Water Quality Summary: pH

2024 Barr Lake & Milton Reservoir

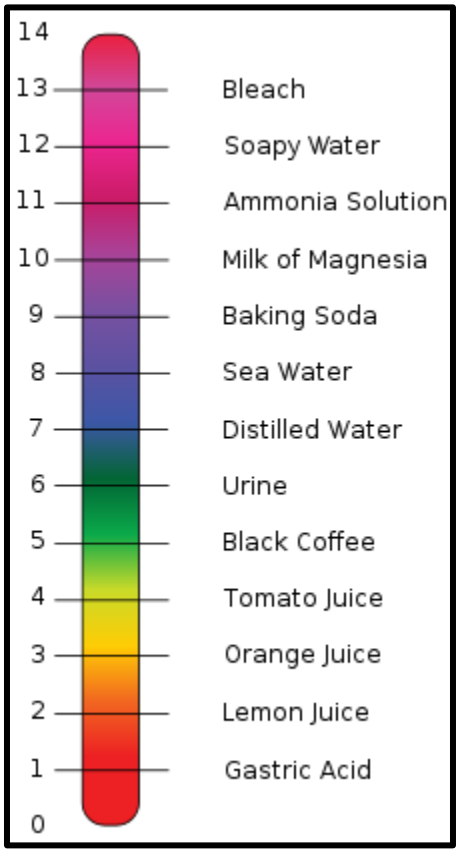
Barr Lake and **Milton Reservoir**'s water quality has been sampled twenty times a year since 2003. These 440 trips to both reservoirs have produced an abundance of data and information. This is Part 1 of 8 of a water quality summary series for 2024 calendar year for both reservoirs. This first summary focuses on reservoir pH.

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. Water quality is complex and very sensitive.

pH – This is the measurement of how many hydrogen ions (H^+) are in the water (scale 1 through 14). The higher the concentration of H^+, the more acidic or lower the number (scale 1-6). The lower the H^+ concentration, the more basic or higher the number (scale 8-14). Pure water has a neutral pH of 7.0. Rainfall is about 5.6 because of exposure to acid forming gases in the air.

Colorado's water quality pH standard is 6.5 to 9.0. To determine if a lake is satisfying this standard, pH data are collected from the surface (epilimnion) to the bottom of the lake (hypolimnion). pH is important when it comes to aquatic organisms.

2024 pH Data – pH data are collected throughout the entire water column in half meter increments during each visit to Barr Lake and Milton Reservoir. pH measurements from 0.5 to 2.0 meters (top layer) are averaged for each visit. For 2024, there were 20 pH averages recorded for each reservoir (Table 1). The data are then ranked from highest to lowest. The 85th percentile pH value is the one that has 15% of the values higher and 85% of the values lower. For **Barr Lake**, the 2024 85th percentile pH value was 8.96 and for **Milton Reservoir** it was 8.87. Barr has met the standard 4 out of the last 5 years.



pH Scale 0 to 14

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Table 1. 2024 Barr Lake and Milton Reservoir average pH for the top water (0.5 – 2.0 m) for each sampling event and the 85th percentile. Bold values exceed the water quality standard.

Barr Lake				Milton Reservoir			
Month	**pH**	**Rank**	**%tile**	**Month**	**pH**	**Rank**	**%tile**
Jan	7.60	9.15	***100***	**Jan**	7.82	9.12	***100***
Feb	8.10	9.05		**Feb**	7.86	8.91	
Mar	8.82	8.97	***90***	**Mar**	8.87	8.88	***90***
Mar	7.85	**8.96**	***85***	**Mar**	8.00	**8.87**	***85***
Apr	8.59	8.93	***80***	**Apr**	8.63	8.79	***80***
Apr	7.81	8.91		**Apr**	7.76	8.64	
May	8.14	8.82	***70***	**May**	7.99	8.63	***70***
May	8.05	8.59		**May**	8.13	8.49	
Jun	8.16	8.49	***60***	**Jun**	8.41	8.41	***60***
Jun	7.88	8.22		**Jun**	8.26	8.40	
Jul	8.08	8.16	***50***	**Jul**	8.27	8.30	***50***
Jul	**9.05**	8.14		**Jul**	8.49	8.27	
Aug	8.91	8.10	***40***	**Aug**	8.18	8.26	***40***
Aug	8.96	8.08		**Aug**	8.40	8.18	
Sep	8.97	8.05	***30***	**Sep**	8.30	8.13	***30***
Sep	8.93	7.88		**Sep**	8.64	8.00	
Oct	8.49	7.85	***20***	**Oct**	8.79	7.99	***20***
Oct	8.22	7.84		**Oct**	**9.12**	7.86	
Nov	**9.15**	7.81	***10***	**Nov**	8.88	7.82	***10***
Dec	7.84	7.60		**Dec**	8.91	7.76	

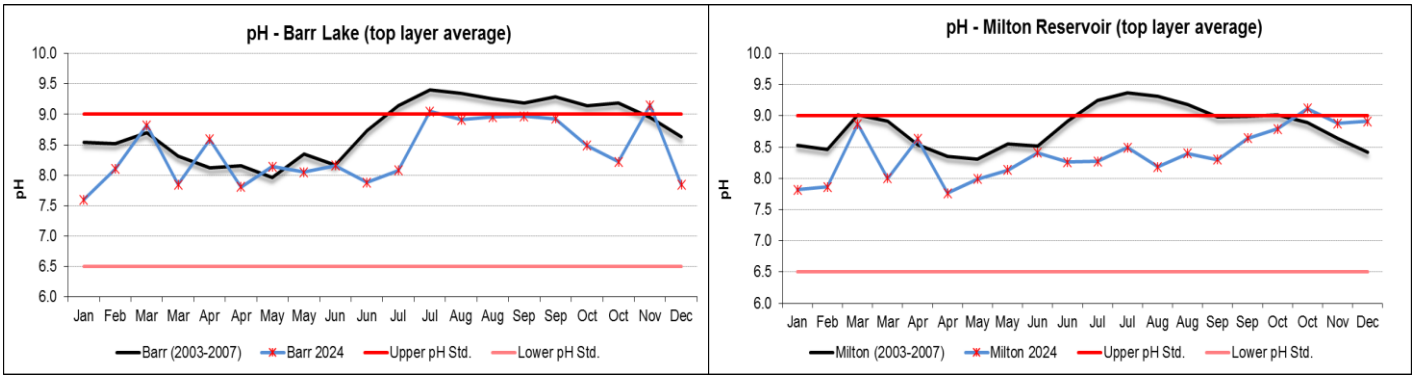
There is no seasonality for the pH standard, all data collected in a year are included in the calculations.

With 20 sampling events, only three can be higher than 9.0. The average between the fourth and third highest pH value is the 85th percentile number.

The median (50th percentile) pH for **Barr Lake** in 2024 was 8.19 and for **Milton Reservoir** it was also 8.35. Both reservoirs experienced typical springtime and wintertime algae growths, and Barr had a bloom in July and August. The lowest pH for both Barr and Milton occurred in January and April, during the clearing phase and when the lakes were frozen over. Only one of the pH exceedances occurred during the growing season. The other two exceedances occurred during late fall.

Figures 1 shows the annual pH patterns, upper pH standard, and 2024 pH values. The annual algae growth cycle determines the annual pH pattern. It is important to notice that the background pH is over 8.0 so there is not much room for higher pH values.

Figure 1. 2024 pH data compared to WQ targets and 2003-2007 annual average.



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Algae and pH – How do the growth of algae change the pH of a lake? When algae grow, they photosynthesize. This is the process of taking up CO_2 and water in the presence of sunlight and producing oxygen and sugar (organic carbon) for growth. Taking CO_2 out of the water results in less carbonic acid (H_2CO_3). Less carbonic acid means less H^+ in the water, and therefore a higher pH. If the algae grow fast, the reservoir does not have enough time to get back into equilibrium with the atmosphere to dissolve more CO_2.

The opposite can also occur. Decomposition of the algae at the lake bottom consumes oxygen and produces CO_2. Bottom water can get below pH of 7.5 because of the carbonic acid formation. **Barr Lake's** lowest bottom water pH was 6.38 and **Milton Reservoir's** was 6.56 (both acidic).

Long-term trends for pH in Barr and Milton do show a steady decline in pH. The 85th percentile of pH data since 2012 shows a major shift. Barr Lake has had six out of the last 10 years meeting the pH standard of. Milton has had five years of no exceedances in the last 10 years. Milton's 85th percentile for 2023 was the lowest ever recorded for the past 20+ years and now has two consecutive years of compliance.

Figure 2. Long term trend data in pH for Barr Lake and Milton Reservoir