SUMMERSIDE LAKE 2019
LIMNOLOGICAL MONITORING REPORT

ENVIRO MAK Inc.
Environmental Management Consultants

SUMMERSIDE LAKE 2019 LIMNOLOGICAL MONITORING REPORT

Submitted to:

DARRYL MARCHUK, MANAGER

OF

SUMMERSIDE LAKE RESIDENTS' ASSOCIATION

EDMONTON, ALBERTA

Submitted by:

K.L. WALKER-MAKOWECKI, R. MAKOWECKI & N. RITOSA

OF

ENVIROMAK INC.
ENVIRONMENTAL MANAGEMENT CONSULTANTS

EDMONTON, ALBERTA

September 19, 2019

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

1.0 INTRODUCTION AND BACKGROUND

Summerside Lake is a private urban recreational 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, skating 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 and stocked fishery management.

The 2019 limnological monitoring gathered data and provided interpretations as to whether various aquatic ecosystem indicators remain within acceptable limits for fish health as well as monitors aquatic ecosystem indicator trends to evaluate the overall status of the lake to provide recommendations for continued management of a functional urban lake environment meeting the targets and expectations of the stakeholders. Monitoring of the water quality and limnologic status of Summerside Lake has been conducted periodically since 2001. Generally, data gathered has focused on standard indicators for limnological health; however, periodically, modifications to the monitoring plan have occurred to address specific issues or concerns. In 2015, the limnological analysis noted trends indicative of changing water quality (i.e. increased aquatic vegetation, coliforms, total dissolved solids and conductivity), fortifying the effort to continue monitoring. Aquatic vegetation in 2017 was noted as a concern; thus, a temporary increased intensity of assessment of vegetation coverage, abundance and diversity indicators occurred along with a substrate characterization of the lake sediments. In 2018 and 2019, the aquatic vegetation was characterized in a similar manner as 2016 with consideration of 2017 methods and results for trend analysis but with less intensity. In 2018, an odour concern related to the aeration system operation was noted, and additional testing of threshold odours was undertaken in response.

With respect to the stocked fishery at Summerside Lake and following assessments conducted by EnviroMak Inc. in 2001 and 2002, Rainbow Trout (*Oncorhynchus mykiss*) were stocked annually for recreational angling. In 2005, Triploid Grass Carp (*Ctenopharyngodon idella*) were stocked in the lake to support aquatic vegetation control. In July 2007, Mr. Gerald Trach (former Manager of Summerside Lake) indicated that he observed some small fish, however, was unsure as to what species they may have been. EnviroMak Inc. undertook sampling in July 2007 and observed stocked Rainbow Trout and Triploid Grass Carp. No other fish species was found or observed at that time. Mr. Craig Beaton's (former manager of Summerside Lake) observations of fish ("small minnows") at Summerside Lake in Edmonton, Alberta in late July 2009 resulted in the subsequent sampling effort undertaken by EnviroMak in 2009 at which time Yellow Perch (*Perca flavescens*) were confirmed to be present within Summerside Lake.

Yellow Perch were likely introduced by persons who illegally transported the fish into the private lake. Yellow Perch is a species that is not permitted for stocking in privately-owned waters (Alberta Government Regulations). 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 – 2019.

In 2010, the efficiency of Yellow Perch catch combined with the potential for mortality of Rainbow Trout resulted in the cessation of fishing after two days. In 2011 the ice remained on the lake until May 8, 2011 and water temperatures increased rapidly to 8°C on May 9, 2011 and fish capture began on May 10. In 2011, fish spawning began quickly and appeared to end quickly as well (after 3 to 4 days). In 2012 the fishing persisted for 5 days and could have continued as relatively large catches continued. In 2013 and 2014, fish spawning again began quickly after the ice cover melted and appeared to end quickly as well (after 3 to 4 days). In 2015, ice cover melted relatively early, and fish removal efforts were completed before the majority of the fish had begun to spawn. Decreasing daily catches in 2015 were the deciding factor to stop fish removal efforts on April 24, 2015. In 2016, ice cover melted relatively early, and fish removal efforts were commenced before the majority of the fish had begun to spawn. In 2016, the fishing occurred consecutively from April 8 to April 12, 2016 following which a break in fishing effort was conducted due to low catch rates. Fishing then continued again from April 18 to April 20, 2016 at which point fishing efforts were ceased as the majority of fish had spawned. In 2017, ice cover melted relatively late; however, removal efforts were completed before the majority of the fish had completed spawning. Fishing occurred consecutively from May 5 to 7, 2017. In 2018, fishing efforts began on May 3 when ice melted and ceased after two days due to low catch rates.

Yellow Perch usually spawn during the spring in waters less than 10m deep at temperatures ranging between 6.7°C to 12.2°C. They prefer submergent and emergent vegetation types, which are utilized to attach their large adhesive egg masses to (Langhorne et al, 2001). Yellow Perch are owned by the province; thus, the management of this fish species is the responsibility of the Alberta government. The legal implications of the Alberta Fishery Regulations would include licensing, catch limits, angling prohibitions and all regulations applicable to Yellow Perch. Since Yellow Perch are present and owned by the provincial government, the habitat that they live within is technically a fish habitat as defined under the Fisheries Act and managed by the Department of Fisheries and Oceans (DFO). The legal implications of fish habitat could technically apply to Summerside Lake which could include numerous fish habitat protection measures that may influence development in the "fish habitat" areas. However, DFO has formally decided not to consider Summerside as a fish habitat under their legislation. Rainbow Trout, Brook Trout and Triploid Grass Carp were stocked by the Association under provincial government permits. These fish are the responsibility of the Association.

In 2018, EnviroMak provided an updated Fish Stocking Plan to the association, and, subsequently, Brook Trout (*Salvelinus fontinalis*) were added to the stocked fishery diversity along with continued stocking of Rainbow Trout. In 2019, current lake manager, Darryl Marchuk, contracted EnviroMak to continue to the annual Yellow Perch removal program. It is also in 2019 that a visual observation by a resident of a potential additional invasive species (Goldfish, *Carassius auratus*) was brought to the attention of the Lake Manager. Response and action relevant to this observation is further detailed in the report.

This report compiles the results of the 2019 Summerside Lake limnological monitoring and Yellow Perch removal program at Summerside Lake as well as provides recommendations to continue to address future fish and lake management strategies.

2.0 OBJECTIVES

The overall objective of the 2019 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 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. The ecological and limnological data gathered over the course of the 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.

The overall objective of the 2019 Yellow Perch removal program was to remove as many Yellow Perch and Yellow Perch eggs as possible from Summerside Lake during the pre-spawning to spawning period in spring. The project objectives also included minimal assessment of the size and age characteristics of the Yellow Perch population for interpretation of trends in the population. Considering the resident observation of two potential invasive Goldfish, the Yellow Perch removal program was slightly modified to capitalize on effort being expended on Yellow Perch removal to include observation for and attempted removal of other invasive fish species if encountered.

3.0 STUDY METHODS

3.1 Limnological Monitoring

Limnological monitoring efforts were conducted during both open water and ice-covered periods (Table 3.3.1). Appendix 9.0 details the spatial and temporal sampling protocol and sampling techniques applied to Summerside Lake.

Water samples for a variety of water quality parameters were collected and tested onsite as well as 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 with an Eckman dredge to characterize the substrate/sediments. Several of the water quality parameters were measured in an accredited Edmonton laboratory (Element Laboratory 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).

Table 3.3.1. Summerside Lake 2019 environmental consultant activity summary.

Date in 2019 (dd-mmm-yy)	Activity Type	Description	Analysis
March 21 April 2	Field Sampling	Winter water quality sampling	-Water quality
April 2 (installation) May 9 (removal)	Field Sampling	Spruce bough installation for Yellow Perch egg capture and removal	-Fish egg quantification
April 18	Field Sampling	Spring limited water quality sampling and Yellow Perch (and invasive species) removal	-Water quality -Fish
August 14	Field Sampling	Comprehensive summer limnological and water quality assessment	-Water quality -Aquatic vegetation -Plankton -Sediment/substrate -Others

3.2 Yellow Perch (Invasive Fish) Removal

The Yellow Perch (and invasive fish as encountered) removal and sampling occurred on April 18, 19 and 25, 2019. Fish collection was conducted utilizing gill nets (April 18/19) and minnow traps (all dates). The selection of these fishing techniques was based on the rationale that the Yellow Perch population is not a native or naturally occurring population and the intent is to remove as many fish as possible within a short time frame in a cost-effective manner. Eight gill nets were set on April 18 and removed on April 19. Ten minnow traps were set on April 19, and five were set on May 3, 2019. A Fisheries Research License authorizing the Yellow Perch removal was obtained from Alberta Environment and Parks (AEP) (FRL #19-3804). The FRL stipulates some conditions relevant to fish handling procedures as well as data management.

The data collected from the invasive Yellow Perch included a select sampling for lengths, weight, sex, age and maturity (i.e. spawning status). Yellow Perch were aged using opercular bones. Other species of fish that may have been captured during the targeted Yellow Perch removal effort were counted, identified, measured and released back into the lake when possible; however, some fish were sacrificed as they were deceased upon net removal. Other species expected included Rainbow Trout (stocked), Brook Trout (stocked) and Triploid Grass Carp (stocked). Stomach contents of these species were observed randomly. Twice daily water temperatures were recorded during the fish removal project to identify likely spawning timing for optimized removal effort scheduling.

In addition to fish removal, an innovative effort to remove Yellow Perch eggs was initiated in 2018 and continued in 2019 to bolster the removal results. Spruce boughs were temporarily installed along key locations of the shoreline where perch may be expected to expel their eggs. The spruce boughs were then removed along with the eggs which were counted using a volumetric methodology to estimate total number of eggs removed.

4.0 RESULTS

4.1 Limnological Monitoring

4.1.1 Limnological Field Data Collection Results 2019

Water quality samples were taken on March 21, April 2 and 18 and August 14, 2019. Water quality parameters sampled included but were not limited to turbidity, conductivity, total dissolved solids, pH, alkalinity, dissolved oxygen and threshold odour number (Table 4.1.1). Water samples taken on August 14, 2019 were also tested for bacteria, nutrients, metals, herbicides and other water quality parameters (Tables 4.1.2 and 4.1.3; Appendix 9.0 Tables 9.3.1, 9.3.2 and 9.3.3).

Table 4.1.1. Routine water quality analysis results at Summerside Lake during 2019.

Parameter	Sampling Date		
	March 21, 2019*	April 18, 2019	August 14, 2019
Turbidity (NTU)	2.57	-	1.47
Conductivity (µs/cm)	269	-	632
Total Dissolved Solids (mg/L)	147	-	453
pH	8.42	-	8.47
Alkalinity (mg/L)	40.8	-	102
Dissolved Oxygen (mg/L)	10.06*	-	8.61
Temperature (°C)	5.3	7.3	18.9
TON	3.67	-	3.85

TON – Threshold Odour Number
*Dissolved oxygen (D) analyzed on April 2, 2019

Microcystin concentration was an added parameter for analysis in 2018 intending to provide information on potential eutrophication (harmful cyanobacteria blooms caused by excess nutrients in the water) issues. Microcystins are toxins produced by 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 4.1.6). Sampling for microcystin occurred in 2019; however, due to an error during the outsourced laboratory analysis, microcystin levels were not analyzed in 2019. The June 2018 microcystin levels were <0.2 ug/L, well below the Alberta recreational guideline limits set at 20 ug/L (Table 4.1.6).

Table 4.1.2. Supplemental water quality analysis results for Summerside Lake on August 14, 2019.

Water Quality Parameter	Result
Total Kjeldahl Nitrogen (mg/L)	0.55
Total Phosphorus (mg/L)	<0.05
Dissolved Phosphorus (mg/L)	<0.05
Chlorophyll A (µg/L)	2
Dissolved Chloride (mg/L)	8.9
Dissolved Sulfate (mg/L)	218
Hydroxide (mg/L)	<5
Carbonate (mg/L)	<6
Bicarbonate (mg/L)	107
Hardness (mg/L)	205
Conductivity (µs/cm)	619
TDS (mg/L)	401
pH	8.07
Alkalinity (mg/L)	88
Total Coliforms (CFU/100ml)	>80
E coli (CFU/100ml)	>60
Aluminum (mg/L)	<0.02
Calcium (mg/L)	44.2
Copper* (mg/L)	<0.001
Iron* (mg/L)	<0.05
Lead* (mg/L)	<0.0001
Magnesium (mg/L)	23.1
Manganese (mg/L)	0.035
Phosphorus (mg/L)	<0.05
Potassium (mg/L)	4.0
Sodium (mg/L)	54.2
Zinc* (mg/L)	<0.001
Microcystin (µg/L)	See footnote[1]

*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 Freshwater Aquatic Life January 2011
[1]Microcystin not analyzed in 2019 due to laboratory error (N. Brilz, Element Laboratories, per comm. September 9, 2019)

Table 4.1.3. Herbicide detection at Summerside Lake on August 14, 2019.

Herbicide type	Result
Neutral Herbicide (µg/L)	<0.5
Acidic Herbicide (µg/L)	<0.1

Dissolved oxygen (DO) levels were sampled at various depths at ~1 m increments. The dissolved oxygen levels were sampled in March, April and August. Results for the March and April winter sampling were provided in detail in a letter to the Lake Manager. In March and April, measured DO levels were predominantly greater than 8.5 mg/L with the exception of 3 samples at 6 and 5 m depths that were <5mg/L. Maximum measured DO in winter was 11.29 mg/L at 2 m depth. In August, DO was measured at 8.61 mg/L at the surface and 9.15 mg/L at 4 m depth. The maximum dissolved oxygen measured was 10.78 mg/L at 3 m depth.

Water clarity was tested using a secchi disk lowered into the water and could be last viewed at depths of 4.5 m, 4.0 m and 4.3 m in north, central and south areas of Summerside Lake, respectively (Table 4.1.4).

Table 4.1.4. Secchi disc reading results for Summerside Lake on August 14, 2019.

Parameter	Result		
	North	Central	South
Secchi Reading Depth (m)	4.5	4.0	4.3

Zooplankton was present in 2 samples collected from the north and south areas of the lake. 70 zooplankton individuals were observed in the north 25 mL sample and 96 individuals in the south 25 mL sample (Table 4.1.5). It could be extrapolated from the lower count of these samples that approximately 1400 zooplankton per 500 ml sample would be expected.

Table 4.1.5. Total zooplankton observed within 25 ml samples of Summerside Lake on August 14, 2019.

Parameter	Result	
	North	South
Zooplankton (#/25mL)	70	96

Aquatic vegetation was sampled from the lake bed around the perimeter of the lake to a maximum water depth of 2.2 m at 25 sample sites (Figure 9.2). Of the 25 samples sites, 10 exhibited high abundance of aquatic vegetation, 11 exhibited medium/moderate abundance and 4 exhibited scant/sparse abundance for an estimated average moderate abundance for all sample sites. A moderate to high abundance of water common stonewort (*Chara vulgaris*) and Coontail (*Ceratophyllum demersum*) were found at most sample sites. Sparse amounts of small-leaf pondweed (*Potamogeton pusillus*) and common water-crowfoot (*Ranunculus aquatilis var.*) were observed around the southern portion of the lake, and *Myriophyllum* sp. (a macrophytic algae) was present within the southeast area. Emergent species, including Cattail (*Typha latifolia)* and Common Great Bulrush (*Scirpus tabernaemontani*), were observed on the northeast shores of the lake (Table 4.1.6). Abundant green algae (*Cladophora* spp.) was observed at most of the aquatic vegetation sample sites. A total of eight (8) different species of aquatic vegetation and/or algae were observed.

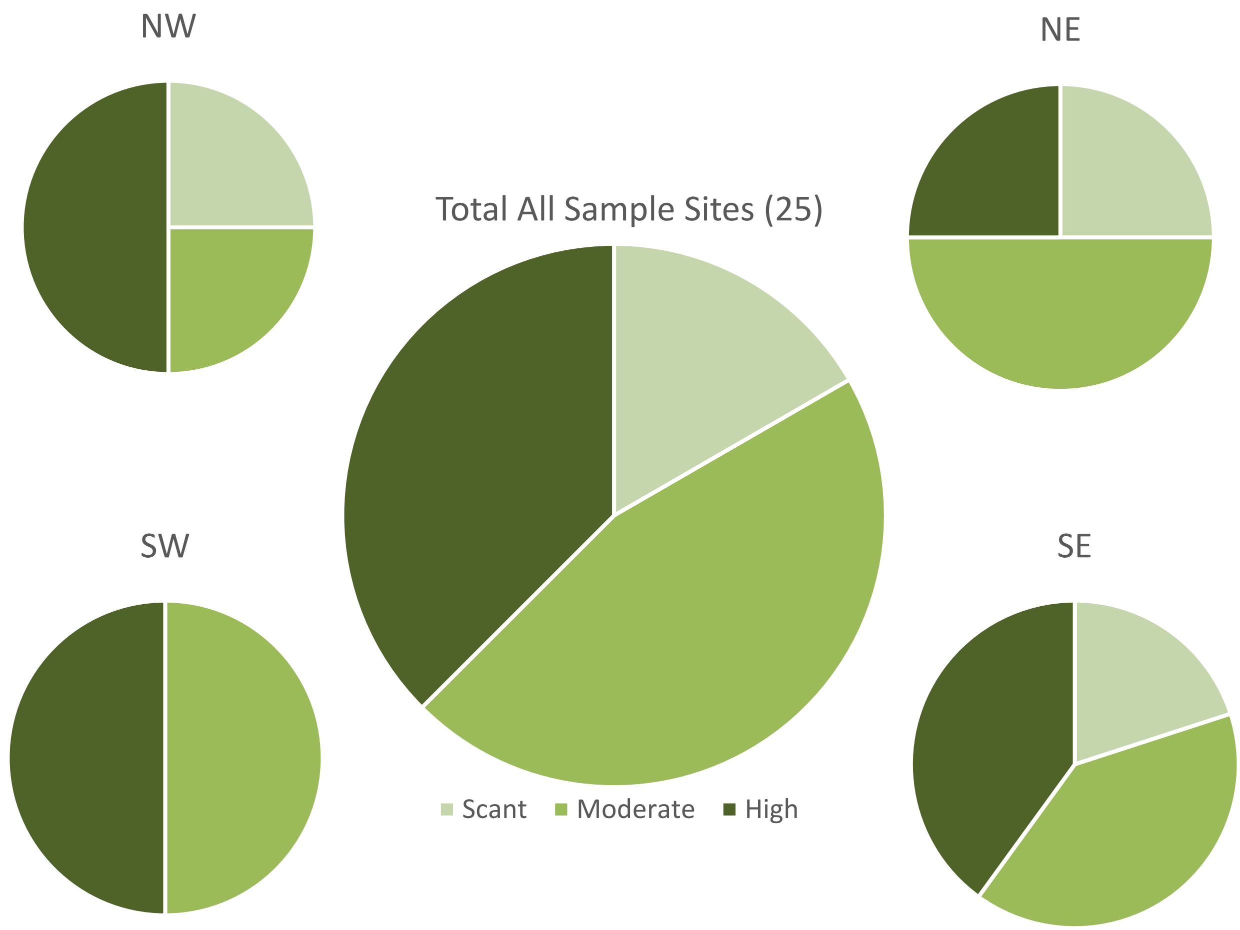

Figure 4.1.1. Aquatic vegetation abundance at 25 sampling sites (depicted by central pie) around the perimeter of Summerside Lake on August 14, 2019. Smaller outer pies depict the abundance within specific areas of the lake including SE – Southeast, SW – Southwest, NE – Northeast, NW – Northwest; Abundance described as H - High, M - Medium/Moderate, S - Sparse/Scant.

Table 4.1.6. Aquatic vegetation species composition and abundance at Summerside Lake on August 14, 2019 utilizing modified vegetation rake sampler, Eckman dredge and visual observation methods.

Sample Location		Water Depth	Aquatic Vegetation Species	Abundance
SE	1	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Cladophora* spp.	S
	2	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Myriophyllum* sp.; *Cladophora* spp.	H
	3	1.0 - 2.25 m	*Chara vulgaris; Ranunculus aquatilis var.*	M
	4	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Cladophora* spp.	H
	5	1.0 - 2.25 m	*Chara vulgaris; Cladophora* spp.	M
			Subtotal	**2 H; 2 M; 1 S**
SW*	6	1.0 - 2.25 m	*Chara vulgaris; Cladophora* spp.	H
	7	1.0 - 2.25 m	*Ranunculus aquatilis var.; Potamogeton pusillis; Cladophora* spp.	M
	8	1.0 - 2.25 m	*Potamogeton pusillis*	H
	9	1.0 - 2.25 m	*Ranunculus sp.*	M
	10	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Cladophora* spp.	H
	11	1.0 - 2.25 m	*Cladophora* spp.	M
	12	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Cladophora* spp.	H
	13	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Cladophora* spp.	M
			Subtotal	**4 H; 4 M**
NW	14	1.0 - 2.25 m	*Chara vulgaris; Cladophora* spp.	H
	15	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Cladophora* spp..	H
	16	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Cladophora* spp.	M
	17	1.0 - 2.25 m	*Chara vulgaris; Cladophora* spp.	S
			Subtotal	**2 H; 1 M; 1 S**
NE	18	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Cladophora* spp.	M
	19	1.0 - 2.25 m	*Typha latifolia; Scirpus tabernaemontani; Cladophora* spp.	H
	20	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Cladophora* spp.	M
	21	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Cladophora* spp.	H
	22	1.0 - 2.25 m	*Ceratophyllum demersum; Cladophora* spp.	S
	23	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Cladophora* spp.	M
	24	1.0 - 2.25 m	*Cladophora* spp.	S
	25	1.0 - 2.25 m	*Chara vulgaris; Ceratophyllum demersum; Cladophora* spp.	M
			Subtotal	**2 H; 4 M; 2 S**
All			**Total (25 sample sites)**	**10 H; 11 M; 4 S (Average All Sites = M)**

Abundance: H – High, M – Moderate/Medium, S- Scant/Sparse, Z- Zero

Lake bed sediment/substrate sampling was conducted on August 14, 2019. Collection and analysis of four substrate samples, collected in both the littoral and deep zones of the lake, was conducted. A fifth sample location was unable to be collected with the Eckman dredge due to abundant aquatic vegetation cover on the lake bed within the southwest littoral area. Characteristics including composition, texture, odour and appearance were described for each sample collected (Table 4.1.7).

Table 4.1.7. Lake bed substrate/sediment sample results from Summerside Lake on August 14, 2019.

Sample Location within Lake	Sample Location (Littoral or Deepwater)	Water Depth at Sample Site	Sediment Odour Description	Settled Sediment Sample Jar Depth Following Agitation	Colour (Munsell)	Texture	Sample Comments
SE	Littoral	0.9 m	Natural - sulphur	0 - 67 mm	100% Black (10YR 2/1)	Organic	
NW	Littoral	2.2 m	Natural - sulphur	0 - 45 mm	100% Black (10YR 2/1)	Organic	High abundance of *Chara vulgaris* at sampling location.
	Deepwater	9.5 m	Natural - sulphur	0 - 1 mm	2% Brown (10YR 5/3)	Silt	Trace sand and gravel noted in the sample.
				1 - 63 mm	98% Black (10YR 2/1)	Organic	
NE	Littoral	2.0 m	Natural - Vegetation/soil	0 – 61 mm	100% Black (10YR 2/1)	Organic	
SW	Littoral	1.2 m	Natural - vegetation	-	-	-	Unable to collect sample due to highly abundant *Chara vulgaris.*

4.1.2 Comparative Limnological Analysis (2001 to 2019)

Water quality samples have been collected since August 8, 2001 (Tables 4.1.8 and 4.1.9). While turbidity, conductivity, pH, and alkalinity have fluctuated since 2001, overall there have been limited changes in these parameters (Table 4.1.8). Total dissolved solids (TDS) do appear to have increased since 2001. Between 2001 and 2006, the maximum TDS value was 256 mg/L, and from 2009 to 2019 TDS ranged from 291 to 520 mg/L. The 2019 TDS value of 453 mg/L was slightly lower than the 2018 value of 470 mg/L.

Threshold odour number (TON) appears to have slightly increased over time. In 2001, the TON value was 1.3, and from 2012 to 2019 TON has ranged from a minimum of 2.1 to a maximum of 6.5, with a measured value of 3.85 in 2019 (Table 4.1.9; Figure 4.1.5).

Water samples have also been tested for bacteria, nutrient levels and metal presence between 2001 and 2019 (Table 4.1.9). Total Coliforms decreased from 84 CFU/100 mL in 2012 to 8 CFU/100 mL in both 2016 and 2017 but increased to 130 CFU/100 mL in 2018 (Table 4.2.9). In 2019, Total Coliforms and *Escherichia coli* were >80 CFU/100 mL and >60 CFU/100 mL, respectively.

Nutrient levels have remained relatively consistent since 2001, with few fluctuations such as spikes noted in 2015 (Table 4.1.9). Total Kjeldahl Nitrogen (TKN) has increased from <0.05 mg/L in 2001 to 0.55 mg/L in 2019 with a peak of 0.93 mg/L in 2015. 2019 values for TKN are similar to those values measured in 2011 and 2012 (Figure 4.1.4). Total Phosphorous (TP) has decreased since construction and Chlorophyll A has generally been stable with exception of a 2015 spike (Figures 4.1.2 and 4.1.3).

Since 2001, limited changes have been observed in most metal parameters. Sodium has appeared to increase from 42.1 mg/L in 2011 to 54.2 mg/L in 2019; however, a slight decrease in concentration was detected from 2018 to 2019 (Table 4.1.9).

Aquatic vegetation was sampled in 2001, 2003, 2004, 2006, 2011, 2012, 2014, 2015, 2017, 2018 and 2019 (Table 4.1.10). In 2003, muskgrass (*Chara* sp.) was the first persistent aquatic vegetation observed within Summerside Lake. Green algae (*Cladophora* sp.) was also observed in 2003 and has generally been observed in the lake each year with the exception of two of those years. In 2019, *Cladophora* sp. was noted as highly abundant in several locations in the lake. Small-leaf pondweed (*Potamogeton pusillus*) and water milfoil (*Myriophyllum* sp.) have been observed throughout Summerside Lake since 2004 (Table 4.1.10). In 2015, *Ceratophyllum demersum* was observed and continues to be present in 2019. In 2017, aquatic buttercup (*Ranunculus aquatilis var.*), was added to the list of observed aquatic vegetation in Summerside Lake and continues to be present in 2019 at which time 6 species of aquatic vegetation including algae were noted. Generally, the trend data suggests increased composition and diversity of aquatic vegetation has occurred (from 0 species present in 2001 to 6 species present in 2017-2019). Abundance and spatial extent of vegetation coverage has increased since original construction. However, the recent past two years of monitoring suggests an average moderate abundance of aquatic vegetation in sample sites versus high abundance noted in 2015-2017 (Table 4.1.10).

Zooplankton counts had increased between 2006 and 2017 with an average of 30 zooplankton/500 mL sample in 2006 to a peak of 5330 zooplankton/500 mL sample in 2017, but have since exhibited a decrease in 2018 and 2019 with 2970 zooplankton/500 mL sample and 1400 zooplankton/500 mL sample counted respectively (Table 4.2.11).

Lake bed substrate sampling has only been conducted since 2017. Composition, odour, colour and texture of the lake substrate in 2018 were similar to 2017 with a layer of silt on top of clay and/or organic material present in all sampled areas. In 2019, the samples appeared to have been primarily composed of organic material. This may be due in part to sampling conditions wherein aquatic vegetation limited ability to collect substrate (Table 4.5.3).

Table 4.1.8. Cumulative summary of routine water quality results at Summerside Lake on various dates from 2001 to 2019.

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	Aug 14, 2019
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	1.52
Conductivity (µs/cm)	298	491	457	504	628	666	579	590	671	672	687	591	730	811	528	683	476	609	633	632
Total Dissolved Solids (mg/L)	148	246	231	256	316	333	291	295	477	340	480	422	520	573	374	478	330	433	470	453
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	8.47
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	102
Temperature (ºC)[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	18.9

[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 4.1.9. Cumulative summary of supplemental water quality results at Summerside Lake on various dates from 2001 to 2019.

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	Aug 14, 2019
Oil and Grease (mg/L)	0	-	<5	0	-	-	62.0	<5	-	-	<0.5	<5	<5	33	<5
Total 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	0.55
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	<0.05
Dissolved Phosphorus (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Chlorophyll A (µg/L)	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	2
Phaeophytin (µg/L)	-	-	-	-	-	-	2	1.2	-	-	1	<0.5	<0.5	1	<0.5
Dissolved Chloride (mg/L)	-	-	-	-	-	-	7.2	7.7	6.0	6.9	7.4	7.2	7.7	8.5	8.9
Dissolved Sulfate (mg/L)	-	-	-	-	-	-	205	191	200	230	207	237	220	221	218
Hydroxide (mg/L)	-	-	-	-	-	-	<5	<5	Not Detected	<0.50	<5	<5	<5	<5	<5
Carbonate (mg/L)	-	-	-	-	-	-	<6	<6	Not Detected	<0.50	<6	<6	<6	<6	<6
Bicarbonate (mg/L)	-	-	-	-	-	-	160	129	120	110	130	115	124	114	107
Hardness (mg/L)	-	-	-	-	-	-	248	219	210	210	212	213	212	216	205
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	4.0-4.5
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	-	8.60-10.78
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	3.85
Total Coliforms (CFU/100ml)	<1-380	<1	-	<1	1-125	7	3	2 (East) 2 (West)	84	250[1]	-	8	8	130	>80
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	>60

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	Aug 14, 2019
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	<0.02
	Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	0.069	0.062
	Calcium	-	-	-	-	-	-	53.2	53.2	49	43.7	43.7	48.3	49.2	49.2	44.2
	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	<0.001
	Iron	-	-	-	-	-	-	0.06	0.06	Not Detected	<0.05	<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	<0.0001
	Magnesium	-	-	-	-	-	-	20.8	20.8	22	18.0	18.0	22.9	22.1	23.6	23.1
	Manganese	-	-	-	-	-	-	0.070	0.070	0.011	<0.05	0.009	0.022	0.010	0.025	0.035
	Phosphorus	-	-	-	-	-	-	<0.05	<0.05	Not Detected	3.2	<0.05	<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	4.0
	Selenium	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0002	<0.0002
	Sodium	-	-	-	-	-	-	42.1	42.1	43	0.002	41.4	53.6	51.5	54.6	54.2
	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	<0.001

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

Table 4.1.10. Summary of aquatic vegetation sampling results at Summerside Lake from 2001 to 2019.

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	Aug 14, 2019
Aquatic Vegetation Species Present (including algae; not including semi-aquatic species)	-	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*	*Chara vulgaris*
	-	*Cladophora* sp.	-	*Cladophora* sp.	*Cladophora* sp.	*Cladophora* sp.	*Cladophora* sp.	-	*Cladophora* sp.	*Cladophora* sp.	*Cladophora* sp.
	-	*Alisma gamineum*	-	-	-	-	-	-	-	-	-
	-	-	*Myriophyllum* sp.	*Myriophyllum* sp.	*Myriophyllum* sp.	*Myriophyllum* sp.	*Myriophyllum* sp.	*Myriophyllum* sp.	*Myriophyllum* sp.	*Myriophyllum* sp.	*Myriophyllum* sp.
	-	-	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*	*Potamogeton pusillus*
	-	-	-	-	-	-	-	*Ceratophyllum demersum*	*Ceratophyllum demersum*	*Ceratophyllum demersum*	*Ceratophyllum demersum*
	-	-	-	-	-	-	-	-	*Ranunculus aquatilis var.*	*Ranunculus aquatilis var.*	*Ranunculus aquatilis var.*
Number of Species	0	3	3	4	4	4	4	4	6	6	6
Average Abundance (Average of all Sample Sites)	None	Low abundance	Moderate abundance	Areas of abundant growth	High abundance	High abundance	High abundance	High abundance	High abundance	Moderate 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	>2.2m

Abundance: H – High, M – Moderate/Medium, S- Scant/Sparse, Z- Zero Note: Semi-aquatic plants, *Typha latifolia* and *Scirpus* sp., have not been included.

Table 4.1.11. Total zooplankton at Summerside Lake from 2006 to 2019.

Parameter	Result													
	June – Oct 2006[1]		September 15, 2011		August 24, 2012		August 20, 2015		August 16, 2017		August 14, 2018		August 14, 2019	
	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Number of Zooplankton (#/500 mL sample derived from 25 mL sample count)	~13	~47	6	63	73	118	883	600	4960	5700	2730	3210	1400	1920

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

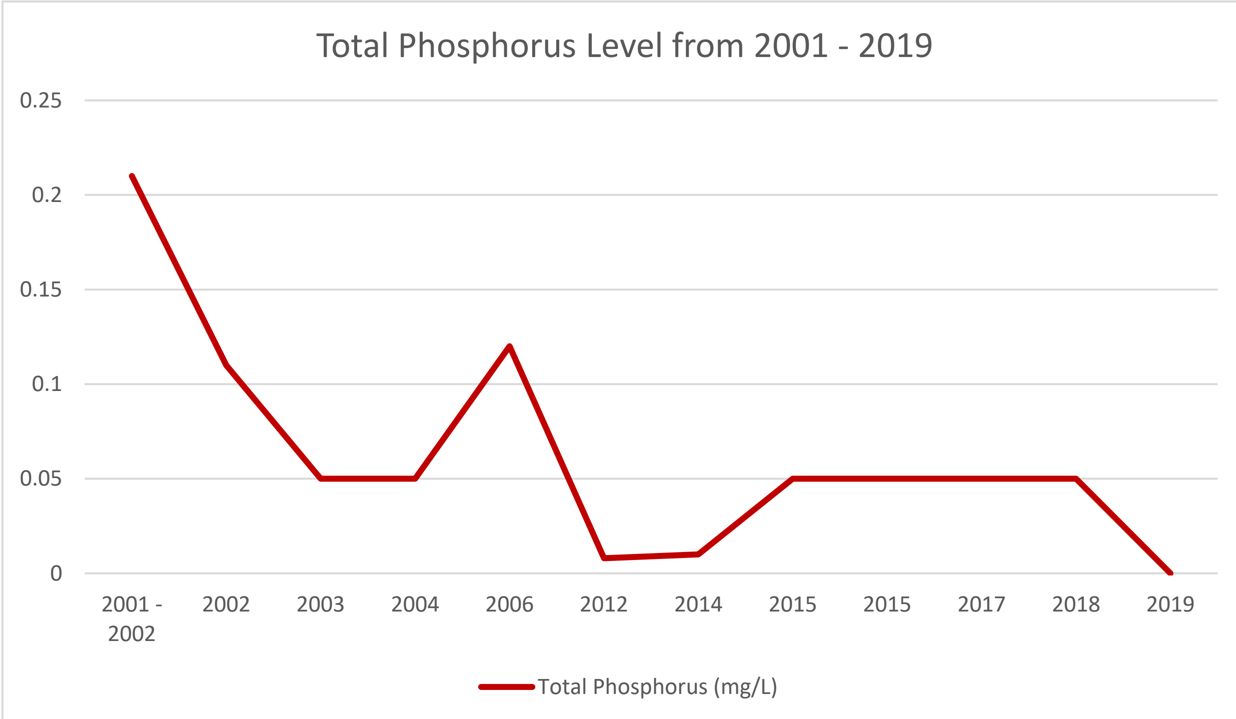

Figure 4.1.2. Total phosphorus levels (mg/L) in Summerside Lake from 2001 to 2019.

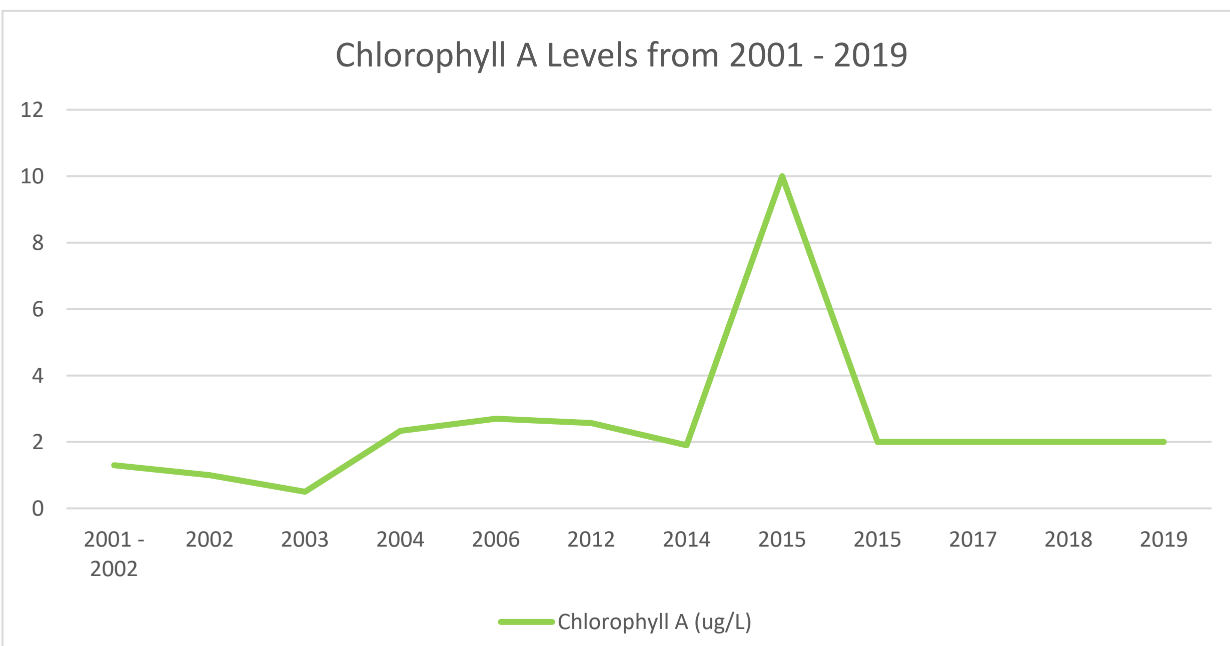

Figure 4.1.3. Chlorophyll A levels (μg/L) in Summerside Lake from 2001 to 2019.

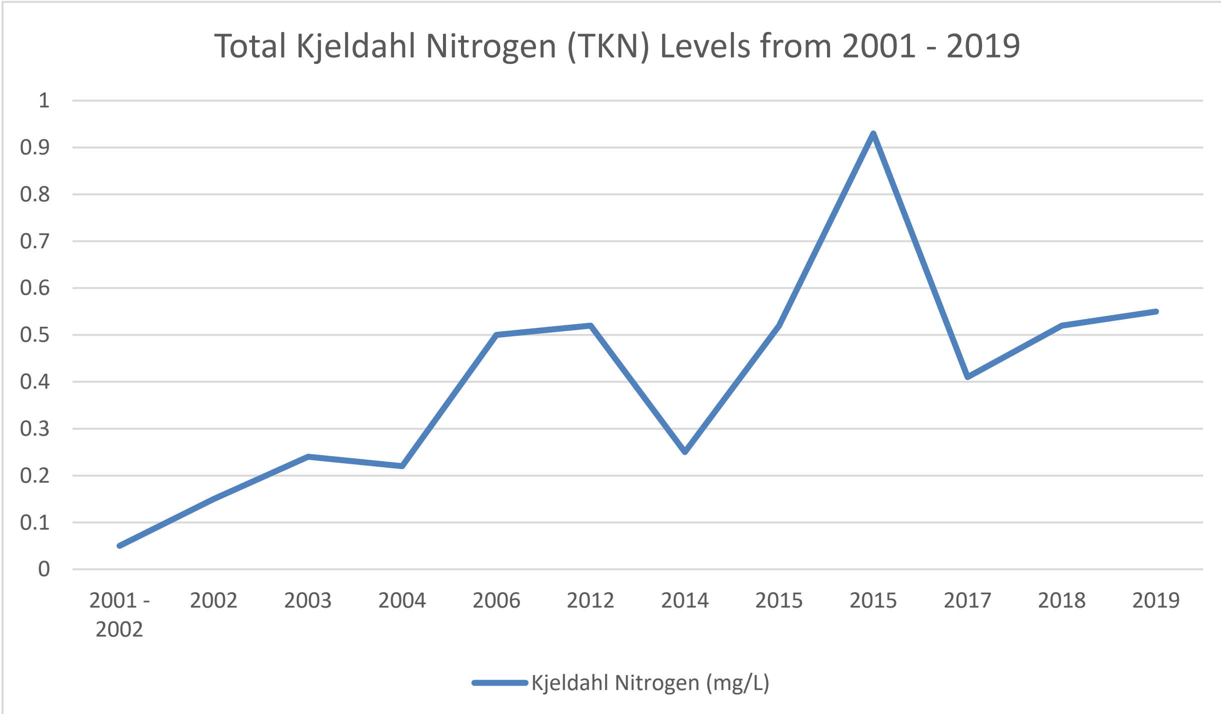

Figure 4.1.4. Total Kjeldahl Nitrogen (TKN) levels (mg/L) in Summerside Lake from 2001 to 2019. No TKN analysis was conducted from 2007 – 2011.

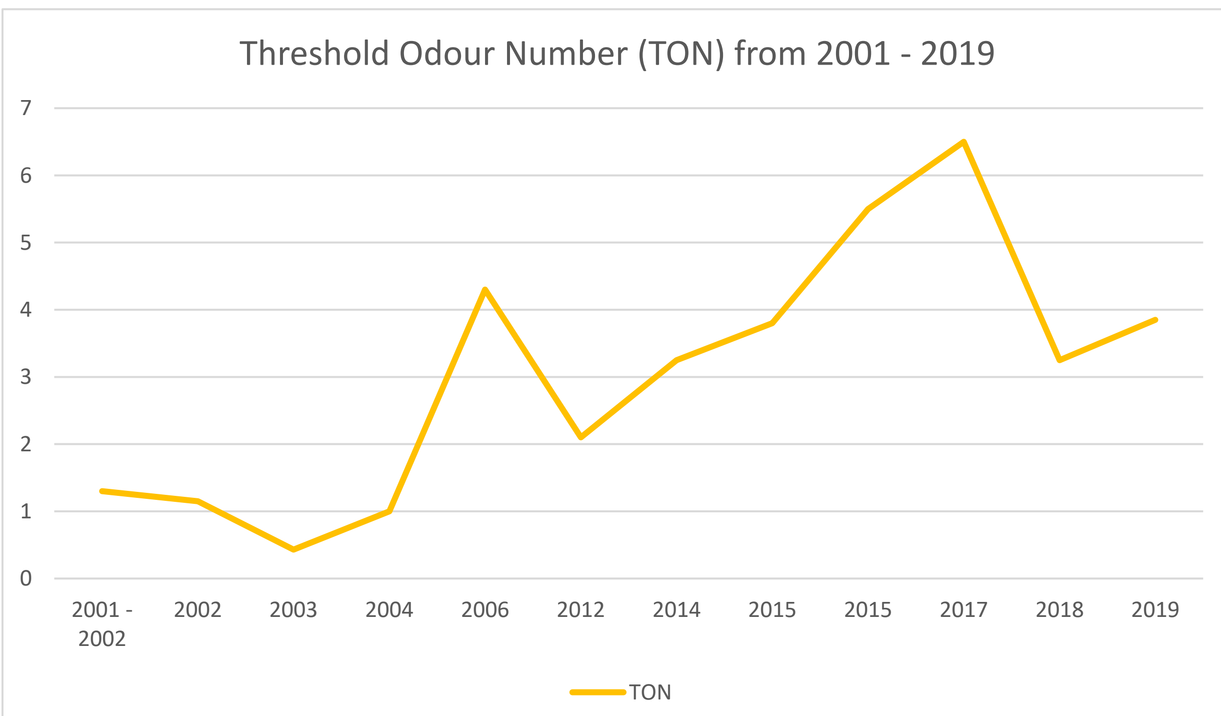

Figure 4.1.5. Threshold Odour Number (TON) in Summerside Lake from 2001 to 2019.

4.2 *Yellow Perch (Invasive Fish) Removal*

4.2.1 Gill Netting Effort Results

A description of the April 18 and 19, 2019 Yellow Perch removal result are provided below.

1. Eight gill nets (50m length, 38mm mesh size) were set daily in areas targeted as having the highest potential for Yellow Perch spawning habitat. One overnight net set (21 hours per net) was conducted.

2. Gill nets were set overnight and inspected each morning for a total of 168 hours of combined gill net fishing effort. A total of 86 fish, including three species, were captured in the gill nets (Table 4.2.1). The fish composition included 11 Rainbow Trout (*Oncorhynchus mykiss*), 23 Brook Trout (*Salvelinus confluentus*) and 52 Yellow Perch (*Perca flavescens*) (Table 4.2.1).

3. The captured Rainbow Trout ranged in length from 180 mm to 335 mm (Table 4.2.2). Of the 11 Rainbow Trout captured, 10 were successfully released back into the lake, while one other was removed and disposed of as it was deceased.

4. Of the 23 Brook Trout captured, 4 were released alive back into the lake while 19 were deceased. The captured Brook Trout ranged in length from 127 mm to 270 mm.

5. The entirety of the 52 Yellow Perch captured were euthanized and disposed of according to the provincial research permit requirements. Typically, a sample population subset of 100 Yellow Perch are assessed for additional measurements, however, due to lower catch rates than previous years, only 52 were measured.

6. The subset of sampled Yellow Perch ranged in length from 125 mm to 270 mm with females averaging 196 mm and males averaging 163 mm (Table 4.2.3; Figure 4.2.1).

7. The subset of sampled Yellow Perch ranged in weight from 20 g to 234 g with females averaging 93 g and males averaging 46 g (Table 4.2.3).

8. The subset of sampled Yellow Perch consisted of nine age classes with the average age of both males and females being 4 and 5 years respectively (Table 4.2.3; Figure 4.2.1).

9. The subset of sampled Yellow Perch consisted of 13% females and 87% males. Most of the mature male Perch were exhibiting signs of milt production; however, most of the mature females did not exhibit signs of egg production. Of the two female Yellow Perch exhibiting egg production, one individual was ripe and one was spent.

10. Some stomach contents of the deceased Rainbow Trout and Brook Trout were examined in 2019 and included dragonfly nymphs, back swimmers and caddisfly larvae.

Table 4.2.1. Daily catch summary of gill net fishing effort at Summerside Lake on April 18 to 19, 2019.

Days	Gill nets (50m lengths)		
	Effort/Time (hrs of 50yd)	Net size (mm)	Number & Species of Fish Caught
April 18-19, 2019	168	38mm (8)	52 YLPR, 11 RNTR, 23 BKTR
Total	**168**	**8 nets per set**	**52 YLPR, 11 RNTR, 23 BKTR**

YLPR – Yellow Perch (*Perca flavescens*) RNTR – Rainbow Trout (*Oncorhynchus mykiss*)
BKTR – Brook Trout (*Salvelinus confluentus*)

Table 4.2.2. Fish species and size composition of sample population subset of measured fish captured from Summerside Lake on April 18 to 19, 2019.

Fish Species	Fork Length (mm) of Fish Captured									
	<50	50 - 69	70 - 89	90 - 109	110 - 149	150 - 199	200 - 249	250 - 299	>300	Total
YLPR	-	-	-	-	8	40	2	2	-	**52**
RNTR	-	-	-	-	-	5	4	1	1	**11**
BKTR	-	-	-	-	2	4	16	1	-	**23**
Total	**-**	**-**	**-**	**-**	**10**	**49**	**22**	**4**	**1**	**86**

YLPR – Yellow Perch (*Perca flavescens*) RNTR – Rainbow Trout (*Oncorhynchus mykiss*)
BKTR – Brook Trout (*Salvelinus confluentus*)

Table 4.2.3. Yellow Perch sample population characteristics at Summerside Lake from 2010 to 2019.

Population Characteristic	April 2010	May 2011	May 2012	May 2013	May 2014	April 2015	April 2016	May 2017	May 2018	April 2019
Range of lengths (mm)	150-270	105-255	105-208	122-193	133-190	134-191	135-240	135-205	80-266	125-270
Mean length males (mm)	188	151	139.6	142	147.4	149.7	158.9	174.2	171.5	162.6
Mean length females (mm)	216	204	145.7	153	163.6	162.7	190.0	168.7	174.4	196.0
Range of weights (gr)	105-300	-	10.6-88	16-69	28-60	27-56	13-170	50-210	3-165	20-234
Mean weight of males (gr)	105	-	27.3	27	30.9	35.7	36.9	106	45	46.5
Mean weight of females (gr)	221	-	33.2	35.1	40.5	48.0	75.9	104	53	92.9
Mean age males	4.0	3.2	3.9	2.4	3.4	3.8	4.2	4.1	4.2	4.3
Mean age females	4.4	4.1	4.4	2.6	4.5	4.5	5.6	4.0	3.4	5.0
Overall mean age	4.3	3.4	4.0	2.5	3.9	4.1	4.5	4.1	4.0	4.4
Sample size (n)	31	30	73	80	76	68	150	101	100	52

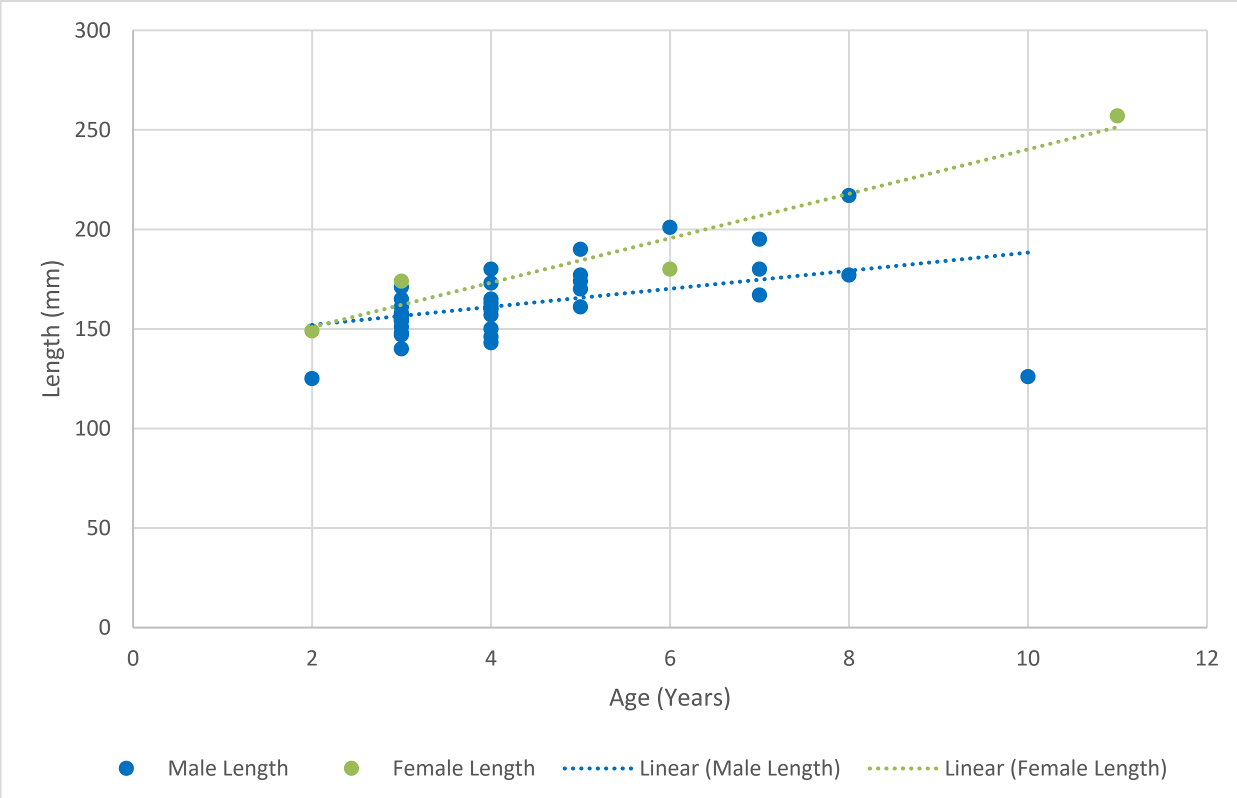

Figure 4.2.1. Age-length relationship of Yellow Perch population sample captured from Summerside Lake on April 18 and 19, 2019.

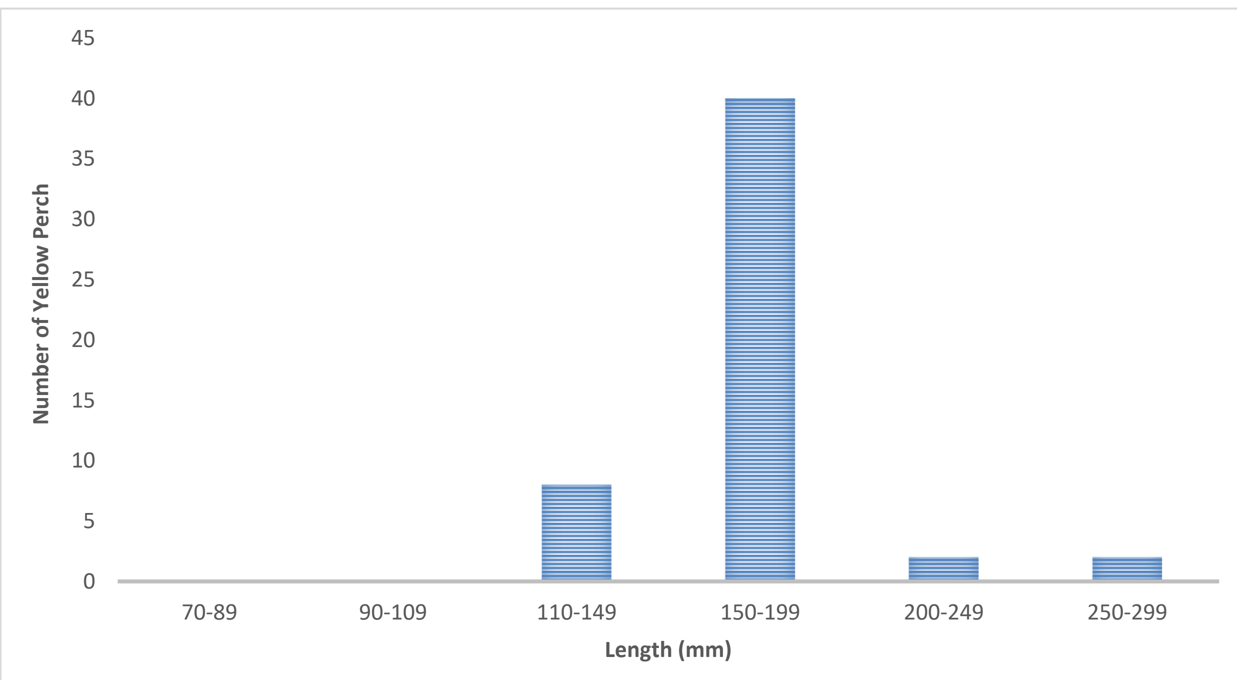

Figure 4.2.2. Length-number frequency relationship of Yellow Perch population sample captured from Summerside Lake on April 18 and 19, 2019.

4.2.2 Minnow Trapping Effort Results

Minnow traps were set on April 18, 19 and 25, 2019 to supplement the gill netting technique for removal of Yellow Perch as well as for effort to capture other invasive species, namely goldfish (*Carassius auratus*). Ten (10) minnow traps were set on the northeast side of the lake on April 18, 2019 and five (5) minnow traps reset on April 19 and April 25, 2019. No goldfish or other fish species were captured within the minnow traps other than 250 Yellow Perch which were disposed of (Table 4.2.4).

Table 4.2.4. Summary of minnow trap catch characteristics at Summerside Lake in April 2019.

Date	Minnow Traps	
	Effort/Time (hrs)	Number & Species of Fish Caught
April 18, 2019	210	0 GOFS 24 YLPR
April 19, 2019	735	0 GOFS 165 YLPR
April 25, 2019	947.5	0 GOFS 61 YLPR
Total	**1892.5**	**0 GOFS 250 YLPR**

YLPR – Yellow Perch (*Perca flavescens*) GOFS – Goldfish (*Carassius auratus*)

4.2.3 Spruce Bough Egg Removal Results

As part of the Yellow Perch Control Program at Summerside Lake and in addition to removing adult perch, EnviroMak placed twenty spruce boughs on top of the ice in select positions around the shoreline of the lake. The boughs sank into the water upon melting of the ice. Following the spring spawning window for the yellow perch, the boughs were to removed along with any fish eggs deposited on the boughs.

No eggs were observed on the spruce boughs during the 2019 season. Boughs were checked periodically following ice melt, and on May 9, 2019 the boughs were removed from the lake. In 2018, six spruce boughs were placed on the ice and secured to the shore in late April at various target locations prior to perch spawning. 330,000 fertilized perch eggs were removed and destroyed in 2018.

4.2.4 Comparison of Yellow Perch Harvest 2010 to 2019

Overall, the Yellow Perch catch rates appeared to increase from 2010 to 2013, declined in 2014, and again increased in 2015. In 2016 to 2019, it appeared catch rates by gill netting significantly decreased when compared with efforts of the previous four years (2012 to 2015) (Table 4.2.5; Figures 4.2.3 and 4.2.4). Since 2012 the fishing effort has consisted of four to five days per year; however, in 2017 and 2018 this was reduced to 2 days as a result of the low catch numbers and reduced further to 1 day in 2019 following a catch rate of 0.3 Yellow Perch per hour (Table 4.2.5). In the past, the focus on 38mm gill net mesh sizes has effectively targeted Yellow Perch and limited needless capture and handling of stocked Rainbow Trout and Brook Trout. However, in 2019, due to the smaller sized Brook Trout having been stocked in the lake, some undesirable incidental catch of Brook Trout did occur in the nets.

Table 4.2.5. Yellow Perch (YLPR) fish catch characteristics at Summerside Lake from 2010 - 2019.

Year	Number of Days GN Fished	Total Number of YLPR Caught[1]	Mean Length of YLPR (mm) [Males M Females F]	Number of YLPR Caught per 50yd Gill Net (GN) 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; Short pre-spawning and ice out period of <3 days; 30 Rainbow Trout
2012	5	4,766	140 M 146 F	312 net hours 15.3 YLPR/hr	Two mesh sizes used (38mm and 63.5mm); 3-6 nets/night; Long pre-spawning and ice out period of >5 days; 3 Rainbow Trout
2013	5	~8,692	142 M 153 F	477.75 net hours 18.2 YLPR/hr	One mesh size used (38mm); 6 nets/night; Short pre-spawning and ice out period of ~3 days; 8 Rainbow Trout
2014	4	~6,919	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; Short pre-spawning 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; Long ; pre-spawning and ice out period of >5 days; 1 Rainbow Trout
2016	5	1,975	159.1 M 195.1 F	804 net hours 2.5 YLPR/hr	One mesh size used (38mm); 8 nets/night; Long pre-spawning and ice out period of >5 days; however only 3 capture days conducted in pre-spawning period than 2 further capture dates during/post-spawning; 16 Rainbow Trout; 1 Triploid Grass Carp
2017	2	452	174.2 M 168.7 F	352 net hours 1.3 YLPR/hr	One mesh size used (38mm); 8 nets/night; Fishing effort completed prior to end of spawning period; 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; 11 Rainbow Trout
2019	1	302 (52 GN 250 MT)	162.6 M 196.0 F	168 net hours 0.3 YLPR/hr	One mesh size used (38mm); 8 nets/night; 11 Rainbow Trout, 23 Brook Trout; Low catch rate first day halted additional gill netting

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

[1]Total capture from fishing methods.

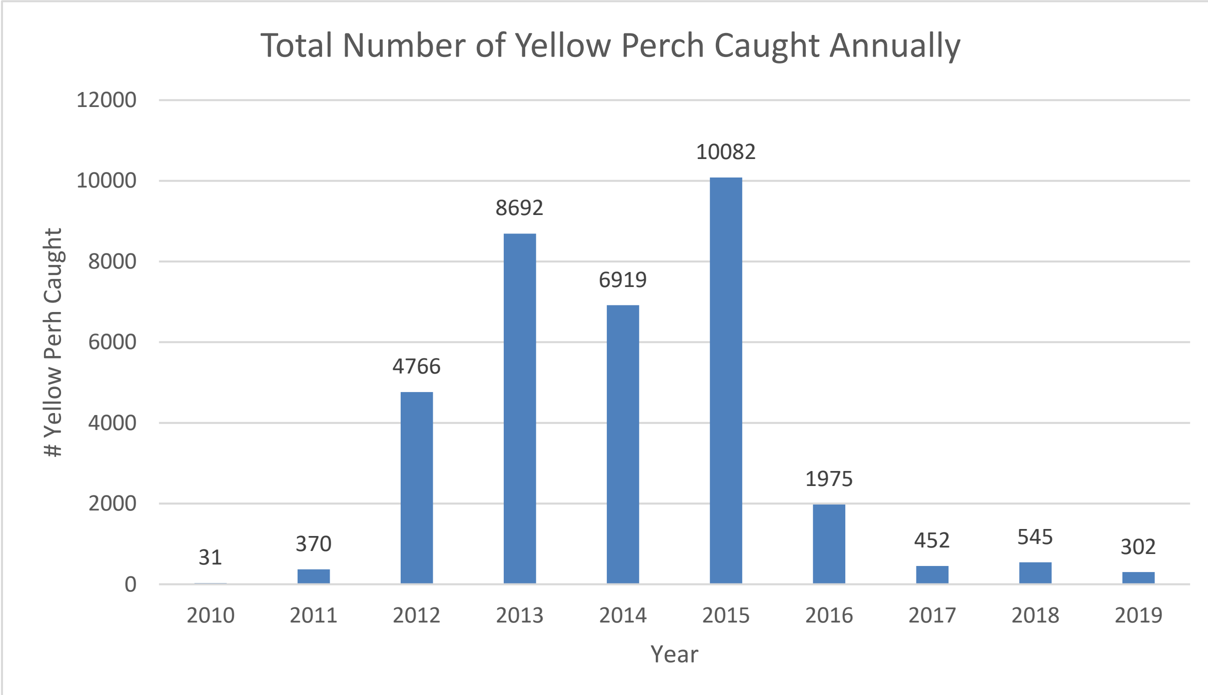

Figure 4.2.3. Number of Yellow Perch captured annually from Summerside Lake in Edmonton from 2010 to 2019.

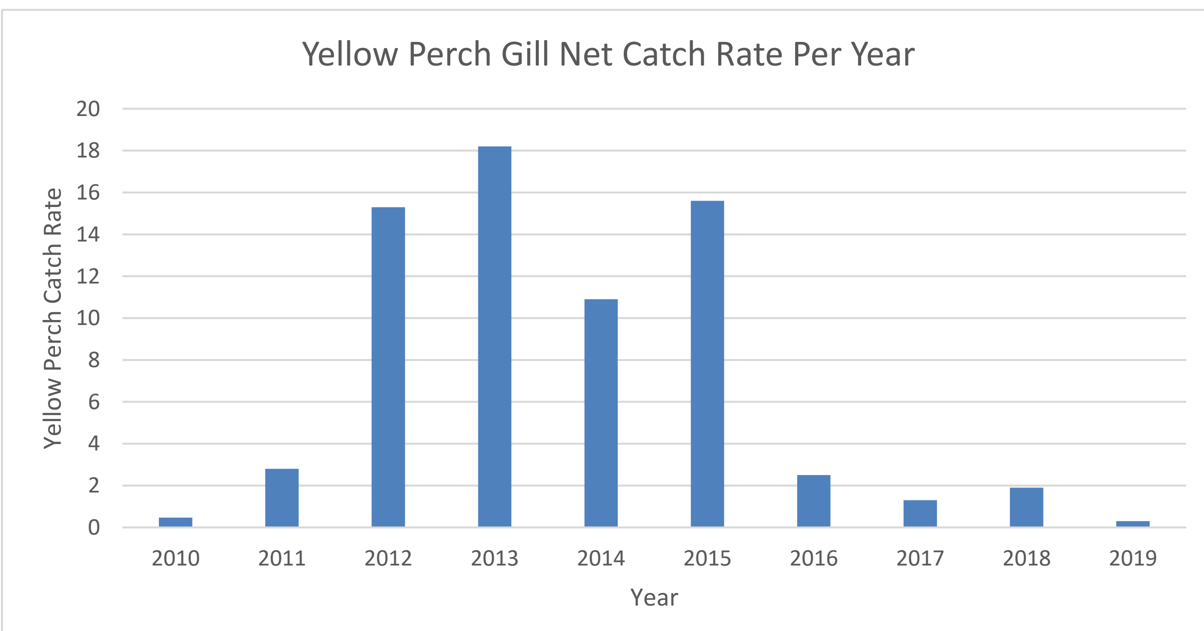

Figure 4.2.4. Yellow Perch gill net catch rate (number of Yellow Perch caught per 50 yard gill net hour) per year from Summerside Lake from 2010 to 2019.

5.0 DISCUSSION AND CONCLUSIONS

The following discussion and conclusions are generated from the interpretation of limnological and fish data compiled during the 2019 monitoring of Summerside Lake.

5.1 Limnological Monitoring

1. Water quality in 2019 was generally within acceptable limits in parameters relevant for fish survival. Targets, indicators and guidelines for water quality for fish health are provided in Appendix 9.3.

2. Dissolved oxygen levels in winter were generally acceptable at surface and most depths at most sampling sites for fish survival; however, 3 measurements at lowest depths in two sample sites indicated concentrations <5 mg/L.

3. Nutrient and eutrophic status indicator parameters indicate some general stability despite limited temporary measured increases in parameters such as Chlorophyll A and Total Kjeldahl Nitrogen (TKN) in 2015. Stability in Total Phosphorous and TKN levels, owing in part to sufficient prevention of inputs of nutrients into the lake, may contribute to limiting the growth and production of undesirable algae (i.e. blue-green algae). Secchi disc reading depths were measured at 4.0 to 4.5 m in 2019 and are indicative of overall lake health. Appendix 9.3 provides further information on indicators of the trophic status of lakes.

4. Water samples taken on August 14, 2019 were also tested for bacteria, nutrients, metals, herbicides and other water quality parameters. None of these elements exceeded the Canadian Environmental Quality Guidelines for Protection of Freshwater Aquatic Life or Alberta Environmental Quality Guidelines for the Protection of Freshwater Aquatic Life (Appendix 9.3).

5. Water quality results including Threshold Odour, clarity, turbidity and pH appear to meet the Guidelines for Canadian Recreational Water Quality (Appendix 9.3). Bacteria were sampled; however, the results were not interpreted to the guidelines as site specific requirements may apply to Summerside Lake and regular sampling by lake maintenance is undertaken to verify compliance for public health relevant to swimming and bacteria (i.e. coliforms).

6. Lake bed substrate sampling has only been conducted since 2017; however, no major changes were noted in substrate sampling that would warrant action.

7. Aquatic vegetation appears to be increasing in diversity (number of species present) over time from 0 to 6 species being present since construction to present. High abundance of various species at various sample locations was noted particularly in 2015-2017; however, both in 2018 and 2019 moderate abundance for the overall lake was determined from the average of sample sites. *Cladophora* sp. (green algae) was noted as being abundantly present in numerous areas in the lake in 2019.

5.2 *Yellow Perch (and Invasive Fish) Removal*

1. In 2019, fishing efforts began on April 18, relatively early in the year with water temperatures around 7.3°C. Very low catch rates (0.3 YLPR/hour and 52 Yellow Perch total) resulted in the decision to stop gill net fish removal efforts on April 19, 2019. The Yellow Perch daily catch and catch rate were lower in 2019 than in any previous years of the perch removal program (2012-2018). In addition to this, an undesirable higher catch rate for stocked non-target trout species was occurring. A total of 302 Yellow Perch were removed using both gill net and minnow trapping techniques in 2019.

2. Reduced gill net mesh sizes during the course of the Yellow Perch removal program have effectively targeted Yellow Perch and reduced capture of stocked Rainbow Trout and Triploid Grass Carp. In 2019, some undesirable catch of newly stocked Brook Trout occurred due to the smaller size of the stocked fish.

3. Numbers of Yellow Perch captured were greater than the Rainbow Trout, especially with the use of smaller gill net mesh at 38mm. In 2019, 11 Rainbow Trout and 23 Brook Trout were captured, while 52 Yellow Perch were removed via gill nets. All of the captured Yellow Perch were euthanized and disposed of. One of the 11 Rainbow Trout and 19 of the 23 Brook Trout were sacrificed, as they were deceased upon capture; the remainder were released alive.

4. In addition to gill nets, minnow traps were also set to capture Yellow Perch and potentially other invasive species. Over 1872.5 minnow trap hours, 250 Yellow Perch were captured and disposed of. No other species were captured via this method.

5. No aquatic invasive species, including goldfish or other species of the carp family, were captured during gill netting and minnow trapping and no observations of these species were recorded during any of the site visits.

6. Yellow Perch were present in most places within the lake and included fish that were up to 11 years of age. Several age classes were mature including males at two years of age. Fewer females were captured than males (7 females to 45 males in the population sample), and they generally appeared to be larger and older than the males. Only one of the seven female Yellow Perch captured was ripe.

7. 38% of all Yellow Perch captured by gill nets were captured within the gill net set along the south central shore of Summerside Lake.

8. In 2019, an attempt to collect and remove Yellow Perch eggs was conducted with the use of spruce boughs used to attract spawning perch and to provide a spawning substrate. No signs of spawning or egg masses were deposited on the spruce boughs. This is a substantive difference from the 2018 result of the technique wherein a total of 330,000 perch eggs were collected and removed via the spruce boughs. The 2018 timing of the egg collection and the removal prior to eggs hatching is important in contributing to the reduction of the perch population.

9. The densities of Yellow Perch in similar environments in central Alberta have been calculated at a water supply reservoir by EnviroMak in 2009. In a pond having a surface area of 1.0 ha (100m x100m), a total of 11,839 fish of one species, Yellow Perch (*Perca flavescens*), were salvaged (with similar age distribution). The density of fish salvaged in this raw water pond was 1.18 fish per square meter of pond area. This may suggest that, without removal efforts, Summerside Lake could have had approximately 154,000 Yellow Perch with 33% being young-of-year fish. Such numbers could potentially be expected in Summerside Lake without a management/removal program.

10. The removal of Yellow Perch and their eggs during the past years appears to have potentially influenced the size, age and density of the population as less fish were captured in 2016-2019 than in previous years.

11. No natural fish kills within Summerside Lake were noted during the past year.

12. Observations from Summerside personnel, visitors and divers during the summer of 2010 to 2014 had indicated that large numbers of Yellow Perch are present. Observations by EnviroMak during the spring of 2015 also verified large numbers of Yellow Perch were still present during the spawning period. Observations from Summerside residents, divers and EnviroMak during the spring of 2016, 2017 and 2018 indicated a potential decrease in number of Yellow Perch present. No data regarding personnel, visitor or diver observations was indicated in 2019.

13. With the continued presence of Yellow Perch, several issues arise as to the future management of the fishery and this includes legal implications of possessing Yellow Perch in these privately-owned waters. From the 2013 to 2015 fish removal programs, high catches of Yellow Perch were recorded. During the 2016 to 2019 removal program, a decrease in the number of fish caught was observed. The effective and efficient elimination of Yellow Perch without substantive harm to the Rainbow Trout, Brook Trout and Triploid Grass Carp populations using specific gill netting mesh sizes or trap (fyke) nets may have potential to control but not eliminate Perch populations. Other techniques such as electrofishing, minnow traps or other fish capture equipment are impractical. Overall, the periodic removal of Yellow Perch via a netting program or a catch and remove program to reduce Perch densities may influence both the quality of the Yellow Perch population as well as the quality of the stocked trout population.

6.0 RECOMMENDATIONS

Recommendations for the aquatic management of Summerside Lake are provided below.

1. Water quality analysis continues to indicate that Summerside Lake water quality remains within acceptable limits for fish health and recreational use. Continued annual sampling during the winter particularly for dissolved oxygen and summer particularly for aquatic vegetation and water quality is recommended. However, a reduction in effort in sampling could be applied in 2020 with respect to elimination of substrate/bed sediment sampling and reduced overall intensity of sampling where possible. Effort should be alternated annually between a reduced sampling effort and comprehensive sampling effort unless changes in parameters warranting annual comprehensive sampling are measured.

2. Selective reduction of Yellow Perch and maintained or increased stocking of Rainbow Trout and Brook Trout should continue. The target and schedule would still be to capture Yellow Perch at a pre-spawning period at a lake ice-out condition that would avoid conflict with other recreational water-based activities. However, a continued low effort of one removal day could be targeted assuming low catch rates are observed. Following the 2019 Yellow Perch removal results, selective reduction of Yellow Perch in 2020 may not be as advantageous as in previous years. However, as discussed at the Annual General Meeting in June 2019, a continued one-day removal effort would establish an understanding of the Yellow Perch population trend that would contribute to the future and continued management of the fish resources of Summerside Lake.

3. Due to the capture of several Brook Trout during the invasive species removal effort, the future stocking should ensure that a larger size of stocked Brook Trout are used. The lack of availability of the larger sized trout by the supplier resulted in the increased capture of the Brook Trout by the mesh sizes used to capture the Yellow perch. Historically, incidental trout capture during the Yellow Perch removal effort has been small.

4. Considering the success of the spruce bough egg removal and retrieval method in 2018 and despite the absence of eggs on the boughs in 2019, spruce boughs should again be placed on ice and attached to shore in early April 2020 and withdrawn post-spawning to remove perch eggs to bolster the perch removal effort. A volumetric estimation of egg numbers removed should be obtained for trend analysis to provide recommendations for future application of the methodology. Although no eggs were retrieved and removed in 2019, this is a relatively low-cost and low-effort method to aid in perch removal and to analyze potential numbers of spawning individuals in the lake. The decision to apply the method following 2020 should be re-evaluated following the spring 2020 effort.

5. Stocking of both trout species was recommended and conducted in 2018 per the Fish Stocking Plan prepared by EnviroMak Inc., with the stocking of both Rainbow Trout and Brook Trout recommended to continue to occur annually. Continued management of the invasive fish populations is recommended to protect the trout fishery and prevent the invasive population from becoming the dominant species.

6. The use of other catch methodologies and efforts, other than the gill netting and minnow trap perch removal and spruce bough egg collection methods applied in 2019, are not recommended at this time. The continued selective reduction of Yellow Perch via gill netting (one annual 24-hour effort) and minnow trapping for potential invasive species (i.e. goldfish) capture and Yellow Perch removal should be applied in 2020. Previous reports prepared for the Association provide a detailed matrix comparison of fisheries management strategy options, pros, cons and ranking. This recommended approach that has been selected in the past and was indicated as the highest ranked option is still considered the most feasible effective option considering the various limitations and influencing factors.

7. During previous years approximately 19,530 Yellow Perch fish were relocated from Summerside Lake to Halfmoon Lake and this included ~3850 fish in 2013, ~7140 fish in 2014 and ~8540 fish in 2015. Alberta Environment and Parks (AEP) declined to support a fish relocation effort in 2016 due to concerns about the spread of invasive species and disease; however, some fish were removed by AEP in 2019 (D. Marchuk, per. comm.). Future Yellow Perch removal efforts could pursue the option of fish relocation rather than disposal. However, considering the current concern of the government for Whirling disease and transfer of invasive species, it is expected that relocation programs would need approval and may not be desirable to the province unless arranged and/or undertaken directly by the government.

8. Observations of other invasive fish species (i.e. Goldfish) should be reported, documented and tracked. Should additional sightings be reported, a review of potential response should occur.

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 kyla@enviromak.com with any questions or concerns.

Sincerely,

Natalie Ritosa, B.Sc.
Junior Biologist, EnviroMak Inc.

&

Ray Makowecki, M.Sc., B.Ed., P.Biol., QAES
Principal, EnviroMak Inc.

&

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

Attachments: *Bibliography and Appendix (Photographs)*

8.0 BIBLIOGRAPHY

Alberta Environment and Parks. 2014. Environmental Quality Guidelines for Alberta Surface Waters. Pub. No. 1. 31 pp.

Alberta Lake Management Society (ALMS). 2017. Muriel Lake Water Quality Report 2017. 12 pp.

Bilas, John. 2015. Supervisor. Sam Livingstone Fish Hatchery. Alberta Environment and Sustainable Resource Development (Calgary). Personal Communication.

Canadian Council of Ministers of the Environment. 2011. Canadian water quality guidelines for the protection of aquatic life. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Egan, K., 2012. Volunteer for Summerside Lake Residents' Association. Personal Knowledge.

Fulford, R. S., Rice, J. A., Miller, T. J., Binkowski, F. P., Dettmers, J. M. and Belonger, B. 2006. Foraging selectivity by larval yellow Perch (*Perca flavescens*): implications for understanding recruitment in small and large lakes. Can. J. Fish. Aquat. Sci. Vol 63, 28-42.

Glover D. C., Dettmers, J. M., and Clapp, D. F., 2008. Lake –wide mark and recapture investigation of Lake Michigan yellow Perch: evaluation of interstate movements, spawning site fidelity, spawning population abundance, and sources of mortality.

Gullion, Denyse. Various Dates. Fisheries Biologist. Alberta Environment and Parks. Personal Communication.

Langhorne, A. L., M. Neufeld, G. Hoar, V. Bourhis, D. A. Fernet and C. K. Minns. 2001. Life history characteristics of freshwater fishes occurring in Manitoba, Saskatchewan and Alberta, with major emphasis on lake habitat requirements. Can. MS Rpt. Fish. Aquat. Sci. 2579: xii + 170 pp.

Makowecki, R. and Walker-Makowecki, K. L. 2005. Summerside Lake Biophysical Assessment 2004. 24pp.

Makowecki, R. and Walker-Makowecki, K. L. 2010. Summerside Fish Assessment Report. 10pp.

Makowecki, R. and Walker-Makowecki, K. L. 2011. Summerside Fish Assessment Report. 21pp.

Makowecki, R. and Walker-Makowecki, K. L. 2012. Summerside Fish Assessment Report. 18pp.

Makowecki, R. and Walker-Makowecki, K. L. 2013. Summerside Fish Assessment Report. 20pp.

Makowecki, R. and Walker-Makowecki, K. L. 2014. Summerside Fish Assessment Report. 30pp.

Makowecki, R. and Walker-Makowecki, K. L. 2015. Summerside Lake Yellow Perch Relocation Results. 27pp.

Makowecki, R. and Walker-Makowecki, K. L. 2016. Summerside Lake Yellow Perch Removal Results Report. 29pp.

Makowecki, R. and Walker-Makowecki, K. L. 2017. Summerside Fish Assessment Report. 30pp.

Makowecki, R. and Walker-Makowecki, K. L. 2017. Summerside Lake Limnological Monitoring Results. 20pp.

Makowecki, R. and Walker-Makowecki, K. L. 2018. Summerside Lake Limnological Monitoring Results. 40pp.

Makowecki, R. and Walker-Makowecki, K. L. 2018. Summerside Lake Yellow Perch Removal Results Report. 32pp.

Makowecki, R. and Walker-Makowecki, K. L. 2019. Summerside Lake Fish Stocking Plan.

Makowecki, R., 2010. Fish Salvage and Environmental Monitoring Report Buffalo Lake Metis Settlement (BLMS). 18pp.

Makowecki, R., 2017. Summerside Aquatic Vegetation Assessment. 23pp.

Makowecki. R., 2015. Summerside Water Quality Assessment Report. 29pp.

Nelson, J. S., and Paetz, M. J., 1992. The Fishes of Alberta. University of Alberta Press.

Newsome, G. E. and S. K. Aalto. 1987. An egg mass census method for tracking fluctuations in yellow Perch (*Perca flavescens*) populations. Can. J. Fish. Aquat. Sci. 44: 1221 – 1232.

Schneider, J. C. 1984. Yellow Perch maturity and fecundity as a function of age and growth. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report No. 1915 October 30, 1984.

Scott, W. B., and Crossman, E. J. 1973. Freshwater Fishes of Canada. Fish. Res. Board Can. Bull. 184. 966pp.

Watkins, Owen. Various dates. Fisheries Biologist. Alberta Environment and Parks. Personal Communication.

Ylikarjula, J., Heino, M., Deikmann, U. 2000. Ecology and adaptation of stunted growth in fish. International Institute for Applied Systems Analysis.

9.0 APPENDICES

9.1 Photographs

Photograph 1. Summerside Lake spruce bough installation on April 4, 2019; facing southwest from boat launch prior to ice melt.

Photograph 2. Summerside Lake Yellow Perch removal on April 19, 2019; facing southwest from boat launch.

Photograph 3. Summerside Lake Yellow Perch removal on April 19, 2019; captured Yellow perch with deceased Brook trout bycatch.

Photograph 4. Summerside Lake Yellow Perch removal on April 19, 2019; Yellow Perch captured in minnow traps.

Photograph 5. Summerside Lake Yellow Perch removal on April 19, 2019; live Brook trout captured, measured and released.

Photograph 6. Summerside Lake Yellow Perch spruce bough check on April 25, 2018, spruce bough with no eggs present.

Photograph 7. Summerside Lake Yellow Perch removal on April 25, 2019; Yellow Perch captured in minnow traps.

Photograph 8. Summerside Lake limnological monitoring on August 14, 2019; facing north from center of lake.

Photograph 9. Summerside Lake limnological monitoring on August 14, 2019; green algae at boat launch.

Photograph 10. Summerside Lake limnological monitoring on August 14, 2019; vegetation including green algae, Cattail and Common Great Bulrush on northeast shore.

9.2 Sampling Plan and Methods

Table 9.2.1. Spatial and temporal sampling plan for Summerside Lake limnological monitoring 2019.

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/cm)	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	µg/L	Water Sample Set – Laboratory Procedures	Central	Summer
Microcystins (Total)	µg/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
Herbicides	µg/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				
Invasive Fish Presence/Absence and Removal Effort	# fish caught Other parameters per Research Licence conditions	Minnow trapping and gill netting	Throughout Lake	Spring

PARAMETERS	MEASUREMENT UNIT	SAMPLING METHOD	SAMPLING LOCATION	SAMPLING DATE(S)
PLANKTON				
Relative Abundance	# / 500 mL	Plankton net pull	North and South	Summer
SUBSTRATE/SEDIMENT				
Lake bed substrate composition	Visual Observation	Eckman dredge	Northeast, Northwest, Southeast, Southwest; Littoral, Deep	Summer

Table 9.2.2. Sampling legend and location for Summerside Lake limnological monitoring 2019.

PARAMETER MEASURED	SAMPLE ID	GENERAL LOCATION IN LAKE	UTM LOCATION (ZONE 12N)	WATER DEPTH
Aquatic Vegetation	V1	Southeast Littoral	335878.97 m E, 5921402.22 m N	Not Collected
	V2	Southeast Littoral	335908.19 m E, 5921397.78 m N	Not Collected
	V3	Southeast Littoral	335894.65 m E, 5921356.38 m N	Not Collected
	V4	Southeast Littoral	335829.71 m E, 5921366.48 m N	Not Collected
	V5	Southeast Littoral	335729.48 m E, 5921364.96 m N	Not Collected
	V6	Southwest Littoral	335668.30 m E, 5921372.86 m N	Not Collected
	V7	Southwest Littoral	335606.41 m E, 5921342.86 m N	Not Collected
	V8	Southwest Littoral	335588.65 m E, 5921276.52 m N	Not Collected
	V9	Southwest Littoral	335574.82 m E, 5921282.26 m N	Not Collected
	V10	Southwest Littoral	335565.72 m E, 5921338.30 m N	Not Collected
	V11	Southwest Littoral	335563.59 m E,5921386.87 m N	Not Collected
	V12	Southwest Littoral	335597.43 m E,5921487.18 m N	Not Collected
	V13	Southwest Littoral	335614.44 m E,5921511.42 m N	Not Collected
	V14	Northwest Littoral	335572.03 m E,5921622.51 m N	Not Collected
	V15	Northwest Littoral	335560.14 m E,5921661.62 m N	Not Collected
	V16	Northwest Littoral	335563.55 m E,5921694.05 m N	Not Collected
	V17	Northwest Littoral	335701.31 m E,5921751.22 m N	Not Collected
	V18	Northeast Littoral	335828.55 m E,5921730.81 m N	Not Collected
	V19	Northeast Littoral	335836.52 m E,5921748.82 m N	Not Collected
	V20	Northeast Littoral	335879.03 m E,5921771.49 m N	Not Collected
	V21	Northeast Littoral	335899.64 m E,5921749.72 m N	Not Collected
	V22	Northeast Littoral	335899.21 m E,5921719.88 m N	Not Collected
	V23	Northeast Littoral	335904.96 m E,5921685.17 m N	Not Collected
	V24	Northeast Littoral	335937.64 m E,5921638.67 m N	Not Collected
	V25	Northeast Littoral	335932.21 m E,5921619.27 m N	Not Collected
Water Quality	North	North	335668.52 m E, 5921704.12 m N	7.5 m
	Central	Central	335718.66 m E, 5921583.39 m N	3.8 m
	South	South	335719.58 m E, 5921455.21 m N	9.0 m
Lake Bed Substrate Sampling	NE-L	Northeast Littoral	335895.75 m E, 5921721.04 m N	2.0 m
	NW-L	Northwest Littoral	335573.27 m E, 5921684.47 m N	2.2 m
	NW-D	Northwest Deep	335632.28 m E, 5921659.22 m N	9.5 m
	SE-L	Southeast Littoral	335848.25 m E, 5921369.11 m N	0.9 m
	SW-L	Southwest Littoral	335653.36 m E, 5921372.55 m N	1.2 m
Threshold Odour Number (TON)	TON	Central	335718.66 m E, 5921583.39 m N	3.8 m
Zooplankton	North	North	335668.52 m E, 5921704.12 m N	7.5 m
	South	South	335719.58 m E, 5921455.21 m N	9.0 m

Urban Constructed Lake Limnological Monitoring Methodology

9.1 Water Quality Parameters

9.1.1 Spatial Monitoring Plan

- The sampling sites are indicated in the figure below and tables inserted above.

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 per the inserted tables.

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, Total Kjeldahl Nitrogen, microcystin, total chlorides and heavy metals (i.e., Al, Cu, Pb, Zn) will be measured at Element Laboratory 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 below) establish the aquatic vegetation sampling plan for Summerside Lake. The first sampling site along each shoreline will be targeted for a depth of 2.0 m.

- Additional sample points (V1 through V25) will be characterized around the perimeter of the lake as relative amounts of vegetation and species change (Figure below). Relative abundance and species composition will be observed visually noted at each sample point.

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 sampling sites are indicated in the figure below and tables inserted above.

9.3.2 Temporal Monitoring Plan

- Bacteria levels will be measured in summer per the tables inserted.

9.3.3 Techniques

- All water samples collected from Summerside Lake will be collected in designated bacteria sampling bottles. Bacteria will be measured at Element 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

- The sampling sites are indicated in the figure below and tables inserted above.

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.

9.5.2 Temporal Monitoring Plan

- Fish sampling will be collected during a one-time 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. A selection of these nets will be applied.
    - 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 if possible.
    - 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.

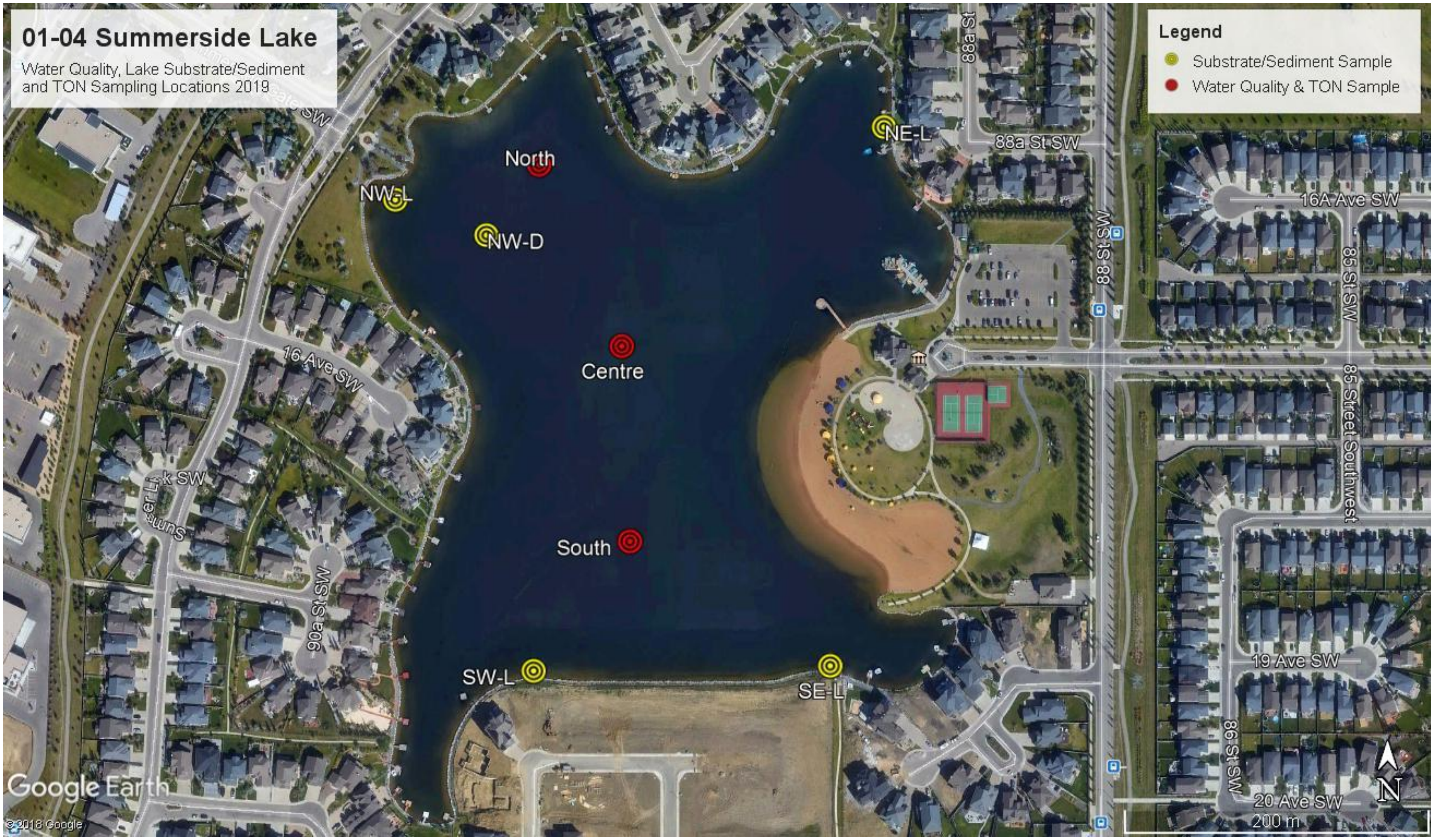

Figure 9.2.1. Water quality, substrate/sediment and threshold odour number (TON) sampling locations in Summerside Lake. Water quality samples collected on various dates in 2019; substrate/sediment samples collected August 14, 2019.

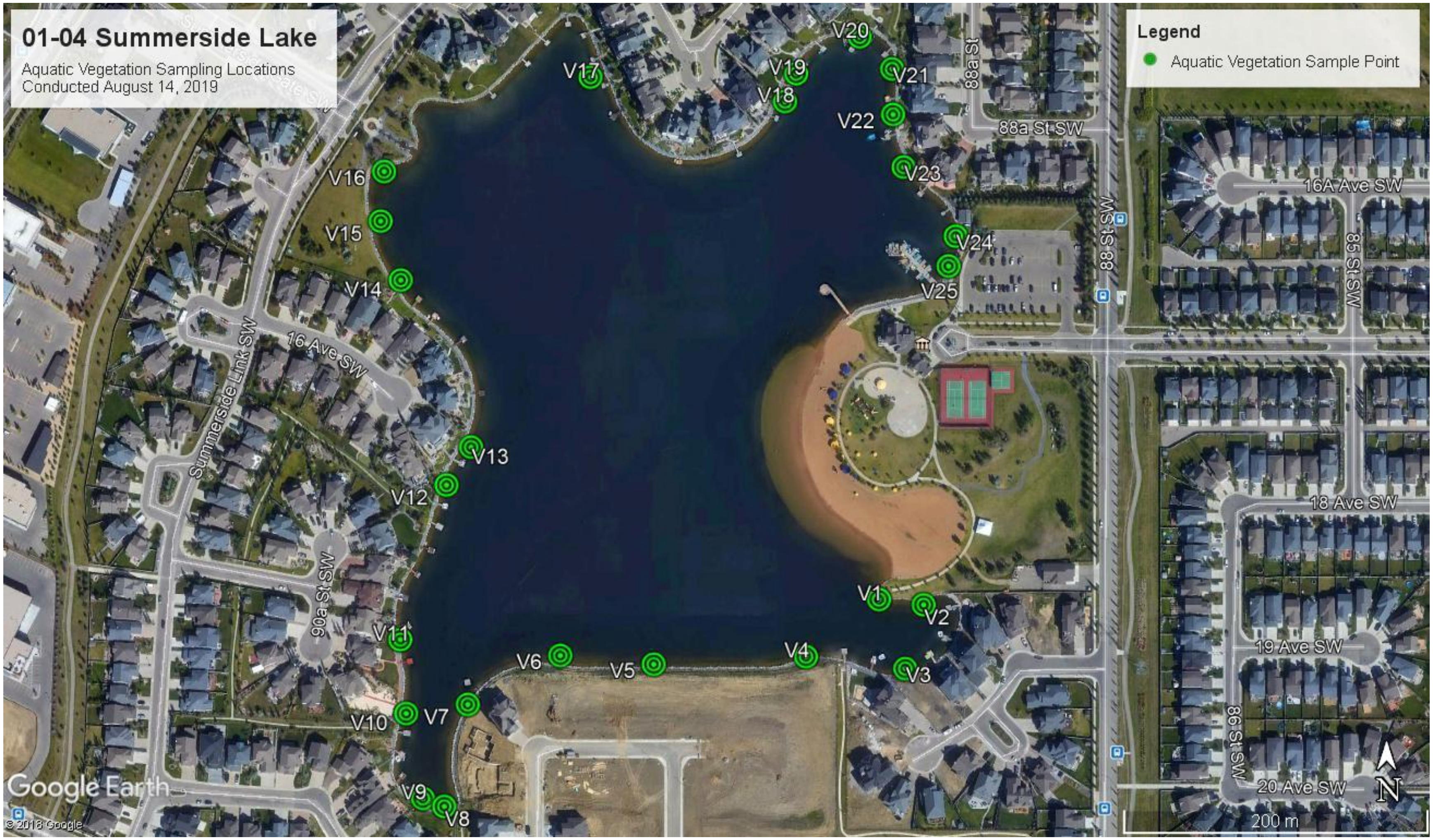

Figure 9.2.2. Aquatic vegetation sampling locations in Summerside Lake. Sampling conducted on August 14, 2019.

9.3 General Water Quality Guidelines, Targets and Indicators

Table 9.3.1a. Desired targets and/or allowable concentrations for selected water quality parameters.

Parameter	[1]EQGASW Guidelines for Protection of Freshwater Aquatic Life		[2]AB WQG for Recreation & Aesthetics
	Long-term	Short-term	
Metals - Total			
Mercury (mg/L)	0.000005	0.000013	-
Aluminum – dissolved (mg/L)	0.05 (pH dependent)	0.1 (pH dependent)	-
Arsenic (mg/L)	0.005	-	-
Barium (mg/L)	-	-	-
Boron (mg/L)	1.5	29	-
Cadmium (mg/L)	0.0003*	0.0046*	-
Chromium (mg/L)	0.001	-	-
Cobalt (mg/L)	0.0014*	-	-
Copper (mg/L)	0.007	0.034*	-
Lead (mg/L)	0.007*	-	-
Molybdenum (mg/L)	0.073	-	-
Nickel (mg/L)	0.1*	0.9*	-
Selenium (mg/L)	0.002	-	-
Silver (mg/L)	0.00025	-	-
Thallium (mg/L)	0.0008	-	-
Uranium (mg/L)	0.015	0.033	-
Zinc (mg/L)	0.03	-	-
Routine and Nutrients			
pH	6.5 to 9.0	-	5.0 to 9.0
Iron (dissolved) (mg/L)	0.3	-	-
Chloride (dissolved) (mg/L)	120	640	-
Nitrate-N (mg/L)	3.0	124	-
Nitrite-N (mg/L)	0.10	0.30	-
Sulfate (dissolved) (mg/L)	429	-	-
T-Alkalinity as $CaCO_3$ (mg/L)	20	-	-
Turbidity (NTU)	2 units above background levels	8 units above background levels	<50
Dissolved Oxygen (mg/L)	6.5 – 9.5	5	-
Microcystin – total (µg/L)	-	-	20
Phosphorus - total (mg/L)	Narrative[5]	Narrative[5]	Relates to algae status
Nitrogen (TKN) (mg/L)	Narrative[5]	Narrative[5]	Relates to algae status
Ammonia (mg/L)	Equation varies with pH and temperature	-	-
Aggregate Organic Constituents			
Oil and Grease	See footnote[3]	See footnote[3]	See footnote[4]
Microbiological Analysis			
Total Coliforms (CFU/100 mL)	-	-	-
Escherichia coli (CFU/100 mL)	-	-	≤100[6]
Herbicides & Pesticides			
Diclofop-methyl (µg/L)	6.1	-	-
Metribuzin (µg/L)	1	-	-
Triallate (µg/L)	0.24	-	-
Trifluralin (µg/L)	0.2	-	-
Bromoxynil (µg/L)	5	-	-
Dicamba (µg/L)	10	-	-
Dinoseb (µg/L)	0.05	-	-
MCPA (µg/L)	2.6	-	-
Mecoprop (µg/L)	13	10,000	-
Picloram (µg/L)	29	-	-

Parameter	[1]EQGASW Guidelines for Protection of Freshwater Aquatic Life		[2]AB WQG for Recreation & Aesthetics
	Long-term	Short-term	
Other Parameters			
Blue-green Algae	-	-	Visible scums to be avoided
Chlorophyll A (µg/L)	-	-	Relates to algae status and lake trophic status; See Table 9.3.1b
Odour (TON)	-	-	<8
Clarity			Sufficient to estimate depths and see surface hazards; Relates to lake trophic status; See Table 9.3.1b

[1]Environmental Quality Guidelines for Alberta Surface Waters' Surface Water Guidelines (EQGASW) for the Protection of Freshwater Aquatic Life (2018).
[2]Environmental Quality Guidelines for Alberta Surface Waters' Surface Water Quality Guidelines (AB WQG) for Recreation and Aesthetics (2018).
[3]Oil and grease attributable to human activities should not be present in amounts that:

- cause visible sheens, films, or discolouration;
- can be detected by odour;
- cause tainting of edible aquatic biota;
- form deposits on shores or bottom material that are detectable by sight or odour, or are deleterious to resident biota.

[4]Should not be present in concentrations that can be detected as a visible film, sheen discolouration or odour, or that can form deposits on shorelines or bottom sediments that are detectable by sight or odour.
*Calculated at a hardness of 216 mg/L dissolved as CaCO3.
[5]For surface waters not covered by specific guidelines, nitrogen (total) and phosphorus concentrations should be maintained so as to prevent detrimental changes to algal and aquatic plant communities, aquatic biodiversity, oxygen levels, and recreational quality. Where priorities warrant, develop site-specific nutrient objectives and management plans. Previous to 2018, phosphorous (total) was noted as 0.15 mg/L for maximum short-term guideline and nitrogen (TKN) was 1 mg/L for maximum short-term guideline. See table 9.3.1b.
[6]Public Health Act indicates maximum of 20 for artificial beaches. See table 9.3.1c for more Canadian recreational water guidelines. Site specific requirements may apply to individual lakes and/or facilities.

Table 9.3.1b. Indicators of the trophic status of lakes according to Thomann and Mueller (1987) and, in brackets, the Atlas of Alberta Lakes (Mitchell & Prepas 1990).

Parameter	Oligotrophic	LONG-TERM TARGET Mesotrophic	Eutrophic
Chlorophyll A (µg/L)	<4 (<2.5)	4-10 (2.5-25)	>10 (>25)
Total Phosphorus (mg/L)	<0.01 (<0.01)	0.01-0.02 (0.01-0.035)	>0.02 (>0.035)
Secchi Disc Readings (m)	>0.27	0.11-0.27	<0.11

Table 9.3.1c. Guidelines for Canadian recreational water quality: summary table (reproduced).

Guidelines		
Parameter	Considerations	Guideline
Escherichia coli (Primary-Contact Recreation)*	Geometric mean concentration (minimum 5 samples) Single sample maximum concentration	≤ 200 *E. coli* /100 mL ≤ 400 *E. coli* /100 mL
Enterococci (Primary-Contact Recreation)*	Geometric mean concentration (minimum 5 samples) Single sample maximum concentration	≤ 35 Enterococci /100 mL ≤ 70 Enterococci /100 mL
Pathogenic Microorganisms (bacteria, viruses, protozoa)	Testing only needed when there is epidemiological or other evidence to suggest that this is necessary	No numerical guideline value
Cyanobacteria Cyanobacterial toxins	Total Cyanobacteria Total Microcystins	≤ 100,000 cells/mL ≤ 20 µg/L
Other Biological Hazards (e.g. schistosomes causing swimmer's itch; aquatic vascular plants and algae)	Recreational activities should not be pursued in waters where the responsible authority deems the presence of these organisms poses a risk to the health and safety of the users	No numerical guideline value
pH	For waters used for primary contact recreation	5.0 to 9.0
Temperature	Should not cause an appreciable increase or decrease in the deep body temperature of swimmers	No numerical guideline value
Chemical Hazards	Risks associated with specific chemical hazards will be dependent on the particular circumstances of the area and should be assessed on a case-by-case basis.	No numerical guideline value
Aesthetic Objectives		
Parameter	Considerations	Aesthetic Objective
Turbidity	To satisfy most recreational uses	50 NTU
Clarity	Clarity should be sufficient for users to estimate depth and to see subsurface hazards	Secchi Disc visible at a depth of 1.2 m
Colour	Colour should not be so intense as to impede visibility in areas used for swimming	No numerical value
Oil and Grease	Should not be present in concentrations that can be detected as a visible film, sheen, discolouration or odour; or that can form deposits on shorelines or bottom sediments that are detectable by sight or odour	No numerical value
Litter	Areas should be free from floating debris as well as materials that will settle to form objectionable deposits	No numerical value

* Advice regarding waters intended for secondary-contact recreational activities is provided in Section 4.2 of guideline.