3088 Hottis Rd. Hale, MI 48739 Hale: 989.728.2200 Clare: 989.386.0600 Fax: 989.516.5900

December 24, 2019

Henderson Lake
Bill Olsen – Primary Contact
2937 Chippewa Trail
Lupton MI. 48635

Henderson Lake Property Owners:

It has been a pleasure managing Henderson Lake this past summer. Every year seems to bring a unique set of challenges and we welcome the opportunity to meet these challenges every single year. We hope that you continue to feel that your lake was managed professionally, economically, and effectively. Much of this data was already distributed back in October in order to discuss the treatments and services that we completed this year during our telephone conference. The Water Quality data was not yet available to be added to the last report distributed. This report is a complete summary containing all the data from all services rendered in 2019.

As we say goodbye to 2019 and look forward to 2020, we are happy to give you a brief re-cap of the work that was performed on Henderson Lake by Savin Lake Services. This year, we treated Henderson Lake (4) times, and conducted water quality tests as follows:

On May 24th, 2019 Savin Lake Services sent our Aquatic Biologist out to Henderson Lake to pull a Spring set of water samples. During our telephone conference this spring with myself, Bill Olsen, and many other HLMC Members, it was decided that we would continue to do some water quality studies to ensure the lake was in a healthy state. There were (3) sites that we obtained water samples from on the lake, with one of the sites being the deepest spot in the lake. These samples and sites were analyzed for the following: Temperature, Dissolved oxygen, Total Alkalinity, Total Phosphorus, Total Nitrate Nitrogen, Conductivity, pH (surface only), Chlorophyll a (surface only), and a Secchi disk depth.

On June 19th, 2019 Savin Lake Services conducted our initial application for non-native and exotic plant communities. Also, during this treatment, we did an algae spray of the entire developed shoreline, treated native vegetation in the canal and around riparian owners' docks where needed, and a Bacterial Augmentation (Mukk Buster) treatment also took place at this time. Savin Lake Services treated approximately 3 acres of Milfoil, 8 acres of Curly Leaf Pondweed, 27 acres of the lake for algae, and 9 acres of the lake for various pondweeds like Large Leaf Pondweed and Richardson's Pondweed. There was also 5.5 acres of the lake that received a Mukk Buster treatment.

On July 18th, 2019 Savin Lake Services conducted our 2nd herbicide application, algae spray, and bacterial augmentation treatment. Savin Lake Services treated 7.5 acres of Naiad and Northern Milfoil, 10 acres of various pondweeds like Richardson's Pondweed and Large Leaf Pondweed, and 20 acres of algae control. We only treated the areas that we felt needed to be treated in developed shoreline areas, in and around docks, and navigational boat ways. During this treatment, we conducted a bacterial augmentation treatment in the same 5.5 acres we did during our first application.

On August 19th, 2019 Savin Lake Services conducted another herbicide treatment and algae spray This treatment consisted of an algae spray in the developed areas of the lake where needed (15 acres) and an herbicide application on 5 acres of various pondweeds.

Our final application for the season was conducted on September 26th, 2019. This application was just a touch up application for algae and residual pondweeds. We treated 12.5 acres of the lake for algae, and 12.5 acres of the lake for residual weeds. We also 40X40 areas for lily pads, Cattails, and a small area of Phragmites where treatment was needed utilizing Imazapyr. Also, during this time, we did the last Bacterial Augmentation treatment for the year in the same areas as we did earlier this year, as it requires 3 treatments per season for the greatest efficacy.

On October 7th, 2019 Savin Lake Services sent our Aquatic Biologist out to Henderson Lake again to pull a fall set water samples in the same 3 sites for testing. After all the Spring and Fall samples are analyzed there will be a report generated and made available for the Henderson Lake Property Owners. This report is in process at this time we are just holding on Fall sampling results for it to be completed. We will send the report as soon as it is completed. We would like approval to plan to continue with the Water Quality testing through the 2020 season as it will give us a vast amount of information that we can use for a trending analysis.

Every treatment, survey, or water quality study that Savin Lake Services has performed, we have provided maps, or generated full reports on the work completed. All treatment maps and reports for 2015, 2016, 2017, 2018, and 2019 are available for you to view on your website HendersonLake.org.

Please keep in mind that we are a fully integrated lakes management company offering solutions including but not limited to mechanical harvesting, herbicide control, dredging, bio-augmentation, and aeration. Savin Lake Services also offers a complete range of water quality testing, depth contour mapping, individual property solutions, and even aquatic plant density reporting.

We look forward to serving you in 2020. We plan to keep the same treatment plans for next year as we did this year with the possibility of adding in some Wild Celery control. We see no reason to deviate from the current treatment plan. We feel this plan is the most effective and efficient way to keep Henderson Lake healthy, clean, and desirable for use by the Henderson Lake residents. Until then; if you have any questions, comments, or require additional information, feel free to contact us.

Sincerely,

Paul Barber

Paul Barber - Operations Manager
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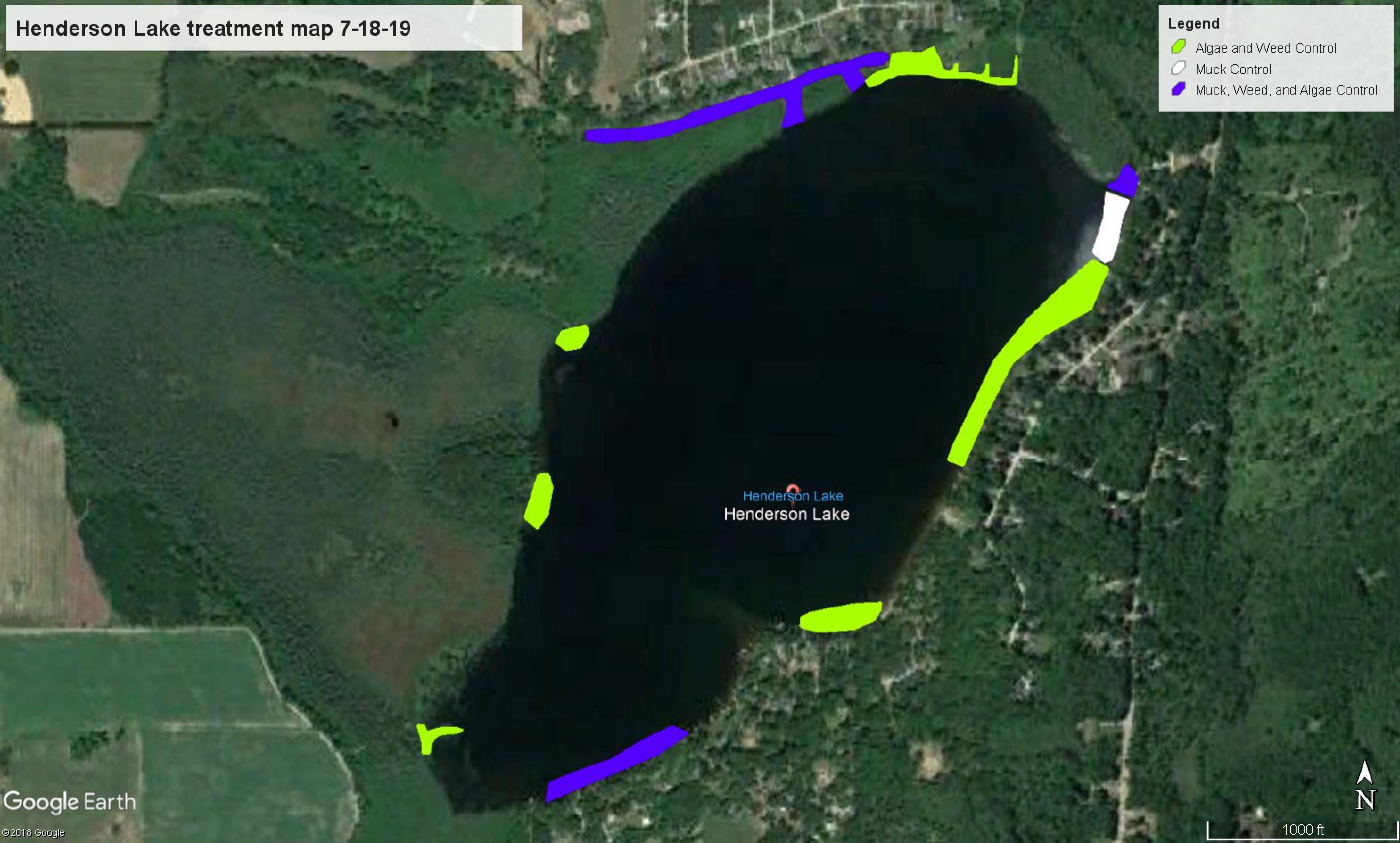
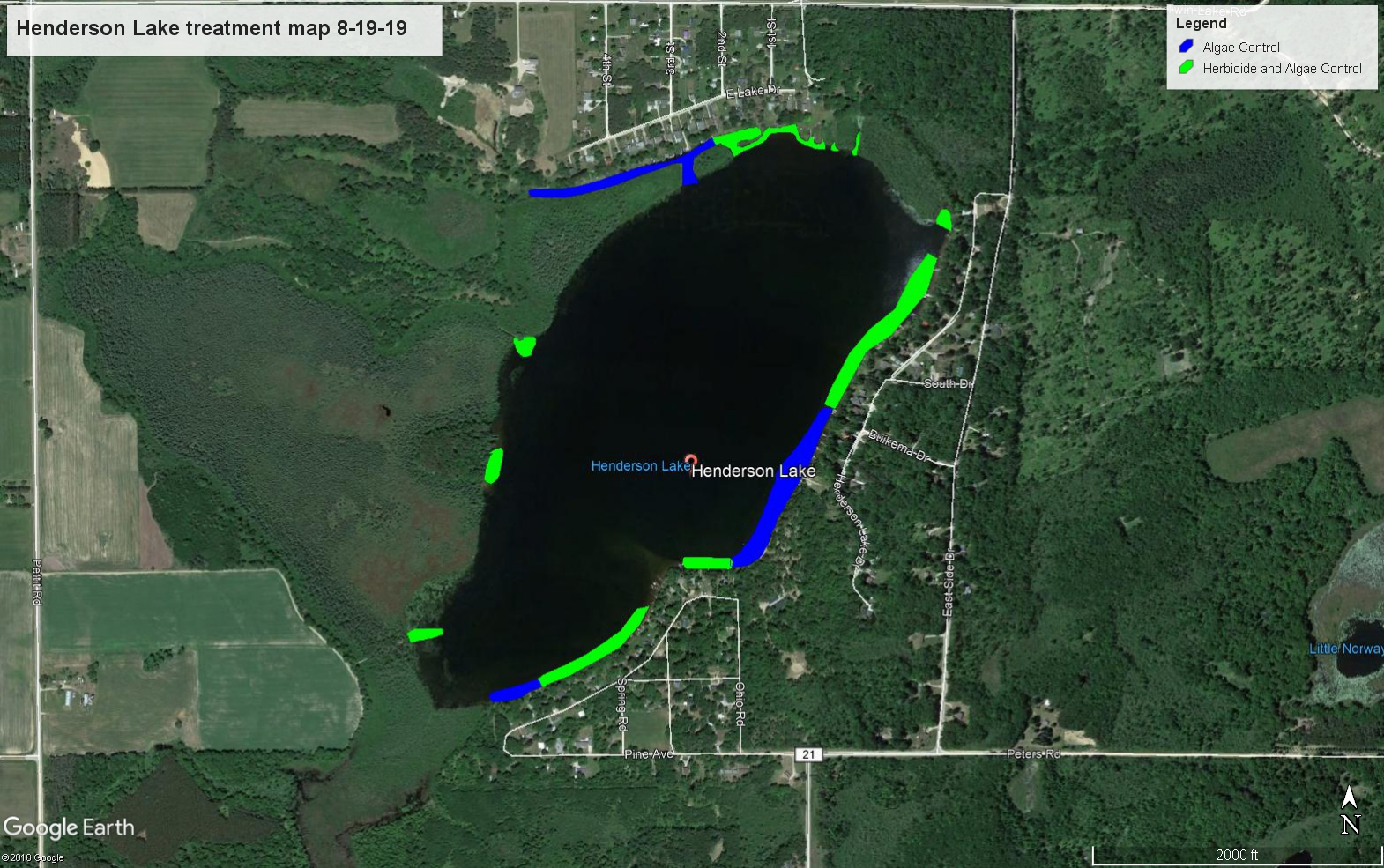
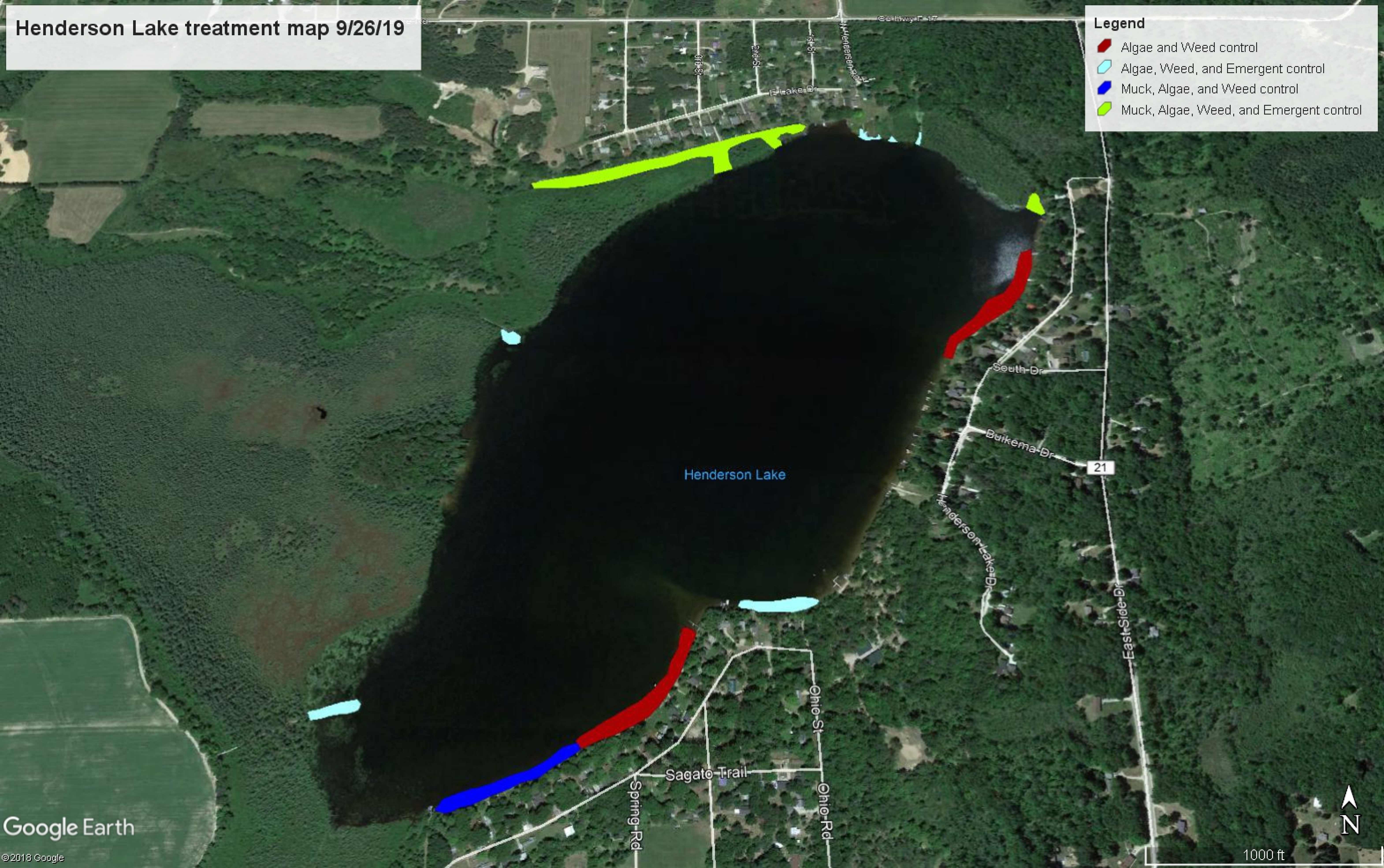
Henderson Lake Treatment Map 6-19-19
Legend
Algae control
Henderson Lake
Herbide control
Muck control
Muck, Herbicide, and algae control
Herbicide and algae control
E Lake Dr
Co Hwy F-47
South Dr
Buikema Dr
21
Henderson Lake Dr
Henderson Lake
Henderson Lake
East Side Dr
Ohio St
Ohio Rd
Sagato Trail
Spring Rd
Google Earth
©2018 Google
1000 ft
N


Henderson Lake treatment map 7-18-19
Legend
Algae and Weed Control
Muck Control
Muck, Weed, and Algae Control
Henderson Lake
Henderson Lake
Google Earth
©2018 Google
N
1000 ft



Henderson Lake treatment map 8-19-19
Legend
Algae Control
Herbicide and Algae Control
4th St
3rd St
2nd St
1st St
E Lake Dr
South Dr
Buikema Dr
Henderson Lake Dr
East Side Dr
Henderson Lake
Henderson Lake
Pettit Rd
Spring Rd
Ohio Rd
Pine Ave
21
Peters Rd
N
2000 ft
Google Earth
©2018 Google


Henderson Lake treatment map 9/26/19
Legend
Algae and Weed control
Algae, Weed, and Emergent control
Muck, Algae, and Weed control
Muck, Algae, Weed, and Emergent control
E Lake Dr
Henderson Lake
South Dr
Buikema Dr
21
Henderson Lake Dr
East Side Dr
Ohio St
Ohio Rd
Sagato Trail
Spring Rd
Google Earth
©2018 Google
1000 ft
N

Henderson Lake 2019 Water Quality Report

Summary:

Water Quality Testing was completed 2 times on Henderson Lake in 2019 at 3 different locations around the lake. Of the parameters tested, Temperature, Dissolved Oxygen, Secchi Disk, and pH were sampled while on the lake. Chlorophyll α, Nitrate-N, Phosphorus, Alkalinity, and Conductivity were sampled by sending the water in sample bottles to an independent laboratory, White Water Associates located in Amasa, MI, where the analysis was ran.

A well known limnologist named Wally Fusilier developed a grading scale for various parameters of water quality. Data collected in 2019 is shown below and given a grade based on Fusilier's scale. Additionally, historical data and parameter descriptions are provided at the end of this report.

Because herbicide treatment of aquatic vegetation has occurred on Henderson Lake, it should be noted that the application of herbicide no direct impact to the water quality of Henderson Lake.

Overall in 2019 based on the analysis results, Henderson Lake had excellent water quality figures again. Poorer than usual secchi disk measurements occurred in the spring. pH values were slightly high compared to years past as well. Both of these lead to a few B grades at sites 1 for both seasons, and site 2 for the fall sampling. However the lake in general had great water quality results!

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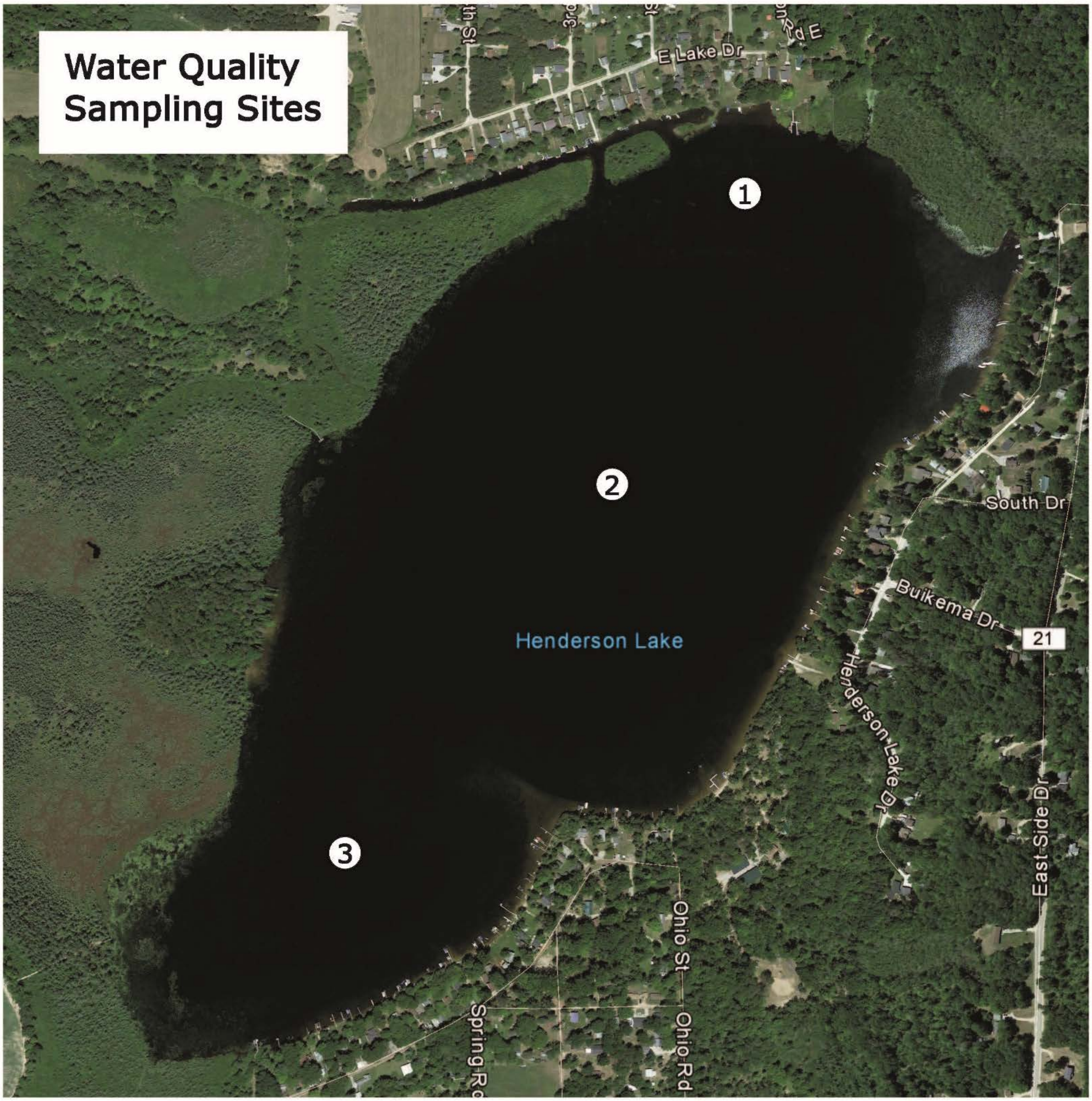

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2019 Results:

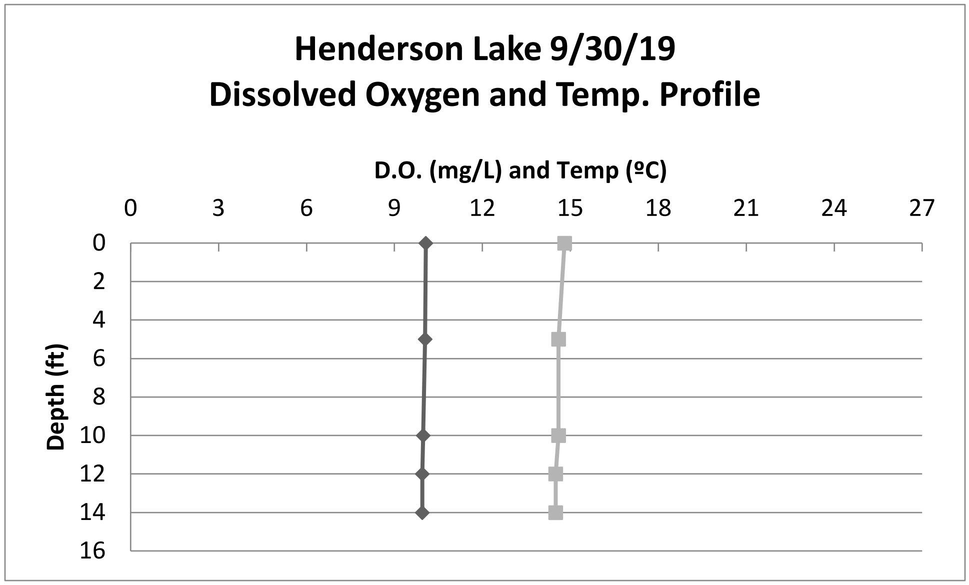
Date	5/24/2019		5/24/2019		5/24/2019		9/30/2019		9/30/2019		9/30/2019	
Station Number	1		2		3		1		2		3	
Temp (ºC)	15.9	A	15.7	A	15.7	A	14.5	A	14.8	A	14.9	A
Dissolved Oxygen (mg/L)	10.5		10.56		10.62		10.24		10.07		10.12	
Dissolved Oxygen (%saturation)	106.4	A	107.2	A	107.8	A	101.7	A	100.0	A	100.5	A
Chlorophyll a (ug/L)	1.6	A	1.3	A	1.3	A	2.4	B	2.1	B	0.8	A
Secchi Disk Depth (ft)	Bottom	F	8.0	F	8.5	F	Bottom	D	12.0	D	Bottom	D
Total Nitrate Nitrogen (ug/L)	<130	A	<130	A	<130	A	<130	A	<130	A	<130	A
Alkalinity (mg/L)	69.0	A	70	A	69	A	69	A	71	A	65	A
pH	8.3	B	8.19	A	8.17	A	8.49	C	8.29	B	8.29	B
Conductivity (umhos/cm)	190.0	A	190	A	190	A	190	A	190	A	190	A
Total Phosphorus (ug/L)	12.0	A	16	A	14	A	<8	A	<8	A	<8	A
Overall Grade		B		A		A		B		B		A

Scale:

Grade	Temp	Dissolved Oxygen	Chloro-phyll α	Secchi Disk Depth	Total Nitrate Nitrogen	Alkalinity	pH	Conduc-tivity	Total Phosphorus
A	0-26.5	85-115	0-2	>19	0-275	50-225	5.75-8.27	0-380	0-20
B	26.5-28.5	85-77; 115-122	2-3	19-16	275-360	50-35; 225-255	5.75-5.55; 8.27-8.47	380-590	20-28
C	28.5-30	77-69; 122-131	3-4	16-12	360-450	35-23; 255-280	5.55-5.33; 8.47-8.69	590-720	28-39
D	30-31.5	69-62; 131-140	4-5	12-9	450-540	23-17; 280-310	5.33-5.14; 8.69-8.88	720-800	39-46
F	>31.5	<62; >140	>5	<9	>540	<17; >310	<5.14; >8.88	>800	>46

Dissolved Oxygen and Temp. Profile

Temp (ºC)	D.O. (mg/L)	Depth (ft)
14.8	10.07	0
14.6	10.04	5
14.6	9.98	10
14.5	9.95	12
14.5	9.95	14

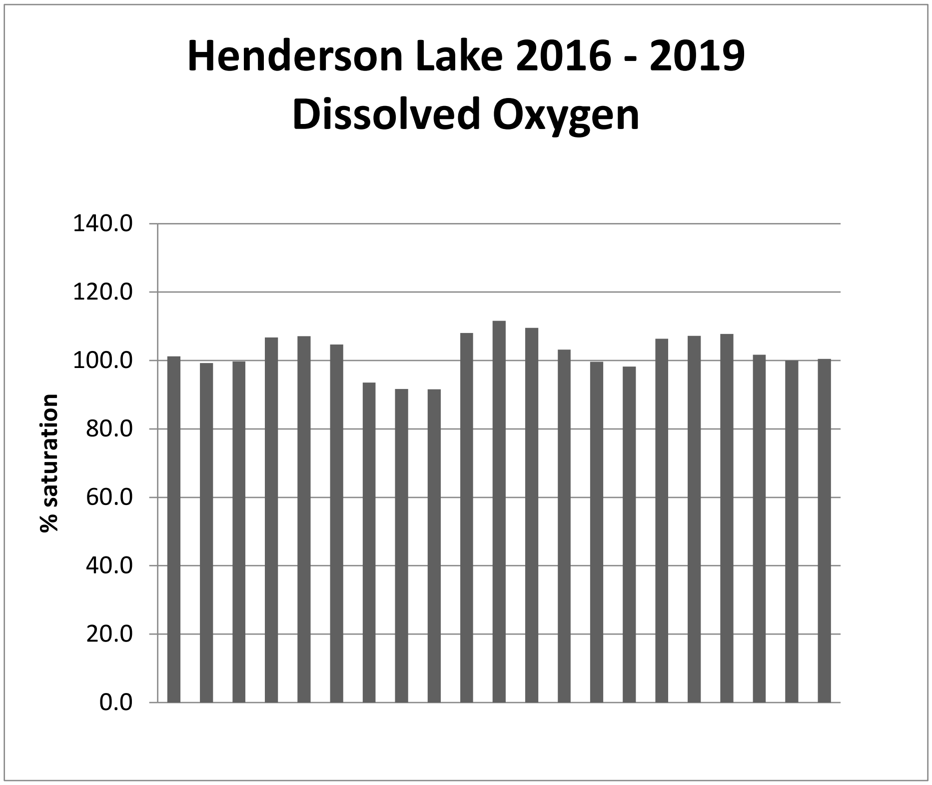


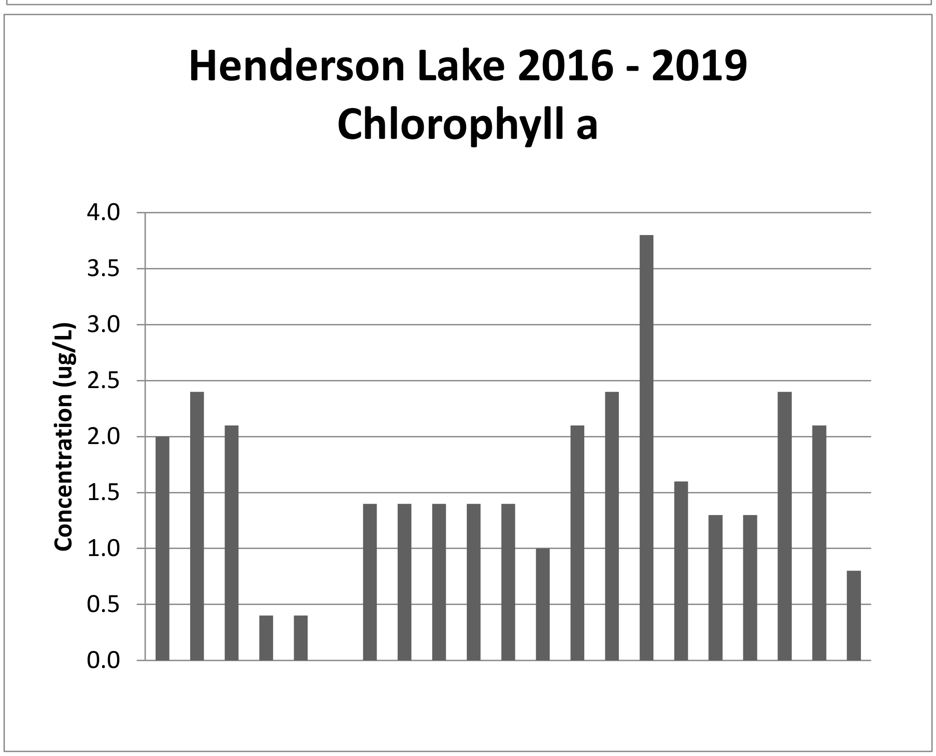
Matt Novotny

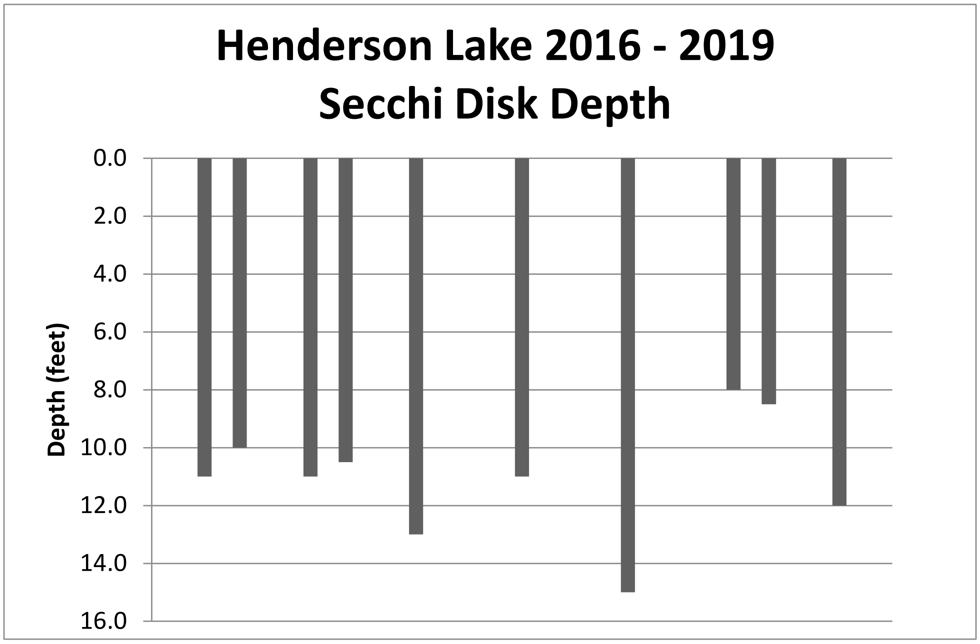
Matthew Novotny

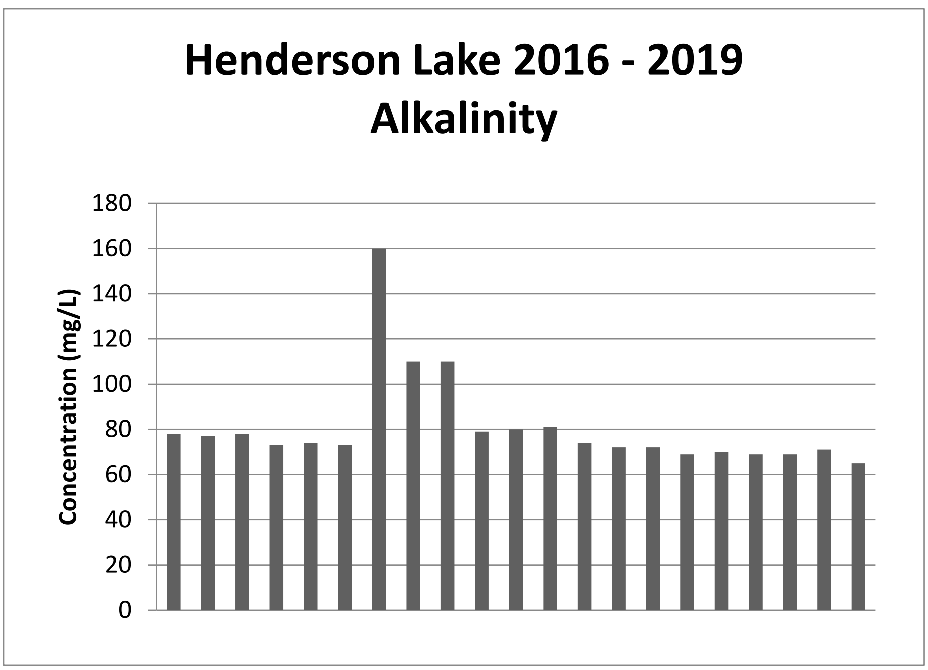
Environmental Scientist

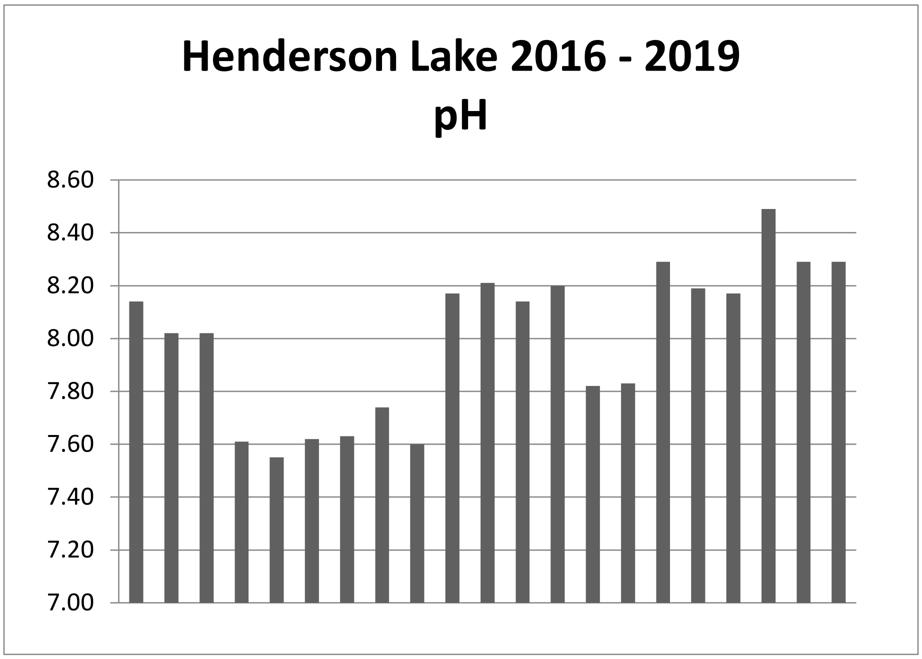
Historical Data:

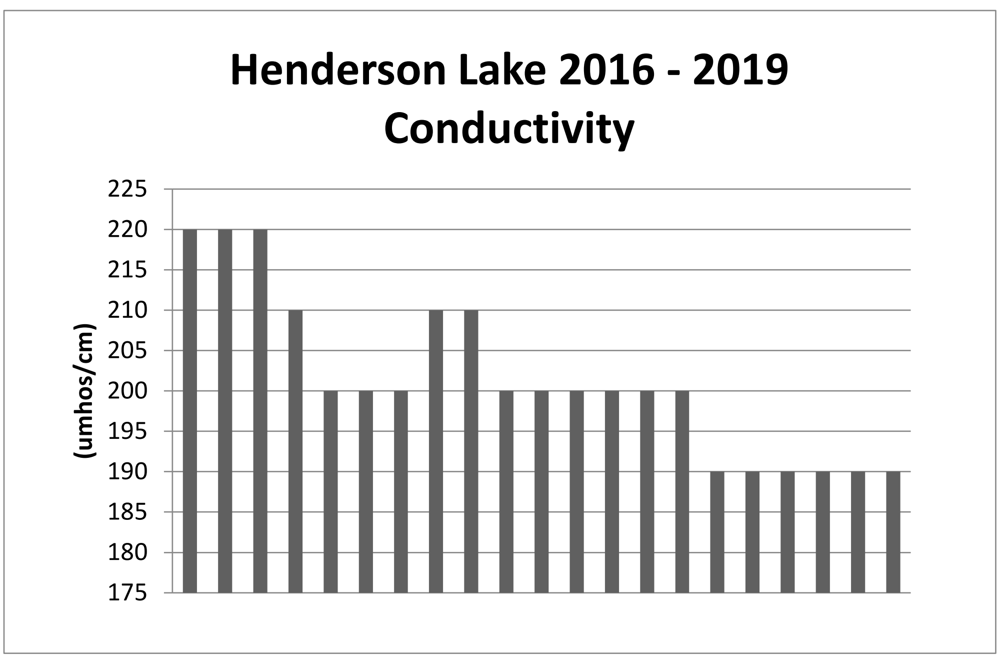





Henderson Lake 2016 - 2019
Secchi Disk Depth
Depth (feet)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0


Henderson Lake 2016 - 2019
Alkalinity
Concentration (mg/L)
180
160
140
120
100
80
60
40
20
0





(Nitrate and Total Phosphorus not shown due to majority of undefined values)

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Henderson Lake Water Quality Data												
Date	Sample Station Number	Temperature (ºC)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Percent Saturation	Chlorophyll α (ug/L)	Secchi Disk Depth (ft)	Total Nitrate Nitrogen (ug/L)	Alkalinity (mg/L)	pH	Conductivity umhos per cm at 25 ºC	Total Phosphorus (ug/L)	Grade
9/28/2016	1	17.2	9.77	101.2	2.0	Bottom	ND	78	8.14	220	<9	A
9/28/2016	2	17.0	9.58	99.3	2.4	11.0	ND	77	8.02	220	<9	A
9/28/2016	3	16.9	9.62	99.7	2.1	10.0	ND	78	8.02	220	<9	A
6/7/2017	1	23.4	9.14	106.8	0.4	Bottom	ND	73	7.61	210	13	A
6/7/2017	2	23.1	9.17	107.1	0.4	11.0	ND	74	7.55	200	13	A
6/7/2017	3	22.4	9.13	104.7	0.0	10.5	ND	73	7.62	200	41	A
10/4/2017	1	14.0	9.64	93.6	1.4	Bottom	ND	160	7.63	200	ND	A
10/4/2017	2	14.3	9.44	91.7	1.4	13.0	ND	110	7.74	210	ND	A
10/4/2017	3	14.1	9.43	91.6	1.4	Bottom	ND	110	7.60	210	ND	A
6/22/2018	1	25.3	8.90	108.0	1.4	Bottom	<80	79.0	8.17	200.0	<8	A
6/22/2018	2	24.7	9.20	111.7	1.4	11.0	<80	80.0	8.21	200.0	<8	A
6/22/2018	3	24.8	9.03	109.6	1.0	Bottom	<80	81.0	8.14	200.0	12.0	A
10/2/2018	1	15.8	10.2	103.1	2.1	Bottom	<80	74.0	8.2	200.0	<8	A
10/2/2018	2	15.3	10.0	99.6	2.4	15.0	<80	72.0	7.8	200.0	<8	A
10/2/2018	3	15.1	9.9	98.2	3.8	Bottom	<80	72.0	7.8	200.0	<8	A
5/24/2019	1	15.9	10.5	106.4	1.6	Bottom	<130	69	8.29	190	12.0	B
5/24/2019	2	15.7	10.6	107.2	1.3	8.0	<130	70	8.19	190	16.0	A
5/24/2019	3	15.7	10.6	107.8	1.3	8.5	<130	69	8.17	190	14.0	A
9/30/2019	1	14.5	10.2	101.7	2.4	Bottom	<130	69	8.49	190	<8	B
9/30/2019	2	14.8	10.1	100.0	2.1	12.0	<130	71	8.29	190	<8	B
9/30/2019	3	14.9	10.1	100.5	0.8	Bottom	<130	65	8.29	190	<8	A

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Parameter Descriptions:

TEMPERATURE AND DISSOLVED OXYGEN

Temperature exerts a wide variety of influences on most lakes, such as the separation of layers of water (stratification), solubility of gases, and biological activity.

Dissolved oxygen is the parameter most often selected by lake water quality scientists as being important. Besides providing oxygen for aquatic organisms in natural lakes, dissolved oxygen is involved in phenomena such as phosphorus precipitation to, and release from, the lake bottom sediments and decomposition of organic material in the lake.

Low dissolved oxygen concentrations (below 4 milligrams per liter) are generally insufficient to support fish life. In most Michigan lakes, there is no dissolved oxygen below the thermocline in late summer. Some experts like to see some dissolved oxygen in the bottom water of a lake, even if it is almost zero. This is because as long as there is some dissolved oxygen in the water at the bottom of the lake, phosphorus precipitated by iron to the bottom sediments will remain there. Once a lake runs out of dissolved oxygen in the water at the bottom iron comes back into solution. When that happens, it releases the phosphorus back into the water. This can cause additional algae to grow when the lake mixes.

DISSOLVED OXYGEN, PERCENT SATURATION

Because the amount of dissolved oxygen a water can hold is temperature dependent with cold water holding more than warm water, dissolved oxygen saturation is often a better way to determine if oxygen supplies are adequate. The best is between 90 and 110 percent.

CHLOROPHYLL α

Chlorophyll α is used by lake scientists as a measure of the biological productivity of the water. Generally, the lower the chlorophyll α, the better. High concentrations of chlorophyll α are indicative of an algal bloom in the lake, an indication of poor lake water quality. The highest surface chlorophyll α concentration found by Wallace Fusilier (Water Quality Investigators, WQI) in a Michigan lake was 216 micrograms per liter. Best is below one microgram per liter.

SECCHI DISK TRANSPARENCY (originally Secchi's disk)

In 1865, Angelo Secchi, the Pope's astronomer in Rome, Italy devised a 20-centimeter (8 inch) white disk for studying the transparency of the water in the Mediterranean Sea. Later an American limnologist (lake scientist) named Whipple divided the disk into black and white quadrants which many are familiar with today.

The Secchi disk transparency is a lake test widely used and accepted by limnologists. The experts generally felt the greater the Secchi disk depth, the better quality the water. However, one Canadian scientist pointed out acid lakes have very deep Secchi disk readings. (Would you consider a very clear lake a good quality lake, even if it had no fish in it? It would be almost like a swimming pool.) Most lakes in southeast Michigan have Secchi disk transparencies of less than ten feet. On the other hand, Elizabeth Lake in Oakland County had 34 foot Secchi disk readings in summer 1996, evidently caused by a zebra mussel invasion a couple of years earlier.

Most limnology texts recommend the following: to take a Secchi disk transparency reading, lower the disk into the water on the shaded side of an anchored boat to a point where it disappears. Then raise it to a point where it's visible. The average of these two readings is the Secchi disk transparency depth.

Secchi disk measurements should be taken between 10 AM and 4 PM. Rough water will give slightly shallower readings than smooth water. Sunny days will give slightly deeper readings than cloudy days. However, roughness influences the visibility of the disk more than sunny or cloudy days.

TOTAL PHOSPHORUS

Although there are several forms of phosphorus found in lakes, the experts selected total phosphorus as being most important. This is probably because all forms of phosphorus can be converted to the other forms. Currently, most lake scientists feel phosphorus, which is measured in parts per billion (1 part per billion is one second in 31 years) or micrograms per liter (ug/L), is the one nutrient which might be controlled. If its addition to lake water could be limited, the lake might not become covered with the algal communities so often found in eutrophic lakes.

Based on WQI's studies of many Michigan inland lakes, they've found many lakes were phosphorus limited in spring (so don't add phosphorus) and nitrate limited in summer (so don't add nitrogen).

10 parts per billion is considered a low concentration of phosphorus in a lake and 50 parts per billion is considered a high value in a lake by many limnologists.

NITRATE NITROGEN

Nitrate, also measured in the parts per billion range, has traditionally been considered by lake scientists to be a limiting nutrient. The experts felt any concentration below 200 parts per billion was excellent in terms of lake water quality. The highest value found by Fusilier was 48,000 parts per billion in an Ottawa County river which flowed into Lake Macatawa in Holland, Michigan.

On the other hand, WQI has studied hundreds of Michigan inland lakes, and many times they find them nitrate limited (very low nitrate nitrogen concentrations), especially in summer.

WQI was finding many lakes have lower nitrate nitrogen concentrations in summer than in spring. This is probably due to two factors. First, plants and algae growing in lakes as water warms can remove nitrates from the water column. And second, bacterial denitrification (where nitrates are converted to nitrogen gas by bacteria) also occurs at a much faster rate in summer when the water is warmer.

Generally limnologists feel optimal nitrate nitrogen concentrations (which encourage maximum plant and algal growth) are about 10-20 times higher than phosphorus concentrations. The reason more nitrogen than phosphorus is needed is because nitrogen is one of the chemicals used in the production of plant proteins, while phosphorus is used in the transfer of energy, but is not used to create plant material. If the nitrate concentration is less than 10-20 times the phosphorus concentration, the lake is considered nitrogen limited. If the nitrate concentration is higher than 10-20 times the phosphorus concentration, the lake is considered phosphorus limited.

TOTAL ALKALINITY

Alkalinity is a measure of the ability of the water to absorb acids (or bases) without changing the hydrogen ion concentration (pH). It is, in effect, a chemical sponge. In most Michigan lakes, alkalinity is due to the presence of carbonates and bicarbonates which were introduced into the lake from ground water or streams which flow into the lake. In lower Michigan, acidification of most lakes should not be a problem because of the high alkalinity concentrations.

HYDROGEN ION CONCENTRATION (pH)

pH has traditionally been a measure of water quality. Today it is an excellent indicator of the effects of acid rain on lakes. About 99% of the rain events in southeastern Michigan are below a pH of 5.6 and are thus considered acid. However, there seems to be no lakes in southern Michigan which are being affected by acid rain. Most lakes have pH values between 7.5 and 9.0.

SPECIFIC CONDUCTIVITY

Conductivity, measured with a meter, detects the capacity of a water to conduct an electric current. More importantly however, it measures the amount of materials dissolved in the water, since only dissolved materials will permit an electric current to flow. Theoretically, pure water will not conduct an electric current. It is the perception of the experts that poor quality water has more dissolved materials than does good quality water