Surface water analysis for the Municipality of the Township of Gore

2024

REPORT PRESENTED AS PART OF THE MONITORING OF SURFACE WATER QUALITY IN THE TOWNSHIP OF GORE

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Canton de Gore

Gore... Un choix naturel !

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Introduction

The environment is present in every sphere of our lives. Whether it's transportation, development or the economy, the environment is a central issue in our community. Quebec has around 3% of the world's freshwater reserves (Stratégie Québécoise d'économie de l'eau potable, MAMH 2023). Just under 1% of all drinking water is represented by lakes in our environment (Beeton, A.M., 2002). Lakes are of vital importance for ecosystems, biodiversity, transportation, agriculture and recreation. Gore Township has over 300 lakes, 36 of which are named. A total of 13 lakes of interest are considered important for community and recreational purposes. A complex hydrographic network of waterways and wetlands links all these lakes, forming a vast and diverse watershed. We are blessed in our region with open spaces and clean air, but residential and commercial development remains one of the most significant pressures on these environments. The Environmental Policy of the Municipality of the Township of Gore emphasizes several points related to surface water quality, in particular the protection of lakes and watersheds, which is defined as follows:

- Monitor and observe the presence of harmful bacteriological species in lakes.
- Raise public awareness of excessive nutrient inputs (phosphorus, nitrogen, etc.).
- Reduce and control erosion and sediment transport to water bodies.
- Eliminate sources of chemical contamination (pesticides, heavy metals, hydrocarbons, etc.).
- Reduce eutrophication and accelerated aging of lakes.
- Reduce and control anthropogenic pressures threatening the integrity of water environments.

In 2004, the *ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs* (MELCCFP) founded the *Réseau de Surveillance Volontaire des Lacs* (RSVL). A partnership between the Ministry and independent lake associations was created to monitor the water quality of lakes and acquire knowledge for their protection. For several years now, lake associations have been taking care of the health of their water bodies, and actively participating in the RSVL program. In addition, it is essential for the Municipality to apply current provincial regulations on the disposal of wastewater from septic systems (R.R.Q., c. Q-2, r.22).

Monitoring is essential due to the number of older facilities that may be showing reduced efficiency in their filtering potential. To improve our knowledge of surface water quality on our territory, we decided to focus on the watercourses and various tributaries of our lakes. Here are the results of our 4th consecutive year of analyses of these points.

Analyses are carried out by H2Lab, an accredited laboratory of the *Centre d'Expertise en Analyse Environnementale du Québec* (CEAEQ) in Ste-Agathe-des-Monts. Two sampling rounds were carried out for the year 2024.

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Definitions

Aerobic: Refers to a microorganism or a biological action requiring the presence of oxygen.

Anaerobic: Refers to a microorganism or a biological action not requiring the presence of oxygen.

Anthropic: Refers to a landscape, terrain, topography or an element whose modification is essentially the result of human intervention.

Bacteria: Microscopic unicellular being with complete reproductive machinery and genetic material that can be passed on to the next generation. Bacteria are living beings in their own right.

Biodiversity: Diversity of genetic characteristics found in plants and animal species in each territory.

Biomass: The total mass of all living species occupying a specific space at a specific time. Biomass can me animal, plant, microscopic, etc. Can also be considered as biodegradable part of biological products.

CFU: CFU (colony forming units) is a measure to determine the presence of live bacteria in each sample. This value is calculated by counting the number of viable bacterial colonies on an agar plate following the culture of a diluted sample. Depending on the volume of medium cultured and the ratio of colonies counted, it is possible to determine approximately the density of live bacteria in a sample.

Dystrophy: Condition affecting the trophic state of a lake characterized by a high concentration of humic substances and organic acids. Causes colored water and acidic conditions unfavorable to biodiversity. Not a trophic state in itself.

Dissolved state: Solute incorporated in a solvent to form a homogeneous mixture known as a solution.

Eutrophication: The accumulation of large amounts of nutrients (especially phosphorus and nitrogen) in a body of water such as a lake or pond. The nutrient input induces the growth of algae and aquatic plants. Eutrophication is a natural and normally very slow process of lake aging.

Humus: The most biologically active top layer of soil. This layer is created and maintained by the decomposition of organic matter through the combined action of animals, bacteria and fungi.

Lake trench: The deepest point of a lake or body of water where sampling is done. The pool is identified on lake bathymetric maps.

Limnology: Science studying lakes and water bodies in our environment.

Microorganisms: Microscopic living organisms such as bacteria, fungi and yeast. Microalgae can be included in this category.

Oxidation-reduction: Also known as redox, this is a chemical reaction in which electrons are transferred. The oxidizing reaction is therefore linked to a reducing reaction. One element will capture electrons (oxidizing) released by a second element (reducing). These reactions can either emit or consume energy. Cellular respiration and photosynthesis are examples of oxidation-reduction processes. Rust forming on iron is also a redox process.

Peat bog: Peat bogs are a type of wetland characterized by increased organic matter production and low decomposition due to the flooded anoxic environment. Peatlands are essential carbon sinks. Two types of peatlands will be discussed: ombrotrophic (bogs) and minerotrophic (fen).

pH: Scale for measuring hydrogen potential (proton or hydrogen ion activity) in an aqueous solution. pH is used to measure the acidity or basicity of a solution. A pH of 7.0 is considered neutral. The lower the pH, the more acidic the solution (lemon juice pH 2.4). The higher the pH, the more basic the solution (bleach pH 11.5).

Photosynthesis: Photosynthesis converts light energy into stable chemical energy that can be used by plants and other photosynthetic organisms. The process takes place in chloroplasts. These chlorophyll cells convert inorganic matter (photons) into organic matter (sugars). This function occurs mainly in plants.

Stream: Any body of water with regular of intermittent flow, including those that have been created or modified by human intervention. An intermittent stream has a flow that is directly dependant on precipitation or snowmelt and is completely dry during certain times of the year. Regular streams flow in all seasons, during periods of high or low rainfall and drought.

Transparency: A parameter used to measure the capacity of light to penetrate a medium (water) and thus allow aquatic autotrophic organisms to synthesize their

energy by photosynthesis. Light is essential to aquatic life and a disturbance of the transparency can compromise the food chain and thus the plant and animal diversity of the ecosystem.

Tributary: A stream that is affluent to a body of water. Water runoff moves with the terrain and is transported to surface waters by tributaries.

Trophic level: Level of eutrophication of a lake or body of water based on different parameters such as water transparency, abundance of plan biomass and concentration of nutrients. In total, 3 major levels are used in the characterization of water bodies:

Oligotrophic: Clear and low-nutrient waters, deep water bodies and low biological productivity.

Mesotrophic: Higher nutrient levels and moderate biological productivity. Higher algae and aquatic plant growth may be observed as well as lower transparency.

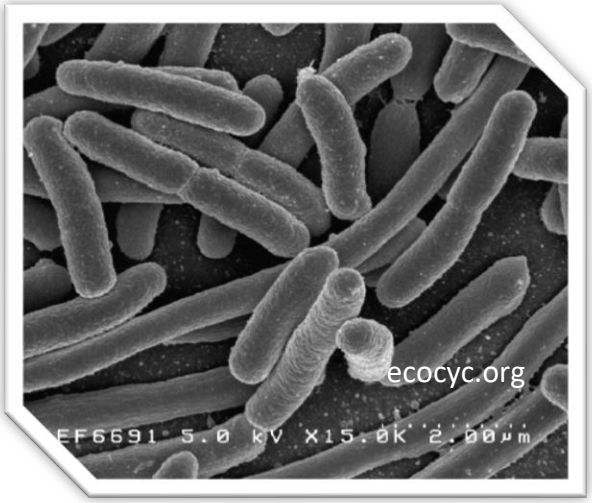
Eutrophic: Very large amount of nutrients, high biological proliferation that can result in a loss of plant and animal species diversity.

Watershed: A geographic area that receives precipitation and runoff from an entire territory. A watershed represents the surface and groundwater connectivity of a distinct region.

Studied parameters

To obtain a detailed picture of the state of the lakes in the region, it is necessary to determine the key parameters to be studied. The following parameters have been selected for their relevance and reliability. The primary objective of monitoring water quality is to prioritize and optimize the management of water, which is a common heritage of the utmost importance. It is also possible to monitor the trophic status of our lakes to track their aging and changes over time.

Bacteriological analysis



Surface water naturally contains a wide variety of microorganisms. These are essential for the decomposition of organic matter and the recycling of nutrients to sustain aquatic life. A key bacteriological indicator of surface water quality is the measure of **fecal coliforms**. Despite their name, not all coliforms are of fecal origin, and may be of industrial or natural origin, in which case they may be referred to as thermotolerant coliforms. Most coliforms are represented by one species, ***Escherichia coli*** (80-90%). They also include *Citrobacter*, *Enterobacter* and *Klebsiella*, rod-shaped bacilli.

Contaminated water can happen for a variety of reasons. It may be due to the proximity of agricultural areas, or to non-compliant or even non-existent septic systems. Bacteria found in high concentrations may be responsible for gastrointestinal illness, respiratory tract disease or skin irritation such as bather's dermatitis.

Criteria and standards:

The presence of coliforms, even in low concentrations, indicates that the water is not drinkable. For water to be of adequate quality for direct skin contact, the concentration of coliforms must be below the threshold of 200 CFU/100ml.

Table I: Water quality according to bacteriological concentration

CFU/100ml	Recreational water quality
0-20	A – Excellent
21-100	B – Good
101-200	C – Acceptable
201 et +	D – Contaminated

Bacteriological presence is not related to eutrophication of a water body. Rather, it is caused by excessive inputs of nutrients such as phosphorus and nitrogen. Unlike phosphorus, which accumulates, populations of microorganisms of fecal origin decrease rapidly in surface waters. The proliferation is stimulated by temperature increases and extensive mixing of waters by recreational and natural activities.

Total Phosphorus (TP)

Phosphorus is a nutrient that occurs naturally in low concentrations in the environment, around 10 and 50 µg/L in water that is little or unaffected by human activity (MELCCFP, 2004). It is a limiting nutrient, meaning that it is found in limited quantities but is essential for the growth of plant species. There is a strong relationship between the concentration of phosphorus, the abundance of algae and aquatic plants, and the trophic level of the lake. A higher concentration of total phosphorus indicates a eutrophic state. Phosphorus can be found under 3 different states: organic, inorganic and dissolved organic. Total phosphorus represents all the phosphorus found in a sample in the form of phosphates or organophosphorus compounds (Centre d'expertise en analyse environnementale du Québec, 2011). Nutrients in their inorganic form are the most used by aquatic plants and algae. Phosphorus, for example, has the ability to bind to lake sediments. During periods of heavy use, the sediment is resuspended by boaters and the stored phosphorus is released back into the water. Sources of phosphorus can be natural or anthropogenic, such as fertilizers, soaps containing phosphate or effluents from defective septic systems.

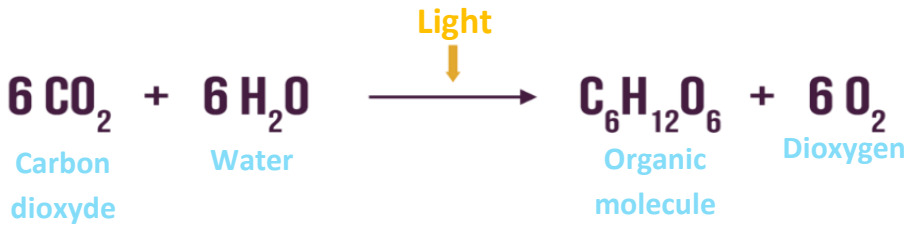
Table II : Phosphorus concentration chart and interpretation.

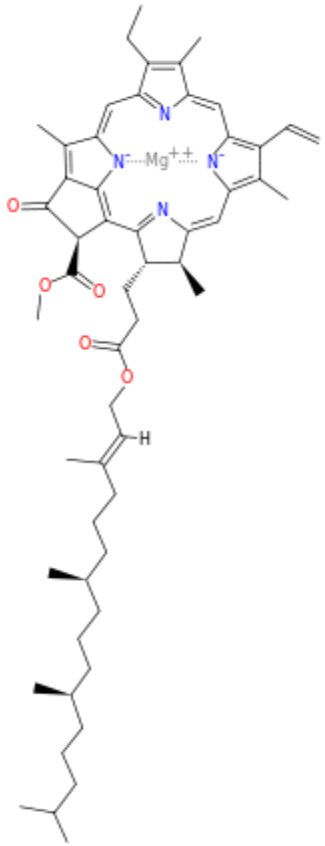
(CRE Laurentides, 2016).

Total Phosphorus (µg/L)	Water enrichment
< 4	Barely enriched
>4-7	Very low enrichment
>7-13	Low enrichment
>13-20	Enriched
>20-35	Significantly enriched
>35-100	highly enriched
>100	Extremely enriched

Chlorophyll α

Chlorophyll α is a green pigment found in the composition of plants and algae. It is this pigment that is responsible for the green hue of various aquatic and terrestrial plant species. Chlorophyll is used in the process of photosynthesis and therefore in the creation of energy using light. The quantification of this parameter is a good indicator of the biomass of aerobic photosynthetic organisms (excluding cyanobacteria) found suspended in a water body. The measurement of chlorophyll α is done by fluorometry. As the concentration of chlorophyll increases, so does the concentration of nutrients, such as phosphorus. An increased presence of suspended algae is a sign of lake eutrophication (Filazolla *et al.* 2020).





American chemical society, 2019

Table III: Chlorophyll α concentrations and its impact on water

(CRE Laurentides, 2016).

Chlorophyll α (µg/L)	Presence
< 1	Very low
>1-2,5	Low
>2,5-3,5	Slightly elevated
>3,5-6,5	Elevated
>6,5-10	High
>10-25	Very high
>25	Extremely high

Dissolved organic carbon (DOC)

Dissolved organic carbon (DOC) is a product of the decomposition of plant and even animal species. Understanding the carbon cycle is critical to grasp the importance of this compound. Lakes play a critical role in biogeochemical cycles and contribute to climate regulation (Sobek, S., *et al*, 2006). Lakes can accumulate as much carbon in their sediments as is accumulated in the entire ocean for a similar duration (Downing, et al, 2006). A higher concentration of DOC causes a yellowish or brownish coloration of the water due to the presence of humic acid (as seen in the picture). DOC concentration directly influences water transparency, temperature, biogeochemical processes, trophic chain, and surface water ecosystem productivity (Solomon *et al*.,2015). By having a more pronounced coloration, light has a much more significant barrier to cross which directly influences the thermocline, the thermal transition zone separating the epilimnion from the hypolimnion (Solomon *et al*.,2015).

Zhang, Jan (2008)

Table IV: Dissolved organic carbon concentrations and its influence on water coloration.

(CRE Laurentides, 2016).

DOC Concentration (mg/L)	Coloration	Impact
<3	Low coloration	Very low impact
>3-4	Lightly coloured	Low
>4-6	Coloured	Significant
>6	Very coloured	High

Urbanistic pressure

Accelerated regional development is a major factor in surface water quality. In recent years, residential development has seen an exponential increase and an influx of new residents into the region. Residential developments abound, increasing deforested and waterproofed surfaces, as well as possible intrusion into sensitive areas. Excessive deforestation and soil degradation lead to increased sedimentation in rivers and lakes. It is vital to promote sustainable development, conservation of sensitive environments (wetlands and waterways) and public awareness of current issues.

Lakes are densely populated with residential properties, and very few vacant lots are still available. New real estate development is therefore concentrated elsewhere, close to other sensitive habitats such as streams and wetlands. The latter are subject to strict regulations concerning their protection and conservation (RAHMMS, REAFFI, LQE). Regulatory changes are made at different levels of application, whether municipal or provincial. With the new environmental challenges we've been facing in recent years, regulations can only become increasingly severe to ensure the protection of remaining natural environments and promote the restoration of those that have been destroyed.

Invasive exotic aquatic species

Invasive exotic plants are a growing phenomenon in Quebec, particularly in the Laurentians. These include Japanese Knotweed, Giant Butterbur and Giant Hogweed. An aquatic species that is causing a great deal of concern is **Eurasian water milfoil**, an invasive plant that reproduces through fragmentation. Fragmentation results from the detachment of pieces of the plant, which in turn can form new entities. Global warming and the loss of good navigation habits are at the center of this species' proliferation. The Municipality is taking serious, tangible steps to limit the spread of milfoil by making it mandatory for boats to be washed when they are launched each year, or when they move from one lake or region to another. The active participation of residents is essential to prevent the arrival of this species on our territory. Fortunately, Eurasian watermilfoil is not present in our lakes at the moment.


CRE Laurentides, 2018

Another exotic species observed in recent years is the **Chinese mystery snail** (*Cipandopaludina chinensis*). This is a small freshwater mollusc native to East Asia. It is known to reproduce easily and rapidly, which can disrupt aquatic environments. The main disruption is to the food chain. By feeding on phytoplankton and decomposing organic matter, the Chinese snail can alter aquatic food chains. It can also compete with native species, reducing biodiversity. It has also been reported that this species can carry parasites that can affect other aquatic species. The effects on humans and long-term impacts of this species are still under study. Supervision by residents is therefore necessary to monitor the progress of this species.


CTV, 2024

Measures taken by the Municipality to limit the premature aging of sensitive environments

The Municipality carries out annual inspections of shoreline protection strips, and helps citizens in planning revegetation, as well as in selecting and planting native vegetation (native to our region). Permanent and seasonal residents have access to documentation designed to raise awareness and encourage the application of good shoreline practices. Most lakes in the region are represented by an association that oversees RSVL's water analyses, the maintenance of peace and tranquility, and compliance with existing regulations. All work on the shore or in sensitive areas must be studied in advance by municipal inspectors and requires permits or certificates of authorization. Municipal and Provincial by-laws are enforced by municipal officers and must be respected by residents of the territory. It is very important to ensure cooperation between the various levels of government regarding regulations aimed at protecting the environment. Over the past year, a multitude of new regulations and amendments to existing laws have been presented to municipal officers. The study of these new laws and amendments is essential to their fair and proper application.

In the event of non-compliance with the by-laws, sanctions are provided for and applied by the Municipality and the Ministries concerned. Corrective measures are also required to bring the property back into compliance, or to cease activities in violation of the law.

Water sampling protocol

The following protocol was developed by the **Réseau de surveillance volontaire des lacs** (RSVL) in collaboration with **MELCCFP** (2017) and **CRE Laurentides** (2016). The parameters studied by the RSVL are total phosphorus (TP), α-chlorophyll, dissolved organic carbon (DOC) and transparency. We therefore chose to study the same parameters but to add bacteriological analysis. Unlike the tests carried out by the lake associations, the sampling protocol does not include the measurement of transparency. This parameter is measured at the deepest point of the lake, using a Secchi disk. It is impossible to measure transparency in a watercourse using this method.

The sampling stations are the same as for the last 3 years, to ensure continuity of data collection. However, we are adding a new point this year, at the boat launch at the Beattie Lake Nature Park (**LBT-1**). Samples are taken by the inspector over a single day. Prior to sampling, the weather must be clear and there must have been no precipitation in the last 48 hours to limit dilution of the parameters measured. Sample bottles are handled in such a way as to protect the sterile field during sampling. The coolers containing the samples are then collected by a shipping company and transported directly to the environmental analysis laboratory. Samples are therefore processed rapidly, enabling the most accurate and representative results to be obtained.

Results interpretation limits

It should be emphasized that the interpretation of the results is based on a scientific approach using random data collection. Comparative monitoring of sampling stations is required to identify major trends in nutrient inputs and watercourse parameters. The data collected cannot be compared with drinking water quality standards, but these standards will be referred to.

Results

Table V: Geographical coordinates of the sampling points

Sample	ID	Location	Longitude	Latitude
1	LRA-1	Lake Ray- tributary	74°13'37.61"O	45°45'26.55"N
2	LWI-1	Lake William- tributary	74°13'56.04"O	45°44'25.37"N
3	LDA-1	Lake Dawson- tributary	74°15'28.15"O	45°45'4.22"N
4	LCH-1	Lake Chevreuil- tributary	74°12'32.87"O	45°43'33.91"N
5	BRW-1	Ch. Brown, unnamed stream 17	74°17'27.67"O	45°47'41.20"N
6	SCO-1	Ch. Scott, unnamed stream 7	74°14'41.22"O	45°47'29.81"N
7	CAM-1	Ch. Cambria, towards Lake Ray Nord	74°13'31.85"O	45°45'41.98"N
8	LSU-1	Lake Sunset- Ruisseau-William tributary	74°15'9.10"O	45°47'23.66"N
9	LBI-1	Lake Bird-tributary	74°13'21.62"O	45°47'14.33"N
10	LBA-1	Lake Barron- west tributary	74°15'4.93"O	45°46'57.12"N
11	LBA-2	Birch rd. lake Barron: Ruisseau William	74°14'29.87"O	45°47'2.98"N
12	LBA-3	Ch. Halbert towards Barron	74°13'22.54"O	45°46'57.51"N
13	LCA-1	Lake Caroline-Ruisseau Williams from Barron	74°14'25.94"O	45°46'33.48"N
14	LSO-1	Lake Solar- Ruisseau Williams from Caroline	74°14'38.31"O	45°46'16.44"N
15	LEV-1	Lake Evans, ch. Sherritt- intermittent	74°14'21.71"O	45°46'0.80"N
16	LSR-1	Lake des Sources- from Cambria	74°13'9.30"O	45°45'37.81"N
17	LRO-1	Lake Robert- exit of East River	74°18'20.45"O	45°45'13.70"N
18	LGA-1	Lake Grace- Exit from Braemar	74°19'2.40"O	45°45'57.25"N
19	LBT-1	Lake Beattie – Boat Launch	74°15'34.00"O	45°43’34.00"N

Table V shows sample numbers, identification codes, description of location, and geographic coordinates associated with each sampling point.

Table VI: Data obtained from laboratory analyses of samples taken from lake tributaries and streams (means).

Sample	ID	DOC (mg/L)	Chlorophyll-α (µg/L)	Bacteriology (CFU/100 ml)	P TOTAL (µg/L)
1	LRA-1	6,200	2,500	10,500	18,150
2	LWI-1	18,450	1,200	10,500	13,500
3	LDA-1	5,150	1,265	16,500	6,750
4	LCH-1	5,100	8,000	289,000	14,450
5	BRW-1	8,200	2,100	24,500	11,350
6	SCO-1	11,600	0,610	30,000	9,800
7	CAM-1	11,100	0,960	6,500	56,000
8	LSU-1	9,800	0,895	20,000	12,650
9	LBI-1	10,350	0,900	7,500	9,750
10	LBA-1	4,600	0,855	12,000	10,450
11	LBA-2	7,200	0,475	12,500	7,450
12	LBA-3	4,150	1,055	35,500	19,000
13	LCA-1	4,900	1,095	5,500	7,500
14	LSO-1	5,600	4,350	5,500	5,100
15	LEV-1	4,750	5,350	6,500	6,950
16	LSR-1	8,850	3,145	8,000	14,300
17	LRO-1	6,000	1,350	5,000	6,900
18	LGA-1	4,600	4,300	0,000	7,050
19	LBT-1	5,800	2,300	1,000	6,900

The colors used in the table above give a visual indication of the standards to be met. Green boxes show data that do not pose a problem or require close monitoring. Yellow boxes show data within the limits to be monitored, with levels slightly higher than the expected normal. Boxes in orange and red are data that exceed normally expected thresholds. These samples should be monitored to ensure that good water quality is maintained and to slow the aging of our water bodies. As two sampling rounds were carried out, the data represents the average of these rounds. The color code in the sample identification column is used to represent points in similar sectors of the municipal territory.

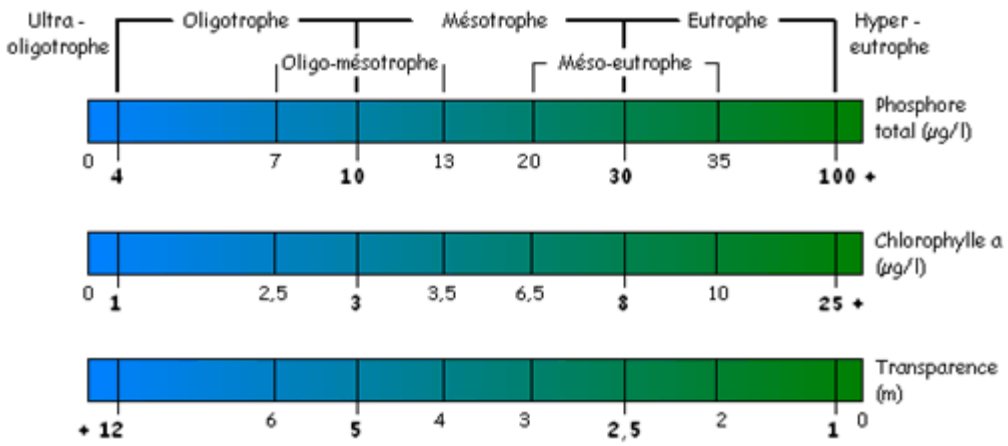


Figure 1: Chart of parameters studied by MELCCFP

Using the data collected, it is possible to position the surveyed sample on Figure 1 and thus determine the overall condition of the stream or tributary. The scales in Figure 1 are used by the Ministry of the Environment to classify the condition of water bodies in the territory. Therefore, these terms will be used in this report. Trophic indicators related to phosphorus input were first described by Robert Carlson (1977). It is not possible to determine the trophic status of a lake or an environment solely by the concentration of phosphorus present. It is an index that can lead us to an adequate and precise analysis of the evolution of the eutrophication process in the water bodies of a territory.

Physicochemical analysis

The data collected is presented in this section in a graph. Notable results are highlighted and interpreted in the following analysis and recommendations section.

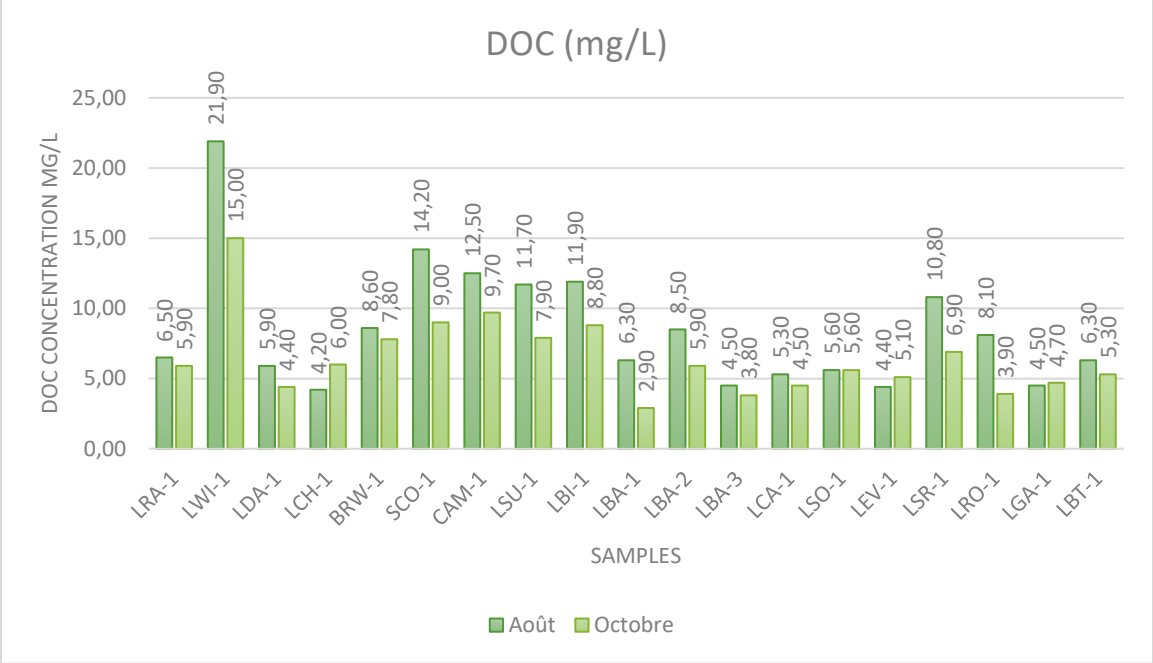


Figure 2: Concentration of dissolved organic carbon sampled in 2024

Dissolved organic carbon expresses the enrichment of the environment by organic matter such as simple or non-humic compounds (lignin and nitrogen compounds), humic compounds (natural biopolymers) and organic pollutants (PAHs, PCBs, pesticides, etc.). Carbon is an important nutrient for microorganisms, which in turn can form biofilms. A high concentration (over 6mg/L) indicates significant coloration of the water at the sampling point. The presence of beaver dams and their activity can also greatly influence DOC levels due to the large amount of decomposing organic matter (dead wood). The high concentration measured at point **LWI-1** is taken from a stream originating from a shallow water, Fen bog or marsh wetland. Peat bogs are known to be important carbon sinks, where organic matter is more important than decomposition due to high water saturation.

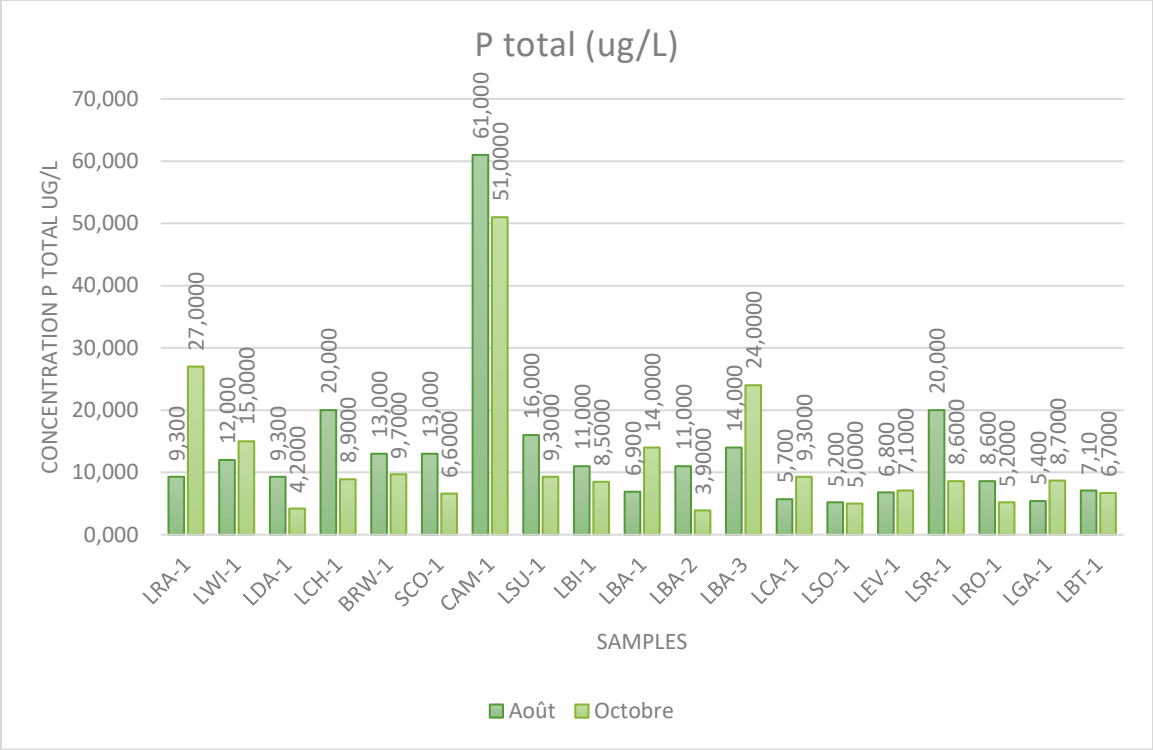


Figure 3: Concentration of total Phosphorus measured in 2024

Phosphorus is a limiting nutrient that controls the primary production of an environment. With a low concentration of total phosphorus, environments show a slower ageing process and therefore move less rapidly towards eutrophication. The highest concentration of total P is found at point **CAM-1**, along Cambria Road near Lac Ray Nord Road.

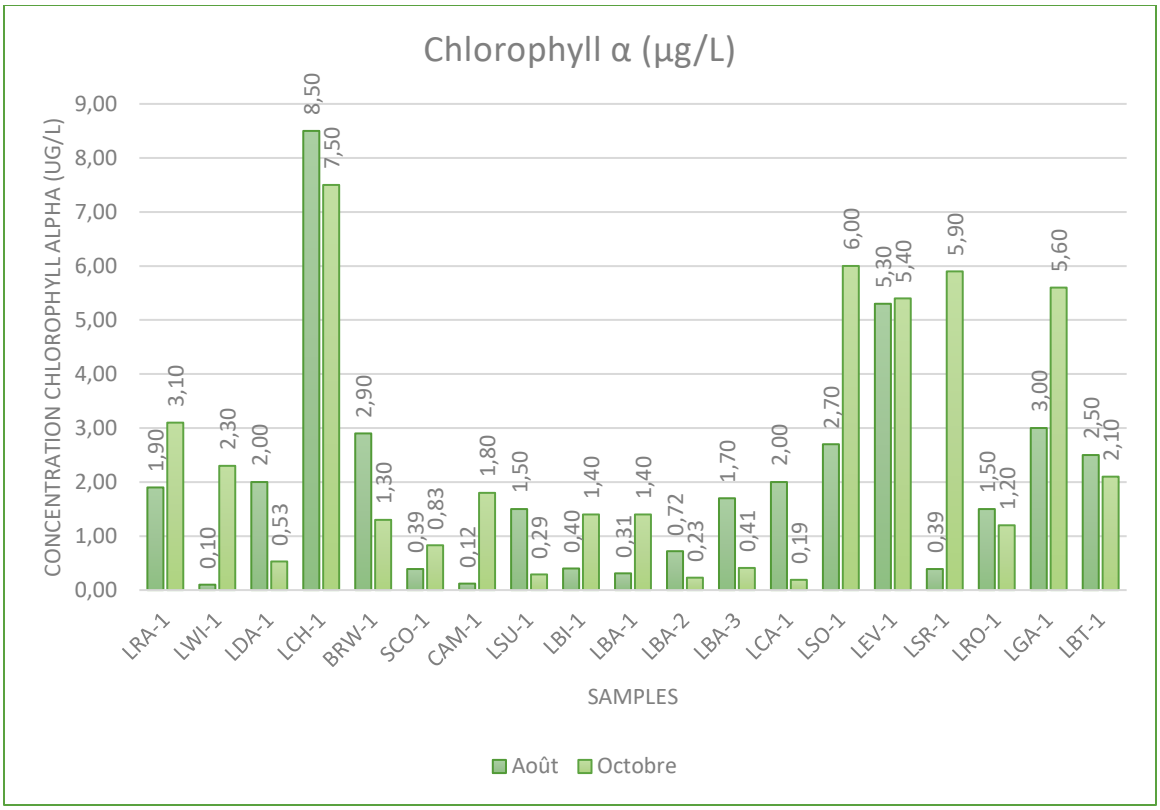


Figure 4: Concentration of chlorophyll α sampled in 2024

Chlorophyll α is a pigment found in terrestrial and aquatic plant species. Measuring the concentration of this pigment gives us a clue to the trophic state of a body of water, by informing us about the presence of microscopic algae in suspension. The highest concentration was measured at point **LCH-1**, a tributary of Lac Chevreuil.

Bacteriological results

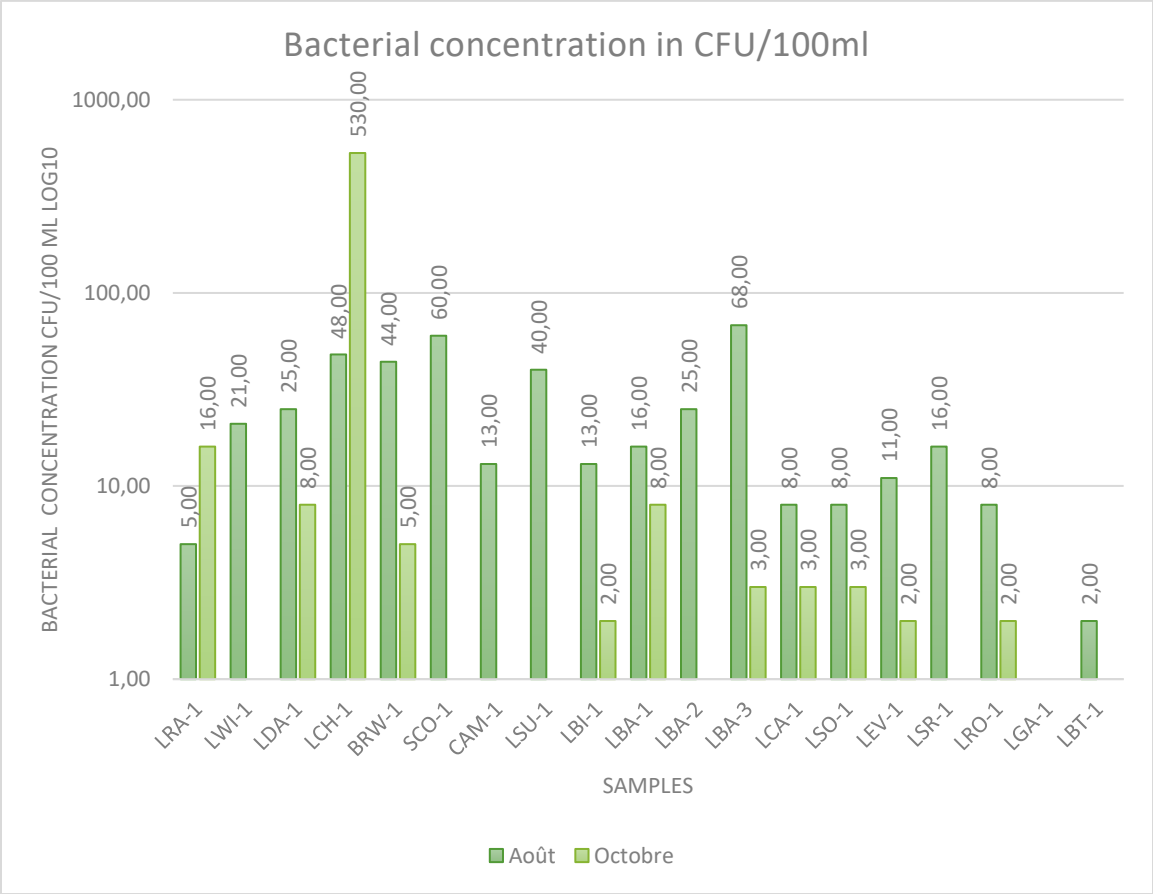


Figure 5: Bacterial concentration sampled in 2024

Bacterial concentration indicates the presence of living bacteria in a sample, in this case fecal coliforms. High bacterial concentrations have a direct impact on water quality, especially for water sports and recreational activities. Any water containing even the slightest concentration of bacteria is considered undrinkable. Some points do not show any data on the graph, this is due to a bacterial concentration in the sample that is too low for detection. The detection threshold for bacteriological analyses is 2 CFU/100 ml. The highest reading was recorded at point **LCH-1** in October.

Results for previous years

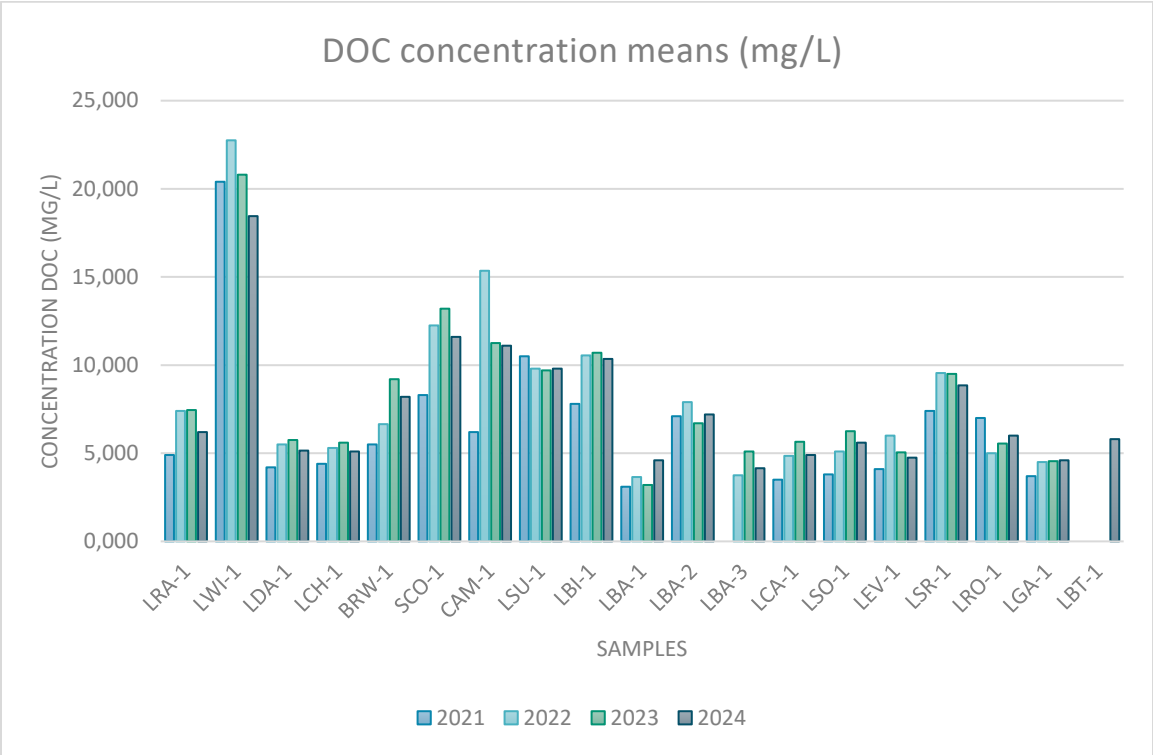


Figure 6: Average DOC concentrations measured from 2021 to 2024.

The point with the highest DOC concentration over the last 4 years is **LWI-1**. This point is sampled in a stream originating from a fen and marsh wetland. This type of wetland is a major carbon sink, given the large amount of organic matter it contains. The other data all follow similar trends, based on the temperatures recorded during the sampling years and the precipitation received.

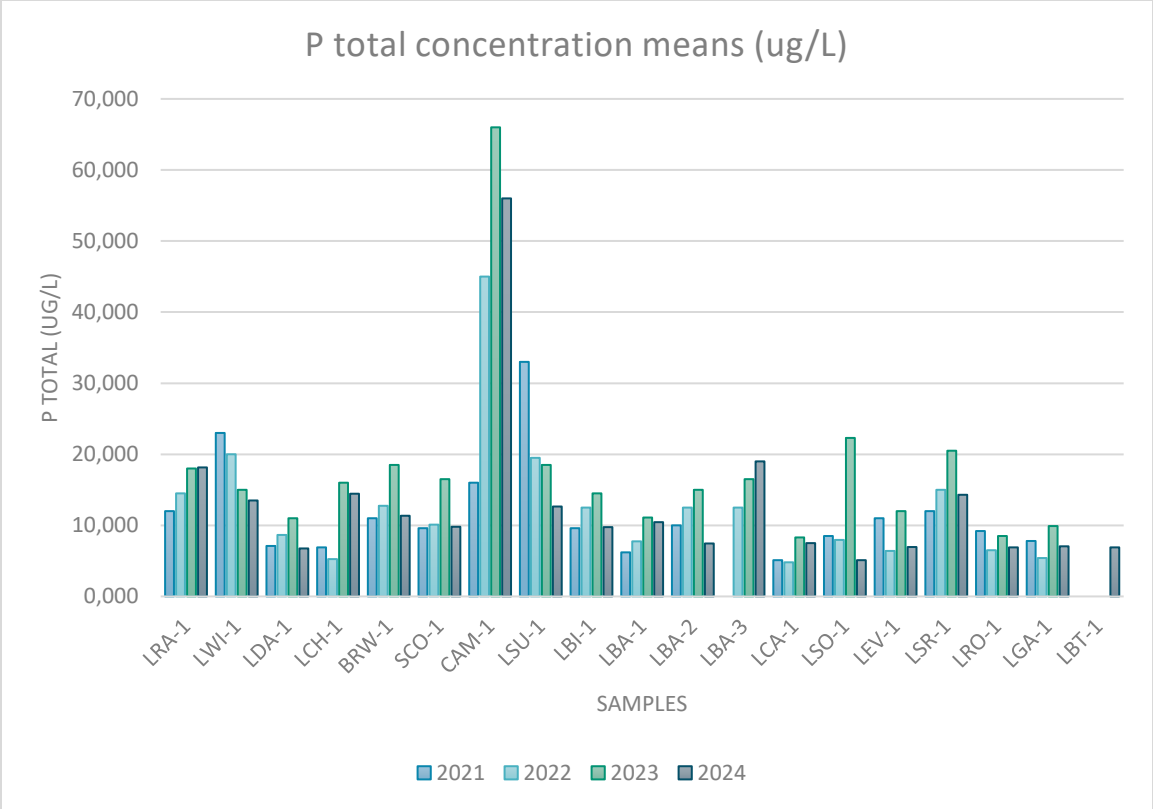


Figure 7: Average total phosphorus concentrations measured from 2021 to 2024

The point with the highest phosphorus concentrations over the last 3 years is **CAM-1**. This point is located along Cambria Road and is sampled in a watercourse originating from an upstream wooded peat bog wetland. Phosphorus can enter the environment from a number of sources. These include soil erosion and ditch maintenance, stormwater runoff and fertilizers. In this case, given the proximity of Cambria Road to the sampling point, it is highly likely that phosphorus concentrations are higher there than elsewhere.

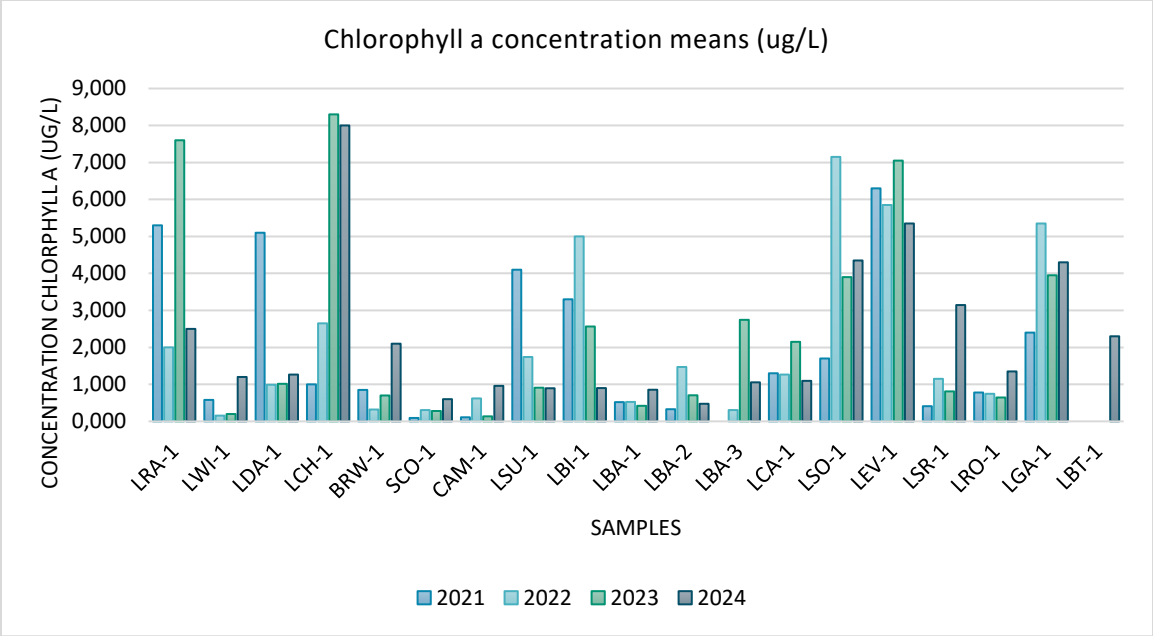


Figure 8: Average concentrations of chlorophyll-α measured from 2021 to 2024.

Sources of **chlorophyll-α** come from microscopic algae suspended in the water. Concentrations vary from point to point and from year to year. Point **LCH-1** showed a very large increase in measured concentrations over the last 2 years. Points **LEV-1** and **LGA-1** have also shown high concentrations over the past 4 years. These three points represent 3 small, shallow lakes in the territory: Lac Chevreuil, Lac Evans and Lac Grace. Small lakes tend to warm up more quickly and thus favor the proliferation of microscopic algae.

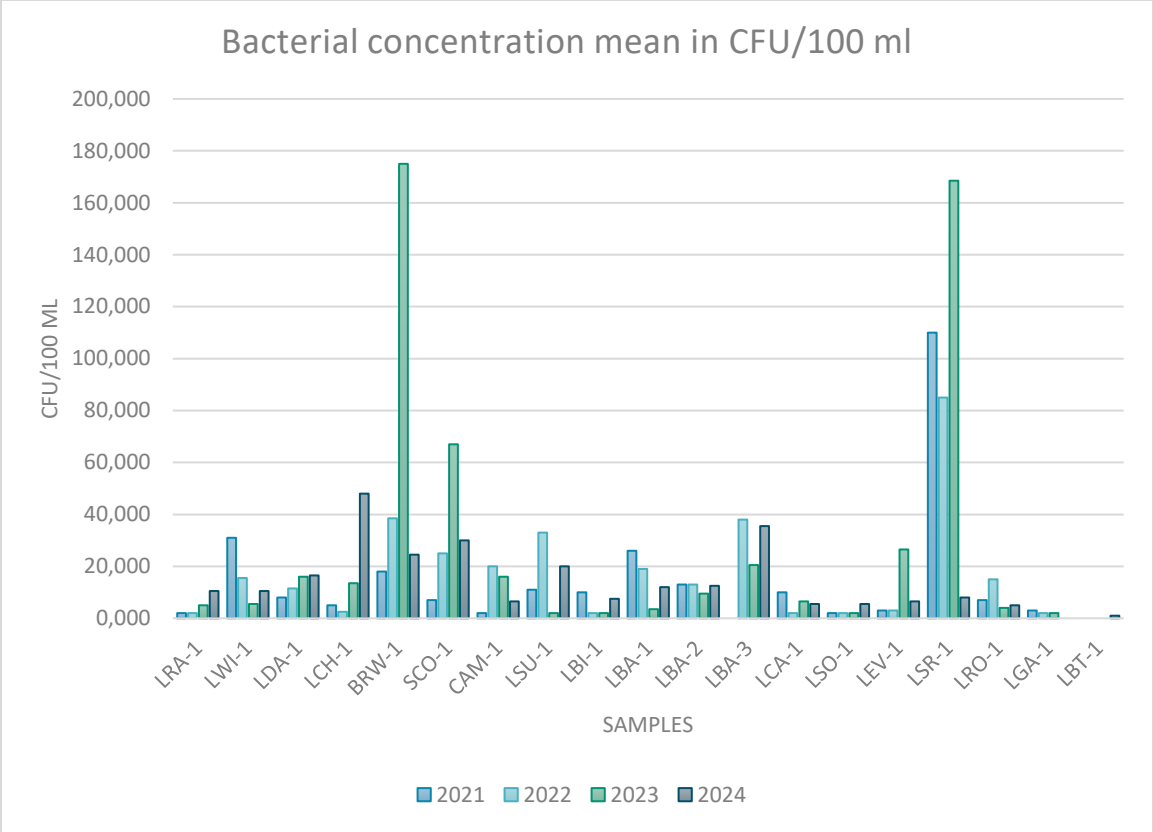


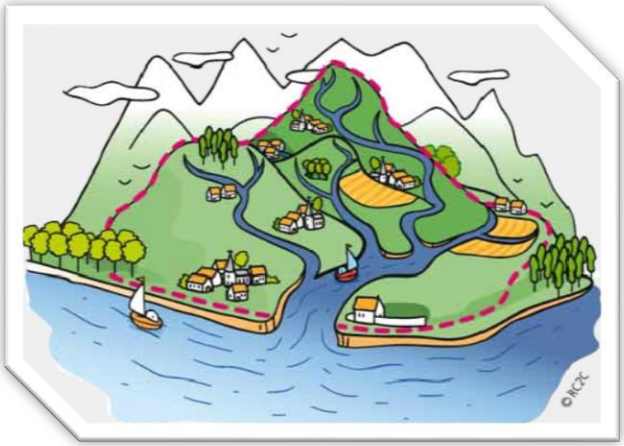
Figure 9: Average bacterial concentrations measured from 2021 to 2024.

The **concentration of bacteria** found in the samples is quite variable over the years, but two points show higher data. These are **BRW-1** and **LSR-1**, with high concentrations in 2023. We can see that these concentrations returned to normal in 2024. It is possible that there was spot contamination during the 2023 sampling, possibly due to nearby animal activity (beavers).

Analysis and recommendations

The values obtained from sampling the selected watercourses and tributaries provide a detailed picture of the health state of the region's surface waters. Data were collected over an 8-hour period. The first sample was taken in August and the second in October 2024. By taking these data frequently and repeating them over several years, we can closely monitor water quality and put in place the necessary measures to protect the Municipality's lakes and waterways. Analysis reports from previous years are available on the municipal website.

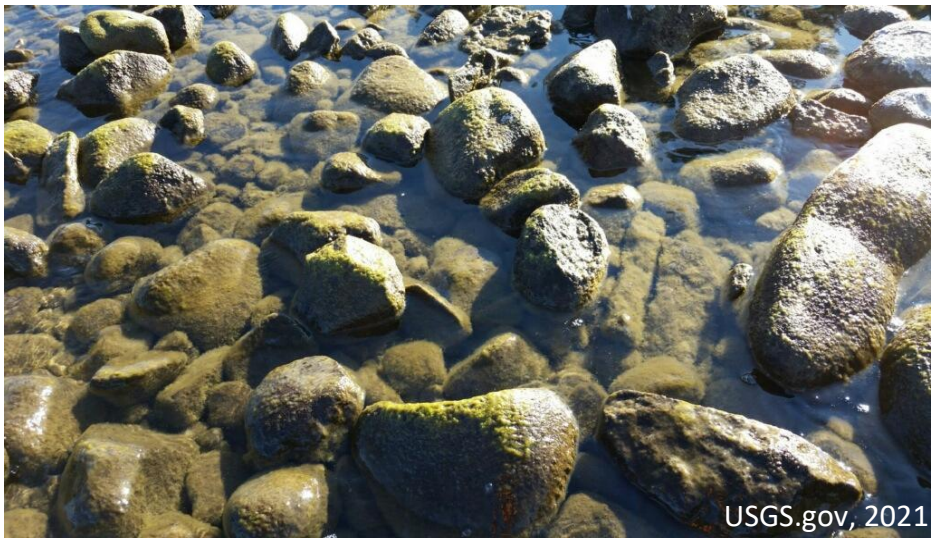
To understand the influence of water quality on adjacent lakes and rivers, it's necessary to understand the concept of the watershed. A watershed is a grouping of lakes, rivers and streams, all of which have a link, a connection that allows a drop of water to travel over kilometers of territory. The watershed is not limited to bodies of water, but also to the mountains and valleys where water runs off and continues its journey towards underground water. Water studies and analyses give us an idea of the health of an entire watershed, as well as more specific areas within a given territory. To put measured values into perspective, 1 µg/L is equivalent to 1 ppm (parts per million), or the equivalent of a thimble in an Olympic-sized swimming pool. Overall, water quality in the region is good to excellent. However, some points have higher-than-average values, which may provide clues as to the influence of various environmental factors on water quality. The parameters studied will be discussed in greater detail in the next section.



Discussion of results

Dissolved organic carbon (DOC) is measured in mg/L. Its concentration is an indicator of water coloration, depending on the presence of organic compounds (plant debris such as lignin and cellulose, agricultural or industrial effluents, etc.). A high presence of COD causes amber or brownish coloration of the water. As carbon is an important nutrient for microorganisms, its presence can then lead to the development of biofilms such as periphyton on pebbles and rocks in the environment, for example (Salomon et al., 2015). Above a concentration of 6 mg/L, DOC may affect not only the coloring but also the odor of the water, which is why the threshold of 6 mg/L was established for critical values. The highest value was measured at point **LWI-1** during sampling in August (21.90 mg/L) and October (15.0 mg/L). Point **LWI-1** is located upstream of Williams Lake. This stream stems from a network of wetlands that are important sources of organic matter and therefore carbon. It must be remembered that these sampling points represent a point value from a tributary that will be greatly diluted by the time it reaches the lake or body of water of interest.

Figure 11. Periphyton on rocks bordering a lake



The effects of high DOC include interference with plant growth and reduced oxygen availability for aquatic organisms. High DOC levels are often associated with a higher-than-normal iron level. We also find higher DOC concentrations in runoff from environments with a high density of evergreens (Kritzberg *et al.,* 2020).

Total phosphorus (TP) is a limiting nutrient, measured in µg/L. Its presence is indicative of eutrophication (premature aging) of a lake, watercourse or sensitive environment. An excessive supply of phosphorus will stimulate the growth of algae and aquatic plants, which can lead to the appearance of harmful algal blooms and

environmental hypoxia (Oldfield et al., 2020). The highest value was measured at point **CAM-1** (61 µg/L) in August, and (51 µg/L) in October. Too high a concentration of phosphorus can indicate a deterioration in fish habitats, aquatic fauna and flora in general, and a loss of diversity. Phosphorus can come from a variety of sources, including erosion and ditch maintenance, stormwater runoff, fertilizer use, phosphated household products and non-compliant septic systems. Approximately 15% of Canadian homes were served by a septic system in 2015 (Statistics Canada, 2015). With the increase in rural and remote development we've seen in recent years, this number can only be much higher as of today. It is therefore essential to ensure that septic systems on the territory are compliant and respect current Provincial regulations (Q-2, r.22).

The presence of phosphorus in an environment is natural, especially in lake or river sediments, or in wetlands. The problem arises when anaerobic conditions are observed and the concentration of phosphorus in the water becomes higher than in the sediment. This is due to a unidirectional exchange of components influenced by the redox conditions of the environment (Wetzel, R.G., 1983). Harmful algal blooms can occur when an input of around 80 µg/L is observed. However, each water body has a maximum daily intake (TMDL) of phosphorus and other limiting elements, while maintaining adequate water quality (Shock et al., 2003). The data collected do not show an alarming situation in terms of total phosphorus concentrations, but we must nonetheless maintain our good practices and remain vigilant for years to come.

Chlorophyll α is a pigment responsible for the green coloration of aquatic and terrestrial plant species, as well as an essential element in the photosynthesis process. The concentration of this component depends on numerous factors such as nutrient supply, water mixing, lake depth, climate and anthropogenic activities (Filazolla et al., 2020). An excessively high concentration of α-chlorophyll may be responsible for the decrease in dissolved oxygen. In addition, the proliferation of certain algae can induce the production of toxins that are hazardous to the health of both humans and domestic animals.

By quantifying the presence of chlorophyll-α, it is possible to assess the biomass of aerobic photosynthetic organisms suspended in the water body under study. The higher the concentration of chlorophyll-α, the greater the presence of algae in suspension. The highest concentrations were recorded at point **LCH-1** in August (8.50 µg/L) and October (7.50 µg/L). These data do not show any worrying concentrations of α-chlorophyll.

For bacteriological results, the highest reading was taken at point **LBA-3** (68 CFU/100ml) in August. The second highest concentration was measured at point **LCH-1**

(530 CFU/100ml) during sampling in October. A concentration of more than 200 CFU/100ml indicates the presence of contamination, and therefore possible health risks. The presence of such a concentration may be due to punctual contamination by an animal source or indicate that a septic system is failing near the sampling point. A follow-up will be carried out in 2025 to verify whether the presence of coliforms has returned to a regular level. As soon as the presence of coliform is observed in a sample, the water is classified as non-potable (MELCC, 2021).

During the summer season, there are more marked variations in the concentrations of living bacteria found. With rising temperatures and water mixing, bacterial species proliferate, as do cyanobacteria, plankton, plant species and so on. With decreasing temperatures, it is normal to observe a decrease in bacterial concentrations in a sample. However, temperatures of around 4°C have shown persistence of bacterial colonies (Jamieson et al., 2003). **The presence of coliforms does not mean that there is fecal contamination, but that there is a bacterial input in the vicinity of the sampling point.**

High levels of bacterial presence can pose certain problems for human health. A concentration of over 100 CFU/100 ml indicates fair water quality but where all recreational uses are permitted (MDELCC, 2015). At over 200 CFU/100 ml, there is a health risk and direct contact with the water is therefore not recommended. However, it is recommended to rinse with clear water following a swim to avoid any risk of bather's dermatitis or other dermatological conditions. Consumption of lake and river water is not recommended, as it is not considered potable according to Ministry standards.

Lake eutrophication indicators

A good indicator of lake health is the presence of **vegetation in the littoral zone**. Whether it is algae or aquatic plants, their proliferation indicates a nutrient supply that may be higher than normal. A chain reaction occurs when too much phosphorus is added to a lake or water body. First, aquatic plants and algae blooms are observed. This is followed by a decrease in the transparency of the water, mainly due to the abundance of microscopic algae. With a proliferation of biomass there is automatically an increase of organic matter to decompose. To carry out the decomposition processes, the organisms require oxygen and therefore a decrease in dissolved oxygen at depth follows. A decrease in dissolved oxygen and light levels in the lake inevitably leads to a change in biodiversity that can greatly affect the health and aging of the lake.

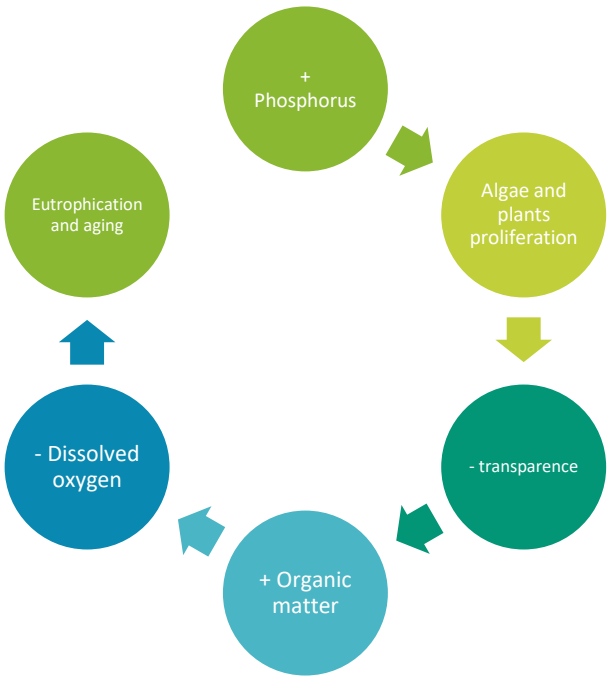


Figure 12: Lake eutrophication cycle

The abundance of phosphorus or other nutrients can be of natural or anthropic origin:

Natural:

- A shallow, small lake or incomplete spring mixing.
- Atmospheric deposits such as rain and dust.
- Proximity of forests or wetlands.
- Presence of beavers and their dams.

Anthropic:

- Deficient septic installations.
- Use of fertilizers.
- Excessive tree cutting and noncompliant shorelines.
- Residential development.
- Urban and industrial effluents.
- Erosion.
- Extensive agriculture.

Good practices

To limit premature aging of our lakes, good practices should be adopted daily:

- Maintain a natural and varied protective shoreline to the depth required by the current by-law (15 meters). A compliant shoreline must be composed of the three vegetation strata: grasses, shrubs, and trees.
- Avoid the use of fertilizers or compost on riparian areas. Too many nutrients will be harmful to the lake where a proliferation of aquatic plants and algae may be observed.
- Do not artificially alter waterfronts by waterproofing with slabs, gravel, sand, or paving stones. Water should flow freely and run off to the water body. In addition, the vegetation in the riparian buffer strip provides soil support and limits soil erosion as well as the capture of minerals and organic matter through their root system.
- Avoid wasting water, it is a limited and precious resource.
- Ensure that your septic system is complying and that it is emptied frequently according to provincial regulations (every 2 years for primary residences and every 4 years for seasonal or secondary residences).
- Use phosphate-free household products.
- Do not interfere with the free flow of water.
- Maintain aquatic grass and plants, which are a source of food and shelter for many aquatic and terrestrial animal species.
- Preserve the integrity of wetlands, which act as genuine water filtration plants.
- Promote responsible navigation by limiting speed near the banks to reduce excessive erosion.
- Carry out a visual inspection and systematic cleaning of boats before the annual launch or when changing water bodies.

Importance of shorelines

The shoreline protection strip is a delimited zone along the edge of lakes, streams and wetlands that must be maintained naturally and without intervention. The width of this strip must be at **least 15 meters** and be composed of the three strata of vegetation: herbaceous, shrubby, and arborescent. The riparian protection strip is a protective belt for lakes and waterways. It allows soil retention and the reduction of shoreline erosion. The vegetation in the buffer strip provides shade and reduces significant temperature

changes. It is also a habitat providing shelter and food for many animal species, both terrestrial and aquatic. It also acts as a filter for runoff water by capturing abundant nutrients and limiting the input of phosphate and nitrogen to the lakes. In addition to protecting the lakes, riparian buffers limit sound projection on the water and provide privacy for lakeside residents. By maintaining natural and diverse riparian buffers, lake water quality can be maintained, and premature aging can be delayed.

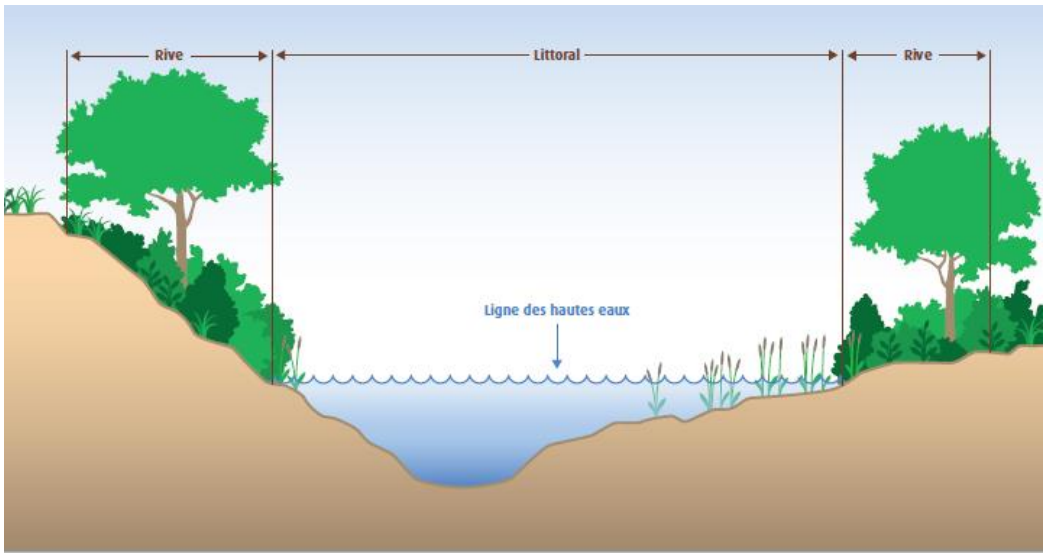


Figure 13 : Measure of the shoreline

(CRE Laurentides)

Conclusion

Importance of current analysis

The sampling of 2024 enabled us to observe various parameters and establish a bigger picture of the surface water quality in the area. As this is the 4th consecutive year of targeted water testing, we have observed a certain continuity in the results. By increasing the frequency and number of sampling points, we will be able to better monitor the situation of our lakes and water bodies. Annual monitoring of the parameters studied, and the characteristics of surface waters will enable us to track nutrient inputs, the possible loss of animal and plant biodiversity, the presence of water quality indicators and many other essential elements. According to MELCC recommendations, annual monitoring is required to obtain a complete assessment of the state of a territory's lakes and watercourses.

Future projects

With the collection of this data, future projects could see the light of day for the Municipality of the Township of Gore. The condition of septic systems is monitored on an annual basis, ensuring that any systems that have fallen below standards are upgraded, and that septic systems are emptied on a regular basis. The Écoprêt program is still in effect, helping owners to obtain a financial aid to allow the upgrading of outdated septic installations, or those with a polluting potential. A portrait of the shorelines was also created in the summer of 2024. These inspections will be maintained and continued in 2025.

Informations

For more information regarding water quality monitoring and interpretation, these resources dans be useful:

Municipalité du Canton de Gore : www.cantondegore.qc.ca

CRE Laurentides : https://crelaurentides.org/

RSVL : http://www.environnement.gouv.qc.ca/eau/rsvl/index.htm

Abrinord : https://www.abrinord.qc.ca/

MRC d'Argenteuil : https://argenteuil.qc.ca/Accueil/affichage.asp?B=80&langue=1

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