



September 3, 2020

Attention: Eric King, CPA, CGA, Chief Administrative Officer, Town of Niverville.

RE: Assessment of the water quality at the Fifth Avenue Estate lakes

Dear Mr. King,

The intent of this letter report is to summarize the findings of our assessment of the water quality of three lakes at the Fifth Avenue Estate in Niverville (Figure 1). Our assessment involved a visual inspection of the lakes on August 10 and August 21 as well as a water quality sampling campaign on August 21.

In addition to providing the results and a summary of our assessment this letter report also provides general recommendations on how to improve water quality in the lakes.

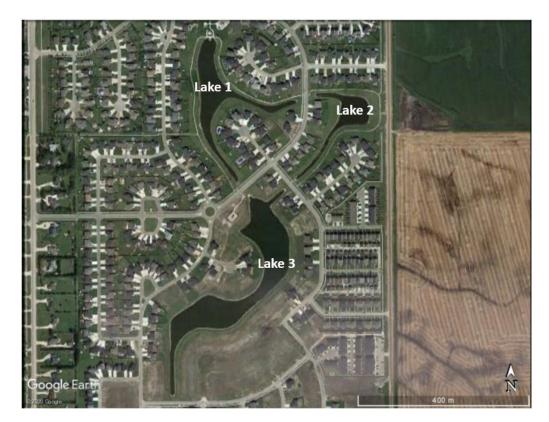


Figure 1. Fifth Avenue Estate lakes included in the water quality assessment.

Visual inspection

On August 10 and 21, 2020 two water quality specialists from Native Plant Solutions (NPS) conducted a visual inspection of the lakes and recorded the vegetation communities present (Table 1).

Community	Photos	Comments
Blue green algae (Cyanobacteria)	<image/>	 Blue green algae can occur in high concentrations referred to as blue green algal blooms. Blue green algal blooms are common in systems with elevated phosphorus levels. Blue green algal blooms present human and pet health concerns as some species produce toxins. Blue green algal blooms are unsightly and produce unpleasant odours when they decompose. Decomposing blue green algal blooms reduce dissolved oxygen levels in lakes resulting in the loss of species sensitive to low oxygen levels.

Table 1. Vegetation communities observed at Fifth Avenue Lakes (August 2020).

Table 1. continued ...

Community	Photos	Comments
Community Green algal mats	<section-header></section-header>	 Some green algal mats originate on the lake sediments and float to the water surface under certain environmental conditions such as warm weather. Other types of green algal mats are composed of free-floating species that occur at or just below the water surface. Green algal mats do not produce toxins. In lakes with elevated nutrient levels green algal mats can be prolific and are often considered to be a nuisance as they are unsightly and produce an odour upon decay. Green algal communities develop in waterbodies when
		no other mechanisms for nutrient uptake exist (e.g., uptake via emergent wetland vegetation).

Table 1. continued...

Community	Photos	Comments
Duckweed (Lemna spp.)	<image/>	 Duckweed occurs floating on the surface of water bodies. High nutrient concentrations and calm water can result in excessive duckweed cover. Wind and water action can cause the accumulation of dense layers of duckweed along the shoreline. Dense layers of duckweed shade lake sediments and can limit the growth of submergent and emergent vegetation.

Table 1. continued ...

Community	Photos	Comments
Submergent vegetation		 Submergent vegetation grows from the sediment of aquatic environments up through the water column to the water surface. Optimum depth range for submergent vegetation is between 50 and 200 cm. Submergent vegetation provides habitat for a wide variety of aquatic invertebrates.
(pond weed)		

Table 1. continued...

Community	Photos	Comments
Emergent vegetation (cattail and bulrush)	<image/>	 Emergent vegetation grows from the sediment of aquatic environments through the water column and extends above the water surface. Optimum depth for emergent vegetation is 30 to 50 cm. Emergent vegetation can remove nutrients from the water and store the nutrients within both above and below ground compartments.

Water quality assessment

On August 21 composite water quality samples were collected from each of the lakes (Figure 2). Lakes 1 and 2 were sampled at 4 locations and Lake 3, due to its larger size was sampled at 8 locations. At each location water samples were collected from shore using an extendable water sampling pole (Figure 3). One composite sample from each lake was then submitted to the ALS Environmental laboratory in Winnipeg for analysis of the parameters listed in Table 2. The water quality results along with a commentary on the health of the lakes are presented in the Table 3. See Appendix A for the full laboratory report from ALS.



Figure 2. Water quality sampling locations.



Figure 3. Water sampling from shore with extendable pole.

Parameter	Rationale
Total phosphorous	Plant nutrient
Dissolved ortho phosphate	Form of phosphorus most readily available for algal growth
Total nitrogen	Plant nutrient
Ammonia	Plant nutrient
Total suspended solids	Indicator of sediment flow into lakes
Chlorophyll <i>a</i>	Indicator of suspended algal levels in the water column
Blue green algae – cell	Counts in the lakes can be compared to the Canadian guideline for
count	recreational water quality
Fecal coliform	Counts in the lakes can be compared to the Provincial guideline for
	recreational water quality
Conductivity	Environmental variable that influences plant growth
pH	Environmental variable that influences plant growth

Parameter	Lake	Value	Guideline	Comment
	1	0.370		Lakes are in the hypereutrophic range (TP
Total phosphorous	2	0.638	0.1 ^A	> 0.1 mg/L).
(mg/L)	3	1.070		
	1	0.072	NA	A high percentage (20 to 70%) of the total
Dissolved ortho	2	0.371		phosphorus in the lakes is dissolved ortho
phosphate (mg/L)	3	0.749		phosphate which is the form that is most
				readily available for plant growth.
	1	2.66	$2 \text{ to } 6^{\text{B}}$	Lakes had TN concentrations typical of
Total nitrogen (mg/L)	2	2.41		aquatic environments in agricultural
	3	2.34		watersheds.
	1	0.072	0.55 ^C	Lakes had ammonia concentrations below
Ammonia (mg/L)	2	0.432		the Provincial guideline for the protection
	3	0.161		of aquatic life.
	1	15.8		Lakes had TSS concentrations below the
Total suspended solids	2	10.6	25 ^C	Provincial guideline for the protection of
(mg/L)	3	14.8		aquatic life.
	1	41.4		Lakes had chlorophyll <i>a</i> concentrations
Chlorophyll a (µg/L)	2	44.4	30 ^D	typical of hypereutrophic systems
	3	51.1		experiencing blue-green algae blooms
	1	306,000	100,000 ^E	Lakes exceeded the Federal guideline for
Blue green algae	2	234,000		blue-green algae cell counts for
(cells/mL)	3	541,000		recreational water use.
	1	17	200 ^C	Lakes had fecal coliform concentrations
Fecal coliform (MPN/100	2	10		below the Provincial guideline for
mL)	3	16		recreational water use.
	1	8.86		Slightly alkaline pH in the lakes may be
pH (pH units)	2	8.91	NA	due in part to the effects of algal blooms as
	3	8.74		photosynthesis removes the slightly acidic
				carbon dioxide from the water column.
	1	2,720		Lakes are within the oligosaline range
Conductivity (µmhos/cm)	2	1,600	NA	(800-8000 µmhos/cm)
	3	1,390		

Table 3. August 21, 2020 water quality results for Fifth Avenue Estate lakes.

^ACanadian Council of Ministers of the Environment 2004. Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems.

^BUnited States Environmental Protection Agency 2011. Nitrogen and phosphorus in agricultural streams. Report on the Environment.

^CManitoba Water Stewardship 2011. Manitoba Water Quality Standards, Objectives and Guidelines.

^DKansas Department of Health and Environment 2015. Blue Green Algae.

^EGovernment of Canada 2012. Guidelines for Canadian Recreational Water Quality. Third Edition.

Summary of the water quality assessment

The Fifth Avenue Estate lakes have phosphorus levels that are in the hypereutrophic range for lakes (> 0.1 mg/L). Much of the phosphorus (20 to 70%) that occurs in the lakes exists as dissolved orthophosphate which is the form of phosphorus most available for plant growth. The lakes have limited aquatic emergent vegetation, such as cattail and bulrush, to take up the phosphorus. As such the nutrient is readily available to the other vegetation communities.

Blue green algae take advantage of elevated phosphorus levels given their rapid cell doubling time compared to other vegetation communities. This has resulted in blue green algae levels in the lakes that exceed the federal guideline for recreational waters. Blue green algae levels above the federal guidelines present human and pet health risks.

Recommendations

Given the associated health risks of blue green algae and their aesthetically unpleasing nature the Town of Niverville should consider strategies to address the high blue green algal levels within the Fifth Avenue Estate lakes.

The Town should consider a bi-weekly water quality monitoring program that measures blue green algae cell counts. When federal blue green algae guidelines are exceeded the Town should initiate a public advisory on their website as well as post signs at the lakes to warn visitors of the risks of exposure to the lake water (Figure 4).



Figure 4. An example of information that could be included in a public advisory.

If no action is taken to limit nutrient availability in the lakes, they will continue to regularly experience blue green algae blooms during the summer months. It is possible that this condition will worsen in future years. One strategy to limit nutrient availability is to reduce nutrients entering the lakes via surface runoff. During our visual assessment we noted that many properties upslope of the lakes have manicured lawns which most likely receive fertilizer inputs (Figure 5). Following rain events nutrients from fertilizers applied to lawns can be carried away in surface runoff and enter the lakes. One way to address this issue is to have a public education campaign calling for a reduction in lawn fertilizer use.

Another approach to addressing nutrient runoff is to install native grasses in the uplands surrounding the lakes (Figure 6). The dense thatch and deep root structures of native upland grasses would provide water quality improvement before surface runoff water enters the lakes, and in most cases they would support improved water infiltration before overland runoff ever reaches the lakes.



Figure 5. Manicured lawns (right side of photo) upslope of Fifth Avenue Estate lakes.



Figure 6. Native grasses upslope of a naturalized stormwater pond in Winnipeg.

The Fifth Avenue Estate lakes currently have minimal emergent vegetation (Figure 7). This is due to the lakes contours that do not provide the required depths for emergent vegetation growth. Emergent vegetation can reduce nutrient loads in water through nutrient uptake and storage in above and below ground compartments. The Fifth Avenue Estate lakes could be retrofitted with re-contoured basins that provide benches with optimum depths to support emergent vegetation (Figures 8 and 9).

Once established, naturalized stormwater ponds require minimum maintenance and provide water quality benefits for many years. For example, a recent study demonstrated that a naturalized stormwater pond in Winnipeg continues to have healthier algal communities and better water quality than a conventional pond more than 15 years post construction (Figures 10 and 11).

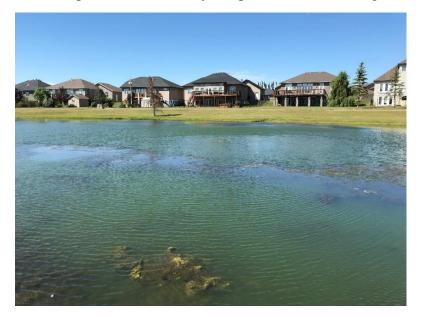


Figure 7. Fifth Avenue Estate lake with minimal emergent vegetation along the shoreline.

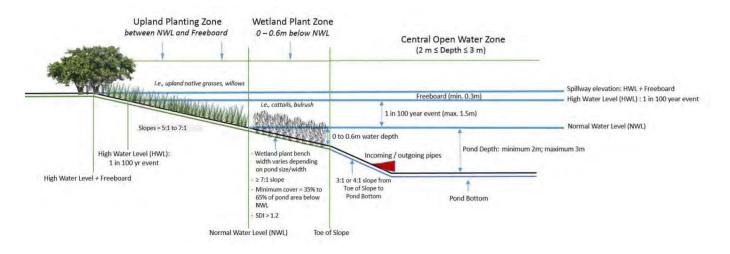


Figure 8. Profile of a naturalized stormwater pond.



Figure 9. Emergent vegetation in a naturalized retrofit of a conventional stormwater pond in Winnipeg during the first year of vegetation establishment.



Figure 10. Algal biomass retained on crucible filters for a conventional stormwater pond (top) and a naturalized stormwater pond (bottom) 17 years post-construction¹.

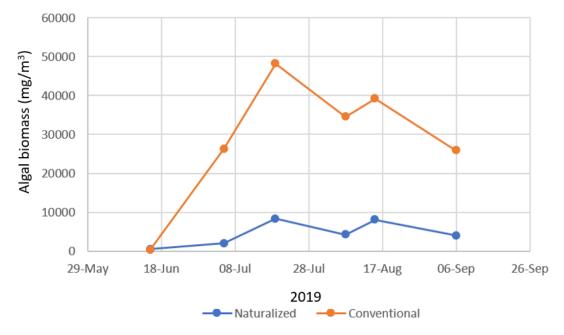


Figure 11. Algal biomass in a conventional stormwater pond and a naturalized stormwater pond¹.

¹Singh, VJ. 2020. Evaluation of the efficiency of a naturalized stormwater retention basin. Master of Engineering Report, Civil Engineering, University of Manitoba.

Closing

Naturalization of the Fifth Avenue Estate lakes will provide a long-term solution to the lakes' water quality issues. NPS has expertise and experience in naturalized retrofits of conventional stormwater lakes. If the Town wishes to pursue naturalized retrofits of its Fifth Avenue Estate lakes, NPS would be happy to discuss next steps for moving forward.

Should you have questions regarding this letter report or require further information regarding its content please feel free to give me a call to discuss.

Sincerely,



Bruce Friesen-Pankratz Wetland Specialist Native Plant Solutions Phone: 204-304-0242 / Email: b_friesen-pankratz@ducks.ca Appendix A. Water quality report from ALS.



Native Plant Solutions ATTN: NICHOLSON JEKE Unit A - 1238 Chevrier Blvd Winnipeg MB R3T 1Y3

Date Received: 21-AUG-20 Report Date: 31-AUG-20 14:49 (MT) Version: FINAL

Client Phone: 204-953-8214

Certificate of Analysis

Lab Work Order #: L2492507 Project P.O. #: Job Reference: C of C Numbers: Legal Site Desc:

NOT SUBMITTED TOWN OF NIVERVILLE

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Hua Wo Chemistry Laboratory Manager [This report shall not be reproduced except in full without the written authority of the Laboratory.]

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BIGHT SOLUTIONS BIGHT PARTDER

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Enumeration of blue green algae cells Total oyanobacterial cell count 308000 1 cells/mL cells/mL cells/mL 25-AUG-20 R5200457 Anbaaren (Cyanophyceae) 2680 1 cells/mL cells/mL 25-AUG-20 R5200457 Microcystis (Cyanophyceae) 89100 1 cells/mL cells/mL 25-AUG-20 R5200457 Panktothrik (Cyanophyceae) 143000 1 cells/mL 25-AUG-20 R5200457 Piseudanabaena (Cyanophyceae) 1230 1 cells/mL 25-AUG-20 R5200457 Nitrate in Water by IC Nitrate (as N) <0.40	Total Suspended Solids	15.8		3.0	mg/L		26-AUG-20	R5204525
Total gyanobacterial cell count 306000 1 cells/mL 225-AUG-20 R5200457 Anabaena (Cyanophyceae) 2480 1 cells/mL 25-AUG-20 R5200457 Aphanothee (Cyanophyceae) 89100 1 cells/mL 25-AUG-20 R5200457 Microsystis (Cyanophyceae) 89100 1 cells/mL 25-AUG-20 R5200457 Pseudanabaena (Cyanophyceae) 2230 1 cells/mL 25-AUG-20 R5200457 Nitrote in Water by IC Nitrate in Water by IC nells/mL 25-AUG-20 R5199622 Nitrate and Nitrite as N <0.40	pH	8.86		0.10	pH units		26-AUG-20	R5202496
Anabaena (Cyanophyceae) 2480 1 cells/mL 25AUG-20 R5200457 Aphanothece (Cyanophyceae) 69300 1 cells/mL 25AUG-20 R5200457 Microcysits (Cyanophyceae) 89100 1 cells/mL 25AUG-20 R5200457 Piseudanabaena (Cyanophyceae) 14000 1 cells/mL 25AUG-20 R5200457 Nitrogen Total 0 1 cells/mL 25AUG-20 R5200457 Nitrate in Water by IC Nitrate and Ninfle as N <0.45								
Aphanothese (Cyanophyceae) 68300 1 cells/mL 25-AUG-20 R5200457 Microcystis (Cyanophyceae) 143000 1 cells/mL 25-AUG-20 R5200457 Pseudanabaena (Cyanophyceae) 2230 1 cells/mL 25-AUG-20 R5200457 Nitrogen Total Nitrate (nw Water by IC 0 0 0 0 0 1 cells/mL 25-AUG-20 R5200457 Nitrate (ns N) <0.40								
Microsystis (Cyanophyceae) 89100 1 cells/mL 25-AUG-20 R5200467 Planktothrik (Cyanophyceae) 143000 1 cells/mL 25-AUG-20 R5200467 Nitrogen Total 23-AUG-20 25-AUG-20 R5200467 R5200467 Nitrate in Water by IC 0.40 DLM 0.40 mg/L 21-AUG-20 R5109622 Nitrate and Nitrite as N <0.45								
Planktothrik (Cyanophyceae) 143000 1 cells/mL 25AUG-20 R5200477 Pseudanabaena (Cyanophyceae) 2230 1 cells/mL cells/mL 25AUG-20 R5200457 Nitrogen Total Nitrate (as N) <0.40								
Pseudanabaena (Cyanophyceae) 10000 1 cells/mL 25AUG-20 R5200457 Nitrogen Total Nitrate in Water by IC 0.40 mg/L 21-AUG-20 R5199622 Nitrate in Water by IC Nitrate ANItrite 0.45 mg/L 25-AUG-20 R5199622 Nitrate ANItrite as N <0.45								
Nitrogen Total Lico I Lico I <thlico< th=""> Lico <thlico< th=""> <thl< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>110200101</td></thl<></thlico<></thlico<>								110200101
Nitrate in Water by IC Nitrate (as N) <		2230			Cenanne		20710020	10200407
Nitrate (as N) -0.40 DLM 0.40 mg/L 21-AUG-20 R5198622 Nitrate +Nitrite Nitrate a Nitrite as N -0.45 0.45 mg/L 25-AUG-20 25-AUG-20 R5198622 Nitrite (as N) -0.20 DLM 0.20 mg/L 21-AUG-20 R5198622 Total Kjeldahl Nitrogen -0.26 DLM 0.20 mg/L 25-AUG-20 R5198622 Total Kjeldahl Nitrogen 2.68 0.45 mg/L 25-AUG-20 R5201197 Total Nitrogen Calculated Total Nitrogen 2.68 0.45 mg/L 25-AUG-20 R5201197 Sampled By: CLIENT on 21-AUG-20 (g) 11:30 Matric WATER 0.10 ug/L 24-AUG-20 R5203472 Fecal Coliforms and E Coli by QT97 E. ooli by QT97 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms and E Coli by QT97 10 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms and E Coli by QT97 0.010 mg/L 27-AUG-20 R5197068 Miscellaneous Paramete								
Nitrate and Nitrite as N <0.45 0.45 mg/L 25-AUG-20 Nitrite (as N) <0.20		<0.40	DLM	0.40	mg/L		21-AUG-20	R5199622
Nitrite in Water by IC Nitrite (as N) cl. C DLM	Nitrate+Nitrite				-			
Nitrite (as N) < <0.20 DLM 0.20 mg/L 21-AUG-20 R5199622 Total Kjeldahi Nitrogen 2.68 0.20 mg/L 25-AUG-20 26-AUG-20 R5201197 Total Kjeldahi Nitrogen 2.68 0.45 mg/L 25-AUG-20 26-AUG-20 R5201197 L2492507-2 LAKE 2 Sampled By: CLIENT on 21-AUG-20 (@ 11:30 mg/L 26-AUG-20 26-AUG-20 26-AUG-20 R5203472 Chlorophyll a WATER Chlorophyll a by fluorometry R5107087 R5203472 R5107087 R5107087 Fecal Coliforms and E Coli by QT97 8 1 MPN/100mL 21-AUG-20 R5107087 Fecal Coliforms py MPN QT97 8 1 MPN/100mL 21-AUG-20 R5197088 Miscellaneous Parameters 0 1 MPN/100mL 21-AUG-20 R5197088 Ammonia, Total (as N) 0.432 0.010 mg/L 26-AUG-20 R5203489 Orthophosphate-Dissolved (as P) 0.371 OPF 0.0030 mg/L 26-AUG-20 R520348	Nitrate and Nitrite as N	<0.45		0.45	mg/L		25-AUG-20	
Total Kjeldahl Nitrogen Total Nitrogen Calculated Total Nitrogen Calculated Total Nitrogen Calculated Total Nitrogen 2.68 0.20 mg/L 25-AUG-20 28-AUG-20 R5201197 Izde Version 2.68 0.45 mg/L 25-AUG-20 28-AUG-20 R5201197 Izde Version 2.68 0.45 mg/L 25-AUG-20 28-AUG-20 R5201197 Izde Version 2.68 0.45 mg/L 25-AUG-20 28-AUG-20 R5203472 Izde Version WATER Value 44.4 0.10 ug/L 24-AUG-20 R5203472 Fecal Coliforms and E Coli by QT97 E-coli by QT97 8 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms by MPN QT97 8 1 MPN/100mL 21-AUG-20 R5197068 Miscellaneous Parameters 10 1 MPN/100mL 21-AUG-20 R5197068 Miscellaneous Parameters 0.371 0PF 0.0030 mg/L 28-AUG-20 R5203489 Onthophosphate-Dissolved (as P) 0.371 0PF 0.0030 mg/L <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>								
Total Kjeldahi Nitrogen 2.68 0.20 mg/L 25-AUG-20 28-AUG-20 R5201197 Total Nitrogen Calculated Total Nitrogen 2.68 0.45 mg/L 26-AUG-20 28-AUG-20 85203472 Fecal Coliforms and E Coli by QT97 44.4 0.10 ug/L 24-AUG-20 R5197087 R5197087 R5197087 R5197087 R5197087 R5197087 R5197088		<0.20	DLM	0.20	mg/L		21-AUG-20	R5199622
Total Nitrogen Calculated Total Nitrogen Description Description <thdescription< th=""> Description</thdescription<>		2.68		0.20	mo/l	25 41 6 20	26 ALIG 20	B5201107
Total Nitrogen 2.66 0.45 mg/L 28-AUG-20 L2492507-2 LAKE 2 Sampled By: CLIENT on 21-AUG-20 @ 11:30 Matrix: WATER WATER Value Val		2.00		0.20	mgr	20-A00-20	20-A00-20	Rozurrar
L2492507-2 LAKE 2 Sampled By: CLIENT on 21-AUG-20 (@) 11:30 Matrix: WATER Chlorophyll a Chlorophyll a by fluorometry Chlorophyll a 44.4 0.10 ug/L Fecal Coliforms and E Coli by QT97 E. coli by QT97 Escherichia Coli Fecal Coliforms Fecal Coliforms 10 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms 10 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms 10 1 Miscellaneous Parameters Ammonia, Total (as N) Conductivity Orthophosphate-Dissolved (as P) Phosphorus (P)-Total Total Suspended Solids PH 8.91 0.10 PH 8.91		2.66		0.45	ma/L		26-AUG-20	
Sampled By: CLIENT on 21-AUG-20 @ 11:30 Matrix: WATER Chlorophyll a Water Fecal Coliforms and E Coli by QT97 Add E. coli by QT97 8 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms 10 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms 00 0.432 0.010 mg/L 21-AUG-20 R5197068 Miscellaneous Parameters 0 0.371 OPF 0.010 mg/L 27-AUG-20 R5203489 Conductivity 1600 0.0371 OPF 0.0300 mg/L 26-AUG-20 R5201088 Phosphorus (P)-Total 0.635 10.6 3.0 mg/L 26-AUG-20 R5201116 Total Suspended Solids 10.6 8.91 0.10 <td>L2492507-2 LAKE 2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	L2492507-2 LAKE 2							
Matrix: WATER Chlorophyll a Chlorophyll a by fluorometry Chlorophyll a by fluorometry Chlorophyll a 44.4 0.10 ug/L 24-AUG-20 24-AUG-20 R5203472 Fecal Coliforms and E Coli by QT97 E. coli by QT97 Escherichia Coli 8 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms by MPN QT97 Fecal Coliforms 10 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms by MPN QT97 Fecal Coliforms 10 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms 00 10 1 MPN/100mL 21-AUG-20 R5197068 Miscellaneous Parameters 0.432 0.010 mg/L 27-AUG-20 R5203489 Conductivity 1600 0.371 OPF 0.0030 mg/L 26-AUG-20 R5201088 Phosphorus (P)-Total 0.635 10.6 3.0 mg/L 26-AUG-20 R5201116 Total Suspended Solids 10.6 8.91 0.10 pH units 26-AUG-20 R5202496								
Chlorophyll a Chlorophyll a by fluorometry Chlorophyll a by fluorometry Chlorophyll a 44.4 0.10 ug/L 24-AUG-20 24-AUG-20 R5203472 Fecal Coliforms and E Coli by QT97 E. coli by QT97 Escherichia Coli 8 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms by MPN QT97 Fecal Coliforms 10 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms 10 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms 10 1 MPN/100mL 21-AUG-20 R5197068 Miscellaneous Parameters 0.010 0.432 0.010 mg/L 27-AUG-20 R5203489 Conductivity 1600 0.371 OPF 0.0030 mg/L 26-AUG-20 R5201088 Phosphorus (P)-Total 0.635 10.6 3.0 mg/L 26-AUG-20 R5201116 Total Suspended Solids 10.6 3.0 mg/L 26-AUG-20 R5204825 pH 8.91 0.10 pH units 26-AUG-20 R5202496								
Chlorophyll a by fluorometry Chlorophyll a 44.4 0.10 ug/L 24-AUG-20 24-AUG-20 R5203472 Fecal Coliforms and E Coli by QT97 E. coli by QT97 8 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliform by MPN QT97 8 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliform by MPN QT97 10 1 MPN/100mL 21-AUG-20 R5197068 Miscellaneous Parameters 10 1 MPN/100mL 21-AUG-20 R5197068 Conductivity 0.432 0.010 mg/L 27-AUG-20 R5203492 Orthophosphate-Dissolved (as P) 0.371 OPF 0.0030 mg/L 26-AUG-20 R5203689 Phosphorus (P)-Total 0.635 10.6 3.0 mg/L 26-AUG-20 R5201116 Total Suspended Solids 10.6 3.0 mg/L 26-AUG-20 R5204525 pH 8.91 0.10 pH units 26-AUG-20 R5202496								
Fecal Coliforms and E Coli by QT97 8 1 MPN/100mL 21-AUG-20 R5197067 E. coli by QT97 Escherichia Coli 8 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliform by MPN QT97 Fecal Coliforms 10 1 MPN/100mL 21-AUG-20 R5197068 Miscellaneous Parameters 10 1 MPN/100mL 21-AUG-20 R5203689 Conductivity 0.432 0.010 mg/L 27-AUG-20 R5203689 Conductivity 1600 1.0 umhos/cm 26-AUG-20 R5203689 Orthophosphate-Dissolved (as P) 0.371 OPF 0.0030 mg/L 26-AUG-20 R5201088 Phosphorus (P)-Total 0.635 0.0030 mg/L 28-AUG-20 R5201116 Total Suspended Solids 10.6 3.0 mg/L 28-AUG-20 R5204625 pH 8.91 0.10 pH units 28-AUG-20 R5202496								
E. coli by QT97 8 1 MPN/100mL 21-AUG-20 R5197067 Escherichia Coli 8 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliforms 10 1 MPN/100mL 21-AUG-20 R5197068 Miscellaneous Parameters 10 1 MPN/100mL 21-AUG-20 R5197068 Ammonia, Total (as N) 0.432 0.010 mg/L 27-AUG-20 R5203689 Conductivity 1600 1.0 umhos/cm 26-AUG-20 R5203689 Orthophosphate-Dissolved (as P) 0.371 OPF 0.0030 mg/L 25-AUG-20 R5201088 Phosphorus (P)-Total 0.635 0.0030 mg/L 28-AUG-20 R5201116 Total Suspended Solids 10.6 3.0 mg/L 28-AUG-20 R5204625 pH 8.91 0.10 pH units 28-AUG-20 R5202496	Chlorophyll a	44.4		0.10	ug/L	24-AUG-20	24-AUG-20	R5203472
Escherichia Coli 8 1 MPN/100mL 21-AUG-20 R5197067 Fecal Coliform by MPN QT97 10 1 MPN/100mL 21-AUG-20 R5197068 Miscellaneous Parameters 10 1 MPN/100mL 21-AUG-20 R5197068 Ammonia, Total (as N) 0.432 0.010 mg/L 27-AUG-20 R5203689 Conductivity 1600 1.0 umhos/cm 28-AUG-20 R5203689 Orthophosphate-Dissolved (as P) 0.371 OPF 0.0030 mg/L 25-AUG-20 R5201088 Phosphorus (P)-Total 0.635 0.0030 mg/L 26-AUG-20 R5201116 Total Suspended Solids 10.6 3.0 mg/L 26-AUG-20 R5204525 pH 8.91 0.10 pH units 26-AUG-20 R5202496	2 · · ·							
Fecal Coliform by MPN QT97 Fecal Coliforms 10 1 MPN/100mL 21-AUG-20 R5197068 Miscellaneous Parameters Ammonia, Total (as N) 0.432 0.010 mg/L 27-AUG-20 R5203689 Conductivity 1600 1.0 umhos/cm 26-AUG-20 R5203689 Orthophosphate-Dissolved (as P) 0.371 OPF 0.0030 mg/L 25-AUG-20 R5201088 Phosphorus (P)-Total 0.635 0.0030 mg/L 26-AUG-20 R5201116 Total Suspended Solids 10.6 3.0 mg/L 26-AUG-20 R5204525 pH 8.91 0.10 pH units 26-AUG-20 R5202496					MDNU100-1		21 4110 22	DELOTOOT
Fecal Coliforms 10 1 MPN/100mL 21-AUG-20 R5197068 Miscellaneous Parameters Ammonia, Total (as N) 0.432 0.010 mg/L 27-AUG-20 R5203689 Conductivity 1600 1.0 umhos/cm 26-AUG-20 R5203689 Orthophosphate-Dissolved (as P) 0.371 OPF 0.0030 mg/L 25-AUG-20 R5201088 Phosphorus (P)-Total 0.635 0.0030 mg/L 26-AUG-20 R5201116 Total Suspended Solids 10.6 3.0 mg/L 26-AUG-20 R5204525 pH 8.91 0.10 pH units 26-AUG-20 R5202496		8		1	MPN/100mL		21-AUG-20	R5197067
Miscellaneous Parameters 0.432 0.010 mg/L 27-AUG-20 R5203689 Conductivity 1600 1.0 umhos/cm 26-AUG-20 R5203689 Orthophosphate-Dissolved (as P) 0.371 OPF 0.0030 mg/L 25-AUG-20 R5201088 Phosphorus (P)-Total 0.635 0.0030 mg/L 26-AUG-20 R5201116 Total Suspended Solids 10.6 3.0 mg/L 26-AUG-20 R5204525 pH 8.91 0.10 pH units 26-AUG-20 R520496		10		1	MPN/100ml		21-AUG-20	R5197068
Ammonia, Total (as N) 0.432 0.010 mg/L 27-AUG-20 R5203689 Conductivity 1600 1.0 umhos/cm 26-AUG-20 R5203689 Orthophosphate-Dissolved (as P) 0.371 OPF 0.0030 mg/L 25-AUG-20 R5201088 Phosphorus (P)-Total 0.635 0.0030 mg/L 26-AUG-20 R5201116 Total Suspended Solids 10.6 3.0 mg/L 26-AUG-20 R5204525 pH 8.91 0.10 pH units 26-AUG-20 R520496							217100-20	
Conductivity 1600 1.0 umhos/cm 28-AUG-20 R5202496 Orthophosphate-Dissolved (as P) 0.371 OPF 0.0030 mg/L 25-AUG-20 R5201088 Phosphorus (P)-Total 0.635 0.0030 mg/L 26-AUG-20 R5201116 Total Suspended Solids 10.6 3.0 mg/L 26-AUG-20 R5204525 pH 8.91 0.10 pH units 26-AUG-20 R5202496		0.432		0.010	ma/L		27-AUG-20	R5203689
Orthophosphate-Dissolved (as P) 0.371 OPF 0.0030 mg/L 25-AUG-20 R5201088 Phosphorus (P)-Total 0.635 0.0030 mg/L 26-AUG-20 R5201116 Total Suspended Solids 10.6 3.0 mg/L 26-AUG-20 R5201255 pH 8.91 0.10 pH units 26-AUG-20 R5202496								
Phosphorus (P)-Total 0.635 0.0030 mg/L 26-AUG-20 R5201116 Total Suspended Solids 10.6 3.0 mg/L 26-AUG-20 R5204525 pH 8.91 0.10 pH units 26-AUG-20 R520496			OPF					
Total Suspended Solids 10.6 3.0 mg/L 26-AUG-20 R5204525 pH 8.91 0.10 pH units 26-AUG-20 R5202496					-			
pH 8.91 0.10 pH units 26-AUG-20 R5202496					-			
	and the second se				-			
	Enumeration of blue green algae cells							

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2492507-2 LAKE 2							
Sampled By: CLIENT on 21-AUG-20 @ 11:30							
Matrix: WATER							
Enumeration of blue green algae cells							
Total cyanobacterial cell count	234000		1	cells/mL		25-AUG-20	R5200457
Anabaena (Cyanophyceae)	1740		1	cells/mL		25-AUG-20	R5200457
Aphanothece (Cyanophyceae)	129000		1	cells/mL		25-AUG-20	R5200457
Microcystis (Cyanophyceae)	59400		1	cells/mL		25-AUG-20	R5200457
Planktothrix (Cyanophyceae)	31700		1	cells/mL		25-AUG-20	R5200457
Pseudanabaena (Cyanophyceae)	11900		1	cells/mL		25-AUG-20	R5200457
Nitrogen Total				[
Nitrate in Water by IC Nitrate (as N)	⊲0.10	DLM	0.10	mg/L		21-AUG-20	R5199622
Nitrate+Nitrite Nitrate and Nitrite as N	⊲0.11		0.11	mg/L		25-AUG-20	
Nitrite in Water by IC Nitrite (as N)	<0.050	DLM	0.050	mg/L		21-AUG-20	R5199622
Total Kjeldahl Nitrogen	-0.000		0.000				
Total Kjeldahl Nitrogen	2.41		0.20	mg/L	25-AUG-20	26-AUG-20	R5201197
Total Nitrogen Calculated							
Total Nitrogen	2.41		0.20	mg/L		26-AUG-20	
L2492507-3 LAKE 3							
Sampled By: CLIENT on 21-AUG-20 @ 12:00							
Matrix: WATER Chlorophyll a							
Chlorophyll a by fluorometry Chlorophyll a	51.1		0.10	ug/L	24-AUG-20	24-AUG-20	R5203472
Fecal Coliforms and E Coli by QT97	01.1		0.10		21710020	21710020	1.0200112
E. coli by QT97							
Escherichia Coli	15		1	MPN/100mL		21-AUG-20	R5197067
Fecal Coliform by MPN QT97							
Fecal Coliforms	16		1	MPN/100mL		21-AUG-20	R5197068
Miscellaneous Parameters							
Ammonia, Total (as N)	0.161		0.010	mg/L		27-AUG-20	R5203689
Conductivity	1390		1.0	umhos/cm		26-AUG-20	R5202496
Orthophosphate-Dissolved (as P)	0.749	OPF	0.0030	mg/L		25-AUG-20	R5201088
Phosphorus (P)-Total	1.07		0.0060	mg/L		26-AUG-20	R5201116
Total Suspended Solids	14.8		3.0	mg/L		26-AUG-20	R520452
pH	8.74		0.10	pH units		26-AUG-20	R5202496
Enumeration of blue green algae cells Total cvanobacterial cell count	544000					05 4110 00	DEDODACT
I otal cyanobactenal cell count Anabaena (Cvanophyceae)	541000 186		1	cells/mL cells/mL		25-AUG-20 25-AUG-20	R520045 R520045
Anabaena (Cyanophyceae) Aphanothece (Cyanophyceae)	455000		1	cells/mL		25-AUG-20 25-AUG-20	R520045
Aphanomece (Cyanophyceae) Merismopedia (Cyanophyceae)	7920		1	cells/mL		25-AUG-20 25-AUG-20	R520045
Microcystis (Cyanophyceae)	69300		1	cells/mL		25-AUG-20	R5200457
Planktothrix (Cyanophyceae)	6200		1	cells/mL		25-AUG-20	R5200457
Pseudanabaena (Cyanophyceae)	1980		1	cells/mL		25-AUG-20	R5200457
Nitrogen Total							
Nitrate in Water by IC							
Nitrate (as N)	<0.10	DLM	0.10	mg/L		21-AUG-20	R5199622
Nitrate+Nitrite Nitrate and Nitrite as N	⊲0.11		0.11	mg/L		25-AUG-20	
Nitrite in Water by IC	<0.050	DLM	0.050	mg/L		21-AUG-20	R5199622
	NU.UOU		0.000	1 109-2		21-400-20	LIK9199077
Nitrite (as N) Total Kjeldahl Nitrogen							

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2492507-3 LAKE 3							
Sampled By: CLIENT on 21-AUG-20 @ 12:00							
Matrix: WATER							
Total Kjeldahl Nitrogen Total Kjeldahl Nitrogen	2.34		0.20	mg/L	25-AUG-20	26-AUG-20	R5201197
Total Nitrogen Calculated Total Nitrogen	2.34		0.20	mg/L		26-AUG-20	
L							

Reference Information

Qualifier	Descript	tion							
DLM	Detection	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).							
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.								
OPF	Orthopho hold time	osphate test e to 30 days	was conducted on frozen (preserved) san according to ISO 5687-3 (2012).	nple. CCME hold time (72 hrs) was exceeded, but freezing can extend					
est Method F	Reference	s:							
ALS Test Code	e	Matrix	Test Description	Method Reference**					
ALGAE-CYANG	O-BACT-	Water	Enumeration of blue green algae cells	APHA 10200 C & F					
			on/settling and examined using a compour us and the cells are enumerated. The tota	nd phase contrast inverted microscope. Cyanobacteria (also known as I cyanobacteria count is also reported.					
CHL/A-ACET-F	LUORO-	Water	Chlorophyll a by fluorometry	EPA 445.0 ACET					
				ophyll a is determined by a 90 % acetone extraction followed with t subject to interferences from chlorophyll b.					
EC-SCREEN-W	VP	Water	Conductivity Screen (Internal Use Only) APHA 2510					
Qualitative ana	lysis of con	ductivity wh	ere required during preparation of other te	st eg. IC, TDS, TSS, etc					
C-WP		Water	Conductivity	APHA 2510B					
Conductivity of and chemically			fers to its ability to carry an electric curren	t. Conductance of a solution is measured between two spatially fixed					
ECOLI-QT97-W	VP	Water	E. coli by QT97	APHA 9223B QT97					
by mixing sam	ple with a p urs and the	roduct conta n the numbe	aining hydrolyzable substrates and sealing of wells exhibiting positive responses are	Substrate Coliform Test". Escherichia coli bacteria are determined in a 97-well packet. The packet is incubated at 35.0 +/- 0.5 degrees e counted. The final results are obtained by comparing the number of					
ETL-N-TOT-AN	IY-WP	Water	Total Nitrogen Calculated	Calculated					
C-QT97-WP		Water	Fecal Coliform by MPN QT97	APHA 9223B QT97					
mixture of hydr	olyzable su	bstrates and	I then sealed in a 97-well packet. The pac	3 "Enzyme Substrate Coliform Test". The sample is mixed with a ket is incubated at 44.5 +/- 0.2 degrees C for 18 hours and then the tained by comparing the number of positive responses to a probability					
N-TOTKJ-WP		Water	Total Kjeldahl Nitrogen	APHA 4500 NorgD (modified)					
Aqueous samp discrete analyz				sulfate as a catalyst. Total Kjeldahl Nitrogen is then analyzed using a					
H3-COL-WP		Water	Ammonia by colour	APHA 4500 NH3 F					
Ammonia in wa nitroprusside ai				d phenol. The intensity is amplified by the addition of sodium					
02+NO3-CAL	C-WP	Water	Nitrate+Nitrite	CALCULATION					
02-IC-N-WP		Water	Nitrite in Water by IC	EPA 300.1 (mod)					
norganic anion	ns are analy	zed by lon (Chromatography with conductivity and/or U	IV detection.					
03-IC-N-WP		Water	Nitrate in Water by IC	EPA 300.1 (mod)					
norganic anion	ns are analy	zed by lon (Chromatography with conductivity and/or U	IV detection.					
P-T-COL-WP		Water	Phosphorus, Total	APHA 4500 P PHOSPHORUS-L					
This analysis is	s carried out	t using proce		0-P "Phosphorus". Total Phosphorus is determined colourmetrically					

Reference Information

Version: FINAL

ALS Test Code	Matrix	Test Description	Method Reference**
colourmetricaly on a sam	ple that has l	been lab or field filtered through a 0.45	micron filter.
SOLIDS-TOTSUS-WP	Water	Total Suspended Solids	APHA 2540 D (modified)
Total suspended solids in	aquesous n	natrices is determined gravimetrically a	fter drying the residue at 103 □ 105⊡C.
" ALS test methods may in	ncorporate m	nodifications from specified reference m	nethods to improve performance.

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there. mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg wwt - milligrams per kilogram based on wet weight of sample mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight mg/L - unit of concentration based on volume, parts per million.

Less than.
 D.L. - The reporting limit.
 N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory. UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION. Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.