances will protect waterways in the township from future sources of phosphorus.

Educational Workshops: The township developed workshops to educate residents about proper septic tank and field maintenance and low impact development. These workshops should help township residents to change behavior to reduce some of their phosphorus sources.

Highland Township

Protective Ordinances: The township has incorporated several protective measures in their zoning ordinance. They include low impact development principles directly within zoning designations, and include 65-foot setback stream buffers for Planned Unit Developments. Both elements help reduce phosphorus sources from future developments.

Yard and Leaf Collection: The township collects yard waste weekly from April through November. This helps to remove residential sources of phosphorus from stormwater runoff.

Livingston County Road Commission

Street Sweeping: The Road Commission sweeps county roads three times a year on a rolling basis. This practice removes phosphorus sources from roadway runoff that otherwise receives little treatment.

Repair of Erosion Hot Spots: The Commission responds to concerns identified through road inspection or reported by municipalities. They prioritize road problems for repair based on a number of criteria that include the likelihood of erosion. Hot spot locations are repaired to capture and treat runoff to prevent erosion or reduce sediment from road runoff.

Livingston County Drain Commissioner

Two-stage Ditch Designs: The Commissioner and staff have identified a couple of county drains that could be redesigned to include floodplain "benches" outside of the low-flow channel. This allows for floodplain wetland development and meanders to reduce sediment transport, thereby reducing phosphorus delivery. More research is needed to show the effectiveness of application on a watershed basis.

Summary of Phosphorus Loading Reduction and Current Status

HRWC and volunteers have collected data since 2008 at tributary monitoring stations within the TMDL drainage area. Volunteers in the Cooperative Lakes Monitoring Program (CLMP) collected samples twice a year from Strawberry and Ore Lakes since 2004. Seasonal (April – September) and annual loads were calculated based on data collected by HRWC[3] and the CLMP[4].

- Strawberry and Ore Lakes have been monitoring twice per year through the CLMP since at least 2004. The **mean TP concentration in Strawberry Lake over this period was 0.018 mg/l**, which is substantially lower than the DEQ estimate from 10 years previous.
- Monitoring by HRWC[2] from 2008-10 from two major branches draining to Strawberry Lake showed mean concentrations of 0.046 mg/l in the mainstem Huron River and 0.038 mg/l in Davis Creek, and 56 lbs/yr of phosphorus from the Huron River and 9 lbs/yr from Davis Creek, for a total of **65 lbs/yr entering Strawberry Lake.**

This total load is well below the load estimated for TMDL development. Obviously, this is a small amount of phosphorus load from a large drainage area. Additional loading beyond the load to Strawberry Lake likely occurs upstream, but it may be assimilated by upstream lakes or low flow areas. The original load estimated for the TMDL development was generated from a lake model, while the current load is based on directly measured stream data. Since the both the monitored concentrations in and loading to Strawberry and Ore Lakes are below TMDL targets, no further load reductions are necessary. Maintenance of current phosphorus concentrations and loads will be the goal of this Implementation Plan.

[2] Samples collected bimonthly, May through September. Loads are averages of daily loads at sample points and may not reflect loads across a full range of discharges.

III. Current and New Programs for Phosphorus Reduction in the Strawberry Lake Catchment

Ongoing and Imminent Programs and Projects

Measures to reduce phosphorus will include many activities that are already underway, and others that are planned and included in other management plans. Some programs and projects are required of the National Pollutant Discharge Elimination System (NPDES) municipal stormwater permittees within the watershed through Phase II of that program.

In order to meet the phosphorus reduction target for the region, the participating community partners in the Livingston WAG developed a number of different approaches, as discussed in the previous section. Many activities originally outlined in previous plans have been accomplished (see Section II) and likely resulted in significant reductions in loading to Brighton Lake, as well as lower phosphorus concentrations downstream to Ore and Strawberry Lakes, based on analysis of monitoring data (see Section II).

The earlier strategies have been updated into the phosphorus reduction strategy here. As discussed in Section II, there is **no phosphorus load reduction target** as of the beginning of 2011, since both lake concentration and loading estimates are below TMDL targets. Still, additional load reductions will come from a combination of stormwater and non-point source projects that are currently planned.

Thus, these activities will reduce the phosphorus load beyond the TMDL target for the watershed. The targeted loading reductions from these activities exceed the target for a number of reasons, all related to uncertainty. The contributors to this plan generally want to use the precautionary principle to account for uncertainty and err on the side of being overprotective. While the TMDL included excess loading up to the daily maximum that was not directly allocated (essentially a margin of safety), that margin was small. As should be clear from the loading analysis discussed in section II, loading estimates are not exact and computational methods can vary. Also, there is extensive uncertainty within the load reduction estimates, though the modelers were conservative in estimates. Further, the exact relationship between the phosphorus load entering Strawberry Lake and the phosphorus concentration in the lake itself (the ultimate target) is not clearly defined and confounded by numerous other variables. Finally, while construction and urban development has slowed considerably in recent years, at some point it is likely to increase. Livingston County was the fastest growing in the state at the peak of development. When building increases, it is likely to put continued pressure on water resources by adding additional impervious surface and the need for substantial stormwater management.

A detailed summary of priority partner projects is included below. Following that, a complete summary of projects to reduce phosphorus pollution as planned or currently underway by the WAG partners are presented in Table 2. This table will provide a basis for partners to review progress towards meeting the TMDL for phosphorus in Strawberry Lake. It includes commitments by individual local agencies in the watershed as well as commitments by the Livingston WAG as a group. Where Livingston WAG is indicated, the commitment of all permitted WAG entities is implied. Where "local governmental units" is indicated, the commitment of all non-county, permitted WAG members is implied. However, it should be noted that, since Strawberry Lake is meeting TMDL limits, these commitments should be considered secondary to those made for addressing Brighton Lake TMDL limits. This plan is premised on the belief that continuing stormwater management activities and achieving Brighton Lake targets will, in turn, maintain Strawberry Lake below loading and concentration targets.

General Milestones

Specific activity milestones are included in Table 2. Generally, overall progress will be measured by monitoring. This plan was developed to maintain phosphorus loading below the TMDL target. It is anticipated that this will be achieved with continued implementation of stormwater activities. Maintaining loading and lake concentrations below TMDL targets are the only truly meaningful milestones.

Priority Partner Projects

Green Oak Township

Drainage and Erosion Remediation: Projects in two locations within the East Ridge subdivision to address poor drainage and erosion issues downstream. Project areas discharge to wetlands in the direct drainage area to the Huron River. Implement 2013-14.

Erosion Remediation at McCabe Rd.: Crossing of the road at the Huron River is used as an unofficial boat launch, causing significant erosion into the River. Working with the Livingston County Road Commission, the site would be improved as a launch site with secure access and drainage through bioswales. Implement 2012-14.

Rushton Road Bridge Drainage Repair: The bridge on Rushton Rd. that crosses a tributary drain to Davis Creek is in need of repair of storm drains. Currently, stormwater runs off around abutments, creating bank erosion. The project would be to work with the Livingston County Road Commission to repair the drains. Implement 2012-14.

Horseshoe Lake Residential Retrofits: Project to target education and possibly incentives for disconnecting downspouts and installing rain gardens, rain barrels and other infiltration in an older development. Implement 2014-15.

City of Brighton

Hydrodynamic Separator Installations: Install separators at major outfalls in the most heavily urbanized areas in the city to reduce sedimentation and remove pollutants before discharging to South Ore Creek. Implement 2016.

Residential Tree Planting: Inventory city residential areas and prioritize areas for opportunities to plant trees to help infiltrate stormwater. Implement 2015.

Mill Pond Enhancement: Improve the pond and park around the pond. The park receives heavy foot traffic and high visibility. Project would clean out existing sediments in pond behind dam to prevent washing downstream, add demonstration infiltration projects and goose exclusion to reduce waste. Implement 2015-16.

Greenspace Conservation: Conserve green space at two locations near wetlands within the city. The city has little remaining undeveloped green space and conservation would ensure continued stormwater treatment. Implement 2014-16.

Glenwith Pond Retrofit: A city-owned detention pond in a residential area that discharges to Brighton Lake was not designed for water quality treatment. Residents have reported significant algae issues. The pond would be redesigned to settle sediments, slow flow-through and add vegetation to absorb nutrients. Implement 2015-16.

Brighton Township

Expand Connections to WWTP: The Township seeks to expand connections to its waste water treatment plant from areas in or outside the township currently being serviced by individual septic treatment or community treatment and groundwater release. Moving to centralized treatment will reduce septic failures and lower phosphorus concentrations in effluent on a per capita basis. Implement 2012-16.

Rain Garden Demonstration: Install significantly sized rain gardens at the township Fire Department site to treat and infiltrate all runoff from impervious surfaces on site. Site will also provide educational benefit as a public location. Implement 2012-15.

Highland Township

Huron Valley High School Improvements: Bordering Woodruff Creek, the High School property includes significant impervious surface without stormwater control. As part of the renovation plan, the township would encourage the school district to include LID features such as a Green Roof, inverted vegetative islands in parking lots, distributed bioinfiltration, and an appropriately sized stormwater retention or detention basin. Implement on the school's renovation schedule.

Farmland Incentives: Much of the township in the Chain of Lakes Watershed is agricultural. The township will work with the Natural Resource Conservation Service and county extension office to promote erosion reduction practices. The township would also promote farmland preservation for farms with proper nutrient management and erosion control. Implement 2012-16.

Livingston County Drain Commissioner

Brighton-Genoa Drain Redesign: Redesign of drainage outlet/inlets to maximize intake capacity and reduce bank erosion along Grand River Avenue at Meier's flowerland site. Implement 2012.

East Ridge Drain: Redesign of drainage outlet to eliminate major erosion at outlet impacting nearby wetlands. Implement 2013.

Hartland County Drain and Outlet: Stabilize meandering downstream channel at terminus of county drain down to Long Lake. Also look for opportunities to do conservation easement/flooding easement acquisition. Implement 2012.

Brighton No. 5 Drain (Brighton): Outlets of drain into Mud Lake are compromised by sedimentation since construction of drain in early 1980's. Mud Lake effectively acts as regional detention, and could be retrofitted as part of maintenance on the drainage outlets. The outlet culvert under i-96 is a small diameter pipe over 40 years old. The project would also work with MDOT to replace the culvert. Implement 2012.

Hawthorne Drain: Sand accumulation in stormwater system has been a persistent problem such that capture capacity of CB sumps has been exceeded despite frequent cleaning. The site will be evaluated for a sediment chamber at the southern pipe outlet. Implement 2012.

Downspout Disconnection Program (Brighton): A program targeted at the area draining to Brighton No. 5 drain to relieve stormwater problems on this system. Implement 2012.

<u>Livingston County Road Commission</u>
Winans Lake Road: Between Chilson and Hamburg Roads, construct a forebay/sedimentation basin if land can be acquired. Implement 2014.

Maintenance Program: Conduct ongoing maintenance of several stormwater control projects including: Hamburg Road/Winans Lake roundabout rain garden, Evergreen and McCabe Road bank stabilizations, Hamburg Road/Winans Lake bridge habitat improvement, Grand River Ave. bioretention, and numerous conservation/mitigation easements. Implement 2011-16.

Street Sweeping/Catch Basin Cleanout Program: Increase the frequency of street sweeping and catch basin cleanouts in TMDL areas. Also increase the frequency of outfall inspections in TMDL areas. Implement 2012-16.

Bioretention Improvements: Depending on the availability of funding and land acquisition, integrate bioretention features into upcoming road improvement projects including Nixon Road (2012), Winans Lake Road (2013), 9-Mile Road (2013), Bishop Lake Road (2015). Implement 2012-15.

Current and Proposed Projects

Site/Project #	Restoration Activity	Schedule (year/qtr)	Milestones	Total Project Costs	Lead Agency	TP redux (lb/yr)
COL-1	Adopt phosphorus fertilizer law	2012	Education in 2012		State of Michigan	1,000
	Targeted projects from Brighton Lake Implementation Plan	2011-16	Various	$1.14 M +	City of Brighton, Brighton Twp, LCDC, LCRC, HRWC	1,136
	Various partner priority projects	2011-16	Various		All	
COL-37-50	Public Education Program (PEP)	Ongoing	Survey results in 2012	$15,000 per year	Local government units; HRWC	
	Review codes and ordinances and revise to improve stormwater control and nutrient assimilation, including:	2011-16			Local government units	
COL-2	- Native landscaping ordinance			$5,000 per government	Local government units	
COL-3	- No dumping ordinance			$5,000 per government	Local government units	
COL-5	- Private roads ordinance			$5,000 per government	Local government units	
COL-8	- Wetlands ordinance w/ natural features setback			$5,000 per government	Local government units	
COL-10	- Overlay zoning for riparian corridor			$5,000 per government	Local government units	
COL-12	- Incorporate Low Impact Design principles into stormwater ordinance					
COL-17	- Minimize total impervious cover in zoning ordinance					
COL-18	- Promote open space preservation in zoning ordinance and master plan					
COL-14-16, 19	Revise policies and continue and improve enforcement of construction controls	ongoing	Increase inspection rate by 20%	$5,000 - $10,000k per community	Local government units	22
COL-9	Develop county-wide septic system time-of-sale and/or maintenance ordinance	ongoing	Increase inspections by 20% from 2010 levels by 2014	$300 per inspection; $5k to establish	Local government units	279
COL-53-62	Illicit discharge elimination program	ongoing w/ 5 year return	Complete round 1 inspections by 2013	$25,000 per year by each city and county	Local government units	2715
COL-23	Inventory and deduce directly-connected impervious surfaces (e.g. downspouts)	2012-14				
COL-24	Practice high-powered street and parking lot sweeping	ongoing	Expand road area swept by 20% by 2014	$129,000 per year	Local government units	71
COL-27	Practice alternative drain practices that improve protection of stream and riparian habitats	2011-16				
COL-28	Storm drain/catch basin marking	ongoing		$20,000 to $30,000	Local government units; HRWC	
COL-32	Inventory and stabilize eroding streambanks	Ongoing			LCDC with local governements	
COL-51	Yard Waste Collection and/or Recycling	Ongoing		Recycling station expenses	Local government units	
COL-66	Improve drain maintenance coordination with County and/or MDOT	Ongoing			LCDC, LCRC, local governments	
COL-76	Inventory and construct bioretention on public, residential and commercial properties, including:	2011-16			All	
COL-72	- Stormwater wetlands					
COL-73	- Grassed swales					
COL-74	- Vegetated filter strips					
COL-78	- Pond buffers					
COL-82	- Rain gardens					
COL-83	- Turf replacement with shrubs and trees					
COL-75	- Riparian buffers					
	Encourage or incentivize agricultural improvements including:	2011-16			Livingston WAG	
COL-79	- Agricultural conservation cover					
COL-80	- Conservation crop rotation with cover crop and mulch/no-till					
COL-81	- Wetland restoration					
COL-33	Inventory retrofit or new construction opportunities for structural practices including:	2011-16			LCDC, local governments	
COL-86	- Stormwater retention/detention basins					
COL-87	- Infiltration trenches/basins					
COL-88	- Vegetated roofs					
COL-90	- Catch basin inserts					
COL-91	- Grade stabilization structures					
COL-92	- Porous pavement					
COL-93	- Sand and organic filters					
COL-89	Technological and other upgrades at WWTPs to reduce nutrients	Ongoing			City of Brighton, Brighton Twp, Green Oak Twp	
	Inventory and prioritize road runoff issues to address the following:	Ongoing			LCRC	
COL-85	- Stabilize soils at crossing embankments					
COL-95	- Repair misaligned/obstructed culverts					
COL-96	- Stabilize road/bridge surfaces					
MS4-1	Lawn maintenance program	ongoing			Local government units, LCRC	
MS4-2	Pollution Prevention and Good Housekeeping program	ongoing			MS4s	
Total						**5,223**

IV. Overcoming Barriers and Gaps

As framed by the terms of the TMDL, the ultimate measure of implementation success will be documented changes in water quality, showing improvement over time. Potential barriers to the continued achievement of TMDL limits and the Strawberry Lake concentration target exist and must be considered in implementation planning.

Positive feedback from even the most diligent efforts may be several years in the future due to the lead time needed to implement best management practices throughout the watershed. Participants must set realistic expectations about the amount of time needed to continue identified programs while awaiting positive results. Otherwise, impatience, discouragement, or competition for limited local funding could lead to discontinuation of effective programs. Prompt communication of small successes through news releases, web sites, and community newsletters will be important to encourage the continued efforts of TMDL partner communities.

The tracking of quantitative results over time carries a set of technical and logistical challenges. Variation in weather patterns over the years of a study adds to the complexity of trend analysis of the data. Collecting correctly timed wet weather samples is particularly daunting, as personnel may not be available during a particular major summer storm occurring outside of business hours. Using trained and dedicated volunteers is helpful in order to overcome budget constraints and to increase the number of samples and data points used in calculations, however, volunteer recruitment and retention is a challenge all its own.

Another challenge is the changing economic environment. With the current economic downturn, usage of current waste water treatment plants has been reduced and no new plants have been proposed. Likewise, little construction activity is occurring, so a potential source of phosphorus runoff is being minimized. As the economy recovers and Livingston County returns as a focal point of growth and expansion, further stress will be placed on waste water treatment capacity and the demand may increase for additional treatment plants. Future development and its likely impacts need to be properly planned for at all levels of government.

For many partners in this TMDL implementation, activities have been in place for several years and have reaped benefits shown in lake concentrations and loading. The lake appears to be achieving an unimpaired state. Still, many of the current programs only recently have been put into place. However, with the current economic downturn restricting government and institutional resources, the challenge will be to identify the most cost-effective measures and to continue funding them. Managers and programs will both need to be adaptive, while continuing to appeal to the public's expectation that the waters of our state will attain the standards set forth by Congress through the passage of the Clean Water Act in 1972.

V. Accountability Structure for Implementation

Participants, Reporting, Timeline, Monitoring, Contingency Plans

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Participants

The stakeholders for this implementation plan are committed to maintaining the current state of good water in the Strawberry Lake Watershed. Those who have a stormwater permit to discharge runoff have accountability under that program. The permit requires that committed actions establish a timeline, include progress evaluation, and get reported to DEQ on a regular basis. Municipalities and agencies regulated under the stormwater program and working together through the Livingston WAG include:

- City of Brighton
- Brighton Township
    - Brighton Area Schools (nested)
- Livingston County Drain Commissioner
- Livingston County Road Commission

Other agencies regulated under the stormwater program, but not participating in the Livingston WAG include:

- City of South Lyon
- Hamburg Township
- Lyon Township
- Milford Township
- City of Novi
- Hartland Consolidated Schools
- Hartland Township

Local governments and the school districts are encouraged to join the Livingston WAG to improve watershed-wide stormwater management and more efficient program implementation.

Reporting

Phase II communities and entities must submit detailed compliance plans and reports that include provisions consistent with the TMDL for phosphorus. Phase II communities with Certificates of Coverage are required to submit an approvable plan to comply with all six minimum measures, including provisions consistent with any TMDL affecting the jurisdiction or watershed.

Under their stormwater permits, these communities and organizations are obligated to develop, implement, and enforce a stormwater management program designed to reduce the discharge of

pollutants from the drainage system to the "maximum extent practicable," to protect the designated uses of the waters of the state, to protect water quality, and to satisfy the appropriate water quality requirements of state and federal law. Stormwater controls designed to attain the goals of the TMDL must be incorporated into the stormwater management plan, and each permittee must implement appropriate best management practices to comply with the TMDL implementation plan. Both separately and jointly, through a coordinated public education and involvement strategy, stakeholders will also engage in communication with the public that addresses phosphorus TMDL problems, solutions, and successes.

All regulated communities have stormwater plans on file with DEQ that are publicly accessible.

The following units of government also are subject to the TMDL and have chosen participate in the Livingston WAG:

- Green Oak Township

Green Oak Township has shown leadership in regional water resources management, not only by its membership in the Livingston WAG, but also by its actions. It produced a model stormwater ordinance and a riparian buffer ordinance and has contributed to numerous individual and WAG initiatives.

The following units of government also are subject to the TMDL, but do not participate in the Livingston WAG:

- Genoa Township
- Oceola Township

The stakeholders in the Livingston WAG are committed to maintaining continued water quality in the Strawberry Lake Watershed. Toward this end, local governments, and the Huron River Watershed Council have been conducting a variety of actions to improve water quality and promote stewardship. Activities included bio-monitoring, septic inspection at time of sale, illicit discharge elimination, mass media educational campaigns, development standards, water resources protection ordinances, wetlands protection and wetlands restoration. Many of these actions have involved stakeholder collaboration; others are unique to individual stakeholders and their constituencies. The variety and number of these programs can be seen in detail in Table 2.

Although many ongoing actions to preserve water quality and habitat in the Strawberry Lake catchment are voluntary, each stakeholder has assumed responsibility to continue their efforts, as resources allow and needs dictate. Through initiating and continuing these voluntary actions, each stakeholder has assumed responsibility for a share of water quality restoration in the Huron River Basin. These discretionary programs are dependent on funding, perceived needs, sound and reliable technical assistance, clear regulatory authority, constituent support, and demonstrated effectiveness.

Livingston WAG members review the status of TMDL implementation on a quarterly basis for continuous improvement opportunities. Additionally, the permitted agencies are required to submit annual progress reports to the Michigan DEQ that contain the following: a description of the status of compliance with general permit conditions; an updated assessment of the water

quality conditions within their jurisdiction; a description of identified water quality stresses; and a summary of all information collected and analyzed—including monitoring data. The report must include a summary of upcoming stormwater activities and a description of planned changes in BMPs or measurement of goals.

Monitoring

In 2007, and at subsequent five-year intervals, the MDEQ completed basin-wide monitoring of the Huron River watershed. Since 2008, HRWC has conducted phosphorus monitoring on behalf of Livingston WAG members, and this is expected to continue. Also in 2008, the WAG members developed a TMDL monitoring plan that expanded monitoring from two sites to several more and included wet weather event monitoring. Results from that monitoring program are included in previous sections of this plan. The monitoring plan is available online.[5]

Monitoring of lake conditions in Strawberry Lake and Ore Lake is conducted via volunteers with the Cooperative Lakes Monitoring Program. Phosphorus is sampled twice per year, along with other parameters and conditions. The data and annual reports are available via the website of the Michigan Clean Water Corps (MiCorps): www.micorps.net. Volunteers are encouraged to continue monitoring these two lakes and are encouraged to add monitoring of lakes in the Davis Creek catchment, such as Limekiln and Sandy Bottom Lakes.

Future projects under this implementation plan may incorporate additional monitoring if resources allow. Stakeholders' stormwater permit reporting will include an updated assessment of the water quality conditions within their jurisdiction in either narrative or numeric form. The purpose of this update is to show any obvious changes in phosphorus levels since the previous progress report. Change may be demonstrated by use of data collected by other sources or a group monitoring program.

Through adaptive management—a process that assesses conditions and trends throughout plan implementation, and provides feedback to stakeholders so that adjustments can be made—this Implementation Plan is intended to maintain TMDL compliance. Through the quarterly meetings of the Livingston WAG, the members will meet to review progress with this Implementation Plan. The MDEQ will track permit compliance through stormwater permit oversight, including monitoring activities that address the TMDL implementation goals. Unless the EPA determines that it is necessary to separate TMDL enforcement from the stormwater permit process, enforcement authority will reside in the MDEQ's authority under the provisions of the stormwater rules.

The partner communities within the Strawberry Lake watershed take seriously the impairments that negatively impact local freshwater resources. This plan is a testament to their efforts over past years, as well as their will to see the nutrient impairment removed and full use of the water resources restored. Past efforts in the watershed have yielded tremendous public awareness of the threats, and their sources and causes, as well as actions to mitigate the threats. It will require a continued combination of supportive citizens and responsive investment in on-the-ground projects to protect the lake from impairment. This 5-year Implementation Plan provides the

blueprint for reaching the goal of maintaining sustainable nutrient limits for Strawberry Lake and downstream waters of the Huron River.

VI. References

[1] Alexander, M. A. 1998. A nutrient chemistry survey of Brighton, Kent, Ore, Portage, Sandy Bottom, and Strawberry Lakes, Livingston, Oakland, and Washtenaw Counties, April, June, and August 1997. MDEQ, Surface Water Quality Division, Report #MI/DEQ/SWQ-98/010.

[2] Alexander, M. A. 2000. Water quality and phosphorus loading analysis of Strawberry and Limekiln Lakes, Livingston and Oakland Counties, April 1998-September 1999. MDEQ, Surface Water Quality Division, Report #MI/DEQ/SWQ-00/020.

[3] Data reports can be found at http://www.hrwc.org/our-work/programs/water-quality-monitoring

[4] Archived data can be found at http://www.umich.edu/~hrstudy

[5] Huron River Watershed Council. *Huron Chain of Lakes Stormwater Plan for Addressing Total Maximum Daily Loads (TMDLs).* 2010.