Swan Lake Water Quality Monitoring 2019 Report

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MARKHAM

Environmental Services

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Executive Summary

Background

Swan Lake is situated in the City of Markham at the intersection of Sixteenth Avenue and Williamson Road. Swan Lake has an approximate area of 5.5 ha and a maximum water depth of 4.5 m. A gravel pit in the 1960s and 1970s, Swan Lake is currently a community feature with multiple trails and urban development surrounding it.

Several issues were discovered with Swan Lake in 2010, including high phosphorus levels and significant algal blooms during the summer months, which led to low oxygen levels and degraded fish habitats. A Phoslock treatment was administered in 2013 to reduce the phosphorus levels and algal blooms in Swan Lake. Water quality monitoring of Swan Lake has been conducted annually since treatment in 2013 in order to track water quality and the continued effectiveness of the Phoslock. The collected data presented in this report is part of the ongoing monitoring program that will allow for continuous assessment of the water quality in Swan Lake and will be used to help establish a long-term plan for the treatment of Swan Lake.

Results

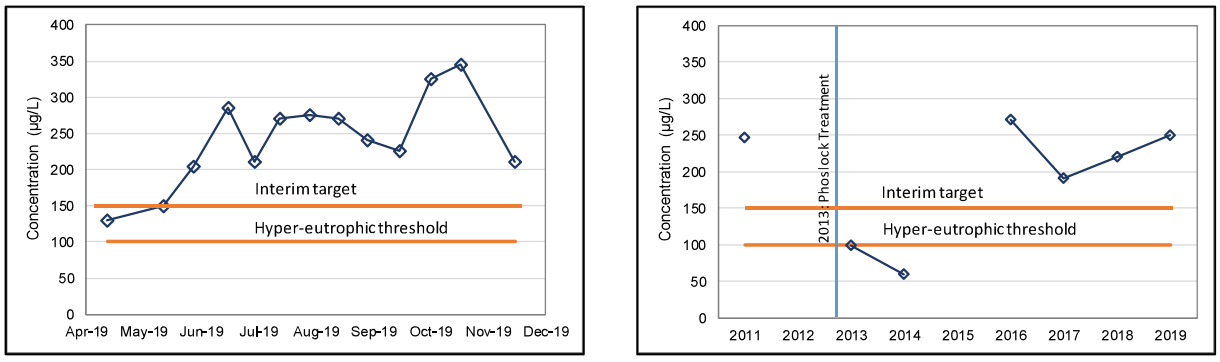
Water quality is currently monitored at two shoreline sites; the Dock, and the Bridge. Water quality is monitored bi-weekly throughout the summer (May-September) and monthly in the spring (April) and fall (October-November). Samples and measurements are taken at 0.5 m increments for the depth of the lake. A level logger is used to record the water level in the Lake.

Figure ES-1 provides the monitoring results for the 2019 monitoring period, as well as annual summaries of available data from 2011 to 2019. The figure includes plots of measured phosphorus concentration, dissolved oxygen, water clarity, chloride concentration, geese count, and water level.

Figure ES-1: 2019 Monitoring Results and 2011-2019 Annual Results

a) Phosphorus Concentration

Phosphorus concentration is the most important indicator of trophic state in Swan Lake. It is an indication of how prone the Lake is to algae growth. Phosphorus concentrations above 100 µg/L represent a hyper-eutrophic condition, which entails extremely high nutrients leading to high algae concentrations.

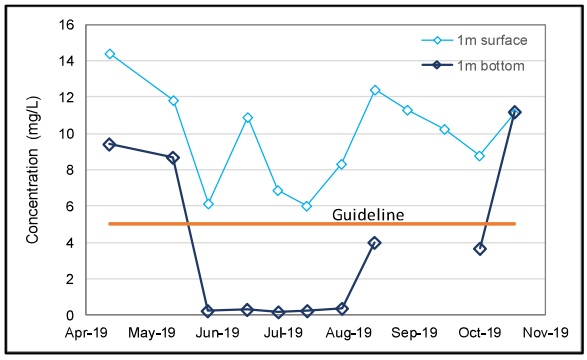


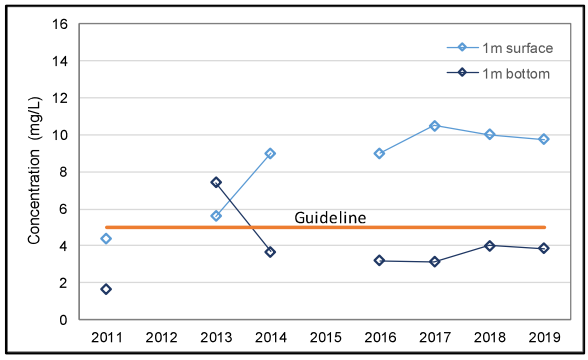
Note 1: The 2019 values are averages of samples collected at 0.5 and 1.5 m from surface.
Note 2: Annual concentrations are summaries of the growing period.
Note 3: The interim target shown is based on the draft water quality improvement strategy report (January 2020), and applies to the average over two consecutive years.

Figure ES-1: 2019 Monitoring Results and 2011-2019 Annual Results, Cont'd

b) Dissolved Oxygen (DO)

Reduced oxygen levels will cause lethal and sub-lethal (physiological and behavioral) effects in aquatic organisms, especially fish. The minimum dissolved oxygen concentration required for the protection of warm water fish is 5 mg/L. DO concentrations are shown at 1 m from the surface and 1 m from bottom, to visualize stratification and habitat suitability for fish, which may be able to survive in different parts of the lake and not others due to the stratification.

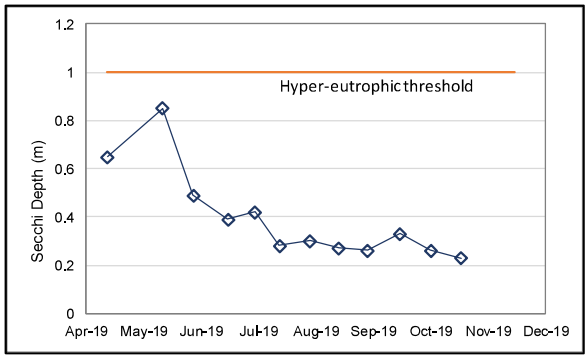


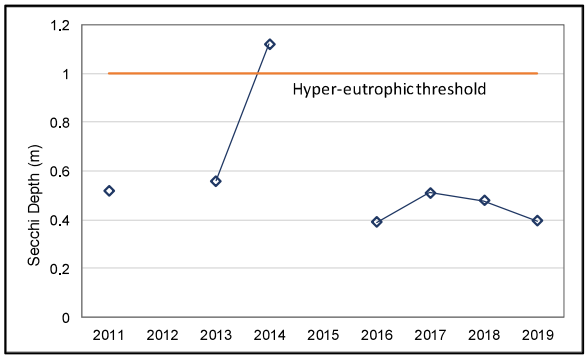


Note : In 2019, the Lake was stratified throughout the summer, but in the fall, the layers were mixed and similar concentrations were observed over depth.

c) Water Clarity (Secchi Depth)

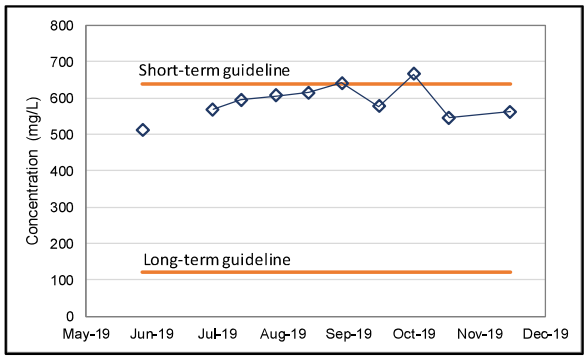
Secchi depth represents water clarity, which declines when algae level increases. Water clarity of **under** 1 m represents a hyper-eutrophic condition.

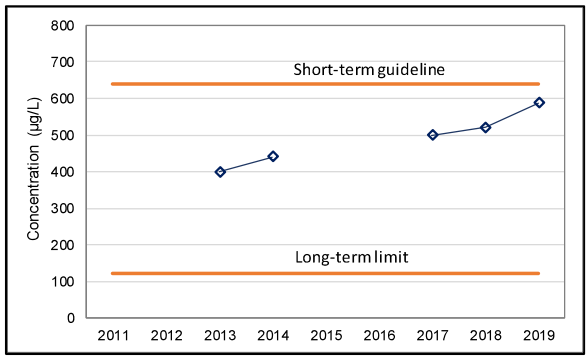




d) Chloride Concentration

Chloride concentration has been increasing in urban lakes as a result of de-icer application for winter maintenance. Fish can survive a short time period if the concentration is above 640 µg/L; however, if the concentration stays above 120 µg/L for an extended period, they cannot survive.



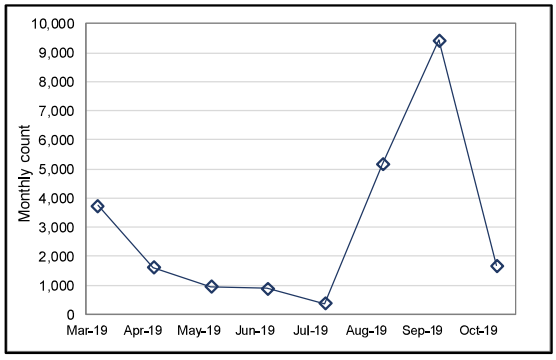


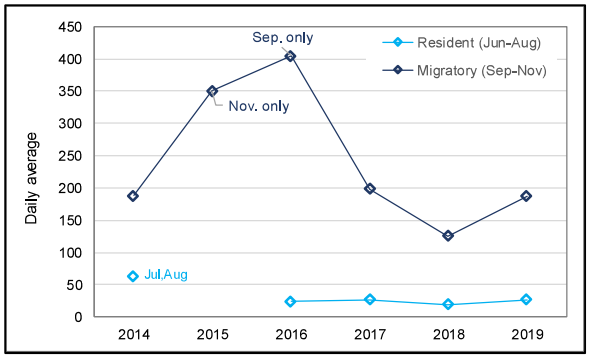
Note: Meeting the long-term guideline provides protection against negative effects on aquatic ecosystem structure and function during indefinite exposure. The short-term guideline is intended for the protection of most species against lethality during severe but transient events.

Figure ES-1: 2019 Monitoring Results and 2011-2019 Annual Results, Cont'd

e) Geese Count

Geese are the primary external source of nutrients in the Lake. Therefore, active geese management is completed annually. The geese control program started in 2014, focusing on resident geese. The program extended to the management of migratory geese in 2016. While the waterfowl number in Ontario has been reported to have doubled over the last ten years[1], the Swan Lake geese population has decreased since the inception of the geese control program, indicating the efficacy of the program.





Note 1: 2019 data are the sum of counts in each month.
Note 2: Annual data are daily averages of counts over June-August and September to November, representing resident and migratory geese, respectively.

Table ES-1 provides a summary of the observed blue-green algae blooms (a.k.a. cyanobacteria) in the Lake over the years. It also shows any tests conducted to measure toxins (mainly in terms of microcystin concentration) in the Lake water.

Table ES-1: Records of Blue-Green Algae Blooms and Toxicity

Year/Period	Blue-green Algae Blooms Observation	Toxicity Test Result
Before 2011	Several blooms of cyanobacteria were observed	Microcystin concentration under detection limit
2013-2016	No apparent cyanobacteria proliferation and blooms; no resident concern related to the Lake's water quality	Microcystin concentration under detection limit
2016	A bloom was detected at one location	Microcystin concentration of 73 µg/L in one sample tested (recreational guideline is 20 µg/L)
2017	No bloom was observed	-
2018	Extended blooms were observed at several sites	Not tested for toxicity; cell density was at half of WHO's threshold for significantly increased risk for human health
2019	Extended blooms were observed at several sites	Microcystin toxicity was measured with test strips; all samples were below 10 µg/L

Results Summary and Recommendations

Based on the measured Secchi desk transparency, and nutrient concentrations, Swan Lake was classified as hyper-eutrophic in 2019. Given that the three year average of 2017-2019 is above the 150 µg/L

[1] https://www.simcoe.com/opinion-story/8074290-goose-population-on-the-rise

threshold, the City should look into the next steps associated with treating the nutrient levels in the Lake to reduce algae growth. This work was initiated in the middle of 2019.

Other observations and decisions made in 2019 are as follows:

- In 2019, Environmental Services staff advised the Park Operations staff not to re-install the decorative fountain until after a treatment has been completed to avoid the spray of 'dirty' water on bystanders.
- Some of the warning signage that was previously in the park may have been removed or damaged. A review of the need for additional signage is to be performed in 2020.

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Appendices

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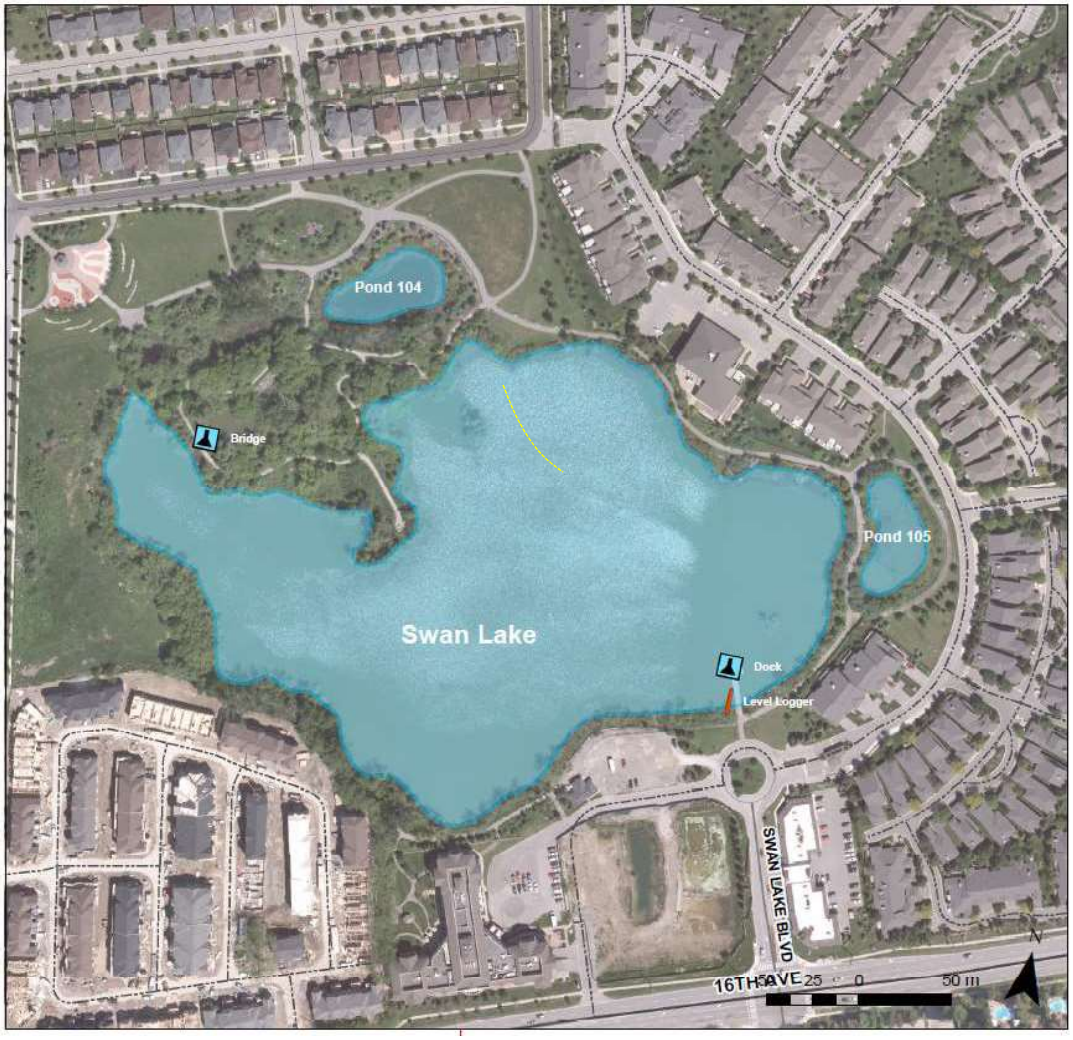
Figures

1. Introduction

Swan Lake is situated in the City of Markham at the intersection of Sixteenth Avenue and Williamson Road, as shown below in Figure 1. Swan Lake has an approximate area of 5.5 ha and a maximum water depth of 4.5 m. Formerly a gravel pit in the 1960s and 1970s, Swan Lake is currently a community feature with multiple trails and urban development surrounding it. Several issues were discovered with Swan Lake in 2010, including high phosphorus levels and significant algal blooms during the summer months, which led to low oxygen levels and degraded fish habitats. Thus, a Phoslock treatment was administered in 2013 to reduce the phosphorus levels and algal blooms in Swan Lake. Water quality monitoring of Swan Lake has been conducted annually since treatment in 2013 in order to track water quality and the continued effectiveness of the Phoslock. The collected data presented in this report is part of the ongoing monitoring program that will allow for continuous assessment of the water quality in Swan Lake and will be used to help establish a long-term plan for the treatment of Swan Lake. The 2019 monitoring results are presented in this report.

Figure 1: Swan Lake Location and Monitoring Stations



2. Water Quality

2.1 Monitoring Program

2.1.1 Locations

Water quality was monitored at two shoreline sites, the dock, and the bridge, as shown in Figure 1. The water depth at the dock is approximately 3 meters deep, which allows it to represent Swan Lake as a whole. The water depth at the bridge is about 0.5 meters deep, which was used to represent the conditions of the shallow bays around Swan Lake. Field testing and sampling for laboratory analysis were completed at both sites to ensure the water conditions at Swan Lake were properly represented.

During the bi-weekly monitoring, samples and measurements were taken at 0.5 m increments for the depth of the lake. The deepest samples were taken just above the bottom of the lake in order to avoid contamination of the samples with sediment. The dock site was the deeper of the two sites, allowing for sampling and monitoring from 0 – 3.0 m, whereas the bridge site was shallow and sampling was typically only achievable at a depth of 0.5 m from the surface. In the event that the water level was lower than normal, the sample was taken slightly above the bottom of the Lake to avoid sediment contamination.

2.1.2 Duration and Frequency

In 2019, water quality was monitored bi-weekly throughout the summer (May-September) and monthly in the spring (April) and fall (October-November). A total of 13 sampling event was completed.

2.1.3 Parameters and Methodology

Vertical water quality profiling, water transparency readings (Secchi depth), and photographic documentation were performed during each site visit.

Field testing was done utilizing a YSI ProODO meter to determine the temperature and dissolved oxygen (DO) at each sampling interval over the vertical profile of the lake. To ensure accurate readings, the meter and probe were stored in a proper carrying bag and regularly calibrated as instructed in the handheld quick-start guide.

In 2019, an Oakton EcoTestr™ pH 2+ Pocket pH Meter was used for onsite measurement of pH.

Water transparency was measured as part of the field testing at both the dock and bridge monitoring sites. Transparency was measured using a Secchi disk by lowering it into the water while rotating the handle until the black and white pattern of the Secchi disk was no longer visible. The water depth read from the Secchi disk was then recorded as the transparency depth.

Water samples for laboratory testing were taken using a LaMotte JT-1 water sampler at different depths for the two sites.

Observations of Swan Lake were noted, and photographs were taken during each monitoring/inspection site visit. Photographs provide a way to record the condition of vegetation and algae around Swan Lake. Completed inspection forms can be found in Appendix A. All photographs from the 2019 monitoring period are provided in Appendix B.

2.2 Water Quality Results

2.2.1 Dissolved Oxygen and Temperature

Table 1 provides the measured DO profile over the 2019 monitoring period. At the Dock station, below 2 m deep, the DO is under 2 m/L from late May through July, indicating anoxic conditions.

Table 2 provides the measured temperature profile in 2019, indicating warm water throughout the depth in the summer months.

Profiles of temperature and dissolved oxygen (see Figure 2) indicate that Swan Lake thermally stratified during the summer despite its shallow depth.

The decorative fountain close to the south shore provides some aeration and circulation in the vicinity of the Dock. As Swan Lake does not have any large flow inputs that regularly mix/stir the layers of water, this fountain helps to prevent stagnant conditions near the Dock site. The separation of water layers is evident during the summer months as DO decreases very drastically as water depth increases.

Table 1: Measured DO Profile (mg/L)

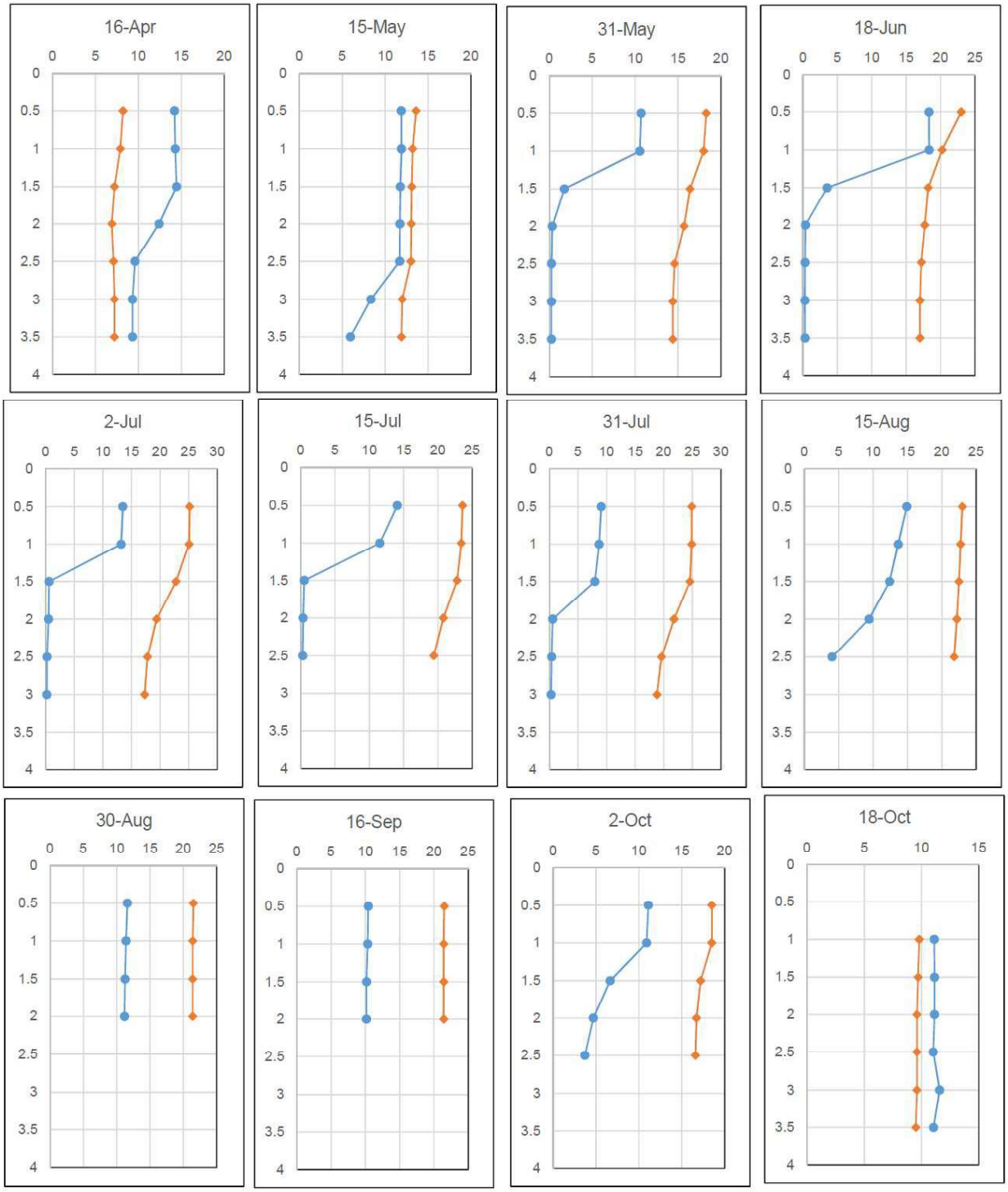
	Bridge		Dock						
	Depth (m)		Depth (m)						
Date	0.25	0.5	0.5	1	1.5	2	2.5	3	3.5
4/16/2019	-	13.6	14.2	14.3	14.4	12.4	9.6	9.3	9.3
5/15/2019	12.0	-	11.9	11.9	11.8	-	11.7	8.3	5.9
5/31/2019	-	4.1	10.7	10.6	1.8	0.3	0.3	0.2	0.2
6/18/2019	-	9.3	18.3	18.3	3.5	0.4	0.3	0.3	0.3
7/2/2019	-	5.2	13.5	13.2	0.6	0.5	0.2	0.2	-
7/15/2019	3.1	-	14.1	11.5	0.5	0.3	0.3	-	-
7/31/2019	4.5	-	9.1	8.7	8.0	0.6	0.4	0.3	-
8/15/2019	12.0	-	14.9	-	12.4	9.4	4.0	-	-
8/30/2019	7.8	-	11.6	11.4	11.2	11.2	-	-	-
9/16/2019	9.1	-	10.4	10.3	10.2	10.1	-	-	-
10/2/2019	6.2	-	11.1	10.9	6.7	4.7	3.7	-	-
10/18/2019	8.4	-	-	11.1	-	11.1	11.0	11.6	11.0

Note: DO below 2 mg/L is shown in red.

Table 2: Measured Temperature Profile (°C)

Date	Bridge		Dock						
	Depth (m)		Depth (m)						
	0.25	0.5	0.5	1	1.5	2	2.5	3	3.5
4/16/2019	-	8.0	8.2	7.9	7.2	6.9	7.1	7.2	7.2
5/15/2019	12.7	-	13.6	13.2	13.1	-	13.0	12.0	11.9
5/31/2019	-	17.3	18.3	18.0	16.4	15.7	14.6	14.4	14.4
6/18/2019	-	22.0	23.0	20.2	18.2	17.7	17.2	17.0	17.0
7/2/2019	-	24.8	25.2	25.1	22.8	19.4	17.8	17.3	-
7/15/2019	22.3	-	23.6	23.4	22.8	20.8	19.4	-	-
7/31/2019	24.0	-	24.9	24.9	24.6	21.8	19.6	18.8	-
8/15/2019	24.5	-	23.0	-	22.5	22.2	21.8	-	-
8/30/2019	21.6	-	21.5	21.4	21.4	21.4	-	-	-
9/16/2019	17.3	-	18.2	18.1	18.1	18.1	-	-	-
10/2/2019	18.0	-	18.5	18.5	17.2	16.7	16.6	-	-
10/18/2019	9.1	-	-	9.8	-	9.6	9.6	9.6	9.5
11/15/2019	-	2.3	7.1	-	5.0	-	4.2	-	-

Figure 2: Temperature and DO Profile at the Dock Station



Note: The vertical axis shows depth (m), while the horizontal axis represents both Temperature (°C) and DO (mg/L).