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Technical Memorandum

To: Black Dog Watershed Management Organization (BDWMO) Commissioners
From: Kevin Menken, Barr Engineering
Subject: Crystal Lake 2021 Water Quality Monitoring Results
Date: April 12, 2022
Project: 23190375

This memorandum presents the results of 2021 management-level water quality monitoring of Crystal Lake, conducted by Barr Engineering Co. (Barr) on behalf of the BDWMO. Monitoring was also performed by a citizen volunteer participating in the Metropolitan Council sponsored Citizen-Assisted Monitoring Program (CAMP). Results continue to show good water quality in Crystal Lake in recent years, with summer averages of water clarity and total phosphorus concentrations consistently better than Minnesota's water quality standards. The Minnesota Pollution Control Agency (MPCA) removed Crystal Lake from the list of impaired waterbodies for eutrophication in 2018 due to more than a decade of good water quality, and the Environmental Protection Agency (EPA) approved the MPCA's decision in January 2019.

1.0 Introduction and Background

Crystal Lake is a 292-acre lake located in the cities of Burnsville and Lakeville. The lake is a major recreational resource; a public beach and public boat landing provide opportunities for swimming, fishing, water skiing, and aesthetic viewing. The mean depth of Crystal Lake is 10 feet, and the maximum depth is 35 feet. The lake's littoral area (shallow area where aquatic plants grow) is 208 acres. The total watershed area of Crystal Lake is 3,667 acres, including the lake's surface area. Several other lakes are also located within the Crystal Lake watershed, including Keller Lake and Lee Lake. Flow from Lee Lake to Crystal Lake occurs only during flood conditions.

During the period from 1996 to 2008, the BDWMO operated a ferric chloride treatment system at Crystal Lake that ran intermittently on a seasonal basis. The system was intended to reduce phosphorus concentrations in the lake by pumping deep water with elevated phosphorus, adding ferric chloride (a chemical containing iron), and discharging the treated water to nearby Keller Lake. The system was shut down at the end of 2009 due to operational costs, limited beneficial impacts, and low water levels in Crystal Lake.

2.0 2021 Water Quality Monitoring Activities

The BDWMO Watershed Management Plan calls for "management-level" water quality monitoring of Crystal Lake once every three years. Management-level monitoring involves a more detailed collection of water quality data than the Metropolitan Council's CAMP. This expanded effort was conducted by Barr in 2021 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 Crystal Lake (0–2 meters); these samples were sent to a laboratory for analyses of total phosphorus concentrations and chlorophyll *a* concentrations (a measure of algal abundance).
- 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 2021 Barr and CAMP measurements of Secchi disc transparency, total phosphorus, and chlorophyll-a measurements are plotted in Figure 1. Secchi disc transparency measurements were similar between Barr and CAMP throughout the season, with the highest water clarity (5.0 meters, or 16.4 feet) occurring on June 8. Chlorophyll-a measurements were also similar between Barr and CAMP in early- and late-summer, while Barr chlorophyll-a measurements were higher in late-June and early-July compared to CAMP measurements. The greatest disagreement between CAMP and Barr water quality measurements in 2021 were phosphorus measurements in early May, early June, and early-July. While Barr measurements of total phosphorus showed a steady decline from 25 µg/L on 4/14/21 to a season low of 14 µg/L on 6/8/21, CAMP measurements of total phosphorus fluctuated up and down several times in early summer, as shown on Figure 1. From 7/14/21 through the end of the monitoring season, the CAMP-measured total phosphorus in Crystal Lake was more consistent from one date to the next and was similar to Barr-measured concentrations over the same period. CAMP water quality samples are analyzed by the Metropolitan Council's laboratory, and we reached out to the Metropolitan Council CAMP contact to request staff review the early season data for Crystal Lake. The laboratory staff were unable to identify an explanation for the fluctuations in phosphorus in Crystal Lake in early 2021, but agreed the high concentration reported for sampling dates 5/7/21, 6/5/21, and 7/3/21 are suspect, and indicated the results will be flagged as suspect in the Metropolitan Council's database. Although we show these suspect phosphorus results in Figure 1 and Table 3, we removed the suspect phosphorus results for those dates from our calculation of the 2021 summer average for total phosphorus.

It is possible errors could have occurred in the laboratory while analyzing the early-summer phosphorus concentrations for select samples, but it is also worth noting that CAMP volunteers collect water samples in a different manner than Barr field staff. CAMP volunteers typically collect samples by directly filling bottles dipped at the lake surface. Algae, pollen, or other debris may float or concentrate at the lake surface during calm weather, thereby elevating phosphorus concentrations if bottles are filled directly at the lake surface. This is most often a problem in mid- to late-summer, when warm surface water and less wind mixing favor algae species that can float and concentrate at the lake surface. Water samples collected by Barr were composites of the top 2 meters (6.6 feet) of the lake, thereby minimizing influence of algae or other materials concentrating at the lake surface. Also, CAMP chlorophyll-a measurements did

not show the same early season fluctuations; therefore, it appears unlikely that algae concentrating at the lake surface would explain the early season fluctuations in CAMP-measured phosphorus.

3.0 Summer Averages of Water Quality Parameters and Associated Goals

The MPCA's lake eutrophication standards include numeric criteria for summer averages (June-September) of Secchi disc transparency (a measure of water clarity), total phosphorus, and chlorophyll *a* (a measure of algal abundance). We calculated the 2021 summer (June-September) averages of water quality parameters for Crystal Lake and plotted them along with previous years' summer averages. The plots of summer averages for total phosphorus (Figure 2a), chlorophyll-a (Figure 2b), and Secchi disc transparency (Figure 2c) are attached to this memorandum. The Crystal Lake summer average SDT in 2021 was 2.5 meters (8.1 feet), the summer average of total phosphorus was 20 µg/L, and the summer average for chlorophyll *a* was 9.3 µg/L, all better than the respective water quality standards. The overall trends for the most recent 10-year period show improving water quality, with a statistically significant trend for Secchi disc transparency (95% confidence level).

The MPCA utilizes the most recent 10 years of water quality data to make assessments of water quality impairments; therefore, the 10-year summer averages of total phosphorus, chlorophyll *a*, and Secchi disc transparency were calculated for 2012-2021 and compared to the lake eutrophication standards for deep lakes within the North Central Hardwood Forest ecoregion (Table 1). The 2012-2021 averages are better than the respective eutrophication standards for all parameters.

Table 1 Crystal 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	Crystal Lake 10-yr Average (2012-2021)
Total Phosphorus (µg/L)	≤ 40	26
Chlorophyll *a* (µg/L)	≤ 14	13
Secchi Disc Transparency (m)	≥ 1.4	2.1

Crystal Lake was added to the MPCA list of impaired waters in 2002 for nutrient (phosphorus) impairments, but was removed from the list in 2019 after more than a decade of improved water quality. During the period from 2008 to 2011, the BDMWO, its member communities, the MPCA, and other state and local agencies conducted a Total Maximum Daily Load (TMDL) study for Crystal, Keller, and Lee Lakes. The purpose of that study was to establish phosphorus load allocations that would help each lake achieve water quality goals. The BDWMO member cities continue to implement water quality improvement measures with the goal of removing the lakes from the impaired waters list – or in the case of Crystal Lake, keeping the lake off the list after it was removed.

4.0 Aquatic Macrophyte Surveys and Early Detection of Invasive Species

The aquatic invasive species (AIS) curly-leaf pondweed and Eurasian watermilfoil are both present in Crystal 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. Blue Water Science conducted aquatic plant surveys in Crystal Lake on May 17, 2021, and July 8, 2021 ("Aquatic Plant Surveys for Crystal Lake, Dakota County, 2021". Blue Water Science, January 26, 2022). The report also summarizes the City of Burnsville's efforts to control curly-leaf pondweed in Crystal Lake in 2021, which consisted of harvesting and removal of curly-leaf pondweed from 36 acres of the lake. A total of 50 trailer loads, or 202,500 pounds (wet weight) of plant material were removed from the lake in 2021. The estimated phosphorus mass that was removed as part of the plant biomass in 2021 was 76 pounds. Curly-leaf pondweed harvesting was most intense in years 2003-2008, where 387,750-510,300 pounds of biomass were harvested annually. Blue Water Science reports that from 2003-2021, a total of 5,705,690 pounds of plant biomass have been harvested from Crystal Lake, equivalent to 1,716 pounds of phosphorus. A total of fourteen native aquatic plant species were identified in Crystal Lake in 2021. Coontail was the most abundant plant, followed by flatstem pondweed. Aquatic plants were reported to be growing in depths of up to 13 feet.

The City of Burnsville also contracted with Blue Water Science to conduct early detection monitoring for new AIS that might have been introduced to Crystal Lake. Blue Water Science inspected the public boat launch area and another nearby shallow area of the lake, as new introductions of AIS are most likely to come from boats transporting from other lakes. Zebra mussels and starry stonewort (an invasive macro algae similar to native Chara) are of primary concern, and neither have been found in Crystal Lake to date.

5.0 Lake Levels

Lake elevation data have been recorded for Crystal Lake regularly since 1963 (Figure 3a). The highest observed lake elevation in 2021 was 933.69 feet on April 1 (Figure 3b), and the lowest was 932.83 on August 23, a difference of 0.86 feet. The City of Burnsville replace the outlet structure of Crystal Lake in 2021. The new outlet has a longer weir to facilitate an increase in the flow rate discharging from the lake. The elevation of the weir did not change from the previous elevation (i.e., no change in the water control elevation). The outlet replacement project also included modifications to the structure that prevents debris from collecting on the outlet weir. The changes to the outlet structure will reduce the time it takes the lake water levels to return to a no-wake condition following high water levels.

6.0 Fishery

The Minnesota Department of Natural Resources (MDNR) reports results of fishery surveys on the MDNR's Lake Finder web portal. The MDNR last performed a survey on Crystal Lake on May 26, 2017, which included electrofishing and trap netting. Some key findings of the MDNR's 2017 Crystal Lake fisheries survey, as well as recent fish stocking activities, are summarized below:

- The MDNR reported that the largemouth bass electrofishing catch rate of 232 fish per hour is extremely high and significantly greater than the 2016 catch rate of 87 fish per hour. Nearly 1/3 measured over 18 inches in length. The MDNR concluded the largemouth bass population "is very robust and meeting management goals."
- Bluegill and black crappie were sampled in the trap nets in the normal range for lakes in Crystal Lake's fisheries class. Bluegill density was lower than previous surveys, and there was a shift towards larger size bluegill, which may be attributed to the high numbers of largemouth bass that would consume smaller size bluegill.
- Black bullhead numbers were lower than previous fish surveys, with 6 black bullhead captured in standard trap nets (0.67 catch per unit effort) in 2018. Twenty-three black bullheads (2.56 catch per unit effort) were captured in standard trap nets in the May 2011 survey.
- The MDNR has stocked tiger muskellunge fingerlings in Crystal Lake every other year since 2010, including 420 fingerlings (140 lbs) in 2018 and 305 yearlings (152 pounds) in 2020.

7.0 Crystal Lake Watershed Improvement Projects

The City of Burnsville, in partnership with the Dakota County Soil and Water Conservation District, undertook a large shoreline stabilization project on Crystal Lake in Fall 2021. Shoreline erosion caused by wave action, including waves generated from recreational boating, can contribute to sediment and nutrient loading to the lake, as well as reduce valuable wildlife habitat along the shore. The 2021 restoration targeted an area of developing erosion on the north shoreline, near Tyacke Park. Restoration included using more natural shoreline materials, rather than more intrusive rock riprap. Invasive buckthorn trees were also removed from the shoreline area, and native grasses and prairie plants were planted, to improve the natural aesthetics of the adjacent parkland. Because the shoreline restoration work was conducted in Fall 2021, summer water quality measurements were not affected

Nearby Keller Lake, which discharges to Crystal Lake when lake levels are high enough, was treated with alum (aluminum sulfate) in October 2018 and again in September 2021, to reduce internal loading of phosphorus from sediments to Keller Lake. Although water quality improvements to Keller Lake from the 2018 alum treatment would have benefited Crystal Lake water quality in subsequent years, the 2021 treatment was conducted after the 2021 summer monitoring season.

8.0 Discussion of Crystal Lake Water Quality Results and Recommendations

The 2021 summer averages of Crystal Lake water quality were better than MPCA eutrophication standards, and overall, some of the best water quality results for Crystal Lake over the past four decades. The summer average of chlorophyll *a* (9 ug/L) tied year 2018 for the best on record, and the summer average total phosphorus (20 ug/L) was the second best on record (year 2014 had a lower summer average). The 2021 summer average of SDT (2.5 meters, or 8.1 feet) was the best since 1992.

For the past 18 years, the overall trend in Crystal Lake has been toward better water quality, with lower concentrations of phosphorus (Figure 2a), lower concentrations of chlorophyll *a* (Figure 2b), and increased water transparency (Figure 2c). Prior to 2007, the summer averages of total phosphorus and chlorophyll *a* were often worse than the MPCA's eutrophication standard, leading Crystal Lake to be listed as impaired for eutrophication. The summer average total phosphorus has been consistently below the MPCA standard for the past 14 years, and the summer average Secchi disc transparency has been worse than the standard just once (in 2010) over that same period. As a result of the improved summer averages of total phosphorus and Secchi disc transparency that are now consistently better than the MPCA eutrophication standards, BDMWO petitioned the MPCA to remove Crystal Lake from its list of waterbodies impaired for eutrophication, and the MPCA delisted the lake in 2018 (the U.S. Environmental Protection Agency approved the delisting on January 28, 2019).

The City of Burnsville continues its efforts to control invasive curly-leaf pondweed in Crystal Lake by mechanical harvesting in early summer each year. Early detection monitoring of other aquatic invasive species was also conducted by a qualified contractor hired by the City. Barr recommends continuation of the yearly CAMP water quality monitoring of Crystal Lake, and continuation of the management-level water quality monitoring once every 5 years moving forward, as recommended in the draft watershed management plan (previously, management-level water quality monitoring was conducted once every 3 years). Barr also recommends continuation of efforts to manage curly-leaf pondweed in Crystal Lake, as mid-summer die-off of curly-leaf pondweed can release nutrients and worsen water quality.

Table 2
Crystal Lake 2021 Water Quality Measured by Barr Engineering
BDWMO

Date	Sample Depth (m)	Field Measurements						Laboratory Analyses	
		Dissolved oxygen [mg/L]	pH	Specific conduct-ance @ 25ºC [µS/cm]	Water temperature [ºC]	Secchi disc trans-parency [m]	Turbidity [NTU]	Chloro-phyll a, pheophytin adjusted [µg/L]	Total phosphorus [µg/L]
4/14/2021	0 - 2	--	--	--	--	2.3	2.4	6.8	25
4/14/2021	0	10.7	6.9	676	9.4	--	--	--	--
4/14/2021	1	10.3	7.1	676	9.4	--	--	--	--
4/14/2021	2	10.3	7.2	676	9.4	--	--	--	--
4/14/2021	3	10.3	7.3	675	9.4	--	--	--	31
4/14/2021	4	10.3	7.3	674	9.4	--	--	--	26
4/14/2021	5	10.3	7.4	675	9.4	--	--	--	20
4/14/2021	6	9.1	7.2	680	8.5	--	--	--	20
4/14/2021	7	8.8	7.1	678	8.0	--	--	--	18
4/14/2021	8	7.8	7.0	679	7.1	--	--	--	16
5/13/2021	0 - 2	--	--	--	--	3.8	2.0	3.2	20
5/13/2021	0	12.1	8.0	664	15.5	--	--	--	--
5/13/2021	1	12.2	8.0	666	15.4	--	--	--	--
5/13/2021	2	12.3	8.0	667	15.4	--	--	--	--
5/13/2021	3	12.4	8.0	662	14.8	--	--	--	32
5/13/2021	4	11.9	7.9	664	14.1	--	--	--	23
5/13/2021	5	11.8	7.8	664	13.1	--	--	--	18
5/13/2021	6	9.8	7.4	665	10.8	--	--	--	17
5/13/2021	7	5.3	7.1	666	10.1	--	--	--	15
5/13/2021	8	3.2	7.0	667	9.7	--	--	--	23
5/26/2021	0 - 2	--	--	--	--	2.9	2.3	4.0	15
5/26/2021	0	9.6	7.9	656	21.8	--	--	--	--
5/26/2021	1	9.6	7.9	653	21.9	--	--	--	--
5/26/2021	2	9.6	8.0	653	21.9	--	--	--	--
5/26/2021	3	11.4	7.8	669	19.3	--	--	--	15
5/26/2021	4	11.8	7.7	671	16.2	--	--	--	18
5/26/2021	5	10.5	7.7	674	13.7	--	--	--	17
5/26/2021	6	9.2	7.4	674	11.8	--	--	--	18
5/26/2021	7	2.2	7.0	675	10.6	--	--	--	28
5/26/2021	8	0.1	6.8	681	9.8	--	--	--	32
6/08/2021	0 - 2	--	--	--	--	5.0	0.70	3.4	14
6/08/2021	0	9.2	8.3	646	25.8	--	--	--	--
6/08/2021	1	9.3	8.3	647	25.6	--	--	--	--
6/08/2021	2	9.5	8.3	647	25.2	--	--	--	--
6/08/2021	3	9.5	8.3	648	24.1	--	--	--	16
6/08/2021	4	8.1	7.9	655	19.7	--	--	--	14
6/08/2021	5	7.7	7.7	670	16.3	--	--	--	18
6/08/2021	6	6.2	7.5	675	13.1	--	--	--	28
6/08/2021	7	1.4	7.1	681	11.2	--	--	--	38
6/08/2021	8	0.6	6.9	690	10.5	--	--	--	53

Table 2
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BDWMO

Date	Sample Depth (m)	Field Measurements						Laboratory Analyses	
		Dissolved oxygen [mg/L]	pH	Specific conduct-ance @ 25ºC [µS/cm]	Water temperature [ºC]	Secchi disc trans-parency [m]	Turbidity [NTU]	Chloro-phyll a, pheophytin adjusted [µg/L]	Total phosphorus [µg/L]
6/22/2021	0 - 2	--	--	--	--	2.7	1.6	8.2	17
6/22/2021	0	8.2	8.1	652	23.0	--	--	--	--
6/22/2021	1	8.2	8.1	652	23.0	--	--	--	--
6/22/2021	2	8.2	8.2	652	23.0	--	--	--	--
6/22/2021	3	8.2	8.2	651	23.0	--	--	--	17
6/22/2021	4	8.0	8.1	651	22.8	--	--	--	20
6/22/2021	5	7.9	7.9	667	19.7	--	--	--	8.4
6/22/2021	6	4.6	7.2	678	14.5	--	--	--	20
6/22/2021	7	0.5	7.0	683	12.0	--	--	--	19
6/22/2021	8	0.1	7.0	700	10.7	--	--	--	63
7/07/2021	0 - 2	--	--	--	--	2.5	2.2	14.4	23
7/07/2021	0	8.55	8.36	652	26.3	--	--	--	--
7/07/2021	1	8.54	8.37	651	26.4	--	--	--	--
7/07/2021	2	8.52	8.38	652	26.4	--	--	--	--
7/07/2021	3	8.47	8.38	652	26.4	--	--	--	20
7/07/2021	4	9.99	8.44	654	25.0	--	--	--	23
7/07/2021	5	3.60	7.56	663	20.7	--	--	--	30
7/07/2021	6	0.75	7.22	676	16.3	--	--	--	38
7/07/2021	7	0.50	7.08	677	13.0	--	--	--	56
7/07/2021	8	0.38	6.92	728	10.9	--	--	--	260
7/21/2021	0 - 2	--	--	--	--	2.4	2.0	6.9	19
7/21/2021	0	9.4	8.5	637	26.8	--	--	--	--
7/21/2021	1	9.5	8.5	637	26.8	--	--	--	--
7/21/2021	2	9.5	8.5	637	26.8	--	--	--	--
7/21/2021	3	9.5	8.5	637	26.8	--	--	--	20
7/21/2021	4	9.3	8.4	638	25.4	--	--	--	26
7/21/2021	5	0.9	7.5	647	22.2	--	--	--	45
7/21/2021	6	1.1	7.2	657	16.6	--	--	--	29
7/21/2021	7	0.5	7.0	674	13.1	--	--	--	59
7/21/2021	8	0.4	6.8	710	11.5	--	--	--	300
8/10/2021	0 - 2	--	--	--	--	2.1	2.5	10.6	23
8/10/2021	0	8.4	8.0	646	25.6	--	--	--	--
8/10/2021	1	8.4	8.1	645	25.7	--	--	--	--
8/10/2021	2	8.4	8.2	644	25.5	--	--	--	--
8/10/2021	3	7.1	8.0	643	25.5	--	--	--	24
8/10/2021	4	4.8	7.7	646	24.6	--	--	--	23
8/10/2021	5	0.5	7.2	653	23.0	--	--	--	24
8/10/2021	6	0.4	6.9	662	17.7	--	--	--	28
8/10/2021	7	0.4	6.6	695	13.2	--	--	--	87
8/10/2021	8	0.3	6.4	737	11.9	--	--	--	470

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Date	Sample Depth (m)	Field Measurements						Laboratory Analyses	
		Dissolved oxygen [mg/L]	pH	Specific conduct-ance @ 25ºC [µS/cm]	Water temperature [ºC]	Secchi disc trans-parency [m]	Turbidity [NTU]	Chloro-phyll a, pheophytin adjusted [µg/L]	Total phosphorus [µg/L]
8/25/2021	0 - 2	--	--	--	--	2.1	2.3	10.0	22
8/25/2021	0	7.9	8.1	650	24.5	--	--	--	--
8/25/2021	1	7.8	8.3	650	24.5	--	--	--	--
8/25/2021	2	7.8	8.3	650	24.5	--	--	--	--
8/25/2021	3	7.5	8.3	648	24.5	--	--	--	28
8/25/2021	4	5.5	8.0	650	24.2	--	--	--	29
8/25/2021	5	4.3	7.8	657	23.8	--	--	--	26
8/25/2021	6	0.4	7.4	665	20.3	--	--	--	30
8/25/2021	7	0.3	7.0	707	14.6	--	--	--	88
8/25/2021	8	0.3	6.7	748	12.9	--	--	--	270
9/09/2021	0 - 2	--	--	--	--	1.8	4.8	12.4	22
9/09/2021	0	8.4	8.2	639	21.9	--	--	--	--
9/09/2021	1	8.3	8.2	639	21.8	--	--	--	--
9/09/2021	2	8.1	8.2	639	21.7	--	--	--	--
9/09/2021	3	7.9	8.2	639	21.7	--	--	--	23
9/09/2021	4	7.7	8.1	639	21.6	--	--	--	22
9/09/2021	5	7.8	8.2	638	21.6	--	--	--	21
9/09/2021	6	2.8	7.6	643	21.0	--	--	--	19
9/09/2021	7	0.5	7.1	704	16.6	--	--	--	47
9/09/2021	8	0.4	6.9	768	13.0	--	--	--	300
9/21/2021	0 - 2	--	--	--	--	1.7	4.2	29.7	35
9/21/2021	0	7.2	7.8	650	20.7	--	--	--	--
9/21/2021	1	7.1	7.8	650	20.7	--	--	--	--
9/21/2021	2	7.0	7.8	650	20.6	--	--	--	--
9/21/2021	3	7.0	7.8	649	20.5	--	--	--	33
9/21/2021	4	6.8	7.8	648	20.5	--	--	--	28
9/21/2021	5	5.5	7.7	649	20.4	--	--	--	26
9/21/2021	6	1.2	7.3	654	20.2	--	--	--	29
9/21/2021	7	0.4	7.0	692	18.2	--	--	--	48
9/21/2021	8	0.2	6.8	780	15.1	--	--	--	160

Table 3: Crystal Lake 2021 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]
4/22/2021	0	3.4	13.5	5.1	0.47	24
5/7/2021	0	3.2	14.6	5.6	0.60	33*
5/23/2021	0	3.1	22.1	2.9	0.60	11
6/5/2021	0	4.0	22.3	2.7	0.57	33*
6/18/2021	0	3.6	27.0	2.1	0.54	14
7/3/2021	0	3.1	27.1	< 1	0.42	40*
7/14/2021	0	2.3	25.2	9.1	0.46	20
7/27/2021	0	1.8	27.8	5.6	0.61	14
8/9/2021	0	2.1	24.4	5.9	0.53	18
8/27/2021	0	2.1	25.2	9.1	0.64	18
9/12/2021	0	1.7	20.4	17	0.70	22
9/25/2021	0	1.2	18.5	9.3	0.76	23
10/6/2021	0	1.2	20.0	15	0.66	20

Notes

< 1 - Result is less than method detection limit.

33* - Laboratory results is suspect.

Figure 1a: Crystal Lake 2021 Total Phosphorus

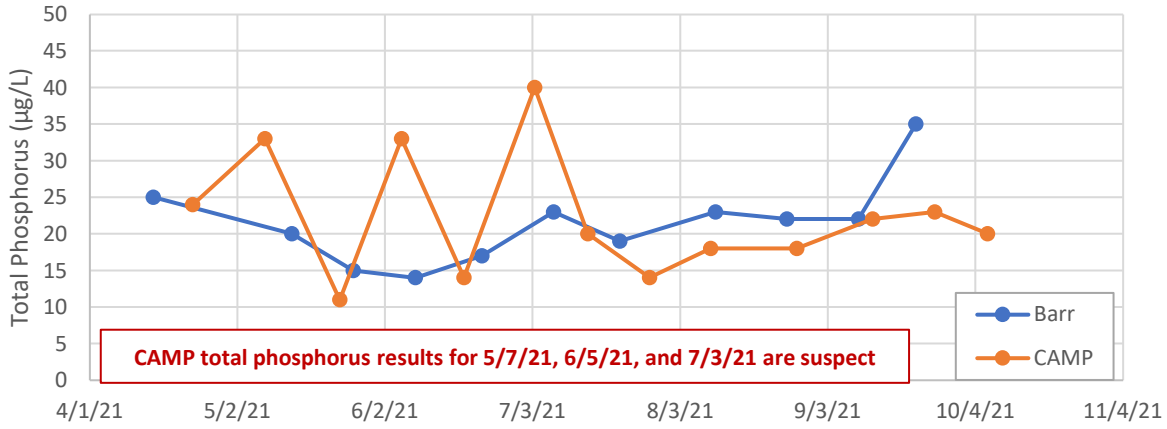

Figure 1b: Crystal Lake 2021 Chlorophyll-a

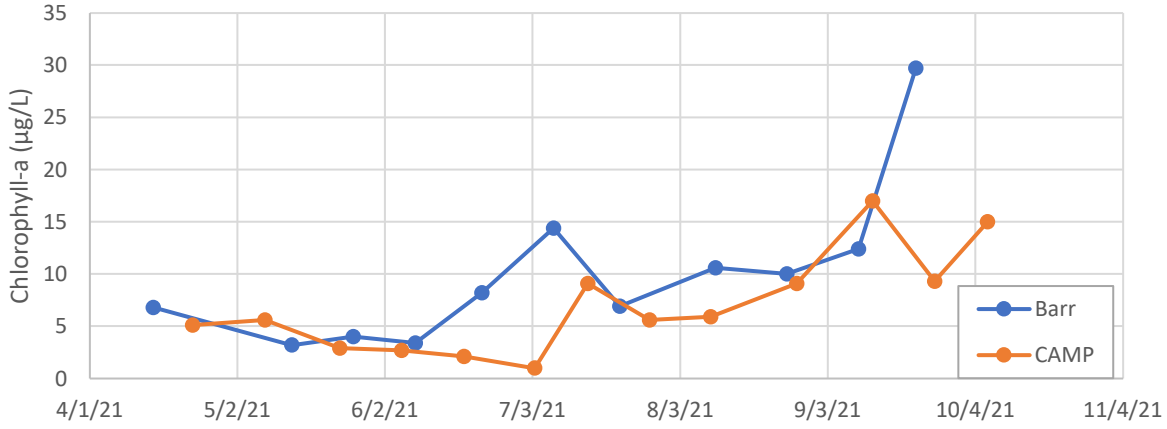

Figure 1c: Crystal Lake 2021 Secchi Disc Transparency

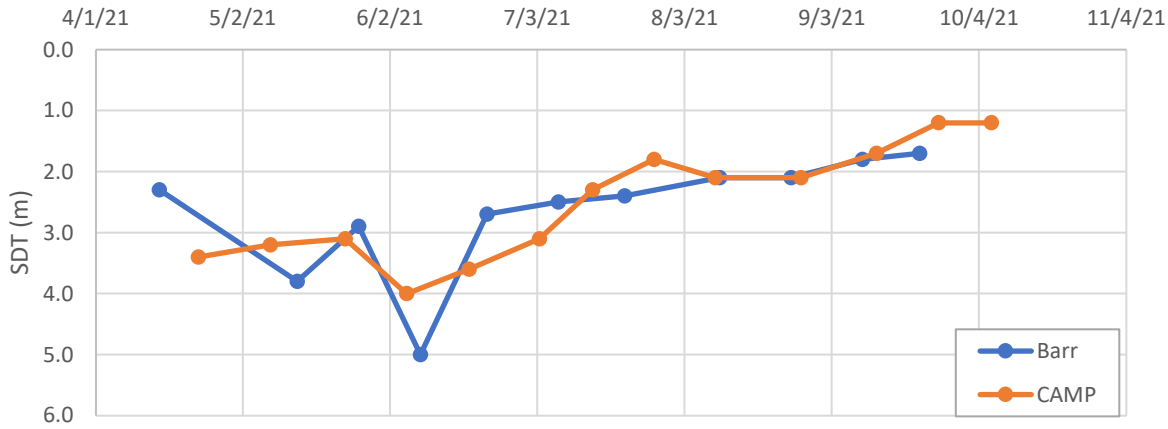

Figure 2a: Crystal Lake June-Sept. Secchi Disc Transparency

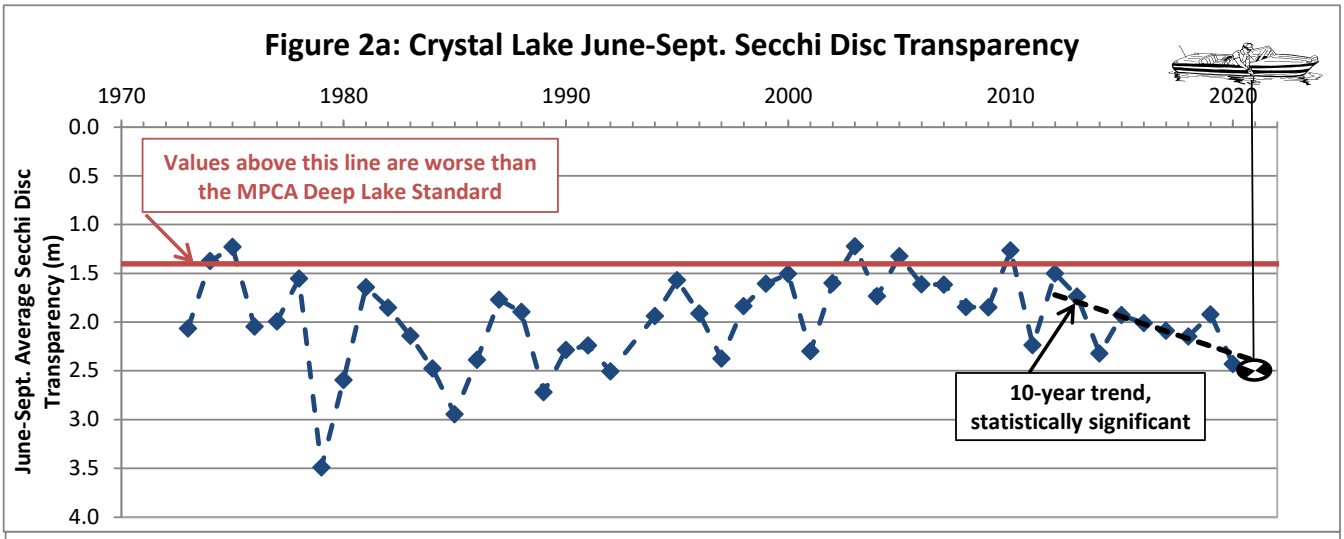

Figure 2b: Crystal Lake June-Sept. Average Chlorophyll *a*

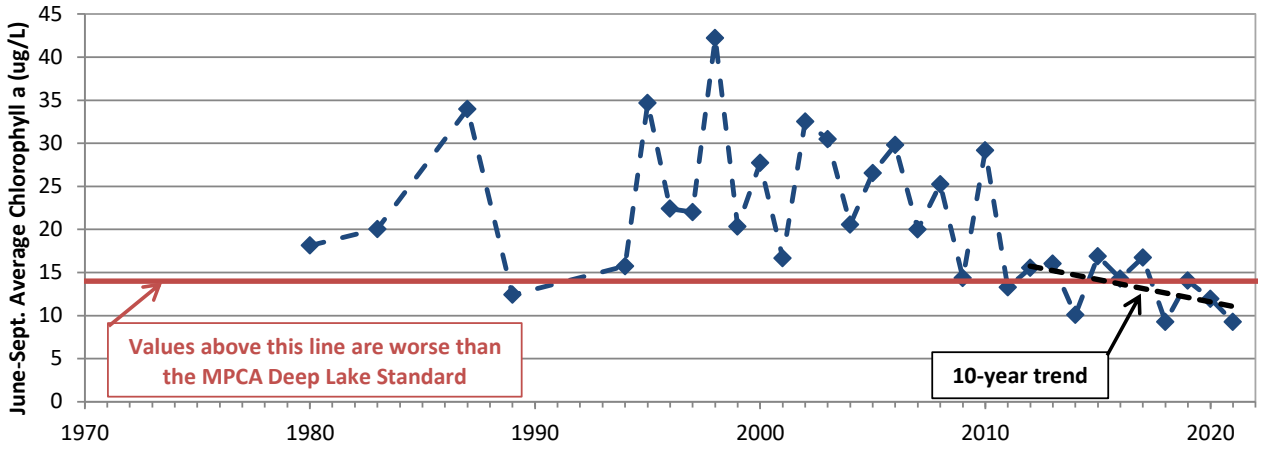

Figure 2c: Crystal Lake June-Sept. Average Total Phosphorus

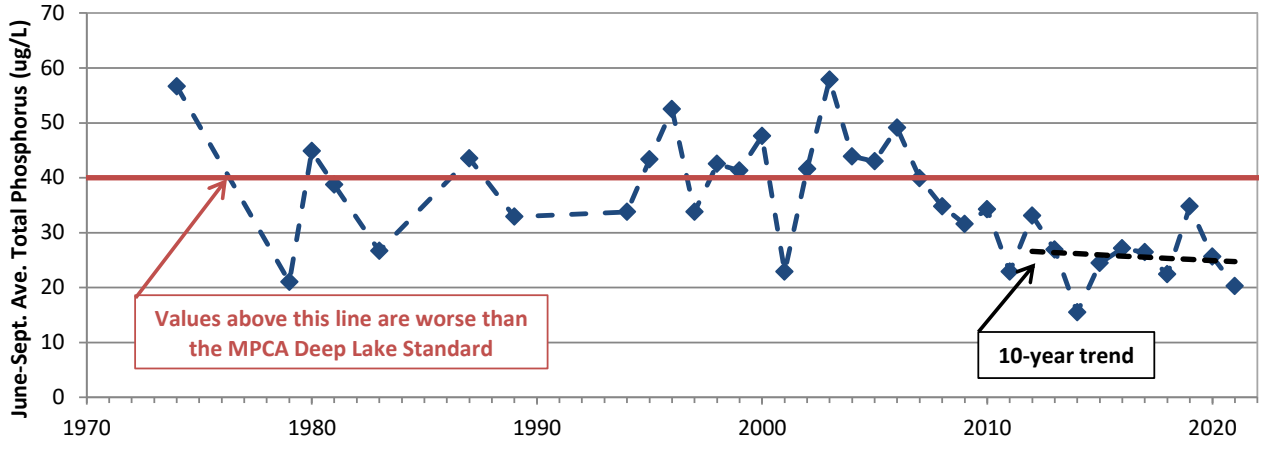

Figure 3a: Crystal Lake Historic Water Surface Elevation, 1964-2021

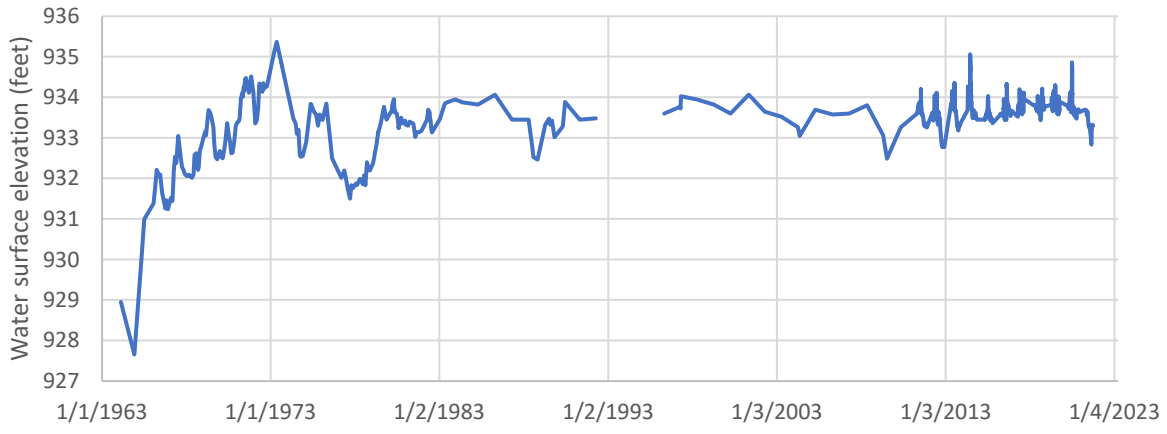

Figure 3b: Crystal Lake Water Surface Elevation, 2021