



BLACK STURGEON LAKES WATER QUALITY MONITORING 2021 REPORT

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1.0 BACKGROUND

In the fall of 2007, the City of Kenora was presented with the results of the *Lake Capacity and Management Study for Black Sturgeon Lake*. One of the recommendations of this study was to conduct a water quality assessment on Lower Black Sturgeon Lake for two consecutive years to establish baseline data and then once every five years to monitor changes to the water quality in the lake. Based on the results of the 2009, 2010, and 2015 sampling seasons, it was recommended by the consultant (Kenora Resource Consultants Inc.) that annual sampling focussing on one spring sampling session and one late summer sampling session would provide a more effective monitoring program than the original project design of 10 sampling sessions conducted every five years.

In 2009 and 2010, the City of Kenora awarded the contract to conduct the baseline data work for the first two years of water quality monitoring on Black Sturgeon Lakes to Ryan Haines Consulting. From 2015 to 2021, the water quality assessment contract was awarded annually to Kenora Resource Consultants Inc. (note – Ryan Haines Consulting was incorporated into Kenora Resource Consultants Inc. in 2012).

The summer of 2021 was characterized by low water levels throughout the region with no significant rain events during or prior to the water quality monitoring field work.

2.0 METHODOLOGY

Two sampling sessions were conducted during the 2021 season, a spring session on May 4th and a late summer session on August 19th. Water samples were taken at two locations on Lower Black Sturgeon Lake and one location at Upper Black Sturgeon during each sampling session. Sample locations on Lower Black Sturgeon correspond to sites identified in the *Lake Capacity and Management Study for Black Sturgeon Lake*. A site on the western end of Upper Black Sturgeon Lake was added during the 2010 sampling season to help to better understand potential sources of the higher nutrient levels found at the upstream site on Lower Black Sturgeon during the 2009 sampling season.

The selection of the site locations has been designed to determine the impacts of development on the water quality of Black Sturgeon Lakes. Site 2 is located at the outlet of Black Sturgeon Lakes into the Winnipeg River, Site 3 is located at the inlet of Black Sturgeon Creek into Lower Black Sturgeon Lake, and Site 4 is located at the outlet of Upper Black Sturgeon Lake (Figure 1) into Black Sturgeon Creek. Site 2 is the main sampling location used to assess the impacts of development on water quality because the new and proposed developments on Lower Black Sturgeon Lake are occurring upstream of this site.

All fieldwork was conducted from a small motorboat with a sonar unit mounted to the stern. At each sampling site, an anchor was used to keep the boat in one location.

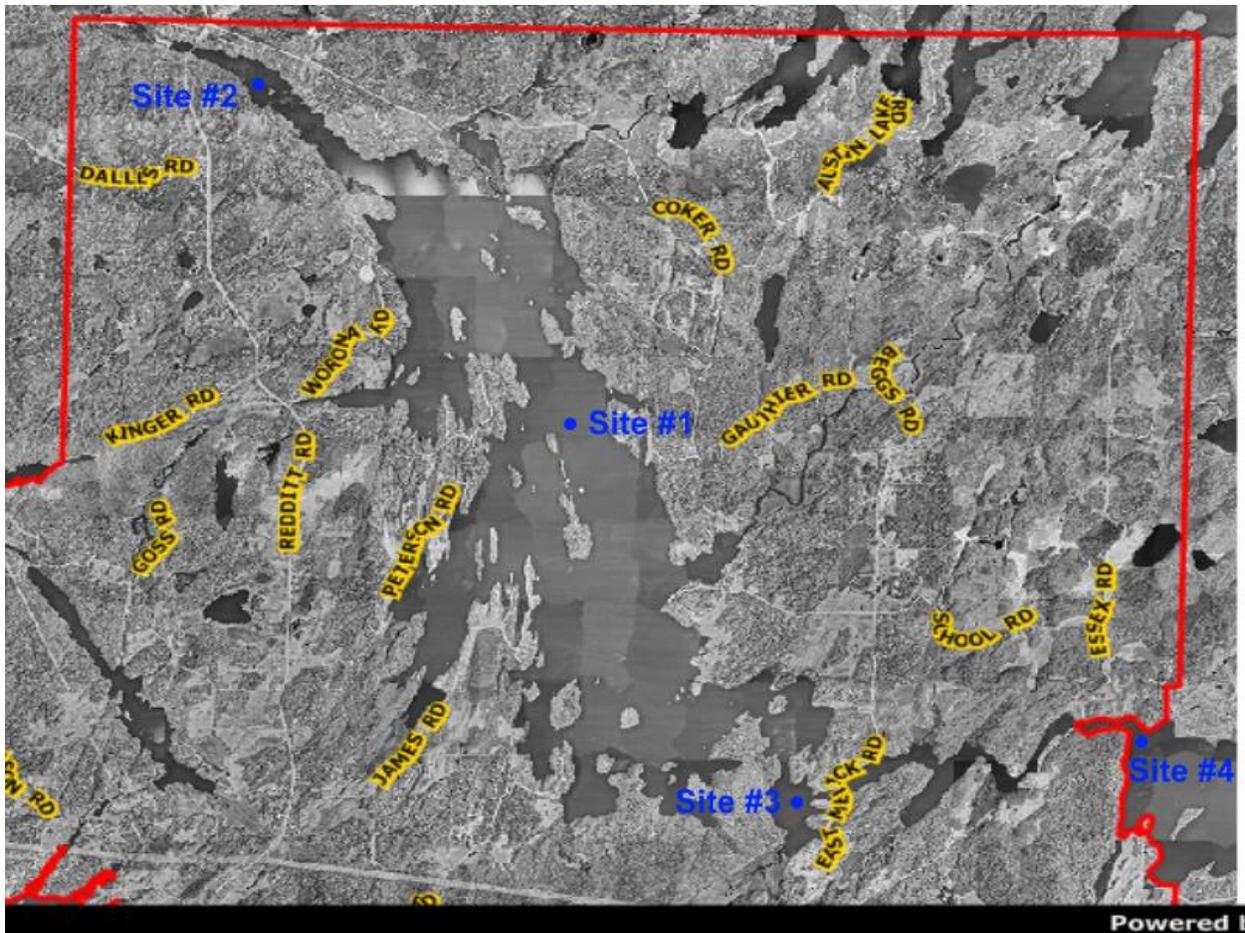


Figure 1 – Sampling Sites for Water Quality Monitoring on Black Sturgeon Lakes

2.1 Spring Sampling

During the spring sampling session, the focus was on the euphotic zone (surface water) sampling to capture spring turnover or mixing of the lake. The spring fieldwork consisted of recording Secchi depths and collecting euphotic zone composites at sites #2, #3, and #4. During the 2021 field season, spring euphotic zone composite samples were also collected from site #1 as well as the middle of the basin of Upper Black Sturgeon Lake for submission to the Ministry of the Environment, Conservation, and Parks (MECP) laboratory in Dorset as part of the Lake Partner Program. Results from the Lake Partner Program were not available when this report was submitted and will be provided in an addendum at a future date.

Secchi depth was determined at each site by lowering a Secchi disk (20-cm disk with alternating black and white quadrants) over the shady side of the boat (Figure 2). The disk was lowered until the observer could no longer distinguish between the white and black quadrants and then raised until the disk came back into view. This was repeated three times and then the depths at which the disk disappeared and then reappeared were averaged to give the Secchi depth.



Figure 2 – Lowering of Secchi disk

The euphotic zone is the section of the water column where enough light penetrates to facilitate algae growth (measured as 2X the Secchi depth). In order to obtain a water sample containing water from the euphotic zone, a weighted, 500 mL, small neck bottle (Figure 3) was lowered with a rope in the water column to a depth of 2X Secchi depth then quickly brought to the surface before the bottle became completely filled. For the two Lake Partner Program sampling sites, the water was filtered with an 80-micron filter as it was poured into the sampling bottles.



Figure 3 – Transferring water sample from euphotic zone composite into lab sample bottle

2.2 Late Summer Sampling

Late summer sampling included all of the fieldwork conducted during the spring (Secchi depths and euphotic zone composite water sampling), but with the addition of temperature/oxygen profiles and

lower water column samples to measure the impacts of the summer thermal stratification and oxygen depletion on water quality.

Temperature/oxygen profiles were obtained at Sites #1, #2, #3, and #4 during the late summer sampling session using a YSI 55 Dissolved Oxygen Meter. These can be found in Appendix 2.

During the later summer sampling session, an additional water sample was taken at sites #2, #3, and #4 approximately one meter from the bottom of the lake using a Beta horizontal water sampler (Figure 4). Both ends of the water sampler were opened prior to lowering it (using a rope) to the desired water depth. At the desired depth, a small weight was sent down through the water column along the length of the rope triggering a release mechanism on the sampler and causing the sampler caps to close.

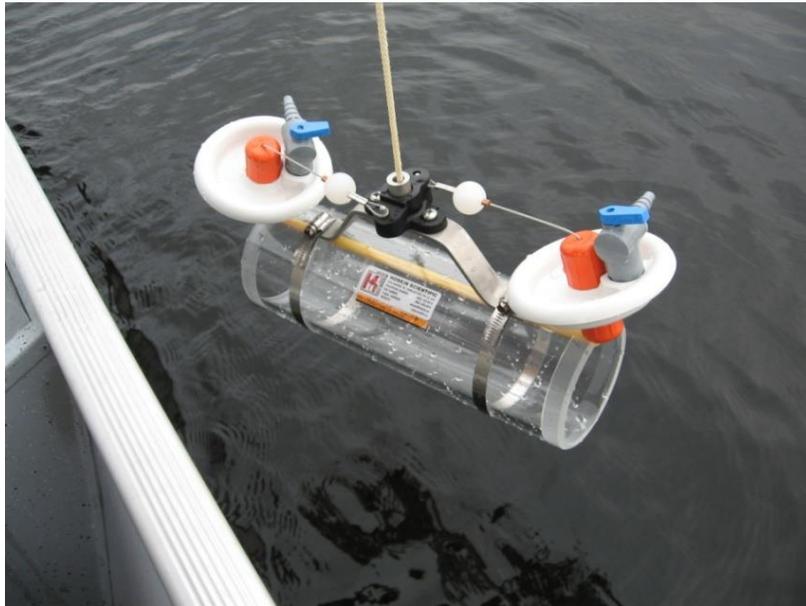


Figure 4 – Horizontal Beta Sampler prior to deployment

All water samples collected were transferred immediately upon collection to sample bottles for analysis at a laboratory. Samples were delivered by vehicle to the ALS Laboratory Group in Winnipeg, MB, for analyses.

3.0 RESULTS

3.1 Sampling Session Dates and Locations

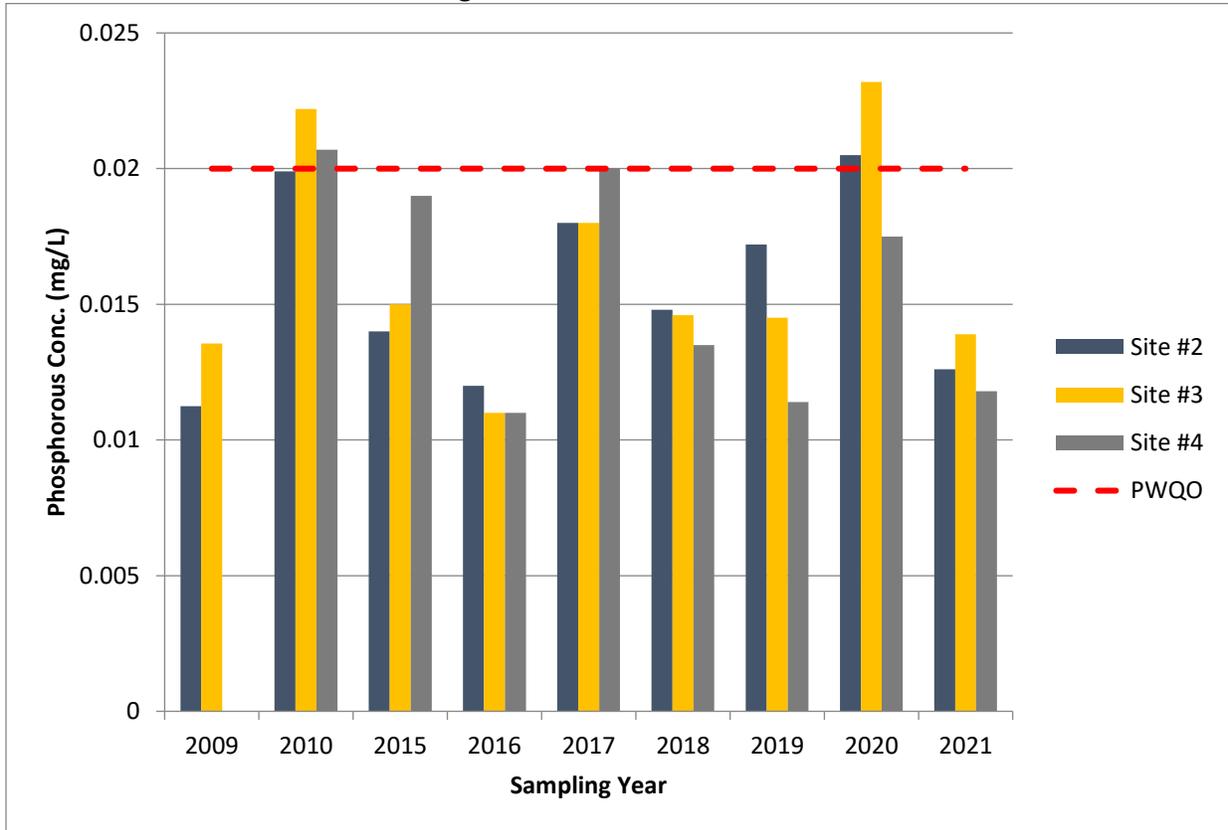
The 2021 sampling sessions were conducted on May 4th and August 19th. The depth of the sampling sites was 27.8 m for Site #1, 14.6 m for Site #2, 8.9 m for Site #3, and 6.9m for Site #4.

3.2 Total Phosphorous

During 2021, the spring turnover euphotic zone phosphorous concentrations taken at Site 2 (0.0126 mg/L), Site 3 (0.0139 mg/L), and Site 4 (0.0118 mg/L) were all below the provincial water quality objective (PWQO) of 0.0200 mg/L. The phosphorous concentrations found at site #2 (the outlet of Black Sturgeon

Lakes) and site #3 (inlet to Lower Black Sturgeon Lakes) in 2021 were the lowest found since 2016 (Figure 5).

Figure 5 – Spring Turnover Total Phosphorous Concentrations for Three Sampling Sites on Black Sturgeon Lakes from 2009 to 2021.



3.3 Chemical Analyses - Water Quality Characteristics

The spring turnover water samples were analyzed for 54 parameters encompassing dissolved organic carbon, colour, pH, alkalinity, turbidity, and scans for cations/anions and trace metals. The 2021 results for Site 2 (outlet of Black Sturgeon Lakes and downstream of new development activities) were comparable to the results for the 2010, 2015, 2016, 2017, 2018, 2019, and 2020 analyses and were all within the provincial water quality objectives (PWQO) for the parameters where an objective is provided. The full results can be found in Appendix 1.

The results at Site #2 in 2021 were the lowest to date for two parameters including total dissolved solids (27.6 mg/L) and potassium (0.913 mg/L). Further, Site #4 had similarly low levels of total dissolved solids (31 mg/L) being the lowest recorded to date at the specific site.

4.0 DISCUSSION

4.1 Total Phosphorous

The total phosphorous readings that are of the most interest for water quality analyses are the ones taken during spring turnover. The reason for this is that turnover is when the phosphorous is mixed throughout

the water column and provides an indication of overall phosphorous concentrations in the waterbody. Spring turnover is also when past phosphorous concentrations (i.e. Lake Partner Program) have been measured, which enables analysis of trends over time using a larger database over a longer time period.

The Ontario provincial water quality objective for total phosphorous concentrations is less than 20 µg/L (0.02 mg/L) “to avoid nuisance concentrations of algae in lakes” (MOE 1994). The 2021 spring sampling results for phosphorous concentrations were all below the provincial water quality objective (PWQO) of 0.0200 mg/L: Site #2 (0.0126mg/L), Site #3 (0.0139 mg/L), and Site 4 (0.0118 mg/L).

The third sampling site on Upper Black Sturgeon Lake (site #4) was added for the 2010 and subsequent sampling seasons to help determine the potential source of higher levels of phosphorous found at the inlet of Black Sturgeon Lake (site #3) when compared to the outlet (site #2). During the 2021 sampling season, it was found that Lower Black Sturgeon had greater concentrations of phosphorous entering the water body at site #3 than leaving it at site #2. In addition, the outlet of Upper Black Sturgeon Lake at site #4 had the lowest phosphorous concentration result of the three sites in 2021 and was well below the PWQO (Figure 5). This indicates that there was a source of phosphorous in the wetland area and/or development area between Upper and Lower Black Sturgeon Lakes. The data shown in Figure 5 indicates that the area between Upper and Lower Black Sturgeon Lakes was acting as a sink (phosphorous concentrations are higher at the outlet of Upper Black Sturgeon Lake (site #4) when compared to the inlet of Lower Black Sturgeon Lake (site #3)) in 2015 and 2017, as a source (phosphorous concentrations are lower at the outlet of Upper Black Sturgeon Lake (site #4) when compared to the inlet of Lower Black Sturgeon Lake (site #3)) in 2010, 2018, 2019, 2020, and 2021. The inlet and outlet of the area between the two lakes had a neutral balance in 2016.

5.0 SUMMARY AND RECOMMENDATIONS

The phosphorous levels at Site #2, Site #3, and Site #4 are below the 0.02 mg/L provincial water quality objective (PWQO). This indicates that the elevated levels of phosphorous in the waterbody noticed in 2020 were likely due to the major rainfall event(s) in the fall of 2019. Thus, the elevated levels of phosphorous found during the 2020 field season may have been due to an isolated environmental event that occurred in 2019.

The 2021 sampling results for sites #2, #3, and #4 for the additional water quality parameters (excluding phosphorous) were all within the PWQO for the parameters where an objective is provided. Notably, the results at Site #2 in 2021 were the lowest to date for two parameters including total dissolved solids (27.6 mg/L) and potassium (0.913 mg/L). Further, Site #4 had similarly low levels of total dissolved solids (31 mg/L) being the lowest recorded to date at the specific site.

6.0 REFERENCES

Gartner Lee Ltd. and Kelli Saunders Environmental Management. October 2007. *Lake Capacity and Management Study for Black Sturgeon Lake, City of Kenora*.

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Ministry of the Environment. 2015b. Lake Partner Secchi Depth Data. Found on website at: <http://desc.ca/programs/lpp>

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Riemersma, S., Little, J., Ontkean, G., and Moskal-Hébert, T. 2006. Phosphorus sources and sinks in watersheds: A review. 82 pp. In Alberta Soil Phosphorus Limits Project. Volume 5: Background information and reviews. Alberta Agriculture, Food and Rural Development, Lethbridge, Alberta, Canada

APPENDIX 1 – 2010 TO 2021 LABORATORY RESULTS FOR WATER QUALITY CHARACTERISTICS

2010 TO 2021 Laboratory Results for Water Quality Characteristics – SITE #2 (OUTLET OF LOWER BLACK STURGEON LAKE)

Parameter	2010	2015	2016	2017	2018	2019	2020	2021	Unit	PWQO
Alkalinity, Bicarbonate (HCO ₃)	21.3	16.8	26.5	21.2	20.5	24.4	24	20.5	mg/L	
Alkalinity, Carbonate (CO ₃)	<	<	<	<	<	<		<0.60	mg/L	
Alkalinity, Hydroxide (OH)	<	<	<	<	<	<		<0.34	mg/L	
Total Alkalinity (CaCO ₃)	17.5	16.8	21.7	17.4	16.8	20	19.7	16.8	mg/L	
Chloride (Cl)	<	3.76	4.16	3.86	3.83	4.35	4.09	4.37	mg/L	
Flouride (F)	0.15	0.037	0.044	0.045	0.042	0.043	0.040	0.043	mg/L	
Sulphate (SO ₄)	<	1.93	1.97	1.81	1.58	2.34	1.61	1.72	mg/L	
Colour, True	20	18	24.2	30.1	29	19.7	26.5	19.9	CU	
Dissolved Organic Carbon	8.7	7.5	7.78	8.14	8.84	7.73	8.17	8.22	mg/L	
Turbidity	1.2	1.1	1.31	1.34	1.28	1.81	1.35	1.07	NTU	
pH	7.3	7.44	6.78	7.11	7.44	7.3	7.58	7.41	pH units	6.5 - 8.5
Aluminum (Al)-Total	0.044	0.0513	0.0655	0.0641	0.0452	0.0489	0.0591	0.0564	mg/L	0.075
Antimony (Sb)-Total	<	<	<	<	<	<0.00010	<0.00010	<0.00010	mg/L	0.02
Arsenic (As)-Total	<	0.00032	0.003	0.00037	0.00036	0.00042	0.00038	0.0003	mg/L	0.005
Barium (Ba)-Total	0.00832	0.00845	0.00822	0.00808	0.00764	0.00821	0.00780	0.00796	mg/L	n/a
Beryllium (Be)-Total	<	<	<	<	<	<0.00010	<0.00010	<0.00010	mg/L	0.011
Bismuth (Bi)-Total	<	<	<	<	<	<0.000050	<0.000050	<0.000050	mg/L	n/a
Boron (B)-Total	<	<	<	<	<	<0.010	<0.010	<0.010	mg/L	0.2
Cadmium (Cd)-Total	<	<	<	<	<	<0.0000050	<0.0000050	<0.0000050	mg/L	0.0001
Calcium (Ca)-Total	5.05	5.77	5.25	5	4.85	5.01	5.12	5.18	mg/L	n/a
Cesium (Cs)-Total	<	<	<	<	<	<0.000010	<0.000010	<0.000010	mg/L	n/a
Chromium (Cr)-Total	<	<	<	<	0.00023	0.00018	0.00021	0.00021	mg/L	0.001
Cobalt (Co)-Total	<	<	<	<	<	<0.00010	<0.00010	<0.00010	mg/L	0.0009
Copper (Cu)-Total	0.00073	0.00087	0.00062	0.00116	0.00088	0.00078	0.00081	0.00089	mg/L	0.001
Iron (Fe)-Total	0.065	<	0.111	0.119	0.097	0.097	0.104	0.084	mg/L	0.3

Parameter	2010	2015	2016	2017	2018	2019	2020	2021	Unit	PWQO
Lead (Pb)-Total	<	0.0001	<	<	<	0.000050	0.000626	<0.000050	mg/L	0.001
Lithium (Li)-Total	n/a	<	<	<	0.0013	0.0012	0.0013	0.0013	mg/L	n/a
Magnesium (Mg)-Total	1.5	1.79	1.61	1.62	1.63	1.82	1.82	1.65	mg/L	n/a
Manganese (Mn)-Total	0.00496	0.00529	0.0151	0.0127	0.00929	0.0113	0.00859	0.00695	mg/L	n/a
Molybdenum (Mo)-Total	<	<	<	<	0.000066	<0.000050	0.000079	<0.000050	mg/L	0.04
Nickel (Ni)-Total	0.00048	<	<	<	0.00065	0.00057	0.00061	0.00056	mg/L	0.025
Phosphorus (P)-Total	0.0157	0.014	0.012	0.018	0.0148	0.0172	0.0205	<0.050	mg/L	0.02
Potassium (K)-Total	0.954	1.08	0.995	1.02	0.968	0.980	1.02	0.913	mg/L	n/a
Rubidium (Rb)-Total	0.00161	0.00202	0.00193	0.00198	0.00194	0.00189	0.00194	0.002	mg/L	n/a
Selenium (Se)-Total	<	<	<	<	0.000131	0.000116	0.000090	0.000098	mg/L	0.1
Silicon (Si)-Total	1.16	0.88	1.07	1.43	0.7	0.80	1.31	1.1	mg/L	n/a
Silver (Ag)-Total	<	<	<	<	<	<0.000010	<0.000010	<0.000010	mg/L	0.0001
Sodium (Na)-Total	2.53	3.25	3.07	3.04	3.1	3.27	3.48	3.5	mg/L	n/a
Strontium (Sr)-Total	0.0219	0.0239	0.023	0.0244	0.0234	0.0231	0.0240	0.0225	mg/L	n/a
Tellurium (Te)-Total	<	<	<	<	<	<0.00020	<0.00020	<0.00020	mg/L	n/a
Thallium (Tl)-Total	<	<	<	<	<	<0.000010	<0.000010	<0.000010	mg/L	0.0003
Thorium (Th)-Total	n/a	<	<	<	<	<0.00010	<0.00010	<0.00010	mg/L	n/a
Tin (Sn)-Total	<	<	<	<	<	<0.00010	<0.00010	<0.00010	mg/L	n/a
Titanium (Ti)-Total	0.00094	0.00124	0.00162	0.00136	0.00099	0.00091	0.00110	0.00106	mg/L	n/a
Tungsten (W)-Total	<	<	<	<	<	<0.00010	<0.00010	<0.00010	mg/L	0.03
Uranium (U)-Total	<	<	<	<	0.000089	0.000072	0.000087	0.00007	mg/L	0.005
Vanadium (V)-Total	<	0.0002	0.00022	0.00023	<	<0.00050	0.00059	<0.00050	mg/L	0.006
Zinc (Zn)-Total	<	<	<	<	<	<0.0030	0.0065	<0.0030	mg/L	0.03
Zirconium (Zr)-Total	<	<	<	<	0.000122	0.000060	<0.00020	<0.00020	mg/L	0.004
Nitrate	n/a	<	0.049	0.0623	<	0.0276	<0.0050	0.0074	mg/L	
Nitrate + Nitrite	0.057	<	n/a	<	<	<			mg/L	
Nitrite	n/a	<	<	<	<	<	<0.0010	<0.0010	mg/L	
Total Kjeldahl Nitrogen	n/a	0.37	0.35	0.38	0.29	0.58	0.42	0.33	mg/L	
Total Nitrogen Calculated	n/a	0.37	n/a	0.38	0.29	0.58	0.42	0.33	mg/L	
Total Organic Carbon			8.14	7.84	8.11	7.57	8.41	8.18	mg/L	

Parameter	2010	2015	2016	2017	2018	2019	2020	2021	Unit	PWQO
Phosphorus (P)-Total	0.0157	0.014	0.012	0.018	0.0148	0.0172	0.0205	0.0126	mg/L	0.02
UV Transmittance			58.6	55.1	54.7	60.3	56.0	60.3	% T	
Total Dissolved Solids			52	42.6	45.3	39	40.9	27.6	mg/L	
Langelier Index 4C			-2.7	-2.5	-2.2	-2.2	-2	-2.2		
Langelier Index 60C			-1.9	-1.7	-1.4	-1.5	-1.2	-1.4		
Hardness Calculated	18.8		19.7	19.2	18.9	20	20.3	19.7	mg/L	
Conductivity	52.6		57.3	56.4	53.2	54.6	53.9	56.3	umhos/cm	
Bromide in Water by IC			<0.10		<	<	<0.010	<0.010	mg/L	

< - concentrations are below the laboratory detection limit
PWQO – Provincial Water Quality Objective

2010 TO 2021 Laboratory Results for Water Quality Characteristics – SITE #3 (OUTLET OF LOWER BLACK STURGEON LAKE)

Parameter	2010	2015	2016	2017	2018	2019	2020	2021	Unit	PWQO
Alkalinity, Bicarbonate (HCO ₃)	23.9	17.2	27.9	21.5	24.4	24.6	20.6	24.8	mg/L	
Alkalinity, Carbonate (CO ₃)	<0.60	<0.60	<0.60	<0.60	<0.60	<	<0.60	<0.60	mg/L	
Alkalinity, Hydroxide (OH)	<0.40	<0.34	<0.34	<0.34	<0.34	<	<0.34	<0.34	mg/L	
Total Alkalinity (CaCO ₃)	19.6	17.2		17.6	20	21.1	16.9	20.3	mg/L	
Chloride (Cl)	9.4	6.87	4.76	5.32	6.73	6.1	5.94	6.91	mg/L	
Flouride (F)	0.15	0.039	0.038	0.043	0.041	0.041	0.040	0.042	mg/L	
Sulphate (SO ₄)	<9.0	2.23	2.09	2.03	1.83	2.7	1.78	2.15	mg/L	
Colour, True	20	26.1	29.6	30.7	30.4	21	34.2	21.2	CU	
Dissolved Organic Carbon	8.7	8.2	8.18	7.7	8.82	7.63	8.13	8.1	mg/L	
Turbidity	1.2	1.4	1.38	1.69	1.6	1.14	1.08	0.84	NTU	
pH	7.3	7.34	6.86	7.26	7.29	7.33	7.32	7.36	pH units	6.5 - 8.5
Aluminum (Al)-Total	0.044	0.0785	0.0525	0.0562	0.0648	0.0269	0.0559	0.0248	mg/L	0.075
Antimony (Sb)-Total	<0.0010	<0.00020	<0.00020	<0.00020	0.00012	<0.00010	<0.00010	<0.00010	mg/L	0.02
Arsenic (As)-Total	<	<	<	<	<	<	<	0.00027	mg/L	0.005
Barium (Ba)-Total	0.00869	0.00946	0.00851	0.00772	0.00847	0.00803	0.00811	0.00822	mg/L	n/a
Beryllium (Be)-Total	<	<	<	<	<	<	<	<0.00010	mg/L	0.011
Bismuth (Bi)-Total	<0.00030	<0.00020	<0.00020	<0.00020	<0.000050	<0.000050	<0.000050	<0.000050	mg/L	n/a
Boron (B)-Total	<0.020	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	mg/L	0.2
Cadmium (Cd)-Total	<0.00020	<0.00001 0	<0.00001 0	<0.00001 0	<0.000005 0	<0.000005 0	<0.000005 0	<0.000005 0	mg/L	0.0001
Calcium (Ca)-Total	6.08	6.93	5.84	5.47	5.82	5.60	5.66	5.82	mg/L	n/a
Cesium (Cs)-Total	<0.00010	<0.00010	<0.00010	<0.00010	0.000025	<0.000010	<0.000010	<0.000010	mg/L	n/a
Chromium (Cr)-Total	<0.0010	<0.0010	<0.0010	<0.0010	0.0003	0.00018	0.00020	0.00013	mg/L	0.001
Cobalt (Co)-Total	<0.00020	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	mg/L	0.0009

Parameter	2010	2015	2016	2017	2018	2019	2020	2021	Unit	PWQO
Copper (Cu)-Total	0.00049	0.00092	0.00057	0.00094	0.00084	0.00071	0.00078	0.00073	mg/L	0.001
Iron (Fe)-Total	0.133	0.1	0.096	0.135	0.125	0.088	0.141	0.069	mg/L	0.3
Lead (Pb)-Total	<	<	<	<	<	<	<	<0.000050	mg/L	0.001
Lithium (Li)-Total		<0.0020	<0.0020	<0.0020	0.0016	0.0012	0.0013	0.0012	mg/L	n/a
Magnesium (Mg)-Total	1.56	1.81	1.43	1.54	1.65	1.73	1.78	1.67	mg/L	n/a
Manganese (Mn)-Total	0.0178	0.0102	0.00608	0.0142	0.00927	0.0128	0.0127	0.00628	mg/L	n/a
Molybdenum (Mo)-Total	<0.00010	<0.00020	<0.00020	<0.00020	0.00011	0.000063	0.000059	0.000051	mg/L	0.04
Nickel (Ni)-Total	0.0004	<0.0020	<0.0020	<0.0020	0.00087	<0.00050	0.00053	<0.00050	mg/L	0.025
Phosphorus (P)-Total	<0.020	<0.10	<0.10	<0.10	<0.050	<0.050	<0.050	<0.050	mg/L	0.02
Potassium (K)-Total	1.15	1.1	1.03	1.05	1.05	0.980	0.976	1.02	mg/L	n/a
Rubidium (Rb)-Total	0.0018	0.00214	0.00203	0.00209	0.00209	0.00199	0.00201	0.00202	mg/L	n/a
Selenium (Se)-Total	<0.0010	<0.0010	<0.0010	<0.0010	0.000202	0.000131	0.000084	0.000108	mg/L	0.1
Silicon (Si)-Total	1.21	1.04	1.22	1.34	1.19	1.06	1.35	1.01	mg/L	n/a
Silver (Ag)-Total	<0.00050	<0.00010	<0.00010	<0.00010	<0.000010	<0.000010	<0.000010	<0.000010	mg/L	0.0001
Sodium (Na)-Total	4.56	4.8	3.4	3.62	4.62	4.24	4.42	4.78	mg/L	n/a
Strontium (Sr)-Total	0.0255	0.0265	0.0263	0.0267	0.0261	0.0264	0.0249	0.0253	mg/L	n/a
Tellurium (Te)-Total	<0.00050	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	mg/L	n/a
Thallium (Tl)-Total	<	<	<	<	<	<	<	<0.000010	mg/L	0.0003
Thorium (Th)-Total		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	mg/L	n/a
Tin (Sn)-Total	<0.00030	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	mg/L	n/a
Titanium (Ti)-Total	0.00188	0.00183	0.00106	0.00157	0.00175	0.00058	0.00113	0.00081	mg/L	n/a
Tungsten (W)-Total	<	<	<	<	<	<	<	<0.00010	mg/L	0.03
Uranium (U)-Total	<	<	<	<	<	<	<	0.000084	mg/L	0.005
Vanadium (V)-Total	<	<	<	<	<	<	<	<0.00050	mg/L	0.006
Zinc (Zn)-Total	<0.0050	<0.0020	<0.0020	<0.0020	<0.0030	<0.0030	0.0038	<0.0030	mg/L	0.03
Zirconium (Zr)-Total	0.00082	<0.00040	<0.00040	<0.00040	0.000187	<0.000060	<0.00020	<0.00020	mg/L	0.004
Nitrate		<0.020		<0.0050	<	<	<0.0050	<0.0050	mg/L	
Nitrate + Nitrite	<0.050	<0.070			<	<	<		mg/L	
Nitrite		<0.010		<0.0010	<	<	<0.0010	<0.0010	mg/L	

Parameter	2010	2015	2016	2017	2018	2019	2020	2021	Unit	PWQO
Total Kjeldahl Nitrogen		0.29	0.33	0.41	0.28	0.42	0.48	0.37	mg/L	
Total Nitrogen Calculated		0.29		0.41	0.28	0.42	0.48	0.37	mg/L	
Total Organic Carbon			7.83	7.6	8.15	7.45	8.23	8.07	mg/L	
Phosphorus (P)-Total	0.0212	<	<	<	<	<	0.0232	<	mg/L	0.02
UV Transmittance			55.2	56.5	55	60	55.5	61.8	% T	
Total Dissolved Solids			53	41.4	48.4	39	49.7	47	mg/L	
Langelier Index 4C			-2.6	-2.3	-2.2	-2.2	-2.2	-2.1		
Langelier Index 60C			-1.8	-1.5	-1.4	-1.5	-1.5	-1.3		
Hardness Calculated			20.5	20	21.3	21.1	21.5	21.4	mg/L	
Conductivity			56.5	60.7	66.7	60.6	61.1	68.5	umhos/cm	
Ammonia (total)				<0.010	<	<	<0.010	<0.010	mg/L	
Bromide						<		<0.010		

< - concentrations are below the laboratory detection limit
PWQO – Provincial Water Quality Objective

2010 TO 2021 Laboratory Results for Water Quality Characteristics – SITE #4 (OUTLET OF LOWER BLACK STURGEON LAKE)

Parameter	2010	2015	2016	2017	2018	2019	2020	2021	Unit	PWQO
Alkalinity, Bicarbonate (HCO ₃)	20.7	15.1	18.8	19.3	18.9	19.9	17	19.5	mg/L	
Alkalinity, Carbonate (CO ₃)	<0.60	<0.60	<0.60	<0.60	<	<	<0.60	<0.60	mg/L	
Alkalinity, Hydroxide (OH)	<0.40	<0.34	<0.34	<0.34	<0.34	<	<0.34	<0.34	mg/L	
Total Alkalinity (CaCO ₃)		15.1	15.4	15.8	15.5	16.3	13.9	16	mg/L	
Chloride (Cl)		3.71	4.09	3.92	3.94	4.6	3.95	4.29	mg/L	
Flouride (F)	0.1	0.035	0.041	0.042	0.038	0.04	0.038	0.04	mg/L	
Sulphate (SO ₄)	<9.0	2.1	2.05	1.96	1.76	2.15	1.77	1.95	mg/L	
Colour, True		15	28	25.9	22.4	21	26.0	16.3	CU	
Dissolved Organic Carbon		7.2	7.88	7.01	7.87	7.49	7.43	7.61	mg/L	
Turbidity	1.05	1.3	2.13	1.37	1.01	1.27	1.11	0.78	NTU	
pH	7.32	7.3	6.73	7.29	7.26	7.28	7.32	7.3	pH units	6.5 - 8.5
Aluminum (Al)-Total	0.038	0.0552	0.0658	0.053	0.0354	0.0321	0.0580	0.0233	mg/L	0.075
Antimony (Sb)-Total	<0.0010	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	mg/L	0.02
Arsenic (As)-Total	<	<	<	<	<	<	<	0.00026	mg/L	0.005
Barium (Ba)-Total	0.00828	0.0085	0.00834	0.0074	0.0077	0.00792	0.00790	0.00801	mg/L	n/a
Beryllium (Be)-Total	<	<	<	<	<	<	<	<0.00010	mg/L	0.011
Bismuth (Bi)-Total	<0.0003 0	<0.00020	<0.00020	<0.00020	<0.00005 0	<0.000050	<0.000050	<0.000050	mg/L	n/a
Boron (B)-Total	<0.020	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	mg/L	0.2
Cadmium (Cd)-Total	<0.0002 0	<0.00001 0	<0.00001 0	<0.00001 0	0.000005	<0.000005 0	<0.000005 0	<0.000005 0	mg/L	0.0001
Calcium (Ca)-Total	5.13	5.58	5.09	4.74	4.7	4.91	4.76	5.05	mg/L	n/a
Cesium (Cs)-Total	<0.0001 0	<0.00010	<0.00010	<0.00010	<0.00001 0	<0.000010	<0.000010	<0.000010	mg/L	n/a
Chromium (Cr)-Total	<0.0010	<0.0010	<0.0010	<0.0010	0.00018	0.00015	0.00020	0.00015	mg/L	0.001
Cobalt (Co)-Total	<	<	<	<	<	<	<	<0.00010	mg/L	0.0009

Parameter	2010	2015	2016	2017	2018	2019	2020	2021	Unit	PWQO
Copper (Cu)-Total	0.0005	0.00072	0.00061	0.00086	0.00075	0.00067	0.00069	0.00069	mg/L	0.001
Iron (Fe)-Total	0.076	<0.10	0.125	0.111	0.092	0.098	0.113	0.053	mg/L	0.3
Lead (Pb)-Total	<0.0001 0	<0.00009 0	<0.00009 0	<0.00009 0	<0.00005 0	<0.000050	<0.000050	<0.000050	mg/L	0.001
Lithium (Li)-Total		<0.0020	<0.0020	<0.0020	0.0012	0.0011	0.0014	0.0012	mg/L	n/a
Magnesium (Mg)-Total	1.34	1.5	1.37	1.37	1.38	1.56	1.44	1.47	mg/L	n/a
Manganese (Mn)-Total	0.0111	0.00417	0.0124	0.00915	0.00972	0.0192	0.0126	0.00592	mg/L	n/a
Molybdenum (Mo)-Total	<0.0001 0	<0.00020	<0.00020	<0.00020	0.000055	<0.000050	0.000052	<0.000050	mg/L	0.04
Nickel (Ni)-Total	<	<	<	<	<	<	<	<0.00050	mg/L	0.025
Phosphorus (P)-Total	<0.020	<0.10	<0.10	<0.10	<	<0.050	<0.050	<0.050	mg/L	0.02
Potassium (K)-Total	0.943	1.04	1.02	1	<0.050	0.940	0.898	0.922	mg/L	n/a
Rubidium (Rb)-Total	0.00175	0.00203	0.00204	0.00223	0.00198	0.00206	0.00190	0.00201	mg/L	n/a
Selenium (Se)-Total	<0.0010	<0.0010	<0.0010	<0.0010	0.000118	0.000116	0.000091	0.000118	mg/L	0.1
Silicon (Si)-Total	1.28	1.07	1.49	1.26	1.36	1.20	1.68	1.21	mg/L	n/a
Silver (Ag)-Total	<0.0005 0	<0.00010	<0.00010	<0.00010	<0.00001 0	<0.000010	<0.000010	<0.000010	mg/L	0.0001
Sodium (Na)-Total	2.92	3.02	2.94	3.02	3.08	3.28	3.48	3.39	mg/L	n/a
Strontium (Sr)-Total	0.0241	0.023	0.0244	0.0248	0.0232	0.0239	0.0222	0.0241	mg/L	n/a
Tellurium (Te)-Total	<0.0005 0	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	mg/L	n/a
Thallium (Tl)-Total	<	<	<	<	<	<	<	<0.000010	mg/L	0.0003
Thorium (Th)-Total		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	mg/L	n/a
Tin (Sn)-Total	<0.0003 0	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	mg/L	n/a
Titanium (Ti)-Total	0.00083	0.00146	0.0013	0.0014	0.00067	0.00065	0.00125	0.00043	mg/L	n/a
Tungsten (W)-Total	<	<	<	<	<	<	<	<0.00010	mg/L	0.03
Uranium (U)-Total	<	<	<	<	<	<	<	0.000085	mg/L	0.005
Vanadium (V)-Total	<0.0010	<0.00020	<0.00020	0.00021	<0.00050	<0.00050	0.00060	<0.00050	mg/L	0.006
Zinc (Zn)-Total	<0.0050	<0.0020	<0.0020	<0.0020	<0.0030	<0.0030	0.0040	<0.0030	mg/L	0.03
Zirconium (Zr)-Total	<	<	<	<	<	<	<	<0.00020	mg/L	0.004

Parameter	2010	2015	2016	2017	2018	2019	2020	2021	Unit	PWQO
Nitrate		<0.020	0.0193	<0.0050	<	0.017	<0.0050	<0.0050	mg/L	
Nitrate + Nitrite	<05050	<0.070			<	<	<	<	mg/L	
Nitrite		<0.010	<0.0010	<0.0010	<	<	<0.0010	<0.0010	mg/L	
Total Kjeldahl Nitrogen		0.24	0.35	0.37	<0.20	0.37	0.37	0.31	mg/L	
Total Nitrogen Calculated		0.24		0.37	<0.20	0.37	0.37	0.31	mg/L	
Total Organic Carbon			7.57	7.53	7.17	7.14	7.63	7.66	mg/L	
Phosphorus (P)-Total	0.0182	0.019	0.011	0.02	0.0135	0.0114	0.0175	0.0118	mg/L	0.02
UV Transmittance			47.4	59.4	61	63.2	59.2	64.4	% T	
Total Dissolved Solids			58	38.9	44.5	36	43.1	31	mg/L	<500
Langelier Index 4C			-2.9	-2.4	-2.4	-2.4	-2.4	-2.3		
Langelier Index 60C			-2.1	-1.6	-1.6	-1.6	-1.6	-1.6		
Hardness Calculated			18.4	17.5	17.4	18.7	17.8	18.6	mg/L	
Conductivity			50.7	52	51.8	52.3	49.4	54	umhos/cm	
Ammonia(total)					<		<0.010	<0.010	mg/L	
Bromide				<0.010	<	<		<0.010		

< - concentrations are below the laboratory detection limit
PWQO – Provincial Water Quality Objective

APPENDIX 2 – DISSOLVED OXYGEN/TEMPERATURE PROFILE RESULTS AND SECCHI DEPTHS FOR 2021 LATE SUMMER SAMPLING SESSION

Site 1

Secchi Depth (m) B.P. (mmHg) Time Depth (m)
 762.4 19:44 28.7

Depth	Temp	DO (%)	DO (mg/L)
0.5	23.4	102.7	8.86
1	22.9	105.3	9.06
2	22.8	105.0	9.08
3	22.8	105.5	9.05
4	22.7	104.2	9.00
5	22.9	103.5	8.94
6	22.5	102.3	8.91
7	22.3	101.9	8.87
8	21.3	97.3	8.63
9	17.2	64.4	6.13
10	13.8	50.3	5.20
11	11.8	47.4	5.11
12	11.1	46.6	5.13
13	10.0	47.1	5.33
14	9.6	46.1	5.29
15	9.2	45.1	5.18
16	9.0	44.1	5.12
17	8.8	43.4	5.04
18	8.6	42.7	5.02
19	8.5	42.1	4.94
20	8.3	40.6	4.78
21	8.2	39.3	4.64
22	8.1	38.2	4.50
23	8.0	37.4	4.43
24	7.9	36.6	4.32
25	7.9	35.2	4.18
26	7.8	32.7	3.89
27	7.8	31.1	3.66
28	7.7	29.0	3.40

Site 2

Secchi Depth (m) **B.P.**
3.5 **(mmHg)**
Time **Depth (m)**
17:15 15.3

Depth	Temp	DO (%)	DO (mg/L)
0.5	24.1	108.4	9.09
1	24.0	107.8	9.12
2	23.9	108.0	9.12
3	23.6	106.9	9.05
4	23.4	105.5	8.99
5	23.2	104.9	8.97
6	23.1	103.7	8.92
7	22.8	102.8	8.89
8	21.8	97.8	8.60
9	19.8	88.1	7.98
10	13.6	55.5	5.70
11	11.1	44.2	4.85
12	10.2	41.3	4.63
13	9.9	38.0	4.28
14	9.7	35.3	4.00
15	9.6	32.2	3.62

Site 3

Secchi Depth (m) **B.P. (mmHg)** **Time** **Depth (m)**
3.5 762.7 18:22 8.8

Depth	Temp	DO (%)	DO (mg/L)
0.5	24.8	106.9	8.85
1	24.7	107.2	8.90
2	24.6	107.2	8.97
3	23.2	105.0	8.99
4	21.6	98.6	8.67
5	20.7	85.6	7.66
6	17.2	39.7	3.69
7	12.7	15.2	1.50
8	10.8	5.0	0.55

Site 4

Secchi Depth (m) **B.P. (mmHg)** **Time** **Depth (m)**
3.0 762.5 19:00 6.2

Depth	Temp	DO (%)	DO (mg/L)
0.5	24.5	106.5	8.94
1	24.5	106.9	8.90
2	22.9	103.2	8.86
3	21.7	99.2	8.73
4	21.4	97.2	8.60
5	21.2	96.2	8.44
6	20.8	86.3	7.66