Executive Summary

The MLA Water Quality Initiative Report presents data collected at 196 locations during the summer of 2018 and compares it to data collected from 2002 to 2017. The objectives of the MLA Water Quality Program are:

- To promote and encourage good stewardship of the lakes;
- To monitor the long-term health of the lakes;
- To identify adverse water quality trends at an early stage; and
- To promote causation studies and remediation by the responsible authorities.

There are multiple cases where the data collected by passionate MLA volunteers has initiated closer inspection of specific sites. The accountability arising from the Water Quality Program contributes to local improvements of septic systems, changes to municipal sewage treatment practices, and, overall, increased vigilance to protect the qualities of our lakes. This report summarizes the efforts of many committed volunteers and staff. Together, we are making a difference!

Area Summary Sheets are used to summarize sampling results, and traffic light symbology, established by the MLA, provides a visual indication of the overall water quality at each Area as follows:

- Green light indicates the water quality remains consistently good;
- Yellow light indicates that further investigation is recommended to maintain good water quality, and
- Red light indicates remedial action may be necessary to improve water quality.

In 2018, of the 56 Areas tested, there were 45 Areas with a green light, 9 Areas with a yellow light and 0 Areas with a red light. It is noted that the green, yellow and red Areas do not add up to the total number of Areas tested as there are a few new sites or sites with only one or two years of data that are not rated yet. This year, 4 Areas changed from a green light to a yellow light, 8 Areas changed from a yellow light to a green light, and 2 Areas (RFL-0 and SDP-0) were sampled for the first time in 2018 and will receive a traffic light classification in 2019.

Changes to the monitoring program in 2018 included the method of obtaining the phosphorus samples and a new laboratory used to complete the analyses. The phosphorous samples were formerly sent to Trent University labs at Dorset (part of the Dorset Environmental Science Centre, DESC) which provided a low method detection limit (<0.7 µg/L). When they closed suddenly in late March 2018 the best replacement solution was a major Toronto lab who was competitively priced but less accurate (higher method detection limit of 2.0 µg /L and accuracy +/- 20% at 8.0 µg /L). Other high accuracy labs at DESC had no capacity to accommodate the MLA work. Changing from Trent to the new lab also required a change from glass test tube sample containers to plastic, pre-treated bottles. Although the glass test tubes were to be rinsed prior to obtaining samples, the pre-treated bottles used in 2018 were not rinsed.

Based on our analysis of the long-term data acquired to date, the water quality at most of the sampling locations remains good to excellent.

The 2018 sampling season started in mid-May, ended in late August and generally included a total of four sampling events at each location. The water quality parameters sampled during the 2018 program are the same as those sampled in 2017 and consisted of temperature, Secchi depth (clarity), Dissolved Organic Carbon (DOC), Total Phosphorus (nutrients), *Escherichia coli (E. coli)* and Total Coliform (bacteria count). There was a total of 233 Secchi depth measurements, 441 Phosphorus samples, 16 DOC and 284 *E. coli* samples taken.

Although there was an overall general increase in most of the deep-water spring phosphorus concentrations in 2017 compared with values in 2016, that was not realized in 2018. At the deep-water station sites that were sampled for spring phosphorus, 20 (42 %) of the 48 sites showed the lowest spring phosphorus concentration recorded to date. In 2018, four of the deep-water sites recorded the highest spring phosphorus concentrations to date at those sites. In general, the phosphorus concentrations were lower than in previous years.

Of the 13 watercourse sites sampled for spring phosphorus, 100% showed a lower phosphorus concentration than in 2017 and 100% of those sites with a measured yearly phosphorus mean also showed lower yearly mean concentrations compared with results from 2017.

New deep-water stations were established at Rosseau Falls (RFL-0), Sandy Point (SDP-0) and Leonard Lake (LEO-8 and LEO-11) in 2018 to investigate phosphorus concentrations. Additionally, new nearshore stations were established at Eilean Gowan (ELG-5), Sandy Point (SDP-1) and Leonard Lake (LEO-9 and LEO-10) to monitor phosphorus and bacteria levels in 2018.

Phosphorus concentrations at near shore sites, including watercourse sites, generally showed a decline from previous years. 52% of the sites showed a decrease in phosphorus concentrations compared to the 2017 levels, with most of those dropping even below 2016 levels. In contrast, 9% of the sites showed an increase over previous years. These sites are of interest and will be followed more closely in future. Finally, 39% of the nearshore phosphorus concentrations in 2018 showed a trend of decreasing phosphorus concentration compared to the values at those stations in 2016 and 2017.

The watercourse stations (WIN-7 and WIN-8) established at Windermere in 2014 to assess nutrient inputs from the lakes and ponds upstream of the long-established WIN-1 site continued to be sampled in 2018. The spring phosphorus concentrations in 2018 at WIN-7 and WIN-8 were both the lowest ever recorded at each of the sites. The yearly mean phosphorus concentrations at both sites were the second lowest recorded in the 5 years of data gathered, which was a result of the low concentrations recorded in the first 2 of 4 sampling events in 2018.

DOC was sampled at 4 of the MLA sites in Three Mile Lake in 2018. An analysis of the total phosphorus concentration versus DOC concentration was undertaken this year, based on 3 full years of data collection in 2016 through 2018. The results of the DOC sampling in Three Mile Lake show indications of higher concentrations of DOC associated with lower levels of phosphorus. Although the correlation of DOC vs TP is difficult to assess on an individual site basis, it would be prudent for the MLA to continue to assess the long-term levels of DOC in Three Mile Lake.

E. coli levels, measured in colony forming units (cfu), exceeded 50 cfu/100 mL at 29 (9.2%) of 316 sampling events for *E. coli* in 2018. These results are similar to the 8% reported in 2017, and 8.7 % in 2016. Sixteen (16) sites reported elevated *E. coli* levels (>50 cfu/100mL) in 2018 compared with 12

sites in 2017. It should be noted that there were 316 samples in 2018, while there were only 282 samples in 2017, potentially contributing to the increased number of sites reporting elevated levels. The sites that reported elevated *E. coli* levels in 2018 include Bala Bay (BAL-2), Gull Lake (GUL-1), Moon River (MOO-14), Muskoka River (MRV-2 and MRV-7), Muskoka Sands (MSN-3), Star Lake (STR-1, STR-2, STR-3, STR-4, and STR5), and Windermere (WIN-5). The focus stations at Minett (MIN-1, MIN-6, MIN-7 and MIN-9), observed elevated *E. coli* levels (>50 cfu/100mL) and required re-testing as well.

From those sites identified in 2016 and 2017 for further analysis and sampled for in 2018, the Minett station (MIN-6) continued to show elevated *E. coli* levels.

In addition to the sites above that were noted to be in excess of *E. coli* levels >50 cfu/100mL, the following sites were above the MLA yellow traffic light limit (30 cfu/100ml) for *E. coli* within the past three years: , Beaumaris (BMR-4 and BMR-9), Gullwing Lake (GLW-1), Moon River (MOO-14), Muskoka Bay (MBA-13), Windermere (WIN-4 and WIN-5), Indian River (IND-2, and IND-3), and Muskoka River (MRV-2 and MRV-7).

Following analysis of the 2018 results, Beacon recommends that the primary Focus Areas for the 2019 sampling season should continue to be Minett (MIN) as well as East Portage Bay (POR).

It is important that everyone contribute to the goal of improving water quality and aesthetics of their lakes, while raising public awareness about healthy lake systems. Any stewardship activities will benefit the watershed over the long-term and leave a positive legacy for future generations.

1. Introduction

The Muskoka Lakes Association (MLA) is a non-profit organization that was founded in 1894 to represent the interests of lakeshore residents on Lakes Rosseau, Joseph and Muskoka and many smaller surrounding lakes, and is Canada's oldest cottage association. The MLA's mission is to 'promote the responsible use, enjoyment and conservation of the unique Muskoka environment.' **The MLA objectives of monitoring lake water quality to provide data to protect vulnerable areas and promoting stewardship are carried out through the Water Quality Initiative.**

The MLA Water Quality & Environment Committee is a group of volunteers that utilize professional expertise to analyze the yearly water quality data and to provide recommendations and program modification/development options. In 2013, Beacon Environmental Limited (Beacon) was retained as the primary consultant to assist the MLA with these tasks and continues to provide professional expertise through 2018. This Water Quality Report presents the most recent data collected in 2018 and compares it to data collected from 2002 to the present.

Area Summary sheets have been prepared for each of the sampling areas in the 2018 program and these are presented in **Appendix A**. The Summaries provide an analysis of the data collected in 2018 and include historical total phosphorus and *E. coli* results, where sampled. In addition, specific recommendations for the sampling areas are provided to continue to maintain, and where possible, improve the health of the lakes.

The results, summaries and scientific opinion regarding general health presented in the 2018 Water Quality Initiative Report are based on Beacon's analysis of data provided by the MLA. This does not represent the health of the entire lake and only captures information collected at a certain time and location during the sampling year. The reader should take this into consideration when reviewing the 2018 Water Quality Initiative Report and use caution in extrapolating data to a lake or watershed.

1.1 Water Quality Initiative – Past and Present

The MLA's Water Quality Initiative (WQI) is a citizen-science based water quality monitoring program designed to measure key biological, chemical, and physical indicators of water quality in lakes throughout the District of Muskoka and parts of Parry Sound. The MLA has been collecting water quality samples since the 1970's, with the current WQI program implemented in 2001 and updates and upgrades have continued to improve the program through the years. The program is directed by the MLA Water Quality & Environment Committee, administered by support staff based at the MLA office in Port Carling, and implemented by a dedicated group of more than 100 volunteers. This program continues to be one of the most comprehensive water monitoring programs of any lake association in Canada.

The MLA partners with provincial agencies to monitor lake health in Muskoka. Over the longer term, the Ministry of the Environment, Conservation and Parks (MECP) Lake Partner Program (LPP) has recorded Secchi depth and phosphorus concentrations in the lakes. The LPP Program is a province wide, volunteer-based, water quality monitoring program in which the MECP monitors more than 600

of the province's inland lakes, dating back more than 20 years. The MLA's WQI continues to follow the detailed sampling protocol of the MECP and goes further with additional sampling for bacterial counts, and in some years for dissolved organic carbon (DOC) and calcium. In 2018, six (6) of the deep-water sampling stations spring phosphorus data was obtained from the LPP.

The MLA has adopted a long-term monitoring strategy for phosphorus, calcium, water clarity, and water temperature, and in 2013 introduced a monitoring strategy for DOC. Additionally, bacteria monitoring activities have focused on determining whether chronically elevated conditions exist in targeted nearshore recreation areas. This document provides a comprehensive overview of the monitoring program including sampling and analytical methodologies.

Similar monitoring programs are presently being undertaken by the MECP Lake Partner Program, District of Muskoka, Lake of Bays Association, Township of the Archipelago (partnered with the Georgian Bay Biosphere Reserve) and other lake associations. The MLA WQI complements and expands upon other monitoring programs conducted in the region by government agencies and other volunteer groups.

The MLA WQI program is different than that of the District Municipality of Muskoka (DMM) and the LPP in that it includes additional sampling sites and more frequent sampling. The DMM tests approximately 190 locations covering 164 lakes over a three-year period with approximately 80 locations done annually at deep-water sites in the spring (just after freshet). A total of 43 parameters are tested at each of these 190 locations. This program has ± 30 years of data. The LPP program samples over 600 lakes across the Province. These locations are at deep-water sites and are also collected in the spring. LPP samples are tested for phosphorus and calcium. MLA tests at 190 locations four times over the summer in May, June, July & August. The locations include both deep-water and nearshore sites. Samples are tested for phosphorus and bacteria. The LPP and MLA programs are accomplished with volunteers while DMM uses hired staff.

Greater collaboration with similar monitoring programs has led to standardization of protocols, methodologies and sampling sites. The MLA continues to review similar monitoring programs to ensure that this program continues to keep up to date on methodologies and sampling parameters.

The WQI has evolved over the years since its initiation as a pilot program in 2001. Changes occur to add analytical power to the existing database. For example, Calcium was sampled for in 2011 and 2012 in response to recent findings that suggested calcium was declining faster than what would be realized under natural processes. The decline of calcium is anticipated to be associated with a longer time frame (decades) and as such, it can be sampled less frequently.

Another example of change is the addition of sampling for dissolved organic carbon (DOC) which was initiated in 2013 and continued through 2017. Three Mile Lake is the only area that continues to be sampled for DOC in 2018. Research has indicated that natural levels of total phosphorus from Precambrian Shield watersheds can most likely be correlated with levels of DOC. By having background data, unnatural (human influenced) increases in phosphorus can be more easily realized. DOC can also be sampled for in intermittent years to analyze for long term trends.

Some of the more notable changes that have helped shape the WQI are presented below:

2001 The program was initiated in the summer of 2001 to gather preliminary information on innovative means of water quality determination in the Muskoka lakes. The first year's programme focussed on developing protocols for the collection of replicable data.

2002 The program established that water quality programs should focus on nearshore areas and not just on open water areas as they have done in the past. Results showed that nutrient and bacterial levels were higher in nearshore areas than in open water and that there were areas of concern.

2003 In 2003 the Board of Directors made a long-term commitment to the initiative and raised funds to pay the operating expenses. Phosphorus samples started to be filtered and the Program was extended to "affiliate" partner associations.

2004 The program was focused on the residential land use activities and their effect on water quality. Monitoring efforts grew to 136 sites monitored by an all-time high number of volunteers. The program discontinued filtering the phosphorus samples because the filters appeared to significantly alter the data collected.

2005 The focus of research in 2005 was to develop a correlation between MLA total phosphorus concentration data with the data that has been collected by both the District of Muskoka and the MOECC.

2006 Statistical analysis conducted on the water quality data collected from 2002-2006 indicated that the WQI program did not have the capacity to consider highly complex relationships.

2007 Additional monitoring efforts were directed towards specific lakes and bays classified as "over-threshold" by the District of Muskoka. The MLA's attention was refocused in 2007 following recommendations of the 2006 Annual Report and the introduction of the District Municipality of Muskoka's Lake System Health Program which classifies lakes and parts of lakes based on estimated human impact on trophic status. The resources of the WQI were directed to specific sampling areas where concerns about water quality had come to light and focussed on determining the sources of phosphorus loading and other contaminants in these areas.

2008 Monitoring efforts scaled back very slightly to fewer sites monitored by over 110 volunteers. Turbidity measurements were discontinued in favour of the Secchi depth protocol that was added in 2007 to enable volunteers in the field to complete more of the program.

2009 The WQI monitoring program data showed decreasing concentrations of phosphorus in Lakes Rosseau, Muskoka and Joseph.

2010 Through the support of the WQI, Stream Monitoring Action Plans were implemented for Muskoka Bay and Cox Bay. Both areas had historically been identified as areas of concern through the WQI. Data analysis revealed that land-based influences on nearshore phosphorus were only detectable at sites located near creek outlets. The Summary Report and Technical Reports were condensed into one report.

2011 Several changes occurred in 2011 to standardize the methodology to allow comparison with other sampling programs. The changes included:

- Re introduction of filtering phosphorus samples, collection of samples at Secchi disk depth, and collection of duplicate samples;
- Sampling frequency was reduced from eight sampling events to four;
- Calcium sampling was undertaken in correlation with spring turnover phosphorus to increase the analytical ability of the WQI program; and
- Twenty-three sampling areas were added to the 2011 WQI, based on volunteer input and areas identified with the potential for concern during the 2010 review.

2012 Bacteria monitoring was discontinued at selected sites that were exhibiting chronically low average bacteria levels (three or more years below the MLA upper limit of 10 cfu/100 mL). New bacteria sampling sites were established in high-use areas where potential risks to health and recreational water quality were of concern (e.g., beaches, popular swimming sites, etc.). Calcium concentration data collected in 2011-2012 suggested that there was limited year-to -year variation (+/- 0.18 mg/L); however, it was determined that further data was required to determine overall trends. Changes to the program were limited to modifications of the deep-water phosphorus sampling methodology, revisions to bacteria sampling sites, and the addition of new sampling areas. The deep-water sampling methodology was changed for 2012 and results suggested that 2012 deep-water total phosphorus data were in general unreliable and were not included in the report.

2013 Consultation was undertaken in the spring to look at the data from each sampling area and location and to assess each site to decide if continued sampling was necessary, or if sites should be discontinued and new sites added. The changes undertaken in 2013 included 15 sites being removed, 8 sites being added, and 4 sites being modified. Additionally, Dissolved Organic Carbon was added to the parameter suite in six locations to better understand potential sources of natural phosphorus versus human impact.

2014 Each sampling area and location was reassessed at the beginning of the year to understand requirements for the sampling season. A total of 13 sites were discontinued, 8 sites were added, 8 sites restarted, 24 sites modified and sampling for DOC was continued. Elevated *E. coli* concentrations were recorded at several sites including at MIN-6 in Wallace Bay. Discussion with the MLA Water Quality & Environment Committee resulted in a proposal to proceed with a second stage monitoring program for 2015.

2015 The 2014 Area Summaries were reviewed to assess each site and modifications were undertaken to restart or temporarily discontinue particular sites. The most important revision in 2015 was the initiation of a Second Stage Water Quality Assessment (SSWQA) in Wallace Bay of Lake Rosseau. The SSWQA was designed to assist in determining whether remedial action was required where elevated levels of *E. coli* had been identified at MIN-6. Compared with the total coliform and *E. coli* levels encountered at MIN-6 in 2014, those recorded in 2015 show a marked decrease.

2016 All of the sampling areas and locations were reassessed at the beginning of the year to understand requirements for the 2016 sampling season. A total of 15 sites were discontinued,

8 sites were added, 10 sites restarted, 11 sites modified and sampling for DOC was continued. *E. coli* samples were collected 3 times versus 2 times previously at routine sampling sites. Increased sampling of 8 times per summer was started at the Minett focus site. New thresholds for the 2016 analysis of *E. coli* concentrations were implemented and discussed in Table 11.

2017 The master list of sampling areas and locations was reviewed early in the year. A list of core deep-water sites was identified for long-term monitoring as they are representative of the main lake embayments. Sampling at 24 previously stable sites was reduced to spring phosphorus only. Monitoring sites were added at locations identified in areas of potential additional loads to the lake, and included creek drainage from 'Yellow' sites, resorts, marinas and public beaches. A change in the methodology occurred such that one single grab sample (previously two samples) was acquired from which 2 samples (one sample plus a duplicate) were taken for phosphorus analysis. This change decreased the number of "bad-splits" to less than half of those encountered in 2016. Several sampling sites for *E. coli* were suspended if they had concentrations < 10 cfu/100 ml for 3 years. The correlation between DOC and total phosphorus was analysed at 22 stations.

2018 Each of the sampling areas was reviewed in the early spring to revise the number of sampling sites, where necessary. The changes undertaken in 2018 included 11 sites being suspended for 2018, 8 sites being added, 6 sites being restarted, 84 being modified. Most of the modifications included increasing the number of Secchi measurements through the summer. Additionally, dissolved organic carbon sampling was suspended at all stations, except for stations in Three Mile Lake.

1.2 Harmful Algae Blooms (HAB's)

Harmful Algae Blooms [HAB's] are becoming an increasing concern in the Muskoka Watershed and are recognized in the DMM update to the Official Plan (OPA 47). Since identification of HAB's requires significant expertise, this is not currently part of the MLA WQI program. Current protocol is to have concerned citizens report suspected algae blooms to the MECP Spills Action Line and for MECP personnel to field verify whether the bloom is blue green algae (also known as cyanobacteria). Verified HAB's are sampled and lab tested for harmful components. As a HAB is a human health issue, HAB sites are posted on the Simcoe Muskoka District Health Unit website.

1.3 Monitoring Volunteers

In 2018, volunteers dedicated their time and continued support in collecting water quality samples at 196 different sampling locations including 233 Secchi depth measurements, 441 phosphorus samples, 16 DOC samples and 284 bacteria samples.

Without the continued dedication and support from the volunteers this sampling program would not be possible. Each Area Summary sheet identifies the volunteer samplers as well as the team leaders (**bolded**).

Each spring, two training workshops are offered to provide the volunteer samplers with an opportunity to review the methodology and understand any updates to the protocol.

2. Water Quality Monitoring Program

The objectives of the MLA Water Quality Program are:

- To promote and encourage good stewardship of the lakes;
- To monitor the long-term health of the lakes;
- To identify adverse water quality trends at an early stage; and
- To promote causation studies and remediation by the responsible authorities.

2.1 Regional Setting

The MLA sampling stations are in the Canadian Shield Physiographic Region (Ontario Geological Survey, 2003). The bedrock throughout this region has extensive outcroppings which are primarily the result of glaciation and post-glacial events. Prominent bedrock knobs and ridges are common and dominate features in some areas. The Precambrian landform expression strongly influences the topographic patterns of the region as well as the local overland drainage characteristics.

2.2 Local Watershed Characteristics

The MLA sampling locations (**Figure 1**) are located within the Great Lakes drainage basin in central Ontario and eventually drain into Lake Huron via Georgian Bay. Within the Georgian Bay catchment area, most of the MLA sampling locations are within the Muskoka River watershed which drains an area approximately 4660 km^2 (Muskoka Water Web, 2013). The Muskoka River watershed is further divided into three subwatersheds: North and South Subwatersheds and the Lower Muskoka Subwatershed (Acres, 2006). Most of the sampling locations are within the Lower Muskoka Subwatershed which originates in Algonquin Park (Acres, 2006).

Approximately 68% of the Muskoka River watershed is covered in forest and other natural vegetation; 15% consists of water (lakes, rivers and ponds), 11% is wetlands, and 2% is rock barrens and outcrops. Settlement areas only make up 2% of the watershed while developed land such as agriculture (cropland, pasture and open fields) and golf courses make up 2% of land cover within the watershed (Muskoka Heritage Foundation, 2007).

Where the bedrock is covered by soils, it is generally very thin and nutrient poor, therefore limiting the amount of nutrients that flow to the adjacent waterbodies.

Lakes with a phosphorus concentration less than 10 µg/L are considered oligotrophic (nutrient poor) (Dillon *et al.* 1986). This generally implies that the lake is very clear and deep with minimal aquatic

plants and algal blooms, as well as high levels of dissolved oxygen. Lakes with a phosphorus concentration between 10 and 20 µg/L are considered mesotrophic (moderately enriched). These lakes have some aquatic vegetation and can support an array of fish species. Lakes with a phosphorus concentration above 20 µg/L are considered eutrophic (nutrient rich). These lakes have large areas of aquatic vegetation and are often subject to algal blooms, thus having lower levels of oxygen. Muskoka naturally has a range of lakes in all three categories, although most lakes are oligotrophic.

Increases in the nutrient content of a lake (primarily phosphorus and nitrogen), can occur as a result of rainfall, overland run-off and percolation of soil-water to the lake. Higher concentrations of these dissolved nutrients can cause the water to become progressively more fertile and productive, stimulating the development of free-floating microscopic plants (algae).

All lakes are subject to nutrient inputs, however, artificial (man-made) enrichment will increase the rate of eutrophication. Eutrophication generally promotes excessive plant growth and decay, favouring simple algae and plankton over other more complicated plants, and causes a severe reduction in water quality.

Lake Muskoka is the largest lake in the Muskoka River watershed based on total surface area and is also the receiving water body for Lake Rosseau and Lake Joseph which are also the third and fourth largest lakes respectively. Lake of Bays is the second largest lake in the Muskoka River watershed.

Water management can typically be broken down into two interrelated components; water quality and quantity. Water quality is directly affected by quantity. For example, flooding and heavy precipitation events can cause several contaminants to enter waterways due to overland flow picking up contaminants on adjacent lands or overflow of sewage treatment systems. Since contaminant loading fluctuates with weather events, it is important to sample continuously through different seasons and years to help understand the fluctuations.

Under normal circumstances, during rainfall events, nutrients (phosphorus and nitrogen) associated with overland flow are generally retained by physical absorption in the lands adjacent to the waterbodies.

Typically, during rainfall and snowmelt conditions, water flows across the land picking up contaminants before entering waterways. As well as chemical contaminants and nutrients being flushed into natural water systems, *E. coli* and other bacterial contaminants from flooded or poorly functioning septic systems and warm-blooded animals may also enter waterways in this fashion.

Nutrient loading from a watershed increases significantly when precipitation rates exceed the average rate. The Muskoka River Water Management Plan (MRWMP) provides for higher spring water levels resulting from the melting snow. The MRWMP states "*High water levels in early spring are natural occurrences which help to recharge groundwater supplies, transfer nutrients and sediments to wetlands and shoreline riparian zones and provides spring spawning fish and amphibians with access to wetlands and shoreline habitats*" (Acres, 2006).

The following three tables (**Table 1**, **Table 2**, and **Table 3**) summarize the rainfall and temperature records from the Beatrice Station from 2013 to 2018.