Water Quality Summary: Chlorophyll-a

2017 Barr Lake & Milton Reservoir

Twenty times a year since 2003, **Barr Lake** and **Milton Reservoir** have been sampled for water quality. These 300 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 2017 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 to water bodies resulting in nuisance algae growth and sedimentation. This natural process usually occurs over a long geological period of time. Many lakes, reservoirs, and even estuaries and bays throughout the world experience "*cultural eutrophication*". This term means that water bodies tend to become more productive and shallower over relatively short periods of time due to increased inputs of nutrients and sediments from human activities. Accelerated aging of lakes causes a quick biological response – severe algae growth. This response then leads to other chemical and physical changes within the water – pH, oxygen, water clarity and color, fish, plants, and aesthetics can all change.


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

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 algae are in the lake. 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, but it is close. 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.

Too much algal growth is the main observable symptom resulting from *cultural eutrophication*. Too much growth leads to aesthetic issues, odor problems, cyanotoxins, large 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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2017 Chl-a Data – Approximately 1 liter of 1-meter depth water is collected and filtered in the boat during each site visit. The filter paper collects the algae contained in that one liter of water and is analyzed for Chl-a. For 2017, there were 20 Chl-a concentrations recorded for each reservoir (Table 1).

Table 1. Barr and Milton 2017 Chl-a data (ug/L). Bold values exceed the water quality target of 25 µg/L.

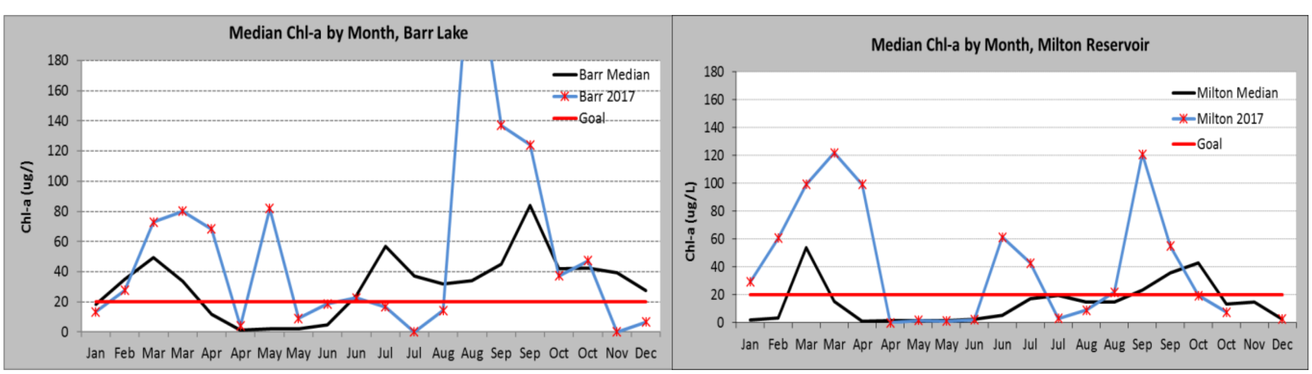
Month	Chl-a (Barr)	Chl-a (Milton)
Jan	13.4	**29.3**
Feb	**27.6**	**60.7**
Mar	**72.9**	**99.3**
Mar	**80.1**	**122.0**
Apr	**68.4**	**99.4**
Apr	4.0	<1.0
May	**81.9**	1.7
May	9.1	1.3
Jun	18.6	2.3
Jun	22.6	**61.4**
Jul	16.7	**43.0**
Jul	<1.0	3.2
Aug	14.2	9.2
Aug	**267.0**	22.0
Sep	**137.0**	**121.0**
Sep	**124.0**	**55.1**
Oct	**37.3**	19.6
Oct	**47.4**	7.8
Nov	<1.0	
Dec	6.7	2.6

The median* Chl-a for **Barr Lake** in 2017 was 25.1 µg/L and 22.0 µg/L for **Milton Reservoir**. The large algal community that occurred in both reservoirs in the spring/late summer not only caused an increase in pH but also an increase in Chl-a. As with the pH, the Chl-a decreased by May before the warmer growing season.

The growing season median for **Barr Lake** was 70.4 µg/L and 32.5 µg/L for **Milton Reservoir**. For comparison, the growing season average was 93.2 µg/L for **Barr Lake** and 42.2 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. There are many ways to summarize water quality data.

Figure 1 shows the annual cycle, goal, and 2017 results for Chl-a. **Milton Reservoir** had low Chl-a between April and June. This was followed by two major blooms in late June and September. Note that 2017 follows a complete refill of Milton in fall 2016. **Barr Lake** had a spring diatom bloom that lasted slightly longer than normal and then a large bloom in late summer. The August spike in Chl-a resulted from storm water inflows to Barr following significant rain events in Denver. The algae in late summer were not the typical blue-greens but dinoflagellates for the first time.

Figure 1. 2017 Chl-a data compared to WQ target and 2003-2017 annual average



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 applies the average between July 1 and September 30.*