Water Quality Summary: Chlorophyll-a

2023 Barr Lake & Milton Reservoir

Barr Lake and **Milton Reservoir**'s water quality has been sampled twenty times a year since 2003. These 420 trips to both reservoirs have produced an abundance of data and information. This is Part 2 of 8 of a water quality summary series for 2023 calendar year for both reservoirs. The first summary focused on pH; this one discusses chlorophyll-a (chl-a).

The Big Picture – Eutrophication is the addition of nutrients and sediments to water bodies resulting in algae and plant growth and sedimentation. This natural process occurs over a long geological period - 1,000's of years. Many lakes, reservoirs, ponds, and even estuaries throughout the world experience "*cultural eutrophication*". This term means that water bodies become more productive and shallower much quicker (months to years) due to increased inputs of nutrients and sediments from human activities. This unnaturally accelerated aging of lakes causes a biological response – algae growth that usually leads to blue-green algal scums. This biological response then triggers chemical and physical changes within the water – pH, oxygen, water clarity and color, fish, water safety, plants, and aesthetics.

Chl-a – This is the measurement of how much green pigment is in the water. Algae, like trees and grasses, produce chl-a through photosynthesis causing the plant to be green. Chl-a is essential in the plant's process of transforming sunlight into biomass. By measuring how green the water is, one can get a relative understanding about how much algal growth is occurring. Chl-a concentrations are expressed in units of micrograms per liter (µg/L) or parts per billion (ppb). Chl-a is not an exact measurement of biomass. Some algae (e.g., diatoms) don't produce as much chl-a as others (e.g., blue-green algae) and can change their rate of chl-a production throughout the day. Chl-a is not the same as the rate of productivity or an indicator of how fast the algae are growing. Concentrations below 5 µg/L are considered low, and values greater than 25 µg/L are considered high.

Chl-a around 85 ug/L at Barr Lake (07/15/03)

Too much algal growth is the main observable symptom resulting from *cultural eutrophication*. Too much growth leads to aesthetic issues, odor problems, cyanotoxins, dissolved oxygen fluctuations, and lower water clarity. Typically, more algae mean more zooplankton and more fish. However, there can be a point where too much algae harms fish and zooplankton. The water quality standard for chl-a for warm water reservoirs is 20 µg/L averaged over the growing season (July 1 – September 30). The chl-a target that has been determined for **Barr Lake** and **Milton Reservoir** is 25 µg/L or less during the growing season. This target is not specified as an average or median.

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2023 Chl-a Data – A 1-meter depth water sample is collected and filtered (200 – 1,000 milliliters) in the boat during each site visit. The filter paper collects the algae contained in that water sample and is analyzed for chl-a. For 2023, there were 20 chl-a concentrations recorded for both Barr and Milton (Table 1).

Table 1. Barr and Milton 2023 chl-a data (ug/L). Bold values exceed the water quality standard of 20 µg/L.

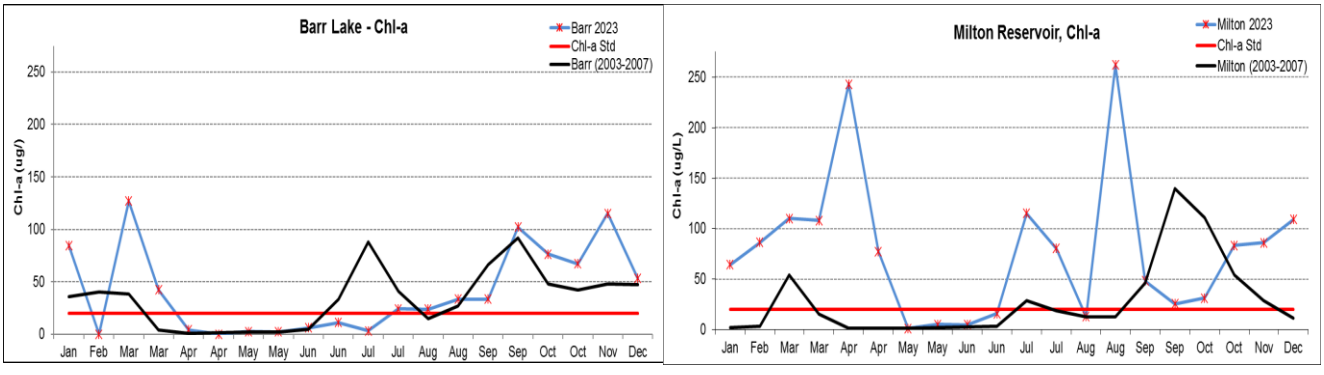
Month	Chl-a (Barr)	Chl-a (Milton)
Jan	84.6	64.3
Feb	<0.1	86.5
Mar	127.0	110.0
Mar	42.3	108.0
Apr	4.1	243.0
Apr	<0.1	77.4
May	2.54	1.15
May	2.16	5.22
Jun	5.8	4.81
Jun	11.0	15.8
Jul	3.2	**115.0**
Jul	**24.2**	80.3
Aug	**23.8**	12.7
Aug	**33.3**	**262.0**
Sep	**33.3**	**48.3**
Sep	**102.0**	**25.6**
Oct	76.4	31.2
Oct	67.1	83.4
Nov	115.0	86.1
Dec	53.0	109.0

The median* chl-a for **Barr Lake** in 2023 was 28.8 µg/L and 78.9 µg/L for **Milton Reservoir**. The large algal community that occurred in both reservoirs in the winter and fall not only caused an increase in pH but also an increase in chl-a. As with pH, the chl-a decreased by April/May before the warmer growing season. Barr didn't have a summer bloom until late September. Milton's major summer bloom was at the end of August.

The growing season median for **Barr Lake** was 28.8 µg/L and 64.3 µg/L for **Milton Reservoir**. With large fluctuations in values, the median is a better estimate of the middle when it comes to chl-a. The range at Milton went from 12.7 µg/L to 262.0 µg/L in about two weeks' time.

Figure 1 shows the annual cycle, goal, and 2023 results for chl-a. **Milton Reservoir** had above average chl-a for most of the year. There were some large blooms during the growing season that were short lived. **Barr Lake** had a growth of wintertime algae followed by a clearing phase between April and July. Most of the algal growth in Barr was during the non-summer season. What is most important to notice, especially for Barr Lake, is the delay in when the cyanobacteria bloom occurred during the summer season. Barr did not have a noticeable bloom until the end of September.

Figure 1. 2023 chl-a data compared to WQ target and 2003-2007 annual average.



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Photosynthesis – This important biochemical process has a major impact on Barr Lake and Milton Reservoir. The process of photosynthesis converts CO_2 into organic matter (sugar) by using energy from the sun. An evaluation of chl-a provides a good representation of the primary biomass in a lake. Photosynthesis helps determine the balance between pH (changes in CO_2), organic matter (chl-a or algae), nutrients, and dissolved oxygen.

$$6CO_2 + 6H_2O + Nutrients \underset{\text{(Respiration/Decomposition)}}{\overset{\text{(Photosynthesis)}}{\rightleftharpoons}} C_6H_{12}O_6 + 6O_2$$

** median is used instead of average because chl-a data has a large range of values and can change quickly. Median does a better job of representing the middle of a data set that has extreme high values along with extreme low values. The state standard uses the average between July 1 and September 30.*