2021 LAKE GAUVREAU WATER QUALITY MONITORING

RECOGNIZED EXPERTISE FOR 25 YEARS

LAKE GAUVREAU WATER QUALITY MONITORING

Compilation of data from 2002 to 2021

Prepared for:

Association for the protection of the environment of Lake Gauvreau (Enviro Lac Gauvreau)

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1 CONTEXT AND MANDATE

Having been unable to join the Voluntary Lake Monitoring Network, the members of the **Association for the Protection of the Environment of Lake Gauvreau** requested the support of RAPPEL for the interpretation of the data collected during their sampling campaign. in 2021.
The methodological approach proposed by the RAPPEL can be summarized as follows:
1 – Analysis and interpretation of water quality monitoring data from summer 2021 at Lac Gauvreau.
2 – Consultation and compilation of historical data (water quality).
3 – Preparation of a summary sheet including the main recommendations for an optimal assessment of the state of health of the lake.

Lac Gauvreau is located on the territory of the municipality of **La Pêche**, in the Outaouais region. For several years, various organizations have collected physicochemical data in order to monitor the state of health of the lake, as well as the quality of bathing water.

The University of Ottawa took measurements of total phosphorus, chlorophyll A and water transparency at the lake pit from 2002 to 2005. The ABV des 7, in collaboration with the municipality, collected concentration data in phosphorus and faecal coliforms from 2002 to 2014 at two stations along the lake, in Ruisseau à Parent and at the outlet. The H2O des Collines program, for its part, enabled the measurement of faecal coliforms at about ten locations, in the shallow zone of the lake and in certain tributaries. The Association continued the work with the sampling of the different variables in two bays, at the outlet and in the Parent stream.

Figure 1 (next page) presents a summary of the different stations that were used for water sampling.

Figure 1. Map of the location of the sampling stations at Lac Gauvreau from 2002 to 2021
*Bélisle stream, located north of Parent stream, is not shown here on the map

The tables below present, for each station, the number of samples taken per year.

Table I. Number of samples and location of total phosphorus sampling according to the years at Lac Gauvreau

Année / Station	FOSSE	BAIE MURRAY	BAIE ST-ALPHONSE	NORD ÎLE	EXUTOIRE	Ruisseau Bélisle	Ruisseau Parent	Total général
2002	15	-	-	-	-	5	15	40
2003	1	-	-	-	-	-	-	1
2004	1	-	-	-	-	3	15	19
2005	1	-	-	-	-	-	-	1
2008	-	-	5	4	-	4	31	44
2009	-	1	4	3	-	2	24	34
2010	-	1	3	2	-	1	20	27
2011	-	5	-	-	7	4	24	40
2012	-	2	2	1	1	2	20	28
2013	-	3	4	4	3	3	16	33
2014	-	2	2	2	2	2	12	22
2021	-	3	3	-	3	-	3	12
Total général	**18**	**17**	**23**	**16**	**16**	**26**	**180**	**301**

Table II. Number of samples and location of sampling of faecal coliforms or of E. coli by year at Lac Gauvreau

Année / Station	BAIE STE-ANNE	BAIE MURRAY	EST	BAIE ST-ALPHONSE	NORD ÎLE	PLAGE	EXUTOIRE	Ruisseau Parent	Ruisseau Bélisle	Autre	Total général
2002	3	6	3	6	3	3	-	18	5	-	47
2003	3	6	3	6	3	3	-	3	-	-	27
2004	2	4	2	7	2	2	-	14	3	-	36
2005	2	4	2	4	2	2	-	2	-	-	18
2006	2	4	2	4	2	2	-	2	-	4	22
2007	2	4	2	4	2	2	-	4	-	-	20
2008	2	8	2	8	6	2	4	26	4	2	64
2009	1	4	1	5	3	1	3	22	2	2	44
2010	2	6	2	6	4	2	2	22	1	2	49
2011	-	3		3	3	-	3	24	4	-	40
2012	-	4		4	2	-	4	20	2	-	36
2013	3	9	3	9	8	3	3	22	3	-	63
2014	2	6	2	6	4	2	2	16	2	-	42
2015	2	4	2	4	2	2	-	4	-	-	20
2016	2	4	2	4	2	2	-	4	-	-	20
2017	3	4	2	4	2	2	-	4	-	-	21
2018	1	2	1	2	1	1	-	2	-	-	10
2019	1	2	1	2	1	1	-	2	-	-	10
2020	2	4	2	4	2	2	-	4	-	-	20
2021	3	3	3	3	3	3	3	3	-	-	24
Total général	**38**	**91**	**37**	**95**	**57**	**37**	**24**	**218**	**26**	**10**	**633**

As for chlorophyll a, it was measured at the lake pit from 2002 to 2005 by the University of Ottawa, about fifteen times. This variable was also monitored by the association in 2021, as well as dissolved organic carbon (DOC), in two bays, at the outlet and in the Parent stream.

2 DESCRIPTION OF THE VARIABLES ANALYZED

The water quality of a lake is determined using several physico-chemical and bacteriological variables. The total phosphorus and chlorophyll A concentration of the deep zone, the transparency of the water and the massive accumulation of cyanobacteria, for example, are indicators of its state of health. In addition, observations made in the littoral zone on the quantity of algae, aquatic plants and sediments provide us with direct information on the nutrient inputs from human activities in the watershed.

2.1 Physico-chemical parameters analyzed

The combined analysis of different descriptors makes it possible to determine the trophic level or, in other words, the state of aging or eutrophication of the lake. In the case of this study, the variables presented in Table III were used for this purpose. This table also presents criteria for interpreting the data obtained.

Table III. Description of the physico-chemical parameters analyzed during the quality monitoring of water and interpretation of data (Hade, 2003; Hébert and Légaré, 2000).

Variable	Description	Interpretation of data
Total phosphorus (ug/L)	• Nutrient essential for life, which regulates plant growth. • Is present in different forms in water (dissolved, associated with particles). • Is naturally not very available in the aquatic environment in its form that can be assimilated by plants.	< 4 (barely enriched) ≥ 4-7 (very slightly enriched) ≥ 7-13 (slightly enriched) ≥ 13-20 (enriched)

Variable	Description	Interpretation of data
		≥ 20-35 (significantly enriched) ≥ 35-100 (very clearly enriched) ≥ 100 (extremely enriched)
Chlorophyll α (ug/L)**	• Pigment present in all organisms that photosynthesize. • Indirect reflection of the quantity of phytoplankton (microscopic algae) suspended in the water. • Is related to the abundance of phosphorus in the water. < 1 (very low)	< 1 (very low) ≥ 1-2.5 (weak) ≥ 2.5-3.5 (weak) ≥ 3.5-6.5 (high) ≥ 6.5-10 (clearly high) ≥ 10-25 (very high) ≥ 25 (extremely high)
Transparency (metres)	• Thickness of the water column up to which the light enters. • Measured at the pit of a lake, using a Secchi disc. • Influenced by the abundance of dissolved organic compounds and suspended matter that color the water or make it cloudy, such as phytoplankton.	> 12 (extremely clear) ≤ 12-6 (very clear) ≤ 6-4 (clear) ≤ 4-3 (slightly cloudy) ≤ 3-2 (cloudy) ≤ 2-1 (very cloudy) ≤ 1 (extremely cloudy)

Dissolved organic carbon (mg/L)	• Comes from the decomposition of organisms, in wetlands and organic soils. • Strongly associated with the presence of humic acids, which are responsible for the yellowish or brownish color of the water. • Influences the transparency of the water. < 3 (lightly colored, very low impact on transparency)	< 3 (lightly colored, very low impact on transparency) ≥ 3-4 (slightly colored, low impact on transparency) ≥ 4-6 (colored, effect on transparency) ≥ 6 (highly colored, strong effect on transparency)

**when measured at the pit of a lake, using the methods and frequencies prescribed in the characterization protocols of the Voluntary Lake Monitoring Network https://www.environnement.gouv.qc.ca/eau/rsvl/index.htm (Source: personal communication, MELCC)*

***for values corrected without pheophytin interference*

2.2 Trophic levels of lakes

The trophic level of a lake tells us about its state of aging. In other words, it allows to know where the lake is in the process of eutrophication, which is illustrated in Figure 2.

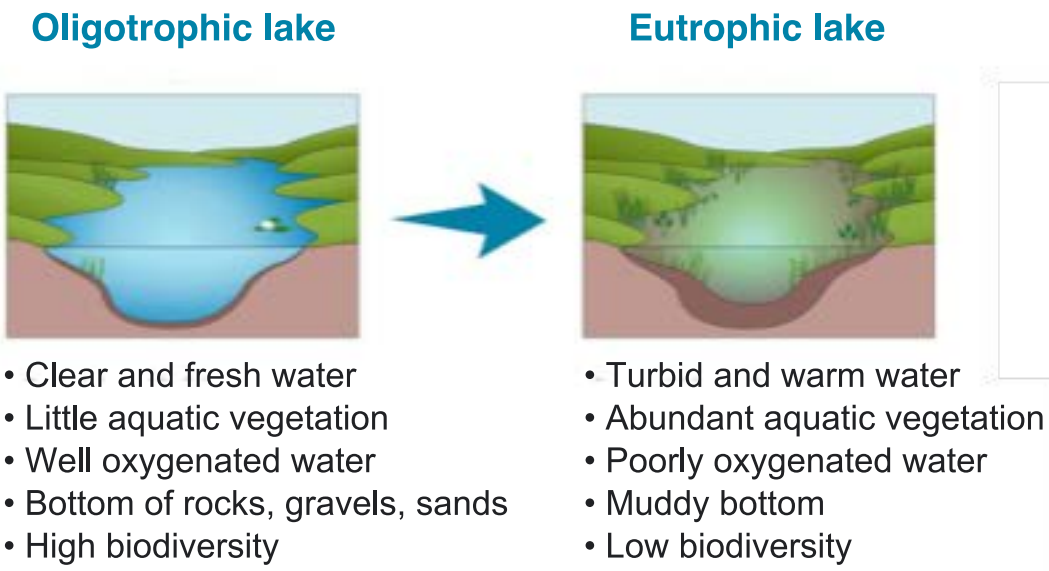

Figure 2. **The eutrophication process and its symptoms**

To determine the trophic state of the lake, the Ministry of the Environment and the Fight against Climate Change (MELCC) developed a classification based on the Carlson index (Carlson, 1977). For each variable, a scale is used (Figure 3). An average of the ranking obtained for these will determine the overall trophic status. Note that when transparency is considered downgrading, according to the criteria defined by the Ministry, it is excluded from the calculation (MELCC, 2021).

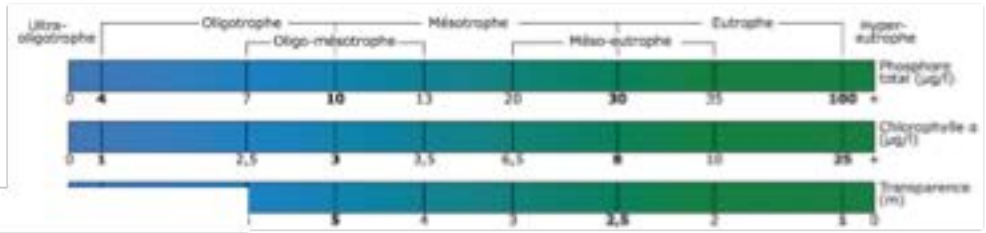

Figure 3 (next page). Trophic level classification according to total phosphorus, chlorophyll a and water transparency values (MELCC, 2021)

Table IV presents the interpretation of the trophic levels concerning the characteristics of the lake.

Table IV. **Trophic levels and associated characteristics (MELCC, 2022)**

Trophic level	Characteristics of the lake
Oligotrophic	"Young" lake poor in nutrients, transparent, generally well oxygenated. Low siltation and low production of aquatic plants.
Oligo-mesotroph	Intermediate stage between oligotrophic and mesotrophic.
Mesotrophic	“Relatively young” lake, moderately transparent, with moderate plant production. Biodiversity changes may occur. Meso-eutroph Intermediate stage between mesotroph and eutrophic.
Eutrophic	“Aging” lake rich in nutrients, aquatic plants and organic matter. Potential for modification of animal communities and loss of biodiversity linked to an oxygen deficit at depth.

2.3 Bacteriological water quality criteria

Faecal coliforms are bacteria from the digestive system of warm-blooded animals, the largest proportion of which corresponds to the bacterium E. coli.
“Their presence in a body of water therefore necessarily indicates contamination by feces and the microbes associated with it” (MDDEFP, 2013). Faecal coliforms can be used as indicators of pollution of faecal origin which, depending on the concentrations, may pose a risk to human health in the context of swimming and other recreational uses of a body of water. In its recommendations for the quality of water used for recreational purposes in Canada published in 2012, Health Canada specifically recommends the use of E. coli as a more specific indicator of faecal contamination than faecal coliforms (MELCC, 2021A).

Table V presents the bacteriological water quality criteria established by the MELCC to assess the quality of bathing water. Note that for concentrations above 200 CFU or E coli. per 100 ml, activities involving direct contact with water are compromised (swimming, water skiing,

sail, etc.). When these concentrations are greater than 1000 CFU or E coli. per 100 ml, all recreational uses, including indirect contact with water, are compromised. The water is then considered unsafe.

Table V. **Classification of the bacteriological water quality of water bodies (MDDEFP, 2013 and MELCC, 2021A).**

Water quality	Faecal coliforms (CFU/100 ml) or E.coli./100ml	Explanation
Excellent (Class A)	0-20	All recreational uses permitted
Good (Class B)	21-100	All recreational uses permitted
Fair (Class C)	101-200	All recreational uses permitted
Polluted (class D)	≥ 201	Swimming and other direct contact with water compromise

* UFC: Colony forming unit

3 RESULTS OF WATER QUALITY MONITORING AT GAUVREAU LAKE

3.1 Pit water quality

Unfortunately, few recent data are available on the physicochemical variables necessary to determine the trophic status of Lake Gauvreau. In fact, several phosphorus data were collected at different locations in the shallow zone and some tributaries of Lac Gauvreau. However, few of these were collected at the lake pit and already date back fifteen years.

Table VI presents the average results obtained following water quality sampling at the Gauvreau Lake pit by the University of Ottawa from 2002 to 2005.

Table VI. **Results of water quality sampling at the Lac Gauvreau pit**

Date	Phosphore total (µg/l)	Chlorophylle *a* (µg/l)	Transparence (m)
2002	21	-	1,8
2003	20	11,7	1,7
2004	21	13,9	2,0
2005	19	14,3	1,9
Moyenne 2002 à 2005	**21**	**13,3**	**1,8**

The combination of the different variables analyzed shows that Lake Gauvreau had, some fifteen years ago, the characteristics of a relatively old lake, i.e. **meso-eutrophic** (Figure 4)

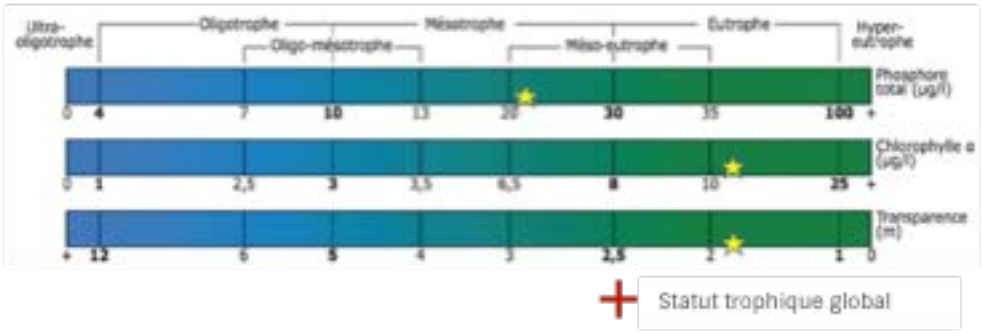

Figure 4. **Evaluation of the trophic status of Lac Gauvreau using multi-year averages of total phosphorus, chlorophyll A and water transparency collected at the lake pit**

T**he lake is significantly enriched in phosphorus** (average concentration of 21 µg/L) and the level of chlorophyll A is very high (average concentration of 13.3 µg/L). The water in the lake is very cloudy, with an average transparency of 1.8 meters (Table III).

Note that a DOC concentration of approximately 8 mg/L was measured a few times in two bays in 2021. Although this was not measured at the pit, it seems to indicate a very strong coloration of water, which could have a major impact on transparency.

3.2 Swimming water quality

From 2002 to 2021, 633 faecal coliform or E. coli were carried out at Lac Gauvreau, as well as in the Parent and Bélisle streams. Parent stream was the most monitored sector with 218 samples collected both upstream and at the outlet of the tributary.

The average values for the vast majority of sectors are representative of "excellent" or "good" category water for swimming, with the exception of the streams in Parent and Bélisle. For these sectors, the maximum values observed exceed the criteria allowing indirect contact with water (the water is considered unhealthy), such as boating and fishing for example (Table VII).

Table VII. Number of samples, average and maximum values of faecal coliforms or E coli. in different sectors of Lac Gauvreau

Sector	Number of smples	Moyenne de coliformes fécaux or E. coli. (UFC or Nbr/100 ml)	Maximum value of faecal coliforms or E. coli. (CFU or Nbr/ 100 ml) or E. coli. (UFC or Nbr/100
BAIE ST-ALPHONSE	95	29	890
BAIE MURRAY	91	5	67
NORD ÎLE	57	8	52
EST	37	7	71
PLAGE	37	18	210
EXUTOIRE	24	57	880
Ruisseau à Parent	218	414	3300
Ruisseau Bélisle	26	227	3300
Autre	10	4	8
Total général	**633**	**165,9**	**3300**

For all sectors, the vast majority of samples taken were representative of water of good or excellent quality for swimming. However, 159 samples, or 73% of the samples taken from the Parent stream, indicate water of fair (25%) or polluted (48%) quality (Table VIII).

Table VIII. **Number of samples according to the classification of the bacteriological quality of the water by**

Secteur / Catégorie - Baignade	A	B	C	D	n/d	Total général
BAIE STE-ANNE	32	5	1	-	-	38
BAIE ST-ALPHONSE	67	12	3	1	12	95
BAIE MURRAY	86	4	-	-	1	91
NORD ÎLE	52	4	-	-	1	57
EST	33	4	-	-		37
PLAGE	24	3	1	1	8	37
EXUTOIRE	15	7	1	1		24
Ruisseau à Parent	16	34	54	105	9	218
Ruisseau Bélisle	9	10	4	3		26
Autre	6		-	-	4	10
Total général	**340**	**83**	**64**	**111**	**35**	**633**

In 2021, two of the three samples taken from the Parent stream showed "fair" or polluted water quality for swimming. All other stations were found to have “excellent” water quality (Table IX).

Table IX. **Results of the analysis of fecal coliforms in the Parent stream in 2021**

Sampling date	**Station-sector**	**Number of E. coli /100 ml**
2021-07-	05 Stream in Parent	250
2021-08-	05 Stream in Parent	180
2021-09-	21 Stream in Parent	52

4 RECOMMENDATIONS

Lake health

- Follow the protocols of the Voluntary Lake Monitoring Network (RSVL) in order to assess the health of the lake in the long term.

o In order to determine the state of health of a lake, the concentrations of total phosphorus and chlorophyll A as well as the transparency of the water, must be measured at the lake pit (deepest place) in the first meter of water. Samples must be taken at a certain frequency. For example, sampling should be done three times during the summer. Water transparency must be assessed at least ten times between the months of May and October (MELCC, 2022). The monitoring of Lac Gauvreau as part of the RSVL program in 2022 will make it possible to carry out these analyses.

- Complete these measurements with a characterization of the littoral zone (aquatic plants and periphyton).

o Periphyton includes microscopic organisms (algae, bacteria, protozoans and metazoans) and detritus that accumulate on the surface of objects (rocks, branches, dock pillars and others) in the aquatic environment. Having access to the nutrients that come from the soil before these are diluted in the mass of open water, the periphyton is the first community to react to the nutrient inputs linked to the development of the resort. Thus, determining the biomass of the chemical composition of littoral algae may prove to be a more effective tool for early detection of lake disturbance compared to conventional methods based on pelagic characteristics (MDDEP, CRE Laurentides and GRIL, 2012; Lambert, Cattaneo and Carignan, 2008; Lambert, 2006).

o The number of dwellings in the drainage unit is directly correlated to the biomass of submerged macrophytes in recreational lakes (Greene, 2012; Denis-Blanchard, 2015). Thus, the characterization of aquatic plants, including their cover, can be useful in analyzing the state of health of a lake.

Hydromorphology

It is important to use specialized scientific equipment to perform, in particular, vertical profiles at the Lac Gauvreau pit. This monitoring would make it possible to obtain data on water temperature, dissolved oxygen concentrations, conductivity, pH and would thus improve our understanding of the functioning of the lake ecosystem. In addition, accurate bathymetric surveys would provide essential information, such as lake volume, water renewal time, maximum depth, average depth, etc.

o The data taken at the pit of a lake with a probe makes it possible to determine if the body of water is subject to the phenomenon of thermal stratification during the summer. This information is essential to better understand the productivity of a water body. Indeed, shallow unstratified water bodies or ponds are generally more productive than lakes. The dissolved oxygen concentrations of a lake constitute an additional element of evaluation for the classification of its trophic level (oligotrophic, mesotrophic, eutrophic). However, in several lakes, completely natural causes explain the oxygen deficits observed at depth during the summer.

o The analysis of the morphometric characteristics of a body of water is essential to understanding the various processes associated with its functioning and its productivity. The distribution of dissolved gases, the abundance of nutrients and the variety of living organisms, among others, are influenced by the morphometry of the lake (Hade, 2003).

- Mapping the Lake Gauvreau watershed would also make it possible to begin the analysis of the natural and anthropogenic factors that can influence the health of the lake. Since the lake is now listed in the RSVL, this should be carried out by the MELCC team in 2022 and published in the Water Atlas.

Swimming water quality

- Follow the recommendations of the Environment-Beach program for the analysis of the quality of swimming water at the beach (Campsite beach). Considering that it is near the mouth of the Parent stream, which shows high concentrations of fecal coliforms or E. coli for years, it would be very relevant to carry out an annual follow-up at this site throughout the swimming season (MELCC, 2021A).

- Since the other resorts have, most of the time, “excellent” or “good” water quality for swimming, systematic annual monitoring at all of them does not seem necessary. However, the measurement of E. coli in the Parent stream should be maintained. For more details, you can consult the documentation on monitoring the quality of small watercourses (Hébert and Légaré, 2000). In addition, it could be interesting to carry out the characterization of benthic macroinvertebrates in this stream (MELCC, 2022A).

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