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Technical Memorandum

To: Black Dog Watershed Management Organization (BDWMO)
From: Kevin Menken, Barr Engineering
Subject: Orchard Lake 2020 Water Quality Monitoring Results
Date: March 10, 2021
Project: 23/19-0375

This memorandum presents the results of 2020 management-level water quality monitoring of Orchard Lake, conducted by Barr Engineering Co. (Barr) on behalf of the BDWMO. Results of monitoring performed by a citizen volunteer participating in the Metropolitan Council sponsored Citizen-Assisted Monitoring Program (CAMP) are included as well.

1.0 Introduction and Background

Orchard Lake is 243 acres in size, 75% of which is less than 15 feet deep. The maximum depth is 33 feet, and the average depth is 10 feet. Its tributary watershed is 2,260 acres, and is almost entirely within the City of Lakeville. A small portion of the Orchard Lake watershed is located within Credit River Township, which is outside of the BDWMO jurisdiction. There are three city parks located on Orchard Lake — a public boat access (Orchard Lake Park on south shore), a public beach (Orchard Lake Beach on west shore), and Wayside Park. Boating, fishing, swimming, and aesthetic and wildlife viewing are all popular recreational uses of the lake. Its 2,260-acre tributary watershed includes the Kingsley Lake watershed.

2.0 2020 Water Quality Monitoring Activities

The BDWMO Watershed Management Plan requires that Orchard Lake undergo "management-level" water quality monitoring 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 2020 and included collection of the following data:

- Measurement of Secchi disc transparency (a measure of water clarity).
- Field probe measurements of dissolved oxygen concentration, water temperature, specific conductivity, and pH at 1-meter depth intervals.
- Composite water samples from the surface of Orchard Lake (0–2 meters); these samples were sent to a laboratory for analyses of total phosphorus and chlorophyll *a* (a measure of algal abundance) concentrations.
- Water samples from 3 meters to 8 meters, taken at 1-meter depth intervals; these samples were sent to a laboratory for analyses of total phosphorus concentrations.

Tabulated water quality data collected by Barr (Table 2) and the CAMP volunteer (Table 3) are attached at the end of this memorandum. The 2020 Barr and CAMP measurements of Secchi disc transparency, total phosphorus, and chlorophyll *a* are plotted in Figure 1. Measurements of SDT collected by Barr were very similar to the CAMP measurements throughout the season. Barr measurements of total phosphorus were higher compared to CAMP measurements for total phosphorus during early summer, while CAMP total phosphorus measurements were higher than Barr's measurements in late summer (Figure 1a). Barr and CAMP measurements of chlorophyll *a* were similar in early summer, but CAMP measurements were higher than Barr measurements in August-September (Figure 1b). The differences between Barr and CAMP measurements of total phosphorus and chlorophyll *a* are likely due to the different methods of water sample collection – Barr samples were collected as a composite of the top 2 meters (6.6 feet) of the lake, while CAMP samples are collected by dipping a sample bottle at the surface of the lake (i.e. elbow length below surface). Changes in lake temperature and predominant phytoplankton (i.e. algae) species during the growing season can result in changes in the depth at which nutrients and chlorophyll *a* are most concentrated near the lake surface. All parameters demonstrate better water quality in early-summer (June) compared to late-summer (August-September), which is typical for many Minnesota lakes.

3.0 Summer Averages of Water Quality Parameters and Associated Goals

The 2020 summer (June-September) averages of water quality parameters were calculated for Orchard Lake and plotted along with previous years' summer averages (Figure 2). The BDWMO classified Orchard Lake 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 Orchard Lake was recalculated to be 2.3 meters (7.6 feet) for the most recent 10 years of monitoring (2011-2020). The summer average SDT in 2020 was 2.1 meters (6.9 feet), which is worse than the action level of 2.3 meters. There is also a statistically significant trend (95% confidence interval) of worsening water quality in summer average SDT for the most recent 10-year period. There were no statistically significant trends in summer averages of total phosphorus or chlorophyll *a*.

The MPCA's lake eutrophication standards include numeric criteria for summer averages (June-September) of Secchi disc transparency, total phosphorus, and chlorophyll *a*. Table 1 provides the eutrophication standards for a deep lake within the North Central Hardwood Forest ecoregion, along with the averages of the most recent 10 years (2011-2020) of monitoring for Orchard Lake. Summer averages of Orchard Lake water quality parameters are consistently much better than the MPCA's lake eutrophication standards. The BDWMO's *2012-2022 Watershed Management Plan* (Plan) lists recommended lake water quality management actions for strategic waterbodies under different scenarios of observed water quality. According to Table 4-1 of the BDWMO Plan, if Orchard Lake has summer average water quality worse than the Management Action Level, and a statistically significant 10-year trend of degrading water quality (i.e., SDT), the following actions are recommended: 1) comprehensive lake/watershed diagnostic-feasibility study; 2) intensive lake monitoring as part of diagnostic-feasibility study; and 3) detailed runoff water quality monitoring as part of diagnostic-feasibility study. Barr's recommendations for future activities on Orchard Lake are discussed at the end of this memorandum.

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

Water Quality Parameter	MPCA Lake Eutrophication Standard	Orchard Lake 10-yr Average (2011-2020)
Total Phosphorus (µg/L)	≤ 40	22
Chlorophyll *a* (µg/L)	≤ 14	6.1
Secchi Disc Transparency (m)	≥ 1.4	2.5

4.0 Aquatic Macrophyte Surveys

The City of Lakeville continues its efforts to monitor and manage aquatic invasive species, including zebra mussels, and the invasive aquatic plant species curly-leaf pondweed and Eurasian watermilfoil. Zebra mussels have not been found in Orchard Lake, but Lakeville considers Orchard Lake at higher risk for infestation due to presence of zebra mussels in nearby Lake Marion. Curly-leaf pondweed and Eurasian watermilfoil are both present in Orchard Lake, and both plant species can form dense nuisance growth at the lake surface. Curly-leaf pondweed can also negatively impact water quality, as it grows and dies earlier in the season than native plants, releasing nutrients as it dies off in mid-summer.

The City of Lakeville's efforts to control curly-leaf pondweed in Orchard Lake include herbicide treatments and harvesting, starting in 2004. The reduction in the amount of curly-leaf pondweed may be one reason why water quality has been better in years 2008-2020 compared to years 2007 and earlier. The city's 2020 early season delineation of curly-leaf pondweed in Orchard Lake showed two areas totaling 9.5 acres that had potential for heavy growth – a 4.0-acre increase compared to 2019. The city treated these areas (9.5 acres) with an herbicide early in the 2020 growing season to reduce the curly-leaf pondweed where there was potential for heavy growth. The city's early season survey also showed 5 areas of heavy Eurasian watermilfoil growth; however, late season surveys showed these areas no longer had heavy growth, and treatment was not warranted. The City of Lakeville last conducted herbicide treatments for Eurasian watermilfoil in Orchard Lake in 2018.

5.0 Lake Levels

Lake elevation data have been collected on Orchard Lake regularly since 1992. The highest observed lake elevation was 977.75 feet above mean sea level on June 20, 2014, while the lowest observed was 975.84 feet on November 6, 2003, a difference of 1.9 feet. Lake elevations are plotted on Figure 3.

6.0 Fishery

The Minnesota Department of Natural Resources (DNR) reports fishery survey results on the DNR's Lake Finder web portal. The most recent fish survey conducted on Orchard Lake that is reported on the Lake Finder web portal was in 2016. Results of the most recent surveys are summarized below (note: this is the same information included in the report on the 2017 Orchard Lake monitoring):

- A nighttime electrofishing survey of Orchard Lake in 2016 that targeted largemouth bass found a relatively high abundance of largemouth bass compared to other lakes in the East Metro area.
- A 2012 DNR survey using trap nets and gill nets found a fishery dominated by small sunfish. Only 1 walleye was sampled in 2012, and northern pike abundance was reported as average. Crappie and yellow perch numbers were also reported as average.
- The lake is regularly stocked with walleye (most recently in 2015) and tiger muskellunge (most recently in 2016).

7.0 Orchard Lake Watershed Improvement Projects

The City of Lakeville conducted street reconstruction in the Orchard Lake watershed in 2020, and the project incorporated several water quality improvements, including rip rap shoreline stabilization along 175th Street West; replacement of degraded outfall structures; replacement of two equalizer culverts; and improvements in two stormwater ponds (source: 2020 Orchard Lake Update, City of Lakeville).

Other recent water quality improvements in the Orchard Lake watershed include an aeration device installed by the City of Lakeville in Orchard Pond, a wetland that contributes flow to Orchard Lake. The aeration system is designed to reduce phosphorus export from Orchard Pond and has operated for the past several open-water seasons.

8.0 Discussion of Orchard Lake Water Quality Results and Recommendations

Orchard Lake continues to experience good water quality. Summer averages of Secchi disc transparency, chlorophyll *a*, and total phosphorus have been consistently better than the MPCA's eutrophication standards for the period of 2008-2020. The 2020 summer-average Secchi disc transparency was worse than the BDWMO Plan "action level" (25th percentile of most recent 10-year summer averages). A statistical analysis shows a worsening trend (95% confidence) of summer averages of Secchi disc transparency for the recent 10-year period of 2011-2020. However, there were no statistically significant trends in either total phosphorus or chlorophyll *a*.

Secchi disc transparency measurements in lakes are affected by a number of factors, including suspended sediment, algae, and dissolved organic compounds (typically referred to as dissolved organic carbon) that originate from the decomposition of plants and algae. For most Minnesota lakes, turbidity from algae is the primary factor influencing water clarity. However, suspended sediments and dissolved organic carbon can also play a significant role in reducing water clarity in lakes. Dissolved organic carbon originates from decaying plant matter in the watershed (i.e. tree leaves, wetland plants), as well as algae and plants that grow in the lake, and at high enough concentrations can make the water look like tea, coffee, or root beer. Increased runoff from above average precipitation not only brings increased phosphorus and sediment loads, it can also increase the amount of dissolved organic carbon as more water is pushed out of wetlands in the watershed. The impact of dissolved organic carbon on Secchi disc transparency in Orchard Lake would be most pronounced during early summer (June), when algal turbidity is typically the lowest.

Secchi disc transparency was plotted separately for each calendar month (June, July, August, September) for the years 2011-2020 to see if trends in water clarity were more pronounced in any part of the growing season (Figure 4). All four months showed similar overall trends of decreasing water clarity for the 10-year period 2011-2020. Water clarity was typically highest in June and decreased each month until it reached the lowest water clarity in September. September 2020 had the worst Secchi disc transparency of any month in the period 2011-2020. There does not appear to be any part of the Orchard Lake summer growing season that has water clarity worsening more rapidly than other months. Although changes in dissolved organic carbon may account for some of the decline in Secchi disc transparency in Orchard Lake, there is not enough information available to make that assessment. In addition, if dissolved organic carbon were the primary reason for the worsening water clarity, we would expect to see a more substantial decrease in June water clarity readings compared to other months.

The BDWMO Plan includes recommended lake water quality management actions for strategic waterbodies under different scenarios of observed water quality. According to Table 4-1 of the Plan, if Orchard Lake has summer-average Secchi disc transparency worse than the updated "action level", and a statistically significant 10-yr trend of degrading water quality, the following actions are recommended: 1) comprehensive lake/watershed diagnostic-feasibility study; 2) intensive lake monitoring as part of diagnostic-feasibility study; and 3) detailed runoff water quality monitoring as part of diagnostic-feasibility study. The trend of degrading water quality is limited to Secchi disc transparency, as summer averages of total phosphorus and chlorophyll *a* do not show statistically significant trends of degrading water quality for the most recent 10-year period. Barr recommends continuation of the yearly CAMP level water quality monitoring of Orchard Lake, and continuation of the management-level water quality monitoring once every 3 years (year 2023). Barr does not recommend a comprehensive lake/watershed diagnostic-feasibility study, more intensive lake monitoring, or watershed monitoring at this time, as neither total phosphorus nor chlorophyll *a* show trends of degrading water quality for years 2011-2020.

Barr recommends the BDWMO consider additional monitoring parameters in 2023, including measurements of dissolved organic carbon, total suspended solids, and volatile suspended solids (the portion of total suspended solids that is organic). These additional parameters would help in understanding the reasons for the worsening Secchi disc transparency in Orchard Lake, considering total phosphorus and chlorophyll *a* do not show a trend of degrading water quality. Barr also recommends the BDWMO consider collecting samples from Orchard Lake in 2023 to analyze for phytoplankton species identification. The predominant phytoplankton types will shift over the summer season as lake temperature and other conditions change, often shifting from diatoms in spring and early-summer to cyanobacteria (i.e. blue-green algae) by late summer. Cyanobacteria have the ability to regulate their buoyancy and can concentrate at the lake surface; as a result, they may cause a larger decrease in water clarity than other phytoplankton types that are dispersed more evenly in the water column. Cyanobacteria can also produce toxins that can be harmful to people and animals. Cyanobacteria prefer warmer water temperatures, and there is a risk that cyanobacteria blooms will increase or occur earlier in the growing season as lake temperatures rise due to a warming climate.

Orchard Lake has a healthy community of native aquatic plants. The non-native plants curly-leaf pondweed and Eurasian watermilfoil are also present, but are kept in check by the City of Lakeville's continued management efforts – most recently targeted herbicide treatments of curly-leaf pondweed. Curly-leaf pondweed can negatively impact water quality when it releases phosphorus as it dies off in early to mid-summer. Barr recommends the City of Lakeville continue their efforts in monitoring aquatic vegetation, and targeted treatments of curly-leaf pondweed with herbicides, or other suitable methods for reducing curly-leaf pondweed. Although Eurasian watermilfoil does not die off early in summer and negatively affect water quality like curly-leaf pondweed, it can grow to nuisance levels, forming dense growth at the water surface that outcompetes native vegetation and impedes recreation activities. Barr recommends continued monitoring and targeted herbicide control of Eurasian watermilfoil to prevent it from becoming established and growing to nuisance levels in Orchard Lake.

Table 2
Orchard Lake 2020 Water Quality Measured by Barr Engineering
BDWMO

		Field Measurements						Laboratory Analyses	
Date	Sample Depth (m)	Dissolved oxygen [mg/l]	pH	Specific conductance @ 25 ºC [umhos/cm}	Water Temperature [ºC]	Secchi disc [m]	Turbidity [NTU]	Chlorophyll a, pheophytin-adjusted [ug/l]	Phosphorus, total, as P [µg/l]
4/20/2020	0 - 2	--	--	--	--	2.8	2.5	3.3	21
4/20/2020	0	12.0	7.9	787	7.8	--	--	--	--
4/20/2020	1	11.9	7.9	786	7.8	--	--	--	--
4/20/2020	2	11.9	8.0	786	7.8	--	--	--	--
4/20/2020	3	11.9	8.0	787	7.8	--	--	--	20
4/20/2020	4	11.9	8.0	786	7.7	--	--	--	18
4/20/2020	5	11.7	8.0	787	7.5	--	--	--	24
4/20/2020	6	11.7	8.0	786	7.4	--	--	--	23
4/20/2020	7	11.7	8.0	786	7.4	--	--	--	22
4/20/2020	8	11.6	8.0	785	7.4	--	--	--	25
4/20/2020	8.5	10.6	7.4	786	7.3	--	--	--	30
5/18/2020	0 - 2	--	--	--	--	2.1	2.8	< 1	15
5/18/2020	0	9.7	8.2	790	13.7	--	--	--	--
5/18/2020	1	9.6	8.2	789	13.7	--	--	--	--
5/18/2020	2	9.6	8.2	790	13.7	--	--	--	--
5/18/2020	3	9.6	8.2	789	13.7	--	--	--	20
5/18/2020	4	9.5	8.2	788	13.6	--	--	--	15
5/18/2020	5	9.6	8.2	786	13.6	--	--	--	17
5/18/2020	6	9.5	8.2	787	13.6	--	--	--	11
5/18/2020	7	9.5	8.2	788	13.6	--	--	--	19
5/18/2020	8	9.0	8.2	786	13.5	--	--	--	23
6/02/2020	0 - 2	--	--	--	--	2.4	2.5	3.6	22
6/02/2020	0	9.8	8.3	767	22.4	--	--	--	--
6/02/2020	1	9.8	8.3	767	22.3	--	--	--	--
6/02/2020	2	9.5	8.3	770	22.0	--	--	--	--
6/02/2020	3	9.4	8.3	770	21.5	--	--	--	24
6/02/2020	4	8.1	8.0	784	18.5	--	--	--	34
6/02/2020	5	6.0	7.7	789	15.3	--	--	--	24
6/02/2020	6	5.2	7.6	789	14.0	--	--	--	25
6/02/2020	7	3.8	7.5	790	13.7	--	--	--	19
6/02/2020	8	1.9	7.4	793	13.3	--	--	--	26
6/02/2020	8.5	0.9	7.3	795	13.2	--	--	--	20
6/15/2020	0 - 2	--	--	--	--	2.8	1.2	2.0	18
6/15/2020	0	8.8	8.3	760	20.8	--	--	--	--
6/15/2020	1	8.8	8.4	758	20.8	--	--	--	--
6/15/2020	2	8.7	8.5	758	20.8	--	--	--	--
6/15/2020	3	8.7	8.5	758	20.8	--	--	--	17
6/15/2020	4	8.7	8.5	756	20.8	--	--	--	15
6/15/2020	5	8.7	8.5	758	20.8	--	--	--	22
6/15/2020	6	2.3	7.8	790	15.4	--	--	--	45
6/15/2020	7	0.6	7.5	793	14.0	--	--	--	41
6/15/2020	8	0.4	7.5	802	13.3	--	--	--	30
6/29/2020	0 - 2	--	--	--	--	3.0	2.4	4.0	18
6/29/2020	0	8.5	8.5	704	24.5	--	--	--	--
6/29/2020	1	8.5	8.5	704	24.8	--	--	--	--
6/29/2020	2	8.6	8.6	705	24.8	--	--	--	--
6/29/2020	3	7.7	8.5	719	24.7	--	--	--	18
6/29/2020	4	2.2	7.7	756	21.6	--	--	--	15
6/29/2020	5	0.5	7.5	781	19.5	--	--	--	18
6/29/2020	6	0.4	7.5	805	14.2	--	--	--	41
6/29/2020	7	0.3	7.5	819	13.5	--	--	--	38
6/29/2020	8	0.3	7.3	820	13.4	--	--	--	72
7/13/2020	0 - 2	--	--	--	--	2.1	3.8	6.7	28
7/13/2020	0	9.0	8.7	668	27.4	--	--	--	--
7/13/2020	1	9.0	8.7	668	27.5	--	--	--	--
7/13/2020	2	9.0	8.8	667	27.5	--	--	--	--
7/13/2020	3	9.0	8.9	668	27.5	--	--	--	22
7/13/2020	4	2.9	7.9	640	25.3	--	--	--	32
7/13/2020	5	0.4	7.7	666	22.1	--	--	--	95
7/13/2020	6	0.3	7.7	784	18.6	--	--	--	44
7/13/2020	7	0.2	7.7	805	15.7	--	--	--	40
7/13/2020	8	0.2	7.7	833	13.4	--	--	--	130

Table 2
Orchard Lake 2020 Water Quality Measured by Barr Engineering
BDWMO

		Field Measurements						Laboratory Analyses	
Date	Sample Depth (m)	Dissolved oxygen [mg/l]	pH	Specific conductance @ 25 ºC [umhos/cm}	Water Temperature [ºC]	Secchi disc [m]	Turbidity [NTU]	Chlorophyll a, pheophytin-adjusted [ug/l]	Phosphorus, total, as P [µg/l]
7/27/2020	0 - 2	--	--	--	--	1.8	3.3	3.1	24
7/27/2020	0	7.7	8.3	665	25.9	--	--	--	--
7/27/2020	1	7.6	8.3	666	25.9	--	--	--	--
7/27/2020	2	7.6	8.4	664	25.9	--	--	--	--
7/27/2020	3	7.6	8.4	664	25.9	--	--	--	22
7/27/2020	4	7.4	8.4	664	25.8	--	--	--	21
7/27/2020	5	0.3	7.4	686	23.4	--	--	--	58
7/27/2020	6	0.3	7.2	779	18.8	--	--	--	42
7/27/2020	7	0.3	7.3	818	15.7	--	--	--	45
7/27/2020	8	0.3	7.3	840	13.9	--	--	--	190
7/27/2020	8.5	0.2	7.2	860	13.0	--	--	--	310
8/10/2020	0 - 2	--	--	--	--	1.6	4.0	7.3	27
8/10/2020	0	7.5	8.2	668	24.5	--	--	--	--
8/10/2020	1	7.4	8.2	668	24.5	--	--	--	--
8/10/2020	2	7.4	8.3	667	24.5	--	--	--	--
8/10/2020	3	7.4	8.3	668	24.5	--	--	--	28
8/10/2020	4	7.4	8.3	667	24.4	--	--	--	28
8/10/2020	5	3.8	7.8	683	23.8	--	--	--	31
8/10/2020	6	0.3	7.3	768	20.1	--	--	--	54
8/10/2020	7	0.3	7.3	830	16.0	--	--	--	68
8/10/2020	8	0.3	7.3	841	14.8	--	--	--	190
8/26/2020	0 - 2	--	--	--	--	1.7	4.3	4.3	24
8/26/2020	0	8.4	8.4	668	26.4	--	--	--	--
8/26/2020	1	8.5	8.5	668	26.4	--	--	--	--
8/26/2020	2	8.5	8.5	667	26.4	--	--	--	--
8/26/2020	3	8.5	8.2	672	25.5	--	--	--	23
8/26/2020	4	2.7	7.6	673	24.4	--	--	--	26
8/26/2020	5	0.4	7.3	688	23.1	--	--	--	36
8/26/2020	6	0.3	7.2	756	20.2	--	--	--	41
8/26/2020	7	0.2	7.2	821	16.9	--	--	--	69
8/26/2020	8	0.2	7.1	862	14.6	--	--	--	96
9/10/2020	0 - 2	--	--	--	--	1.5	5.0	4.3	28
9/10/2020	0	6.2	7.3	678	17.6	--	--	--	--
9/10/2020	1	5.8	7.4	678	17.6	--	--	--	--
9/10/2020	2	5.8	7.5	678	17.6	--	--	--	--
9/10/2020	3	5.7	7.6	678	17.6	--	--	--	29
9/10/2020	4	5.7	7.7	678	17.6	--	--	--	26
9/10/2020	5	5.7	7.7	677	17.6	--	--	--	26
9/10/2020	6	5.6	7.7	677	17.5	--	--	--	26
9/10/2020	7	4.2	7.6	695	17.1	--	--	--	36
9/10/2020	8	0.5	7.3	846	15.8	--	--	--	140
9/21/2020	0 - 2	--	--	--	--	1.5	7.3	4.3	28
9/21/2020	1	8.4	7.7	691	16.8	--	--	--	--
9/21/2020	2	8.4	7.8	691	16.8	--	--	--	--
9/21/2020	3	8.3	7.8	691	16.8	--	--	--	29
9/21/2020	4	8.3	7.8	691	16.8	--	--	--	26
9/21/2020	5	8.2	7.9	692	16.8	--	--	--	26
9/21/2020	6	8.2	7.8	692	16.8	--	--	--	26
9/21/2020	7	8.3	7.8	692	16.8	--	--	--	36
9/21/2020	8	8.1	7.8	693	16.7	--	--	--	140

Notes

-- Not analyzed

< 1 Less than method detection limit

Table 3: Orchard Lake 2020 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]
5/30/2020	0	1.9	20.0	4.0	0.65	14
6/11/2020	0	2.8	--	2.2	0.58	12
6/26/2020	0	3.4	24.8	1.6	0.62	~9
7/8/2020	0	2.8	29.4	3.6	0.44	16
7/24/2020	0	1.8	25.7	6.9	0.72	29
8/7/2020	0	1.5	24.9	11	1.00	30
8/20/2020	0	1.9	24.7	9.8	0.94	33
9/4/2020	0	1.1	21.7	<1	0.68	34
9/20/2020	0	1.9	17.4	9.5	0.90	34
10/3/2020	0	2.0	14.9	8.9	0.84	22
10/17/2020	0	3.0	11.5	5.9	0.69	26

Notes

~9 - Value is less than the laboratory's method reporting limit, and is therefore an approximate value.

-- Not measured.

< 1 Less than method detection limit.

Figure 1a: Orchard Lake 2020 Total Phosphorus

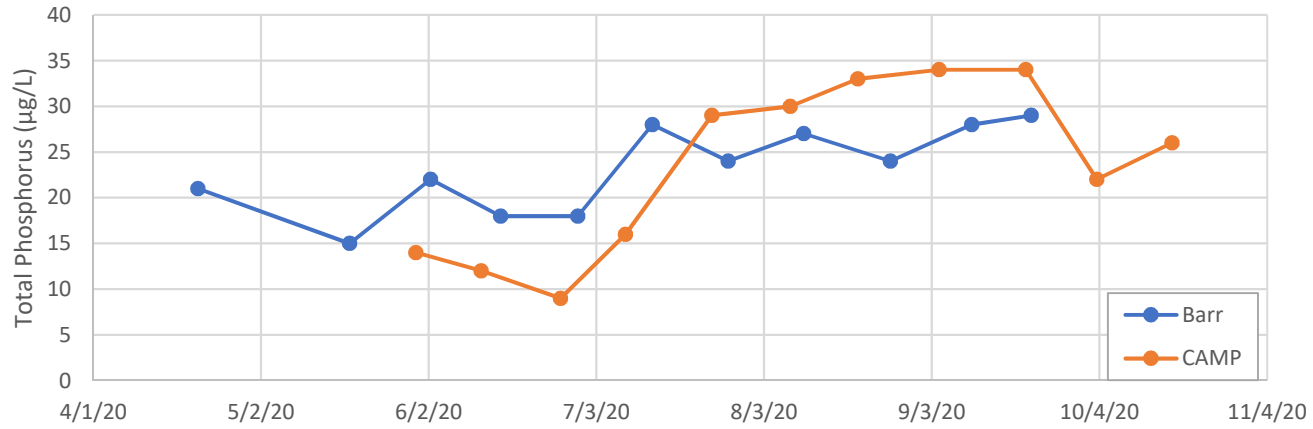

Figure 1b: Orchard Lake 2020 Chlorophyll-a

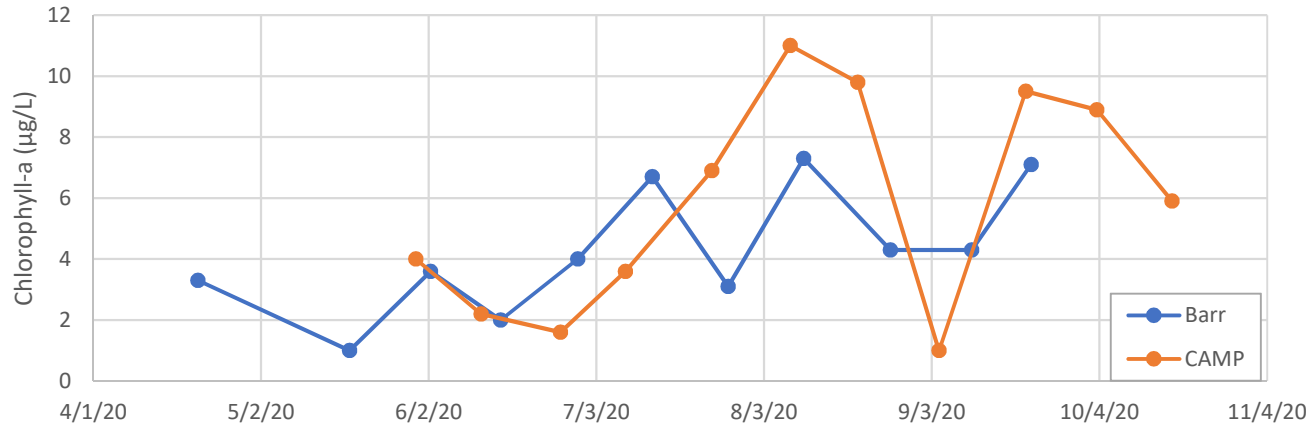

Figure 1c: Orchard Lake 2020 Secchi Disc Transparency

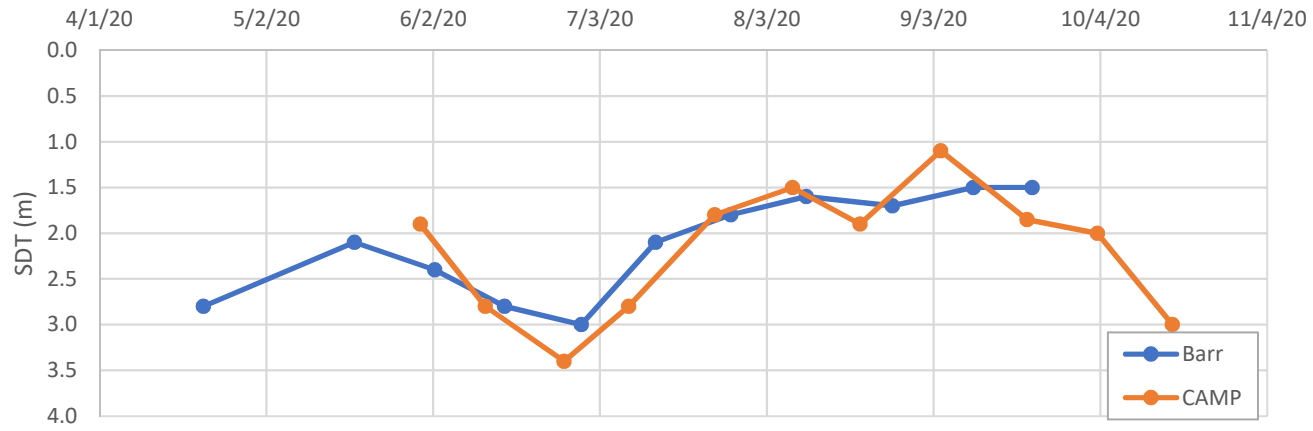

Figure 2a: Orchard Lake June-Sept. Secchi Disc Transparency

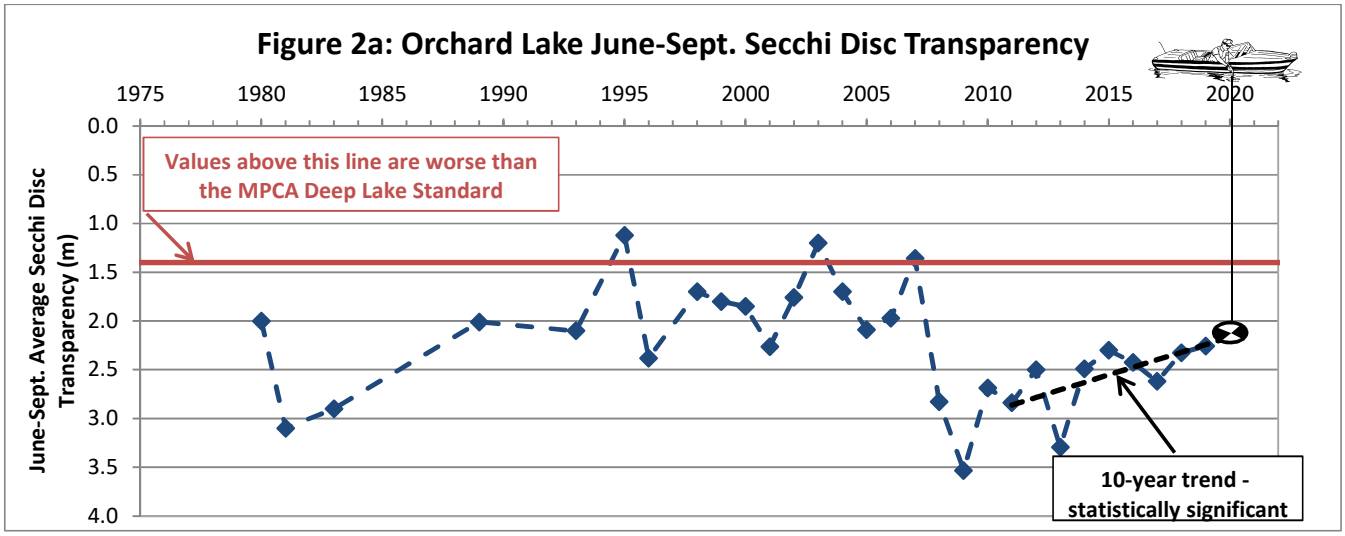

Figure 2b: Orchard Lake June-Sept. Average Chlorophyll *a*

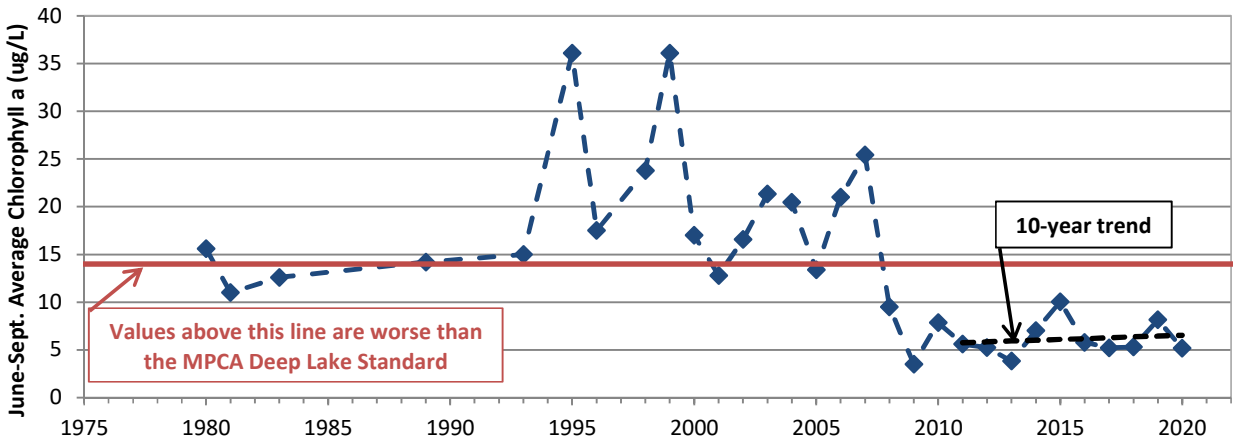

Figure 2c: Orchard Lake June-Sept. Average Total Phosphorus

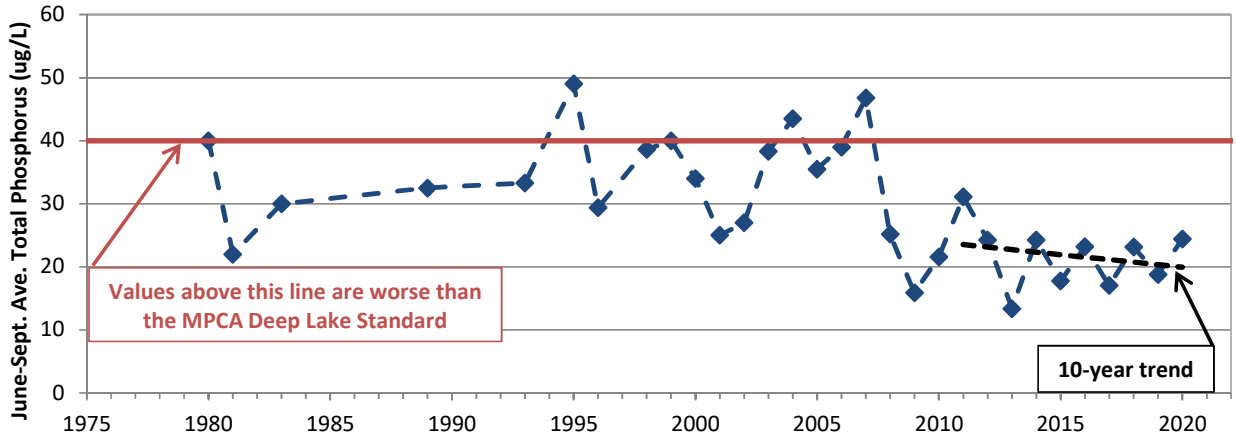

Figure 3: Orchard Lake Water Surface Elevation.

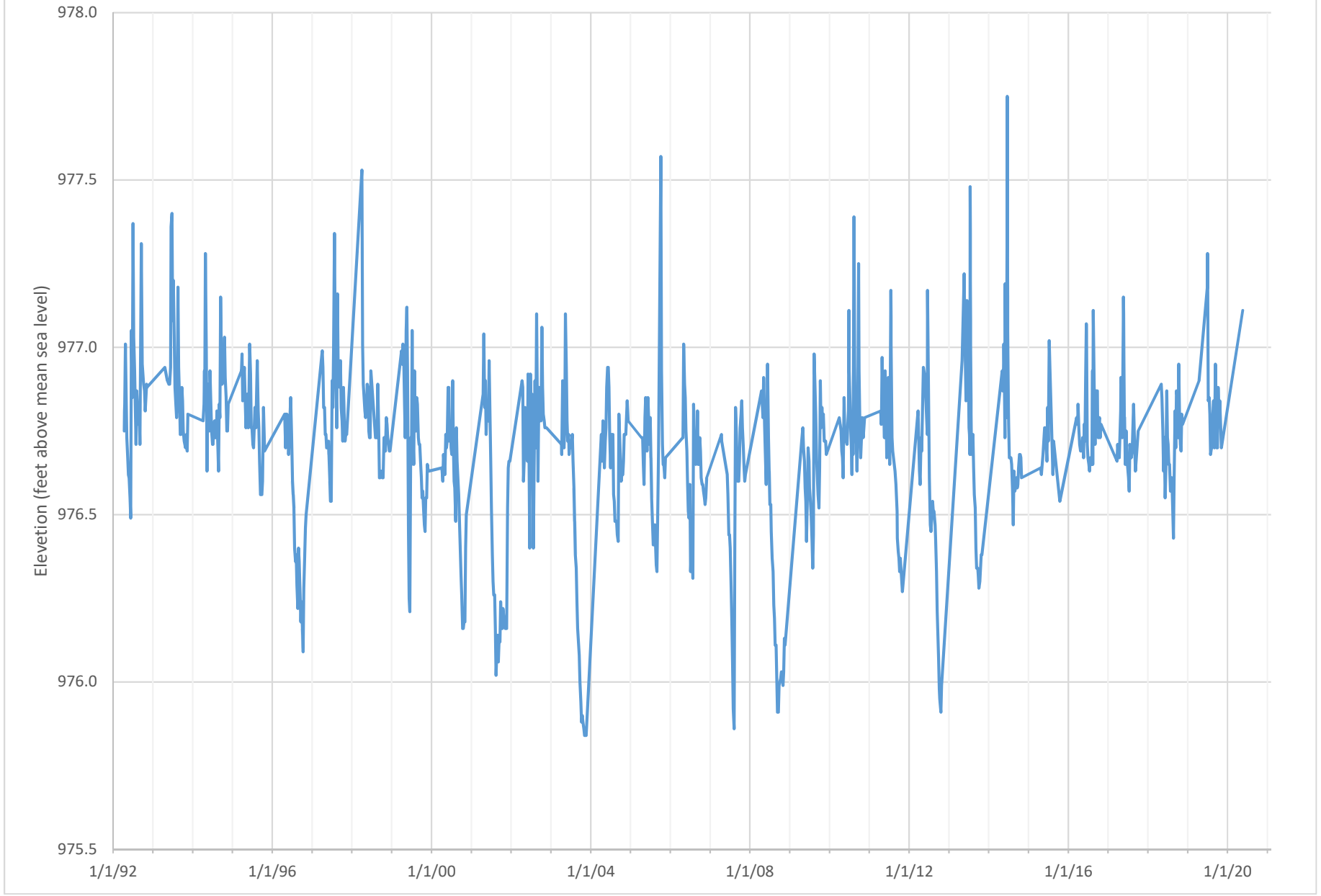

Figure 4: Orchard Lake Secchi Disc Transparency by Calendar Month, Years 2011-2020