

Technical Memorandum

To: Black Dog Watershed Management Organization (BDWMO)
From: Kevin Menken, Barr Engineering
Subject: Lac Lavon 2022 Water Quality Assessment
Date: April 11, 2023
Project: 23190375

This memorandum presents the results of 2022 management-level water quality monitoring of Lac Lavon, as well as discussion of aquatic macrophyte surveys conducted in June and August 2022. Management-level water quality monitoring was conducted by Barr Engineering Co. (Barr) on behalf of the BDWMO in 2022. Monitoring was also performed by a citizen volunteer participating in the Metropolitan Council sponsored Citizen Assisted Monitoring Program (CAMP).

Introduction and Background

Lac Lavon lies on the Burnsville/Apple Valley border, and its 184-acre watershed encompasses portions of both Burnsville and Apple Valley. The only surface water outlet from Lac Lavon is a 12-inch diameter emergency overflow outlet to Keller Lake. A valve controls the flows in the overflow pipe; normally the valve is closed. Lac Lavon is unique in that it is an abandoned gravel pit and therefore not part of the original Minnesota Department of Natural Resources (MDNR) public waters inventory. However, the MPCA considers Lac Lavon to be a fully-supporting deep lake that can be listed on the impaired waters list.

The lake's primary water source is groundwater. Lac Lavon's surface area is approximately 60 acres, with 65 percent of the lake less than 15 feet (4.6 meters) deep, and a maximum depth of approximately 32 feet (9.8 meters).

The Lac Lavon watershed land use is low density residential and park. Two city parks are located on Lac Lavon—a City of Burnsville park on the west shore, and a City of Apple Valley park on the northeast shore. Very little, if any, change in land use development is expected in the Lac Lavon watershed. Lac Lavon is used for a variety of recreational purposes, including fishing, swimming, aesthetic viewing, and wildlife habitat. The City of Burnsville park has access for launching canoes and the City of Apple Valley park has a path to a fishing pier on the shoreline. These park amenities provide for most of the recreational use of the lake. There is no public boat ramp for launching trailered boats on Lac Lavon.

The City of Apple Valley has conducted fish surveys (years 2020 and 2022) and fish stocking (2020) on Lac Lavon. The Lac Lavon fish community includes bluegill, northern pike, black crappies, hybrid sunfish, pumpkin-seed sunfish, largemouth bass, and bullhead. In 2020, a total of 500 walleye and 500 largemouth bass were stocked in Lac Lavon.

2022 Water Quality Monitoring Activities

The 2012 BDWMO Watershed Management Plan calls for “management-level” water quality monitoring of Lac Lavon once every three years. Management-level monitoring involves a more detailed collection of water quality data than the Metropolitan Council’s Citizen-Assisted Monitoring Program (CAMP). This expanded effort was conducted by Barr in 2022 and included collection of the following data:

- Measurement of Secchi disc transparency (a measure of water clarity).
- Field probe measurements of water temperature, dissolved oxygen concentration, specific conductivity, and pH levels at 1-meter depth intervals.
- Composite water samples from the surface of Lac Lavon (0–2 meters); these samples were sent to RMB Environmental Laboratories for analyses of total phosphorus and chlorophyll *a* concentrations. Chlorophyll *a* is a pigment that algae use for photosynthesis, and concentrations indicate the abundance of algae in the water. Phosphorus is the nutrient that drives algae growth in most Minnesota lakes.
- Water samples from 3 meters to 9 meters, taken at 1-meter depth intervals; these samples were sent to RMB Environmental Laboratories for analyses of total phosphorus concentrations.

Also, a citizen volunteer conducted CAMP water quality monitoring in 2022. The volunteer collected three samples in May, one sample in June, and one sample in August, but did not collect samples in July or September. Tabulated water quality data collected by Barr (Table 2) and the CAMP volunteer (Table 3) are attached at the end of this memorandum.

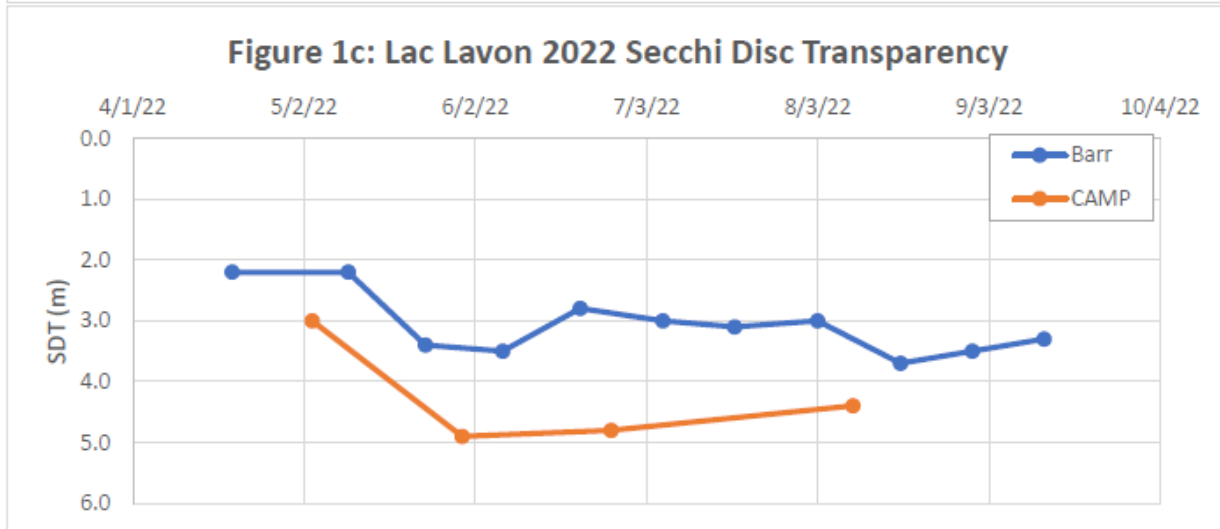
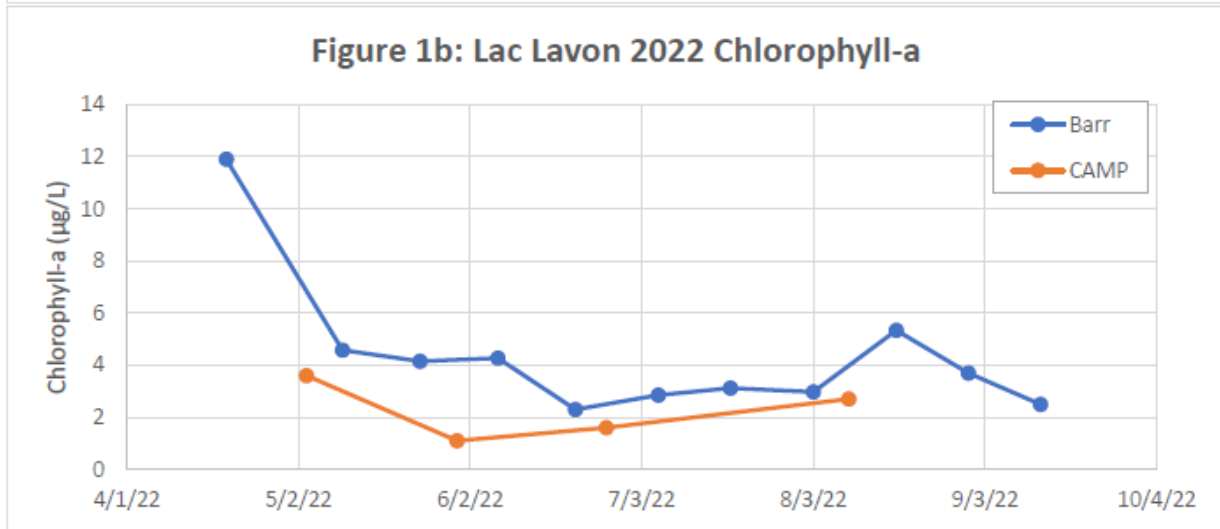
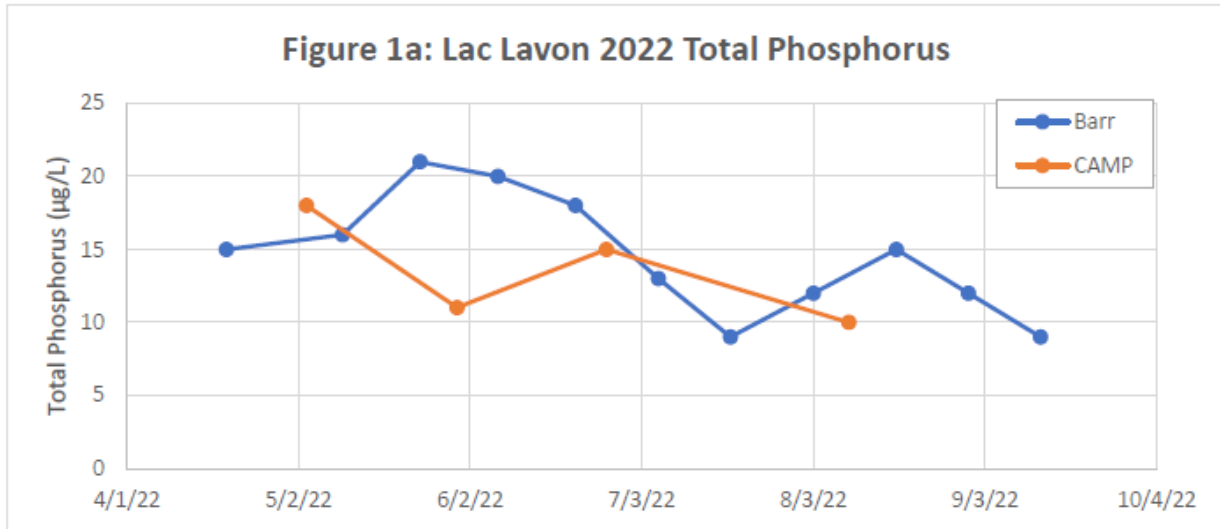
The 2022 Barr and CAMP measurements of Secchi disc transparency (SDT), total phosphorus, and chlorophyll *a* measurements are plotted in Figure 1, with Barr and CAMP data identified separately. Chlorophyll *a* and total phosphorus results were overall similar between Barr and CAMP measurements, with the exception of late-May. The CAMP total phosphorus and chlorophyll *a* measurements collected on May 30 were much lower compared to Barr measurements collected on May 24 and June 7. Barr measurements of SDT were generally lower (worse) than CAMP measurements throughout the season. SDT measurements are somewhat subjective, and can be influenced by time of day of measurements (e.g., wave action and sun angle). Barr measurements of SDT have been lower (worse) than CAMP measurements in previous years (2019) as well. Observed differences in Barr and CAMP measurements of total phosphorus and chlorophyll *a* concentrations could be due to the manner of sample collection – a composite of top 2 meters of lake water (Barr) versus dipping a sample bottle below the lake surface (CAMP).

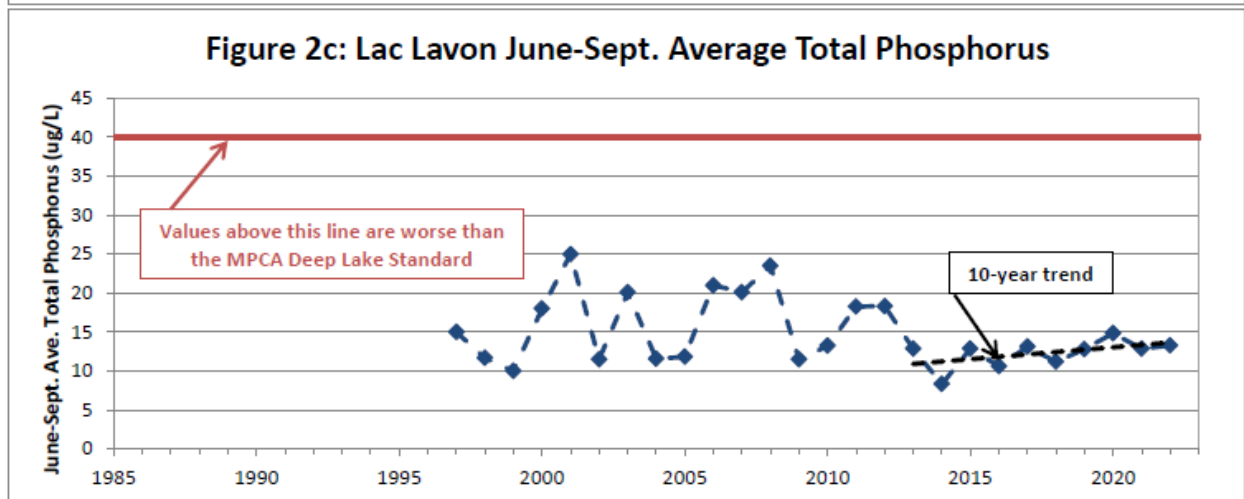
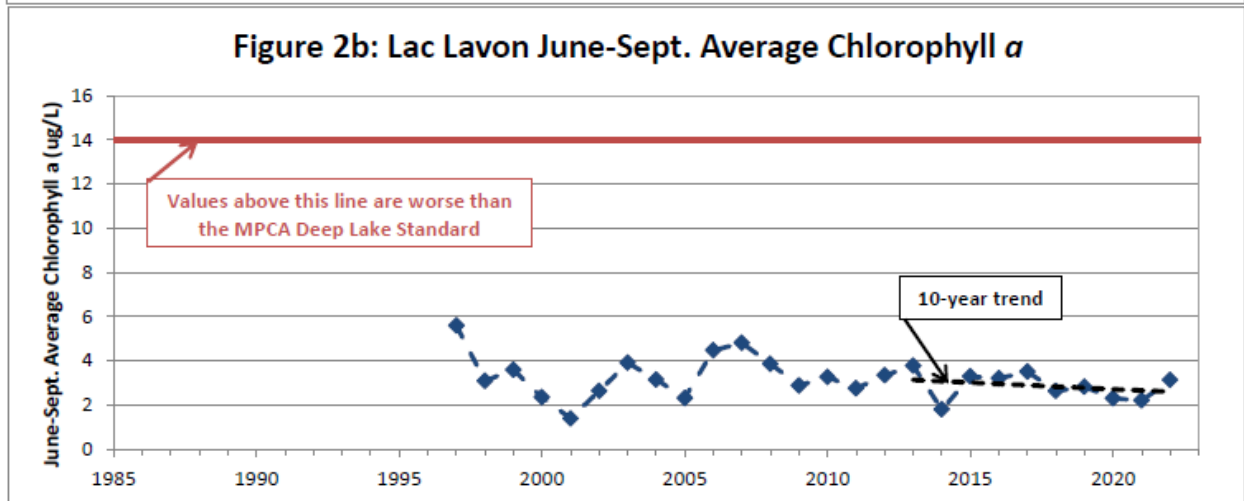
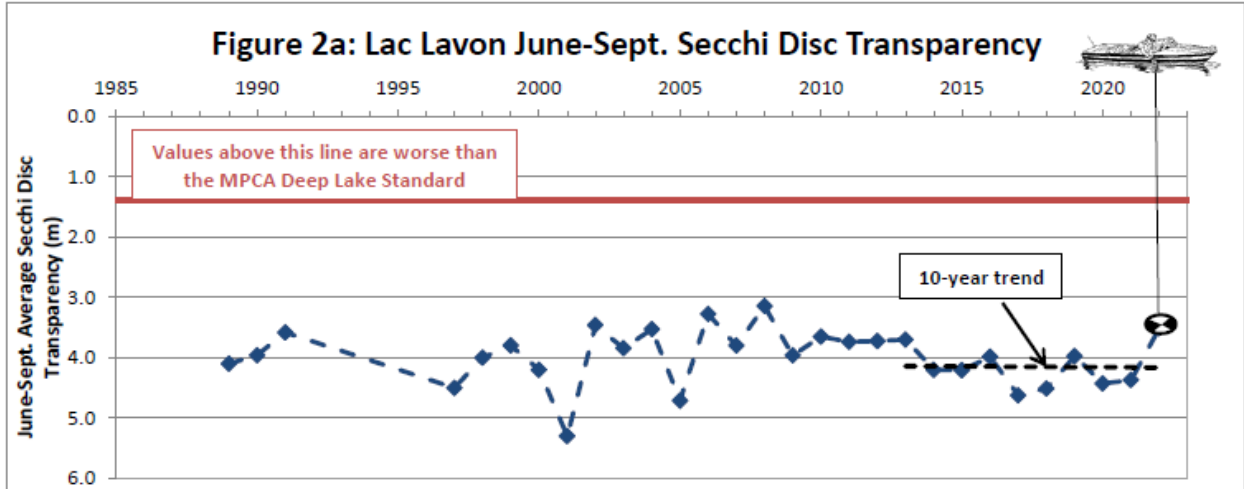
Summer Averages of Water Quality Parameters and Associated Goals

The 2022 summer (June-September) averages of water quality parameters were calculated for Lac Lavon and plotted with previous years’ summer averages. The summer averages for Secchi disc transparency,

To: Black Dog Watershed Management Organization (BDWMO)
From: Kevin Menken, Barr Engineering
Subject: Lac Lavon 2022 Water Quality Assessment
Date: April 11, 2023
Page: 3

total phosphorus, and chlorophyll *a* are plotted in Figure 2. The 2012 BDWMO Watershed Management Plan classified Lac Lavon as a Category I water body (supporting swimming and other direct contact recreational activities). The water quality action level for summer average (June-September) Secchi disc transparency (SDT) for Lac Lavon in 2022 is 4.0 meters (13.1 feet), determined by calculating the 25th percentile of the most recent 10-years of SDT summer averages. When a statistical trend analysis indicates that water transparency has degraded beyond this level (i.e., SDT less than 4.0 meters), then a diagnostic study of potential causes is recommended according to the BDWMO's 2012 Watershed Management Plan. The summer average SDT in 2022 was 3.5 meters (11.5 feet), which is worse than the action level of 4.0 meters. However, there was no statistically significant trend in summer average SDT for the most recent 10-year period. There were no statistically significant trends in summer averages of total phosphorus and chlorophyll *a* for the most recent 10-year period, and summer averages of SDT, total phosphorus, and chlorophyll *a* all indicate continued excellent water quality in Lac Lavon. Based on results of 2022 water quality monitoring and considering that the BDWMO's 2022 Watershed Management Plan no longer relies on action levels, a diagnostic study of Lac Lavon is not required or recommended.





The MPCA's lake eutrophication standards include numeric criteria for summer averages (June-September) of Secchi disc transparency, total phosphorus concentrations, and chlorophyll *a* concentrations. The eutrophication standards for a deep lake within the North Central Hardwood Forest ecoregion are provided in Table 1, along with the averages of the most recent 10 years (2013-2022) of monitoring for Lac Lavon. Summer averages of Lac Lavon water quality parameters are consistently much better than the MPCA's lake eutrophication standards.

Table 1 Lac Lavon Water Quality and the MPCA's Lake Eutrophication Standards for Deep Lakes in North Central Hardwood Forest

Water Quality Parameter	MPCA Lake Eutrophication Standard	Lac Lavon 10-yr Average (2013-2022)
Total Phosphorus (µg/L)	≤ 40	12
Chlorophyll <i>a</i> (µg/L)	≤ 14	3
Secchi Disc Transparency (m)	≥ 1.4	4.2

Aquatic Plant (Macrophyte) Surveys

Barr contracted with Endangered Resource Services, LLC to conduct point-intercept surveys in June and August of 2022. Aquatic plant (macrophyte) surveys have previously been completed by Barr staff in 2013, 2014, and 2016; and by Endangered Resources Services in 2019. A total of 11 aquatic plant species were identified in 2022, including 8 native species. Three non-native aquatic invasive plants were also identified in Lac Lavon: curly-leaf pondweed, Eurasian watermilfoil, and brittle naiad. Purple loosestrife, an emergent plant that is also an aggressive non-native species, has been found along the shoreline of Lac Lavon. Brittle naiad (*Najas minor*) had not been reported in the 2019 point-intercept surveys, but had been reported in Lac Lavon as far back as 2003. It had also been observed in the lake in years 2013, 2014, and 2016.

Brittle naiad was observed at multiple locations in Lac Lavon during the August 2016 survey. Unlike curly-leaf pondweed and Eurasian watermilfoil, which have infested numerous Minnesota lakes, brittle naiad has only been reported in a total of six Minnesota lakes, according to MDNR web page on the invasive plant (<https://www.dnr.state.mn.us/invasives/aquaticplants/brittlenaiad/index.html>). Brittle naiad grows much shorter than curly-leaf pondweed and Eurasian watermilfoil (both of which can create dense surface mats); and does not appear to be growing at nuisance levels in Lac Lavon. Because brittle naiad does not grow very tall, and more easily breaks into small fragments (it truly is "brittle"), it may not show up on the plant rake during surveys even when present, and it's possible its abundance is underreported. It can be transferred to other waterbodies by plant fragments stuck to boats or equipment, or by tiny seeds in mud stuck to boots, anchors, etc.

Eurasian watermilfoil, and the native plant coontail, were the two most abundant plants in both the June and August 2022 surveys. Curly-leaf pondweed was the 3rd most abundant plant during the June survey, but had diminished by the August survey. The mid-summer die-off of curly-leaf pondweed is typical, as it

begins growing much earlier in the spring and dies back earlier in summer than native plants, which can release nutrients and contribute to worse water quality in mid- to late-summer when abundant.



Photograph 1. Non-native Brittle naiad in Lac Lavon, August 10, 2022

In June 2022, curly-leaf pondweed was found at 29% of sampling points with plant growth. No curly-leaf pondweed was observed in August 2022. Curly-leaf pondweed can create dense, nuisance growths, and can also have negative impacts on water quality due to its earlier seasonal life cycle than native aquatic plants. Curly-leaf pondweed dies back in early to mid-summer, resulting in the release of phosphorus from the decaying plant tissue, as well as consumption of oxygen due to decomposition. The decrease in oxygen can further lead to phosphorus release from lake sediments. The water quality of Lac Lavon remained excellent throughout the summer months; therefore, curly-leaf pondweed does not appear to be degrading Lac Lavon water quality.

Eurasian watermilfoil can create dense, nuisance growths at the lake surface, and have a negative impact on recreational activities, including swimming and boating. Eurasian water milfoil may also crowd out native plant species. Eurasian watermilfoil was found at 65% of sampling points with plant growth in June 2022, and 82% in August 2022.

The Floristic Quality Index (FQI) was calculated for the submergent plant zone of Lac Lavon. The FQI utilizes species richness (the number of different species present) and the Mean Coefficient of Conservatism (C-value) for the observed species. A higher C-value is given to species that are sensitive to anthropogenic disturbances or eutrophication, while a lower C-value is given to species that are

To: Black Dog Watershed Management Organization (BDWMO)
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Date: April 11, 2023
Page: 8

opportunistic invaders or do well in disturbed environments, including degraded water quality associated with eutrophication. Four species were identified in June 2022 that have a C-value of 7 or higher, and would therefore be considered indicative of good water quality: muskgrass, Nitella, small pondweed, and white water crowfoot. Four species were identified in August with a C-value of 7 or higher: long-leaf pondweed (not identified in June), Southern naiad (not identified in June), muskgrass, and small pondweed. Nitella and white water crowfoot were not encountered in August. The Mean C-Value rating was determined to be moderate (5.6) in June and moderate (5.6) in August. The June FQI was 16.7 and the August FQI was 17.7.

Lake Levels

Lac Lavon has no regularly flowing outlet (landlocked), and the lake level changes in response to precipitation, evaporation, and groundwater flux. City of Apple Valley staff collected lake elevation data for years 2010-2014, and 2018-2021. Water surface elevations were not measured in 2022, but were observed to be low during summer water quality monitoring visits. During the period of monitoring, the lake elevation has fluctuated from a low of 927.6 feet on June 2, 2010 to a high of 934.13 feet on May 6, 2021, a difference of 6.53 feet (Figure 3). The high lake levels flooded the path leading to the fishing dock in years 2019-2021 (Photograph 2). Many landlocked lakes in the Twin Cities experienced high water levels in 2019-2021 due to record-breaking precipitation in years 2019-2020, combined with above-average precipitation in prior recent years. The last two years have seen below average precipitation, and lake levels have come down, including in Lac Lavon. By August 2022, the receding water levels were visible along the lakeshore (Photograph 3).

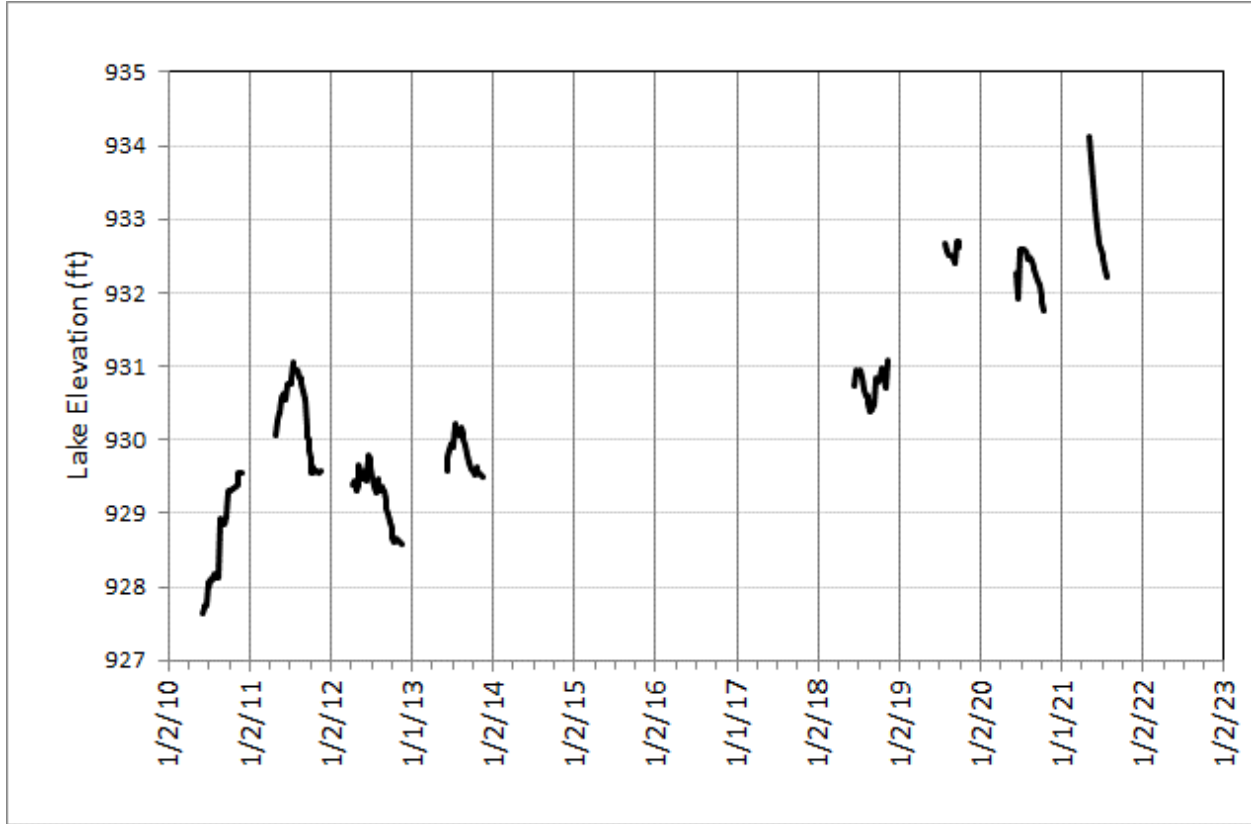


Figure 3: Lac Lavon Water Surface Elevation



Photograph 2: High lake levels in 2019 preventing access to the Lac Lavon fishing dock in city park.



Photograph 3: Low lake levels on August 31, 2022 exposing near shore lake bottom.

Discussion of 2022 Lac Lavon Water Quality and Macrophyte Monitoring

Lac Lavon continues to experience excellent water quality. Summer averages of Secchi disc transparency, chlorophyll *a*, and total phosphorus are consistently better than the MPCA's eutrophication standards. There were no statistically significant trends in water quality for the most recent 10-year period. Barr recommends continuation of the yearly CAMP level water quality monitoring of Lac Lavon, and continuation of the management-level water quality monitoring once every 5 years (per the BDWMO's 2022 Watershed Management Plan).

A variety of native and non-native aquatic plants grow in Lac Lavon. Six different species of native plants that are indicative of good water quality were identified in 2022. However, dense growths of non-native curly-leaf pondweed and Eurasian watermilfoil are occurring in some areas of the lake. Non-native brittle naiad is also present, but do not grow at nuisance levels. Barr recommends continued macrophyte surveys to monitor the aquatic plant community of Lac Lavon.

The City of Apple Valley received a grant to install a rain garden in the parking lot in the city park on the northeast shore of Lac Lavon. The purpose of the rain garden is to collect stormwater from the parking lot, and allow for infiltration into the ground or filtration of stormwater to remove pollutants. Installation of the rain garden is planned for 2023.

Table 2
Lac Lavon 2022 Water Quality Measured by Barr Engineering
BDWMO

Date	Sample Depth (m)	Field Measurements						Laboratory Analyses	
		Dissolved oxygen [mg/L]	pH	Specific conductance @ 25°C [µS/cm]	Water temperature [°C]	Secchi disc transparency [m]	Turbidity [NTU]	Chlorophyll a, pheophytin adjusted [µg/L]	Total phosphorus [µg/L]
4/19/2022	0 - 2	--	--	--	--	2.2	4.0	11.9	15
4/19/2022	0	12.6	6.73	596	5.1		--	--	--
4/19/2022	1	12.6	6.86	596	5.1		--	--	--
4/19/2022	2	12.6	7.02	595	5.1		--	--	--
4/19/2022	3	12.6	7.14	593	5.0		--	--	17
4/19/2022	4	12.4	7.22	594	5.0		--	--	18
4/19/2022	5	12.4	7.27	594	5.0		--	--	17
4/19/2022	6	12.5	7.30	594	5.0		--	--	16
4/19/2022	7	12.5	7.32	593	5.0		--	--	17
4/19/2022	8	12.5	7.33	593	4.9		--	--	18
4/19/2022		12.5	7.60	593	4.9		--	--	24
5/10/2022	0-2	--	--	--	--	2.2	2.2	4.6	16
5/10/2022	0	11.0	8.31	598	14.7		--	--	--
5/10/2022	1	11.1	8.30	598	14.6		--	--	--
5/10/2022	2	11.2	8.28	598	14.5		--	--	--
5/10/2022	3	11.1	8.25	595	14.2		--	--	20
5/10/2022	4	11.4	8.23	589	10.4		--	--	22
5/10/2022	5	12.0	8.24	587	8.9		--	--	14
5/10/2022	6	12.0	8.14	589	8.5		--	--	19
5/10/2022	7	12.1	8.01	591	8.3		--	--	23
5/10/2022	8	8.5	7.90	594	8.1		--	--	22
5/10/2022	9	6.1	7.67	606	8.1		--	--	23
5/24/2022	0-2	--	--	--	--	3.4	1.3	4.2	21
5/24/2022	0	10.2	7.82	592	17.4		--	--	--
5/24/2022	1	10.1	8.00	590	17.4		--	--	--
5/24/2022	2	10.1	8.08	591	17.3		--	--	--
5/24/2022	3	9.8	8.14	592	16.9		--	--	13
5/24/2022	4	11.6	8.25	597	13.8		--	--	23
5/24/2022	5	12.1	8.34	589	10.4		--	--	16
5/24/2022	6	12.1	8.17	593	9.2		--	--	17
5/24/2022	7	5.3	7.73	600	8.6		--	--	28
5/24/2022	8	0.9	7.41	617	8.1		--	--	33
5/24/2022	9	0.6	7.36	618	8.0		--	--	56
6/07/2022	0-2	--	--	--	--	3.5	4.6	4.3	20
6/07/2022	0	10.1	8.55	596	20.1		--	--	--
6/07/2022	1	10.1	8.60	595	20.1		--	--	--
6/07/2022	2	10.1	8.60	595	20.1		--	--	--
6/07/2022	3	10.1	8.57	595	19.6		--	--	13
6/07/2022	4	11.0	8.50	600	17.2		--	--	15
6/07/2022	5	12.8	8.61	598	12.1		--	--	17
6/07/2022	6	11.0	8.38	601	10.2		--	--	17
6/07/2022	7	2.5	7.88	616	9.1		--	--	22
6/07/2022	8	0.8	7.72	632	8.5		--	--	39

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Lac Lavon 2022 Water Quality Measured by Barr Engineering
BDWMO

Date	Sample Depth (m)	Field Measurements						Laboratory Analyses	
		Dissolved oxygen [mg/L]	pH	Specific conductance @ 25°C [µS/cm]	Water temperature [°C]	Secchi disc transparency [m]	Turbidity [NTU]	Chlorophyll a, pheophytin adjusted [µg/L]	Total phosphorus [µg/L]
6/21/2022	0-2	--	--	--	--	2.8	1.8	2.3	18
6/21/2022	0	9.6	8.50	535	21.7		--	--	--
6/21/2022	1	9.7	8.50	535	21.7		--	--	--
6/21/2022	2	9.7	8.50	535	21.6		--	--	--
6/21/2022	3	9.7	8.50	535	21.5		--	--	9
6/21/2022	4	11.2	8.40	549	19.4		--	--	16
6/21/2022	5	12.6	8.40	557	15.1		--	--	18.0
6/21/2022	6	10.0	7.90	566	11.0		--	--	33
6/21/2022	7	4.5	7.60	574	8.9		--	--	24
6/21/2022	8	0.2	7.10	610	7.6		--	--	38
6/21/2022	9	0.1	7.10	666	7.2		--	--	58
7/06/2022	0-2	--	--	--	--	3.0	1.0	2.9	13
7/06/2022	0	9.5	9.14	603	25.8		--	--	--
7/06/2022	1	9.6	9.13	602	25.8		--	--	--
7/06/2022	2	9.6	9.12	602	25.8		--	--	--
7/06/2022	3	9.4	9.03	606	24.7		--	--	11
7/06/2022	4	9.4	8.75	618	22.9		--	--	13
7/06/2022	5	15.1	8.95	625	15.9		--	--	14
7/06/2022	6	13.4	8.91	640	12.0		--	--	20
7/06/2022	7	2.1	8.15	661	9.8		--	--	33
7/06/2022	8	0.8	7.86	681	9.0		--	--	64
7/19/2022	0-2	--	--	--	--	3.1	1.7	3.1	9
7/19/2022	0	9.4	9.00	545	27.0		--	--	--
7/19/2022	1	9.4	8.90	546	27.0		--	--	--
7/19/2022	2	9.4	8.90	546	27.0		--	--	--
7/19/2022	3	8.5	8.60	555	26.2		--	--	9
7/19/2022	4	8.2	8.40	568	24.5		--	--	8
7/19/2022	5	11.9	8.20	580	18.2		--	--	9
7/19/2022	6	10.7	8.20	592	12.8		--	--	14
7/19/2022	7	3.4	7.60	607	10.7		--	--	16
7/19/2022	8	0.7	7.30	632	9.3		--	--	36
8/03/2022	0-2	--	--	--	--	3.0	2.7	3.0	12
8/03/2022	0	9.1	8.80	581	25.5		--	--	--
8/03/2022	1	9.2	8.80	580	25.5		--	--	--
8/03/2022	2	9.2	8.80	580	25.5		--	--	--
8/03/2022	3	9.2	8.80	580	25.5		--	--	11
8/03/2022	4	8.9	8.80	585	24.8		--	--	15
8/03/2022	5	11.1	8.40	620	21.7		--	--	9
8/03/2022	6	10.0	8.10	633	14.7		--	--	14
8/03/2022	7	4.3	7.80	654	11.4		--	--	20
8/03/2022	8	0.9	7.30	730	9.4		--	--	48

Table 2
Lac Lavon 2022 Water Quality Measured by Barr Engineering
BDWMO

Date	Sample Depth (m)	Field Measurements						Laboratory Analyses	
		Dissolved oxygen [mg/L]	pH	Specific conductance @ 25°C [µS/cm]	Water temperature [°C]	Secchi disc transparency [m]	Turbidity [NTU]	Chlorophyll a, pheophytin adjusted [µg/L]	Total phosphorus [µg/L]
8/18/2022	0-2	--	--	--	--	3.7	1.8	5.3	15
8/18/2022	0	9.5	8.80	562	24.3		--	--	--
8/18/2022	1	9.6	8.80	562	24.3		--	--	--
8/18/2022	2	9.6	8.80	562	24.3		--	--	--
8/18/2022	3	9.2	8.80	563	24.1		--	--	9
8/18/2022	4	8.4	8.70	565	23.3		--	--	8
8/18/2022	5	6.3	8.10	601	22.6		--	--	11
8/18/2022	6	8.1	8.00	633	16.5		--	--	11
8/18/2022	7	1.3	7.70	651	12.4		--	--	14
8/18/2022	8	0.8	7.20	683	10.1		--	--	52
8/31/2022	0-2	--	--	--	--	3.5	1.8	3.7	12
8/31/2022	0	8.6	8.70	548	23.5		--	--	--
8/31/2022	1	8.6	8.80	548	23.5		--	--	--
8/31/2022	2	8.5	8.80	548	23.5		--	--	--
8/31/2022	3	8.5	8.80	548	23.5		--	--	14
8/31/2022	4	8.5	8.80	548	23.5		--	--	11
8/31/2022	5	7.1	8.50	561	22.9		--	--	14
8/31/2022	6	6.4	7.90	618	18.2		--	--	9
8/31/2022	7	1.0	7.50	643	13.4		--	--	17
8/31/2022	8	0.7	7.10	677	10.5		--	--	28
9/13/2022	0-2	--	--	--	--	3.3	1.6	3	9
9/13/2022	0	8.8	8.80	530	22.1		--	--	--
9/13/2022	1	8.7	8.80	531	22.2		--	--	--
9/13/2022	2	8.6	8.80	531	22.2		--	--	--
9/13/2022	3	8.6	8.80	531	22.2		--	--	9
9/13/2022	4	8.6	8.80	531	22.2		--	--	10
9/13/2022	5	8.2	8.80	532	22.2		--	--	8
9/13/2022	6	3.2	7.70	600	18.7		--	--	10
9/13/2022	7	0.8	7.60	617	14.2		--	--	28
9/13/2022	8	0.7	7.20	660	10.8		--	--	164
9/13/2022	9	0.2	7.40	813	9.4		--	--	94

Table 3: Lac Lavon Water Quality Measured by CAMP Volunteer

Sample Date	Sample Depth [m]	Secchi Disc Transparency [m]	Water Temperature [°C]	Chlorophyll-a, Pheophytin Corrected [µg/L]	Nitrogen, Total Kjeldahl [mg/L]	Total Phosphorus [ug/L]
5/3/2022	0	3.0	12.6	3.6	0.66	18
5/30/2022	0	4.9	21.1	1.1	0.58	11
6/26/2022	0	4.8	25.4	1.6	0.48	15
8/9/2022	0	4.4	25.4	2.7	0.48	10