

## Meadow Lake 2021 Water Quality Review

### Introduction

This testing protocol's goals were to check various water quality parameters of Meadow Lake, compare results to historical data, and identify any potential risks to Meadow Lake's health. LakePro collected a water sample at two locations on August 18<sup>th</sup>, 2021, and tested 13 parameters. LakePro utilized a YSI ProDSS Multiparameter Meter and a LaMotte SMART2 Colorimeter to conduct the tests. LakePro also conducted a standard AVAS survey and BioBase mapping.

The aerial map below shows the testing sites:



### Results

Parameter	North Site	Middle Site	Target Range	Status
Temperature	74.6 °F	78.0 °F	Less than 75 °F	● Slightly High
Dissolved Oxygen	5.1 mg/L	5.6 mg/L	4.0 – 12.0 mg/L	● Healthy
Total Phosphorus	90 ppb	60 ppb	0 – 100 ppb	● Slightly High
Phosphate	50 ppb	50 ppb	0 – 100 ppb	● Healthy
Nitrate	704 ppb	572 ppb	0 – 1000 ppb	● Slightly High
Chlorophyll-α	4.9 ppb	3.4 ppb	0 – 7.3 ppb	● Healthy
Transparency		8.6 feet	More than 6.5 feet	● Healthy
pH	7.8	8.1	7.0 – 9.0 S.U.	● Healthy
Total Dissolved Solids	465 ppm	378 ppm	0 – 1,000 ppm	● Healthy
Conductivity	715 μS	582 μS	0 – 1,500 μS	● Healthy
Alkalinity	128 ppm	135 ppm	0 – 250 ppm	● Healthy
Hardness	149 ppm	154 ppm	100 – 300 ppm	● Healthy
Total Salinity	350 ppm	280 ppm	0 – 500 ppm	● Healthy



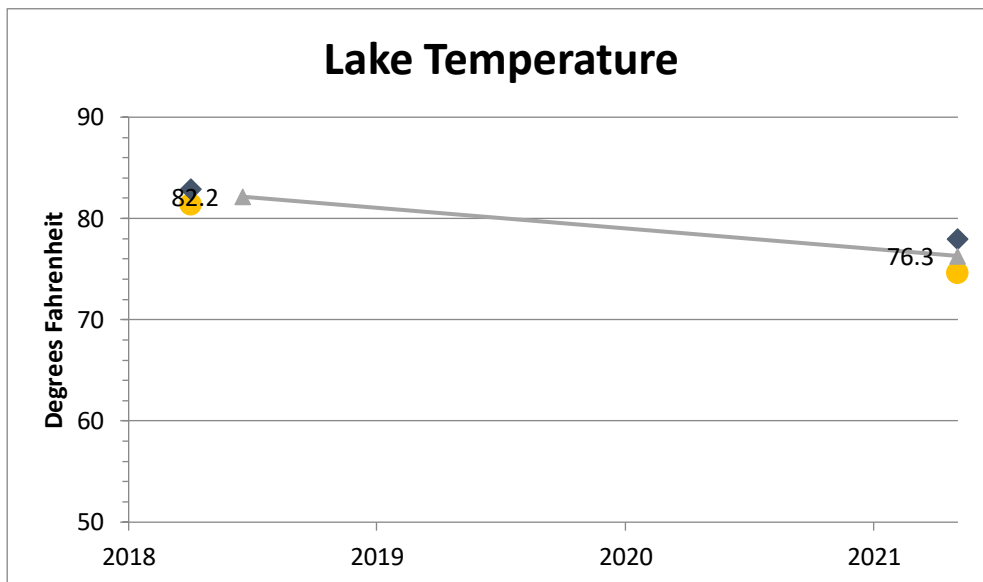
### Discussion

Meadow Lake's water quality was good at the time of testing. Results showed that most parameters were within target, except for temperature. Seasonal peaks in water temperature are normal because they are dependent on weather and air temperature.

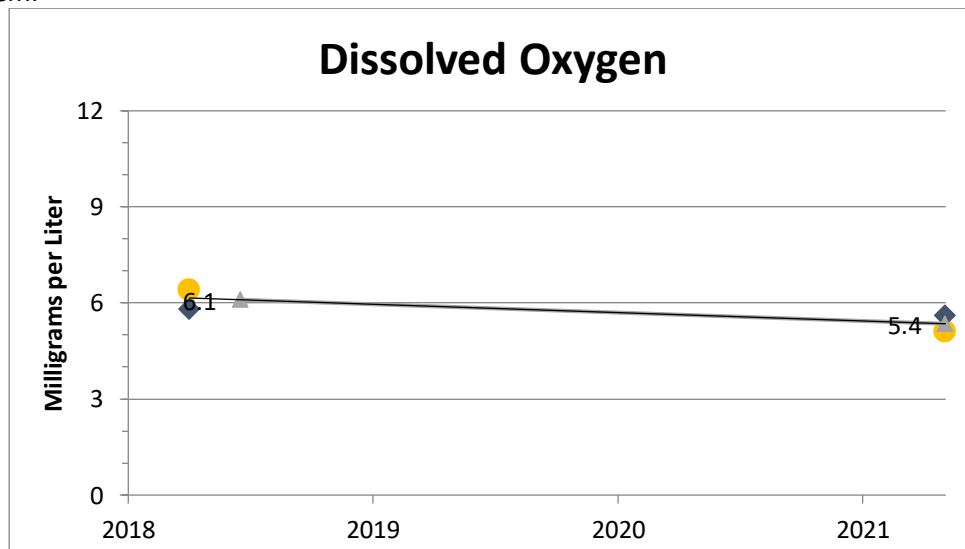
An in-depth look at the individual parameters and their results is below. The graphs include historical results and trendlines to indicate changes over time. The middle site is shown in blue and the north site shown in yellow. The gray points are the average of the two.

#### Temperature and Dissolved Oxygen

Dissolved oxygen is vital for a healthy aquatic ecosystem. The amount of dissolved oxygen that can be in the water relies on water temperatures. Colder water can hold more dissolved oxygen, so cooler temperatures are generally better. The water **temperature** was above the target range at the time of this testing for one site. This is typical for late summer readings and does not raise any concern.



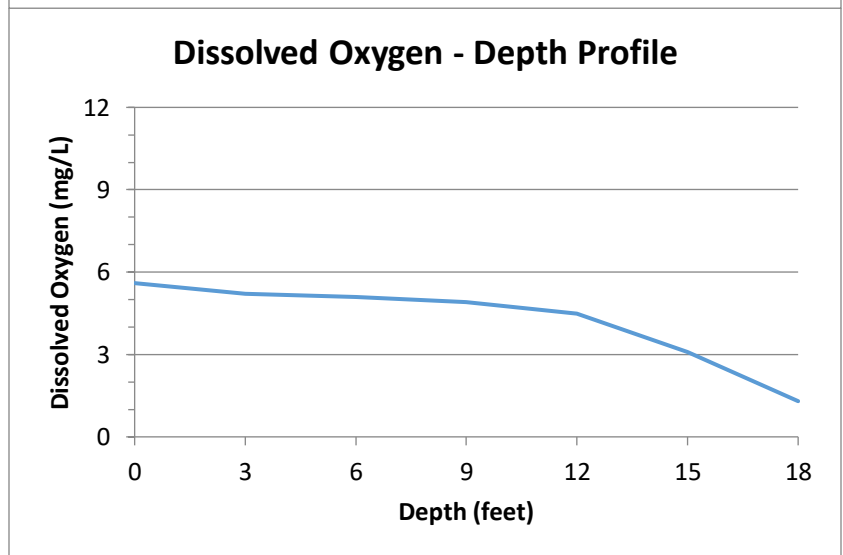
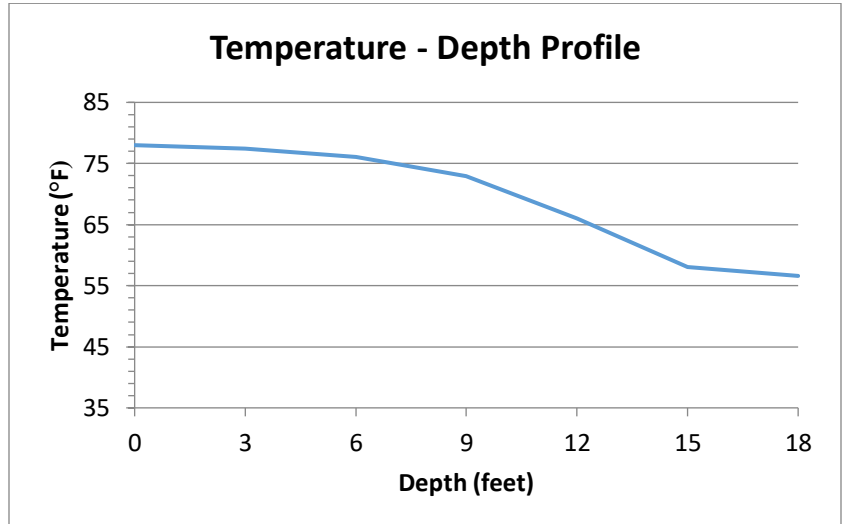
Because dissolved oxygen is reliant on water temperature, high temperatures can sometimes be a concern. However, despite the temperature, **dissolved oxygen** levels were within the target and indicative of a healthy aquatic ecosystem.





We also measured temperature and dissolved oxygen at three-foot intervals at the middle site to create a depth profile. This data shows how the parameters changed with depth. Below are the results of this summer's depth profile.

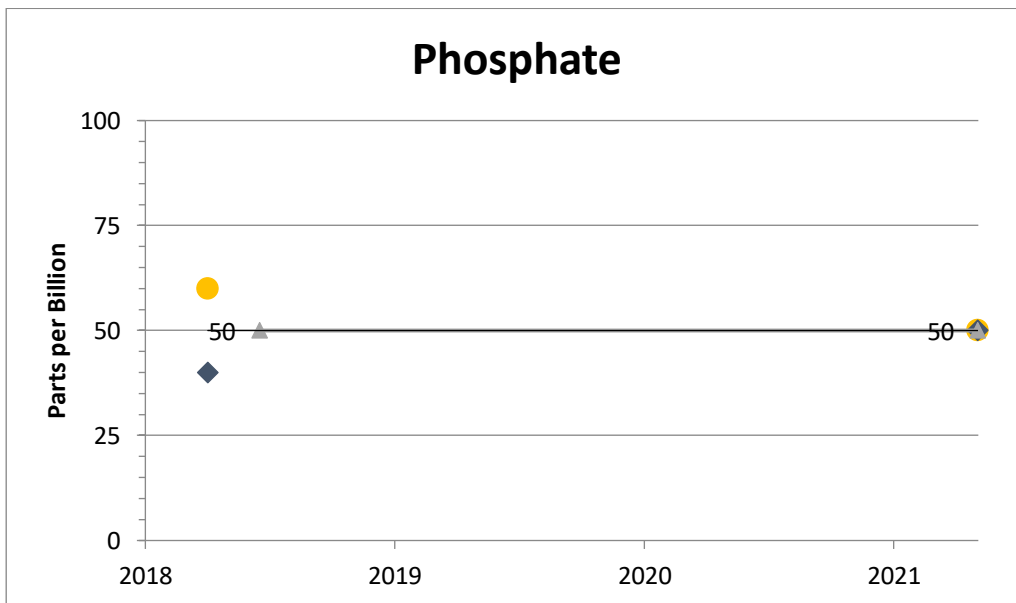
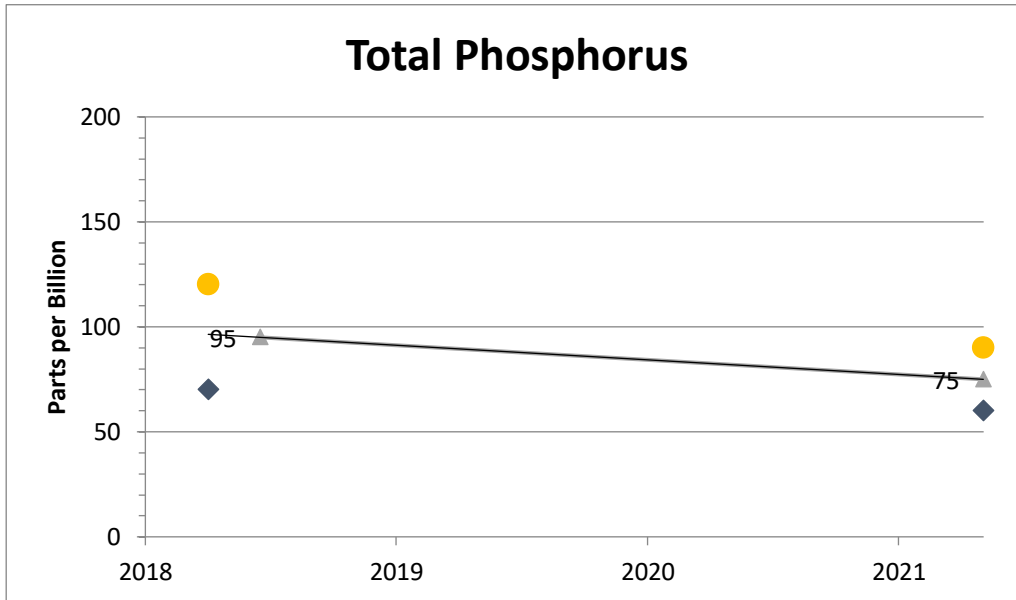
Depth (ft)	Temperature (°F)	D.O. (mg/L)
0	78.0	5.6
3	77.4	5.2
6	76.1	5.1
9	72.9	4.9
12	66.0	4.5
15	58.1	3.1
18	56.6	1.3





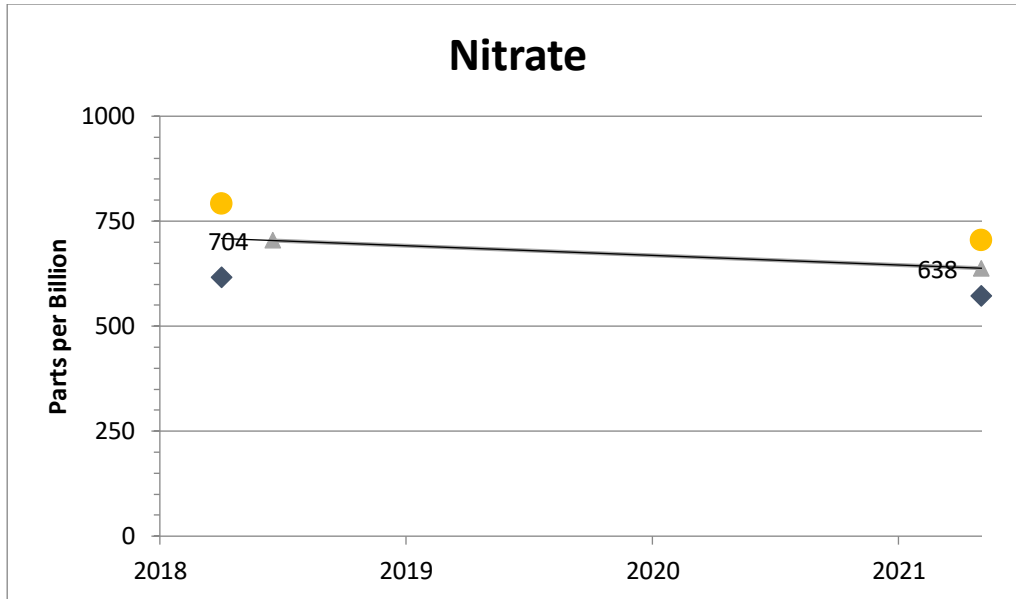
Nutrients, Plant Production, and Transparency

Nutrients in the water are the fuel for plant growth, and nutrient data reveals the potential for nuisance plant growth. Phosphorus is a major nutrient for aquatic plant growth. The **phosphorus** and the active form **phosphate** were within the target range.





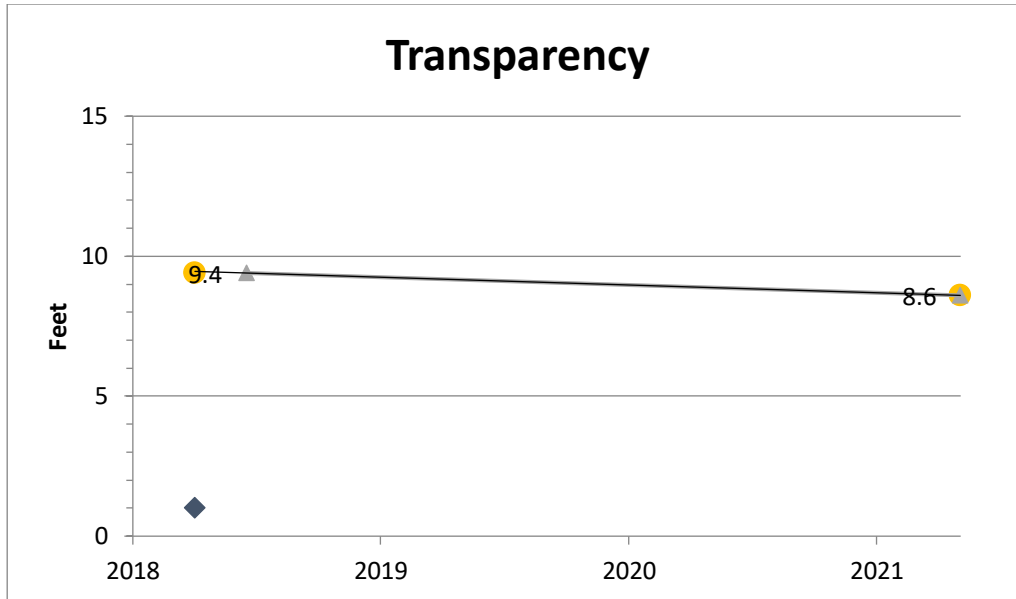
Nitrate is another major nutrient for aquatic plant growth. During this test, the **nitrate** concentration was within the target range. Nitrates have been on a downward trend historically. It is essential to fertilize and use the land responsibly to prevent more nutrients from entering the lake.



Chlorophyll concentration is an indicator of plant production. The **chlorophyll** concentration was within the target range and categorized the lake as moderately productive. This is not the natural concentration. Plant management with herbicides limits plant growth throughout the year, causing lower results for this test. Chlorophyll concentration has trended downward historically.



One effect of plant growth on the lake is the reduction of water clarity. Algae stay suspended in the water column before forming green mats on the surface and can decrease clarity before it's visible. This summer, the **transparency** was within the target range.



**Trophic State Indices**

To better understand the relationship between nutrients, plant production, and transparency, limnologists use Trophic State Indices (TSI) to score each category and examine the relationship between them. Lower scores tend to indicate a less productive lake. The TSIs for Meadow Lake this summer were as follows:

Category	Water Quality Parameter	Trophic State Index (season average)	Classification
Nutrients	Total Phosphorus	66	Eutrophic
Plant Production	Chlorophyll	44	Eutrophic
Clarity	Transparency	46	Mesotrophic

The TSI for total phosphorus classified the lake as eutrophic or very productive, based on the availability of nutrients to sustain plant growth. The TSI for transparency showed the clarity was poorer than the index for plant production. The reason for this is the use of water dye meant to reduce sunlight and clarity.



Water Chemistry Parameters

It is important to track the water chemistry of the lake. Significant changes or shifts in water chemistry can alert us to examine the water body further and make necessary changes and recommendations.

The **pH** of the lake remained within the target range this summer.

The **total dissolved solids** (TDS) results showed low to average amounts of dissolved substances in the water. This parameter includes nutrients, salts, and other substances, so it is positive when this parameter remains low.

Conductivity measures the molecules in the water's ability to conduct electricity. The **conductivity** indicated a healthy amount of ionic molecules in the lake and no immediate concern about salts.

Alkalinity measures the concentration of Calcium Carbonate, a salt that is beneficial to the aquatic ecosystem. Carbonate ions are a natural buffer for acidity and prevent extreme changes in pH. The **alkalinity** was at a healthy level during this test, and historical trends are downward.

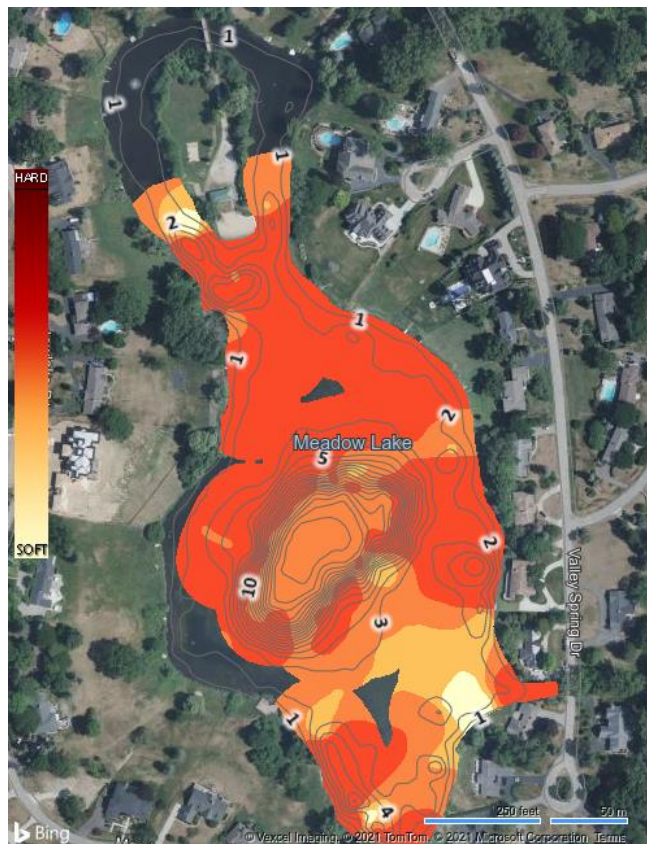
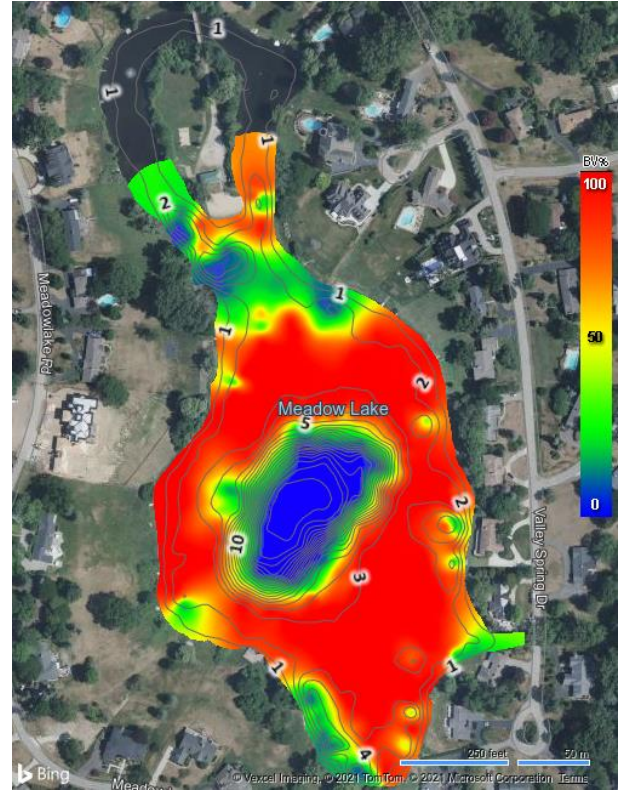
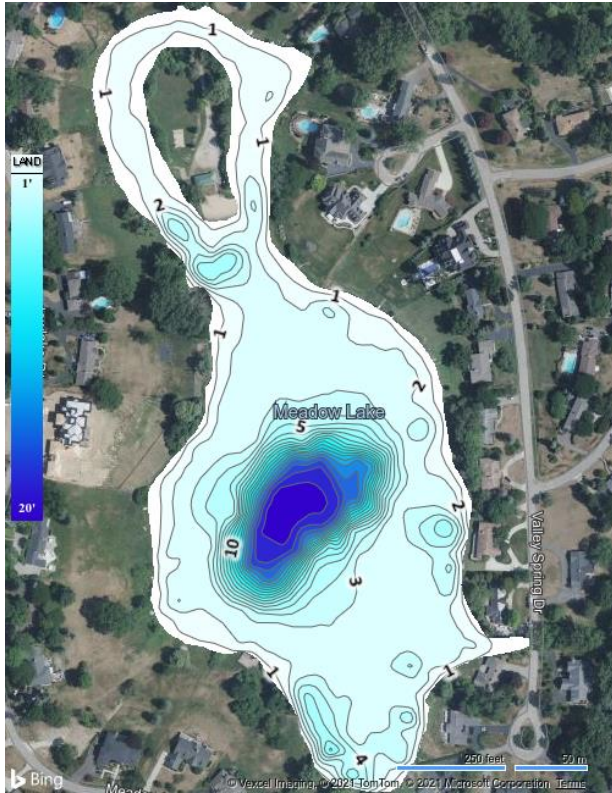
While alkalinity measures the carbonate concentration, hardness measures the calcium or magnesium concentration. Because one of the most common salts is calcium carbonate, hardness and alkalinity levels are typically very similar. **Hardness** was at a healthy level at the time of testing.

High salinity levels can be an indicator of pollution and may pose a risk to the ecosystem. **Salinity** was within the target range at the time of testing.

**AVAS Results**

Below is the AVAS Map results followed by the BioBase Mapping

Meadow Lake		Oakland County								8/18/2021				
Standard Aquatic Vegetation Summary Sheet										SURVEY BY: Tyson Wood				
Code No	Plant Name	Total number of AVASs for each Density Category				Calculations				Sum of Previous	Total Number	Quotient of Column 9	Code No	Plant Name
		A	B	C	D	A x 1	B x 10	C x 40	D x 80	Four of Columns	of AVASs	divided by Column 10		
1	Eurasian milfoil					0	2	0	0	2	24	0.1	1	Eurasian milfoil
3	Chara					2	3	17	2	24	24	1.0	3	Chara
4	Thinleaf pondweed					0	8	4	0	12	24	0.5	4	Thinleaf pondweed
27	Sago pondweed					2	1	0	0	3	24	0.1	27	Sago pondweed
33	Lemna minor					2	0	0	0	2	24	0.1	33	Lemna minor
39	Cattails					1	0	0	0	1	24	0.0	39	Cattails
43	Purple Loosestrife					0	1	0	0	1	24	0.0	43	Purple Loosestrife







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### Summary & Conclusions

Overall, the water quality of Meadow Lake was excellent this summer. The data gave us a view of how things changed from last testing and strengthened the long-term trends.

The temperature was the only parameters outside of the target this year. Temperature is dependent on the weather and cannot be changed. And although temperatures were high, dissolved oxygen remained at a healthy level. More testing events may reveal better trends. We will continue to monitor.

Nutrient trends remain downward or relatively flat and remain within the target ranges. Chlorophyll levels continue to be in the target range. Some native aquatic plant growth is essential to a healthy ecosystem and fishery, and the plant management herbicide program is in place to control nuisance algae blooms.

In any lake or pond, there are always areas of quality that could be improved. That said, your continued efforts and care on Meadow Lake leave it in excellent condition.

Thanks for choosing LakePro,

Tyson Wood  
*Lake Manager – LakePro, Inc.*



### **Analysis Information**

Temperature:	The water temperature directly affects the amount of oxygen that is able to dissolve into the water. The temperature of surface waters is not indicative of the entire water column.
Dissolved Oxygen:	D.O. is a measure of the amount of oxygen dissolved in the water. This oxygen is available to fish and other animals for respiration. Vegetation generally increases DO, particularly during the day and early evening. Animals and other respiring organisms consume the oxygen, mostly during the day. Oxygen is also added to the lake through wave action, rain, fountains and aerators.
Total Phosphorus:	Phosphorus is an essential nutrient for plant growth. However, concentrations exceeding 100 ppb can impair the water and results in nuisance vegetation growth.
Nitrate:	Nitrogen is also essential for plant growth. Nitrate is the predominant form of nitrogen in water. Excessive nitrate concentrations may also result in pollution and increased vegetation.
Chlorophyll-a:	Chlorophyll-a is a direct measurement of the amount of green pigment produced by plants and phytoplankton. This indicates the amount of plant growth and is used to calculate a Trophic State Index.
Transparency:	The ability of light to penetrate the water column is determined by the amount of dissolved and suspended particles in the water. Although aesthetically desirable, transparent water allows increased light to reach the lake bed and may result in vegetation growth.
pH:	pH is a measure of acidity or alkalinity. pH is a general measure of lake health and can roughly indicate the range of other measurements such as alkalinity and hardness.
TDS:	Total Dissolved Solids is the amount of all organic and inorganic substances in the water in a molecular or ionized state. Higher values generally indicate richer and more productive water. Lower values usually indicate cleaner and less productive water.
Conductivity:	Conductivity is a measure of the ability of water to conduct electricity. Dissolved ions in the water increase conductivity, thus TDS and Conductivity are closely related.
Alkalinity:	Alkalinity refers to the ability of the water to neutralize acids, mainly through the hydrogenation of carbonate ions. This is why the alkalinity is expressed as "ppm as CaCO <sub>3</sub> ". However, other basic molecules in the water can also contribute to alkalinity.

### **Trophic States**

Oligotrophic:	Water is very clear. Nutrient levels are generally low. Plant and algae productivity is also low. Sufficient dissolved oxygen in the bottom, cooler waters allows cold-water fish to survive, such as salmon and trout.
Mesotrophic:	Water is moderately clear. Nutrient levels are slightly elevated. Plant and algae productivity is present, but generally not a nuisance. Oxygen and temperature in the lower portion of the lake allow walleye and perch to survive.
Eutrophic:	Water is not clear due to high nutrients levels, increased turbidity, and excessive algal growth. There is no oxygen in the bottom, cooler waters, restricting the lake to warm water species, such as bass and bluegill.
Hypereutrophic:	Nutrient levels are extremely high, promoting very high algae productivity. Blue-green algae blooms are likely. High turbidity and algae growth make the water opaque. Little plant growth is restricted to invasive plants. The only fish that can survive this environment are rough fish, such as carp, catfish, and mudminnows.



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Date	Temperature °F	Dissolved Oxygen mg/L	Total Phosphorus ppb	Phosphate ppb	Nitrate ppb	Chlorophyll ppb	Secchi Disk Depth (feet)	pH	TDS ppm	Conductivity µS	Alkalinity mg/L	Hardness mg/L	Salinity ppm	Chloride ppm
3/26/09	46.6	7.9	830	740	1848	14.8	5.5	8.3	827	1235	209	260	587	---
7/6/09	78.3	7.8	635	390	1188	13.1	2.5	8.4	805	1135	186	213	563	---
9/1/09	70.5	6.9	620	470	264	9.3	4.0	8.6	745	1051	188	210	517	---
4/20/10	59.7	9.5	45	20	132	8.2	4.9	8.9	798	1133	165	189	552	---
7/7/10	85.8	6.7	120	80	440	7.8	4.2	8.6	562	924	183	207	450	---
8/31/10	79.8	4.7	165	110	355	6.5	6.0	8.7	465	930	176	206	460	---
5/12/11	65.6	8.4	255	95	330	5.9	4.5	8.3	565	1130	186	216	560	---
7/6/11	84.0	5.1	226	104	386	4.9	6.2	8.4	533	1054	182	215	423	---
8/30/11	77.7	5.7	245	80	924	4.2	3.2	8.3	529	1058	179	210	536	---
5/11/12	66.1	9.1	185	60	552	6.3	3.5	8.3	508	1016	145	179	500	---
7/9/12	86.0	7.1	90	10	264	5.2	6.4	8.3	532	1065	105	137	520	---
9/6/12	78.8	4.8	120	40	418	3.6	4.0	9.1	477	953	127	159	470	---
5/7/13	67.3	8.7	90	40	264	4.2	7.8	7.6	527	1053	134	172	520	---
7/10/13	78.4	6.4	70	40	396	3.9	5.9	7.9	481	974	129	169	410	---
9/24/13	65.0	7.8	40	10	132	2.3	4.4	8.2	448	896	156	174	440	---
5/23/14	69.4	8.4	70	30	572	4.8	5.4	8.0	405	803	171	206	450	132
8/5/14	79.0	8.6	40	10	616	6.1	4.3	8.6	434	866	196	231	430	119
9/23/14	66.4	7.7	20	10	660	3.3	3.6	8.3	423	846	157	179	420	104
5/6/15	64.6	9.1	110	60	572	6.6	5.6	7.4	469	941	182	218	470	144
7/15/15	74.9	6.9	30	10	264	5.5	3.6	8.1	462	925	150	196	450	136
9/16/15	71.9	8.0	50	10	308	3.1	4.3	7.8	459	919	132	169	450	124
7/25/16	81.9	7.4	80	30	176	4.2	6.3	8.1	437	879	126	160	440	121
7/19/17	79.4	6.9	100	40	352	2.8	5.0	7.7	450	891	127	157	450	124
8/2/18	77.5	7.6	110	50	440	3.6	2.7	7.6	486	973	119	153	480	116
7/22/19	72.1	7.3	80	40	308	2.5	4.0	7.5	458	916	126	150	450	108
7/28/20	82.7	8.4	60	20	100	4.8	5.3	7.2	435	870	150	181	420	170