2018 SUMMERSIDE LAKE LIMNOLOGICAL MONITORING RESULTS

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Submitted to:

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OF

SUMMERSIDE LAKE RESIDENTS' ASSOCIATION

EDMONTON, ALBERTA

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1.0 INTRODUCTION AND BACKGROUND

Summerside Lake is an urban lake located in Edmonton, Alberta. Summerside Lake was constructed in 1999-2000 and filled with water in 2000. The lake provides residents of the community with various opportunities for recreation and aesthetic use including swimming, fishing, non-motorized boating and "natural area" viewing.

The Summerside Lake Residents' Association (herein referred to as the "Association") manages the use and maintenance of the lake. Over the course of operation, the Association has contracted EnviroMak Inc. Environmental Management Consultants to provide science-based information contributing to lake management decision-making and action including limnological monitoring of the aquatic ecosystem.

Assessment of the water quality and limnologic status of Summerside Lake has been conducted periodically since 2001 and was assessed again in 2018. The 2018 limnological monitoring assesses whether various aquatic ecosystem indicators remain within acceptable limits for fish health and monitors aquatic ecosystem indicator trends including water quality trends to evaluate the overall status of the lake and provide recommendations for continued management of a functional urban lake environment meeting the targets and expectations of the stakeholders.

Following biophysical assessments conducted by EnviroMak Inc. in 2001 and 2002, Rainbow Trout (*Oncorhynchus mykiss*) were stocked annually for recreational angling. In 2005 following an assessment by EnviroMak Inc., Triploid Grass Carp (*Ctenopharyngodon idella*) were stocked in the lake to control aquatic vegetation. A presentation and discussion at the Summerside Lake Association Annual General Meeting in June 2011 led to the decision to reduce the Yellow Perch (*Perca flavescens*) population so as to fortify the health of the stocked trout population and continue to meet stakeholder expectations for recreational use. As a result, the Yellow Perch removal project has occurred every year from 2012 – 2018.

The overall 2018 limnological monitoring at Summerside Lake was conducted in conjunction with the Yellow Perch removal and ongoing lake monitoring.

This report provides the results from the 2018 Summerside Lake limnological monitoring and represents the results of the culmination of all 2018 activities, results and observations including Yellow perch removal and the detailed aquatic vegetation assessment undertaken in 2018. For specific details regarding the 2018 Yellow Perch removal, please see the EnviroMak Inc. 2018 Summerside Lake Yellow Perch Removal Report.

2.0 OBJECTIVES

The overall objective of the 2018 limnological monitoring was to assess whether various aquatic ecosystem indicators remained within acceptable limits for fish health and to monitor aquatic ecosystem indicator trends including water quality trends to evaluate the overall status of the lake and provide recommendations for continued management of a functional urban lake environment meeting the targets and expectations of the stakeholders.

In 2015, the limnological analysis found trends indicative of changing water quality (increased aquatic vegetation, coliforms, total dissolved solids and conductivity), prompting the continued sampling analysis including the water quality assessment in 2018. Aquatic vegetation in 2017 was noted as a concern and increased intensity of assessment of coverage, abundance and diversity occurred in 2017 as a result along with a substrate characterization of the lake bed materials. In 2018, the aquatic vegetation was characterized in a similar manner as 2016 with consideration of 2017 methods and results for trend analysis.

The ecological and limnological data gathered over the course of the 2018 year was considered with historical data for trend characterization. This data was then used to produce conclusions and recommendations to guide future action for management of a healthy lake ecosystem servicing the surrounding community.

3.0 STUDY AREA AND METHODS

Sampling was conducted during both open water and ice-covered periods on April 24, May 4 and August 14, 2018 (Table 3.1). Appendix 9.0 describes the spatial and temporal sampling protocol and sampling techniques applied to Summerside Lake.

Table 3.1. List of EnviroMak Inc. on-site Summerside Lake activity dates and descriptions for 2018.

Date	Activity Type	Description	Analysis
24-Apr-18	Field Sampling	Baseline limnological assessment - Winter	Water quality
4-May-18	Field Sampling	Baseline limnological assessment and perch removal - Spring	Water quality
14-Aug-18	Field Sampling	Comprehensive limnological assessment – Summer	Water quality Aquatic vegetation Plankton Sediment/substrate Other

Water samples for a variety of water quality parameters were collected and tested onsite and submitted to a qualified laboratory for appropriate analyses. Water clarity (light penetrance) was recorded in the field using a Secchi disk. Vegetation sampling was undertaken during the open water period, and aquatic macrophytes were harvested using a modified vegetation rake sampler. Plankton sampling was conducted with standard plankton net using a 3.0m horizontal draw. Macroscopic plankton were counted and recorded as a number count per volume unit. Substrate/sediment sampling was conducted in 2018 with an Eckman dredge to characterize the substrate/sediments. Substrate sampling had previously only been conducted on the lake on the lake in 2017.

Several of the water quality parameters were measured in an accredited Edmonton laboratory (Exova Labs accredited by all relevant federal and provincial agencies including the Canadian Association for Environmental Analytical Laboratories and the Standards Council of Canada) while other parameters were measured with EnviroMak Inc. calibrated meters and laboratory equipment (Appendix 9.0).

4.0 RESULTS

4.1 Yellow Perch Removal Results Summary

The spring 2010 to 2018 Yellow Perch removal included the following results:

1. Between 2013 and 2015, approximately 19,530 fish were relocated from Summerside Lake to Halfmoon Lake, including ~3850 fish in 2013, ~7140 fish in 2014 and ~8540 fish in 2015. From 2016 to 2018, 2972 yellow perch were removed and disposed of according to the Alberta Government Fisheries Research Licence Requirements. This included 2972 fish in 2016, 452 fish in 2017 and 545 fish in 2018.

2. Yellow Perch were present in most places in the lake and included fish that were possibly up to 10 years of age; however, no fish older than 8 years of age were sampled. Several age classes were spawning including two and three-year old fish.

3. The removal of Yellow perch appears to be, to some extent, influencing the size, mean age and densities of the population. In 2018, both female and male Yellow Perch were measured to be decreasing in size, primarily in weight (Tables 4.1.1 & 4.1.2; Figure 4.1.1).

4. The 2018 fish appeared to be smaller in weight than the fish captured in 2017 and similar to the fish caught in 2012-2016. The range of lengths increased with both shorter and longer fork lengths measured compared to 2017, while the range of weights significantly decreased during the same time period. The significant difference in weight between 2017 and 2018 may be due to timing of capture and whether the fish were pre or post-spawn (Figure 4.1.1).

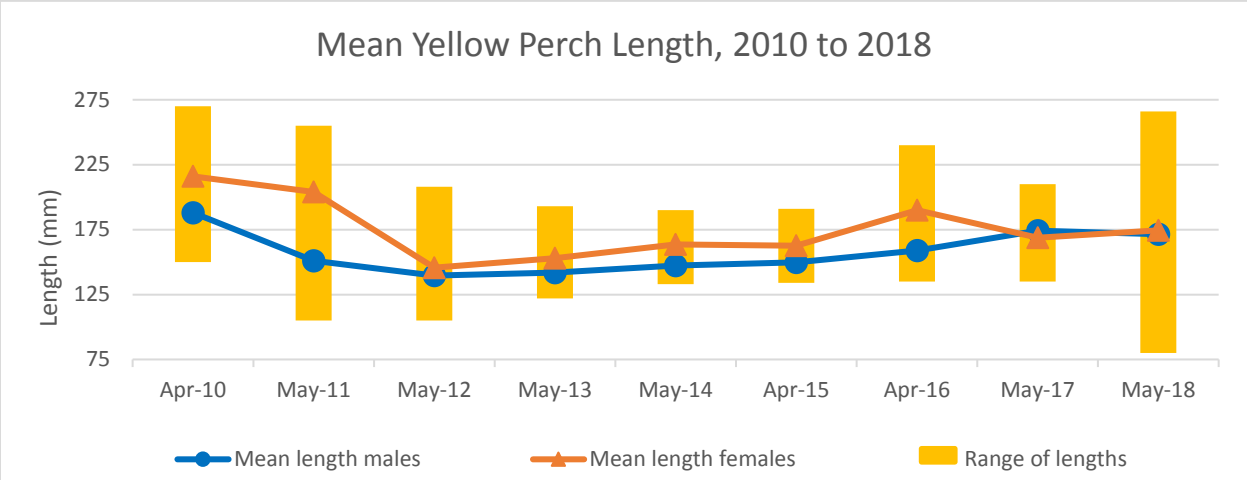
5. The catch rate in 2018 increased slightly from the previous year. From 2010 until 2012, catch rates of Yellow Perch increased from 0.47/net hour in 2010, 2.8/net hour in 2011 and 15.3/net hour in 2012, followed by a peak in 2013 and 2015 at 18.2/net hour and 15.6/net hour, respectively. In 2016 and 2017 catch rates declined to 2.5/net hour and 1.2/net hour, respectively. The 2018 catch rate increased from the 2017 catch rate, at 1.9/net hour. The density of Yellow Perch declined as intended in 2016 and 2017, but 2018 showed a slight increase in density.

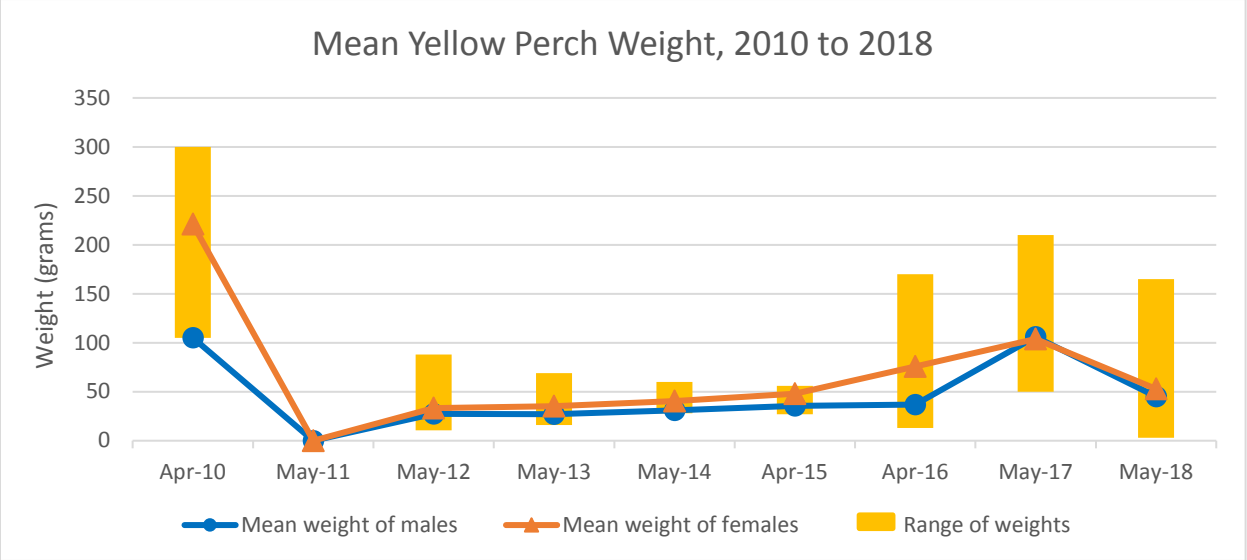
6. The focus on 38mm gill net mesh sizes has effectively targeted Yellow Perch and avoided needless capture and handling of stocked Rainbow Trout.

7. Other wildlife observed/heard during the 2018 fish removal and water quality site visits include: Sandpiper species, Double-crested Cormorant (*Phalacrocorax auratus*), Canada Goose (*Branta canadensis*) and various leeches/aquatic invertebrates.

Table 4.1.1. Yellow Perch population characteristics at Summerside Lake from 2010 to 2018.

Population Characteristic	April 2010	May 2011	May 2012	May 2013	May 2014	April 2015	April 2016	May 2017	May 2018
Range of lengths (mm)	150-270	105-255	105-208	122-193	133-190	134-191	135-240	135-210	80-266
Mean length males (mm)	188	151	139.6	142	147.4	149.7	158.9	174.2	171.5
Mean length females (mm)	216	204	145.7	153	163.6	162.7	190.0	168.7	174.4
Range of weights (gr)	105-300	-	10.6-88	16-69	28-60	27-56	13-170	50-210	3-165
Mean weight of males (gr)	105	-	27.3	27	30.9	35.7	36.9	106	45
Mean weight of females (gr)	221	-	33.2	35.1	40.5	48.0	75.9	104	53
Mean age males	4.0	3.2	3.9	2.4	3.4	3.8	4.2	4.1	4.2
Mean age females	4.4	4.1	4.4	2.6	4.5	4.5	5.6	4.0	3.4
Overall mean age	4.3	3.4	4.0	2.5	3.9	4.1	4.5	4.1	4.0
Sample size (n)	31	30	73	80	76	68	150	101	100





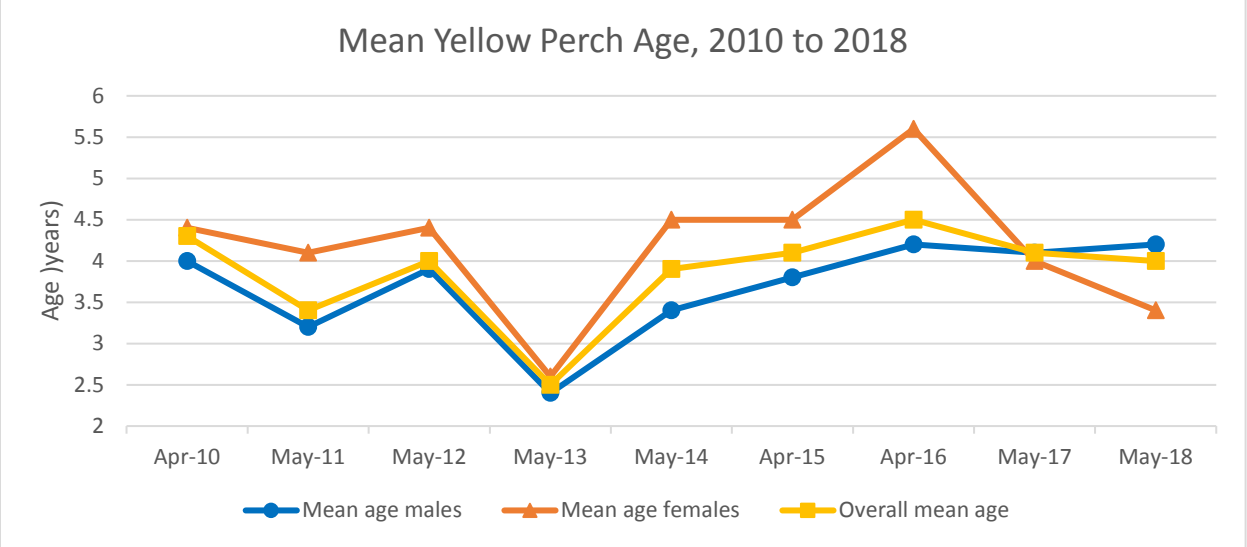


Figure 4.1.1. Summary of trends in length (mm), weight (gr) and age of the Yellow Perch population at Summerside Lake from 2010 to 2018.

Table 4.1.2. Yellow Perch fish catch characteristics at Summerside Lake from spring of 2010 to 2018.

Year	Number of Days Fished	Total Number of YLPR Caught	Mean Length of YLPR (mm) [Males M Females F]	Number of YLPR Caught per 50yd Gill Net Hour	Comments
2010	2	31	188 M 216 F	66 net hours 0.47 YLPR/hr	Multi-mesh nets used to sample Initial scoping 63 Rainbow Trout
2011	3	370	151 M 204 F	132 net hours 2.8 YLPR/hr	Two mesh sizes used (38mm and 63.5mm); 3-5 nets/night During short pre-spawning capture dates and ice out period of <3 days 30 Rainbow Trout
2012	5	4766	140 M 146 F	312 net hours 15.3 YLPR/hr	Two mesh sizes used (38mm and 63.5mm); 3-6 nets/night During long pre-spawning capture dates and ice out period of >5 days 3 Rainbow Trout
2013	5	~8692	142 M 153 F	477.75 net hours 18.2 YLPR/hr	One mesh size used (38mm); 6 nets/night During short pre-spawning capture dates and ice out period of ~3 days 8 Rainbow Trout
2014	4	~6919	147.4 M 163.55 F	*636 net hours 10.9 YLPR/hr	One mesh size focused (38mm); two other sizes used but did not capture YLPR); 9 nets/night During short pre-spawning capture dates and ice out period of ~3 days 10 Rainbow Trout
2015	4	~10,082	149.7 M 162.7 F	*646 net hours 15.6 YLPR/hr	One mesh size focused (38mm); two other sizes used but did not capture YLPR; 8 to 9 nets/night During long pre-spawning capture dates and ice out period of >5 days 1 Rainbow Trout
2016	5	1975	159.1 M 195.1 F	804 net hours 2.5 YLPR/hr	One mesh size used (38mm); 8 nets/night During long pre-spawning captures dates and ice out period of >5 days; however only 3 capture dates conducted in pre-spawning period then 2 further capture dates during post-spawning 16 Rainbow Trout; 1 Triploid Grass Carp
2017	2	452	174.2 M 168.7 F	368 net hours 1.2 YLPR/hr	One mesh size used (38mm); 8 nets/night During long pre-spawning capture dates and ice out period of >5 days; however only 2 days pre-spawning capture dates, none post spawning 11 Rainbow Trout
2018	2	545	171.5 M 174.4 F	290 net hours 1.9 YLPR/hr	One mesh size used (38mm); 8 nets/night 7 Rainbow Trout 4 Rainbow Trout captured alive and released

*Only 38mm nets used in net hour count as the other nets did not effectively capture Yellow Perch

4.2 Limnological Field Data Collection Results

Water quality samples were taken on April 24, May 3 and August 14, 2018. Water quality parameters sampled include turbidity, conductivity, total dissolved solids, pH, alkalinity, dissolved oxygen and threshold odour number (Table 4.2.1). An additional threshold odour test was conducted in July 2018 as well. See Figure 9.1 for sampling locations for water quality, lake sediment/substrate and TON.

Water clarity was tested using a secchi disk lowered into the water and could be viewed at a depth of 3.2 m and 3.5 m in both the north and south portions of Summerside Lake, respectively (Table 4.2.2).

Aquatic vegetation was sampled along the lake bed at various locations (Figure 9.2), and a moderate abundance of water common stonewort (*Chara vulgaris*) and small-leaf pondweed (*Potamogeton pusillus*) were found throughout most of Summerside Lake. Coontail (*Ceratophyllum demersum*) was observed around the southern portion of the beach area as well as the southwest corner of the lake, and *Myriophyllum* sp. (a macrophytic algae) was present. Semi-aquatic species, including Cattail (*Typha latifolia)* and Common Great Bulrush (*Schoenoplectus tabernaemontani*), were observed on the northeast shores of the lake (Table 4.2.3). Aquatic vegetation was present to a depth of 7.3 m (Table 4.3.3) throughout Summerside Lake and was sampled and quantified to a depth of 2.0 m (Table 4.2.3).

Zooplankton was present throughout Summerside Lake with 161 zooplankton or more observed per 25ml sample (Table 4.2.4). It would be extrapolated from this sampling result that approximately 3220 zooplankton per 500 ml sample would be expected.

Lake bed sediment/substrate sampling was conducted on August 14, 2018. Analysis of ten substrate samples, collected in both the littoral and deep zones of the lake, was conducted. Characteristics including composition, texture, odour and appearance were described for each sample collected (Table 4.2.5).

Water samples taken on August 14, 2018 were tested for bacteria, nutrient levels and metal presence, as well as other water quality parameters (Table 4.2.6). In addition, these water samples were also tested for herbicides (Table 4.2.7). None of these elements exceeded the Canadian Environmental Quality Guidelines for Protection of Freshwater Aquatic Life (2011).

For the 2018 sampling, microcystin concentration was added to the analysis in order to address any potential eutrophication (harmful cyanobacteria blooms caused by excess nutrients in the water) issues. Microcystins are toxins produced cyanobacteria (blue-green algae) that can cause severe liver damage, and their concentrations are directly correlated with increased cyanobacteria blooms (ALMS 2017). Alberta's recreational guidelines sets the limits for microcystin at 20 ug/L, and the June 2018 microcystin levels were below these guidelines at <0.2 ug/L (Table 4.2.5).

Dissolved oxygen levels were sampled at three different depths within the lake including surface, mid-depth and bottom. The dissolved oxygen levels were sampled in April, May and August. In May, the levels

ranged from 12.82 mg/L at the surface to 13.0 mg/L at the bottom. In August, dissolved oxygen measured at 8.48mg/L throughout all depths.

On June 25, 2018 an unpleasant odour was detected at the lake and EnviroMak was contacted to conduct an additional threshold odour test. A strong slough-odour was noted in the air near recently turned on aerator heads that were operating at that time. Threshold Odour Number (TON) was analyzed and it was determined that there was no increase in water TON between the June 27, 2018 and August 2017 samples. It was concluded from the TON results, that the aerator system was producing the increase of odour into the air but the odour of the lake water itself was not affected.

Additionally, on July 13, 2018 an elevated fecal coliform reading (170FC/100ml) was measured and reported by Summerside Lake maintenance staff. More intensive sampling was conducted and all further samples were acceptable having low fecal coliform readings. The one elevated sample was concluded to be an anomaly.

Table 4.2.1. Water quality characteristics at Summerside Lake during the 2018 sampling season.

Parameter	Date			
	April 24, 2018	May 3, 2018	June 27, 2018	August 14, 2018
Turbidity (NTU)	1.90	1.41	-	1.47
Conductivity (µs)	476	609	-	633
Total Dissolved Solids (mg/L)	330	433	-	470
pH	8.50	9.02	-	8.54
Alkalinity (mg/L)	47.6	102.0	-	108.8
Dissolved Oxygen (mg/L)	11.06	12.93	-	8.48
Temperature (°C)	6.7	7.9	-	19.6
TON	2.4	-	5.6	3.25

TON – Threshold Odour Number

Table 4.2.2. Secchi disc reading results for Summerside Lake at north and south sampling locations on August 14, 2018.

Secchi Reading Depth (m)	North	Central	South
	3.2	3.75	3.5

Table 4.2.3. Aquatic vegetation species composition and abundance at Summerside Lake on August 14, 2018 found at 1.0 – 1.5 m depth utilizing modified vegetation rake sampler, Eckman dredge and visual observation methods.

Location		Depth	Species	Abundance
SE	1	1.0-1.5 m	*Chara vulgaris* *Potamogeton pusillus* *Ceratophyllum demersum*	M
	2	1.0-1.5 m	*Chara vulgaris* *Potamogeton pusillus* *Ceratophyllum demersum*	H
	3	1.0-1.5 m	*Chara vulgaris* *Ceratophyllum demersum*	S
	4	1.0-1.5 m	-	Z
	5	1.0-1.5 m	*Chara vulgaris*	M
	6	1.0-1.5 m	*Myriophyllum* sp.	M
	Total			1 H; 3 M; 1 S; 1 Z
SW*	7	1.0-1.5 m	*Chara vulgaris*	M
	8	1.0-1.5 m	*Chara vulgaris* Green algae sp.	M
	9	1.0-1.5 m	*Chara vulgaris*	H
	10	1.0-1.5 m	*Chara vulgaris*	H
	Total			2 H; 2 M
NW	11	1.0-1.5 m	*Chara vulgaris*	M
	12	1.0-1.5 m	*Chara vulgaris* *Potamogeton pusillus* *Ceratophyllum demersum*	H
	13	1.0-1.5 m	*Potamogeton pusillus*	M
	14	1.0-1.5 m	-	S
	15	1.0-1.5 m	*Chara vulgaris*	M
	Total			1 H; 3 M; 1 S
NE	16	1.0-1.5 m	*Typha latofolia* *Schoenoplectus tabernaemontani*	M
	17	1.0-1.5 m	*Chara vulgaris* *Potamogeton pusillus* *Ceratophyllum demersum*	H
	18	1.0-1.5 m	-	Z
	19	1.0-1.5 m	*Chara vulgaris*	S
	Total			1 H; 1 M; 1 S; 1 Z

Abundance: H – High, M – Medium, S- Scant, Z- Zero
**Ranunculus aquatilis var.* observed in southwest littoral zone but abundance not quantified.

Table 4.2.4. Total zooplankton observed within 25 ml samples of Summerside Lake North and South from August 14, 2018.

Zooplankton (#/25mL)	North	South
	137	161

Table 4.2.5. Water quality analysis results for Summerside Lake on August 14, 2018.

Water Quality Parameter	Date
	August 14, 2018
Kjeldahl Nitrogen (mg/L)	0.52
Total Phosphorus (mg/L)	<0.05
Dissolved Phosphorus (mg/L)	<0.05
Chlorophyll A (ug/L)	2
Dissolved Chloride (mg/L)	8.5
Dissolved Sulfate (mg/L)	221
Hydroxide (mg/L)	<5
Carbonate (mg/L)	<6
Bicarbonate (mg/L)	114
Hardness (mg/L)	216
Conductivity (us)	652
TDS (ppm)	415
pH	8.25
Alkalinity (mg/L)	93.7
Total Coliforms (CFU/100ml)	130
E coli (CFU/100ml)	96
Aluminum (mg/L)	<0.02
Calcium (mg/L)	49.2
Copper* (mg/L)	0.001
Iron* (mg/L)	<0.05
Lead* (mg/L)	<0.0001
Magnesium (mg/L)	23.6
Manganese (mg/L)	0.025
Phosphorus (mg/L)	<0.05
Potassium (mg/L)	4.1
Sodium (mg/L)	54.6
Zinc* (mg/L)	0.002
Microcystin (ug/L)	<0.2

*Maximum acceptable limits for Copper = 0.002, Iron = 0.3, Lead =0.00213, Zinc = 0.03 (mg/L) as determined by the CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life January 2011

Table 4.2.6. Lake substrate/sediment sample results from Summerside Lake on August 14, 2018.

Lake Area Location (SE, SE, SW, NW)	Sample ID	Odour	Depth	Colour	Texture	Sample Comments
SE	Littoral	Light earthy	0 - 1 mm	Light brown	Silt	Some sand grains noted in sample.
			1 - 66 mm	Black	Organic muck	
SW	Littoral	Earthy / Vegetation	0 - 2 mm	Dark brown	Silty loam	Higher undecomposed plant content than other samples.
			2 - 55 mm	Black	Organic muck	
NW	Littoral	Strong egg/Sulphur	0 - 1 mm	Dark brown	Silty loam	Some substrate material floating on water.
			1 - 40 mm	Black	Organic muck	
	Deep	Moderate egg/Sulphur	0 - 3 mm	Light brown	Silt	-
			3 - 30 mm	Black	Organic muck	
NE	Littoral	Strong egg/Sulphur	0 - 2 mm	Light brown	Silt	-
			2 - 43 mm	Black	Organic muck	

Table 4.2.7. Herbicide detection at Summerside Lake on August 14, 2018.

Herbicide type	August 14, 2018
Neutral Herbicide (ug/L)	<0.5
Acidic Herbicide (ug/L)	<0.1

4.3 Comparative Analysis of Results (2001 to 2018)

Water quality samples have been collected since August 8, 2001. While turbidity, conductivity, pH, and alkalinity have fluctuated since 2001, overall there have been only small changes in these values. (Table 4.3.1). Total dissolved solids (TDS) do appear to have increased since 2001. In 2001 – 2006 the maximum TDS value was 256 mg/L, and from 2009 to 2018 TDS ranged from 291-520 mg/L. The 2018 TDS value of 470 mg/L was slightly higher than the 2017 value of 433 mg/L. Threshold odour number (TON) also appears to have increased; in 2001 the TON value was 1.3, and from 2012 to 2018 TON has ranged from 2.1-6.5, with a 2018 value of 3.25 (Table 4.3.2 & Figure 4.3.4).

Water samples have also been tested for bacteria, nutrient levels and metal presence from August 8, 2001 to August 14, 2018 (Table 4.3.2). Total Coliforms decreased from 84 CFU/100 mL in 2012 to 8 CFU/100 mL in both 2016 and 2017, but significantly increased to 130 CFU/100 mL in 2018 (Table 4.3.2). Nutrient levels have stayed relatively consistent since 2001, with only a few fluctuations including spikes in 2015 (Table 4.3.2). Kjeldahl Nitrogen steadily increased since 2001, peaking at 0.93 mg/L in 2018 and leveling out to 0.52 in 2018 (Figure 4.3.3). In 2001 – 2007 the maximum Kjeldahl Nitrogen value was 0.4mg/L, and from 2011 to 2018 Kjeldahl Nitrogen ranged from 0.25-0.93 mg/L. From 2017 to 2018, Kjeldahl Nitrogen slightly increased from 0.41 mg/L to 0.52 mg/L. Since 2001, small increases have also been observed in a few metals, such as Magnesium and Sodium, while other metals, such as Aluminum, have decreased. From 2004 to 2018, Aluminum has been <0.02 mg/L (Table 4.3.2). None of these elements have exceeded the Canadian Water Quality Guidelines for the Protection of Aquatic Life (January 2011).

Aquatic vegetation was sampled for in 2001, 2003, 2004, 2006, 2011, 2012, 2014, 2015, 2017 and 2018 (Table 4.3.3). In 2003, muskgrass (*Chara* sp.) was the first persistent aquatic vegetation observed within Summerside Lake. Small-leaf pondweed (*Potamogeton pusillus*) and water milfoil (*Myriophyllum* sp.) were observed throughout Summerside Lake since 2004 (Table 4.3.3). Beginning in 2012, aquatic vegetation has been found to depths of 6.0 m. Since 2003, a consistent increase in aquatic vegetation has been observed (Table 4.3.3).

Zooplankton also increased since 2006 with an average of 30 zooplankton/500mL in 2006, 35 zooplankton/500mL in 2011, 96 zooplankton/500mL in 2012, 742 zooplankton/500mL in 2015, 5330 zooplankton/500mL in 2017 and a decrease in 2018 at 2970 zooplankton/500mL (Table 4.3.4).

Lake bed substrate sampling occurred once previously, in 2017. Composition and texture of the lake substrate in 2018 were similar to 2017 with a layer of silt on top of clay and/or organic muck present in all sampled areas. Increased sand content was noted in the southeast littoral sample, likely due to proximity to the beach or potentially due to erosion from the upland development on the adjacent banks.

Table 4.3.1. Water quality characteristics at Summerside Lake on various dates from August 8, 2001 to August 14, 2018.

Parameter	Aug 8, 2001	Sept 2, 2003	Sept 16, 2004	June 2, 2006	July 30, 2009	March 28, 2011	Sept 15, 2011	Aug 24, 2012	May 6, 2013	Sept 15, 2014	April 22, 2015	March 24, 2015	Aug 20, 2015	March 9, 2017	May 5, 2017	Aug 16, 2017	April 24, 2018	May 3, 2018	Aug 14, 2018
Turbidity (NTU)	2.87	1.16	0.42	0.94	2.80	1.37	2.74	-	1.44	1.04	2.32	4.08	0.86	2.34	0.98	1.21	1.90	1.41	1.47
Conductivity (µs)	298	491	457	504	628	666	579	590	671	672	687	591	730	811	528	683	476	609	633
Total Dissolved Solids (mg/L)	148	246	231	256	316	333	291	295	477	340	480	422	520	573	374	478	330	433	470
pH	8.53	8.4	7.65	8.43	7.15	6.75	6.76	7.55	8.41	8.14	8.26	9.22	8.67	8.58	8.99	8.81	8.50	9.02	8.54
Alkalinity (mg/L)	120	120	120	120	140	130	160	120	130	120	120	100	200	40.8*	102	110.5	47.6*	102.0	108.8
Temperature (°C)[1]	-	17.7	13.3	-	-	2.5	15.9	20.3	9.5	14.6	8.0	2.1	19.7	1.4	8.1	20.1	6.7	7.9	19.6

[1]Temperature readings taken at a depth of 0-20 cm below the water surface.
*Result may be indicative of error in sample analysis

Table 4.3.2. Additional water quality characteristics at Summerside Lake on various dates from August 8, 2001 to August 14, 2018.

Water Quality Parameter	Aug 8, 2001 - March 1, 2002	July 4, 2002 - Aug 7, 2002	Sept 2, 2003	Sept 16, 2004	June 2, 2006 - Oct 5, 2006	June 11, 2007 - Aug 7, 2007	March 28, 2011	Sept 15, 2011	Aug 24, 2012	Sept 23, 2014	Mar 24, 2015	Aug 20, 2015	Aug 16, 2017	Aug 14, 2018
Oil and Grease (mg/L)	0	-	<5	0	-	-	62.0	<5	-	-	<0.5	<5	<5	33
Kjeldahl Nitrogen (mg/L)	<0.05	0.07-00.15	0.24	0.22	0.26-<0.5	0.33-0.4	0.71	0.50	0.52	<0.25	0.52	0.93	0.41	0.52
Total Phosphorus (mg/L)	0.21	<0.05-0.11	<0.05	<0.05	<0.05-0.12	<0.05	<0.05	<0.05	0.0080	0.010	<0.05	<0.05	<0.05	<0.05
Dissolved Phosphorus (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05
Chlorophyll A (ppm)	1.3	<1	0.5	2.333	0.345-2.7	0.8-1.9	10	3.6	2.57	1.9	10	2	2	2
Phaeophytin (ppm)	-	-	-	-	-	-	2	1.2	-	-	1	<0.5	<0.5	1
Dissolved Chloride (mg/L)	-	-	-	-	-	-	7.2	7.7	6.0	6.9	7.4	7.2	7.7	8.5
Dissolved Sulfate (mg/L)	-	-	-	-	-	-	205	191	200	230	207	237	220	221
Hydroxide (mg/L)	-	-	-	-	-	-	<5	<5	Not Detected	<0.50	<5	<5	<5	<5
Carbonate (mg/L)	-	-	-	-	-	-	<6	<6	Not Detected	<0.50	<6	<6	<6	<6

Water Quality Parameter		Aug 8, 2001 - March 1, 2002	July 4, 2002 - Aug 7, 2002	Sept 2, 2003	Sept 16, 2004	June 2, 2006 - Oct 5, 2006	June 11, 2007 - Aug 7, 2007	March 28, 2011	Sept 15, 2011	Aug 24, 2012	Sept 23, 2014	Mar 24, 2015	Aug 20, 2015	Aug 16, 2017	Aug 14, 2018
Bicarbonate (mg/L)		-	-	-	-	-	-	160	129	120	110	130	115	124	114
Hardness (mg/L)		-	-	-	-	-	-	248	219	210	210	212	213	212	216
Clarity (m)		2.14	6.8-8.75	5.7	4.71	4.08-6.5	9.42	-	-	4.6	3.0	-	4.2 – 5.0	4.8-5.0	3.2-3.75
Dissolved Oxygen (mg/L)		-	9.28-12.34	7.30-8.48	11.55-13.10	10.71-11.7	9.69-9.75	5.29 - 7.60	8.20-9.0	9.16	8.22	~7	8.53	9.11-9.20	8.48
TON		1.3	0.43-1.15	0.43	1	0-4.3	-	-	-	2.1	3.25	3.8	North: 2.8 South: 5.5	6.5	3.25
Total Coliforms (CFU/100ml)		<1-380	<1	-	<1	1-125	7	3	2 (East) 2 (West)	84	250[1]	-	8	8	130
***E coli* (CFU/100ml)**		<1-111	<1	<1-1	2	<1-89	5	<1	1 (East) 2 (West)	3.0	2.0	-	4	<1	96
Metals (mg/L)	**Aluminum**	0.058	0.027-0.117	0.017	0.006	0.012-0.669	-	0.04	0.04	0.013	<0.02	<0.02	<0.02	<0.02	<0.02
	Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	0.069
	Calcium	-	-	-	-	-	-	53.2	53.2	49	43.7	43.7	48.3	49.2	49.2
	Copper	0.014	0.001-0.004	0.002	0.004	0.002-0.006	-	<0.001	<0.001	0.0016	<0.001	<0.001	<0.001	0.001	<0.001
	Iron	-	-	-	-	-	-	0.06	0.06	Not Detected	<0.05	<0.05	<0.05	<0.05	<0.05
	Lead	<0.002	<0.0001-0.0002	<0.0001	0.0001	<0.0001-0.0052	-	<0.0001	<0.0001	Not Detected	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Magnesium	-	-	-	-	-	-	20.8	20.8	22	18.0	18.0	22.9	22.1	23.6
	Manganese	-	-	-	-	-	-	0.070	0.070	0.011	<0.05	0.009	0.022	0.010	0.025
	Phosphorus	-	-	-	-	-	-	<0.05	<0.05	Not Detected	3.2	<0.05	<0.05	<0.05	<0.05
	Potassium	-	-	-	-	-	-	3.3	3.3	3.6	41.4	3.2	4.2	3.8	4.1
	Selenium	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0002
	Sodium	-	-	-	-	-	-	42.1	42.1	43	0.002	41.4	53.6	51.5	54.6
	Zinc	0.0076	0.001-0.006	<0.001	0.008	0.002-0.034	-	0.001	0.001	Not Detected	<0.0030	0.002	0.001	0.001	0.002

[1]Lab analysis may have errors due to care of sample while in possession of laboratory.

Table 4.3.3. Summary of aquatic vegetation at Summerside Lake summary from 2001 to 2018.

Parameter	Dates Measured									
	Aug 8, 2001	**Sept 2, 2003**	**Sept 16, 2004**	**June – Oct 2006**	**Sept 15, 2011**	**Aug 24, 2012**	**Sept 15, 2014**	**Aug 20, 2015**	**July 20, 2017**	**Aug 14, 2018**
Species Present	-	*Chara* sp.	*Chara* sp.	*Chara* sp.	*Chara* sp.	*Chara* sp.	*Chara* sp.	*Chara* sp.	*Chara vulgaris*	*Chara vulgaris*
	-	*Cladophora* sp.	*Myriophyllum* sp.	*Myriophyllum* sp.	*Myriophyllum* sp.	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*
	-	*Alisma gamineum*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Myriophyllum* sp.	*Myriophyllum* sp.	*Myriophyllum* sp.	*Ranunculus aquatilis var.*	*Ranunculus aquatilis var.*
	-	-	-	*Cladophora* sp.	- *Cladophora* sp.	- *Cladophora* sp.	- *Cladophora* sp.	*Ceratophyllum demersum*	*Ceratophyllum demersum*	*Ceratophyllum demersum*
	-	-	-	-	-	-	-	-	*Myriophyllum sp.*	*Myriophyllum* sp.
Number of Species	0	3	3	4	4	4	4	4	5	5
Average Abundance	None	Low abundance	Moderate abundance	Areas of abundant growth	High abundance	High abundance	High abundance	High abundance	High abundance	Moderate abundance
Maximum Depth of Observed Presence (m)	0	Shoreline surveyed only	3.4 (most species <1.0m)	1.2	2.8	6.0	6.0	6.0	6.0	7.3

Table 4.3.4. Total zooplankton observed within 500ml of Summerside Lake North and South samples from 2006 to 2018.

Zooplankton (#/500mL)	**June – Oct 2006[1]**		**September 15, 2011**		**August 24, 2012**		**August 20, 2015**		**August 16, 2017**		**August 14, 2018**	
	North	South	North	South	North	South	North	South	North	South	North	South
	~13	~47	6	63	73	118	883	600	4960	5700	2730	3210

[1]Average of 5 water samples taken in the open water season.

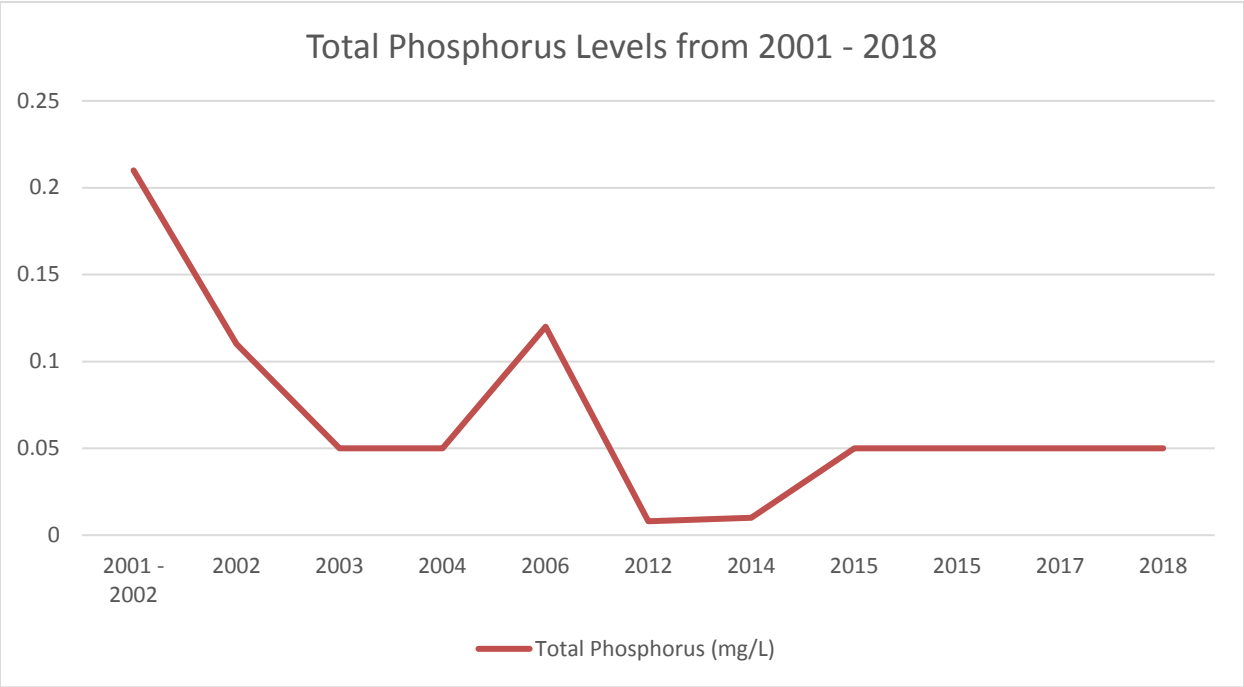


Figure 4.3.1. Total phosphorus levels (mg/L) in Summerside Lake from 2001 to 2018.

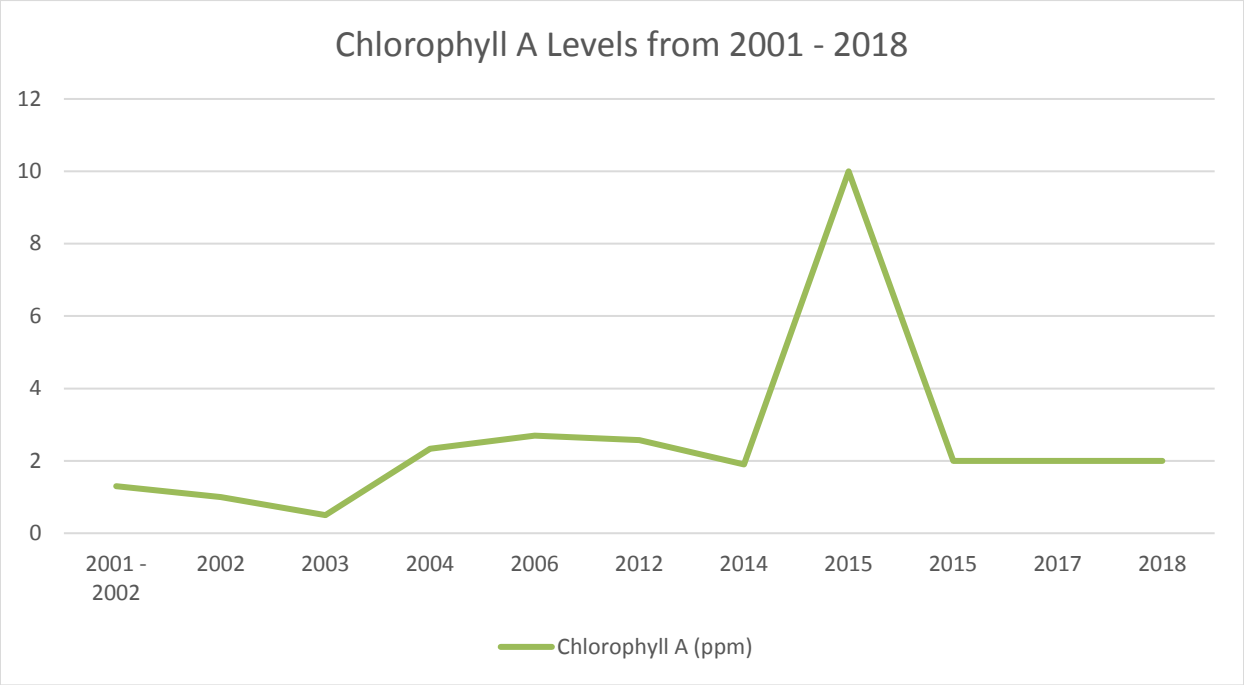


Figure 4.3.2. Chlorophyll A levels (ppm) in Summerside Lake from 2001 to 2018.

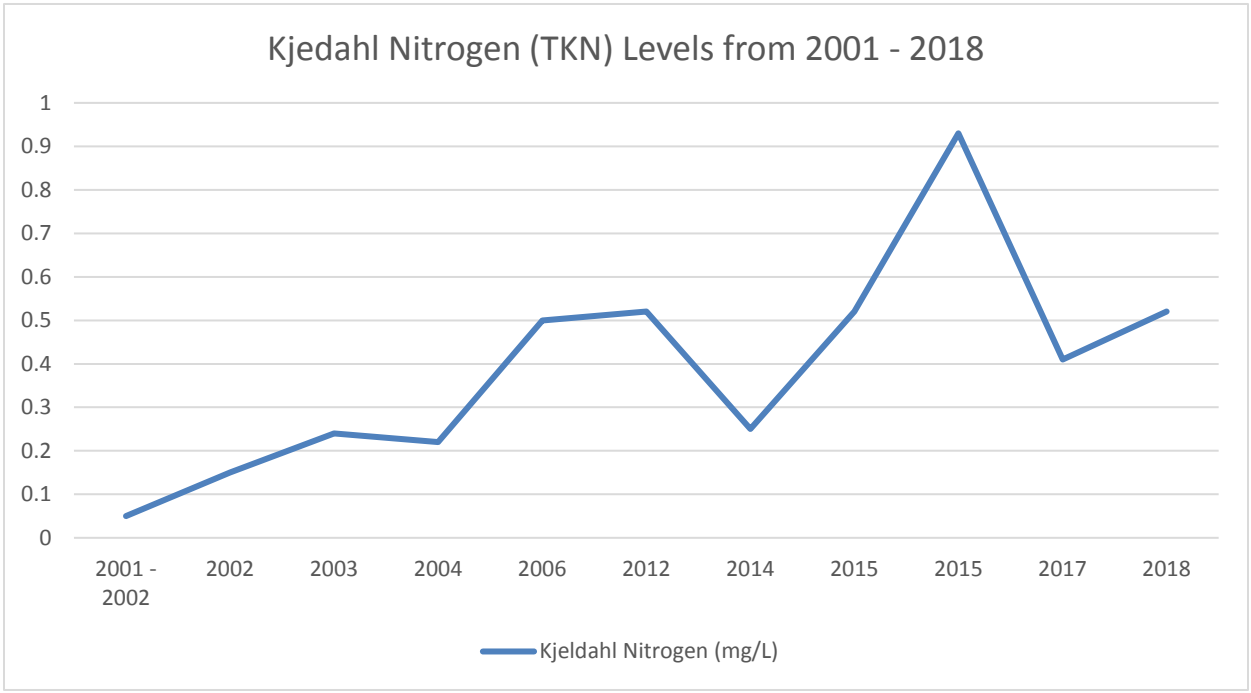


Figure 4.3.3. Total Kjeldahl Nitrogen (TKN) levels (mg/L) in Summerside Lake from 2001 to 2018. No TKN analysis was conducted from 2007 – 2011.

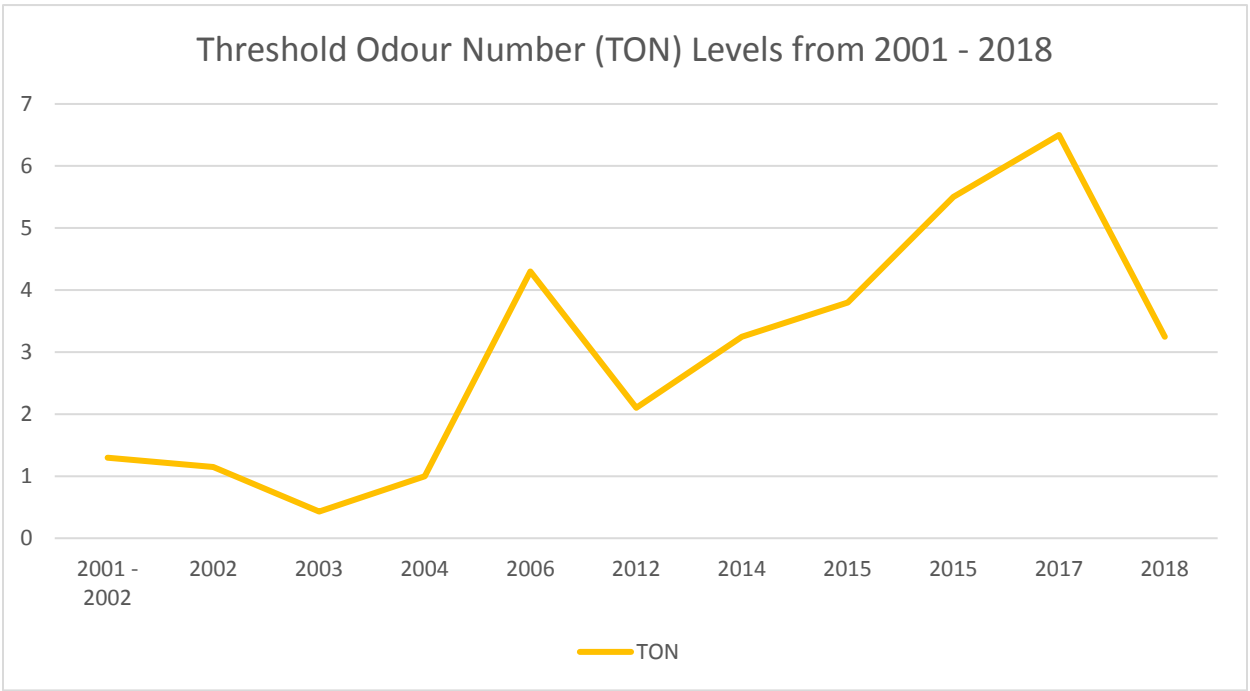


Figure 4.3.4. Threshold Odour Number (TON) in Summerside Lake from 2001 to 2018.

4.4 Key Results Summary

The key observations from the 2018 assessment includes the following:

1. The Yellow Perch hourly catch rate was slightly higher in 2018 than it was in 2017. A slight increase in fish densities were observed in 2018 as compared to 2017 densities. Fishing effort has been reduced due to low catch and lower fish densities. The 2018 fish appeared to be much smaller weight than those caught in 2017, but similar to those caught between 2014 and 2016; however, they are significantly smaller and younger is age to those caught in 2010, when fishing efforts began. No natural fish kills within Summerside Lake were noted during the past year.
2. Water quality is within acceptable limits for fish survival. In regard to recreational use, Summerside Lake water quality was within acceptable limits for parameters including E. coli, total coliforms and pH. Total coliforms should be closely monitored for the 2019 assessment due to the sudden short-term anomaly increase in 2018.
3. Lake substrate/sediment observations suggested that silt deposition into the lake noted during the 2017 assessment was less prevalent or apparent in 2018 samples. Silt content appeared to be highest in sediment samples taken from the deep northwest zone of the lake. No hydrocarbon or contaminant odours were noted within any samples. Higher sand content in some samples (southeast littoral) is likely due to proximity to the beach.
4. The aquatic vegetation species composition and diversity of the vegetation in the lake appears to be increasing with 5 species of aquatic vegetation and algae noted during the 2017 and 2018 sampling. This is an increase in species observed in the 2006-2014 aquatic vegetation assessments, during which 4 species were noted. The dominant species of vegetation sampled within the lake was similar to that of 2017. No invasive species of aquatic vegetation were observed and/or sampled during the 2018 assessment. The abundance and distribution of the vegetation in the lake appears to be continuing to increase as it has since 2003 when vegetation was documented as establishing within Summerside Lake. The southwest (SW) area of the lake appears to generally have the highest occurrence of high abundance vegetation.

5.0 DISCUSSION

Periodic limnologic monitoring of Summerside Lake has been conducted from 2001 to 2018. Although detailed routine sampling has not been conducted, several conclusions and trends or potential trends have been identified for discussion below.

1. Water quality has been and continues to be within acceptable limits for fish survival (CCME CEQG 2011).
2. Some changes in water quality from August 8, 2001 to August 14, 2018 have been observed. Water quality has changed since 2001, with some parameters potentially indicating a slight increasing trend towards eutrophication or excess nutrient load. Common indicators of eutrophication include increased phosphorus, total nitrogen, chlorophyll a and microcystins (ALMS 2017).
    a. Chlorophyll a has increased slightly overall since 2001 and is influenced by the time of year the sample is collected. Levels have remained the same from 2015 to 2018 at 2 ppm (Figure 4.3.2).
    b. Total phosphorus has declined since 2001 and has been stable since 2015 at <0.05 mg/L (Figure 4.3.1). Additional dissolved phosphorus analysis has been added in 2018 and should also be analyzed in future water quality sampling for trend analysis.
    c. Dissolved oxygen has fluctuated each year and is also influenced by the time of year the sample is collected. It has ranged between 5.9 mg/L and 12.34 mg/L but usually is between 8 mg/L and 10 mg/L. Samples collected in late winter/early spring have been found to be as low as 5.29 mg/L in March 2011 and 7 mg/L in March 2015. In August 2018, dissolved oxygen was recorded at 8.48 mg/L.
    d. Threshold odor number (TON) has generally shown an increase since 2001. Between 2017 and 2018, TON decreased from an average of 6.5 to 3.25, respectively (Figure 4.3.4). A TON of 3.25 indicates that the sample must be diluted 3.25 times with an equal volume of odourless water to produce odour-free water.
    e. Total dissolved solids (TDS) has increased since the initial sampling in August 2001 (148mg/L) to 470mg/L in August 2018. Prior to 2015, the TDS samples collected have generally remained within 250-350mg/L.
    f. Conductivity was at its lowest in 2001 (298 µs) but has remained between 457 µs and 730 µs from 2003 - 2018.
    g. Total coliforms have decreased substantially (from 250 CFU/100ml in 2014 to 8 CFU/100ml in 2017) since 2014. This large decrease may be attributed to errors in sample handling by the

outside laboratory used to do the analysis in 2014 which produced an artificially high result. However, in 2018 total coliforms increased significantly to 130 CFU/100ml.

h. Zooplankton is increasing since 2006. Zooplankton increased by more than seven times from 2012 to 2015 and more than four times from 2015 to 2018.

i. Dissolved phosphorus and microcystin levels were added to the analysis in 2018; no historical data is available for these parameters but both fell within acceptable levels and did not indicate eutrophication issues.

3. Aquatic vegetation abundance has consistently increased since 2003, when it became established within Summerside Lake.

4. From the results of the lake bed substrate/sediment sampling, silt content was higher in the deep northwest zone of the lake. In aquatic ecosystems such as Summerside Lake, high silt content is undesirable as it may potentially cause increased eutrophication leading to excess nutrients in the lake, increase in aquatic vegetation, and lack of oxygen for aquatic life including desirable species such as Rainbow Trout. The higher silt content in some areas of the lake is due to runoff from point sources/erosion from the surrounding land. During the May 2018 site visit, erosion control devices including silt fencing was noted around potential sources, primarily surrounding the south side of the lake. These devices are likely mitigating siltation and are responsible for the apparent decrease in silt measured in substrate samples in 2018 along with general water movement distributing existing silt throughout the lake bed area.

6.0 RECOMMENDATIONS

While the water quality analysis continues to show that Summerside Lake water quality remains within acceptable limits for fish health, trends indicative of changing water quality (increased aquatic vegetation, zooplankton, total dissolved solids, conductivity and eutrophication factors including increased total nitrogen, phosphorus, and chlorophyll a) suggest that water sampling should continue to monitor water quality trends.

The following recommendations are made based on the limnological monitoring, future management of fish stocks and management of aquatic vegetation:

1. The Summerside Lake Association members should be advised of water quality status and trends.
2. No in-water or in-lake actions are currently recommended.
3. The Summerside Lake Association members should be reminded at the Annual General Meeting that no nutrients such as fertilizers or herbicides should be used if they could potentially enter the lake.
4. Water quality and limnological parameters should continue to be monitored annually (ideally).
5. Aeration should be employed generally in the spring and/or fall season for a short duration if desired. Fall season would be preferable at Summerside Lake for aeration use. However, dissolved oxygen levels appear to be suitable for fish survival. Additional testing of dissolved oxygen levels during the ice-covered period in 2019 is recommended. There is risk of increased odours during aeration use unless maintenance of the system occurs or has occurred to address this issue.
6. Selective reduction of Yellow Perch and maintained or increased stocking of Rainbow Trout should continue. The target and schedule would still be to capture Yellow Perch at a pre-spawning period at an ice-out condition. The spruce bough egg removal method should also be applied with greater intensity.
7. Should aquatic vegetation be considered undesirable, various options exist to control or manage the vegetation, including: chemical removal, substrate alteration, mechanical removal, ongoing maintenance, increase in number of triploid grass carp, selection of target areas and/or preventative measures. At this time, no specific measures are recommended as aquatic vegetation did not appear to increase significantly since 2017 and user complaints did not appear to increase in 2018. Should complaints increase in the 2019 open water season, additional assessment and control methods could be applied.

These recommendations are intended to meet the objectives and form a basis for discussion and inform decision making regarding the lake, it's use, and the surrounding community.

7.0 LIMITATIONS AND CLOSURE

In conducting the assessment and rendering our conclusions, EnviroMak gives the benefit of its best judgment based on its experience and in accordance with generally accepted professional standards for this type of assessment in present time. This report was submitted with the best information to date and on the information provided. This report has been prepared for the exclusive use of the proponent/client. Any use which any other third party makes of this report, or any reliance on or decisions to be made on it, are the responsibility of such third parties. EnviroMak accepts no responsibility for damages, if any, suffered by any other third party as a result of decisions made or actions based on this report.

Please contact EnviroMak Inc. by telephone at (780) 425-2461 (office) or email to info@enviromak.com with any questions or concerns.

Sincerely,

Kyla Walker-Makowecki, M.Sc., QAES, CPESC, EP, RT(Ag)
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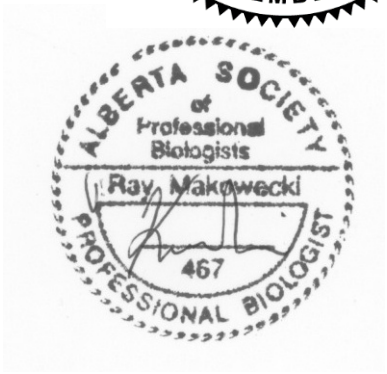

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9.0 APPENDIX - SAMPLING PROTOCOL

PARAMETERS	MEASUREMENT UNIT	SAMPLING METHOD	SAMPLING LOCATION	SAMPLING DATE(S)
WATER QUALITY				
Temperature	Celsius degrees	Alcohol or mercury field thermometer and/or PCSTestr 35 Multi-Parameter	Central	Spring, Summer, Winter
pH		Oakton PCSTestr 35 Multi-Parameter	Central	Spring, Summer, Winter
Conductivity	Microsiemens (µs)	Oakton PCSTestr 35 Multi-Parameter	Central	Spring, Summer, Winter
Total Dissolved Solids	mg/L	Oakton PCSTestr 35 Multi-Parameter	Central	Spring, Summer, Winter
Dissolved Oxygen	mg/L	Orion Star A223 RDO Optical DO Meter and Dissolved Oxygen Sensor	Central	Spring, Summer, Winter
Alkalinity	mg/L	Hach Model AL-AP Test Kit	Central	Spring, Summer, Winter
Turbidity	Nephelometric Turbidity Units (NTU)	Hach 2100Q Turbidimeter	Central	Spring, Summer, Winter
Light Penetration	m	Secchi Disc	North and South	Summer
Nutrients and Metals	mg/L	Water Sample Set – Laboratory Procedures	Central	Summer, Winter
Chlorophyll a	ug/L	Water Sample Set – Laboratory Procedures	Central	Summer, Winter
Microcystins (Total)	ug/L	Water Sample Set – Laboratory Procedures	Central	Summer
Selenium	mg/L	Water Sample Set – Laboratory Procedures	Central	Summer
Bacteria (Fecal and Total)	Coliforms/100mL	Water Sample Set – Laboratory Procedures	Central	Summer, Winter
Herbicides	ug/L	Water Sample Set – Laboratory Procedures	Central	Summer
TON (Threshold Odour No.)	Scale	Water Sample Set – Laboratory Procedures	Central & South	Summer, Winter
AQUATIC VEGETATION				
Species Composition Relative Abundance	Observed Amount	Visual observation	Northeast-L Northwest-L Southeast-L Southwest-L Northwest-D	Summer
Species Composition Relative Abundance	Presence or absence	Modified rake sampler and Ekman dredge		
Species Composition Relative Abundance	Visual: High Moderate Scant Zero	Visual observation	Perimeter	Summer
FISH				
Fish Presence/Absence	# fish caught	Minnow trapping and gill netting	Throughout Lake	Spring
PLANKTON				
Relative Abundance	# / 500 mL	Plankton net pull	North and South	Summer

PARAMETERS	MEASUREMENT UNIT	SAMPLING METHOD	SAMPLING LOCATION	SAMPLING DATE(S)
SUBSTRATE/SEDIMENT				
Lake bed substrate composition	Visual Observation	Eckman dredge	Northeast, Northwest, Southeast, Southwest; Littoral, Deep	Summer

SAMPLING LEGEND AND LOCATIONS

PARAMETER MEASURED	SAMPLE ID	GENERAL LOCATION IN LAKE	UTM LOCATION (ZONE 12N)	WATER DEPTH
Aquatic Vegetation	V1	Southeast Littoral	335892.96 m E, 5921358.19 m N	Not Collected
	V2	Southeast Littoral	335881.56 m E, 5921424.05 m N	Not Collected
	V3	Southeast Littoral	335890.66 m E, 5921398.48 m N	Not Collected
	V4	Southeast Littoral	335821.19 m E, 5921366.86 m N	Not Collected
	V5	South Littoral	335765.71 m E, 5921365.69 m N	Not Collected
	V6	South Littoral	335732.49 m E, 5921366.85 m N	Not Collected
	V7	Southwest Littoral	335591.16 m E, 5921288.23 m N	Not Collected
	V8	Southwest Littoral	335571.78 m E, 5921421.91 m N	Not Collected
	V9	West Littoral	335601.93 m E, 5921492.01 m N	Not Collected
	V10	West Littoral	335621.56 m E, 5921525.35 m N	Not Collected
	V11	Northwest Littoral	335579.36 m E, 5921693.84 m N	Not Collected
	V12	Northwest Littoral	335595.20 m E, 5921724.23 m N	Not Collected
	V13	Northwest Littoral	335613.98 m E, 5921732.85 m N	Not Collected
	V14	Northwest Littoral	335691.58 m E, 5921785.84 m N	Not Collected
	V15	Northwest Littoral	335703.53 m E, 5921757.59 m N	Not Collected
	V16	Northeast Littoral	335838.04 m E, 5921746.74 m N	Not Collected
	V17	Northeast Littoral	335893.84 m E, 5921757.18 m N	Not Collected
	V18	Northeast Littoral	335932.33 m E, 5921641.40 m N	Not Collected
	V19	Northeast Littoral	335931.79 m E, 5921625.95 m N	Not Collected
Water Quality	North	North	335698.66 m E, 5921704.53 m N	5.5 m
	Central	Central	335710.24 m E, 5921610.53 m N	6.6 m
	South	South	335695.20 m E, 5921478.60 m N	9.2 m
	NE-L	Northeast Littoral	335892.45 m E, 5921717.01 m N	2.0 m
	NW-L	Northwest Littoral	335606.40 m E, 5921674.35 m N	2.4 m
	NW-D	Northwest Deep	335666.58 m E, 5921640.27 m N	7.3 m
	SE-L	Southeast Littoral	335836.27 m E, 5921375.62 m N	2.2 m
	SW-L	Southwest Littoral	335646.06 m E, 5921379.12 m N	2.1 m

PARAMETER MEASURED	SAMPLE ID	GENERAL LOCATION IN LAKE	UTM LOCATION (ZONE 12N)	WATER DEPTH
Threshold Odour Number (TON)	TON	Southeast Deep	335796.95 m E, 5921414.10 m N	7.5 m
Zooplankton	North	North	335698.66 m E, 5921704.53 m N	5.5 m
	South	South	335710.24 m E, 5921610.53 m N	6.6 m

Urban Constructed Lake Evaluation Methodology

9.1 Water Quality Parameters

9.1.1 Spatial Monitoring Plan

- The Centre Water Quality sampling point (Figure 9.1 below) will be located near the centre of Summerside Lake and it will be the single sampling station.
- Light penetration will be measured at two sample stations (one from the north end of the lake and the second from the south).

9.1.2 Temporal Monitoring Plan

- Water quality parameters will be measured in spring, summer, and winter (if feasible) to capture variable seasonal conditions in Summerside Lake.

9.1.3 Techniques

- All water samples collected from Summerside Lake will be handled in the following manner:
  - Water samples for a variety of water quality parameters will be collected with appropriately sized sterilized sample bottles. Samples are generally taken from approximately 15 cm below the water surface. Sample preservatives shall be utilized as necessary.
  - Chlorophyll a, total phosphorus, Kjeldahl nitrogen, microcystin, total chlorides and heavy metals (i.e., Al, Cu, Pb, Zn) will be measured at Exova Laboratories in Edmonton, which is certified by the Canadian Association of Environmental and Analytical Laboratories (CAEAL).
  - Dissolved oxygen, turbidity, water clarity, conductivity, total dissolved solids, alkalinity and pH will be measured on site with appropriate metres and analysis kits that are accurately calibrated and maintained for quality assurance/quality control.
  - The threshold odour number will be measured in the EnviroMak Inc. laboratory as per the Standard Methods for the Examination of Water and Wastewater (American Public Health Association 20th Edition 1999).
  - Light penetration will be measured using a Secchi disk. The Secchi disk is a circular disk, patterned with alternating black and white quadrants. The disk is lowered into the water on a graduated line until it is no longer visible in the water column, dropped slightly further, and then pulled up until it becomes visible. The depth of the water level on the graduated Secchi disk line will be recorded when the disk is no longer visible, and again once it

becomes visible (the average of the two depths is the Secchi depth) (Alberta Environment, 2006).

9.2 Aquatic Vegetation

9.2.1 Spatial Monitoring Plan

- Four sample stations identified as Northwest, Northeast, Southwest and Southeast (Figure 9.1 below) establish the aquatic vegetation sampling plan for Summerside Lake. The first sampling site along each shoreline will be targeted for a depth of 2.0m.

9.2.2 Temporal Monitoring Plan

- Aquatic vegetation will be measured in summer to capture optimal vegetation growth in Summerside Lake.

9.2.3 Techniques

- Aquatic macrophytes will be harvested using a benthic rake system (Makowecki 1973) where the rake rotates around a spike that has been driven into the substrate. The rake has a width of 35 centimetres, thereby raking an area of 0.38 m2 at each site. Samples will be placed in pre-labelled pails and put into a cooler for transport to the laboratory for identification.
- A secondary method to capture aquatic macrophytes will include an Ekman dredge. The dredge is lowered in a controlled fashion into the waterbody with the jaws on the dredge set to the locked open position. The dredge will be lowered to be in contact with the lake substrate. The messenger on the dredge will be dropped (if applicable) and the dredge is slowly raised to the water surface level. The dredge is deemed acceptable if the desired depth of penetration was achieved, and the sampler has completely closed and was not inserted on an angle or tilted upon retrieval. Contents will be removed from the dredge, placed in pre-labelled pails, and macrophyte presence or absence will be recorded (Alberta Environment, 2006).

9.3 Bacteria

9.3.1 Spatial Monitoring Plan

- The Centre Water Quality sampling point (Figure 9.1 below) will be located near the centre of Summerside Lake and it will be the single sampling station.

9.3.2 Temporal Monitoring Plan

- Bacteria levels will be will be measured in summer and winter to capture variable seasonal conditions in Summerside Lake.

9.3.3 Techniques

- All water samples collected from Summerside Lake will be collected in designated bacteria sampling bottles. Bacteria will be measured at AGAT Laboratories in Edmonton, which is certified by the Canadian Association of Environmental and Analytical Laboratories (CAEAL).

9.4 Macro-Zooplankton

9.4.1 Spatial Monitoring Plan

- Two sample stations (one from the north end of the lake and the second from the south) establish the aquatic vegetation sampling plan for Summerside Lake.

9.4.2 Temporal Monitoring Plan

- Zooplankton samples will be collected in summer months from Summerside Lake.

9.4.3 Techniques

- Samples collected from Summerside Lake will be handled using a zooplankton net in the following manner:
  - Prior to immediate use, the plankton net will be rinsed with lake water to dislodge any attached material prior to sampling.
  - Plankton will be collected by undertaking three-metre horizontal tows through the water near the surface using a standard plankton net. The plankton net is lowered vertically into the euphotic zone of the lake and towed at a continuous rate to minimize escaping of the net by fast-swimming zooplankton (Alberta Environment, 2006).
  - Captured plankton will be rinsed from the collection screen into pre-labelled bottles and transported to the lab for immediate analysis.
  - Identification of amphipods and other macro-zooplankton and a total count for each sample will be conducted in the laboratory.
  - The plankton net and bucket will be rinsed with lake water between sites.
  - Triplicate sampling will be conducted at each sample station in Summerside Lake.

9.5 Fish Capture

9.5.1 Spatial Monitoring Plan

- Fish sampling stations conducted throughout Summerside Lake targeting areas as having the highest potential for Yellow Perch spawning habitat (Summerside Yellow Perch Relocation Results Report, 2015).

9.5.2 Temporal Monitoring Plan

- Fish sampling will be collected during a one-time, multi-day fishing event during the spring, immediately following ice melt.

9.5.3 Techniques

- Samples collected from Summerside Lake will be handled using gill nets in the following manner:
    - Three size classes of nets are allocated for Yellow Perch capture. These include; 25.4mm, 38mm, and 50.8mm sized gill nets.
    - Nets are to be set and pulled daily (or as per frequency identified in Fish Research Licence) in areas targeted as having highest Yellow Perch spawning habitat.
    - Any incidental fish captured that are not the targeted species will be returned live to the lake.
    - Target species captured in gill nets will be removed from nets and living individuals will be relocated as per the issued Fish Research Licence. Deceased individuals will be appropriately disposed of.
    - Any additional sampling requirements set forth in the issued Fish Research Licence will be adhered to.
- Samples collected from Summerside Lake will be handled using minnow traps in the following manner:
    - Minnow traps with 5mm mesh size and 0.11m by 0.22m dimensions will be set and pulled daily (or as per frequency identified in Fish Research Licence) in areas targeted as having highest Yellow Perch spawning habitat.
    - Dry cat food shall be used as bait for the minnow traps.
    - Any incidental fish captured that are not the targeted species will be returned live to the lake.

- Target species captured in gill nets will be removed from nets and living individuals will be relocated as per the issued Fish Research Licence. Deceased individuals will be appropriately disposed of.
- Any additional sampling requirements set forth in the issued Fish Research Licence will be adhered to.

9.6 Wildlife

Other notable wildlife observations will be recorded during environmental data collection.

9.7 Substrate/Sediment Composition

- Lake bed substrate/sediment samples from Summerside Lake will be collected in the following manner:
  1. The sampler should be "set" according to the manufacturer's instructions and lowered through the water column.
  2. Dredges should never be allowed to free fall into the substrate. The sampler should be carefully lowered the last few feet to minimize dispersal of fine material due to a sampler induced shock wave.
  3. In shallow waters, some samplers can be pushed directly into the sediment. Five and ten foot extension handles can be attached to Eckman dredges for sampling in shallow waters to plunge the sampler into the sediment. These handles can minimize some of the limitations of the dredge.
  4. The sampler is then tripped either with the weight or extension handle.
  5. The sampler should be slowly raised through the water column and placed in the sieve. Allow the water from the sieve to drain into a 5 gal pail.
  6. If an insufficient or improper sample is collected, additional weights should be added (if appropriate) to the sampler to allow deeper penetration into the sediment.

- Samples are then analysed in-house and the following physical characteristics are recorded:
  - Composition/texture/particle size
  - Appearance
  - Colour (using Munsell soil colour chart)
  - Odour

9.8 Quality Assurance/Quality Control (QA/QC)

Standard operating procedures for sample handling and data management (transfer and verification) have been developed and will be used for all aspects of the monitoring program. These procedures have been described as part of the description of the methods.

The laboratory QA/QC are worthy of noting and utilize basic methods of insuring confident results, and these methods include:

- Periodic calibration of equipment used to measure turbidity and other water quality parameters.
- Triplicate sampling to measure turbidity and other water quality parameters (to establish replication consistency).

Sample handling will consist of:

- storing samples in sealed coolers to maintain a constant temperature (4 degrees Celsius);
- completing a field data sheet that ensures a chain of custody and continuity;
- shipping and analyzing samples as soon as possible following collection; and
- random duplicate testing of samples.

Data is recorded in hard copy and digital formats and the laboratory records provide a verification of calculations for follow up should they be required. Laboratories continually assess their calibration standards and validate periodically.

9.9 Bibliography

Alberta Environment. 2006. Aquatic Ecosystems Field Sampling Protocols. Alberta Environment, Environmental Monitoring and Evaluation Branch. March 2006. 137 pp.

American Public Health Association. 1999. Methods for the Examination of Water and Wastewater. 20th Edition.

Makowecki, R. 1973. The trophy pike, *Esox lucius*, of Seibert Lake. M.Sc. Thesis, University of Alberta, Dept. of Zoology. 273 pp.

Figure 9.1. Water quality, substrate/sediment and threshold odour number (TON) sampling locations in Summerside Lake. Water quality samples collected on various dates in 2018; substrate/sediment samples collected August 14, 2018.

Figure 9.2. Aquatic vegetation sampling locations in Summerside Lake. Sampling conducted on August 14, 2018.