Environmental Applied Science Technology

Ecological Health of the Ponds in Charlottetown, Prince Edward Island, Canada

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1 INTRODUCTION AND OBJECTIVES

This project involved Holland College's Environmental Applied Science Technology student and faculty worked directly with Ellen's Creek and Wright's Creek Watershed Groups to help determine the ecological health of 11 ponds within the Charlottetown, Prince Edward Island (PEI), limits.

In conversations with the watershed groups in Charlottetown, with Agriculture Canada and the Department of Environment, it was determined that these water bodies had not been monitored for their ecological health. Determining the water and sediment quality along with the invertebrate life can help those interested parties to develop an action plan to restore damaged watersheds.

1.1 SCOPE OF WORK

Due to the low budget of the project, the scope of work changed and included the following activities:

- Collection of 33 macroinvertebrates samples;
- Identification and classification of macroinvertebrates using the biotic index card;
- Field testing of water including physicochemical parameters such as dissolved oxygen, pH, temperature, and conductivity;
- Collection of 33 surface water samples for chemical analyses;
- Filtration and preservation (HNO3) of the surface water samples;
- Analyses of the surface water samples by the PEI Analytical Lab for the following: Ba, Ca, Cl, Cu, Fe, Pb, Mg, Mn, Nitrate, pH, P, K, Na, SO_4 (calculated from S), Se, Zn, Alkalinity, and Hardness;
- Collection of 33 sediment samples;
- Preparation of the sediment samples for analyses;
- Analyses of the sediment samples by the PEI Analytical Laboratory for the following: pH, C, Ca, Cr, C:N rate, N, P, K, Mg, Cu, Zn, Fe, Mn, B, Na, and dry matter;
- Interpretation of the results and preparation of this report.

2 *DESCRIPTIONS OF SITES*

In total, eleven different sites were assessed:

Governor's Pond (GOP)

The pond occupies an approximate area of 4,002 square meters (m^2) and is located at the intersection between Terry Fox Drive and Kent Street, beside the parking lot of the Government Building (Figure 1 - Attachment A).

The site is in a commercial and residential area. It is surrounded by the parking lot and two roads as mentioned above. Figure 1 (Attachment A) also shows a possible connection to the Charlottetown Harbour.

Historically, the Governor's Pond was part of a tidal estuary.

Dead Man's Pond (DMP)

Dead Man's Pond located in Victoria Park has an estimated area of 737 m^2. The principal means of access to the site is the trail that starts on Victoria Park Driveway, by the tennis courts in the park (Figure 2 - Attachment A).

The pond area is a tranquil area surrounded by forest and a popular stop on a trail system that passes beside of the pond.

Lower Slick's Pond (LSP)

Part of the Hazards Creek system, the Lower Slick's Pond is visible from the Malpeque Rd (Route 2) behind Princess Auto (Figure 3 - Attachment A). It is approximately 1,424 m^2 and is surrounded commercial and industrial development. It is the lower of two connected ponds constructed in the sixties to provide water for cattle. The ponds do not appear to have any official name. ECWG provided the name, Slick's Ponds, after a lifelong resident of area, Alexander (Slick) Rhynes.

MacNeills Pond (MNP)

It is also part of Hazards Creek system, located at the intersection of Capital Drive and Lower Malpeque Road (Figure 4 - Attachment A). MacNeills Pond has an estimated area of 10,261 m^2. It is surrounded commercial and residential development.

Hermitage Pond (HEP)

As shown in Figure 5 (Attachment A), Hermitage Pond (also referred to as the Tremploy Pond) is situated in a residential area off Raiders Road nearby the

Charlottetown Rural High School. It has an estimated area of 3,820 m². The dam creating the pond is an extension of Raiders Road which ends in a cul-de-sac at Tremploy Inc. A drop culvert outlet under the road connects the pond to Hermitage Creek.

Farmers Market Pond (FMP)

Delimited by the Charlottetown Farmers Market parking lot in the North and a wetland and agricultural land in the South, Farmers Market Pond is located off Belvedere Avenue with an estimated area of 1,086 m² (Figure 6 - Attachment A).

Ag. Canada Pond (ACP)

Located behind the Charlottetown Research and Development Centre of Agriculture and Agri-Food Canada (Figure 7 - Attachment A). It occupies around 7,203 m² and is delimitated by the Ravenwood Drive access road and agricultural land.

Jardine's Pond (JAP)

The pond occupies approximately 405 m² and its principal means of access is via a farm field behind a residential area on MacRae Drive (Figure 8 - Attachment A). The site is in a wooded area surrounded by agricultural land. Upstream in the Northwest, there is an excavation pit and the Charlottetown Airport.

Barbour's Pond (BAP)

Barbour's Pond has an estimated area of 1,096 m² and is located downstream from Jardine's Pond. Figure 9 (Attachment A) shows the means of access off MacRae Drive through a path beside the Elmer MacFadyen Memorial Recreational Complex. There is a public walking trail along the lower end of the pond.

Andrew's Pond North (APN)

Andrew's Pond North is in a high density residential area downstream from Barbour's Pond (Figure 10 - Attachment A). It has an estimated area of 42,089 m². Access is off Elena Court or St. Peters Road.

Andrew's Pond South (APS)

Andrew's Pond South is just across St. Peters Road, downstream from Andrew's Pond North (Figure 11 - Attachment A). It has an estimated area of 18,769 m² and its access is by St. Peters Road.

Figures 1 to 13 (Attachment B) include some photographs of the ponds cited above.

3 MATERIAL AND METHODS

The following equipment and materials were used to conduct the sampling and the analysis:

-0.01M EDTA
-0.1% Calmagite Indicator Catalog 1830-4, Ricca
-0.45 µm (White Gridded 47mm) Filters, Merck Millipore
-10.5 Liter-Buckets
-1000ml Volumetric Flasks, Fisherbrand
-100-1000µl Pipette, Fisherbrand
-125ml Erlenmeyer Flasks, Fisherbrand
-250ml Beakers, Kimax Kumble
-250ml Erlenmeyer Flasks, Fisherbrand
-25ml Graduated Cylinder, Kimax Kumble
-25ml Volumetric Flasks, Fisherbrand
-26l Cooler, Coleman
-2-Propanol Catalog A416p-4, Fisher Chemical
-500µl and 1000µl Pipette, Eppendorf
-500ml Mason Jars
-500ml Vacuum Flask Kimax Kumble And Vacuum Tube
-50ml Burette, Kimax Kumble
-50ml Polypropylene Screw Top Tubes, VWR
-68-70% Nitric Acid Cas 7697-37-2 Fisher Scientific
-8ml Screw Cap Teflon Lined Test Tubes
-Conductivity Meter Model Sension 5, Hach
-Dip Sampler (Scoop)
-Disposable Polyethylene Transfer Pipettes, Fisherbrand
-Dissolved Oxygen Meter Model PRO 20, YSI
-Distilled Water
-Eckman Dredge
-Filter Holder (Rubber Adapter)
-Fine Sieve 0.5mm Mesh, Fisherbrand
-Hardness Buffer Solution
-Isotemp Oven Fisherbrand
-Mettler Toledo Balance
-Microscope Stereo Master Ii Model Spt-Ith, Fisher Scientific
-Net 400µm Mesh
-Parafilm, Bemis
-pH Meter Model Sension 1, Hach
-Post Hole Digger
-Rubber Funnel
-Soap Sparkleen, Fisherbrand
-White Tray

3.1 FIELD ACTIVITIES

Field activities were performed in 3 different rounds and in 4 different groups so to avoid movement of plant or animal species between ponds not within the same watershed. Governor's and Dead Man's Ponds were part of one group; Lower Slick's Pond, MacNeills and Hermitage Ponds were treated as a second group; Farmers Market and Ag. Canada Ponds were considered third; and Jardine's, Barbour's, Andrew's Pond North and South were part of the last group.

The first round took place between the 19th and 29th of June 2017. The second round was executed from July 10 to July 19, 2017. The last round was performed from July 31 to August 17, 2017. Invertebrate, surface water, and sediment samples were collected for analyses at the same location in each pond every time.

At the end of the third round 33 invertebrate samples, 32 sediment samples and 33 surface water samples were collected. Table 3.1 shows the summary of the invertebrates, surface water, and sediment sampling. Table 3.2 presents the location of each sample collected.

Table 3.1 - Invertebrate, Surface Water, and Sediment Sampling Summary

Groups	Round	ID (3 Letter Pond Name-YYYYMMDD)	Sampling Date	Sampling time (Invertebrates)	Sampling time (water)	Sampling time (sediment)
Group 1	1st	GOP-20170619	19-Jun-17	10:20	10:40	10:50
	2nd	GOP-20170710	10-Jul-17	8:50	9:00	-
	3rd	GOP-20170731	31-Jul-17	9:05	9:15	9:50
	1st	DMP-20170619	19-Jun-17	11:45	12:00	12:20
	2nd	DMP-20170710	10-Jul-17	10:10	10:30	10:50
	3rd	DMP-20170731	31-Jul-17	11:00	11:20	12:00
Group 2	1st	LSP-20170621	21-Jun-17	10:00	10:20	10:30
	2nd	LSP-20170712	12-Jul-17	9:00	9:10	9:15
	3rd	LSP-20170802	2-Aug-17	9:30	9:55	10:10
	1st	MNP-20170621	21-Jun-17	11:15	11:30	11:45
	2nd	MNP-20170712	12-Jul-17	10:00	10:10	10:25
	3rd	MNP-20170802	2-Aug-17	10:45	11:00	11:10
	1st	HEP-20170621	21-Jun-17	12:30	13:00	13:20
	2nd	HEP-20170712	12-Jul-17	10:55	11:20	11:30
	3rd	HEP-20170802	2-Aug-17	11:45	12:00	12:20
Group 3	1st	FMP-20170623	23-Jun-17	10:00	10:20	10:40
	2nd	FMP-20170714	14-Jul-17	9:00	9:20	9:45
	3rd	FMP-20170804	4-Aug-17	9:05	9:25	9:30
	1st	ACP-20170623	23-Jun-17	11:20	11:42	12:00
	2nd	ACP-20170714	14-Jul-17	10:25	10:45	11:00
	3rd	ACP-20170804	4-Aug-17	10:25	10:45	11:00
Group 4	1st	JAP-20170627	27-Jun-17	10:20	10:30	10:45
	2nd	JAP-20170718	18-Jul-17	10:10	10:20	10:35
	3rd	JAP-20170817	17-Aug-17	9:20	9:30	9:45
	1st	BAP-20170627	27-Jun-17	11:15	11:25	11:40
	2nd	BAP-20170718	18-Jul-17	9:00	9:25	9:45
	3rd	BAP-20170810	10-Aug-17	9:30	9:40	9:50
	1st	APN-20170629	29-Jun-17	10:45	9:40	10:30
	2nd	APN-20170719	19-Jul-17	10:05	10:15	10:35
	3rd	APN-20170808	8-Aug-17	9:10	9:30	9:50
	1st	APS-20170629	29-Jun-17	11:25	11:35	11:50
	2nd	APS-20170719	19-Jul-17	9:05	9:15	9:30
	3rd	APS-20170808	8-Aug-17	10:25	10:35	10:50

Table 3.2 - Sample Locations

ROUND	SAMPLE ID	COORDINATES (Decimal Degrees)	
		Water	Sediment
1st	GOP-20170619	46.2317, -63.1346	46.2317, -63.1346
2nd	GOP-20170710	46.2317, -63.1346	46.2317, -63.1346
3rd	GOP-20170731	46.2317, -63.1346	46.2318, -63.1345
1st	DMP-20170619	46.2297, -63.1400	46.2296, -63.1399
2nd	DMP-20170710	46.2297, -63.1400	46.2297, -63.1401
3rd	DMP-20170731	46.2297, -63.1400	46.2297, -63.1401
1st	LSP-20170621	46.2707, -63.1503	46.2707, -63.1503
2nd	LSP-20170712	46.2707, -63.1503	46.2707, -63.1503
3rd	LSP-20170802	46.2707, -63.1503	46.2707, -63.1503
1st	MNP-20170621	46.2656, -63.1572	46.2656, -63.1572
2nd	MNP-20170712	46.2656, -63.1572	46.2656, -63.1572
3rd	MNP-20170802	46.2656, -63.1572	46.2656, -63.1572
1st	HEP-20170621	46.2579, -63.1481	46.2579, -63.1481
2nd	HEP-20170712	46.2579, -63.1481	46.2579, -63.1481
3rd	HEP-20170802	46.2579, -63.1481	46.2579, -63.1481
1st	FMP-20170623	46.2524, -63.135	46.2524, -63.135
2nd	FMP-20170714	46.2524, -63.135	46.2524, -63.135
3rd	FMP-20170804	46.2524, -63.135	46.2524, -63.135
1st	ACP-20170623	46.2488, -63.134	46.2487, -63.134
2nd	ACP-20170714	46.2488, -63.134	46.2487, -63.134
3rd	ACP-20170804	46.2488, -63.134	46.2487, -63.134
1st	JAP-20170627	46.2804, -63.1152	46.2804, -63.1152
2nd	JAP-20170718	46.2804, -63.1152	46.2804, -63.1152
3rd	JAP-20170817	46.2804, -63.1152	46.2804, -63.1152
1st	BAP-20170627	46.2764, -63.1115	46.2760, -63.1116
2nd	BAP-20170718	46.2764, -63.1115	46.2760, -63.1116
3rd	BAP-20170810	46.2764, -63.1115	46.2760, -63.1116
1st	APN-20170629	46.2734, -63.1114	46.2734, -63.1114
2nd	APN-20170719	46.2734, -63.1114	46.2734, -63.1114
3rd	APN-20170808	46.2734, -63.1114	46.2734, -63.1114
1st	APS-20170629	46.2720, -63.1059	46.2720, -63.1059
2nd	APS-20170719	46.2720, -63.1059	46.2720, -63.1059
3rd	APS-20170808	46.2720, -63.1059	46.2720, -63.1059

All field work was supervised by Norman Dewar, Ellen's Creek Watershed Group Inc.

3.2 HEALTH AND SAFETY

During the field activities, the Holland College Health & Safety Plan was followed.

Prior to initiating any activities, an evaluation was performed to detect any possible danger. It was decided that the collection of all samples would be performed from the edges of the ponds because the depth of water in some ponds, and the risk of entrapment in soft sediment.

3.3 MACROINVERTEBRATES SAMPLING

Invertebrates were sampled three times (June, July, and August) at the 11 different sites. Each pond was sampled for 3 minutes in total, where the 3 minutes refers to net-in-the-water time and it did not include the time moving between netting spots. Due to safety issues, sampling was limited to only the edges of the ponds, but the shallowest and deepest water areas were considered. Also, where there was a stony or sandy substrate, they were lightly 'kick-sampled' before being scooped up with the net.

The samples were collected at each site using a 400µm mesh net, collected and placed in 10.5 liter-buckets, labeled, and brought to the Environmental Applied Science Technology (E.A.S.T.) Laboratory at Holland College.

At the lab, the samples were sorted and processed as soon as possible after collection. First, the samples were washed very gently in a fine sieve (Fisherbrand 0.5mm mesh), removing as much mud and fine detritus as possible. Small amounts of each sample were placed in a white tray with approximately 10mm depth of water, and the material was spread out across the tray and the invertebrates were carefully sorted using tweezers and placed in beakers. To sort the next portion of the sample, the material was discarded, and the tray filled with clean water, and the process was repeated until the entire sample was sorted.

The animals were identified to their family level by using the keys by Voshell (2002) and Chu (1949). The results were recorded and prior to sorting the next sample, all the equipment used was thoroughly cleaned.

A microscope (Stereo Master II, Model SPT-ITH manufactured by Fisher Scientific) was used to help with the identification. Some specimens were preserved in 70% isopropanol and stored in the fridge at a temperature around $0^{o}C$ for further use in the E.A.S.T program at Holland College.

To assess the water quality, the Hilsenhoff's Family Biotic Index (FBI) (Hilsenhoff 1988) was used to assess the water quality condition. Tolerance values for the invertebrate families were assigned based on Bode et al (1996); Hauer & Lamberti (1996); Hilsenhoff

(1988); Plafkin et al (1989); and Barbour et al. (1999). The following formula was used to obtain the FBI and the results were evaluated using Table 3.3.

$$FBI = \sum \frac{(xi \times ti)}{n}$$

x = the number of individual taxa, t = tolerance value, and n = total number of invertebrates in the sample.

Table 3.3 - Evaluation of water quality using Hilsenhoff's Family Biotic Index

Family Biotic Index	Water Quality	Degree of Organic Pollution
0.00 - 3.75	Excellent	Organic pollution unlikely
3.76 - 4.25	Very Good	Possible slight organic pollution
4.26 - 5.00	Good	Some organic pollution probable
5.01 - 5.75	Fair	Fairly substantial pollution likely
5.76 - 6.50	Fairly Poor	Substantial pollution likely
6.51 - 7.25	Poor	Very substantial pollution likely
7.26 - 10.00	Very Poor	Severe organic pollution likely

Some photos of the macroinvertebrates found in the sampling process are included in Attachment B, figures 14 to 18.

3.4 SURFACE WATER SAMPLING

Three surface water samples were collected at each pond between June 19 and August 17, 2017. Figures 1 to 11 (Attachment A) present the location of the samples.

The water quality was assessed by measuring several physicochemical parameters. Dissolved oxygen and temperature were measured using a handheld YSI Model Pro 20 using the probe placed directly into the pond. The conductivity and pH were measured using handhelds Hach models Sension 5 and Sension 1 respectively. For these readings, the probes were placed in a container filled with pond water.

The equipment used for the surface water sampling was calibrated in accordance with the manufacturer's recommendation prior to starting the field measurements. The calibration sheet for the equipment is included in Attachment C. Surface water samples were collected using a dip sampler, the device was extended to the sample location and sample was collected by dipping the sampler into the water 15 cm. The pond water was transferred from the sampler to two (2) clean 500 ml home canning glass jars (commonly referred to as Mason jars) that were filled to capacity. The jars were labeled, stored in coolers with ice at temperatures below 4 ^{o}C (± 2 ^{o}C), and brought to the E.A.S.T lab.

At the E.A.S.T. lab, 250 ml of each sample were placed into a plastic bottle provided by the PEI Analytical Laboratory and labeled. Also, following the PEI Analytical Lab recommendation, 50ml of each sample was filtered through 0.45 µm (White Gridded 47mm) filters from Merck Millipore, placed into 50 ml Polypropylene screw top tubes, acidified with concentrated nitric acid to a final concentration of 1% (by volume), and labeled. Both were stored in the fridge at a temperature around $0^{o}C$.

Before sending the samples to the PEI Analytical Lab, all samples were tested for hardness in the E.A.S.T lab, following the standard method by Clesceri et. al (1988):

-The titration solution (0.01N EDTA) and the hardness buffer solution were made;
-The burette was filled with 0.01N EDTA;
-25 ml of the sample was added to a 125 ml Erlenmeyer flask;
-1 ml of Hardness buffer was added to the Erlenmeyer flask;
-1 ml of indicator solution (Calmagite) was added to the Erlenmeyer flask;
-It was titrated until the color changed;
-The reading (in ml) was recorded in the notebook; and
-Calculation of Hardness.

Calculation:

$$Hardness = \frac{(reading\ in\ mL) \times (1000 \frac{mg}{L})}{25\ mL}$$

In the first round, the titration was done in triplicates and for the other 2 rounds, it was done only once with duplicates after every 10 samples.

The filtered portion in the polypropylene screw top tubes and the unfiltered portion in the PEI analytical lab bottle were delivered in batches to the PEI Analytical Lab where 17 of the 35 surface water samples were analyzed for Ba, Ca, Cl, Cu, Fe, Pb, Mg, Mn, Nitrate, pH, P, K, Na, SO_4 (calculated from S), Se, Zn, Alkalinity, and Hardness.

A "Mason" jar for each sample collected was kept in the E.A.S.T. lab fridge to be used by the E.A.S.T program for further analyses. Figures 19 to 24 (Attachment B) show the steps for the surface water sampling process cited above.

3.5 SEDIMENT SAMPLING

Three sediment samples were collected at each pond between June 19 and August 17, 2017, with an exception of the Governor's Pond where only two samples were collected. Figures 1 to 11 (Attachment A) present the location of the samples.

Samples were collected using three different tools listed in Table 3.4, the sediment was stored in 10.5 liter-buckets, labeled, and brought to the E.A.S.T. Laboratory at Holland College. At the Lab, the samples were placed on a metallic tray and dried in the Fisher Scientific Isotemp oven at 50°C for 48 hours and weighed with a Mettler Toledo model BP8001 scale before and after dry.

The dry samples were stored in airtight sealed plastic bags and placed in the fridge. A portion of each sample (approximately 300g to 500g) was placed in bags provided by the PEI Analytical Lab, and delivered in batches to the lab where 13 of the 34 sediment samples were analyzed for dry matter, C, C:N Ratio, N, P, K, Ca, Mg, Cr, Cu, Zn, B, Fe, Mn, and pH.

The remaining sample collected was kept in the E.A.S.T. lab fridge to be used by the E.A.S.T program or for further analyses. Figures 25 to 30 (Attachment B) show all the steps in the sediment sampling process cited above.

Table 3.4 - Equipment used during the sediment sampling

ROUND	SAMPLE ID	EQUIPMENT USED
1st	GOP-20170619	Scoop
2nd	*not sampled*	*not sampled*
3rd	GOP-20170731	Post hole digger
1st	DMP-20170619	Scoop
2nd	DMP-20170710	Landscape Rake
3rd	DMP-20170731	Post hole digger
1st	LSP-20170621	Scoop
2nd	LSP-20170712	Post hole digger
3rd	LSP-20170802	Post hole digger
1st	MNP-20170621	Scoop
2nd	MNP-20170712	Post hole digger
3rd	MNP-20170802	Post hole digger
1st	HEP-20170621	Eckman Dredge
2nd	HEP-20170712	Eckman Dredge
3rd	HEP-20170802	Eckman Dredge
1st	FMP-20170623	Scoop
2nd	FMP-20170714	Post hole digger
3rd	FMP-20170804	Post hole digger

ROUND	SAMPLE ID	EQUIPMENT USED
1st	ACP-20170623	Scoop
2nd	ACP-20170714	Post hole digger
3rd	ACP-20170804	Post hole digger
1st	JAP-20170627	Landscape Rake
2nd	JAP-20170718	Post hole digger
3rd	JAP-20170817	Post hole digger
1st	BAP-20170627	Landscape Rake
2nd	BAP-20170718	Post hole digger
3rd	BAP-20170810	Post hole digger
1st	APN-20170629	Eckman Dredge
2nd	APN-20170719	Eckman Dredge
3rd	APN-20170808	Eckman Dredge
1st	APS-20170629	Eckman Dredge
2nd	APS-20170719	Post hole digger
3rd	APS-20170808	Post hole digger

3.6 DATA VALIDATION

All sediment samples were stored in a cooler with ice with temperatures of approximately 4 ^{o}C (± 2 ^{o}C) or in a fridge with temperatures of 0 ^{o}C prior to processing and submission to the PEI Analytical Laboratory.

3.6.1 Equipment Calibration

Prior to initiating fieldwork activities, equipment used for recording physicochemical data was calibrated on a weekly basis, in accordance with the manufacturer's instructions. The calibration validation sheets for the equipment are compiled in Attachment C.

3.6.2 Equipment Decontamination

All non-disposable lab equipment was decontaminated before and after each sample, collection event using the following procedure: washing and rinsing of equipment with fresh water and Fisherbrand™ Sparkleen™ 1 Detergent with disposable sponges and brushes; rinsing with fresh water; and re-rinsing with de-ionized water.

All non-disposable field equipment and personal equipment such as nets, samplers, and waders were cleaned and inspected between different pond groups. All plants, animals, and mud were removed using high pressure and hot tap water. Eventually, the equipment was decontaminated with bleach following the Occupational Safety and Health Administration (OSHA) recommendations.

4 APPLICABLE ENVIRONMENTAL GUIDELINES

The federal guidelines were used to detect exceedances in water and sediment quality parameters under baseline conditions. The guidelines used to assess baseline water and sediment quality were:

- Canadian Council of the Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines (CEQG) for the Protection of Aquatic Life; and
- CCME Canadian Sediment Quality Guidelines (CSQG).

5 RESULTS

5.1 MACROINVERTEBRATES

The results of the macroinvertebrates sorted and identified, as well as the FBI results are included in Table 1 of the Attachment E. Table 5.1 presents a summary of the evaluation of water quality for each pond using Hilsenhoff's Family Biotic Index.

Table 5.1 – Summary of FBI Results

ROUND	SAMPLE ID	FBI	FBI AVERAGE	WATER QUALITY	DEGREE OF ORGANIC POLLUTION
1st	GOP-20170619	6.68	5.97	Fairly Poor	Substantial pollution likely
2nd	GOP-20170710	5.56			
3rd	GOP-20170731	5.66			
1st	DMP-20170619	7.51	6.59	Fairly Poor	Substantial pollution likely
2nd	DMP-20170710	6.14			
3rd	DMP-20170731	6.11			
1st	LSP-20170621	5.73	6.23	Fairly Poor	Substantial pollution likely
2nd	LSP-20170712	6.55			
3rd	LSP-20170802	6.40			
1st	MNP-20170621	5.54	6.02	Fairly Poor	Substantial pollution likely
2nd	MNP-20170712	6.13			
3rd	MNP-20170802	6.38			
1st	HEP-20170621	5.21	6.08	Fairly Poor	Substantial pollution likely
2nd	HEP-20170712	6.77			
3rd	HEP-20170802	6.27			
1st	FMP-20170623	6.96	6.24	Fairly Poor	Substantial pollution likely
2nd	FMP-20170714	5.88			
3rd	FMP-20170804	5.87			
1st	ACP-20170623	5.84	5.82	Fairly Poor	Substantial pollution likely
2nd	ACP-20170714	5.26			
3rd	ACP-20170804	6.35			
1st	JAP-20170627	6.43	6.13	Fairly Poor	Substantial pollution likely
2nd	JAP-20170718	6.94			
3rd	JAP-20170817	5.01			
1st	BAP-20170627	6.19	6.15	Fairly Poor	Substantial pollution likely
2nd	BAP-20170718	6.42			
3rd	BAP-20170810	5.83			
1st	APN-20170629	6.81	6.56	Poor	Very substantial pollution likely
2nd	APN-20170719	6.60			
3rd	APN-20170808	6.27			
1st	APS-20170629	4.91	5.56	Fair	Fairly substantial pollution likely
2nd	APS-20170719	6.17			
3rd	APS-20170808	5.60			

The water quality of most of the ponds was fairly poor, except for Andrew's Pond North and Andrew's Pond South that were ranked as poor and fair, respectively.

5.2 SURFACE WATER QUALITY

5.2.1 Physicochemical Parameters

During the sampling of surface water, field measurements of pH, temperature, conductivity, and dissolved oxygen (DO) were recorded. The readings are presented in Table 5.2 below. An extra reading was done at the outflow of Governor's Pond (Figure 31 – Attachment B).

Table 5.2 – Field Measurements

ROUND	SAMPLE ID	DO (mg/L)	CONDUCTIVITY (µS/cm)	pH	TEMPERATURE (°C)
1st	GOP-20170619	0.74	2170	7.34	20.0
2nd	GOP-20170710	0.53	2070	6.83	19.6
3rd	GOP-20170731	0.50	8150	7.25	17.3
1st	DMP-20170619	0.45	50.0	5.64	19.3
2nd	DMP-20170710	1.02	20.3	5.32	19.4
3rd	DMP-20170731	0.93	21.1	5.79	21.5
1st	LSP-20170621	9.60	1082	7.61	15.9
2nd	LSP-20170712	6.60	1025	7.48	19.1
3rd	LSP-20170802	2.51	955	7.59	18.1
1st	MNP-20170621	11.82	1154	7.72	16.8
2nd	MNP-20170712	9.85	1074	7.60	15.3
3rd	MNP-20170802	10.12	1127	7.45	17.0
1st	HEP-20170621	9.68	820	8.07	20.0
2nd	HEP-20170712	10.18	147.3	7.90	17.6
3rd	HEP-20170802	8.23	837	7.78	19.5
1st	FMP-20170623	1.72	1496	6.58	16.8
2nd	FMP-20170714	1.03	1431	6.32	15.1
3rd	FMP-20170804	0.65	1900	6.56	18.4
1st	ACP-20170623	1.84	547	6.47	22.4
2nd	ACP-20170714	1.18	1699	6.74	21.3
3rd	ACP-20170804	2.89	554	6.98	22.5
1st	JAP-20170627	7.99	444	7.36	12.1
2nd	JAP-20170718	10.78	515	7.59	15.5
3rd	JAP-20170817	8.58	494	7.65	12.9
1st	BAP-20170627	7.64	518	7.49	15.4
2nd	BAP-20170718	7.14	544	7.43	15.3
3rd	BAP-20170810	7.85	511	7.54	14.0
1st	APN-20170629	10.16	688	7.66	16.3
2nd	APN-20170719	12.74	689	8.09	18.3
3rd	APN-20170808	7.48	476	7.62	18.4
1st	APS-20170629	11.99	668	8.01	18.8
2nd	APS-20170719	6.63	677	7.58	20.8
3rd	APS-20170808	10.51	637	8.23	19.1
Extra	GOP outflow	9.4	3810	6.83	19.6

Regarding the readings above and comparing all ponds. The pH values ranged from

5.32 at DMP-20170710 to 8.23 at APS-20170808 and indicate a slightly acidic to a slightly basic environment. Temperature readings varied from 12.1 ºC (JAP-20170627) to 22.5 ºC (ACP-20170804).

Electrical conductivity is the capacity of the water to conduct an electrical current, and this parameter is related to the presence of ions dissolved in the water. The higher the number of ions, the higher is the electrical conductivity value. The values measured ranged from 20.3 µS/cm (DMP-20170710) to 8,150 µS/cm (GOP-20170731). With regards to dissolved oxygen, readings ranged from 0.45 to 12.74 mg/L.

5.2.2 Lab Measurements

Hardness is caused by compounds of calcium and magnesium, and by a variety of other metals. The general guidelines for classification of water hardness by USGS are: 0 to 60 mg/L (milligrams per liter) as calcium carbonate is classified as soft; 61 to 120 mg/L as moderately hard; 121 to 180 mg/L as hard; and more than 180 mg/L as very hard.

The results and the classification of each sample are presented in Table 5.3 below.

Table 5.3 - Hardness

Groups	Round	Sample ID	Average (mL)	Hardness (mg CaCO3/L)	Classification
Group 1	1st	GOP-20170619	9.2	368.0	Very Hard
	2nd	GOP-20170710	9.3	372.0	Very Hard
	3rd	GOP-20170731	26.1	1044.0	Very Hard
	1st	DMP-20170619	0.3	10.7	Soft
	2nd	DMP-20170710	0.3	12.0	Soft
	3rd	DMP-20170731	0.2	8.0	Soft
Group 2	1st	LSP-20170621	7.7	309.3	Very Hard
	2nd	LSP-20170712	7.2	288.0	Very Hard
	3rd	LSP-20170802	6.9	276.0	Very Hard
	1st	MNP-20170621	8.5	340.0	Very Hard
	2nd	MNP-20170712	8.4	336.0	Very Hard
	3rd	MNP-20170802	8.5	340.0	Very Hard
	1st	HEP-20170621	6.7	268.0	Very Hard
	2nd	HEP-20170712	6.9	276.0	Very Hard
	3rd	HEP-20170802	6.9	276.0	Very Hard
Group 3	1st	FMP-20170623	2.1	82.7	Moderately hard
	2nd	FMP-20170714	2.0	80.0	Moderately hard
	3rd	FMP-20170804	2.6	104.0	Moderately hard
	1st	ACP-20170623	0.8	33.3	Soft
	2nd	ACP-20170714	0.9	36.0	Soft
	3rd	ACP-20170804	0.9	36.0	Soft
Group 4	1st	JAP-20170627	5.5	221.3	Very Hard
	2nd	JAP-20170718	5.9	236.0	Very Hard

Groups	Round	Sample ID	Average (mL)	Hardness (mg CaCO3/L)	Classification
	3rd	JAP-20170817	-	-	-
	1st	BAP-20170627	6.0	238.7	Very Hard
	2nd	BAP-20170718	6.1	244.0	Very Hard
	3rd	BAP-20170810	5.8	232.0	Very Hard
	1st	APN-20170629	6.1	242.7	Very Hard
	2nd	APN-20170719	6.0	240.0	Very Hard
	3rd	APN-20170808	4.1	164.0	Hard
	1st	APS-20170629	5.6	224.0	Very Hard
	2nd	APS-20170719	5.6	224.0	Very Hard
	3rd	APS-20170808	5.4	216.0	Very Hard

Regarding the results above, mg CaCO3/L indicates very hard water for most of the ponds; soft water for Dead Man's and the Ag. Canada Ponds; and a moderately hard water for the Farmers Market Pond.

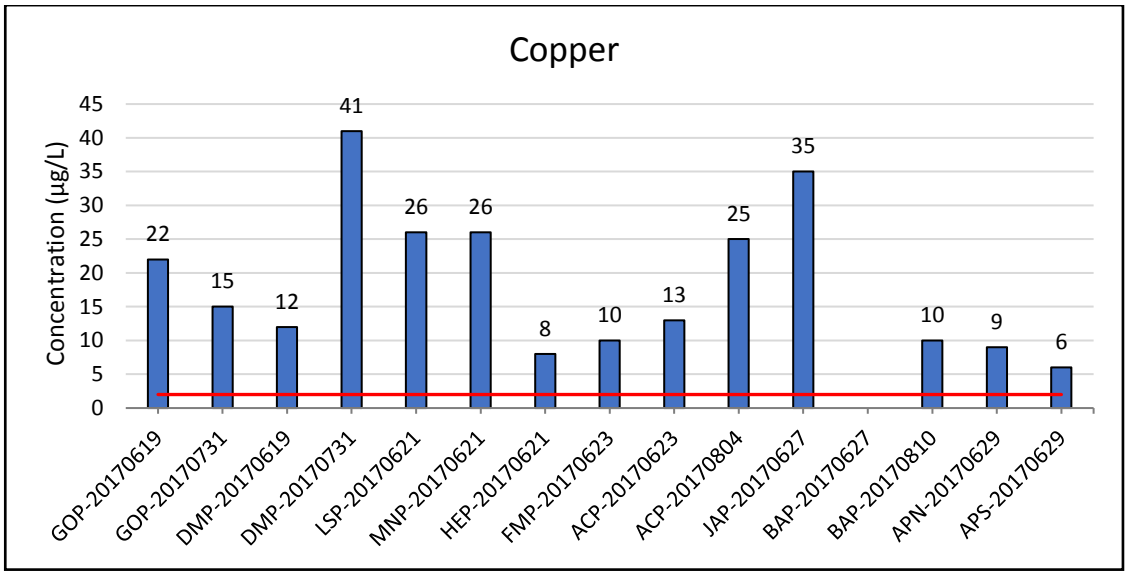
5.2.3 Analytical Results

The first round of the surface water samples was sent to the PEI Analytical Lab. The samples of the third round GOV-20170731, DMP-20170731, ACP-20170804, and BAP-20170810 were also sent to the lab to be compared with the results found in the first round. The laboratory analytical reports are included in Attachment D. Table 2 of the Attachment E summarizes the analytical data.

Copper, Iron, Chromium, and Chloride (long-term) were detected above the guideline values.

Below are graphs of some of the compounds analyzed for with their concentration in the ponds in blue and their respective CEQG for the protection of aquatic life in red.

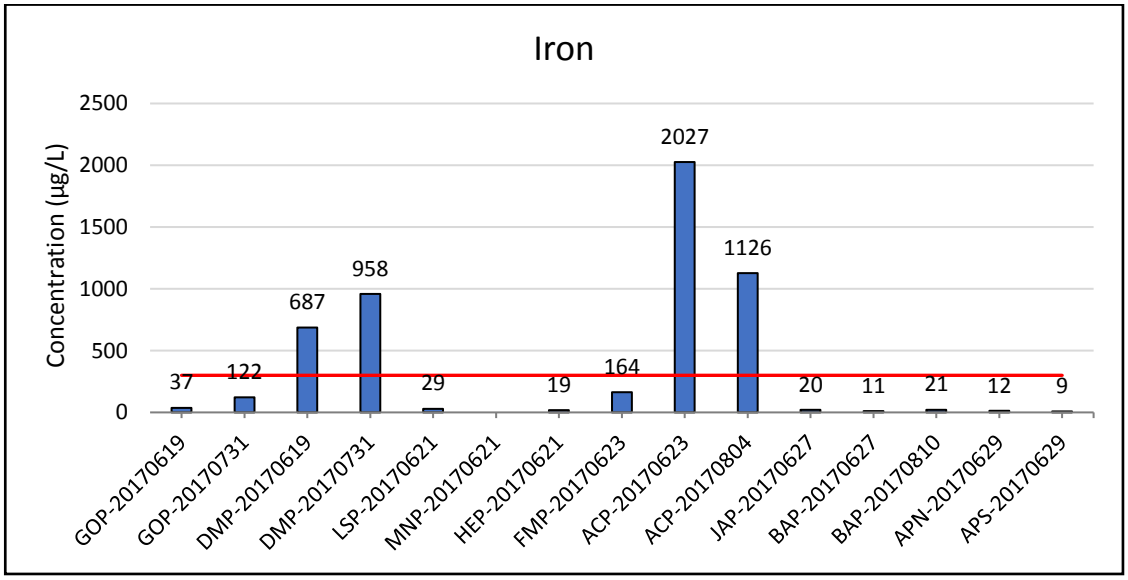
Copper



Graph 5.1 – Concentration of Copper in surface water from the 11 ponds analyzed.

Concentrations of Copper were detected above the CEQG (2µg/L) in all ponds. It was not detected in Barbour's Pond at the end of June, but it was detected in August. The highest concentration was detected in Jardine's Pond, followed by MacNeills and Lower Slick's Ponds, and Governor's Pond.

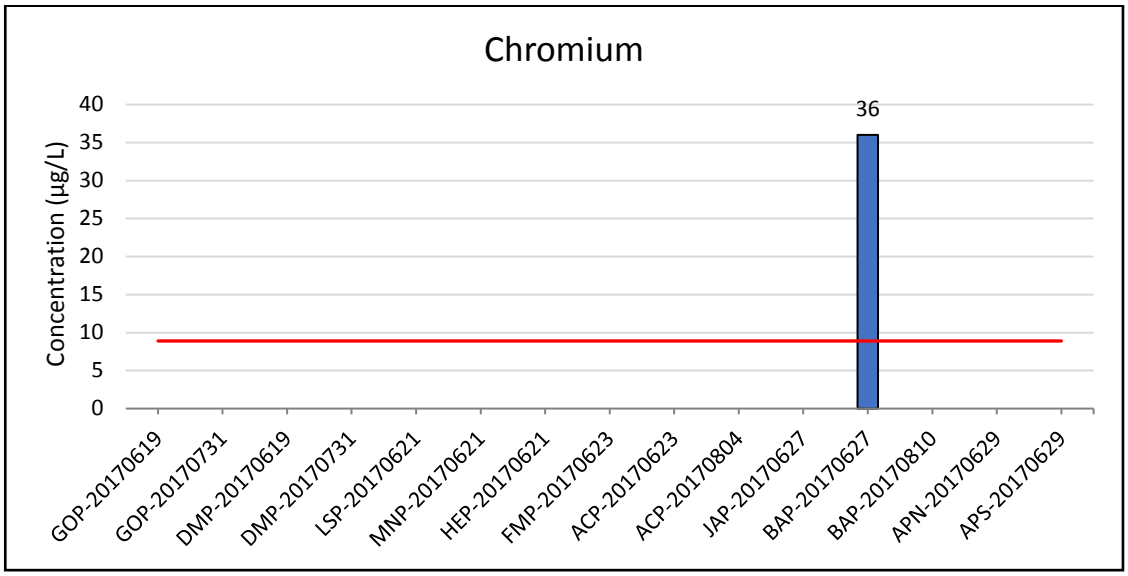
Iron



Graph 5.2 – Concentration of Iron in surface water from the 11 ponds analyzed.

Concentrations of Iron were detected above the CEQG (300µg/L) in Ag. Canada and Dead Man's Ponds.

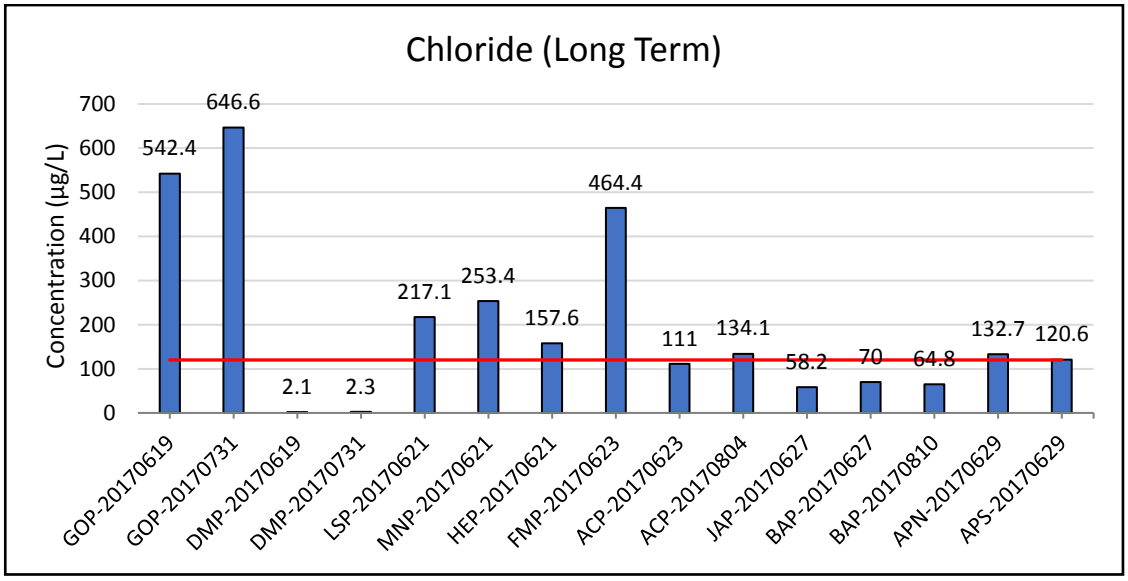
Chromium



Graph 5.3 – Concentration of Chromium in surface water from 11 ponds analyzed.

Concentrations of Chromium were detected above the CEQG (8.9 µg/L – Chromium III) on June 27 in Barbour's Ponds. It was retested on August 10, and Chromium was not detected.

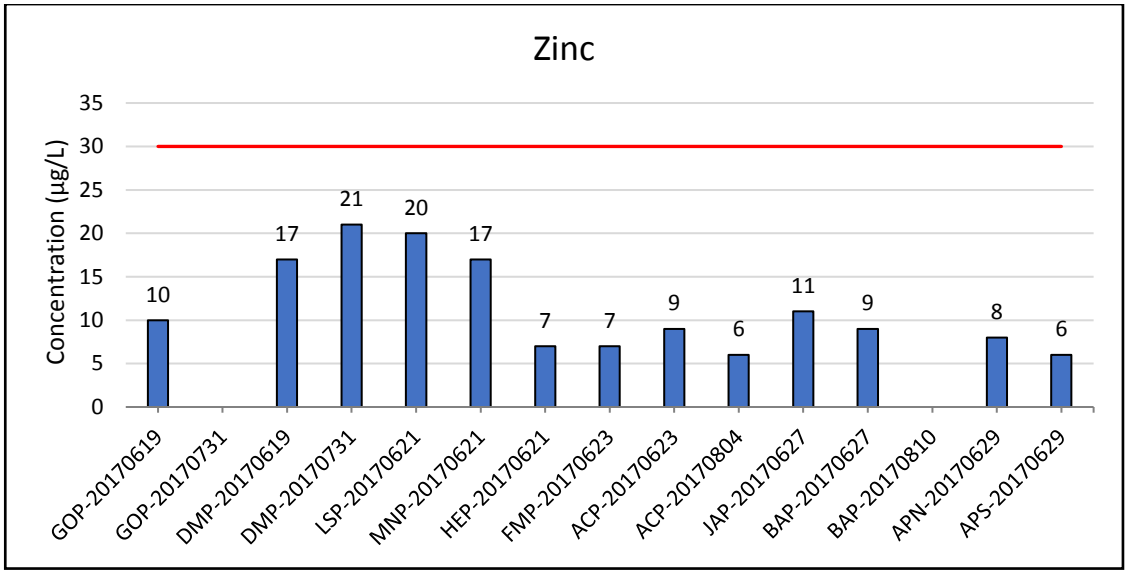
Chloride



Graph 5.4 – Concentration of Chloride in surface water from the 11 ponds analyzed.

Concentrations of Chloride were detected above the CEQG (120 µg/L – long term) in 7 of the 11 ponds analyzed. The highest concentration was detected in Governor's Pond, followed by Farmers Market Pond.

Zinc



Graph 5.5 – Concentration of Zinc in surface water from the ponds analyzed.

None of the concentrations of Zinc were detected above the CEQG (30 µg/L).

5.3 SEDIMENT QUALITY

Table 5.4 below shows the amount of sample collected with its percentage of sediment and water in the sample.

Table 5.4 - Sediment Data

ROUND	SAMPLE ID	WET SAMPLE (g)	DRY SAMPLE (g)	SEDIMENT (%)	WATER (%)
1st	GOP-20170619	3602.9	766.7	21.3	78.7
2nd	*not sampled*	*not sampled*	*not sampled*	*not sampled*	*not sampled*
3rd	GOP-20170731	4922.5	3067.5	62.3	37.7
1st	DMP-20170619	2459.1	374.8	15.2	84.8
2nd	DMP-20170710	4040.8	2069.3	51.2	48.8
3rd	DMP-20170731	5177.9	3249.5	62.8	37.2
1st	LSP-20170621	5992.7	2281.5	38.1	61.9
2nd	LSP-20170712	5851.9	3321.1	56.8	43.2
3rd	LSP-20170802	5756.7	3032.0	52.7	47.3
1st	MNP-20170621	4006.5	1479.7	36.9	63.1
2nd	MNP-20170712	5202.1	2810.8	54.0	46.0
3rd	MNP-20170802	5712.1	3316.6	58.1	41.9
1st	HEP-20170621	7241.0	1700.0	23.5	76.5
2nd	HEP-20170712	5538.8	1629.8	29.4	70.6
3rd	HEP-20170802	5004.2	1156.7	23.1	76.9

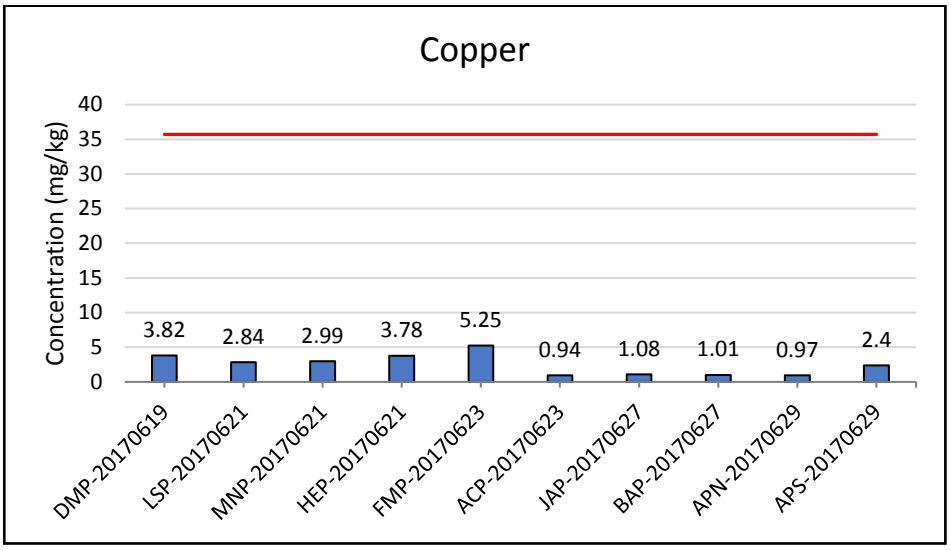
ROUND	SAMPLE ID	WET SAMPLE (g)	DRY SAMPLE (g)	SEDIMENT (%)	WATER (%)
1st	FMP-20170623	5385.6	2226.8	41.3	58.7
2nd	FMP-20170714	3724.3	1651.2	44.3	55.7
3rd	FMP-20170804	7315.1	4139.9	56.6	43.4
1st	ACP-20170623	2872.5	1756.6	61.2	38.8
2nd	ACP-20170714	7456.3	4360.6	58.5	41.5
3rd	ACP-20170804	7495.7	5275.4	70.4	29.6
1st	JAP-20170627	7388.2	3927.4	53.2	46.8
2nd	JAP-20170718	6872.8	3004.5	43.7	56.3
3rd	JAP-20170817	5344.3	2916.0	54.6	45.4
1st	BAP-20170627	6974.5	3481.4	49.9	50.1
2nd	BAP-20170718	5021.2	2941.9	58.6	41.4
3rd	BAP-20170810	5536.4	3282.0	59.3	40.7
1st	APN-20170629	5216.7	2790.8	53.5	46.5
2nd	APN-20170719	4594.2	2122.8	46.2	53.8
3rd	APN-20170808	4639.0	2438.4	52.6	47.4
1st	APS-20170629	4116.8	2225.1	54.0	46.0
2nd	APS-20170719	4969.0	3368.6	67.8	32.2
3rd	APS-20170808	5756.0	3920.8	68.1	31.9

5.3.1 Analytical Results

The first round of the sediment samples was sent to the PEI Analytical Lab. The laboratory analytical reports are included in Attachment D. Table 3 of the Attachment E summarizes the analytical data.

Only Zinc had concentrations detected above the guideline value. The graphs below present some of the compounds analyzed with their concentration in the ponds in blue and their respective Interin Freshwater Sediment Quality Guidelines (ISQG) for the protection of aquatic life in red.

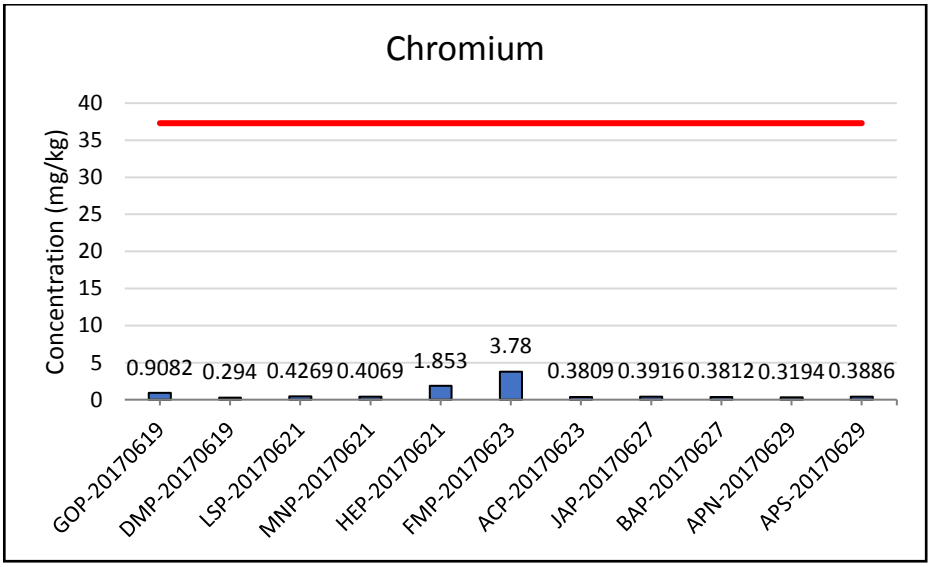
Copper



Graph 5.6 – Concentration of Copper in the sediment from 10 ponds analyzed.

None of the concentrations of Copper analyzed were detected above the ISQG (35.7 mg/kg).

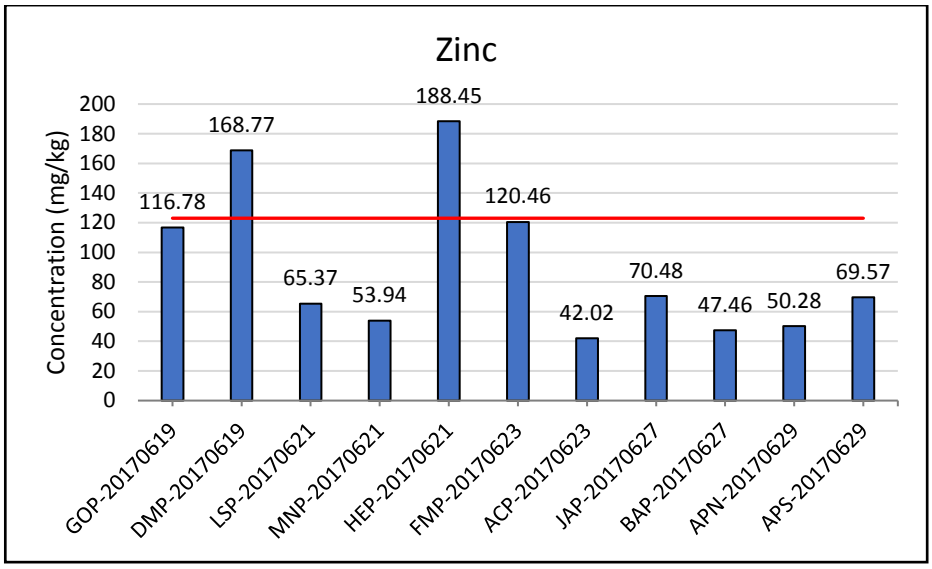
Chromium



Graph 5.7 – Concentration of Chromium in the sediment from 11 ponds analyzed.

None of the concentrations of Chromium analyzed were detected above the ISQG (37.3 mg/kg).

Zinc



Graph 5.8 – Concentration of zinc in the sediment from 11 ponds analyzed.

Concentrations of Zinc were detected above the ISQG (123 mg/kg) in 2 of the 11 ponds analyzed. The highest concentration was detected in Hermitage Pond, followed by Dead Man's Pond.

5.4 PLANTS

For information regarding vegetation with a focus on invasive species, field notes prepared by Isaac Fortune and Nicole Countway (summer students with the City of Charlottetown) are presented in Attachment F.

6 DISCUSSION

Regarding the macroinvertebrates, the water quality of most of the ponds was considered fairly poor (substantial pollution likely), except for Andrew's Pond North and Andrew's Pond South that were ranked as poor and fair, respectively. Although it is an indicator of pollution, FBI may not measure pollution especially in standing waters (FBI is primarily applied to streams), the index can be affected by low natural biological potential such as poor habitat condition. For instance, species with low tolerance value are rarely found in standing waters such as ponds.

With regards to dissolved oxygen, readings ranged from 0.45 to 12.74 mg/L. Low dissolved oxygen is primarily related to excessive algae growth. As the algae die and decompose, the process consumes dissolved oxygen. Algae was present in all ponds.

Copper, Iron, Chromium, and Chloride were detected above the guideline values.

Copper was detected in all ponds. It is a very common substance that occurs naturally in the environment and spreads through the environment naturally, but water-soluble copper compounds might also occur in the environment after release through agricultural application as fungicides, algicides, and insecticides.

Concentrations of iron were detected above the CEQG in Ag. Canada and Dead Man's Ponds. The presence of iron in natural waters can be attributed to the weathering of rocks and minerals, acidic mine water drainage, landfill leachates, sewage effluent, and iron-related industries.

Chromium was detected in Barbour's Pond at the end of June but in August, no concentration of chromium was found. At airports, antirust chemicals are periodically sprayed on the airplanes which may contain chromium in its composition. The stream that feeds Barbour's Pond pass through the airport area which might indicate the source of chromium.

Electrical conductivity ranged from 20.3 µS/cm (DMP-20170710) to 8,150 µS/cm (GOP-20170731). Higher electrical conductivity readings were detected in those ponds in urban areas with streets and sidewalks near them. The presence of chlorine with concentrations detected above the CEQG in 7 of the 11 ponds reinforces that it can be attributed to salting of highways to control ice and snow, or seawater intrusion in coastal areas such as near Governor's Pond.

Each pond has its peculiarity and changes can occur in short periods, making the comparison between different ponds difficult. As it was the first study covering these ponds, there is no previous data to compare the results.

7 CONCLUSION AND RECOMMENDATION

Based on the results of the assessment, it can be concluded that:

- Based on the macroinvertebrates, the water quality of most of the ponds was considered fairly poor, except for Andrew's Pond North and Andrew's Pond South that were ranked as poor and fair, respectively.

- The pH values ranged from 5.32 at DMP-20170710 to 8.23 at APS-20170808 and indicate a slightly acidic to a slightly basic environment. Temperature readings varied from 12.1 ^{o}C (JAP-20170627) to 22.5 ^{o}C (ACP-20170804). Electrical conductivity from 20.3 µS/cm (DMP-20170710) to 8,150 µS/cm (GOP-20170731) and dissolved oxygen readings ranged from 0.45 to 12.74 mg/L.

- The water in most of the ponds was very hard. The water in Dead Man's and the Ag. Canada Ponds was soft. The water in the Farmers Market Pond was moderately hard.

- Based on the surface water analyses, Copper, Iron, Chromium, and Chloride (long-term) were detected above the guideline values.

- Based on the sediment analyses, only Zinc had concentrations detected above the guideline value.

Based on the results obtained, it is recommended yearly monitoring continue which will provide additional data to understand better the behavior of the ponds over time. Improvements in water and sediment sampling techniques, such as taking samples not only from the edges of the ponds could be considered.

8 REFERENCES

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Attachment A

Maps

Figure 1

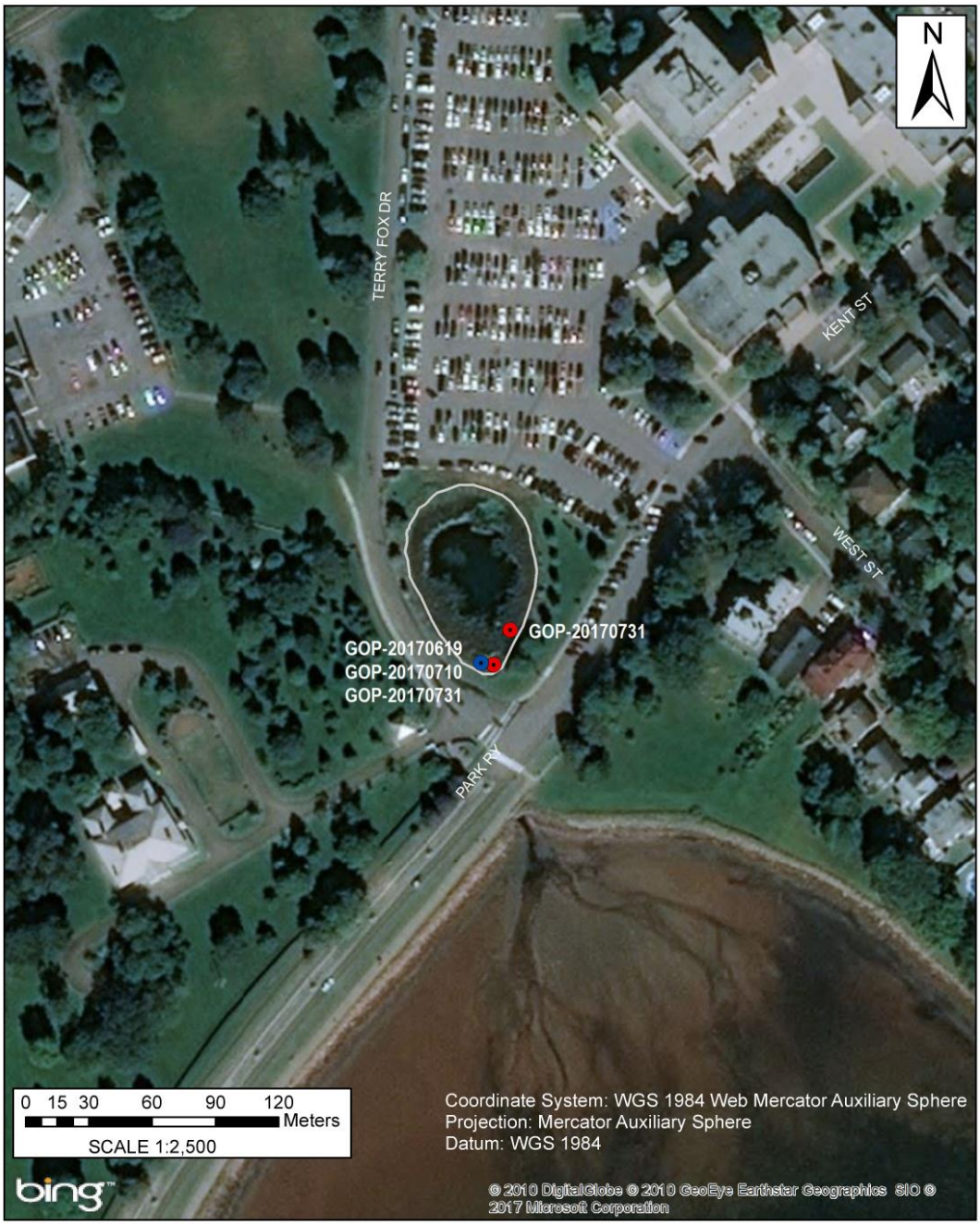

Figure 2

Project	Site
Ecological Health of the Ponds in Charlottetown	**Dead Man's Pond**

Legend:
- Water Sample
- Sediment Sample
- Pond Area *

Description: Site Location - Water and Sediment Samples

Note: * Estimated pond area: 737 square meters

Prepared by: Alex Uema Silva

Date: July 28, 2017

Figure: Figure 2

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Figure 3

Project	Site
Ecological Health of the Ponds in Charlottetown	Lower Slick's Pond

Legend:	Description	Prepared by / Date / Figure
Water Sample Sediment Sample Pond Area *	Site Location - Water and Sediment Samples Note: * Estimated pond area: 1424 square meters	Alex Uema Silva July 28, 2017 Figure 3

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Figure 4

Project	Site
Ecological Health of the Ponds in Charlottetown	**MacNeills Pond**

Legend:	Description	Prepared by / Date / Figure
Water Sample Sediment Sample Pond Area *	Site Location - Water and Sediment Samples Note: * Estimated pond area: 10260 square meters	Alex Uema Silva July 28, 2017 Figure 4

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Figure 5

Project	Site
Ecological Health of the Ponds in Charlottetown	Hermitage Pond

Legend:	Description	Prepared by / Date / Figure
Water Sample Sediment Sample Pond Area *	Site Location - Water and Sediment Samples Note: * Estimated pond area: 3820 square meters	Alex Uema Silva July 28, 2017 Figure 5

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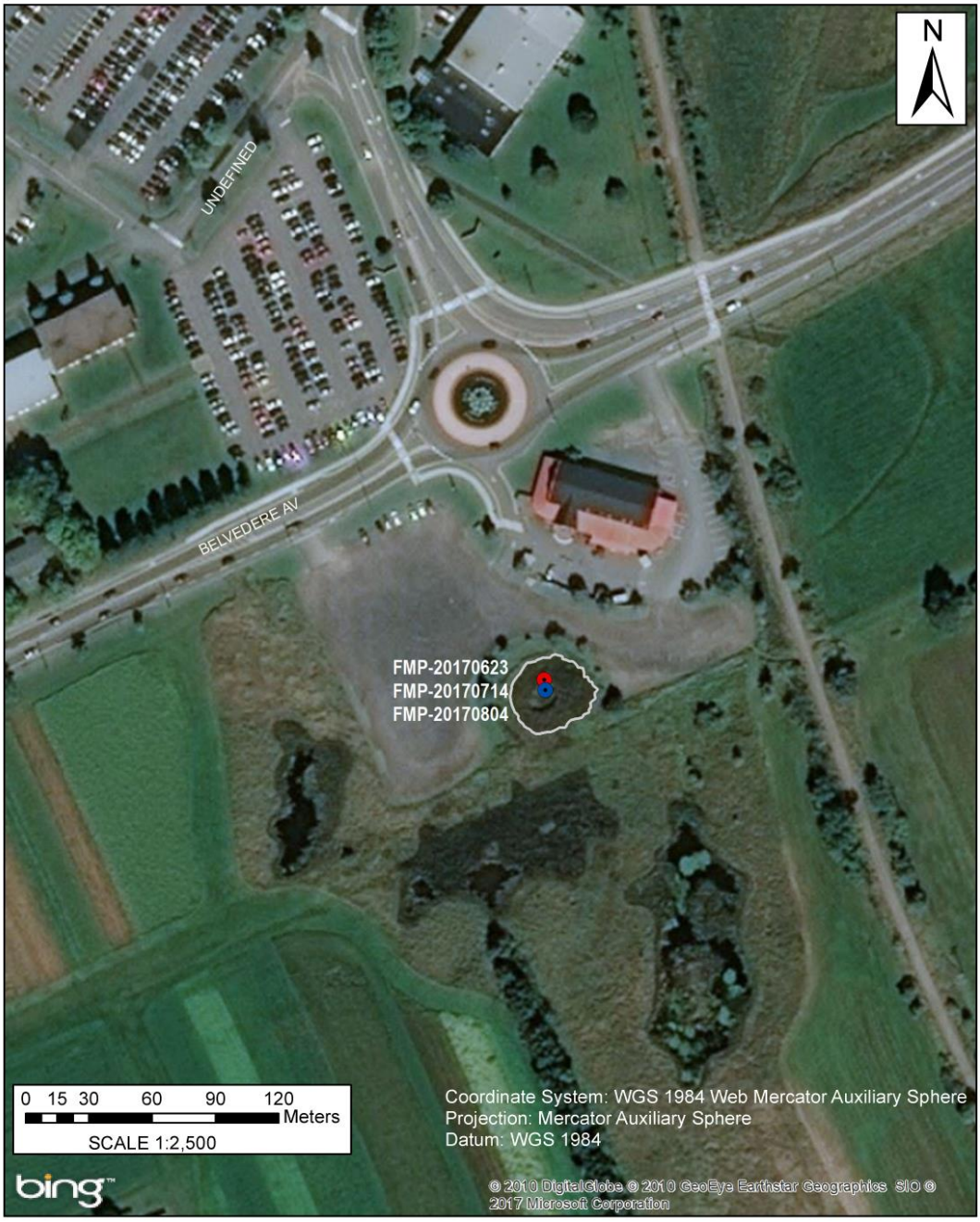
Figure 6



Project	Site
Ecological Health of the Ponds in Charlottetown	**Farmers Market Pond**

Legend:	Description	Prepared by / Date / Figure
Water Sample Sediment Sample Pond Area *	Site Location - Water and Sediment Samples Note: * Estimated pond area: 1087 square meters	Alex Uema Silva July 28, 2017 Figure 6

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Figure 7

Project	Site
Ecological Health of the Ponds in Charlottetown	**Ag. Canada Pond**

Legend:	Description	Prepared by / Date / Figure
Water Sample Sediment Sample Pond Area *	Site Location - Water and Sediment Samples Note: * Estimated pond area: 7203 square meters	Alex Uema Silva July 28, 2017 Figure 7

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Figure 8

Project: **Ecological Health of the Ponds in Charlottetown**	Site: **Jardine's Pond**
Legend: Water Sample; Sediment Sample; Pond Area *	Description: Site Location - Water and Sediment Samples Note: * Estimated pond area: 405 square meters
	Prepared by: Alex Uema Silva Date: July 28, 2017 Figure: Figure 8

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Figure 9

Project	Site
Ecological Health of the Ponds in Charlottetown	Barbour's Pond

Legend:	Description	Prepared by / Date / Figure
Water Sample Sediment Sample Pond Area *	Site Location - Water and Sediment Samples Note: * Estimated pond area: 1096 square meters	Alex Uema Silva July 28, 2017 Figure 9

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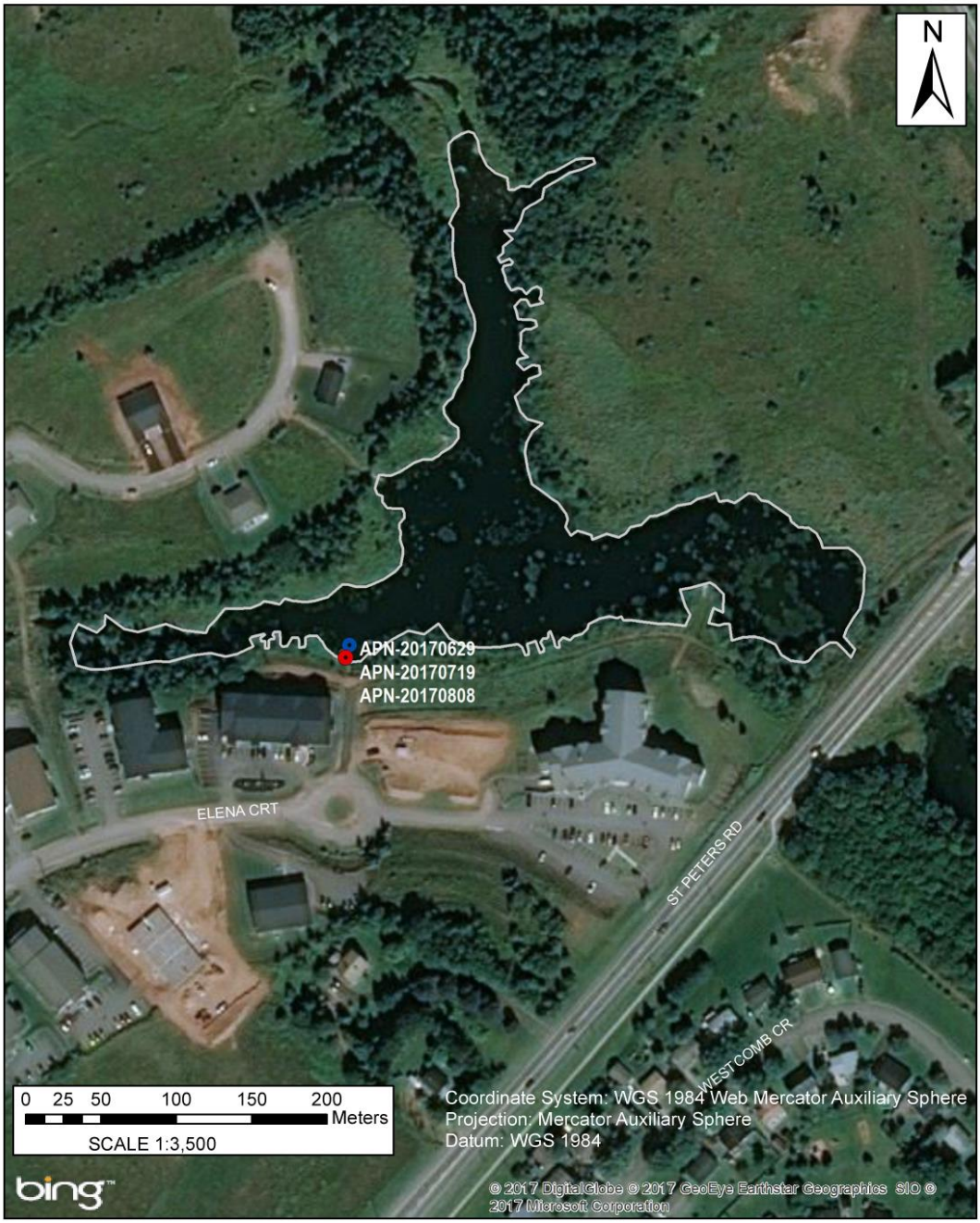
Figure 10



Project	Site
Ecological Health of the Ponds in Charlottetown	Andrew's Pond North

Legend:	Description	Prepared by / Date / Figure
Water Sample Sediment Sample Pond Area *	Site Location - Water and Sediment Samples Note: * Estimated pond area: 42090 square meters	Alex Uema Silva July 28, 2017 Figure 10

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Figure 11

Project	Site
Ecological Health of the Ponds in Charlottetown	**Andrew's Pond South**

Legend:	Description	Prepared by / Date / Figure
Water Sample Sediment Sample Pond Area *	Site Location - Water and Sediment Samples Note: * Estimated pond area: 18770 square meters	Alex Uema Silva July 28, 2017 Figure 11

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Attachment B

Photographs

Figure 1 – View of the Governor's Pond. Photo from July 31, 2017 by Norman Dewar

Figure 2 – View of Dead Man's Pond. Photo from July 10, 2017 by Norman Dewar

Figure 3 – View of Dead Man's Pond. Photo from July 31, 2017 by Norman Dewar

Figure 4 – View of Lower Slick's Pond. Photo from August 2, 2017 by Norman Dewar

Figure 5 – View of MacNeills Pond. Photo from June 21, 2017 by Norman Dewar

Figure 6 – View of MacNeills Pond. Photo from August 2, 2017 by Norman Dewar

Figure 7 – View of Hermitage Pond. Photo from July 10, 2017 by Norman Dewar

Figure 8 – View of Farmers Market Pond. Photo from June 23, 2017 by Norman Dewar

Figure 9 – View of Ag. Canada Pond. Photo from June 23, 2017 by Norman Dewar

Figure 10 – View of Barbour's Pond from August 10, 2017 by Norman Dewar

Figure 11 – View of Andrew's Pond North from June 29, 2017 by Norman Dewar

Figure 12 – View of Andrew's Pond North from August 08, 2017 by Norman Dewar

Figure 13 – View of Andrews Pond South from June 27, 2017 by Norman Dewar

Figure 14 - Macroinvertebrates sampling at Hermitage Pond on June 21, 2017 by Norman Dewar

Figure 15 - Macroinvertebrates sampling at MacNeills Pond. Photo from June 21, 2017 by Norman Dewar

Figure 16 - Macroinvertebrates sampling at Andrew's Pond South. Photo from June 29, 2017 by Norman Dewar

Figure 17 - Invertebrates sampling at Andrew's Pond South. June 29, 2017 by Norman Dewar

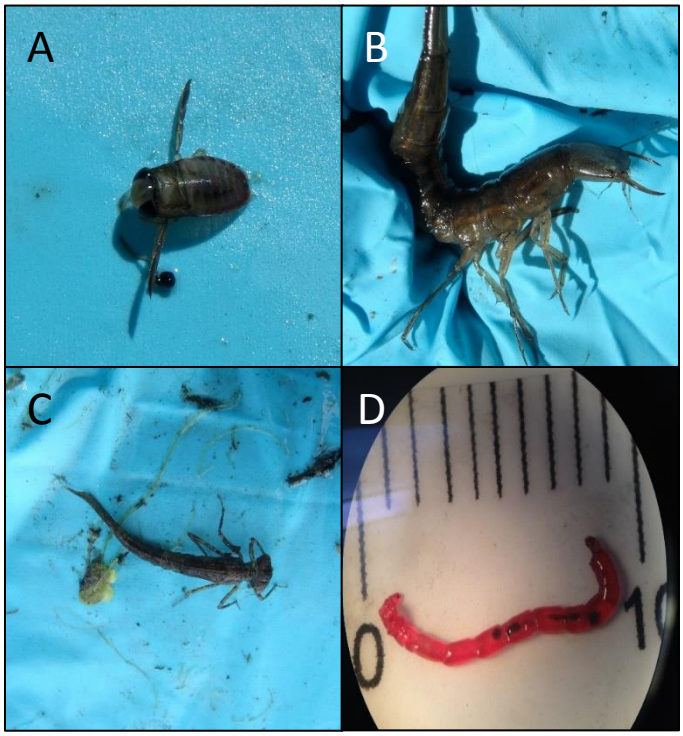

Figure 18 – Example of macro-invertebrates found in the ponds. A- Water boatman, B- Predaceous Diving Beetle, C- Damselfly, D- Midge fly larvae

Figure 19 - Readings of the physicochemical parameters at Hermitage Pond. Photo June 21, 2017 by Norman Dewar

Figure 20 - Dissolved oxygen measurement at Lower Slick's Pond. Photo from June 21, 2017 by Norman. Dewar

Figure 21 - Surface water sampling at Governor's Pond. Photo from June 19, 2017 by Norman Dewar

Figure 22 – Filtration using a vacuum flask and 0.45-micron filter.

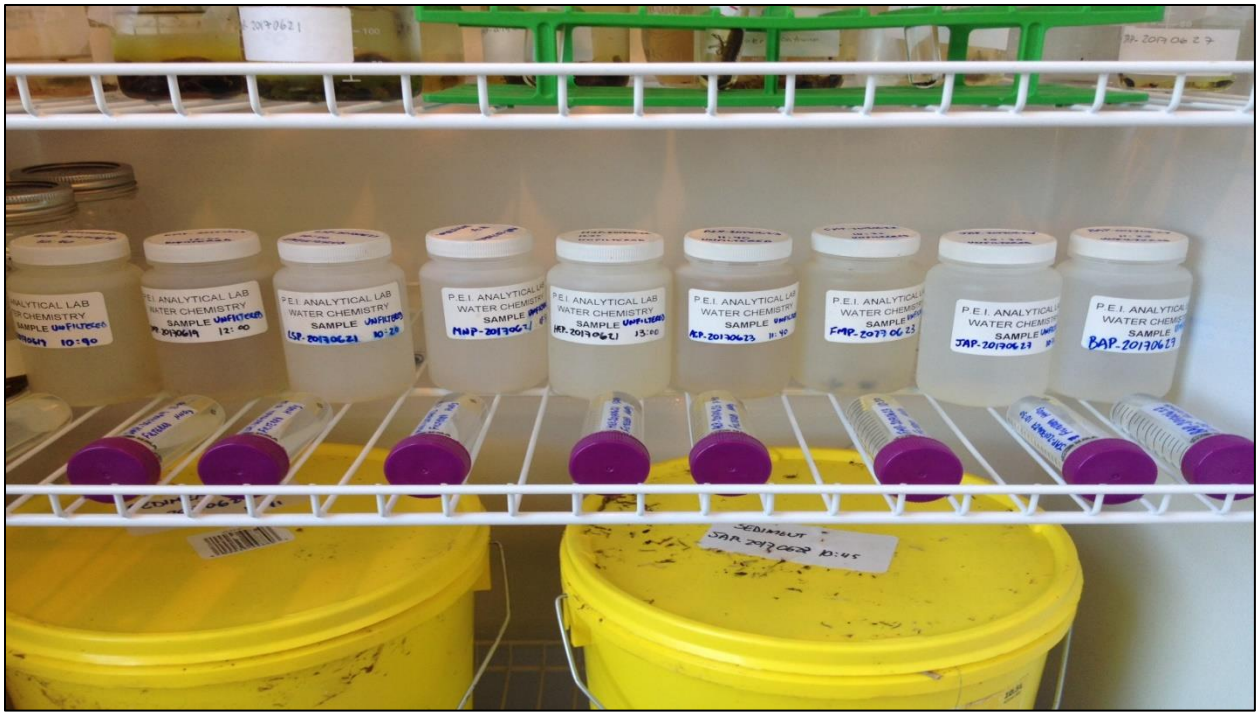

Figure 23 - Surface water and sediment samples labeled and stored in fridge at the E.A.S.T Lab.

Figure 24 – Hardness test

Figure 25 - Sediment sampling using the Eckman dredge. Photo from June 21, 2017 by Norman Dewar

Figure 26 - Sediment Sampling at Jardine's Pond using a landscape rake. Photo from June 27, 2017 by Norman Dewar

Figure 27 - Sediment sampling near the beaver dam at Barbour's Pond using a landscape rake. Photo from June 27, 2017 by Norman Dewar

Figure 28 - Sediment sampling at Governor's Pond using scoop. Photo from June 19, 2017 by Norman Dewar

Figure 29 - Sediment sampling at Governor's Pond. Photo from June 19, 2017 by Norman Dewar

Figure 30 - Sediment sample being dried in oven at 50 degrees Celsius

Figure 31 -Outflow of Governor's Pond during the low tide. Photo from July 10, 2017 by Norman Dewar

Attachment C

Equipment Calibration Sheets

CALIBRATION SHEET

Date of calibration: JUNE 02, 2017

Instruments:
1- HACH SENSION 5 (conductivity) Serial Number: 51975-00
2- HACH SENSION 1 (pH) Serial Number: 16397
3- YSI OD PRO20 Serial Number: 75645
4- Pocket Turbidimeter Serial Number: 52600-00

(HOLLAND COLLEGE #63122)

Temperature Reading: 24.5° Accurate Temperature: ☑ Y ☐ N

DO Membrane changed? ☒ Y ☐ N Color of membrane: Yellow

True Barometric Pressure at time of Calibration: 100.8 kPa

	Pre cal	After Cal	Observation
Conductivity		981 µS/cm	Temp. 24,5°C
DO	66.5 %	99.9 %	* CAP MEMBRANE WAS DAMAGED, IT WAS REPLACED.
Turbidity		1 / 20 NTU	
pH 7		7.02	Slope 57.6
pH 4		4.01	//
pH 10		10.03	//

Calibrated by: ALEX SILVA Date: JUNE 02, 2017

CALIBRATION SHEET

Date of calibration: JUNE 09, 2017

Instruments:
1- HACH SENSION 5 Serial Number: 51975-00
2- HACH SENSION 1 Serial Number: 16397
3- YSI PRO 20 Serial Number: 75645
4- POCKET Turbidimeter Serial Number: 52600-00

Temperature Reading: 22.5°C Accurate Temperature: ☐ Y ☐ N

DO Membrane changed? ☐ Y ☒ N Color of membrane: Yellow

True Barometric Pressure at time of Calibration: 100.7 kPa

	Pre cal	After Cal	Observation
Conductivity	948 µS/cm	982 µS/cm	Temp. 23°C
DO	102.7 %	100.0 %	
Turbidity	—	—	
pH 7	6.89	7.02	SLOPE -56.7
pH 4	3.77	4.00	
pH 10	9.82	10.07	

Calibrated by: ALEX SILVA Date: JUNE 08, 2017

CALIBRATION SHEET

Date of calibration: JUNE 27, 2017

Instruments:
1- HACH SENSION 5 Serial Number: 51975.00
2- HACH SENSION 1 Serial Number: 16397
3- YSI ON PRO 20 Serial Number: 75645
4- _____ Serial Number: _____

Temperature Reading: 22.4 °C Accurate Temperature: ☒ Y ☐ N

DO Membrane changed? ☐ Y ☒ N Color of membrane: yellow

True Barometric Pressure at time of Calibration: 101.7 kPa

	Pre cal	After Cal	Observation
Conductivity	1013 µS/cm	1000 µS/cm	
DO	101.8 %	100.0 %	
Turbidity	—	—	
pH 7	7.00	7.01	
pH 4	3.91	4.00	
pH 10	10.00	10.02	-57.0 SLOPE 16.9 mV

Calibrated by: ALEX SILVA Date: JUNE 27, 2017

CALIBRATION SHEET

Date of calibration: July 07, 2017

Instruments:
1- HACH SENSION 5 Serial Number: 51975
2- HACH SENSION 1 Serial Number: 16397
3- YSI PRO 20 Serial Number: 75645
4- _____ Serial Number: _____

Temperature Reading: 23.7 °C Accurate Temperature: ☒ Y ☐ N

DO Membrane changed? ☐ Y ☒ N Color of membrane: Yellow

True Barometric Pressure at time of Calibration: 101.0 kPa

	Pre cal	After Cal	Observation
Conductivity	978 µS/cm	997 µS/cm	OK ± 10 µS/cm
DO	96.6 %	100 %	—
Turbidity	—	—	—
pH 7	7.05	7.02	Slope -57.1 17.2 mV
pH 4	3.93	4.00	
pH 10	10.01	9.99	

Calibrated by: Alex Vema Silva Date: July 07, 2017

CALIBRATION SHEET

Date of calibration: July 14, 2017

Instruments:
1- HACH SENSION 5 Serial Number: 51975
2- HACH SENSION 1 Serial Number: 16397
3- YSI PRO 20 Serial Number: 75645
4- _____ Serial Number: _____

Temperature Reading: 22.2°C Accurate Temperature: ☒ Y ☐ N

DO Membrane changed? ☐ Y ☒ N Color of membrane: Yellow

True Barometric Pressure at time of Calibration: 101.9kPa

	Pre cal	After Cal	Observation
Conductivity	976 µS/cm	996 µS/cm	Ok ± 10µS/cm
DO	71.0 %	99.9 %	—
Turbidity	—	—	—
pH 7	7.27	7.01	Slope - 57.1 2.9 mV
pH 4	4.12	4.01	
pH 10	10.20	10.04	

Calibrated by: ALEX SILVA Date: July 14, 2017

CALIBRATION SHEET

Date of calibration: July 28, 2017

Instruments:
1- HACH SENSION 5 Serial Number: 31975
2- HACH SENSION 1 Serial Number: 16397
3- YSI PRO 20 Serial Number: 75645
4- _____ Serial Number: _____

Temperature Reading: 21.8 °C Accurate Temperature: ☒ Y ☐ N

DO Membrane changed? ☐ Y ☒ N Color of membrane: yellow

True Barometric Pressure at time of Calibration: 100.8 kPa

	Pre cal	After Cal	Observation
Conductivity	986 µS/cm	993 µS/cm	± 10 µS/cm OK
DO	79.8 %	100.0 %	—
Turbidity	—	—	—
pH 7	6.93	7.01	-56.8 mL/ slope 3.1 mV
pH 4	3.93	4.01	—
pH 10	9.89	10.04	—

Calibrated by: ALEX SILVA Date: July 28, 2017

CALIBRATION SHEET

Date of calibration: AUGUST 7, 2017

Instruments:
1- HACH SENSION 5 Serial Number: 51975
2- HACH SENSION 1 Serial Number: 16397
3- YSI PRO 20 Serial Number: 75645
4- _____ Serial Number: _____

Temperature Reading: 22.3°C Accurate Temperature: ☒ Y ☐ N

DO Membrane changed? ☐ Y ☒ N Color of membrane: Yellow

True Barometric Pressure at time of Calibration: 101.1 kPa

	Pre cal	After Cal	Observation
Conductivity	983 µS/cm	992 µS/cm	± 10 µS/cm OK
DO	111.6 %	99.9 %	—
Turbidity	—	—	—
pH 7	6.76	7.01	Slope - 55.8 5.5 mV
pH 4	4.31	4.01	—
pH 10	9.56	10.04	—

Calibrated by: ALEX SILVA Date: AUGUST 7, 2017

CALIBRATION SHEET

Date of calibration: August 16, 2017

Instruments:
1- HACH SENSION 5 Serial Number: 51975
2- HACH SENSION 1 Serial Number: 16397
3- YSI PRO 20 Serial Number: 75645
4- _____ Serial Number: _____

Temperature Reading: 23.0°C Accurate Temperature: ☒ Y ☐ N

DO Membrane changed? ☐ Y ☒ N Color of membrane: yellow

True Barometric Pressure at time of Calibration: 100.7 kPa

	Pre cal	After Cal	Observation
Conductivity	995	995	OK I 10 µS/cm
DO	96.2 %	100.3 %	—
Turbidity	—	—	—
pH 7	7.06	7.01	Slope - 55.8 mV/ 6.8 mV
pH 4	4.02	4.01	—
pH 10	9.76	10.04	—

Calibrated by: Alex Silva Date: August 16, 2017

Attachment D

Laboratory Reports

Special Products Test Report
8/15/2017

HOLLAND COLLEGE
C/O BRYAN GRIMMELT
140 WEYMOUTH STREET
CHARLOTTETOWN, PEI
C1A 4Z1

PEI Analytical Laboratories
PEI Department of Agriculture and Forestry
23 Innovation Way
PO Box 2000, Charlottetown, PEI, C1A7N8

Fax: (902) 368-6299
Telephone: (902) 620-3300

Client: 6498
Accession: 4733
Samples Reported: 8/15/2017
Samples Received: 8/11/2017

Analysis Performed	Lab #: 4733-1 Sample Type: Pond Sediment Sample Id: GOP-170619	Lab #: 4733-2 Sample Type: Pond Sediment Sample Id: DMP-170619	Lab #: 4733-3 Sample Type: Pond Sediment Sample Id: LSP-170621	Lab #: 4733-4 Sample Type: Pond Sediment Sample Id: MNP-170621
Dry Matter %	95.60	98.00	99.29	99.25
Carbon %	10.10	16.60	4.91	5.00
C:N Ratio	15.54	20.41	16.50	18.67
Nitrogen %	.65	.81	.30	.27
Phosphorus %	.08	.08	.10	.07
Potassium %	.12	.06	.09	.06
Calcium %	2.06	.10	1.02	.85
Magnesium %	.25	.07	.13	.10
Copper ppm		3.82	2.84	2.99
Zinc ppm	116.78	168.77	65.37	53.94
Boron ppm	7.76	5.28	4.53	3.18
Iron ppm	3742.52	2354.13	5698.97	7039.90
Manganese ppm	228.14	103.99	349.16	137.12
pH	7.45	4.86	7.25	7.37

Date of analysis available upon request.

Comment:

Copies to:	Test values approved by: P.S.	**We are members of the following Sample Check Programs: Compost Analysis Proficiency Testing Program and Manure Testing Laboratory Certification Program**

Special Products Test Report
8/15/2017

HOLLAND COLLEGE
C/O BRYAN GRIMMELT
140 WEYMOUTH STREET
CHARLOTTETOWN, PEI
C1A 4Z1

PEI Analytical Laboratories
PEI Department of Agriculture and Forestry
23 Innovation Way
PO Box 2000, Charlottetown, PEI, C1A7N8

Fax: (902) 368-6299
Telephone: (902) 620-3300

Client: 6498
Accession: 4733
Samples Reported: 8/15/2017
Samples Received: 8/11/2017

Analysis Performed	Lab #: 4733-5 Sample Type: Pond Sediment Sample Id: HEP-170621	Lab #: 4733-6 Sample Type: Pond Sediment Sample Id: FMP-170623	Lab #: 4733-7 Sample Type: Pond Sediment Sample Id: ACP-170623	Lab #: 4733-8 Sample Type: Pond Sediment Sample Id: JAP-170627
Dry Matter %	89.95	95.94	97.67	91.08
Carbon %	9.29	5.18	3.27	4.18
C:N Ratio	14.76	18.62	20.94	17.65
Nitrogen %	.63	.28	.16	.24
Phosphorus %	.10	.11	.05	.12
Potassium %	.11	.15	.07	.06
Calcium %	.38	.21	.07	.23
Magnesium %	.26	.37	.08	.09
Copper ppm	3.78	5.25	.94	1.08
Zinc ppm	188.45	120.46	42.02	70.48
Boron ppm	3.79	5.16	2.56	3.04
Iron ppm	6971.86	6575.79	3027.47	3796.65
Manganese ppm	114.11	159.76	66.56	201.31
pH	6.87	6.04	6.33	6.99

Date of analysis available upon request.

Comment:

Copies to:	Test values approved by: P. S.	**We are members of the following Sample Check Programs: Compost Analysis Proficiency Testing Program and Manure Testing Laboratory Certification Program**

Special Products Test Report
8/15/2017

HOLLAND COLLEGE
C/O BRYAN GRIMMELT
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CHARLOTTETOWN, PEI
C1A 4Z1

PEI Analytical Laboratories
PEI Department of Agriculture and Forestry
23 Innovation Way
PO Box 2000, Charlottetown, PEI, C1A7N8

Fax: (902) 368-6299
Telephone: (902) 620-3300

Client: 6498
Accession: 4733
Samples Reported: 8/15/2017
Samples Received: 8/11/2017

Analysis Performed	Lab #: 4733-9 Sample Type: Pond Sediment Sample Id: BAP-170627	Lab #: 4733-10 Sample Type: Pond Sediment Sample Id: APN-170629	Lab #: 4733-11 Sample Type: Pond Sediment Sample Id: APS-170629	Sample Type: Sample Id:
Dry Matter %	97.74	99.80	99.64	
Carbon %	3.43	3.49	4.31	
C:N Ratio	20.65	19.44	18.83	
Nitrogen %	.17	.18	.23	
Phosphorus %	.07	.06	.06	
Potassium %	.04	.07	.06	
Calcium %	.21	.30	.21	
Magnesium %	.07	.14	.09	
Copper ppm	1.01	.97	2.40	
Zinc ppm	47.46	50.28	69.57	
Boron ppm	3.72	2.99	2.75	
Iron ppm	2178.32	3470.59	2379.53	
Manganese ppm	130.99	112.67	146.31	
pH	7.61	7.07	7.04	

Date of analysis available upon request.

Comment:

Copies to:	Test values approved by: P. S.	**We are members of the following Sample Check Programs: Compost Analysis Proficiency Testing Program and Manure Testing Laboratory Certification Program**

Standards Council of Canada
Accredited Laboratory
Scope of Accreditation 424

Conseil canadien des normes
Laboratoire accrédité
Portée d'accréditation 424 TM

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170704007
Sample Point: Bryan Grimmelt
Sample Location: ACP-20170623
Date Sampled: June 23, 2017
Sampler: Alex Silva/Norm 3936461
Date Received: July 04, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Copper, dissolved	13	ppb	5.00
WCL_07M	*	Hardness	36.6		0.00
WCL_07M	*	Iron, dissolved	2027	ppb	9.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Magnesium, dissolved	1.70	ppm	0.10
WCL_07M	*	Manganese, dissolved	2164	ppb	3.00
WCL_07M	*	Phosphorus, dissolved	0.13	ppm	0.02
WCL_07M	*	Potassium, dissolved	0.74	ppm	0.10
WCL_07M	*	Sodium, dissolved	68.71	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	7.67	ppm	0.20
WCL_07M	*	Zinc, dissolved	9	ppb	6.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Barium, dissolved	59	ppb	2.00
WCL_07M	*	Calcium, dissolved	11.86	ppm	0.20
Approved By:		Jackie Garnhum	Date:	July 13, 2017	
WCL_01M	*	Chloride	111.0	ppm	1.00
WCL_01M	*	Alkalinity	43.9	ppm of CaCO3/L	8.00
WCL_01M	*	Nitrate-N + Nitrite-N	<0.2	ppm	0.20
Approved By:		Lori Brine	Date:	July 13, 2017	
WCL_04M	*	pH for Water	7.4		0.00
Approved By:		Taylor Main	Date:	July 12, 2017	

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

Standards Council of Canada
Accredited Laboratory
Scope of Accreditation 424

Conseil canadien des normes
Laboratoire accrédité
Portée d'accréditation 424 TM

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170823005
Sample Point: Bryan Grimmelt
Sample Location: ACP-20170804
Date Sampled: August 04, 2017
Sampler: Alex Silva
Date Received: August 23, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_04M	*	pH for Water	8.0		0.00
WCL_01M	*	Alkalinity	50.8	ppm of CaCO3/L	8.00
WCL_01M	*	Chloride	134.1	ppm	1.00
WCL_07M	*	Calcium, dissolved	13.90	ppm	0.20
WCL_07M	*	Potassium, dissolved	0.45	ppm	0.10
WCL_07M	*	Magnesium, dissolved	2.05	ppm	0.10
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	6	ppb	6.00
WCL_07M	*	Barium, dissolved	49	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	25	ppb	5.00
WCL_07M	*	Iron, dissolved	1126	ppb	9.00
WCL_07M	*	Manganese, dissolved	474	ppb	3.00
WCL_07M	*	Sodium, dissolved	81.49	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	4.97	ppm	0.20
WCL_02M	*	Ammonia-N	<0.100	ppm	0.10
WCM_05M	*	Total Nitrogen	0.5	ppm	0.50
WCL_08M	*	Total Phosphorus	89.7	ppb	10.00
WCL_07M	*	Phosphorus, dissolved	0.15	ppm	0.02
Approved By:		Anna Marie MacFarlane	Date:	October 12, 2017	
WCL_01M	*	Nitrate-N + Nitrite-N	<0.2	ppm	0.20
Approved By:		Jackie Garnhum	Date:	September 11, 2017	
WCL_07M	*	Hardness	43.1		0.00
Approved By:		Lori Brine	Date:	November 07, 2017	

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

Standards Council of Canada Accredited Laboratory Scope of Accreditation 424

Conseil canadien des normes Laboratoire accrédité Portée d'accréditation 424 TM

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt

Sample Number: SW170704011

Sample Point: Bryan Grimmelt

Sample Location: APN-20170629

Date Sampled: June 29, 2017

Sampler: Alex Silva/Norm 3936461

Date Received: July 04, 2017

Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Copper, dissolved	9	ppb	5.00
WCL_07M	*	Hardness	240.2		0.00
WCL_07M	*	Iron, dissolved	12	ppb	9.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Magnesium, dissolved	26.78	ppm	0.10
WCL_07M	*	Manganese, dissolved	34	ppb	3.00
WCL_07M	*	Phosphorus, dissolved	<0.02	ppm	0.02
WCL_07M	*	Potassium, dissolved	2.21	ppm	0.10
WCL_07M	*	Sodium, dissolved	56.59	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	13.07	ppm	0.20
WCL_07M	*	Zinc, dissolved	8	ppb	6.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Barium, dissolved	239	ppb	2.00
WCL_07M	*	Calcium, dissolved	52.06	ppm	0.20
Approved By:		Jackie Garnhum	Date:	July 13, 2017	
WCL_01M	*	Chloride	132.7	ppm	1.00
WCL_01M	*	Alkalinity	161	ppm of CaCO3/L	8.00
WCL_01M	*	Nitrate-N + Nitrite-N	2.1	ppm	0.20
Approved By:		Lori Brine	Date:	July 13, 2017	
WCL_04M	*	pH for Water	8.0		0.00
Approved By:		Taylor Main	Date:	July 12, 2017	

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

Standards Council of Canada Accredited Laboratory Scope of Accreditation 424

Conseil canadien des normes Laboratoire accrédité Portée d'accréditation 424 TM

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170704010
Sample Point: Bryan Grimmelt
Sample Location: APS-20170629
Date Sampled: June 29, 2017
Sampler: Alex Silva/ Norm 3936461
Date Received: July 04, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Copper, dissolved	6	ppb	5.00
WCL_07M	*	Hardness	223.9		0.00
WCL_07M	*	Iron, dissolved	9	ppb	9.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Magnesium, dissolved	25.08	ppm	0.10
WCL_07M	*	Manganese, dissolved	5	ppb	3.00
WCL_07M	*	Phosphorus, dissolved	<0.02	ppm	0.02
WCL_07M	*	Potassium, dissolved	2.06	ppm	0.10
WCL_07M	*	Sodium, dissolved	50.55	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	12.20	ppm	0.20
WCL_07M	*	Zinc, dissolved	6	ppb	6.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Barium, dissolved	214	ppb	2.00
WCL_07M	*	Calcium, dissolved	48.31	ppm	0.20
Approved By:		Jackie Garnhum	Date:	July 13, 2017	
WCL_01M	*	Chloride	120.6	ppm	1.00
WCL_01M	*	Alkalinity	154	ppm of CaCO3/L	8.00
WCL_01M	*	Nitrate-N + Nitrite-N	1.9	ppm	0.20
Approved By:		Lori Brine	Date:	July 13, 2017	
WCL_04M	*	pH for Water	8.1		0.00
Approved By:		Taylor Main	Date:	July 12, 2017	

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

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PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170704009
Sample Point: Bryan Grimmelt
Sample Location: BAP-20170627
Date Sampled: June 27, 2017
Sampler: Alex Silva/ Norm 3936461
Date Received: July 04, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Copper, dissolved	<5	ppb	5.00
WCL_07M	*	Hardness	231.4		0.00
WCL_07M	*	Iron, dissolved	11	ppb	9.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Magnesium, dissolved	25.50	ppm	0.10
WCL_07M	*	Manganese, dissolved	20	ppb	3.00
WCL_07M	*	Phosphorus, dissolved	0.03	ppm	0.02
WCL_07M	*	Potassium, dissolved	1.89	ppm	0.10
WCL_07M	*	Sodium, dissolved	27.75	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	10.52	ppm	0.20
WCL_07M	*	Zinc, dissolved	9	ppb	6.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	36	ppb	5.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Barium, dissolved	245	ppb	2.00
WCL_07M	*	Calcium, dissolved	50.64	ppm	0.20
Approved By:		Jackie Garnhum	Date:	July 13, 2017	
WCL_01M	*	Chloride	70.0	ppm	1.00
WCL_01M	*	Alkalinity	169	ppm of CaCO3/L	8.00
WCL_01M	*	Nitrate-N + Nitrite-N	3.4	ppm	0.20
Approved By:		Lori Brine	Date:	July 13, 2017	
WCL_04M	*	pH for Water	7.9		0.00
Approved By:		Taylor Main	Date:	July 12, 2017	

Date of Analysis available upon request.

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PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170823007
Sample Point: Bryan Grimmelt
Sample Location: BAP-20170810
Date Sampled: August 10, 2017
Sampler: Alex Silva
Date Received: August 23, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_04M	*	pH for Water	8.1		0.00
WCL_01M	*	Alkalinity	188	ppm of CaCO3/L	8.00
WCL_01M	*	Chloride	64.8	ppm	1.00
WCL_07M	*	Calcium, dissolved	52.89	ppm	0.20
WCL_07M	*	Potassium, dissolved	2.10	ppm	0.10
WCL_07M	*	Magnesium, dissolved	27.43	ppm	0.10
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	<6	ppb	6.00
WCL_07M	*	Barium, dissolved	188	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	10	ppb	5.00
WCL_07M	*	Iron, dissolved	21	ppb	9.00
WCL_07M	*	Manganese, dissolved	15	ppb	3.00
WCL_07M	*	Sodium, dissolved	27.04	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	10.55	ppm	0.20
WCL_02M	*	Ammonia-N	<0.100	ppm	0.10
WCM_05M	*	Total Nitrogen	3.4	ppm	0.50
WCL_08M	*	Total Phosphorus	37.0	ppb	10.00
WCL_07M	*	Phosphorus, dissolved	0.04	ppm	0.02
Approved By:		Anna Marie MacFarlane	Date:	October 12, 2017	
WCL_01M	*	Nitrate-N + Nitrite-N	3.4	ppm	0.20
Approved By:		Jackie Garnhum	Date:	September 11, 2017	
WCL_07M	*	Hardness	245.0		0.00
Approved By:		Lori Brine	Date:	November 07, 2017	

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
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End of Report

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PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170704001
Sample Point: Bryan Grimmelt
Sample Location: DMP-20170619
Date Sampled: June 19, 2017
Sampler: Alex Silva/Norm 3936461
Date Received: July 04, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Copper, dissolved	12	ppb	5.00
WCL_07M	*	Hardness	5.7		0.00
WCL_07M	*	Iron, dissolved	687	ppb	9.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Magnesium, dissolved	0.44	ppm	0.10
WCL_07M	*	Manganese, dissolved	230	ppb	3.00
WCL_07M	*	Phosphorus, dissolved	0.17	ppm	0.02
WCL_07M	*	Potassium, dissolved	0.17	ppm	0.10
WCL_07M	*	Sodium, dissolved	0.30	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	0.76	ppm	0.20
WCL_07M	*	Zinc, dissolved	17	ppb	6.00
WCL_07M	*	Barium, dissolved	41	ppb	2.00
WCL_07M	*	Calcium, dissolved	1.54	ppm	0.20
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
Approved By:		Jackie Garnhum	Date:	August 09, 2017	
WCL_01M	*	Chloride	2.1	ppm	1.00
WCL_01M	*	Nitrate-N + Nitrite-N	<0.2	ppm	0.20
WCL_01M	*	Alkalinity	<8.00	ppm of CaCO3/L	8.00
Approved By:		Lori Brine	Date:	July 13, 2017	
WCL_04M	*	pH for Water	6.7		0.00
Approved By:		Taylor Main	Date:	July 12, 2017	

Date of Analysis available upon request.

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PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170823006
Sample Point: Bryan Grimmelt
Sample Location: DMP-20170731
Date Sampled: July 31, 2017
Sampler: Alex Silva
Date Received: August 23, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_04M	*	pH for Water	7.1		0.00
WCL_01M	*	Alkalinity	<8.00	ppm of CaCO3/L	8.00
WCL_01M	*	Chloride	2.3	ppm	1.00
WCL_07M	*	Calcium, dissolved	2.37	ppm	0.20
WCL_07M	*	Potassium, dissolved	0.38	ppm	0.10
WCL_07M	*	Magnesium, dissolved	0.87	ppm	0.10
WCL_07M	*	Nickel, dissolved	<7	ppb	7.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Zinc, dissolved	21	ppb	6.00
WCL_07M	*	Barium, dissolved	38	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	41	ppb	5.00
WCL_07M	*	Iron, dissolved	958	ppb	9.00
WCL_07M	*	Manganese, dissolved	261	ppb	3.00
WCL_07M	*	Sodium, dissolved	1.09	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	1.01	ppm	0.20
WCL_02M	*	Ammonia-N	<0.100	ppm	0.10
WCM_05M	*	Total Nitrogen	2.2	ppm	0.50
WCL_08M	*	Total Phosphorus	294	ppb	10.00
WCL_07M	*	Phosphorus, dissolved	0.16	ppm	0.02
Approved By:		Anna Marie MacFarlane	Date:	October 12, 2017	
WCL_01M	*	Nitrate-N + Nitrite-N	<0.2	ppm	0.20
Approved By:		Jackie Garnhum	Date:	September 11, 2017	
WCL_07M	*	Hardness	9.5		0.00
Approved By:		Lori Brine	Date:	November 07, 2017	

Date of Analysis available upon request.

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PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170704006
Sample Point: Bryan Grimmelt
Sample Location: FMP-20170623
Date Sampled: June 23, 2017
Sampler: Alex Silva/Norm 3936461
Date Received: July 04, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Copper, dissolved	10	ppb	5.00
WCL_07M	*	Hardness	82.8		0.00
WCL_07M	*	Iron, dissolved	164	ppb	9.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Magnesium, dissolved	2.82	ppm	0.10
WCL_07M	*	Manganese, dissolved	209	ppb	3.00
WCL_07M	*	Phosphorus, dissolved	0.02	ppm	0.02
WCL_07M	*	Potassium, dissolved	1.17	ppm	0.10
WCL_07M	*	Sodium, dissolved	286.00	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	16.16	ppm	0.20
WCL_07M	*	Zinc, dissolved	7	ppb	6.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Barium, dissolved	82	ppb	2.00
WCL_07M	*	Calcium, dissolved	28.53	ppm	0.20
Approved By:		Jackie Garnhum	Date:	July 13, 2017	
WCL_01M	*	Chloride	464.4	ppm	1.00
WCL_01M	*	Alkalinity	70.5	ppm of CaCO3/L	8.00
WCL_01M	*	Nitrate-N + Nitrite-N	<0.2	ppm	0.20
Approved By:		Lori Brine	Date:	July 13, 2017	
WCL_04M	*	pH for Water	7.2		0.00
Approved By:		Taylor Main	Date:	July 12, 2017	

Date of Analysis available upon request.

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End of Report

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Conseil canadien des normes
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PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170704002
Sample Point: Bryan Grimmelt
Sample Location: GOP-20170619
Date Sampled: June 19, 2017
Sampler: Alex Silva/ Norm 3936461
Date Received: July 04, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Copper, dissolved	22	ppb	5.00
WCL_07M	*	Hardness	347.8		0.00
WCL_07M	*	Iron, dissolved	37	ppb	9.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Magnesium, dissolved	30.44	ppm	0.10
WCL_07M	*	Manganese, dissolved	6	ppb	3.00
WCL_07M	*	Phosphorus, dissolved	0.04	ppm	0.02
WCL_07M	*	Potassium, dissolved	5.98	ppm	0.10
WCL_07M	*	Sodium, dissolved	294.40	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	40.82	ppm	0.20
WCL_07M	*	Zinc, dissolved	10	ppb	6.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Barium, dissolved	102	ppb	2.00
WCL_07M	*	Calcium, dissolved	89.13	ppm	0.20
Approved By:		Jackie Garnhum	Date:	July 13, 2017	
WCL_01M	*	Chloride	542.4	ppm	1.00
WCL_01M	*	Alkalinity	181	ppm of CaCO3/L	8.00
WCL_01M	*	Nitrate-N + Nitrite-N	<0.2	ppm	0.20
Approved By:		Lori Brine	Date:	July 13, 2017	
WCL_04M	*	pH for Water	7.4		0.00
Approved By:		Taylor Main	Date:	July 12, 2017	

Date of Analysis available upon request.

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PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170823004
Sample Point: Bryan Grimmelt
Sample Location: GOP-20170731
Date Sampled: July 31, 2017
Sampler: Alex Silva
Date Received: August 23, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_04M	*	pH for Water	8.1		0.00
WCL_01M	*	Alkalinity	210	ppm of CaCO3/L	8.00
WCL_01M	*	Chloride	646.6	ppm	1.00
WCL_07M	*	Calcium, dissolved	163.40	ppm	0.20
WCL_07M	*	Potassium, dissolved	43.73	ppm	0.10
WCL_07M	*	Magnesium, dissolved	156.30	ppm	0.10
WCL_07M	*	Zinc, dissolved	<6	ppb	6.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M	*	Copper, dissolved	15	ppb	5.00
WCL_07M	*	Iron, dissolved	122	ppb	9.00
WCL_07M	*	Manganese, dissolved	568	ppb	3.00
WCL_07M	*	Nickel, dissolved	18	ppb	7.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Phosphorus, dissolved	0.09	ppm	0.02
WCL_02M	*	Ammonia-N	<0.100	ppm	0.10
WCM_05M	*	Total Nitrogen	<0.5	ppm	0.50
WCL_08M	*	Total Phosphorus	27.7	ppb	10.00
WCL_07M	*	Barium, dissolved	259	ppb	2.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
Approved By:		Anna Marie MacFarlane	Date:	October 12, 2017	
WCL_01M	*	Nitrate-N + Nitrite-N	<0.2	ppm	0.20
Approved By:		Jackie Garnhum	Date:	September 11, 2017	
WCL_07M	*	Sodium, dissolved	1241.00	ppm	0.20
WCL_07M	*	Hardness	1051.3		0.00
WCL_07M	*	Sulfate, calc from S diss	289.00	ppm	0.20
Approved By:		Lori Brine	Date:	November 07, 2017	

Date of Analysis available upon request.

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PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170704005
Sample Point: Bryan Grimmelt
Sample Location: HEP-20170621
Date Sampled: June 21, 2017
Sampler: Alex Silva/Norm 3936461
Date Received: July 04, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Copper, dissolved	8	ppb	5.00
WCL_07M	*	Hardness	251.5		0.00
WCL_07M	*	Iron, dissolved	19	ppb	9.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Magnesium, dissolved	26.70	ppm	0.10
WCL_07M	*	Manganese, dissolved	63	ppb	3.00
WCL_07M	*	Phosphorus, dissolved	0.03	ppm	0.02
WCL_07M	*	Potassium, dissolved	2.41	ppm	0.10
WCL_07M	*	Sodium, dissolved	60.57	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	13.78	ppm	0.20
WCL_07M	*	Zinc, dissolved	7	ppb	6.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Barium, dissolved	384	ppb	2.00
WCL_07M	*	Calcium, dissolved	56.71	ppm	0.20
Approved By:		Jackie Garnhum	Date:	July 13, 2017	
WCL_01M	*	Chloride	157.6	ppm	1.00
WCL_01M	*	Alkalinity	147	ppm of CaCO3/L	8.00
WCL_01M	*	Nitrate-N + Nitrite-N	0.8	ppm	0.20
Approved By:		Lori Brine	Date:	July 13, 2017	
WCL_04M	*	pH for Water	8.1		0.00
Approved By:		Taylor Main	Date:	July 12, 2017	

Date of Analysis available upon request.

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PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170704008
Sample Point: Bryan Grimmelt
Sample Location: JAP-20170627
Date Sampled: June 27, 2017
Sampler: Alex Silva/Norm 3936461
Date Received: July 04, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Copper, dissolved	35	ppb	5.00
WCL_07M	*	Hardness	219.3		0.00
WCL_07M	*	Iron, dissolved	20	ppb	9.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Magnesium, dissolved	23.70	ppm	0.10
WCL_07M	*	Manganese, dissolved	72	ppb	3.00
WCL_07M	*	Phosphorus, dissolved	0.02	ppm	0.02
WCL_07M	*	Potassium, dissolved	2.02	ppm	0.10
WCL_07M	*	Sodium, dissolved	24.77	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	7.86	ppm	0.20
WCL_07M	*	Zinc, dissolved	11	ppb	6.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Barium, dissolved	132	ppb	2.00
WCL_07M	*	Calcium, dissolved	48.76	ppm	0.20
Approved By:		Jackie Garnhum	Date:	July 13, 2017	
WCL_01M	*	Chloride	58.2	ppm	1.00
WCL_01M	*	Alkalinity	165	ppm of CaCO3/L	8.00
WCL_01M	*	Nitrate-N + Nitrite-N	5.1	ppm	0.20
Approved By:		Lori Brine	Date:	July 13, 2017	
WCL_04M	*	pH for Water	8.0		0.00
Approved By:		Taylor Main	Date:	July 12, 2017	

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Scope of Accreditation 424

Conseil canadien des normes
Laboratoire accrédité
Portée d'accréditation 424 TM

PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170704003
Sample Point: Bryan Grimmelt
Sample Location: LSP-170621
Date Sampled: June 21, 2017
Sampler: Alex Silva/Norm 3936461
Date Received: July 04, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Copper, dissolved	26	ppb	5.00
WCL_07M	*	Hardness	303.3		0.00
WCL_07M	*	Iron, dissolved	29	ppb	9.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Magnesium, dissolved	33.19	ppm	0.10
WCL_07M	*	Manganese, dissolved	45	ppb	3.00
WCL_07M	*	Phosphorus, dissolved	0.09	ppm	0.02
WCL_07M	*	Potassium, dissolved	2.66	ppm	0.10
WCL_07M	*	Sodium, dissolved	114.70	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	16.15	ppm	0.20
WCL_07M	*	Zinc, dissolved	20	ppb	6.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Barium, dissolved	304	ppb	2.00
WCL_07M	*	Calcium, dissolved	66.75	ppm	0.20
Approved By:		Jackie Garnhum	Date:	July 13, 2017	
WCL_01M	*	Chloride	217.1	ppm	1.00
WCL_01M	*	Alkalinity	192	ppm of CaCO3/L	8.00
WCL_01M	*	Nitrate-N + Nitrite-N	1.3	ppm	0.20
Approved By:		Lori Brine	Date:	July 13, 2017	
WCL_04M	*	pH for Water	7.7		0.00
Approved By:		Taylor Main	Date:	July 12, 2017	

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

Standards Council of Canada
Accredited Laboratory
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PEI Analytical Laboratories - Water Quality Test Report

23 Innovation Way, Charlottetown, PE C1E 0B7

Client Name: Holland College: Bryan Gimmelt
Sample Number: SW170704004
Sample Point: Bryan Grimmelt
Sample Location: MNP-20170621
Date Sampled: June 21, 2017
Sampler: Alex Silva/Norm 3936461
Date Received: July 04, 2017
Water Type: Surface Water - Fresh

Water Chemistry Results

(analysed at 23 Innovation Way)

Method ID		Parameter	Results	Units	Detection Limit
WCL_07M	*	Copper, dissolved	26	ppb	5.00
WCL_07M	*	Hardness	328.6		0.00
WCL_07M	*	Iron, dissolved	<9	ppb	9.00
WCL_07M	*	Lead, dissolved	<6	ppb	6.00
WCL_07M	*	Magnesium, dissolved	35.86	ppm	0.10
WCL_07M	*	Manganese, dissolved	38	ppb	3.00
WCL_07M	*	Phosphorus, dissolved	0.07	ppm	0.02
WCL_07M	*	Potassium, dissolved	2.77	ppm	0.10
WCL_07M	*	Sodium, dissolved	119.60	ppm	0.20
WCL_07M	*	Sulfate, calc from S diss	21.70	ppm	0.20
WCL_07M	*	Zinc, dissolved	17	ppb	6.00
WCL_07M	*	Cadmium, dissolved	<2	ppb	2.00
WCL_07M	*	Chromium, dissolved	<5	ppb	5.00
WCL_07M		Cobalt, dissolved	<2	ppb	2.00
WCL_07M	*	Barium, dissolved	425	ppb	2.00
WCL_07M	*	Calcium, dissolved	72.48	ppm	0.20
Approved By:		Jackie Garnhum	Date:	July 13, 2017	
WCL_01M	*	Chloride	253.4	ppm	1.00
WCL_01M	*	Alkalinity	185	ppm of CaCO3/L	8.00
WCL_01M	*	Nitrate-N + Nitrite-N	1.4	ppm	0.20
Approved By:		Lori Brine	Date:	July 13, 2017	
WCL_04M	*	pH for Water	7.9		0.00
Approved By:		Taylor Main	Date:	July 12, 2017	

Date of Analysis available upon request.

Legend: MPN = Most Probable Number
cfu/100 mls = colony forming unit per 100 millilitres
* = method accredited by Standards Council of Canada;
ppm = parts per million
Ammonia is equivelent to (Ammonia + Ammonium)-N
mg/L = milligrams per litre
nd = not detected; na = not analysed
ppb = parts per billion

End of Report

Attachment E

Tables

Table 1 *- Water Quality Testing Using the Biotic Index for macroinvertebrates found in 11 ponds in Charlottetown (available as an Excel spreadsheet via this OneDrive link:* https://1drv.ms/x/s!Aq6QB1bZs0e0gcUqsFlb8jHpweEhjw*)*

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
1st	GOP-20170619	Gastropoda		Physidae	19	8	152
				Lymnaeidae	1	6	6
		Insecta	Coleoptera	Dytiscidae	1	5	5
			Diptera	Tipulidae	8	3	24
				Chironomidae	8	8	64
			Onodata	Libellulidae	1	2	2
			Trichoptera	Limnephilidae	1	3	3
			Zygoptera	Coenagrionidae	5	8	40
		Malacostraca	Amphipoda	Gammaridae	3	6	18
				Total:	47		314
						FBI:	**6.68**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
2nd	GOP-20170710	Gastropoda		Physidae	7	8	56
		Insecta	Coleoptera	Dytiscidae	7	5	35
				Scirtidae	34	5	170
			Diptera	Chironomidae	7	8	56
				Ceratopogonidae	3	6	18
				Stratiomyidae	1	7	7
				Tipulidae	3	3	9
			Onodata	Aeshnidae	1	3	3
			Onodata	Libellulidae	1	2	2
				Total:	64	**Total:**	356
						FBI:	**5.56**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
3rd	GOP-20170731	Gastropoda		Physidae	4	8	32
		Insecta	Coleoptera	Dytiscidae	8	5	40
				Scirtidae	28	5	140
			Diptera	Stratiomyidae	2	7	14
				Chironomidae	5	8	40
				Total:	47		266
						FBI:	**5.66**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
1st	DMP-20170619	Insecta	Coleoptera	Dytiscidae	4	5	20
			Diptera	Chironomidae	66	8	528
				Stratiomyidae	1	7	7
			Onodata	Libellulidae	4	2	8
				Total:	75		563
						FBI:	**7.51**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
2nd	DMP-20170710	Insecta	Coleoptera	Scirtidae	37	5	185
				Dytiscidae	2	5	10
			Diptera	Chironomidae	26	8	208
				Ceratopogonidae	30	6	180
				Total:	95		583
						FBI:	**6.14**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
3rd	DMP-20170731	Insecta	Coleoptera	Scirtidae	21	5	105
				Dytiscidae	1	5	5
			Diptera	Chironomidae	15	8	120
				Ceratopogonidae	35	6	210
				Total:	72		440
						FBI:	**6.11**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
1st	LSP-20170621	Clitellata	Hirudinea		1	8	8
		Gastropoda		Hydrobiidae	12	6	72
				Planorbidae	6	7	42
		Insecta	Coleoptera	Dytiscidae	6	5	30
			Diptera	Ceratopogonidae	9	6	54
				Tipulidae	4	3	12
			Onodata	Aeshnidae	1	3	3
				Libellulidae	4	2	8
			Trichoptera	Limnephilidae	7	3	21
			Zygoptera	Coenagrionidae	16	8	128
				Total:	66		378
						FBI:	**5.73**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
2nd	LSP-20170712	Arachnida	Acariformes	Hydracarina	2	6	12
		Clitellata	Hirudinea		4	8	32
		Gastropoda		Hydrobiidae	2	6	12
				Planorbidae	6	7	42
		Insecta	Coleoptera	Dytiscidae	9	5	45
				Hydrophilidae	2	5	10
			Diptera	Tipulidae	1	3	3
				Chironomidae	18	8	144
			Hemiptera	Corixidae	1	5	5
				Gerridae	1	5	5
			Onodata	Aeshnidae	1	3	3
				Libellulidae	5	2	10
			Zygoptera	Coenagrionidae	12	8	96
				Total:	64		419
						FBI:	**6.55**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
3rd	LSP-20170802	Clitellata	Hirudinea		5	8	40
		Gastropoda		Hydrobiidae	15	6	90
				Planorbidae	7	7	49
		Insecta	Coleoptera	Dytiscidae	4	5	20
			Diptera	Tipulidae	1	3	3
				Chironomidae	3	8	24
				Ceratopogonidae	6	6	36
			Hemiptera	Corixidae	1	5	5
				Gerridae	2	5	10
			Onodata	Libellulidae		2	0
			Zygoptera	Coenagrionidae	3	8	24
				Total:	47		301
						FBI:	**6.40**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
1st	MNP-20170621	Arachnida	Acariformes	Hydracarina	27	6	162
		Gastropoda		Hydrobiidae	35	6	210
		Insecta	Diptera	Chironomidae	7	8	56
				Dixidae	1	1	1
			Hemiptera	Corixidae	89	5	445
			Onodata	Aeshnidae	1	3	3
			Zygoptera	Coenagrionidae	4	8	32
				Total:	164		909
						FBI:	**5.54**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
2nd	MNP-20170712	Arachnida	Acariformes	Hydracarina	26	6	156
		Clitellata	Hirudinea		2	8	16
		Gastropoda		Hydrobiidae	19	6	114
		Insecta	Coleoptera	Dytiscidae	5	5	25
			Diptera	Chironomidae	40	8	320
				Ceratopogonidae	18	6	108
			Hemiptera	Corixidae	60	5	300
			Trichoptera	Limnephilidae	1	3	3
			Zygoptera	Coenagrionidae	3	8	24
				Total:	174		1066
						FBI:	**6.13**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
3rd	MNP-20170802	Arachnida	Acariformes	Hydracarina	5	6	30
		Clitellata	Hirudinea		2	8	16
		Gastropoda		Hydrobiidae	6	6	36
		Insecta	Coleoptera	Dytiscidae	2	5	10
			Diptera	Chironomidae	32	8	256
			Hemiptera	Corixidae	37	5	185
			Zygoptera	Coenagrionidae	2	8	16
				Total:	86		549
						FBI:	**6.38**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
1st	HEP-20170621	Arachnida	Acariformes	Hydracarina	12	6	72
		Clitellata	Hirudinea		5	8	40
		Gastropoda		Physidae	2	8	16
		Insecta	Coleoptera	Hydrophilidae	4	5	20
			Diptera	Tipulidae	1	3	3
				Dixidae	1	1	1
			Trichoptera	Limnephilidae	16	3	48
			Zygoptera	Coenagrionidae	4	8	32
		Malacostraca	Amphipoda	Gammaridae	3	6	18
				Total:	48		250
						FBI:	**5.21**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
2nd	HEP-20170712	Arachnida	Acariformes	Hydracarina	2	6	12
		Clitellata	Hirudinea		4	8	32
		Gastropoda		Physidae	4	8	32
		Insecta	Coleoptera	Dytiscidae	1	5	5
			Coleoptera	Hydrophilidae	1	5	5
			Diptera	Ceratopogonidae	6	6	36
				Chironomidae	25	8	200
			Ephemroptera	Baetidae	2	5	10
			Hemiptera	Corixidae	2	5	10
				Belostomatidae	1	5	5
			Trichoptera	Limnephilidae	6	3	18
			Zygoptera	Coenagrionidae	3	8	24
		Malacostraca	Amphipoda	Gammaridae	4	6	24
				Total:	61		413
						FBI:	**6.77**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
3rd	HEP-20170802	Arachnida	Acariformes	Hydracarina	5	6	30
		Clitellata	Hirudinea		5	8	40
		Gastropoda		Physidae	5	8	40
		Insecta	Coleoptera	Hydrophilidae	8	5	40
			Diptera	Chironomidae	12	8	96
			Ephemroptera	Baetidae	16	5	80
			Hemiptera	Notonectidae	4	5	20
				Gerridae	1	5	5
				Total:	56		351
						FBI:	**6.27**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
1st	FMP-20170623	Gastropoda		Physidae	3	8	24
		Insecta	Diptera	Chironomidae	30	8	240
				Stratiomyidae	1	7	7
				Tipulidae	2	3	6
			Hemiptera	Corixidae	2	5	10
			Onodata	Libellulidae	1	2	2
			Zygoptera	Coenagrionidae	6	8	48
				Total:	45		313
						FBI:	**6.96**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
2nd	FMP-20170714	Insecta	Coleoptera	Scirtidae	2	5	10
				Dytiscidae	6	5	30
			Diptera	Chironomidae	20	8	160
				Ceratopogonidae	7	6	42
			Hemiptera	Notonectidae	4	5	20
			Onodata	Libellulidae	8	2	16
			Zygoptera	Coenagrionidae	4	8	32
				Total:	51		300
						FBI:	**5.88**

Id	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
3rd	FMP-20170804	Gastropoda		Physidae	2	8	16
		Insecta	Coleoptera	Dytiscidae	11	5	55
			Diptera	Culicidae	11	8	88
			Ephemroptera	Baetidae	5	5	25
			Hemptera	Veliidae	5	5	25
			Onodata	Libellulidae	3	2	6
			Zygoptera	Coenagrionidae	1	8	8
				Total:	38		223
						FBI:	**5.87**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
1st	ACP-20170623	Gastropoda		Physidae	5	8	40
		Insecta	Coleoptera	Dytiscidae	9	5	45
			Diptera	Tipulidae	2	3	6
			Ephemroptera	Caenidae	1	6	6
			Hemiptera	Corixidae	9	5	45
			Onodata	Libellulidae	4	2	8
				Aeshnidae	2	3	6
			Trichoptera	Limnephilidae	2	3	6
			Zygoptera	Coenagrionidae	17	8	136
				Total:	51		298
						FBI:	**5.84**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
2nd	ACP-20170714	Gastropoda		Physidae	17	8	136
		Insecta	Coleoptera	Dytiscidae	7	5	35
			Diptera	Chironomidae	10	8	80
			Ephemroptera	Caenidae	1	6	6
			Hemiptera	Corixidae	41	5	205
				Notonectidae	21	5	105
			Hemptera	Veliidae	3	5	15
			Onodata	Libellulidae	18	2	36
				Aeshnidae	10	3	30
			Trichoptera	Limnephilidae	3	3	9
			Zygoptera	Coenagrionidae	11	8	88
		Malacostraca	Amphipoda	Gammaridae	3	6	18
				Total:	145		763
						FBI:	**5.26**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
3rd	ACP-20170804	Arachnida	Acariformes	Hydracarina	17	6	102
		Clitellata	Hirudinea		4	8	32
		Gastropoda		Physidae	6	8	48
		Insecta	Coleoptera	Dytiscidae	6	5	30
			Diptera	Chironomidae	15	8	120
			Ephemroptera	Caenidae	31	6	186
			Hemiptera	Notonectidae	4	5	20
				Veliidae	11	5	55
			Onodata	Libellulidae	7	2	14
				Aeshnidae	5	3	15
			Zygoptera	Coenagrionidae	37	8	296
		Malacostraca	Amphipoda	Gammaridae	27	6	162
				Total:	170		1080
						FBI:	**6.35**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
1st	JAP-20170627	Clitellata	Hirudinea		1	8	8
		Gastropoda		Physidae	2	8	16
		Insecta	Coleoptera	Dytiscidae	11	5	55
			Diptera	Chironomidae	10	8	80
			Ephemroptera	Baetidae	3	5	15
		Malacostraca	Amphipoda	Gammaridae	1	6	6
				Total:	28		180
						FBI:	**6.43**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
2nd	JAP-20170718	Clitellata	Hirudinea		41	8	328
		Gastropoda		Physidae	5	8	40
		Insecta	Coleoptera	Dytiscidae	19	5	95
				Hydrophilidae	1	5	5
			Diptera	Chironomidae	35	8	280
				Tipulidae	2	3	6
			Hemptera	Gerridae	2	5	10
			Onodata	Aeshnidae	8	3	24
		Malacostraca	Amphipoda	Gammaridae	4	6	24
				Total:	117		812
						FBI:	**6.94**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
3rd	JAP-201708	Clitellata	Hirudinea		11	8	88
		Gastropoda		Physidae	11	8	88
		Insecta	Coleoptera	Dytiscidae	39	5	195
			Diptera	Chironomidae	10	8	80
			Ephemroptera	Baetidae	3	5	15
			Hemiptera	Corixidae	1	5	5
				Veliidae	15	5	75
			Onodata	Libellulidae	8	2	16
				Aeshnidae	30	3	90
			Trichoptera	Limnephilidae	8	3	24
			Zygoptera	Coenagrionidae	2	8	16
				Total:	138		692
						FBI:	**5.01**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
1st	BAP-20170627	Clitellata	Hirudinea		2	8	16
		Gastropoda		Hydrobiidae	31	6	186
				Planorbidae	26	7	182
		Insecta	Coleoptera	Haliphidae	42	5	210
			Diptera	Chironomidae	4	8	32
				Tipulidae	2	3	6
			Ephemroptera	Baetidae	5	5	25
			Onodata	Aeshnidae	1	3	3
			Trichoptera	Limnephilidae	4	3	12
			Zygoptera	Coenagrionidae	29	8	232
				Total:	146		904
						FBI:	**6.19**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
2nd	BAP-20170718	Arachnida	Acariformes	Hydracarina	5	6	30
		Gastropoda		Hydrobiidae	20	6	120
				Planorbidae	65	7	455
		Insecta	Coleoptera	Haliphidae	57	5	285
			Diptera	Chironomidae	35	8	280
				Tipulidae	4	3	12
			Ephemroptera	Baetidae	1	5	5
			Zygoptera	Coenagrionidae	9	8	72
				Total:	196		1259
						FBI:	**6.42**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
3rd	BAP-20170810	Gastropoda		Hydrobiidae	160	6	960
				Planorbidae	40	7	280
		Insecta	Coleoptera	Haliphidae	75	5	375
			Diptera	Tipulidae	3	3	9
			Hemiptera	Notonectidae	1	5	5
				Gerridae	3	5	15
			Trichoptera	Limnephilidae	2	3	6
			Zygoptera	Coenagrionidae	3	8	24
				Total:	287		1674
						FBI:	**5.83**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
1st	APN-20170629	Clitellata	Hirudinea		4	8	32
		Gastropoda		Physidae	27	8	216
		Insecta	Coleoptera	Hydrophilidae	1	5	5
				Dytiscidae	8	5	40
			Diptera	Chironomidae	15	8	120
			Onodata	Aeshnidae	1	3	3
			Trichoptera	Limnephilidae	9	3	27
			Zygoptera	Coenagrionidae	1	8	8
		Malacostraca	Amphipoda	Gammaridae	2	6	12
				Total:	68		463
						FBI:	**6.81**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
2nd	APN-20170719	Clitellata	Hirudinea		12	8	96
		Gastropoda		Physidae	27	8	216
		Insecta	Coleoptera	Dytiscidae	10	5	50
			Diptera	Chironomidae	7	8	56
				Tipulidae	2	3	6
			Onodata	Libellulidae	5	2	10
				Aeshnidae	1	3	3
			Zygoptera	Coenagrionidae	1	8	8
		Malacostraca	Amphipoda	Gammaridae	26	6	156
				Total:	91		601
						FBI:	**6.60**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
3rd	APN-20170808	Insecta	Hemiptera	Belostomatidae	1	5	5
		Arachnida	Acariformes	Hydracarina	5	6	30
		Clitellata	Hirudinea		1	8	8
		Gastropoda		Physidae	18	8	144
		Insecta	Coleoptera	Dytiscidae	35	5	175
				Haliplidae	6	5	30
			Diptera	Tipulidae	3	3	9
			Ephemroptera	Caenidae	15	6	90
			Hemiptera	Corixidae	2	5	10
			Onodata	Libellulidae	2	2	4
				Aeshnidae	10	3	30
			Zygoptera	Coenagrionidae	58	8	464
		Malacostraca	Amphipoda	Gammaridae	77	6	462
				Total:	233		1461
						FBI:	**6.27**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
1st	APS-20170629	Arachnida	Acariformes	Hydracarina	27	6	162
		Clitellata	Hirudinea		5	8	40
		Insecta	Coleoptera	Hydrophilidae	1	5	5
			Diptera	Tipulidae	2	3	6
			Ephemroptera	Caenidae	12	6	72
			Trichoptera	Limnephilidae	35	3	105
		Malacostraca	Amphipoda	Gammaridae	12	6	72
				Total:	94		462
						FBI:	**4.91**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
2nd	APS-20170719	Arachnida	Acariformes	Hydracarina	13	6	78
		Clitellata	Hirudinea		4	8	32
		Gastropoda		Physidae	46	8	368
		Insecta	Coleoptera	Dytiscidae	22	5	110
			Diptera	Tipulidae		3	0
			Ephemroptera	Caenidae	1	6	6
			Onodata	Aeshnidae	3	3	9
			Trichoptera	Limnephilidae	16	3	48
			Zygoptera	Coenagrionidae	1	8	8
		Malacostraca	Amphipoda	Gammaridae	27	6	162
				Total:	133		821
						FBI:	**6.17**

Round	Sample ID	Class	Subclass or Order	Family	Total	Tolerance value	Total x Tolerance
3rd	APS-20170808	Insecta	Hemiptera	Belostomatidae	1	5	5
		Arachnida	Acariformes	Hydracarina	11	6	66
		Gastropoda		Physidae	16	8	128
		Insecta	Coleoptera	Dytiscidae	16	5	80
			Diptera	Tipulidae	2	3	6
			Onodata	Libellulidae	1	2	2
				Aeshnidae	3	3	9
			Trichoptera	Limnephilidae	8	3	24
			Zygoptera	Coenagrionidae	2	8	16
				Total:	60		336
						FBI:	**5.60**

Table 2 - Surface Water Results in Comparison with the Canadian Environmental Quality Guidelines (available as an Excel spreadsheet via this OneDrive link: https://1drv.ms/x/s!Aq6QB1bZs0e0gcUqsFlb8jHpweEhjw)

Table 2 - Surface Water Results in Comparison with the Canadian Environmental Quality Guidelines

Parameter	Unit	Canadian Environmental Quality Guidelines (CEQG) CCME 2007	GOP-20170619	GOP-20170731	DMP-20170619	DMP-20170731	LSP-20170621	MNP-20170621	HEP-20170621	FMP-20170623	ACP-20170623	ACP-20170804	JAP-20170627	BAP-20170627	BAP-20170810	APN-20170629	APS-20170629
Copper,dissolved	µg/L	2 to 4 [1]	22	15	12	41	26	26	8	10	13	25	35	<5	10	9	6
Hardness	-	-	347.8	1051.3	5.7	9.5	303.3	328.6	251.5	82.8	36.6	43.1	219.3	231.4	245.0	240.2	223.9
Iron, dissolved	µg/L	300	37	122	687	958	29	<9	19	164	2027	1126	20	11	21	12	9
Lead, dissolved	µg/L	1 to 7 [2]	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
Magnesium, dissolved	mg/L	-	30.44	156.30	0.44	0.87	33.19	35.86	26.7	2.82	1.7	2.05	23.7	25.5	27.43	26.78	25.08
Manganese, dissolved	µg/L	-	6	568	230	261	45	38	63	209	2164	474	72	20	15	34	5
Phosphorus, dissolved	mg/L	-	0.04	0.09	0.17	0.16	0.09	0.07	0.03	0.02	0.13	0.15	0.02	0.03	0.04	<0.02	<0.02
Potassium, dissolved	mg/L	-	5.98	43.73	0.17	0.38	2.66	2.77	2.41	1.17	0.74	0.45	2.02	1.89	2.1	2.21	2.06
Sodium, dissolved	mg/L	-	294.4	1241.00	0.3	1.09	114.7	119.6	60.57	286	68.71	81.49	24.77	27.75	27.04	56.59	50.55
Sulfate, calc from S dissolved	mg/L	-	40.82	289	0.76	1.01	16.15	21.7	13.78	16.16	7.67	4.97	7.86	10.52	10.55	13.07	12.2
Zinc, dissolved	µg/L	30	10	<6	17	21	20	17	7	7	9	6	11	9	<6	8	6
Cadmium, dissolved	µg/L	0.09	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Chromium, dissolved	µg/L	8.9 (Chromium III)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	36	<6	<5	<5
Cobalt, dissolved	µg/L	-	<2	-	<2	-	<2	<2	<2	<2	<2	<2	<2	<2	-	<2	<2
Barium, dissolved	µg/L	-	102	259	41	38	304	425	384	82	59	49	132	245	188	239	214
Calcium, dissolved	mg/L	-	89.13	163.4	1.54	2.37	66.75	72.48	56.71	28.53	11.86	13.9	48.76	50.64	52.89	52.06	48.31
Chloride	mg/L	640 (short term)/120 (long term)	542.4	646.6	2.1	2.3	217.1	253.4	157.6	464.4	111	134.1	58.2	70	64.8	132.7	120.6
Alkalinity (as CaCO3)	mg/L	-	181	210	<8.00	<8.00	192	185	147	70.5	43.9	50.8	165	169	188	161	154
Nitrate-N + Nitrite-N	mg/L	-	<0.2	<0.2	<0.2	<0.2	1.3	1.4	0.8	<0.2	<0.2	<0.2	5.1	3.4	3.4	2.1	1.9
pH for Water	-	-	7.4	8.1	6.7	7.1	7.7	7.9	8.1	7.2	7.4	8.0	8.0	7.9	8.1	8.0	8.1

Note:

[1] CEQG guideline is hardness dependent: 2 µg/L at [CaCO3] = 0 to 120 mg/L, 3 µg/L at [CaCO3] = 120 to 180 mg/L, and 4 µg/L at [CaCO3] > 180 mg/L.

[2] CEQG guideline is hardness dependent: 1 µg/L at [CaCO3] = 0 to 60 mg/L; 2 µg/L at [CaCO3] = 60 to 120 mg/L; 4 µg/L at [CaCO3] = 120 to 180 mg/L; 7 µg/L at [CaCO3] > 180 mg/L.

AO - aesthetic objective

CEQG - Canadian Environmental Quality Guidelines

CCME - Canadian Council of Ministers of the Environment

Table 3- Sediment Results in Comparison with the Canadian Environmental Quality Guidelines (available as an Excel spreadsheet via this OneDrive link: https://1drv.ms/x/s!Aq6QB1bZs0e0gcUqsFlb8jHpweEhjw)

Table 3 - *Sediment Results in Comparison with the Canadian Environmental Quality Guidelines*

Analysis	Unit	CCME 2002 ISQG	CCME 2002 PEL	GOP-20170619	DMP-20170619	LSP-20170621	MNP-20170621	HEP-20170621	FMP-20170623	ACP-20170623	JAP-20170627	BAP-20170627	APN-20170629	APS-20170629
Dry Matter	%	-	-	95.6	98	99.29	99.25	89.95	95.94	97.67	91.08	97.74	99.8	99.64
Carbon	%	-	-	10.1	16.6	4.91	5	9.29	5.18	3.27	4.18	3.43	3.49	4.31
C:N Ratio		-	-	15.54	20.41	16.5	18.67	14.76	18.62	20.94	17.65	20.65	19.44	18.83
Nitrogen	%	-	-	0.65	0.81	0.3	0.27	0.63	0.28	0.16	0.24	0.17	0.18	0.23
Phosphorus	%	-	-	0.08	0.08	0.1	0.07	0.1	0.11	0.05	0.12	0.07	0.06	0.06
Potassium	%	-	-	0.12	0.06	0.09	0.06	0.11	0.15	0.07	0.06	0.04	0.07	0.06
Calcium	%	-	-	2.06	0.1	1.02	0.85	0.38	0.21	0.07	0.23	0.21	0.3	0.21
Magnesium	%	-	-	0.25	0.07	0.13	0.1	0.26	0.37	0.08	0.09	0.07	0.14	0.09
Cobalt	µg/g	-	-	0.0765	0.049	0.0794	0.0695	0.9	0.1727	0.0488	0.0638	0.0391	0.0798	0.0498
Chromium	µg/g	37.3	90.0	0.9082	0.294	0.4269	0.4069	1.853	3.78	0.3809	0.3916	0.3812	0.3194	0.3886
Copper	µg/g	35.7	197		3.82	2.84	2.99	3.78	5.25	0.94	1.08	1.01	0.97	2.4
Zinc	µg/g	123	315	116.78	168.77	65.37	53.94	188.45	120.46	42.02	70.48	47.46	50.28	69.57
Boron	µg/g	-	-	7.76	5.28	4.53	3.18	3.79	5.16	2.56	3.04	3.72	2.99	2.75
Iron	µg/g	-	-	3742.52	2354.13	5698.97	7039.9	6971.86	6575.79	3027.47	3796.65	2178.32	3470.59	2379.53
Manganese	µg/g	-	-	228.14	103.99	349.16	137.12	114.11	159.76	66.56	201.31	130.99	112.67	146.31
pH		-	-	7.45	4.86	7.25	7.37	6.87	6.04	6.33	6.99	7.61	7.07	7.04

Note:

ISQG - Interim Freshwater Sediment Quality Guidelines

PEL - Permissible Exposure Limit

Attachment F

Invasive Plants

Invasive Plant Survey - Isaac Fortune and Nicole Countway

Invasive Plants

Ponds studied within this project were checked for invasive plants. Area checked included the water, bank, and riparian zone, defined as 30ft from the water's edge. Invasive plants found were recorded and samples taken to be pressed.

Results found are as follow:

Dead Man's Pond

July 11, 2017

The water is 90-95% covered with non-native water lilies. There are small patches of glossy buckthorn scattered throughout the riparian zone. Also scattered in small patches throughout the riparian zone is bittersweet nightshade and hedge bindweed.

Government Pond

July 11, 2017

The pond in enclosed with cattails, with the inner 40% of the pond being clear, the outer 60% covered with cattails. There is one large patch of bittersweet nightshade at the water's edge, as well as smaller patches scattered around the banks. Small patches of curled dock are seen scattered around the pond. There is a maintained lawn 6m from the water line surrounding the entire pond.

Farmer's Market Pond

July 13, 2017

Approximately 100% of the pond is composed of cattails, it is very hard to see a defined pond shape, representing more of a wetland. Purple loosestrife is scattered in small patches around the pond. On the outskirts of the riparian zone, curled dock and hedge bindweed can be found.

Ag Canada Ponds

July 13, 2017

The water is 60% covered with non-native water lilies. There is purple loosestrife growing in scattered around the water's edge. The ponds are enclosed with cattails. There is a maintained lawn surrounding the pond.

MacNeil's Pond

July 13, 2017

Purple loosestrife is scattered along the banks. There are large patches of glossy buckthorn throughout the riparian zone. Some of the buckthorn patches are composed of large trees, no longer a shrub-sized plant. There are patches of bittersweet nightshade scattered around the pond. Towards the head of the pond, there are larger patches. Near the outlet of the pond, area closest to Queen's Arm Intersection, there is a small patch of cattails.

Hermitage Pond

July 20, 2017

There is a small amount of purple loosestrife scattered throughout the riparian zone. 90% of the bank is bordered by cattails. The head of the pond has large patches of glossy buckthorn and bittersweet nightshade.

Wright's Creek

July 25, 2017

Along the creek are scattered patches of glossy buckthorn and purple loosestrife. There are also small bunches of cattails in the water. There are sections of the creek which have large patches of small balsam in the riparian zone.

Jardine's Pond

July 25, 2017

Scattered throughout the riparian zone is purple loosestrife and small balsam.

Barbour's Pond

July 25, 2017

Scattered throughout the riparian zone is glossy buckthorn and purple loosestrife. There are small clusters of cattails in the water.

Andrew's Pond North

July 25, 2017

There are small clumps of cattails along the banks of the water. Scattered throughout the riparian zone, there are small clusters of bittersweet nightshade, glossy buckthorn, and purple loosestrife. There is also a small stream leading into the pond which is being chocked off by watercress.

Andrew's Pond South

July 25, 2017

Scattered throughout the riparian zone, there are small clusters of glossy buckthorn and purple loosestrife. There are patches of bittersweet nightshade scattered along the shore of the pond. There are also small patches of cattails throughout the pond. There was one multiflora rose seen, although it was outside of the tested area.

Hazards Creek (including the Lower Slick's Pond)

July 31, 2017

The part of the creek on the side of Highway 2 near Princess Auto had cattails growing along the banks. There was a small amount of bittersweet nightshade scattered throughout the site, as well as glossy buckthorn at the far end.

Majority of the creek is on the other side of Highway 2. At the section of creek closest to Highway 2 there is a small patch of multiflora rose. There is also a section where small balsam lines the banks. Scattered throughout the entire creek is bittersweet nightshade and hedge bindweed. There was a single wild cucumber found about half way through the survey. Close to MacNeil's Pond cattails begin appearing in small patches, until they eventually cover the entire waterway. There is glossy buckthorn found throughout the riparian zone for the entire length of the creek.