VLAWMO
Vadnais Lake Area Water Management Organization

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2021 Water Monitoring Report

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Prepared by
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December, 2021

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Definitions & Abbreviations

Ammonia (NH3) – an inorganic form of nitrogen that is contained in fertilizers, septic system effluent, and animal wastes. It is also a product of bacterial decomposition of organic matter. NH3 becomes a concern if high levels of the un-ionized form are present. In this form NH3 can be toxic to aquatic organisms. The presence of un-ionized ammonia is a function of the NH3 concentration, pH, and temperature. Conversion of NH3 to NO2 by nitrification requires large quantities of oxygen which can kill aquatic organisms due to the lowered dissolved oxygen concentrations in water.

Aquatic Invasive Species (AIS) – non-native species such as zebra mussels and Eurasian watermilfoil

Birch Lake Improvement District (BLID) – Homeowner/lakeshore owners on Birch Lake in White Bear Lake MN

Chlorophyll-a (Chl A) - Chl A is a green pigment in algae. Measuring Chl A concentration gives an indication of how abundant algae are in a waterbody.

Colony Forming Units (CFU) – unit used in measuring the level of E. coli in a water sample.

Conductivity (mS/cm) - Conductivity is a good measure of salinity in water. The measurement detects chloride ions from the salt. Salinity affects the potential dissolved oxygen levels in the water. The greater the salinity, the lower the saturation point. Measurement in millisiemens per cm. 1 mS/cm = 1000 uS/cm.

Dissolved Oxygen (DO) - The concentration of molecular oxygen (O2) dissolved in water. The DO level represents one of the most important measurements of water quality and is a critical indicator of a water body's ability to support healthy ecosystems. Levels above 5 mg/L are considered optimal, and most fish cannot survive for prolonged periods at levels below 3 mg/L. Microbial communities in water use oxygen to breakdown organic materials, such as animal waste products and decomposing algae and other vegetation. Low levels of dissolved oxygen can be a sign that too much organic material is in a water body.

Ecoli – Criteria for E. coli set forth in Minn.R. 7050.0222 creek must not exceed 126 organisms per 100 ml as a geometric mean of not less than 5 samples in any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 ml

EQuIS - a repository for water quality, biological, and physical data and is used by state environmental agencies, EPA and other federal agencies, universities, private citizens, and many others. The MPCA uses the information entered into the database to determine the quality of the state's water bodies. If water quality standards are not met, the water body will designated as impaired and will need to have a TMDL study conducted.

Eutrophic – a water body that is high in nutrients and low oxygen content. A eutrophic lake is usually shallow, green, with limited oxygen in the bottom layer of water.

Eutrophication – The aging process by which lakes are fertilized with nutrients. Natural eutrophication will gradually change the character of a lake. Human activities can accelerate the process.

Hypereutrophic – A very nutrient-rich lake with murky water, frequent algal blooms and fish kills, foul odor, and rough fish

Definitions & Abbreviations

Impaired Waters – The Clean Water Act requires states to publish, every two years, a list of streams and lakes that are not meeting their designated uses because of excess pollutants. The list, known as the 303(d) list, is based on violations of water quality standards.

Mesotrophic – the classification between eutrophic and oligotrophic lakes. These lakes have moderately clear water, late-summer algal blooms, moderate macrophyte populations, and occasional fish kills.

Molecular Sourcing – the use of specific DNA markers to determine presence of a specific host origin of E.coli in a water sample (example, Human or Avian)

Most Probable Number (MPN) - unit used in measuring the level of E. coli in a water sample, similar to (CFU)

Nitrate (NO3) – High NO3 levels are often caused by over application of fertilizers that leach into waterbodies. Nitrate loading from water bodies in Minnesota has national implications as it is the primary chemical contributing to the hypoxia (low oxygen) zone at the mouth of the Mississippi River in the Gulf of Mexico. The Environmental Protection Agency (EPA) has a standard for nitrates in drinking water of 10ppb, infants and children are especially at risk.

Nitrite (NO2) – The second stage of the nitrogen cycle. Nitrite is poisonous to fish. Levels over 75 ug/L can cause stress in fish and greater than 500 ug/L can be toxic

Nitrogen (N) – Nitrogen is second only to phosphorus as an important nutrient for plant and algae growth. The amount of nitrogen in a water body strongly correlates to land use. Nitrogen comes from fertilizers, animal waste, sewage treatment plants and septic systems through surface runoff or groundwater sources. Nitrogen does not occur naturally in soil minerals but is a major component of all organic matter.

Nitrogen Cycle - the process of nitrogen breakdown in water. The first stage is the production of NH3. The second stage is the oxidation of NH3 into NO2 which is very poisonous to fish. The final stage is conversion of NO3 which aquatic plants use. Once the plants have used their share of NO3, bacteria change it back into a gaseous form and release it back to the atmosphere. The Nitrogen Cycle is dependent on oxygen. If a water body has low DO, organic decay of nitrogen is slower and the water will have increased interim levels of toxic products (NH3 and NO2). The cycle also moves quicker in warmer water.

Oligotrophic – a water body that is generally clear, deep, and free of weeds or large algae blooms.

Particulate Phosphorus – a form of phosphorus that is attached to sediment particles and in plant and animal fragments suspended in the water and may not be immediately available to support algae growth. Some of this phosphorus is readily available but the amount can vary.

Phosphorus (P) - Phosphorus is the primary cause of excessive plant and algae growth in lake systems. Phosphorus originates from a variety of sources, many of which are human related. Major sources include human and animal wastes, soil erosion, detergents, septic systems and runoff from farmland, yards, and streets.

Definitions & Abbreviations

Secchi Disk – a round, white, metal disk that is used to determine water clarity. It is lowered into the water until it is not visible. The depth is recorded, and then the disk is raised until it is visible. The mean value of the two readings gives the clarity.

Secchi Disk Transparency (SDT) - the term used in describing the results of a secchi reading expressed in feet or meters.

Soluble Reactive Phosphorus (SRP) – a form of phosphorus that dissolves in water and is readily available (bio-available) to algae and has an immediate effect on algae growth and DO depletion. Its concentration varies widely over short periods of time as plants take it up and release it.

St. Paul Regional Water Service (SPRWS) – Agency which assists VLAWMO with water quality testing and controls the Vadnais chain of lakes, which supplies drinking water to the city of St. Paul.

Surface Water Assessment Grant (SWAG) - Grant awarded by the PCA to help fund surface water monitoring

Total Kjehldahl Nitrogen (TKN) – The sum of NO2, NO3, and NH3 in a water body. High measurements of TKN typically results from sewage and manure discharges to water bodies.

Total Maximum Daily Load (TMDL) – Calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards and an allocation of that amount to the pollutant's source.

Total Nitrate and Nitrite Nitrogen - Nitrate (NO3) plus nitrite (NO2) as nitrogen. In lakes, most nitrate/ nitrogen is in NO3 form.

Total Phosphorus (TP) – A nutrient essential to the growth of organisms, and is commonly the limiting factor in the primary productivity of surface water bodies. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particle form. Agricultural drainage, wastewater, and certain industrial discharges are typical sources of phosphorus, and can contribute to the eutrophication of surface water bodies.

Total Suspended Solids (TSS) – Very small particles remaining dispersed in a liquid due to turbulent mixing that can create turbid or cloudy conditions. A measure of the material suspended in water in mg/l. Total suspended solids (TSS) cause: a) interference with light penetration, b) buildup of sediment and c) potential reduction in aquatic habitat. Solids also carry nutrients that cause algal blooms and other toxic pollutants that are harmful to fish. Clay, silt, and sand from soils, phytoplankton (suspended algae), bits of decaying vegetation, industrial wastes, and sewage are common suspended solids.

Trophic Status Indicator (TSI) – TSI is an indicator of water quality. Lakes can be divided into three categories based on trophic state – oligotrophic, mesotrophic and eutrophic. A natural aging process occurs in lakes which cause them to change from oligotrophic to eutrophic over time and eventually fill in. Humans can accelerate this process by allowing nutrients from agriculture, lawn fertilizers, streets, septic systems, and urban storm drains to enter lakes. Trophic status is determined through TP, Chl A, and SDT measurements.

Definitions & Abbreviations

Turbidity – a water quality parameter that refers to how clear the water is. It is an indicator of the concentration of suspended solids in the water. Excessive sedimentation in streams and rivers is considered to be the major source of surface water pollution in the United States. Polluted waters are commonly turbid. Turbidity is expressed in NTU (Nephelometric Turbidity Units).

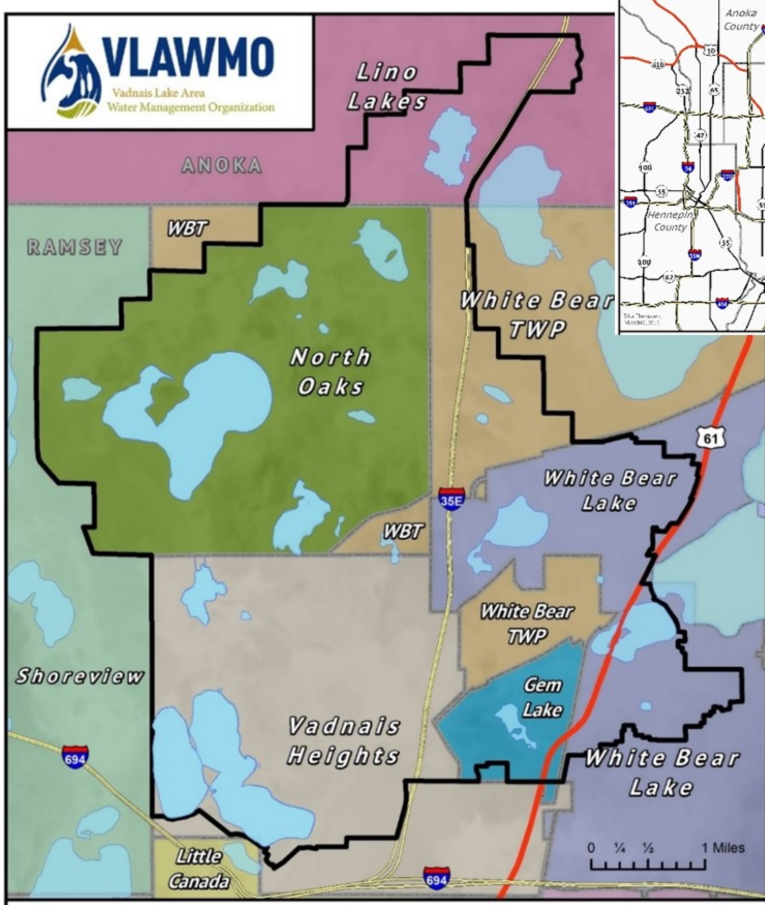
Volatile Suspended Solids (VSS) – a measure of the organic matter in suspended particles. When measured in conjunction with TSS, the proportions of organic versus mineral content of the particles can be determined.

INTRODUCTION

The Vadnais Lake Area Water Management Organization (VLAWMO) covers approximately 25 square miles in the northeast metropolitan area. The watershed encompasses the City of North Oaks and portions of the Cities of White Bear Lake, Gem Lake, Vadnais Heights, Lino Lakes, and White Bear Township. The watershed is 96% urbanized; agricultural land exists in the northern end of the boundaries. New land development is occurring near Wilkinson Lake. Data collected through this program tracks changes in water quality in conjunction with the change in land use around these water bodies.

VLAWMO works in conjunction with the St. Paul Regional Water Service (SPRWS) on water quality monitoring. The SPRWS monitors the direct surface water flow into Vadnais Lake to assure high quality drinking water for over 400,000 consumers. The SPRWS monitors the main chain of lakes (Charley Lake, Pleasant Lake, Sucker Lake and Vadnais Lake) and VLAWMO monitors Lambert Creek which flows directly into Vadnais Lake.

Figure 1: Map of VLAWMO with political boundaries



VLAWMO's mission is

"to protect and enhance the water and natural resources within the watershed through water quality monitoring, education and outreach projects, wetland protection, and water quality enhancement projects and programs."

VLAWMO began the Citizens Lake Monitoring Program (CLMP) in 1997 to monitor several lakes and ponds within the watershed that were identified as having local significance. CLMP volunteers have helped collect samples from 15 water bodies: Amelia Lake, Birch Lake, Black Lake, Charlie Lake, Deep Lake, Gem Lake, Gilfillan Lake, Goose Lake East, Goose Lake West, Pleasant Lake, Sucker Lake, Tamarack Lake, East & West Vadnais Lake and Wilkinson Lake. These lakes are mostly shallow with average depths no greater than 9 feet. Five lakes are deeper than 9 feet (Charlie, Gem, Pleasant. Sucker and East Vadnais) Six areas along Lambert Creek are also sampled as part of the Organization's mission to protect and improve the water-related environment. The data received from the monitoring is used by VLAWMO and the Minnesota Pollution Control Agency (MPCA) to determine the health of the state's waters.

Figure 2: Map of VLAWMO Water Resources

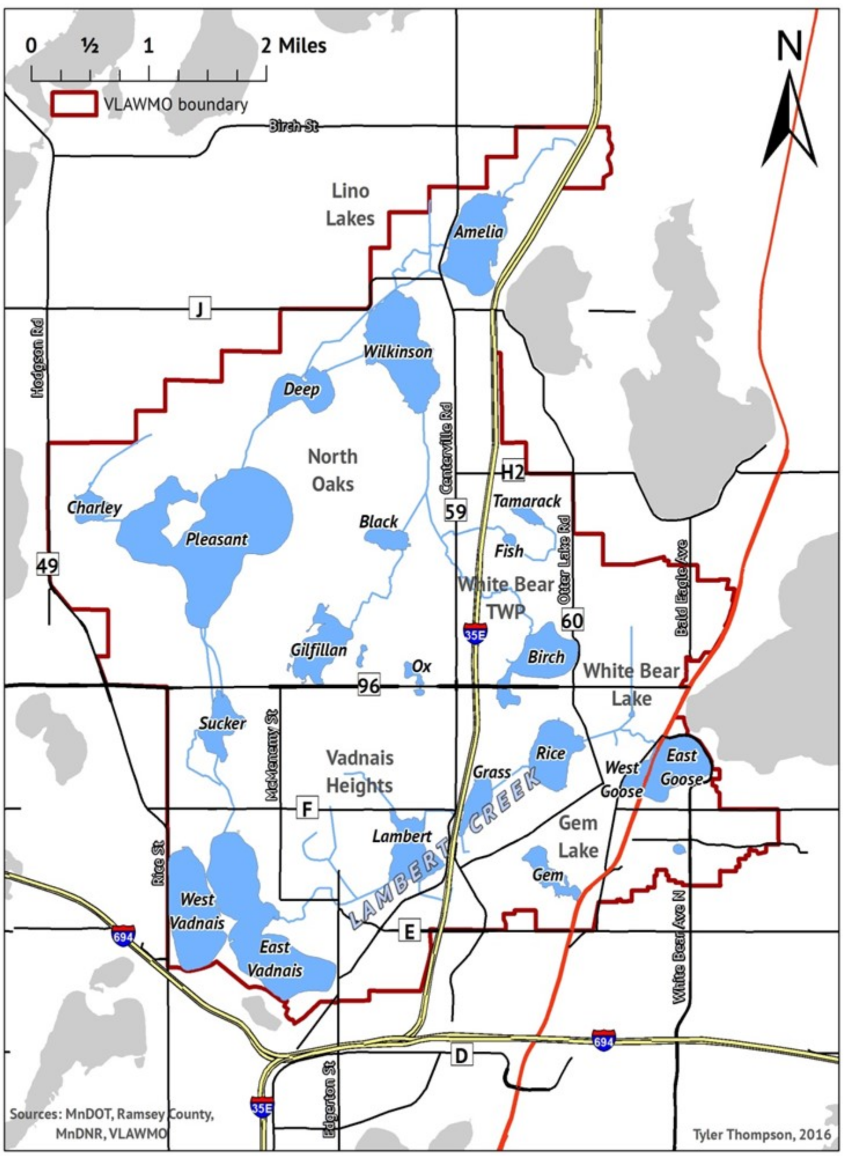
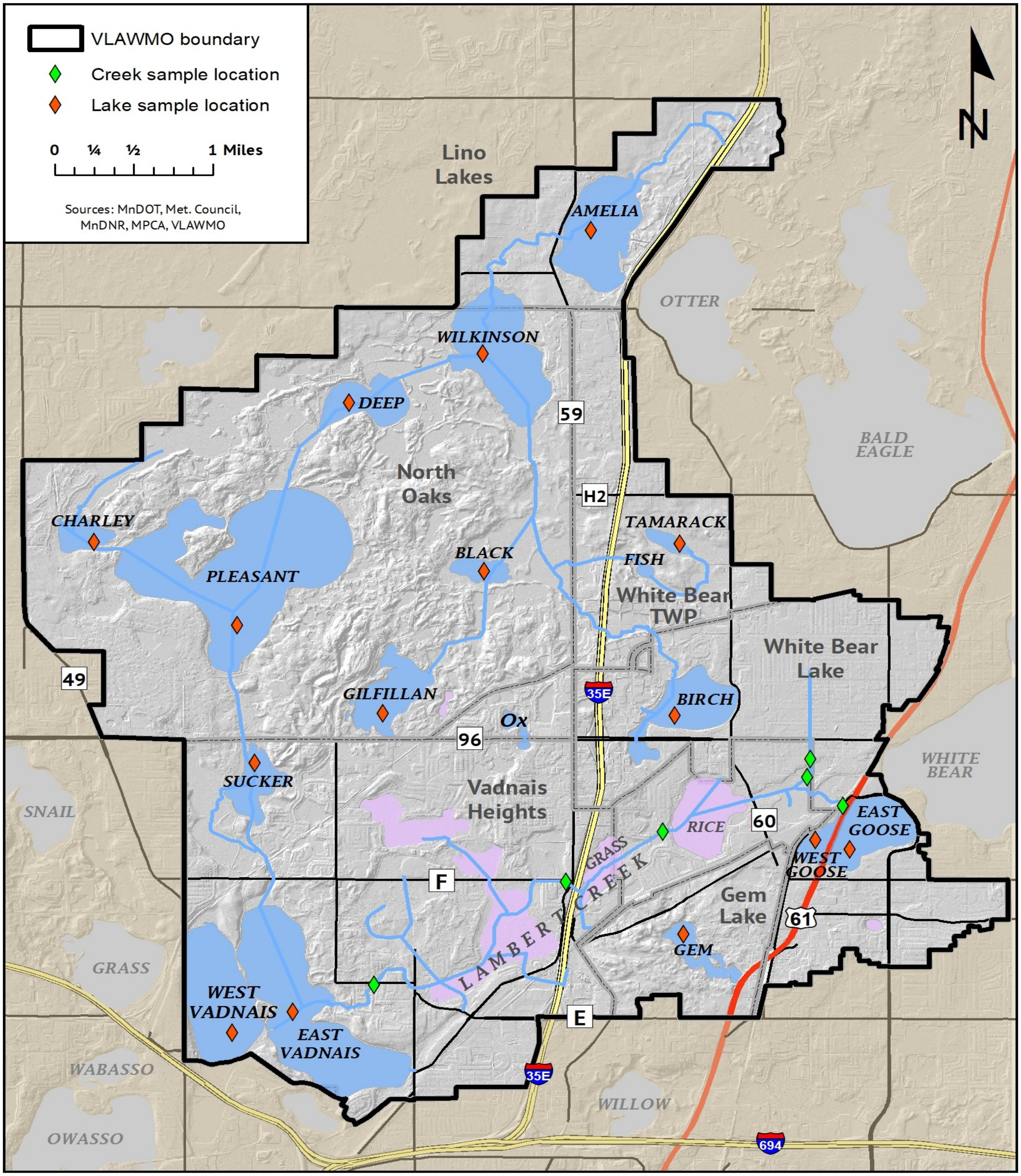


Figure 3: Monitoring Sites in VLAWMO



Impaired Water Designations

The watershed has had several water bodies listed on the MPCA 303(d) list for Impaired Waters. The SPRWS Chain of Lakes (Pleasant, Sucker and Vadnais Lakes) have all been listed for nutrient pollution, specifically mercury. These lakes have been infested with zebra mussels, an aquatic invasive species, though this is not a condition of the Impaired Waters listing. This chain of lakes is fed by the Mississippi River through a pump in Fridley, MN. Lambert Creek has been added to the impaired list for bacteria, specifically fecal coliform or E. coli. Gilfillan Lake, Goose Lake and Wilkinson Lake, impaired for nutrients, have also been added. Pleasant Lake, Tamarack Lake and West Vadnais Lake were added to the impaired list for nutrients in 2018.

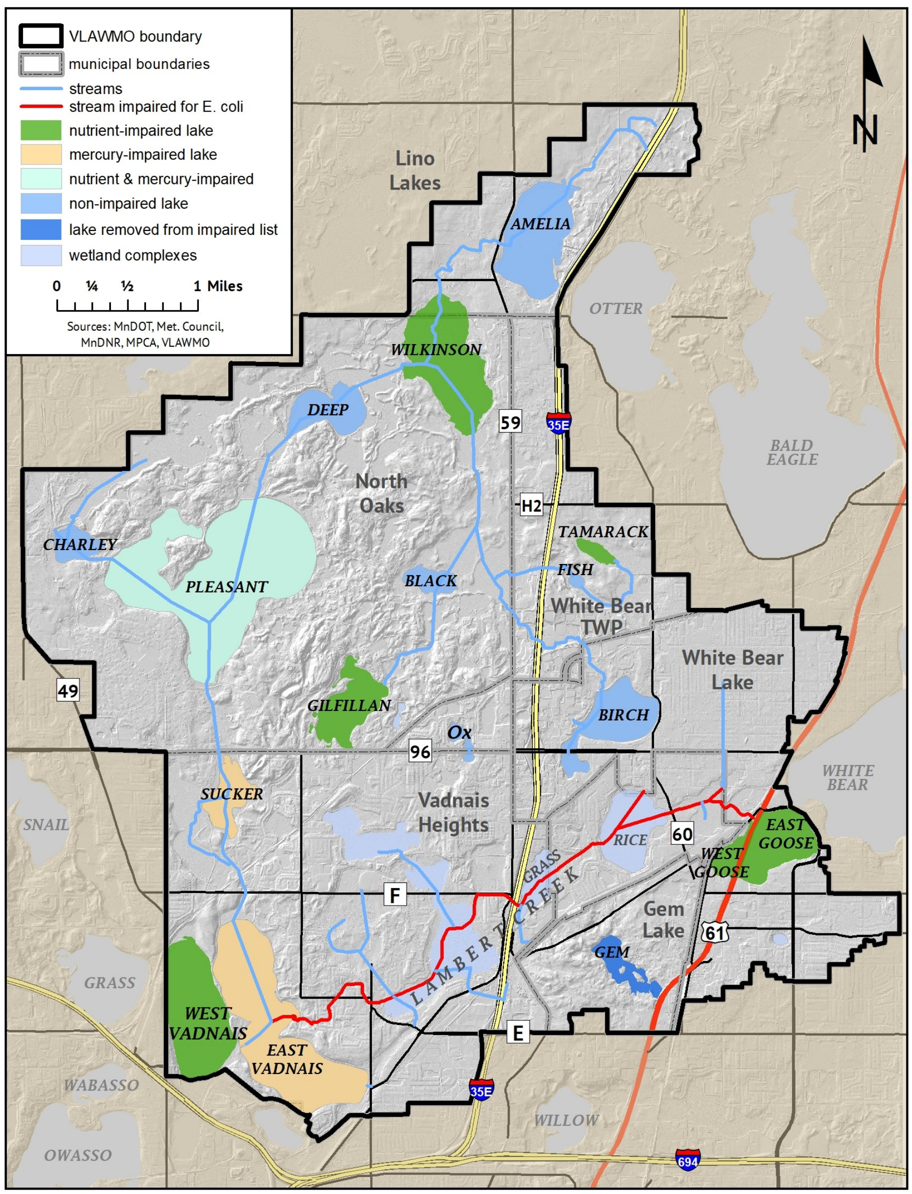


Figure 4: Waterbodies listed on the MPCA 303(d) Impaired Waters List

Typical Measurements for Lakes and Streams

VLAWMO's watershed falls within the North Central Hardwood Forest (CHF) ecoregion. This ecoregion is an area of transition between the forested areas to the north and east and the agricultural areas to the south and west. The terrain varies from rolling hills to smaller plains. Non-urbanized upland areas are forested by hardwoods and conifers. Plains include livestock pastures, hay fields and row crops such as potatoes, beans, peas and corn.

The ecoregion contains many lakes, and water clarity and nutrient levels are moderate. Land surrounding many of these lakes has been developed for housing and recreation, and the densely populated metropolitan area dominates the eastern portion of this region. Water quality problems that face many of the water bodies in the area are associated with contaminated runoff from paved surfaces and lawns.

Below are typical measurements one might find for lakes and streams in the CHF ecoregion:

Typical Lake Measurements in CHF Ecoregion							
Field pH	TSS (mg/L)	NO_X (µg/L)	TP (µg/L)	Turb (NTU)	SDT (m)	Chl-a (µg/L)	TKN (µg /L)
8.6 – 8.8	2 – 6	<100	23 – 50	1 – 2	1.5 – 3.2	5 – 22	600 - 1200
Streams							
Field pH	TSS (mg/L)	NO_X (µg/L)	TP (µg/L)	Turb (NTU)	Fecal Coliform (cfu/100 ml)	Temp (˚C)	BOD (in mg/L)
7.9 – 8.3	4.8 – 16	4 - 26	6 – 15	3 – 8.5	40 – 360	2 – 21	– 3.2

The MPCA has water quality standards based on a designated use for the water body. VLAWMO's water is classified as "2B". The SPRWS chain of lakes has a stricter designation of "2Bd" due to it being the drinking water source for St. Paul. The quality of Class 2B water must be suitable for aquatic recreation of all kinds as well as to support fish and aquatic plant life. In 2008, the MPCA approved new standards which will separate deep from shallow lakes. All of the lakes VLAWMO monitors are considered shallow and therefore those standards will apply. For those parameters which the MPCA does not have standards, the federal Environmental Protection Agency (EPA) has maximum contaminant level standards. VLAWMO's goal is to have its waterbodies within these standards.

MPCA Standards Lakes					**EPA Standards**	
TP (µg/L)	Chl A (µg/L)	SDT (m)	Turb (NTU)	TSS (mg/L)	TKN (µg/L)	NO_2 (µg/L)
< 60	< 20	> 1	< 25	< 100	< 1000	< 100
MPCA Standards – Rivers and Streams					**EPA Standards**	
Fecal Coliform daily maximum (cfu/100 ml)	Chloride (Cl) chronic (mg/L)	Turb (NTU)	TSS (mg/L)	Un-ionized Ammonia (µg/L)	TKN (µg/L)	NO_2 (µg/L)
< 1260	< 230	< 25	< 100	<40	< 1000	< 100

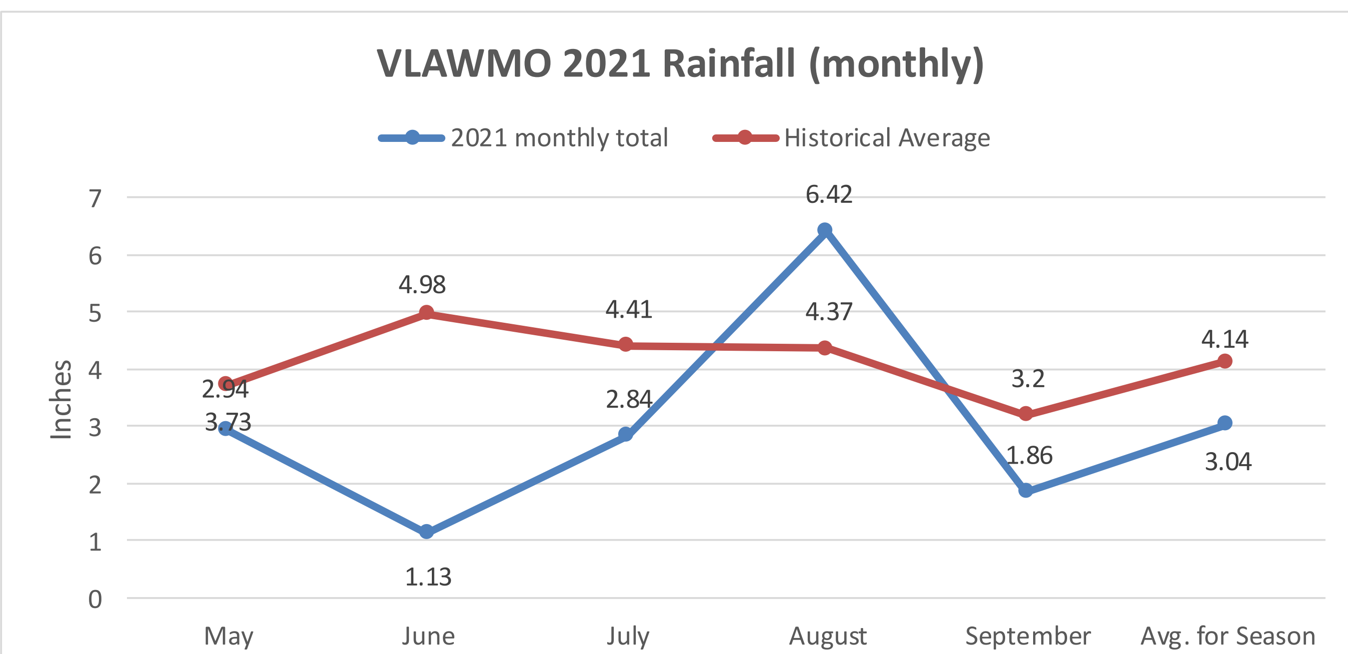
Precipitation in 2020

Major factors influence water quality including the amount of precipitation, timing of precipitation events, and land use practices in the watershed. Long-term monitoring is necessary to characterize the impacts of various land use practices on surface water runoff within VLAWMO.

The 2021 monitoring season precipitation was below average by 1.10 inches per month and 1.02 inches below 2020 monitoring season precipitation. Above average monthly rainfall in August, below average in May, June, July & September. Precipitation moves contaminants resting on lawns, roofs, streets, and parking lots into nearby water bodies or into storm sewers that outlet into water bodies. Typically, the more precipitation that occurs, the more runoff there will be in the watershed. However, the timing and intensity of the precipitation, as well as soil types, land slopes, land uses, and other factors can influence the amount of runoff that reaches the water bodies. Lack of rain can also have an effect on the concentration of nutrients and chemicals in our water bodies. With a smaller volume of water in our water bodies, the more concentrated the nutrients and chemicals can become.

2021 Precipitation Data (in inches)
Vadnais Heights City Hall Rain Gauge, Vadnais Heights, MN

	2021 monthly total	Historical Average	Deviation
May	2.94	3.73	-0.79
June	1.13	4.98	-3.85
July	2.84	4.41	-1.57
August	6.42	4.37	2.05
September	1.86	3.2	-1.34
Month Avg. Season	**3.24**	**4.14**	-0.90

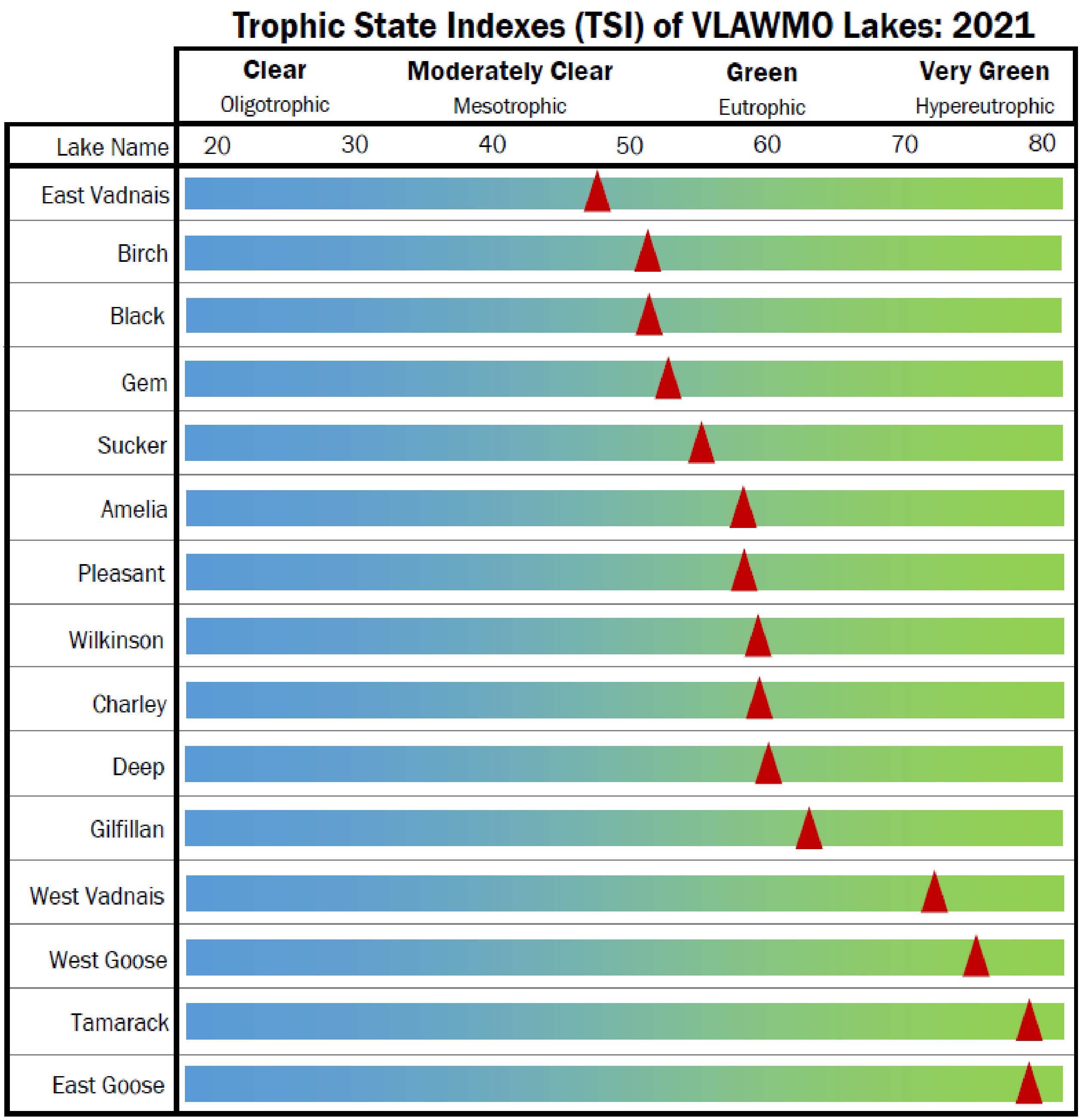


Preliminary Analysis of Lake Data

VLAWMO staff worked with volunteers to collect samples from the lakes at two-week intervals from May through September. VLAWMO staff collected all creek samples. At the time of collection, staff measure water transparency with a Secchi disk (SDT), evaluate the physical and recreational conditions of the water, and if available, take a lake level reading. Samples are shipped to RMB Labs by VLAWMO staff within 24 hours for chemical analysis. Parameters measured at the lab include Phosphorus (TP &SRP), Chlorophyll-a (Chl A), total Kjeldahl Nitrogen, nitrate, ammonia and Total Suspended Solids (TSS). The data from these tests aid in the determination of the state of the water quality in a particular lake or stream and allow for monitoring of the long term health of the water body. Standards for water quality are set by the US Environmental Protection Agency (EPA) and enforced through the MPCA.

A measure of the lake health and lake age is Carlson's Trophic State Index (TSI), which measures the productivity level of a lake or degree of eutrophication. As a lake ages, it becomes more eutrophic, however human impact speeds up the process. High TSI values can relate to poorer water quality, with the possibility of variations from lake to lake. To accommodate for these possible variations, the trophic state serves as an absolute scale that describes the biological condition of a water body. VLAWMO lake TSI ratings are listed on page 15 consistent with Minnesota Pollution Control Agency's (MPCA) parameters, which range from hypereutrophic to oligotrophic. Additional TSI rating charts as well as factsheets specific to each lake are also available at vlawmo.org/waterbodies.

Water quality, on the other hand, is a term used to describe the condition of a water body in relation to human needs or values. Analysis of these conditions continue from page 18 and onwards.



See page 16 for numeric values associated with this scale.

TSI Data: Comparison of 2021 and 2020

2021 TSI Lake Data	Averge Secchi Disk (m)	Secchi Disk TSI	Average Chlorophyll A ChlA (mg/m³)	Chlorophyll A ChlA TSI	Average Total Phosphorus (TP) µg/L	Total Phosphoros (TP) TSI	Total TSI
Amelia	1.3	56	14	56	49	60	58
Birch	2	50	9	52	23	49	51
Black	2.4	47	7	50	36	56	51
Charley	1.4	55	19	59	52	61	59
Deep	1.2	57	14	56	81	68	60
Gem	2.4	47	13	56	38	57	53
Gilfillan	0.9	62	39	67	54	62	63
East Goose	0.3	77	125	78	191	80	78
West Goose	0.3	77	118	77	98	70	75
Pleasant	1.5	54	20	60	52	61	58
Sucker	2.2	49	17	58	44	59	55
Tamarack	0.4	73	186	82	177	79	78
East Vadnais	2.7	46	4	44	24	50	47
West Vadnais	0.5	70	106	76	104	71	72
Wilkinson	1.1	59	10	53	63	64	59

2020 TSI Lake Data	Averge Secchi Disk (m)	Secchi Disk TSI	Average Chlorophyll A ChlA (mg/m³)	Chlorophyll A (ChlA) TSI	Average Total Phosphorus (TP) µg/L	Total Phosphorus (TP) TSI	Total TSI
Amelia	1.3	56	5	46	29	53	52
Birch	2	50	3	41	18	46	46
Black	2	50	4	44	25	51	48
Charley	1.3	56	7	50	52	61	56
Deep	1.4	55	8	51	72	66	57
Gem	2.4	47	14	56	35	55	53
Gilfillan	0.8	63	35	65	54	62	63
East Goose	0.3	77	167	81	187	80	79
West Goose	0.3	77	148	80	129	74	77
Pleasant	1.7	52	16	58	41	58	56
Sucker	2	50	8	51	41	58	53
Tamarack	0.4	73	122	78	146	76	76
East Vadnais	1.9	51	3	41	25	51	48
West Vadnais	0.5	70	80	74	127	74	73
Wilkinson	1.1	59	18	59	92	69	62

A list of possible changes that might be expected in a north temperate lake as the amount of algae changes along the trophic state gradient.

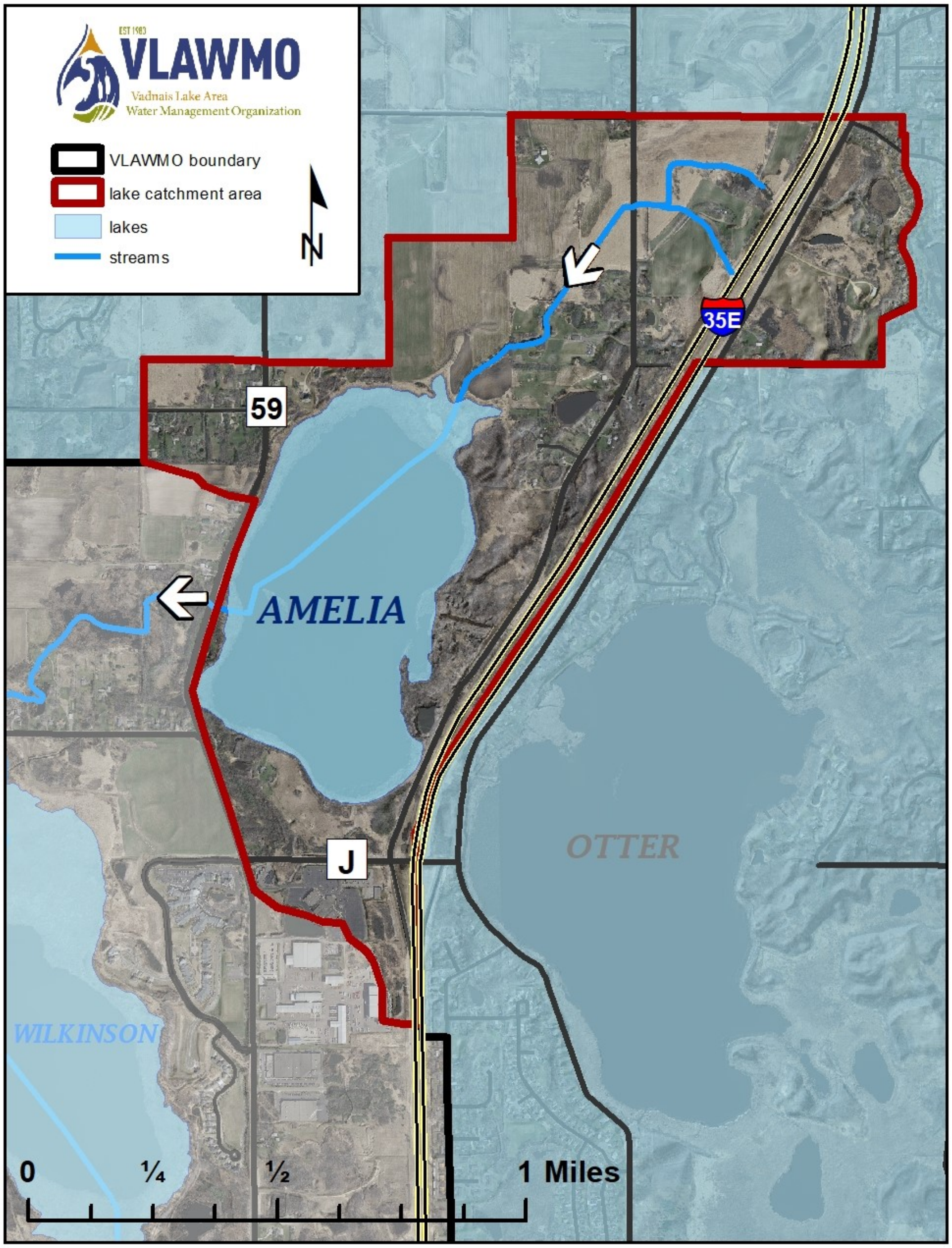
TSI	Chl (ug/L)	SD (m)	TP (ug/L)	Attributes	Water Supply	Fisheries & Recreation
<30	<0.95	>8	<6	**Oligotrophy:** Clear water, oxygen throughout the year in the hypolimnion	Water may be suitable for an unfiltered water supply.	Salmonid fisheries dominate
30-40	0.95-2.6	8>4	6<12	Hypolimnia of shallower lakes may become anoxic		Salmonid fisheries in deep lakes only
40-50	2.6-7.3	4>2	12<24	**Mesotrophy:** Water moderately clear; increasing probability of hypolimnetic anoxia during summer	Iron, manganese, taste, and odor problems worsen. Raw water turbidity requires filtration.	Hypolimnetic anoxia results in loss of salmonids. Walleye may predominate
50-60	7.3-20	2>1	24-48	**Eutrophy:** Anoxic hypolimnia, macrophyte problems possible		Warm-water fisheries only. Bass may dominate.
60-70	20-56	0.5-1	48-96	Blue-green algae dominate, algal scums and macrophyte problems	Episodes of severe taste and odor possible.	Nuisance macrophytes, algal scums, and low transparency may discourage swimming and boating.
70-80	56-155	0.25-0.5	96-192	**Hypereutrophy:** (light limited productivity). Dense algae and macrophytes		
>80	>155	<0.25	192-384	Algal scums, few macrophytes		Rough fish dominate; summer fish kills possible

VLAWMO's water resource manager completes the required data entry each year into the MPCA EQuIS program which makes the determination of impairment and opens opportunities for grants to help remedy the impairments.

2021 MONITORING RESULTS

AMELIA LAKE

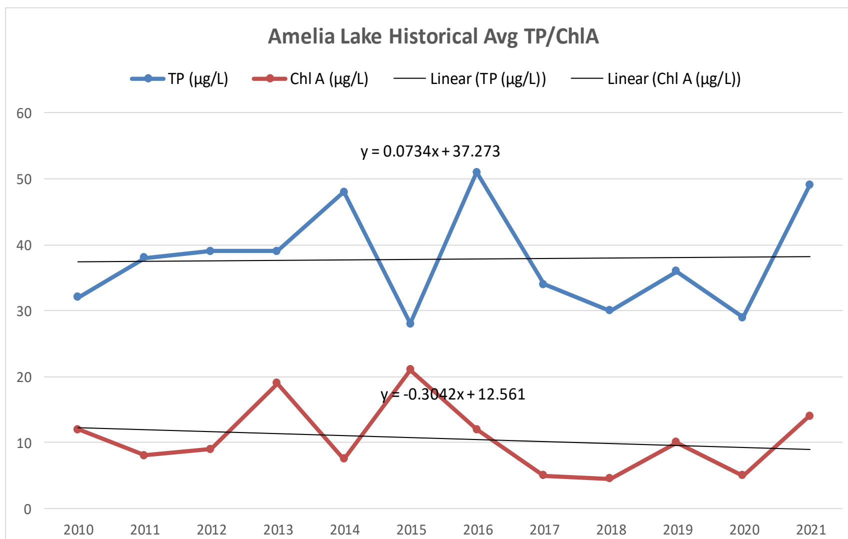
Amelia is located in Anoka County and is approximately 217 acres. Maximum depth for the lake is 5 feet. The majority of agricultural land left in the watershed is near Amelia Lake. VLAWMO staff also collected all DO and YSI parameter readings on Amelia. VLAWMO has been monitoring Amelia since 1997.



AMELIA LAKE

Amelia Lake Historical Avg TP/Chl A/ SDT			
Year	TP (µg/L)	Chl A (µg/L)	Secchi (m)
1997	28	0	1.5
1998	36	14	1.1
1999	38	9	1.2
2000	40	12	0.9
2001	33	8	1.1
2002	34	13	1.4
2003	29	7	1.5
2004	28	0	0
2005	24	7	0
2006	36	12	0
2007	82	32	0.4
2008	26	5	1.1
2009	55	24	0.9
2010	32	12	1.1
2011	38	8	1.1
2012	39	9	1.1
2013	39	19	1.1
2014	48	7.5	1.3
2015	28	21	1.1
2016	51	12	1.1
2017	34	5	1.3
2018	30	4.5	1.4
2019	36	10	1.3
2020	29	5	1.3
2021	49	14	1.3

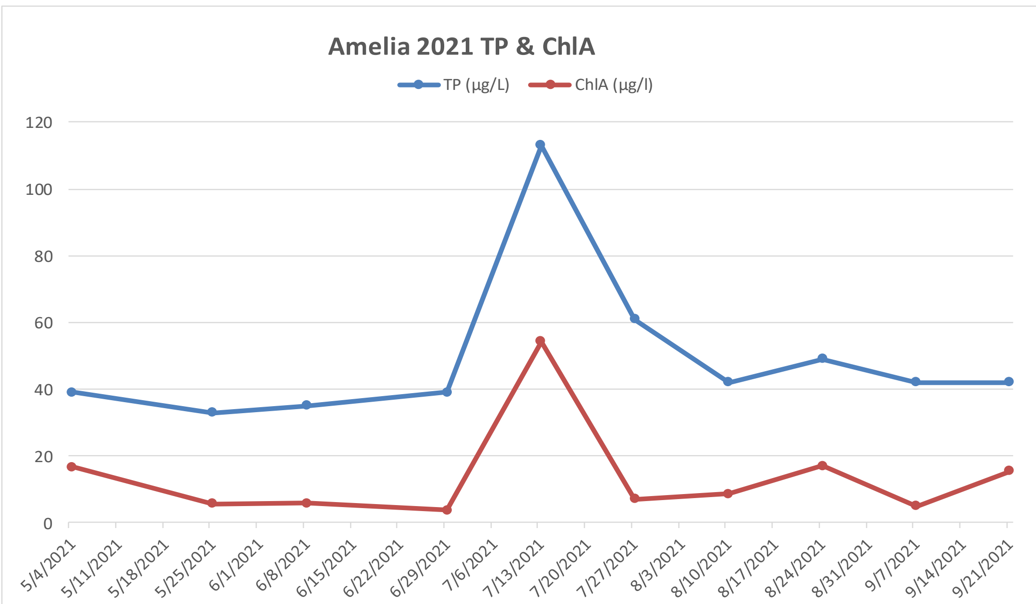
Date	Reading Depth (Bottom/Top)	Temp °C	Conduc-tivity (mS/cm)	DO (mg/L)	pH
5/25/2021	b	23.68	0.403	3.28	7.55
5/25/2021	t	23.99	0.405	4.22	7.56
6/29/2021	b	23.51	0.405	2.61	7.25
6/29/2021	t	24.25	0.399	4.29	7.29
7/27/2021	b	25.98	0.519	1.23	7.46
7/27/2021	t	26.06	0.449	3.19	7.51
9/21/2021	b	17.81	0.455	5.99	7.44
9/21/2021	t	17.99	0.456	5.92	7.5



- YSI parameters are good for Amelia Lake, no signs of concern. Red values indicate averages above state standard.

AMELIA LAKE

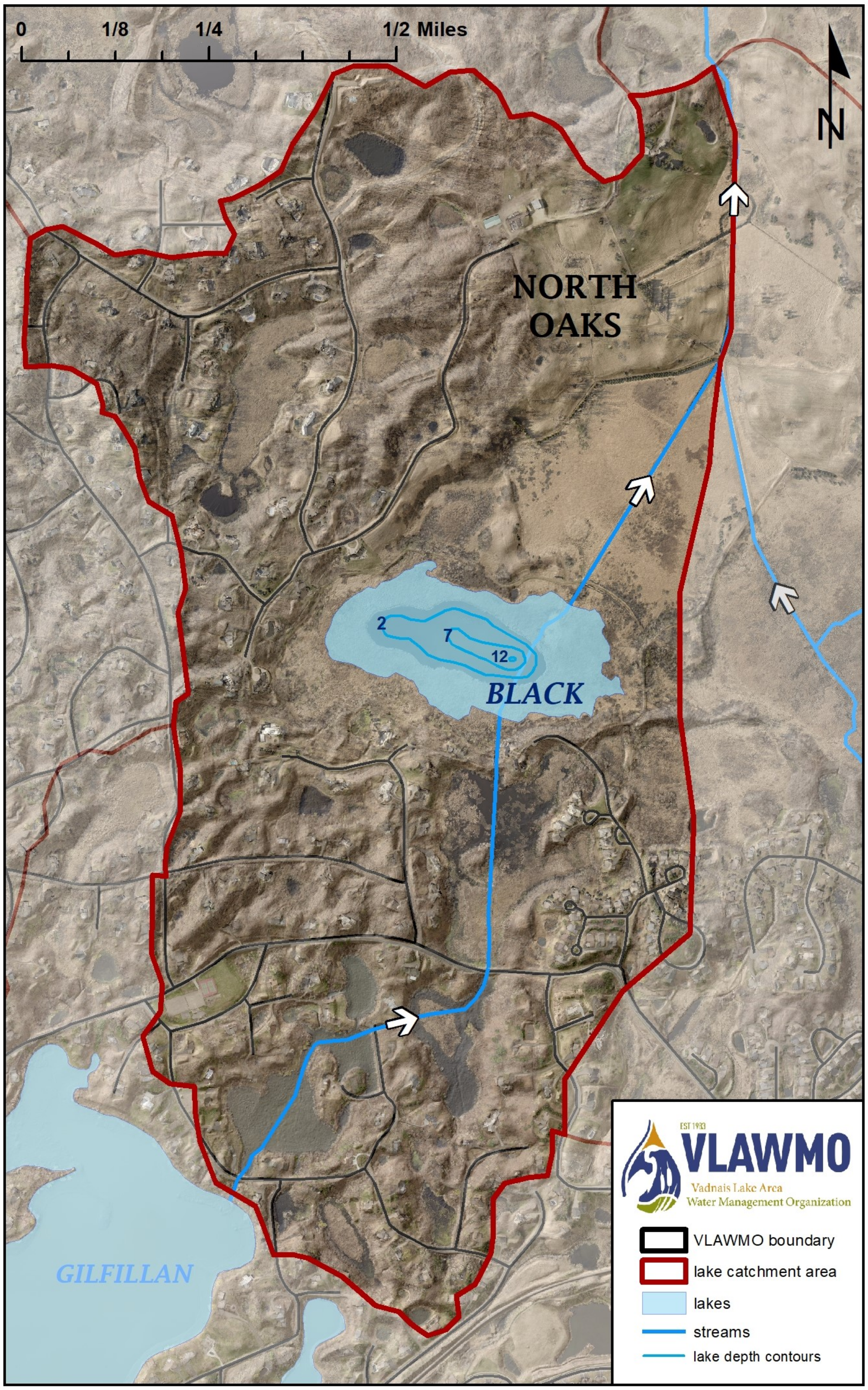
SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/l)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
amelia	4/6/2021								70
amelia	5/4/2021	4.5	39	0.007	16.6	0.96	0.03	<0.03	
amelia	5/25/2021	4	33	0.007	5.64				
amelia	6/8/2021	4	35	0.006 [2]	5.87	1.12	0.07	<0.03	
amelia	6/29/2021	4	39	0.003	3.77				
amelia	7/13/2021	4	113	0.003	54.2	1.97	0.04	<0.03	
amelia	7/27/2021	4.5	61	<0.003	7.01				
amelia	8/10/2021	4.5	42	<0.003	8.68		0.05	0.06	
amelia	8/24/2021	4	49	<0.003 [1]	17				
amelia	9/7/2021	4.5	42	<0.003	5.01	1.39	0.11	<0.03	
amelia	9/21/2021	5	42	<0.003 [1]	15.4				



- Nitrogen and ammonia levels are well below state standards for Amelia Lake as well as chloride.

BLACK LAKE

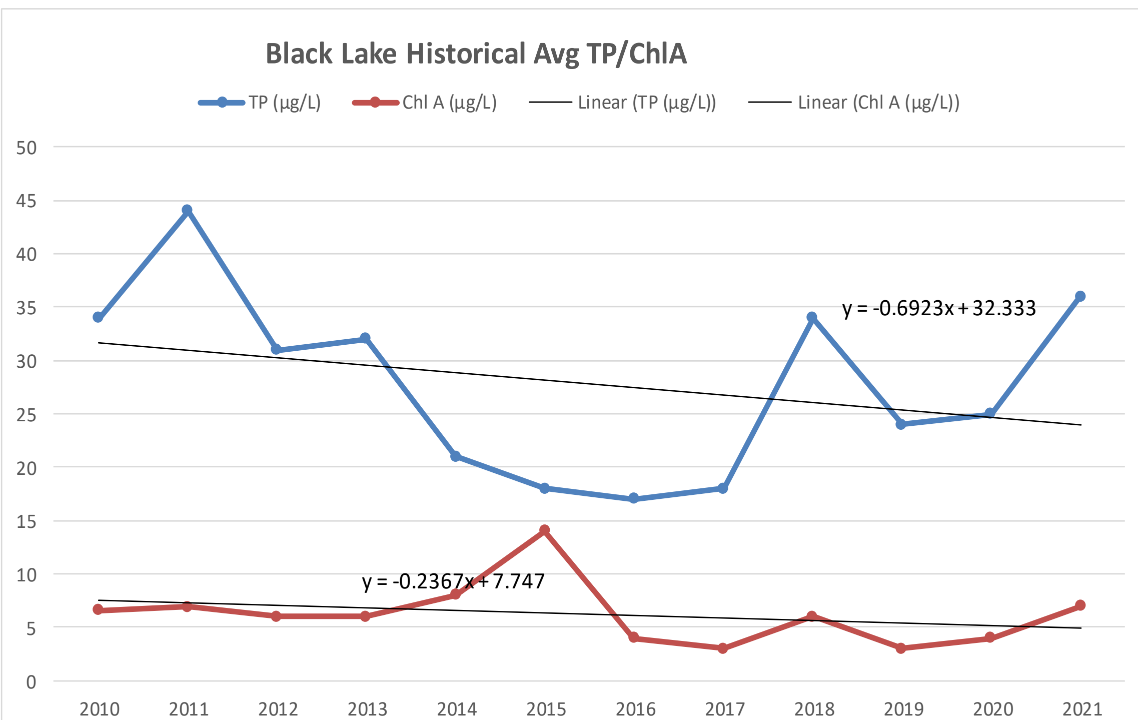
Black Lake is located in North Oaks. There is very little developed land or roads around the lake. The lake is about 10 acres and has a maximum depth of 12 feet. VLAWMO began to monitor Black Lake in 2009. Black Lake is also one of, if not the only lake left within VLAWMO that has a significant population of wild rice. Access to the lake is minimal and the lake is surrounded by private property, is very isolated and has a large wetland fringe. Black Lake is one of the healthiest lakes within VLAWMO.



BLACK LAKE

Black Lake Historical Avg TP/Chl A/SDT			
Year	TP (µg/L)	Chl A (µg/L)	Secchi (m)
2009	23	5.9	2
2010	34	6.6	2.1
2011	44	6.9	2.3
2012	31	6	2.4
2013	32	6	2
2014	21	8	2
2015	18	14	1.6
2016	17	4	2
2017	18	3	2.1
2018	34	6	2
2019	24	3	2.2
2020	25	4	2
2021	36	7	2.4

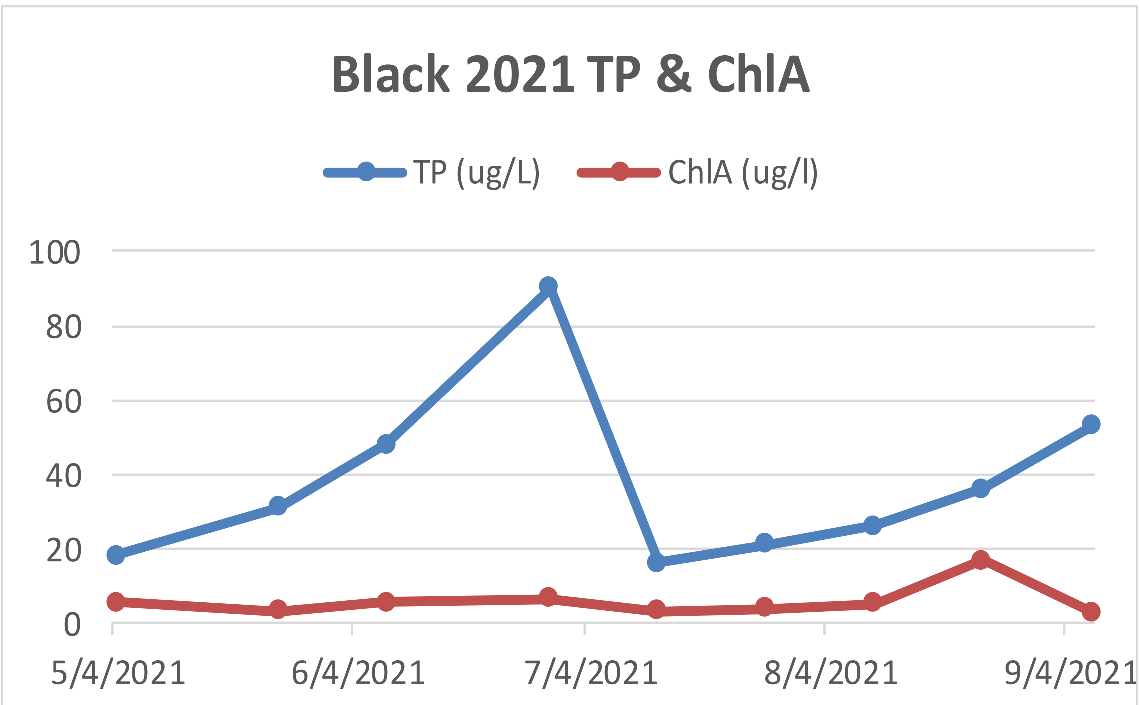
Date	Reading Depth (Bottom/ Top)	Temp °C	Conduc-tivity (mS/ cm)	DO (mg/L)	pH
5/25/2021	b	17.46	0.35	9.05	7.16
5/25/2021	t	24.67	0.309	6.84	7.26
7/27/2021	b	22.09	0.362	0.53	7.41
7/27/2021	m	26.51	0.314	1.47	7.43
7/27/2021	t	27.16	0.303	3.66	7.47
9/21/2021	b	17.98	0.353	3.61	7.36
9/21/2021	m	19.52	0.352	4.38	7.4
9/21/2021	t	19.7	0.353	4.64	7.43
9/22/2020	t	17.33	0.341	5.35	7.76



- Black Lake YSI parameters are very good for this type of lake. Black Lake is around 12 ft deep and does show some signs of stratification. .

BLACK LAKE

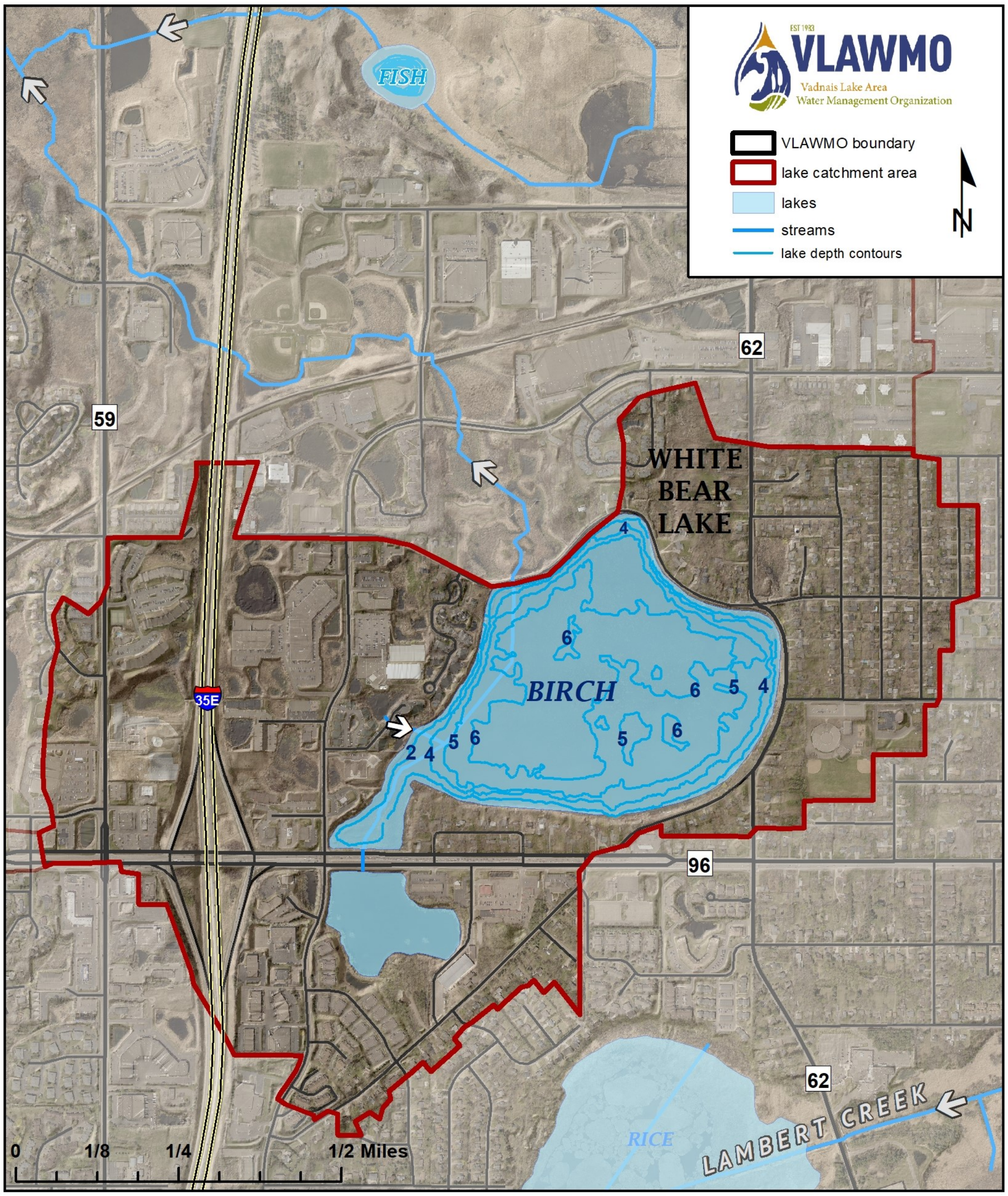
SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/l)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
black	4/6/2021								25
black	5/4/2021	8	18	0.009	5.34	0.6	0.05	<0.03	
black	5/25/2021	6	31	0.005	2.97				
black	6/8/2021	8	48	0.017	5.34	1.16	0.25	<0.03	
black	6/29/2021	6	90	0.014	6.41				
black	7/13/2021	8	16	0.003	3	0.73	<0.02	<0.03	
black	7/27/2021	7	21	0.003	3.56				
black	8/10/2021	8	26	0.003	5.04		0.03	<0.03	
black	8/24/2021	5.5	36	0.003	16.6				
black	9/7/2021	7.5	53	0.011	2.86	0.97	0.06	<0.03	
black	9/21/2021	4.5	28	0.007	25.9				



- Nitrogen and ammonia levels are well below state standards for Black Lake as well as chloride

BIRCH LAKE

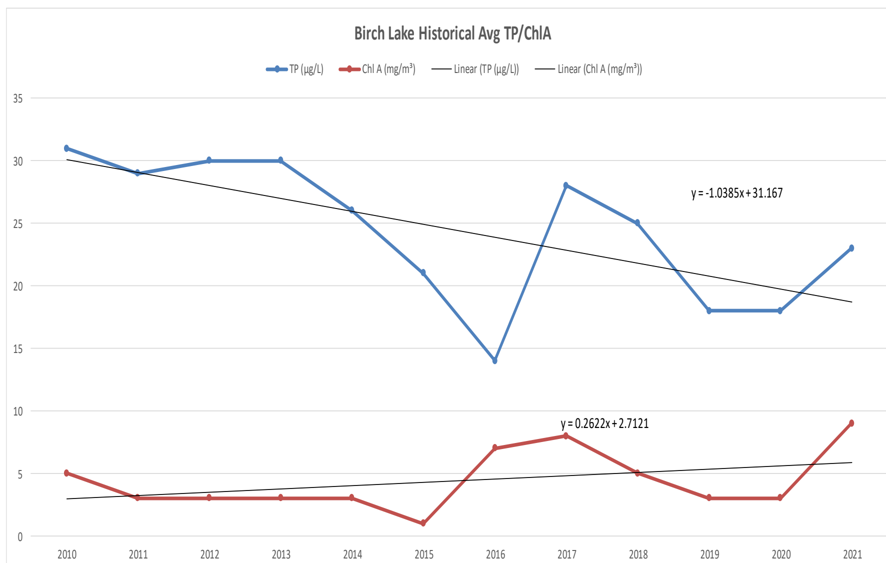
Birch Lake is located within the City of White Bear Lake and is 127 acres with a maximum depth of 6 feet. Land is completely developed around Birch Lake and there are 4 main storm sewer inlets around the lake as well as other storm inlets. Birch Lake is a rare find in the metropolitan area because of its clarity and water quality. Results of ChlA and TP are very low for such an urbanized water body.



BIRCH LAKE

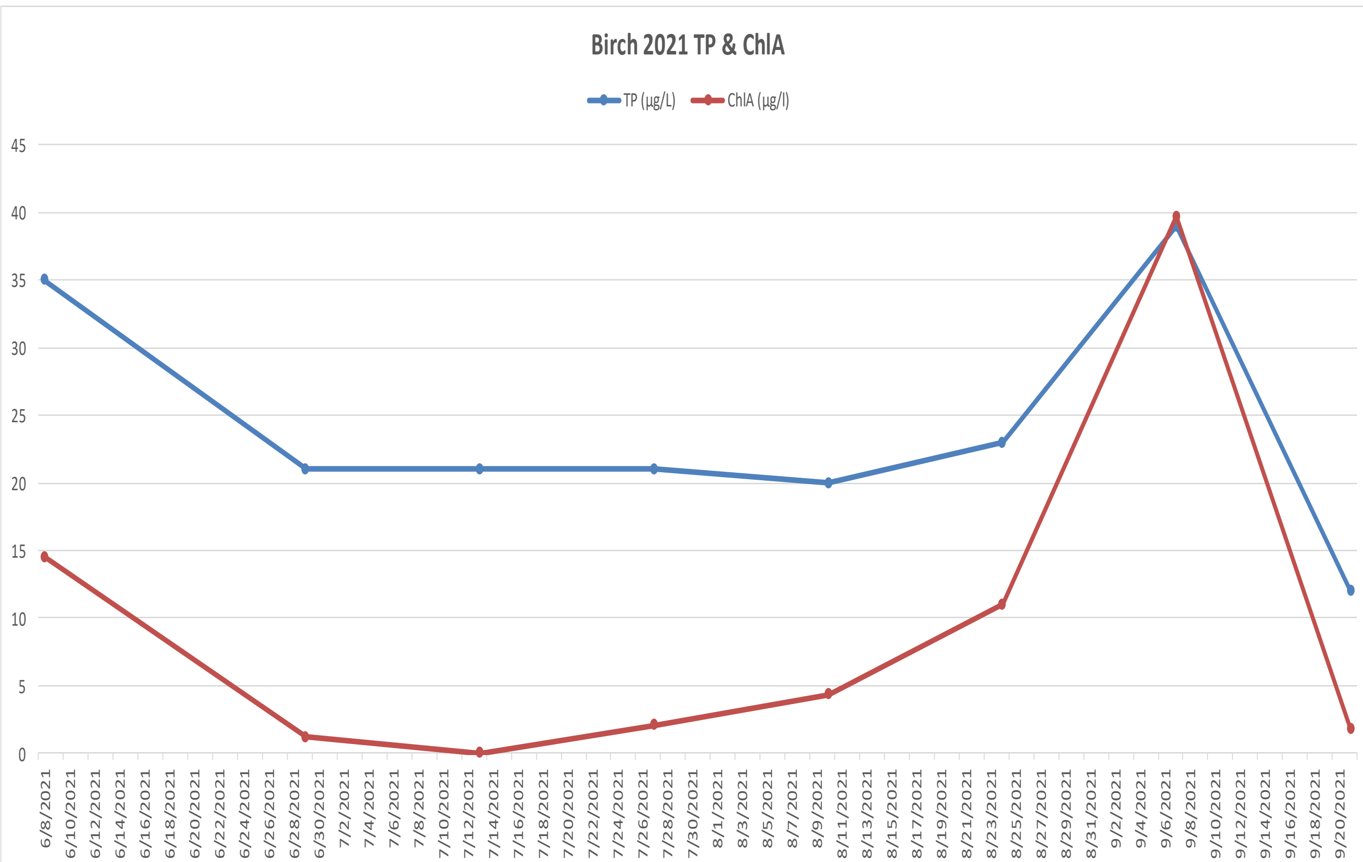
Birch Lake Historical Avg TP/Chl A/SDT			
Year	TP (µg/L)	Chl A (mg/m³)	Secchi (m)
1997	22	14	2.4
1998	41	4	2.4
1999	31	8	2.4
2000	27	14	2.4
2001	42	8	2.4
2002	31	10	2.4
2003	35	13	2.4
2004	31	0	2.4
2005	31	4	2.4
2006	32	3	2.4
2007	41	5	2.4
2008	34	5	1.2
2009	40	8	1.1
2010	31	5	1
2011	29	3	2
2012	30	3	2
2013	30	3	2
2014	26	3	1.7
2015	21	1	1.7
2016	14	7	1.8
2017	28	8	1.8
2018	25	5	1.8
2019	18	3	2
2020	18	3	2
2021	23	9	2

Date	Reading Depth (Bottom/Top)	Temp °C	Conductiv-ity cm)	DO (mg/L)	pH
5/25/2021	b	23.75	0.492	6.49	7.63
5/25/2021	t	23.77	0.491	6.33	7.65
6/29/2021	b	24.97	0.548	4.16	7.61
6/29/2021	t	25.03	0.548	4.21	7.65
7/27/2021	b	26.75	0.556	4.61	7.79
7/27/2021	t	26.94	0.556	4.64	7.8
9/21/2021	b	19.18	0.549	5.65	7.53
9/21/2021	t	19.45	0.548	4.69	7.56



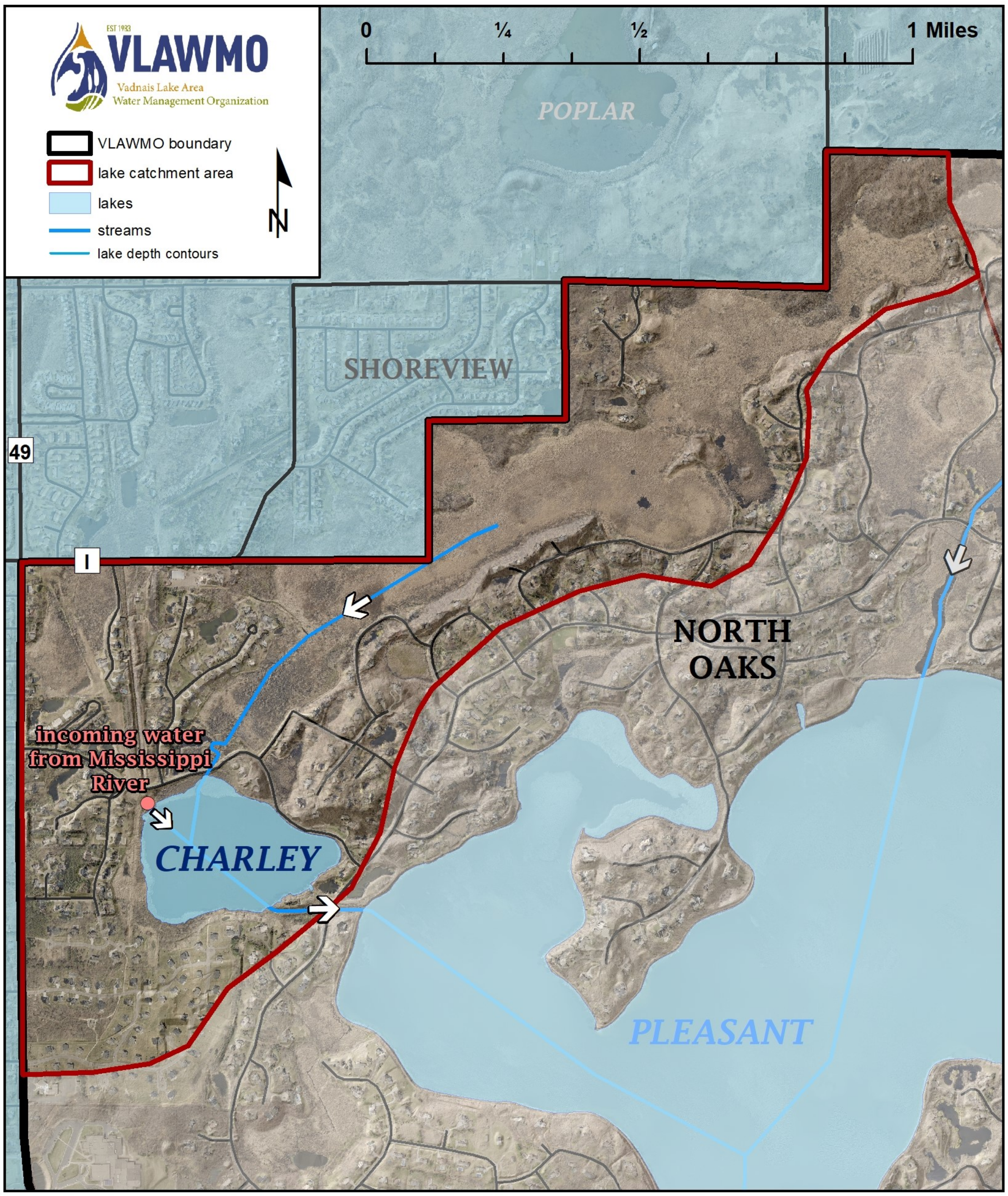
BIRCH LAKE

SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/l)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
birch	4/6/2021								115
birch	5/4/2021	6	21	0.005	5.93	0.61	0.03	<0.03	
birch	5/25/2021	6	16	0.006	1.48				
birch	6/8/2021	6	35	0.005	14.5	1.05	0.04	<0.03	
birch	6/29/2021	5	21	<0.003	1.19				
birch	7/13/2021	5	21	<0.003	<1.25	0.91	0.03	<0.03	
birch	7/27/2021	5	21	<0.003	2.08				
birch	8/10/2021	6	20	<0.003	4.34		0.03	<0.03	
birch	8/24/2021	5	23	<0.003	11				
birch	9/7/2021	6	39	<0.003	39.7	1.12	0.04	<0.03	
birch	9/21/2021	5	12	<0.003	1.78				



CHARLEY LAKE

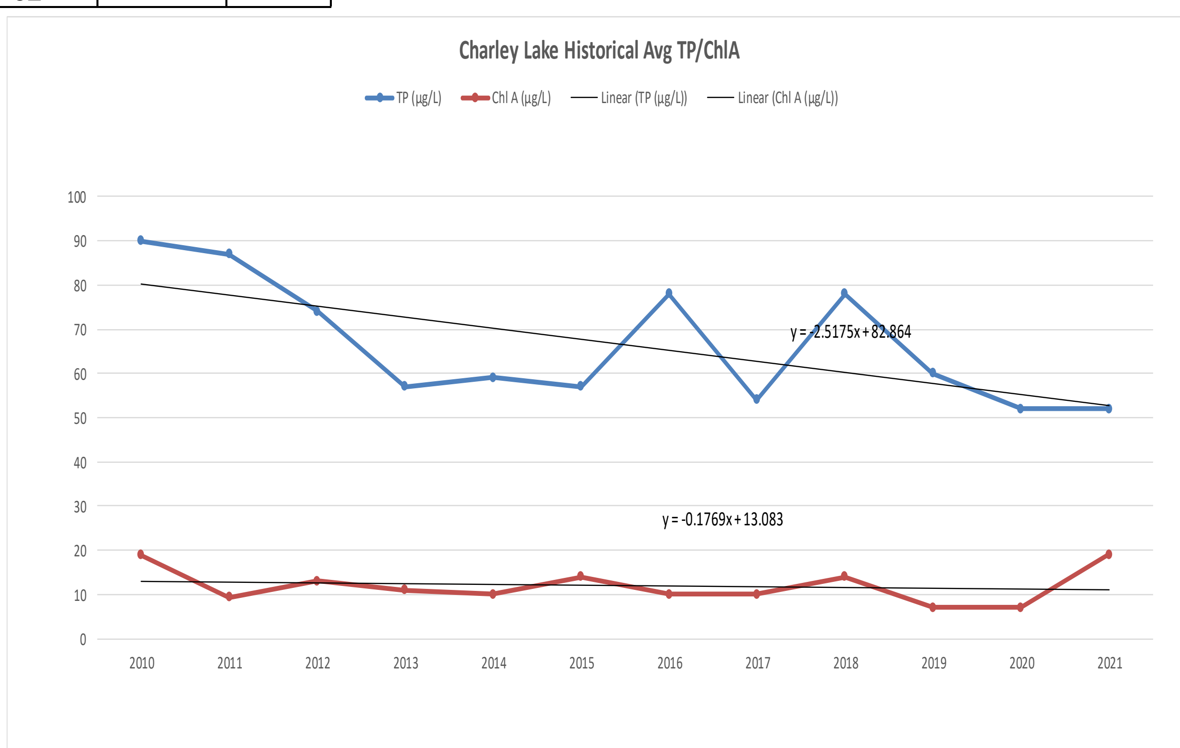
Water is pumped from the Mississippi River to Charley Lake via a 60 inch 8 mile long pipe from a pumping station in Fridley. An average of 32 million gallons of water is pumped into Charley Lake each day. Charley Lake is the start of the chain of lakes controlled by the St. Paul Water Utility. This chain of lakes supplies drinking water for more than 400,000 customers. Most of the drinking water is coming from the Mississippi River, while some comes from wells to help cool the water and reduce treatment costs. VLAWMO began sampling Charley in 2009.



CHARLEY LAKE

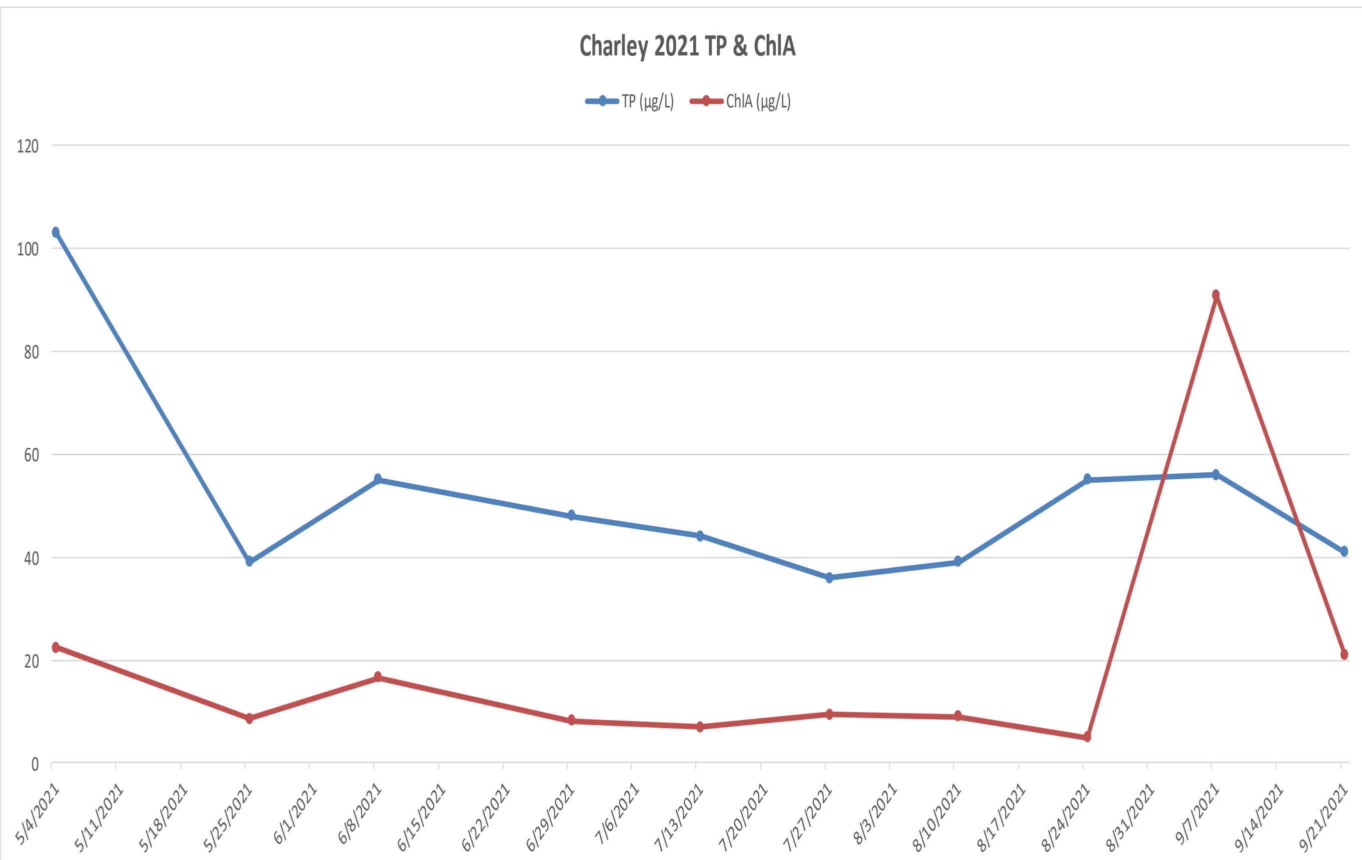
Charley Lake Historical Avg TP/Chl A/ SDT			
Year	TP (µg/L)	Chl A (µg/ L)	Secchi (m)
2009	39	18	1
2010	90	18.9	1
2011	87	9.3	1.1
2012	74	13	1
2013	57	11	1
2014	59	10	1.1
2015	57	14	1.1
2016	78	10	1.2
2017	54	10	1.2
2018	78	14	1.5
2019	60	7	1.6
2020	52	7	1.3
2021	52	19	1.4

Date	Reading Depth (Bottom/ Top)	Temp °C	Conduc-tivity (mS/ cm)	DO (mg/L)	pH
5/25/2021	b	22.85	0.383	6.4	7.31
5/25/2021	t	23.04	0.387	6.21	7.39



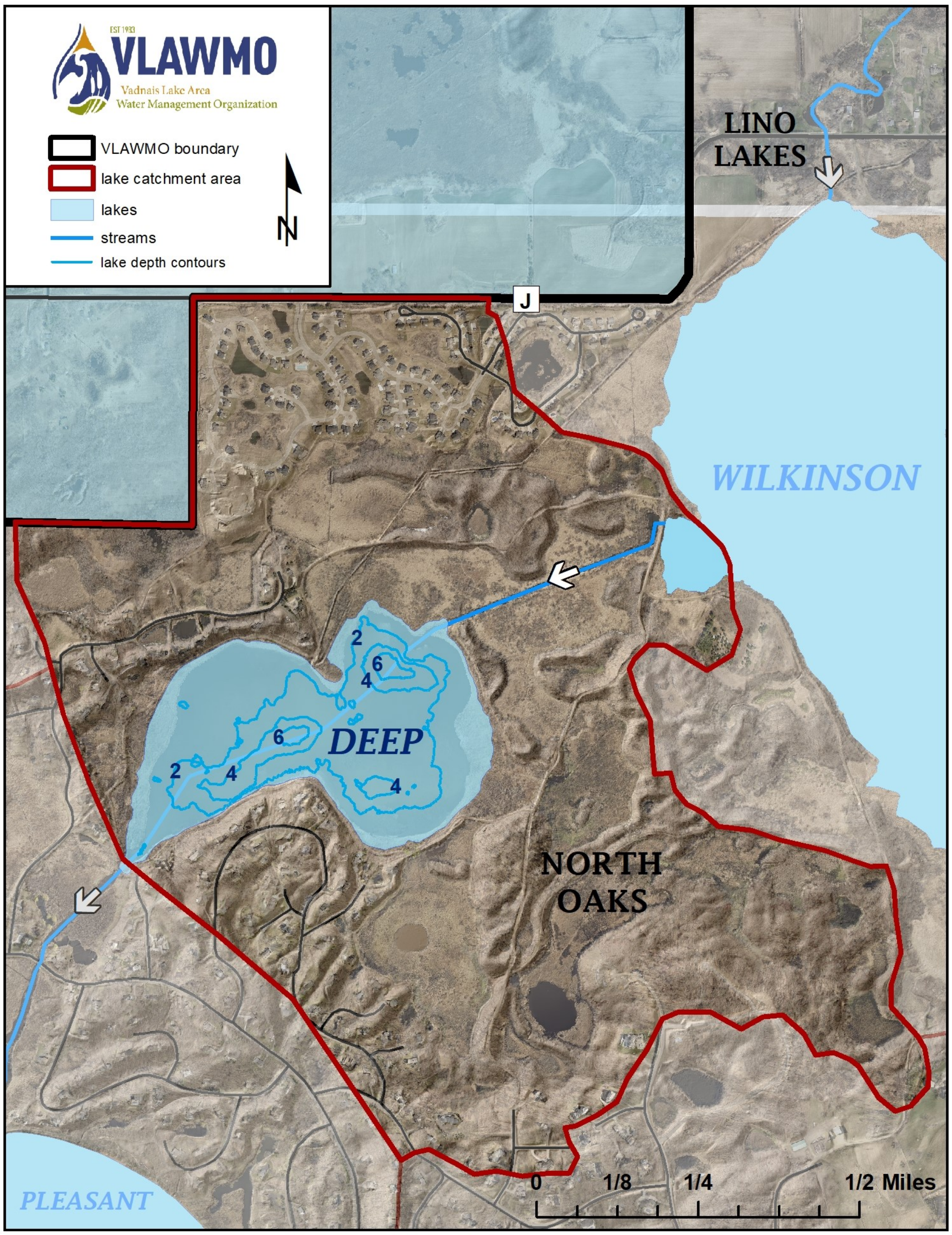
CHARLEY LAKE

SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/L)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
charley	4/6/2021								20
charley	5/4/2021	6	103	0.012	22.4	0.63	0.05	0.19	
charley	5/25/2021	4	39	0.01	8.54				
charley	6/8/2021	4.5	55	0.013 [2]	16.6	1.03	0.09	0.38	
charley	6/29/2021	6	48	0.009	8.17	-			
charley	7/13/2021	6.5	44	0.01	7.01	0.51	0.03	0.21	
charley	7/27/2021	4.5	36	<0.003	9.42				
charley	8/10/2021	6	39	0.007	9.01		0.09	0.27	
charley	8/24/2021	6	55	0.021 [1]	4.93				
charley	9/7/2021	6	56	0.004	90.8	0.94	<0.02	<0.03	
charley	9/21/2021	4	41	0.005 [1]	20.9				



DEEP LAKE

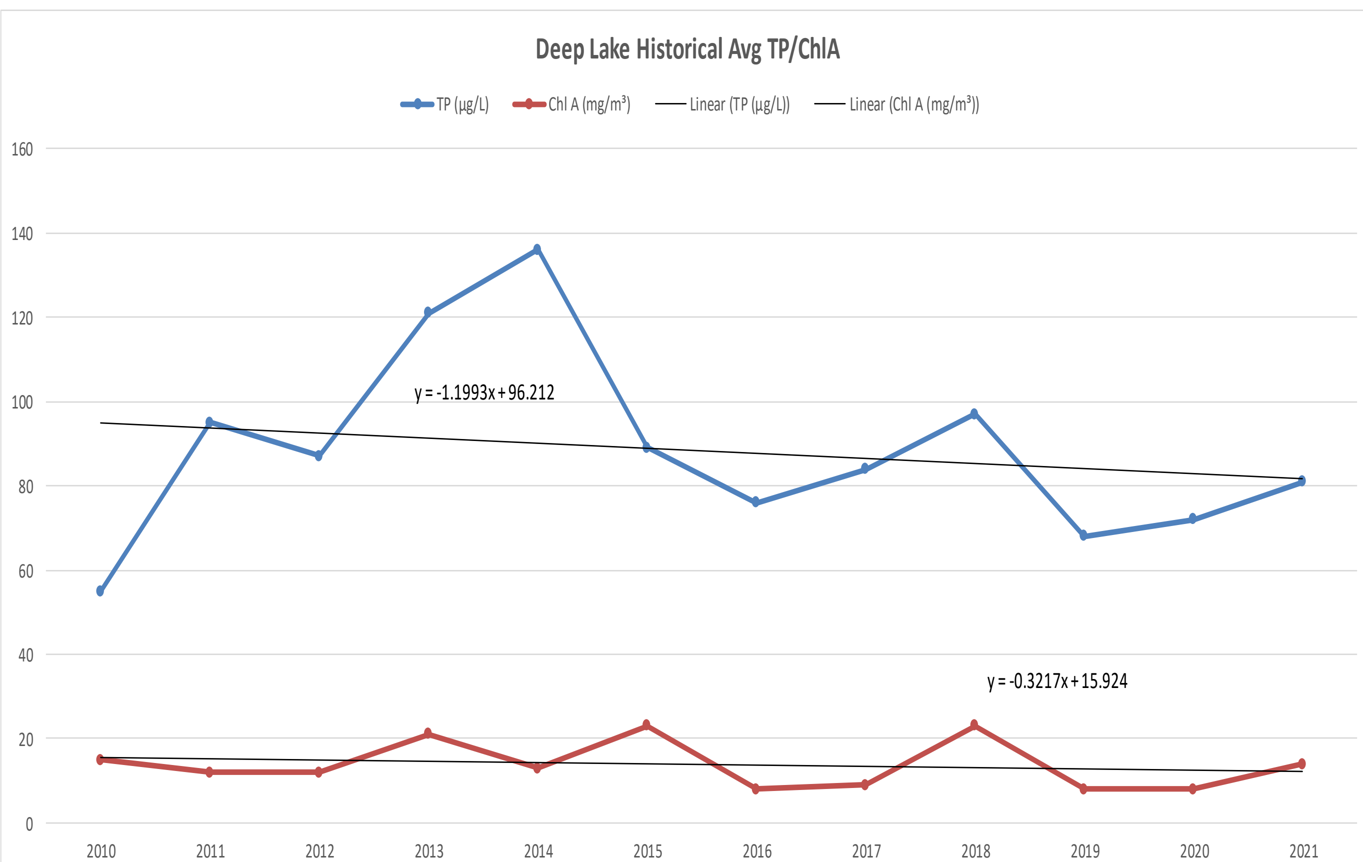
Deep lake is a little over 80 acres and sits between and is hydro logically connected to Wilkinson Lake to the north and Pleasant Lake to the south. A channel connects the three lakes. All VLAWMO lakes are tested for nitrogen's and ammonia and Deep lake year over year tends to have the highest concentrations, although they are still below the standards. TP and ChlA have been trending slowly down since sampling began in 2009. By mid to late summer Deep Lake is very weedy and this has been a concern for residents along with the high nutrients coming from Wilkinson.



DEEP LAKE

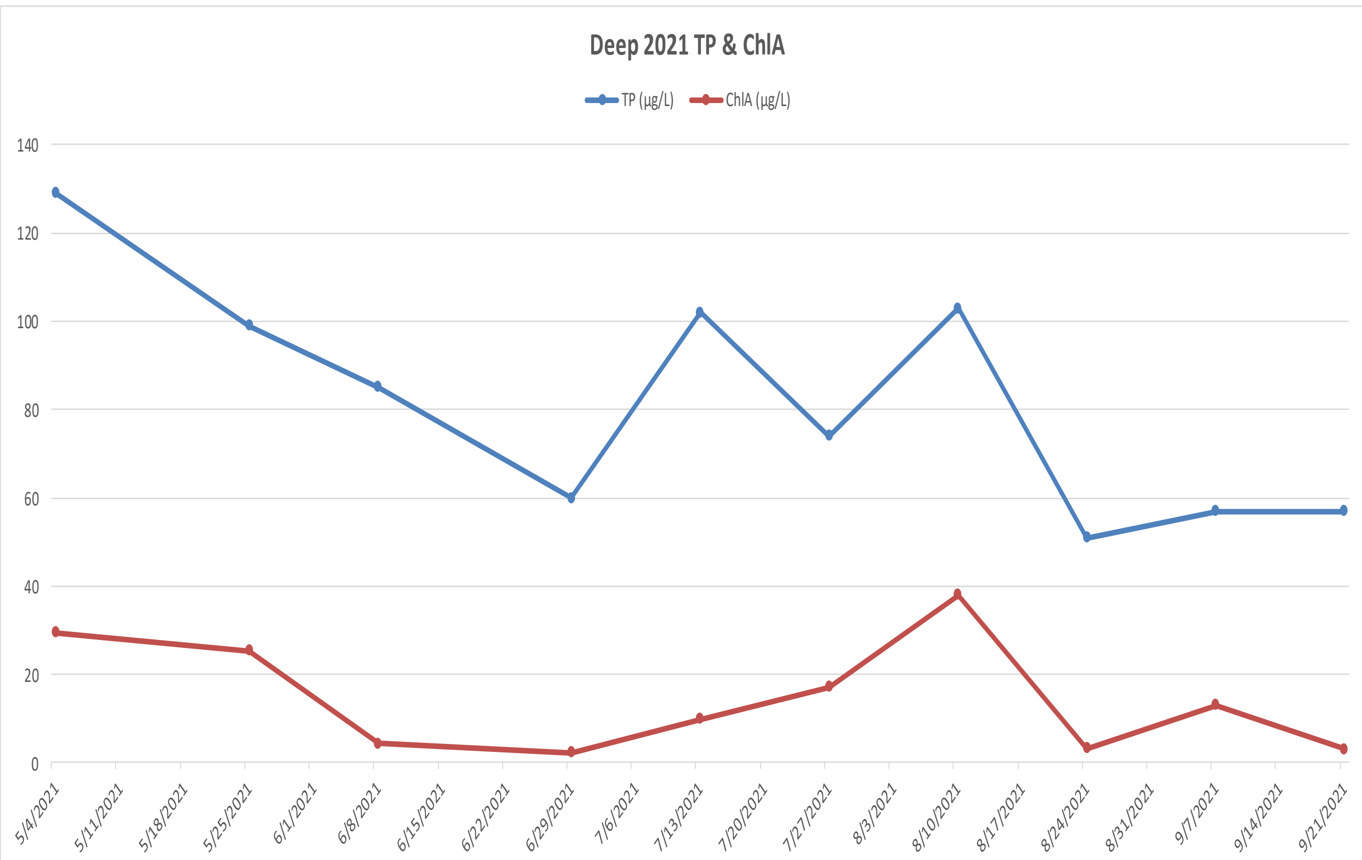
Deep Lake Historical Avg TP/Chl A/SDT			
Year	TP (µg/L)	Chl A (mg/m³)	Secchi (m)
2009	112	21	1
2010	55	15	0.9
2011	95	12	1.2
2012	87	12	1
2013	121	21	1
2014	136	13	1.1
2015	89	23	1
2016	76	8	1.1
2017	84	9	1.1
2018	97	23	1.3
2019	68	8	1.4
2020	72	8	1.4
2021	81	14	1.2

Date	Reading Depth (Bottom/ Top)	Temp °C	Conduc-tivity (mS/cm)	DO (mg/L)	pH
5/25/2021	b	24.48	0.472	4.33	7.44
5/25/2021	t	24.97	0.47	5.12	7.43
6/29/2021	b	24.21	0.351	0.91	7.47
6/29/2021	t	24.31	0.348	1.24	7.48
7/27/2021	b	28.14	0.334	4.51	7.57
7/27/2021	t	28.62	0.333	4.69	7.58
9/21/2021	b	16.73	0.414	1.6	7.23
9/21/2021	t	18.62	0.407	3.88	7.28



DEEP LAKE

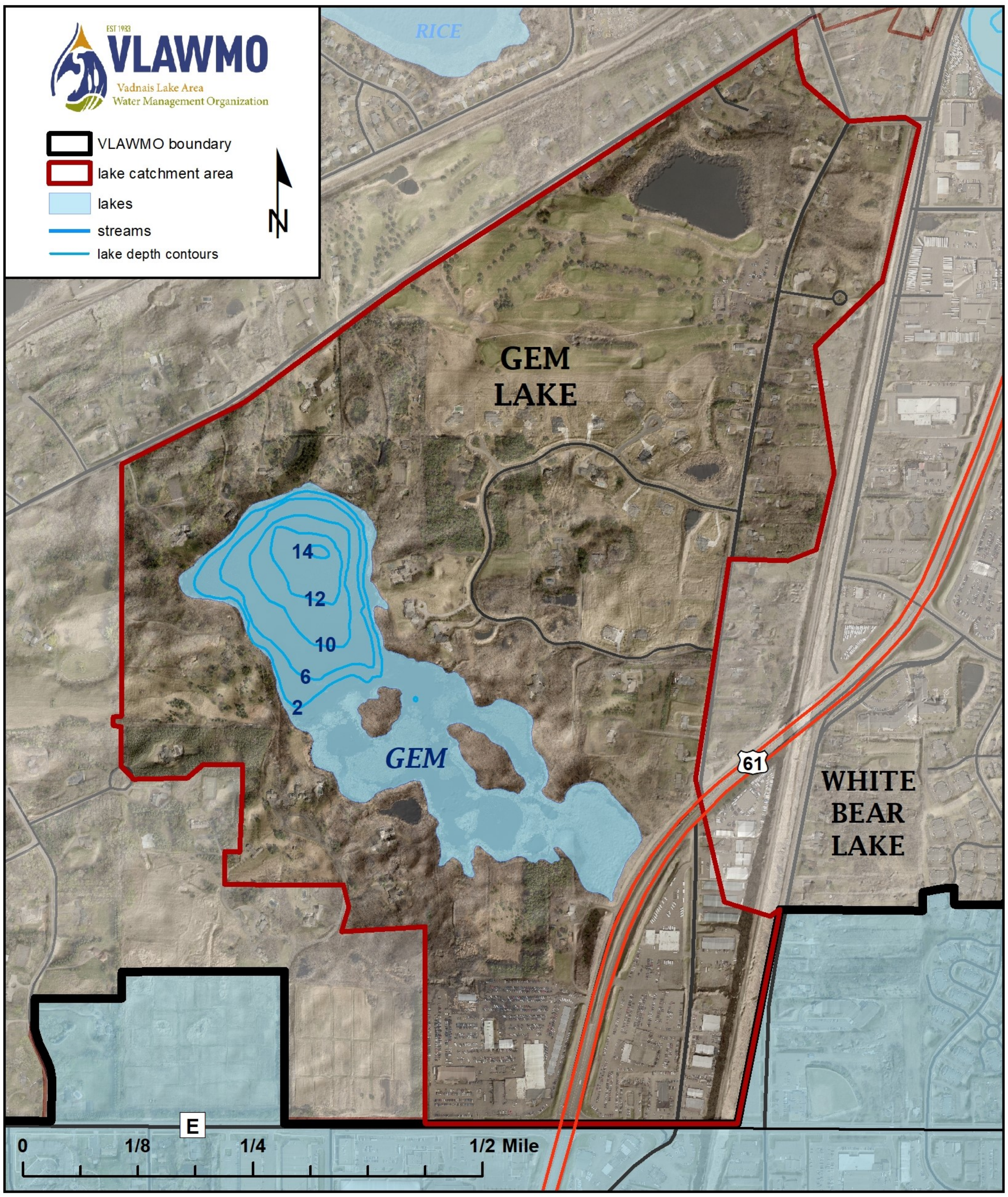
SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/L)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
deep	4/6/2021								60
deep	5/4/2021	6	129	0.008	29.4	1.22	0.04	<0.03	
deep	5/25/2021	3	99	0.009	25.4				
deep	6/8/2021	4	85	0.032 [2]	4.27	1.33	0.14	<0.03	
deep	6/29/2021	4.5	60	0.031	2.2				
deep	7/13/2021	4	102	0.031	9.92	1.12	0.03	<0.03	
deep	7/27/2021	2.5	74	0.003	17.1				
deep	8/10/2021	4	103	0.045	37.9		0.12	<0.03	
deep	8/24/2021	4.5	51	0.021 [1]	3.14				
deep	9/7/2021	4.5	57	0.017	13	0.88	0.04	<0.03	
deep	9/21/2021	5	57	0.019 [1]	3				



GEM LAKE

Gem Lake is within the City of Gem Lake and has no public access. It is 25 acres in size and is 17 feet deep. There has been development along portions of the lake in recent years. In 2000, volunteers noticed a distinct algae bloom and noted that water clarity was getting poorer. Over the 22 years of monitoring data there is a down trend in TP and ChlA levels.

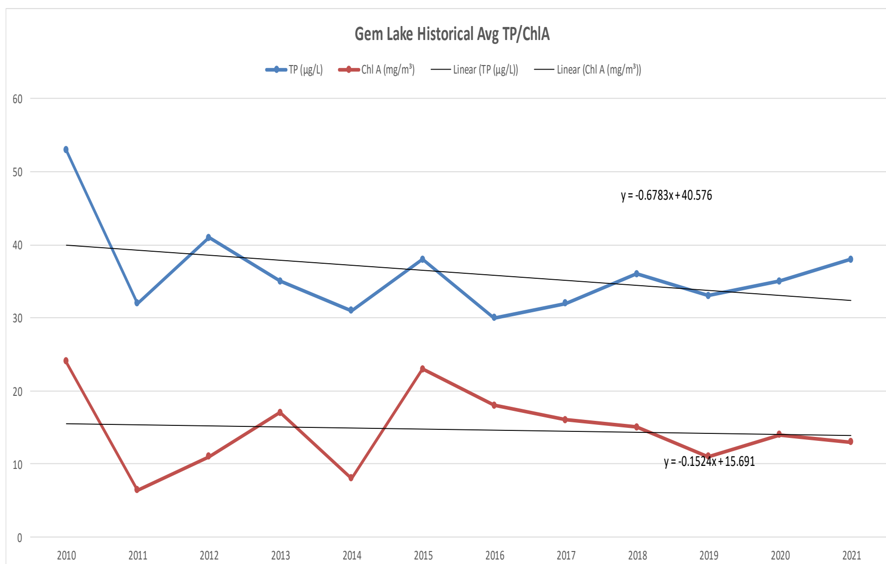
Gem Lake has also been included on the Lambert Creek TMDL study for nutrient impairment. Recent years of monitoring data have shown a reduction in nutrient levels to below state standards. MNDOT's Hwy 61 ditch work in 2011 improved the water quality going into Gem Lake. In 2018 Gem Lake was delisted from the MN PCA's impaired waters list.



GEM LAKE

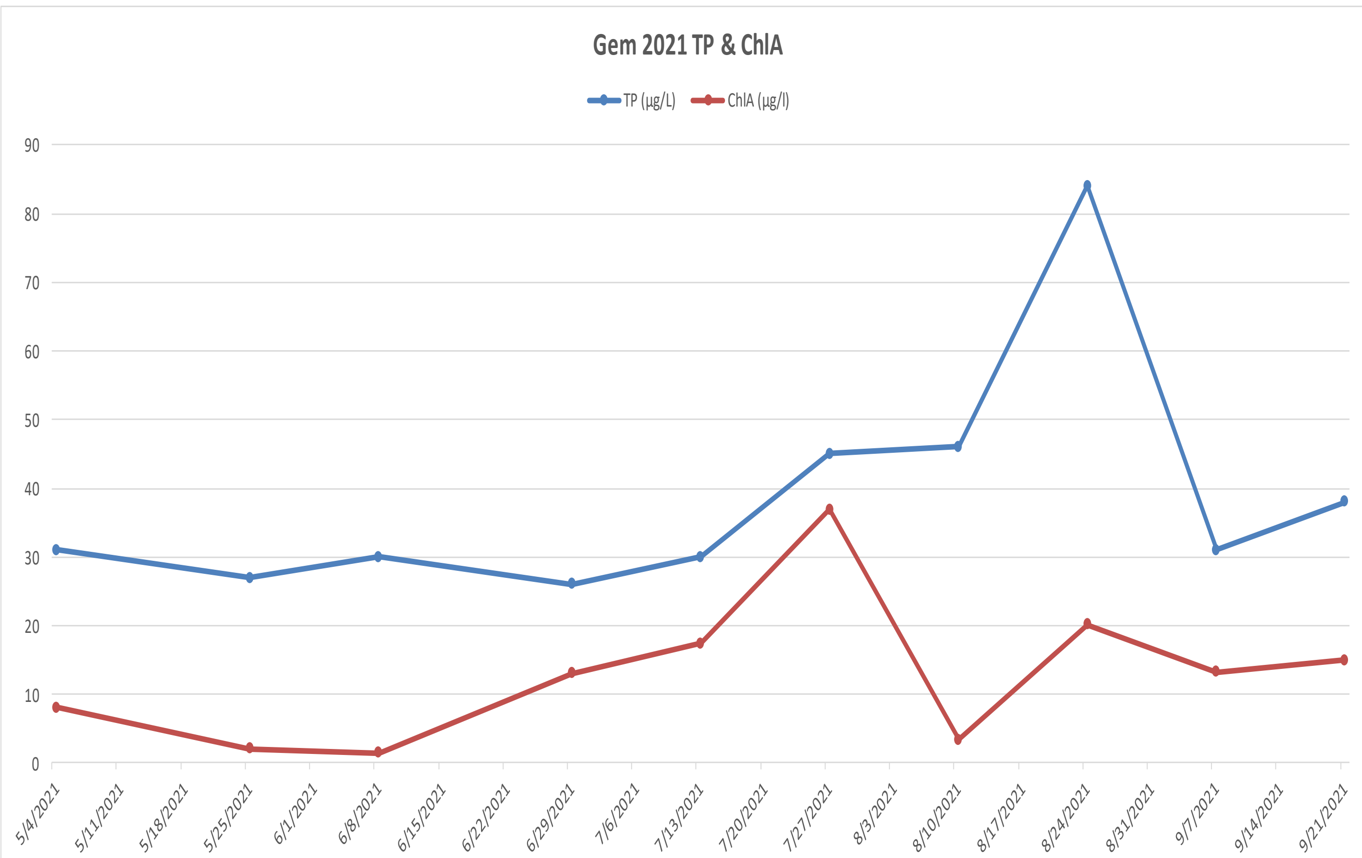
Gem Lake Historical Avg TP/Chl A/SDT			
Year	TP (µg/L)	Chl A (mg/m³)	Secchi (m)
1997	54	23	1.2
1998	33	24	
1999	26	16	1.2
2000	36	17	1.1
2001	56	12	1.8
2002	39	25	1.3
2003	52	20	1.4
2004	49	0	1.5
2005	43	26	0
2006	63	25	0
2007	48	33	1.1
2008	64	17	1.5
2009	89	28	1.3
2010	53	24	1.4
2011	32	6.4	2.1
2012	41	11	2
2013	35	17	2
2014	31	8	2.9
2015	38	23	2.2
2016	30	18	1.6
2017	32	16	1.5
2018	36	15	1.8
2019	33	11	1.8
2020	35	14	2.4
2021	38	13	2.4

Date	Reading Depth (Bottom/ Middle/ Top)	Temp °C	Conduc-tivity (mS/cm)	DO (mg/L)	pH
5/25/2021	b	15.65	0.207	7.07	7.36
5/25/2021	m	22.94	0.209	5.44	7.33
5/25/2021	t	23.04	0.209	5.98	7.37
6/29/2021	b	18.33	0.223	0.29	7.43
6/29/2021	m	22.87	0.217	6.41	7.45
6/29/2021	t	25.12	0.219	6.15	7.5
7/27/2021	b	24.03	0.223	0.25	7.71
7/27/2021	t	27.25	0.231	5.67	7.78
9/21/2021	b	20.27	0.223	4.31	7.66
9/21/2021	m	20.35	0.223	4.37	7.67
9/21/2021	t	20.55	0.223	4.12	7.67



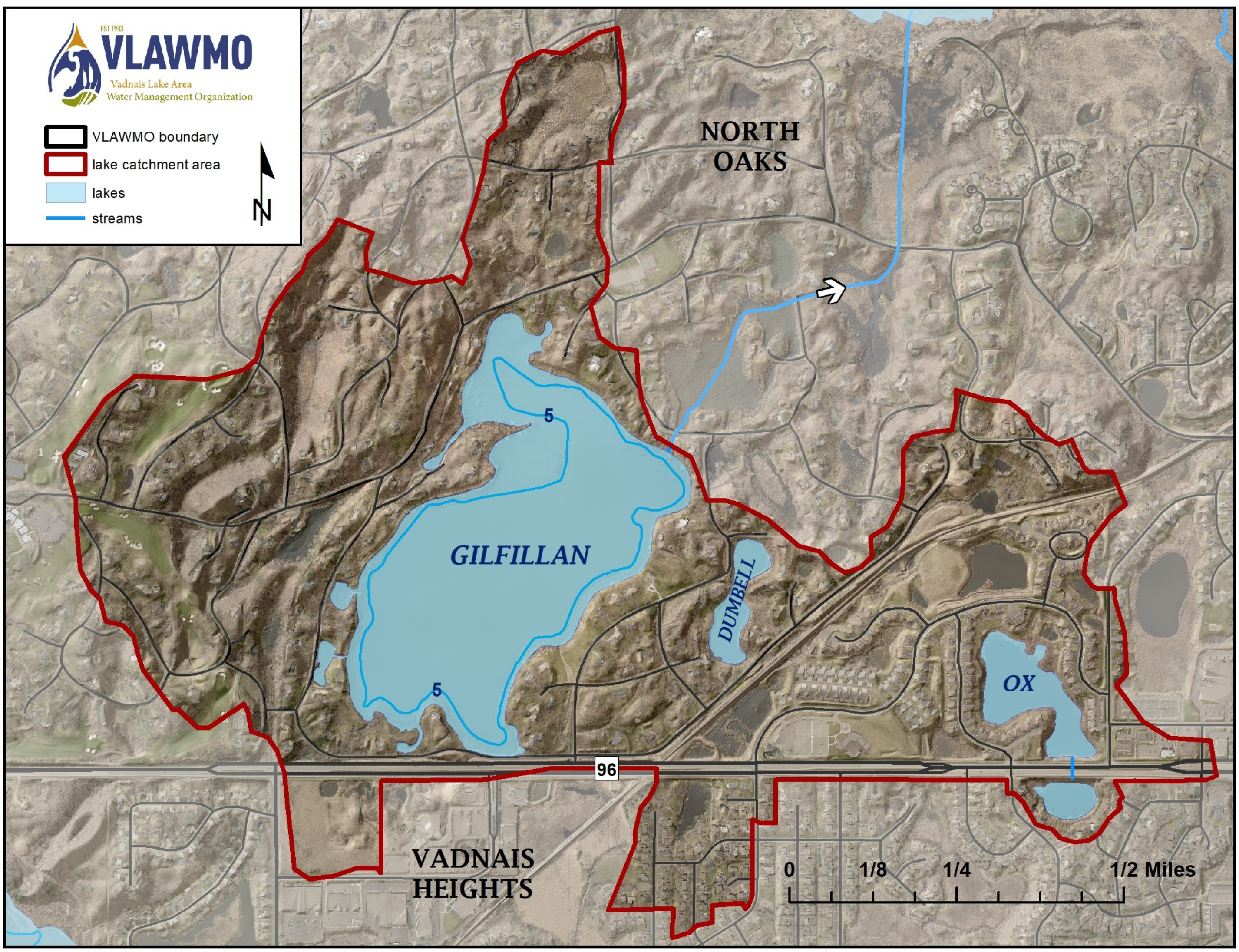
GEM LAKE

SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/l)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
gem	4/6/2021								45
gem	5/4/2021	10	31	0.019	8.01	0.54	0.02	<0.03	
gem	5/25/2021	8	27	0.005	2.08				
gem	6/8/2021	10	30	0.005 [2]	1.48	0.54	0.03	<0.03	
gem	6/29/2021	7	26	<0.003	13				
gem	7/13/2021	6	30	<0.003	17.4	0.74	<0.02	<0.03	
gem	7/27/2021	4	45	<0.003	36.9				
gem	8/10/2021	7	46	0.003	3.34		0.27	<0.03	
gem	8/24/2021	8	84	<0.003 [1]	20.1				
gem	9/7/2021	8	31	<0.003	13.2	0.6	0.1	<0.03	
gem	9/21/2021	6	38	<0.003 [1]	15				



Gilfillan Lake

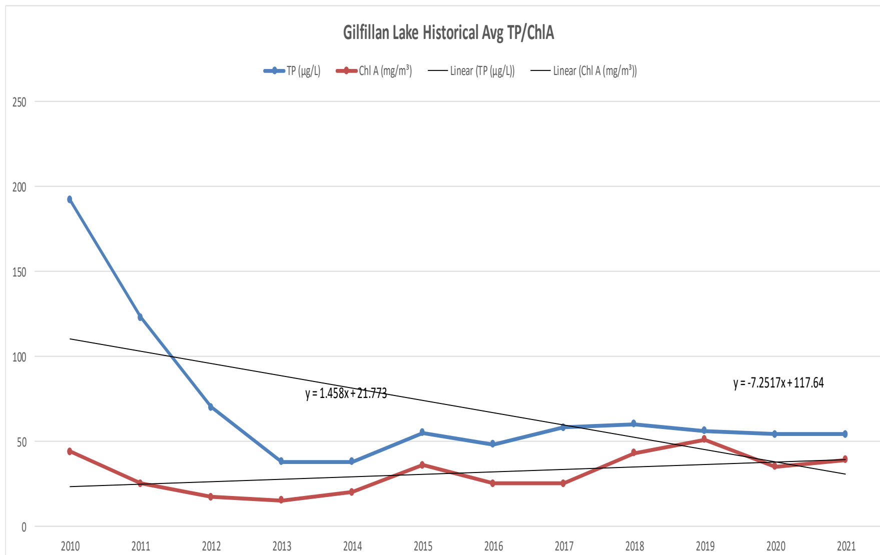
Gilfillan Lake is located within the City of North Oaks and is surrounded by homes. It is 110 acres with a maximum depth of 6 feet. The Minnesota Department of Natural Resources has used the lake for walleye stocking nursery in the past. According to available information, there has not been any fish stocking activity for a few years other than homeowners socking minnows. Gilfillan is one of four VLAWMO lakes that are part of the TMDL study due to nutrient impairment. The City of North Oaks and the SPRWS have been pumping water from Pleasant Lake to Gilfillan Lake to increase water levels. The pump, filter and piping were installed fall of 2011, pumping began spring of 2012. The increased water level (about 4.5ft) has significantly reduced nutrient levels in the lake, although they are still above state standards. The pumps have been turned on in the spring the last few years to make sure everything was working properly and were then shut off for the season due to high water. Water level stayed close to the max elevation of 910ft for the summer.



Gilfillan Lake

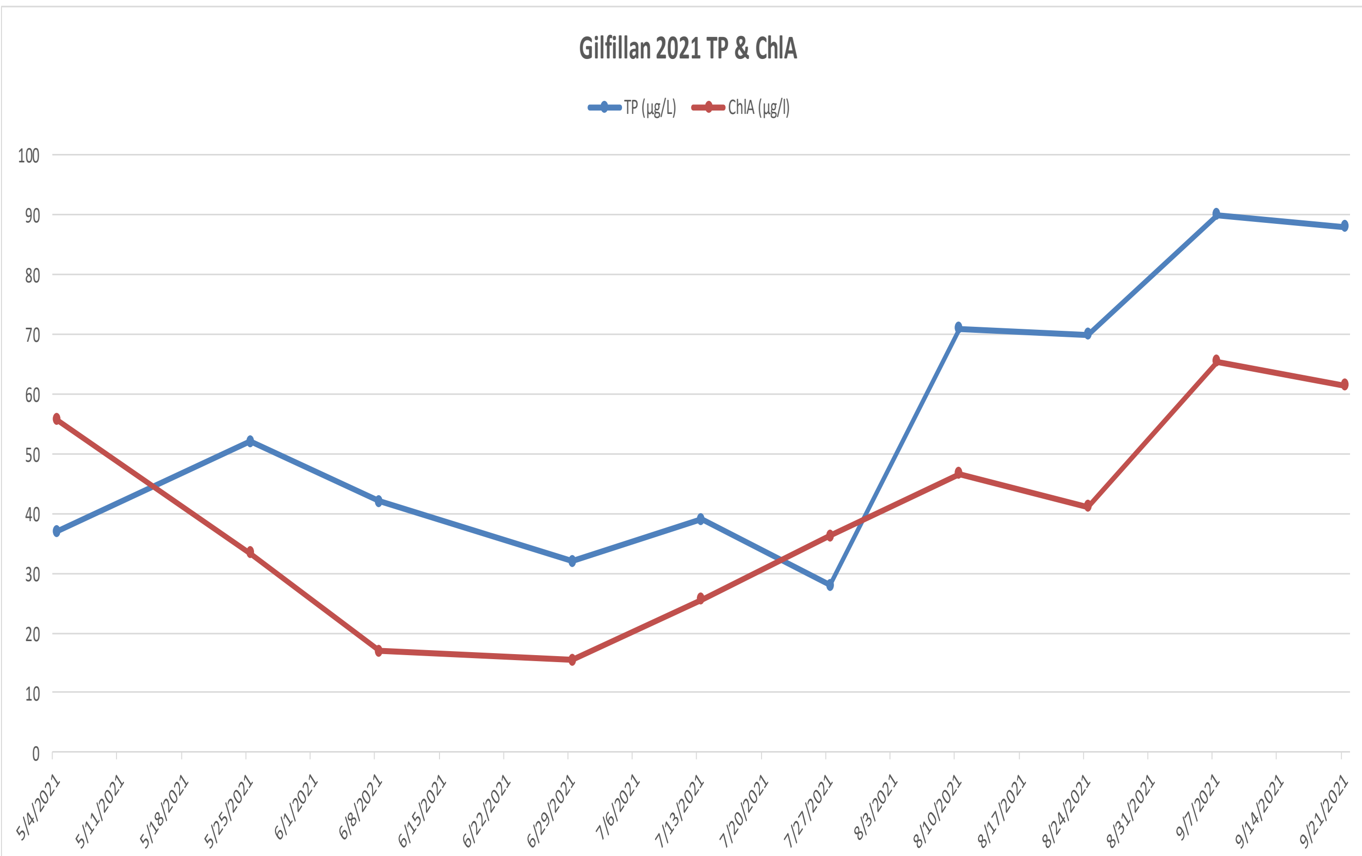
Gilfillan Lake Historical Avg TP/Chl A/SDT			
Year	TP (µg/L)	Chl A (mg/m³)	Secchi (m)
1997	96	32	0.5
1998	47	44	0.5
1999	72	23	0
2000	35	47	0
2001	84	20	0
2002	81	43	0.4
2003	44	25	1.4
2004	58	0	0
2005	52	8	0
2006	91	19	0
2007	100	33	0.7
2008	96	31	0.5
2009	152	44	0.4
2010	192	44	0.4
2011	123	25	0.4
2012	70	17	0.8
2013	38	15	1
2014	38	20	0.8
2015	55	36	0.6
2016	48	25	0.7
2017	58	25	0.7
2018	60	43	0.7
2019	56	51	0.6
2020	54	35	0.8
2021	54	39	0.9

Date	Reading Depth (Bottom/Top)	Temp °C	Conduc-tivity (mS/cm)	DO (mg/L)	pH
5/25/2021	b	19.48	0.323	5.63	7.34
5/25/2021	t	23.42	0.313	5.88	7.37
6/29/2021	b	24.7	0.338	2.59	7.51
6/29/2021	t	26.29	0.333	5.37	7.56
7/27/2021	b	26.32	0.344	4.1	7.38
7/27/2021	t	26.94	0.343	4.39	7.4
9/21/2021	b	20.11	0.338	5.66	7.25
9/21/2021	t	20.18	0.338	5.56	7.33



Gilfillan Lake

SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/l)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
gilfillan	4/6/2021								42
gilfillan	5/4/2021	4	37	0.007	55.7	1.76	0.02	<0.03	
gilfillan	5/25/2021	2.5	52	0.007	33.4				
gilfillan	6/8/2021	3	42	0.007 [2]	16.9	1.42	0.03	<0.03	
gilfillan	6/29/2021	4	32	0.004	15.5				
gilfillan	7/13/2021	3.5	39	<0.003	25.6	1.12	<0.02	<0.03	
gilfillan	7/27/2021	3	28	<0.003	36.3				
gilfillan	8/10/2021	4	71	0.007	46.7		<0.02	<0.03	
gilfillan	8/24/2021	3	70	0.007 [1]	41.2				
gilfillan	9/7/2021	4	90	0.005	65.4	1.62	<0.02	<0.03	
gilfillan	9/21/2021	2	88	0.007 [1]	61.4				



- Nitrogen and ammonia levels are below state standards for Gilfillan Lake

Goose Lake

Goose Lake is located in White Bear Lake and is 145 acres with a maximum depth of 6-8 feet. The land use is largely residential and industrial around the lake and Highway 61 cuts through the lake. The old White Bear Lake sewage treatment plant discharged to Goose Lake for almost 50 years. A sediment study conducted in 1989 found that there was PCB contamination as well as high levels of cadmium, lead, and zinc.

Though the lake is connected via culverts under the highway, VLAWMO began to assess the lake on each side of the highway to track any differences between the two water bodies. In years past, only the east side of the lake was monitored. In 2006, VLAWMO began to collect samples from the west side. Both East and West Goose Lake are included in the Lambert Creek TMDL for nutrient impairment.

Groundwater used to cool equipment at the Kohler Mix Company is discharging into the south end of West Goose Lake. This seems to be "flushing" the west side of the lake and could be a reason the west side of the lake has had better water quality compared to the east side over the years. The north end of West Goose discharges through a weir into Lambert Creek which flows into East Vadnais Lake, the drinking water reservoir for the SPRWS. Ground water pumping seems to have slowed from the Kohler Mix company and nutrient levels in West Goose are now similar to those in East Goose.

Approximately 16,000lbs of bullhead were removed out of both basins in 2013. The main source of nutrient issues in Goose Lake is from internal loading. Rough fish (bullhead, carp, sucker) suspend nutrients in the water column while foraging for food. We hope to see a decrease in nutrient levels over the next few years due to the rough fish removal. Spring of 2015 nets were be placed in the lake again to make sure the fish harvest was successful. BioBase surveys were done on both basins in 2014 to monitor the aquatic vegetation.

The 2017 fish survey showed the rough fish removal worked and bullhead numbers are still low and seem to be in check. A 2021 fish survey showed the rough fish population has increased and removal may be needed. Planning for possible projects in and around the Goose Lake subwatershed in the next few are ongoing.

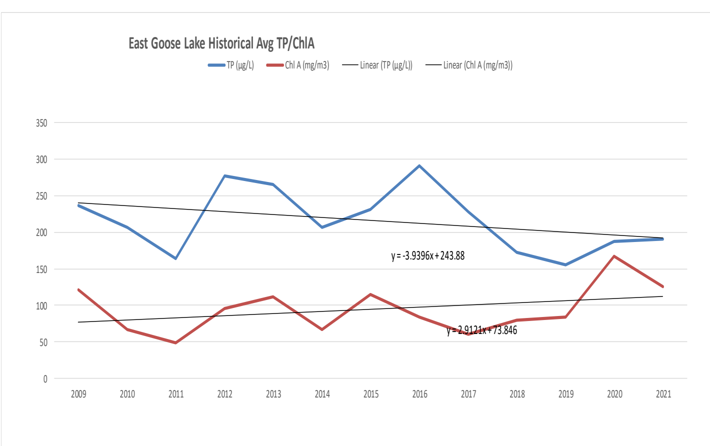
Goose Lake

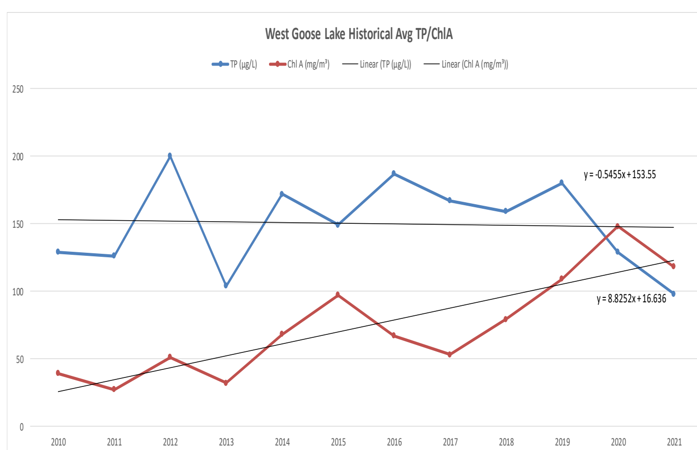

VLAWMO
Vadnais Lake Area Water Management Organization
VLAWMO boundary
lake catchment area
lakes
streams
lake depth contours
N
LAMBERT CREEK
62
WEST GOOSE
EAST GOOSE
WHITE BEAR
F
GEM LAKE
61
OAK KNOLL POND
65
WHITE BEAR LAKE
0
1/8
1/4
1/2 Miles

Goose Lake

East Goose Lake Historical Avg TP/Chl A/SDT			
Year	TP (µg/L)	Chl A (mg/m^3)	Secchi (m)
1997	21	134	0.4
1998	17	93	0.2
1999	475	56	0.3
2000	49	154	0.3
2001	603	28	0.3
2002	613	170	0.2
2003	342	66	0.3
2004	526	0	0
2005	407	38	0
2006	392	81	0
2007	260	97	0
2008	218	86	0.3
2009	237	121	0.3
2010	207	67	0.3
2011	164	48	0.3
2012	277	96	0.2
2013	265	112	0.5
2014	207	67	0.4
2015	231	115	0.6
2016	291	84	0.5
2017	228	60	0.7
2018	172	79	0.4
2019	155	84	0.4
2020	187	167	0.3
2021	191	125	0.3

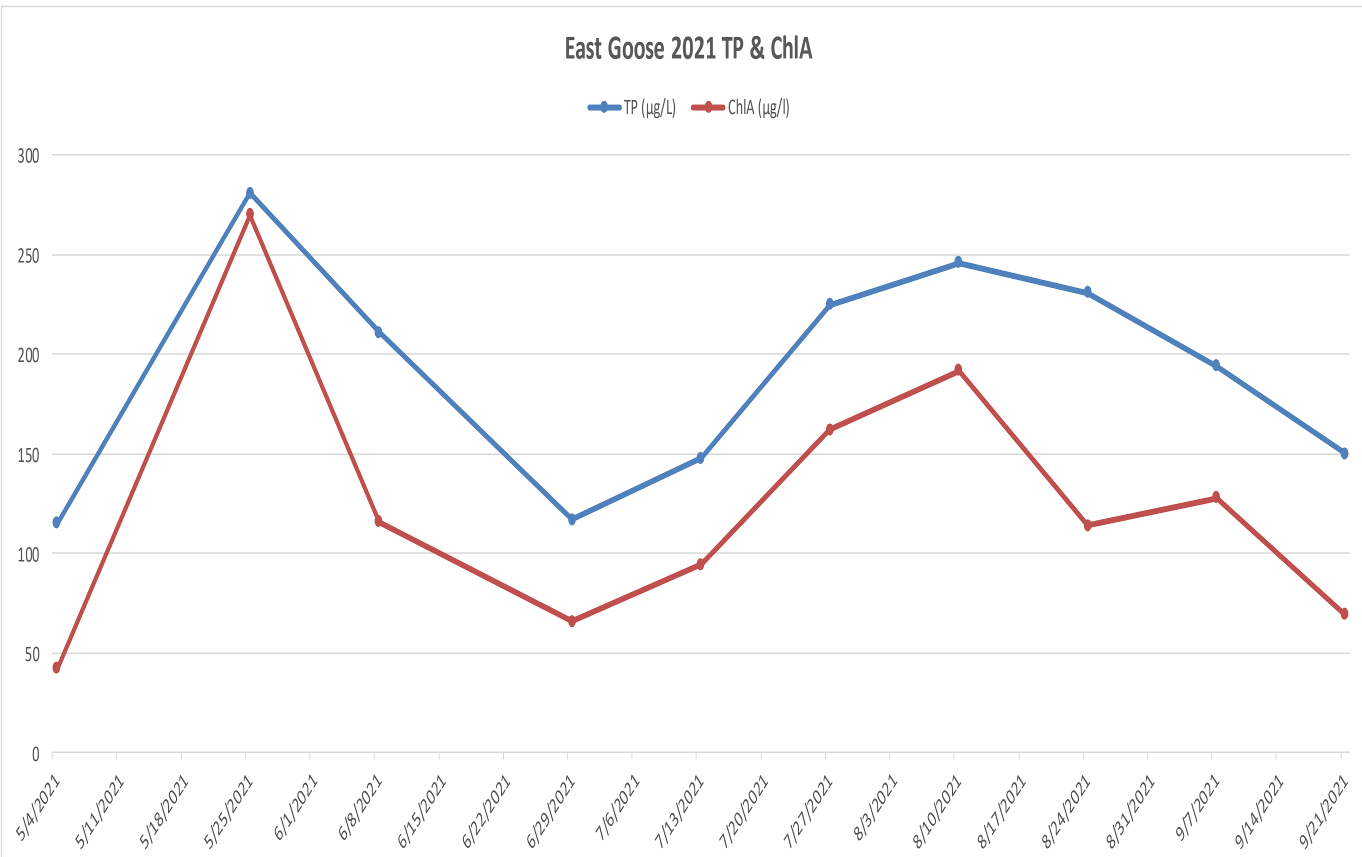
West Goose Lake Historical Avg TP/Chl A/SDT			
Year	TP (µg/L)	Chl A (mg/m^3)	Secchi (m)
2006	213	58	
2007	159	66	
2008	168	55	0.3
2009	134	40	0.5
2010	129	39	0.5
2011	126	27	0.8
2012	200	51	0.7
2013	104	32	1
2014	172	68	0.5
2015	149	97	0.5
2016	187	67	0.4
2017	167	53	0.4
2018	159	79	0.4
2019	180	109	0.3
2020	129	148	0.3
2021	98	118	0.3





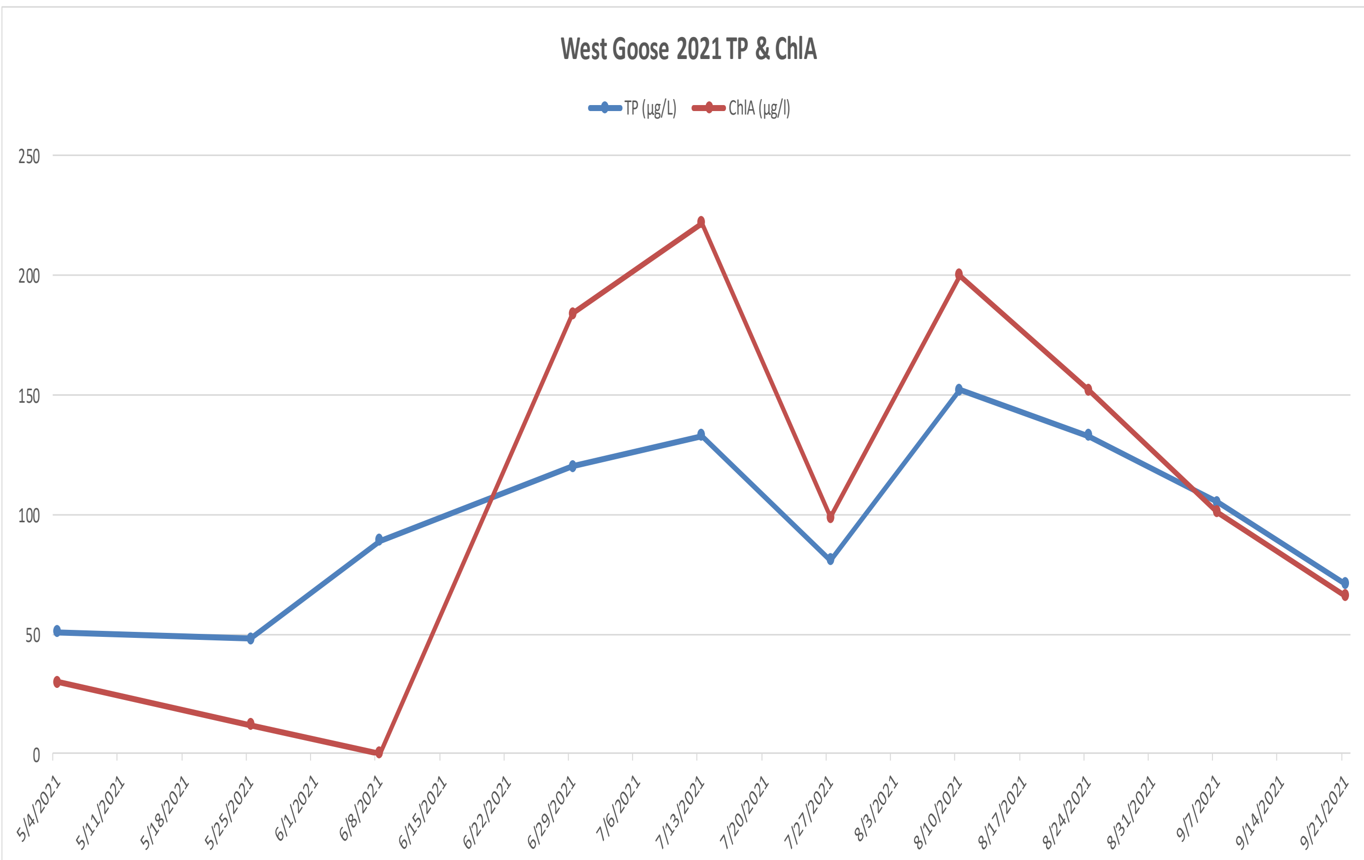
Goose Lake

SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/l)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
east goose	4/6/2021								109
east goose	5/4/2021	3	115	0.01	42.1	3.08	0.13	0.05	
east goose	5/25/2021	1.5	281	0.005	270				
east goose	6/8/2021	0.75	211	0.009 [2]	116	3.96	0.04	<0.03	
east goose	6/29/2021	1.25	117	0.017	65.9				
east goose	7/13/2021	1	148	0.007	94.3	2.99	<0.02	<0.03	
east goose	7/27/2021	0.75	225	0.007	162				
east goose	8/10/2021	0.5	246	0.004	192		0.02	0.03	
east goose	8/24/2021	0.5	231	<0.003 [1]	114				
east goose	9/7/2021	0.75	194	<0.003	128	2.63	<0.02	<0.03	
east goose	9/21/2021	1.25	150	0.004 [1]	69.4				



Goose Lake

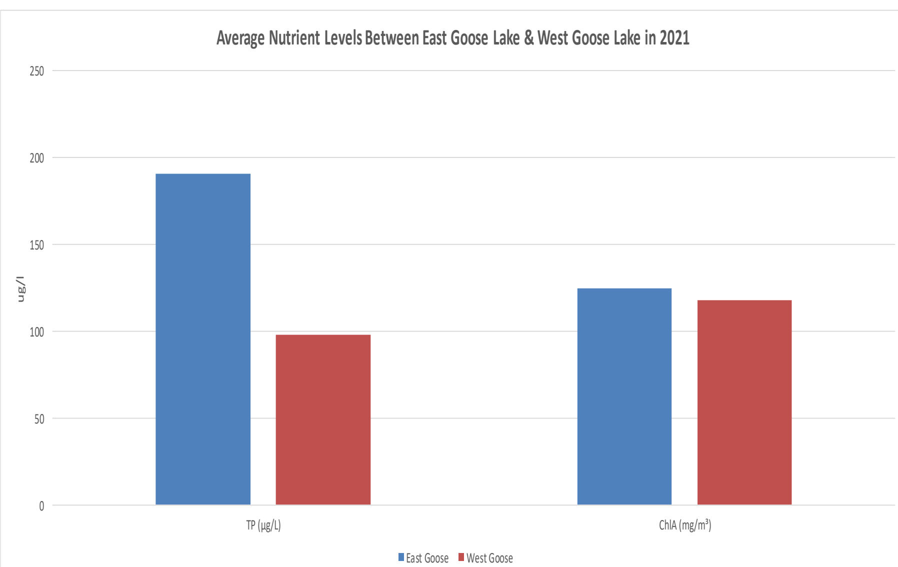
SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/l)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
east goose	4/6/2021								109
east goose	5/4/2021	3	115	0.01	42.1	3.08	0.13	0.05	
east goose	5/25/2021	1.5	281	0.005	270				
east goose	6/8/2021	0.75	211	0.009 [2]	116	3.96	0.04	<0.03	
east goose	6/29/2021	1.25	117	0.017	65.9				
east goose	7/13/2021	1	148	0.007	94.3	2.99	<0.02	<0.03	
east goose	7/27/2021	0.75	225	0.007	162				
east goose	8/10/2021	0.5	246	0.004	192		0.02	0.03	
east goose	8/24/2021	0.5	231	<0.003 [1]	114				
east goose	9/7/2021	0.75	194	<0.003	128	2.63	<0.02	<0.03	
east goose	9/21/2021	1.25	150	0.004 [1]	69.4				



Goose Lake

East Goose Date	Reading Depth (Bottom/ Top)	Temp °C	Conductivity (mS/cm)	DO (mg/L)	pH
5/25/2021	b	21.21	0.472	1.34	7.5
5/25/2021	t	23.08	0.461	7.94	7.6
6/29/2021	b	23.58	0.506	2.85	7.41
6/29/2021	t	24.74	0.451	5.58	7.54
7/27/2021	b	25.54	0.536	0.52	7.75
7/27/2021	t	26.38	0.471	3.03	7.77
9/21/2021	b	19.16	0.44	5.25	7.67
9/21/2021	t	19.4	0.439	5.03	7.69

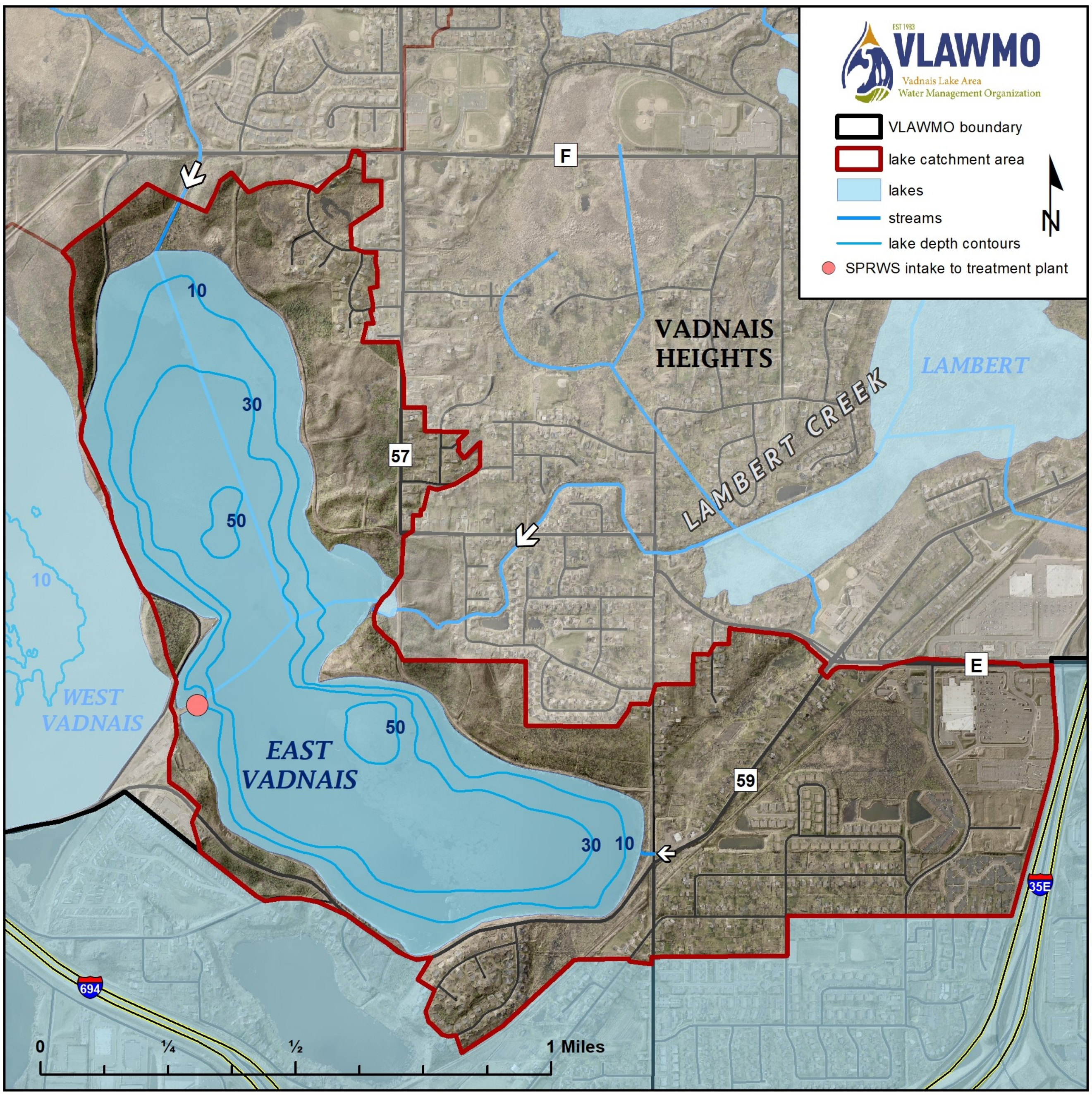
West Goose Date	Reading Depth (Bottom/ Top)	Temp °C	Con-ductivity (mS/ cm)	DO (mg/L)	pH
5/25/2021	b	23.14	0.343	5.81	7.48
5/25/2021	t	23.38	0.343	5.24	7.5
6/29/2021	b	24.41	0.371	5.01	7.52
6/29/2021	t	24.45	0.371	4.43	7.55
7/27/2021	b	26.73	0.359	5.21	7.85
7/27/2021	t	27.06	0.36	5.49	7.87
9/21/2021	b	19.35	0.343	5.46	7.68
9/21/2021	t	19.55	0.344	4.98	7.69



	TP (µg/L)	ChlA (mg/ m³)
East Goose	191	125
West Goose	98	118

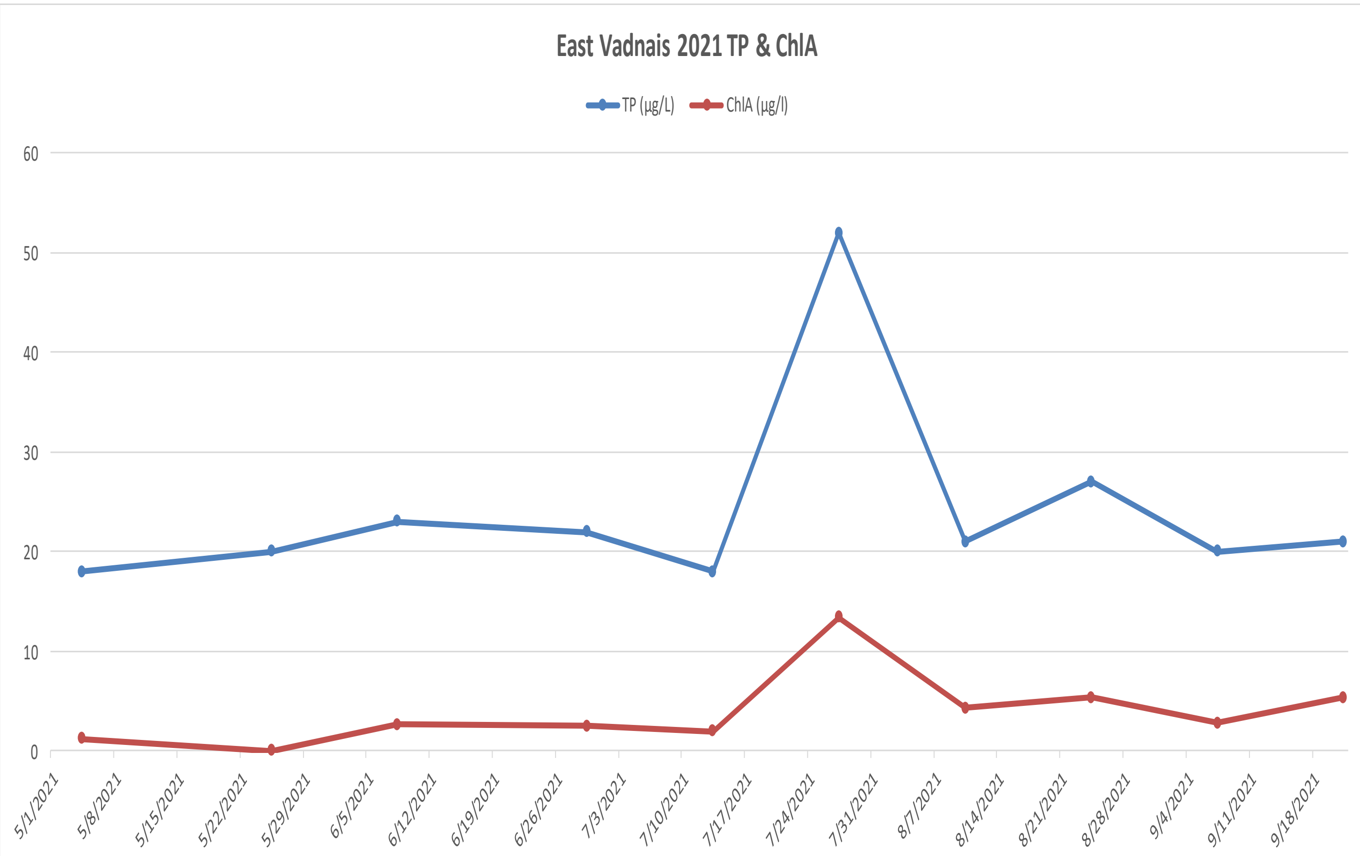
East Vadnais

East Vadnais Lake is the drinking water reservoir for the City of Saint Paul and several surrounding suburbs. It receives water from the Mississippi River via a chain of lakes (Charley, Pleasant, Sucker, Vadnais). It is managed and monitored by the Saint Paul Regional Water Services (SPRWS). Water exits the lake through an underground pipe to the water treatment plant in Roseville. From the treatment plant, water is distributed to over 446,000 residents and businesses. No recreational use is allowed on the lake except for shoreline fishing. An oxygenation/aeration system is used in the lake to help reduce TP levels. VLAWMO began sampling in 2020.



East Vadnais

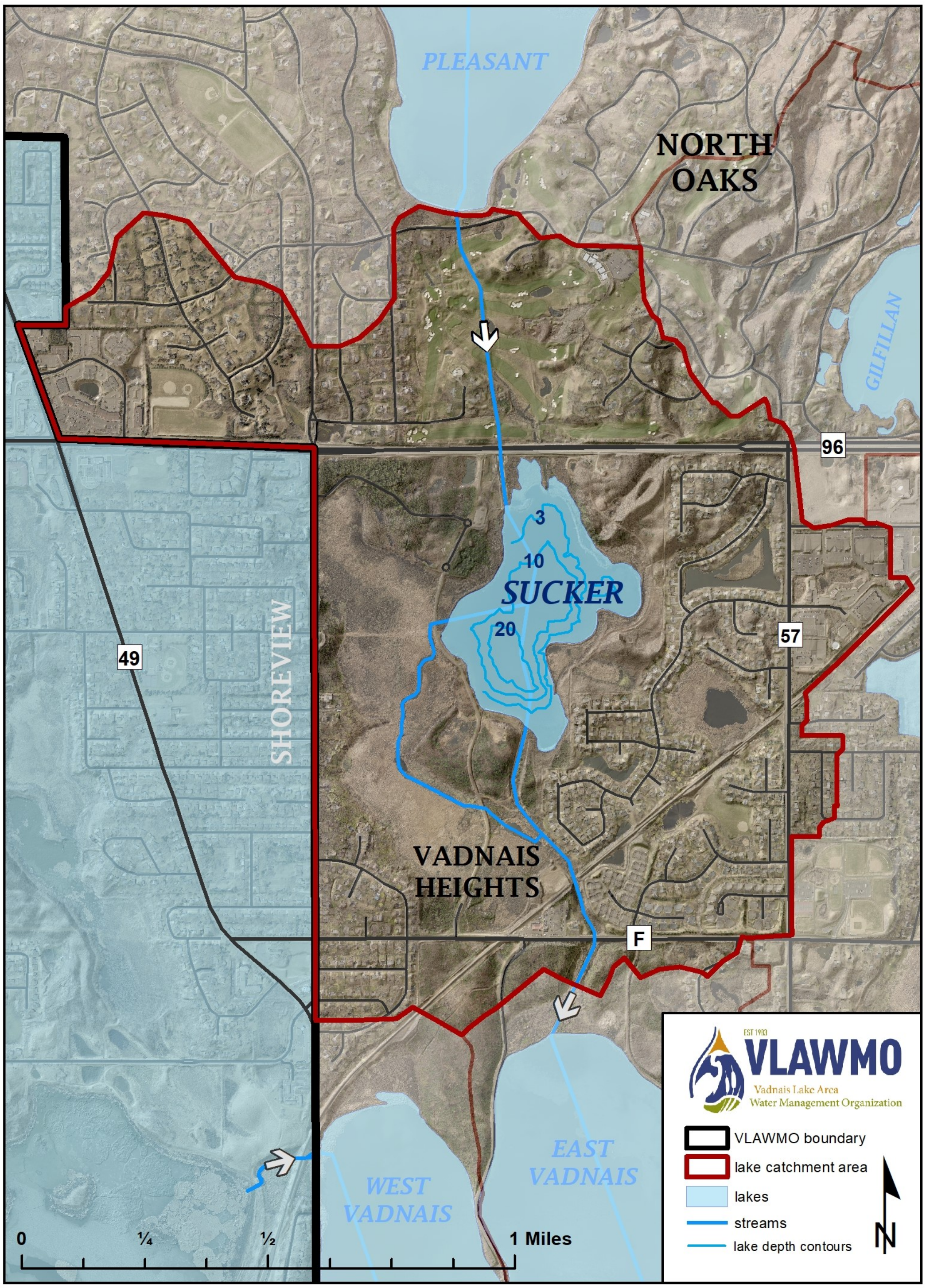
East Vadnais Lake Historical Avg TP/Chl A/SDT			
Year	TP (ug/L)	Chl A (mg/m3)	Secchi (m)
2020	25	3	
2021	24	4	2.7



SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/l)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
East Vadnais	4/6/2021								30
East Vadnais	5/4/2021		18	0.011	1.19	0.43	0.06	0.21	
East Vadnais	5/25/2021		20	0.01	<1.11				
East Vadnais	6/8/2021		23	0.008 [2]	2.67	0.51	0.05	<0.03	
East Vadnais	6/29/2021	10	22	0.004	2.51				
East Vadnais	7/13/2021	9	18	<0.003	2	0.57	<0.02	<0.03	
East Vadnais	7/27/2021	5	52	<0.003	13.4				
East Vadnais	8/10/2021		21	0.005	4.34		0.05	<0.03	
East Vadnais	8/24/2021	11	27	0.006 [1]	5.34				
East Vadnais	9/7/2021		20	0.004	2.83	0.71	0.04	0.04	
East Vadnais	9/21/2021		21	0.005 [1]	5.34				

Sucker Lake

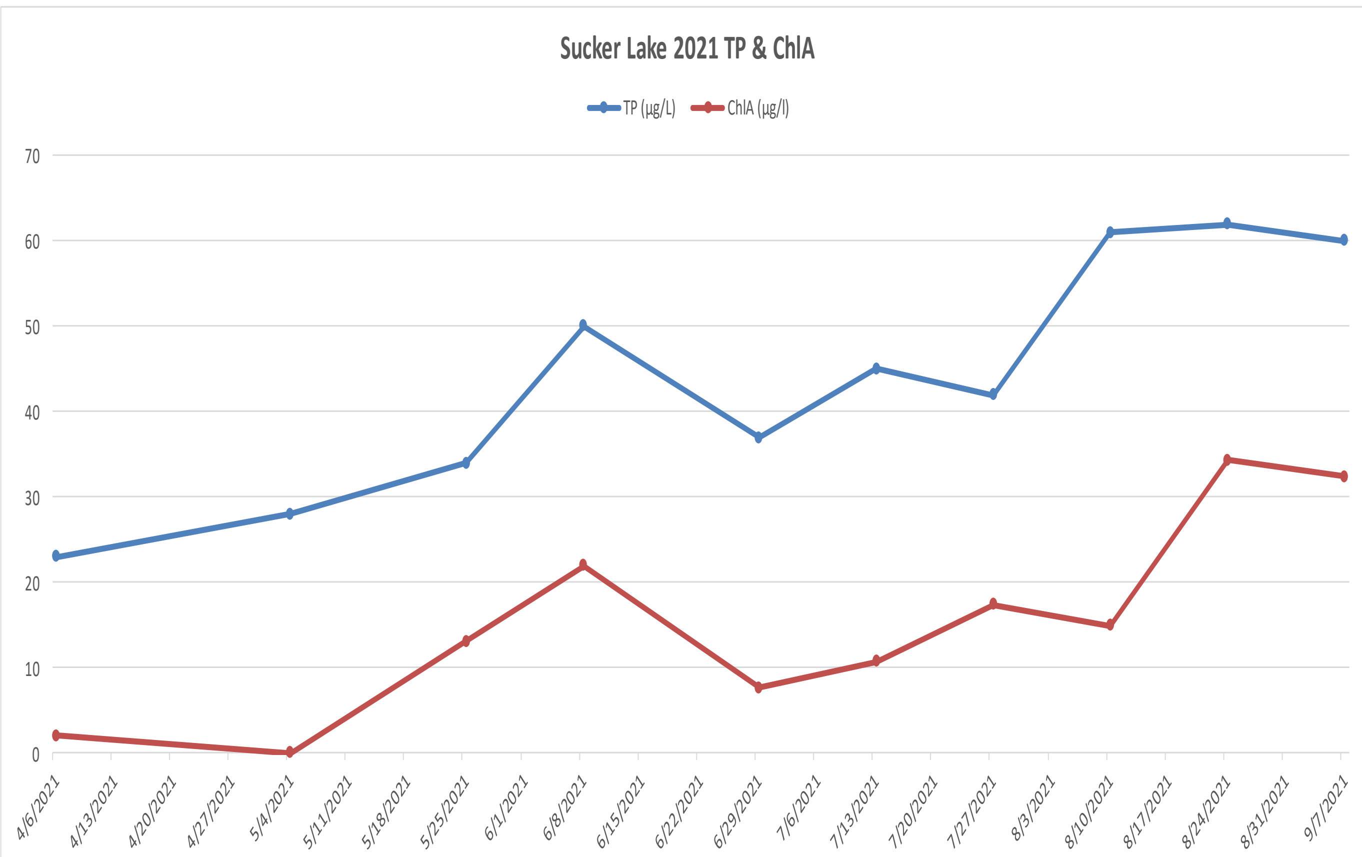
Sucker Lake is located within the City of Vadnais Heights and is surrounded by Ramsey County park land. It is 63 acres with a maximum depth of 26 feet. According to available information, there is a diverse fish population ranging from pan fish to walleye as well as white bass that were stocked in 2010 & 2011. Sucker Lake is part of the SPRWS chain of lakes and sits between Pleasant Lake to the north and East Vadnais Lake to the south. VLAWMO began sampling the lake in 2019 for water quality.



Sucker Lake

Sucker Lake Historical Avg TP/Chl A/SDT			
	TP (ug/L)	Chl A (mg/m3)	Secchi (m)
2019	49	14	1.3
2020	41	8	2
2021	44	17	2.2

Date	Reading Depth (Bottom/ Top)	Temp °C	Conduc-tivity (mS/cm)	DO (mg/ L)	pH
5/25/2021	b	18.25	0.361	6.19	7.24
5/25/2021	t	18.89	0.36	5.99	7.28
6/29/2021	b	24.59	0.359	5.71	7.56
6/29/2021	t	24.63	0.358	5.25	7.57
7/27/2021	b	26.47	0.374	4.92	7.85
7/27/2021	t	26.45	0.374	4.36	7.65
9/21/2021	b	19.91	0.396	4.25	7.5
9/21/2021	t	20.57	0.392	5.61	7.51



Sucker Lake

SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/l)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
sucker	4/6/2021								30
sucker	5/4/2021	7	23	0.011	2.08	0.62	0.11	0.1	
sucker	5/25/2021	8	28	0.016	<1.11				
sucker	6/8/2021	6	34	0.009 [2]	13.1	2.38	0.12	0.05	
sucker	6/29/2021	6	50	0.005	22				
sucker	7/13/2021	9	37	0.007	7.68	0.66	0.07	<0.03	
sucker	7/27/2021	4.5	45	<0.003	10.7				
sucker	8/10/2021	7.5	42	0.008	17.4		0.08	<0.03	
sucker	8/24/2021	7	61	0.022 [1]	14.9				
sucker	9/7/2021	8	62	0.013	34.3	0.61	0.03	<0.03	
sucker	9/21/2021	4	60	0.010 [1]	32.4				

Pleasant Lake

Pleasant Lake is managed by the Saint Paul Regional Water Services (SPRWS) in partnership with VLAWMO and the North Oaks Home Owners' Association (NOHOA). It is part of the chain of lakes that moves water from the Mississippi (Fridley) to East Vadnais Lake. It is impaired for mercury in fish tissue. SPRWS collects water quality information for Pleasant Lake. No motorized recreational use is allowed on the lake. An oxygenation system was installed in 2013 to address high Phosphorus levels. VLAWMO began sampling in 2020.

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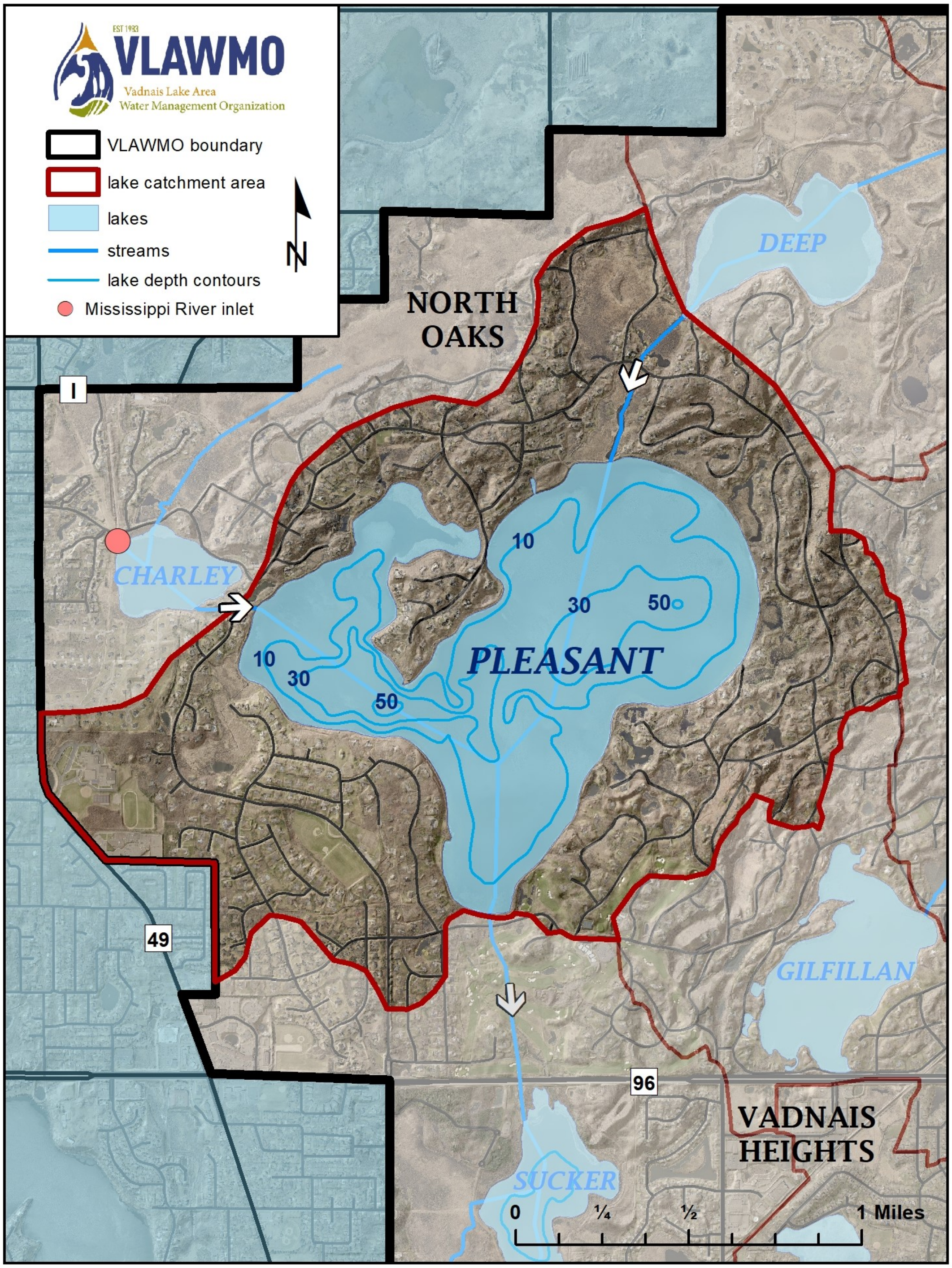
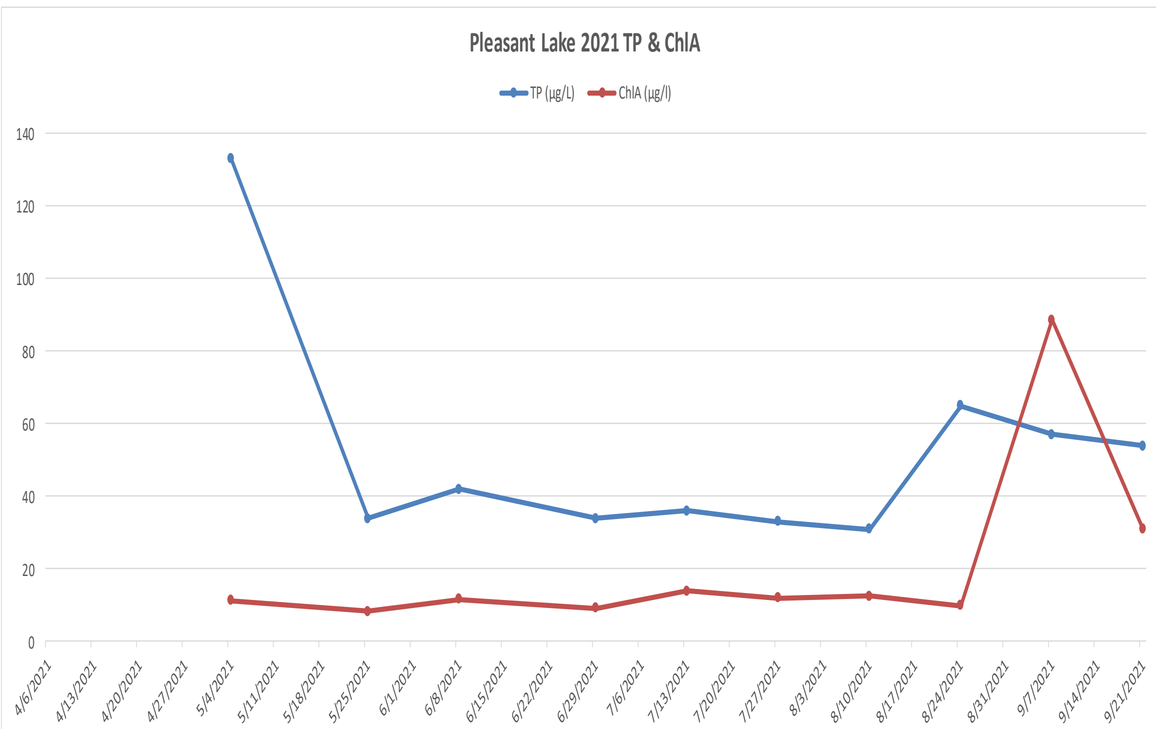


Pleasant Lake

Pleasant Lake Historical Avg TP/Chl A/ SDT			
Year	TP (ug/L)	Chl A (mg/m3)	Secchi (m)
2020	41	16	1.7
2021	52	20	1.5

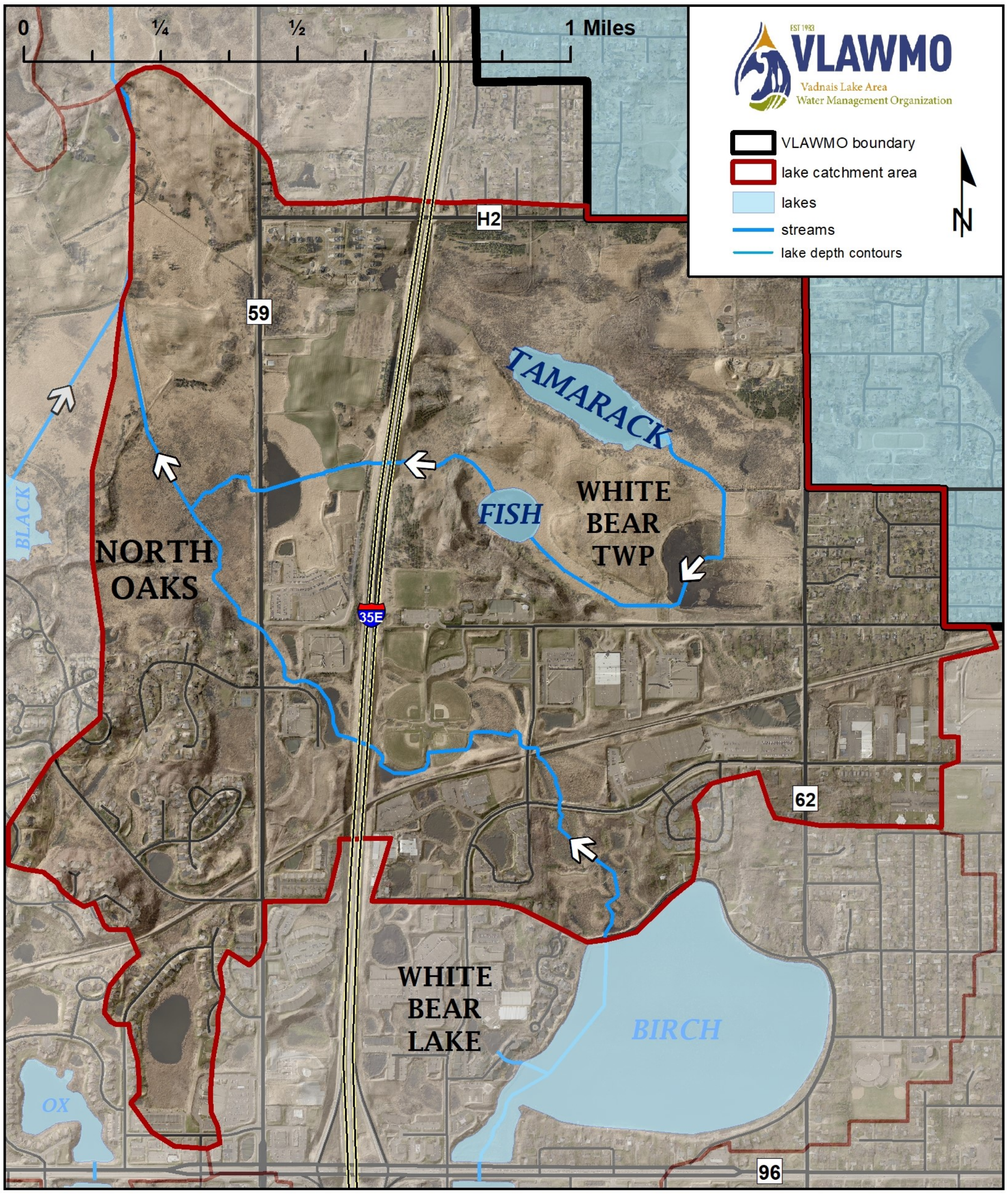
Date	Reading Depth (Bottom/ Top)	Temp °C	Conduc-tivity (mS/cm)	DO (mg/ L)	pH
5/25/2021	b	23.01	0.376	5.46	7.17
5/25/2021	t	23.34	0.375	5.29	7.28
6/29/2021	b	24.81	0.392	5.67	7.54
6/29/2021	t	25.88	0.395	6.81	7.59
7/27/2021	b	27	0.401	5.94	7.61
7/27/2021	t	27.76	0.407	5.27	7.63
9/21/2021	b	20.52	0.437	4.83	7.42
9/21/2021	m	20.48	0.436	4.79	7.43
9/21/2021	t	20.59	0.436	4.99	7.45



SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/ L)	ChlA (µg/l)	TKN (mg/ L)	NH3 (mg/ L)	NO2+NO3 mg/L	CL (mg/L)
Pleasant	4/6/2021								21
Pleasant	5/4/2021	8	133	0.009	11.2	0.61	0.06	0.14	
Pleasant	5/25/2021	6	34	0.009	8.31				
Pleasant	6/8/2021	4.5	42	0.014 [2]	11.7	0.71	0.07	0.38	
Pleasant	6/29/2021	6.5	34	0.006	9.2				
Pleasant	7/13/2021	8	36	0.005	13.9	0.54	<0.02	0.07	
Pleasant	7/27/2021	5.5	33	<0.003	12				
Pleasant	8/10/2021	8	31	0.007	12.5		0.03	0.16	
Pleasant	8/24/2021	7	65	0.025 [1]	9.84				
Pleasant	9/7/2021	7.5	57	0.007	88.6	0.67	<0.02	<0.03	
Pleasant	9/21/2021	4.5	54	0.005 [1]	31				

Tamarack Lake

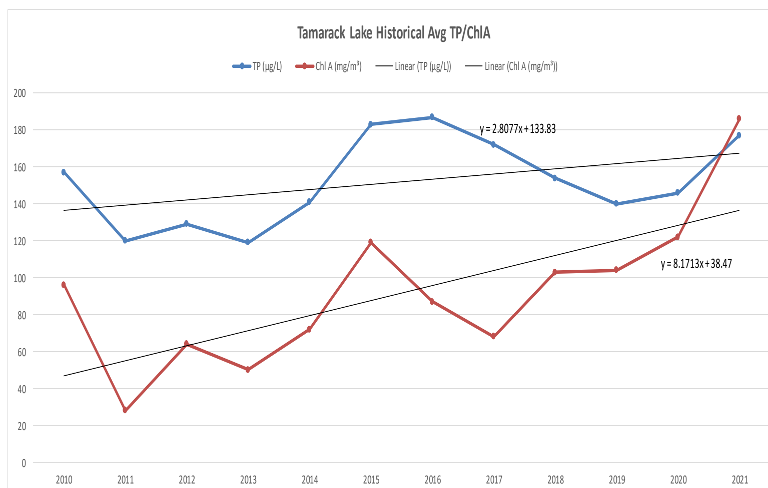
Tamarack Lake is part of the Tamarack Nature Center. It is 86 acres with a maximum depth of 10 feet. As there is no boat access, samples are taken from the observation dock on the southeast side of the lake. Ramsey County restored a large ditched wetland downstream of Tamarack and upstream of Fish Lake, as part of a wetland-banking project in 1997. Tamarack Lake is one of 4 lakes listed as impaired for nutrients on the 2010 Lambert Creek TMDL study. Internal loading is the major reason for the impairment. This is a very isolated lake with a large natural buffer, runoff from Hwy 35E will make its way to Tamarack on the west side after going through a large wetland. Historically Tamarack was surrounded by farmland. TP & ChlA levels are extremely high and show little sign of lowering.



Tamarack Lake

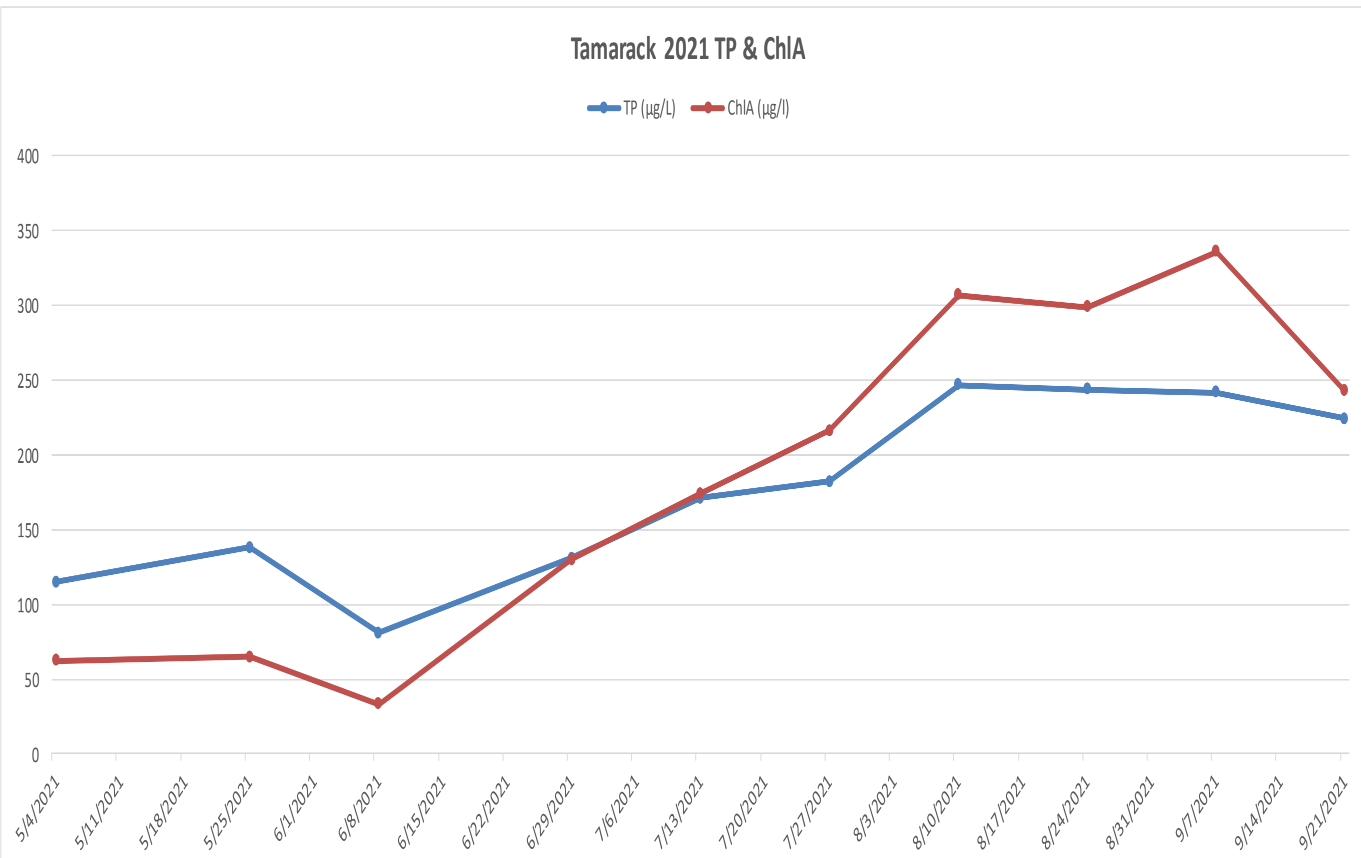
Tamarack Lake Historical Avg TP/ChlA/SDT			
Year	TP (µg/L)	Chl A (mg/m³)	Secchi (m)
1997	17	180	0.2
1998	54	32	0.5
1999	90	26	0.4
2000	60	27	0.4
2001	132	37	0.4
2002	164	120	0.4
2003	168	95	0.3
2004	96	0	0.8
2005	143	65	0
2006	136	38	0
2007	148	109	0.5
2008	115	99	0.3
2009	161	161	0.2
2010	157	96	0.2
2011	120	28	0.6
2012	129	64	0.4
2013	119	50	0.5
2014	141	72	0.5
2015	183	119	0.4
2016	187	87	0.4
2017	172	68	0.4
2018	154	103	0.4
2019	140	104	0.4
2020	146	122	0.3
2021	177	186	0.3

Date	Reading Depth (Bottom/ Top)	Temp °C	Conduc-tivity (mS/cm)	DO (mg/L)	pH
5/25/2021	b	24.13	0.435	5.33	7.59
5/25/2021	t	24.19	0.434	5.54	7.59
6/29/2021	b	25.22	0.412	6.21	7.3
6/29/2021	t	25.96	0.409	7.01	7.37
7/27/2021	b	26.68	0.382	2.71	7.77
7/27/2021	t	27.01	0.371	4.52	7.79
9/21/2021	b	18.84	0.392	6.41	7.64
9/21/2021	t	18.91	0.393	5.33	7.65



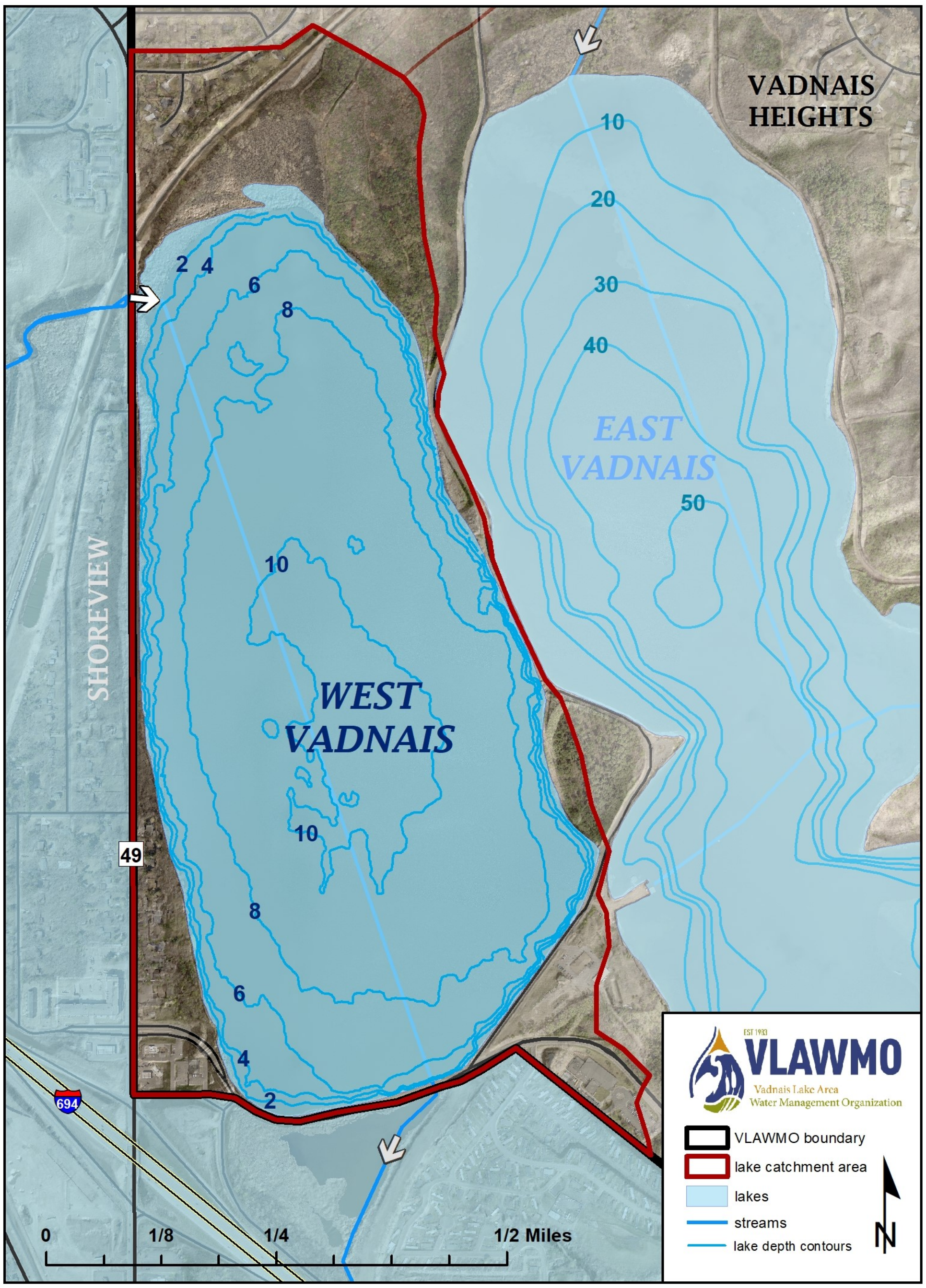
Tamarack Lake

SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/l)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
tamarack	4/6/2021								54
tamarack	5/4/2021	2.5	115	0.018	62.3	2.15	0.03	<0.03	
tamarack	5/25/2021	4	138	0.013	64.8				
tamarack	6/8/2021	2	81	0.014 [2]	33.1	1.56	0.07	<0.03	
tamarack	6/29/2021	2	131	0.01	130				
tamarack	7/13/2021	0.75	171	0.011	174	3.2	0.03	<0.03	
tamarack	7/27/2021	0.75	182	0.004	216				
tamarack	8/10/2021	0.5	247	0.012	307		0.02	<0.03	
tamarack	8/24/2021	0.5	244	0.012 [1]	299				
tamarack	9/7/2021	0.5	242	0.012	336	4.86	0.05	<0.03	
tamarack	9/21/2021	1	224	0.013 [1]	243				



West Vadnais

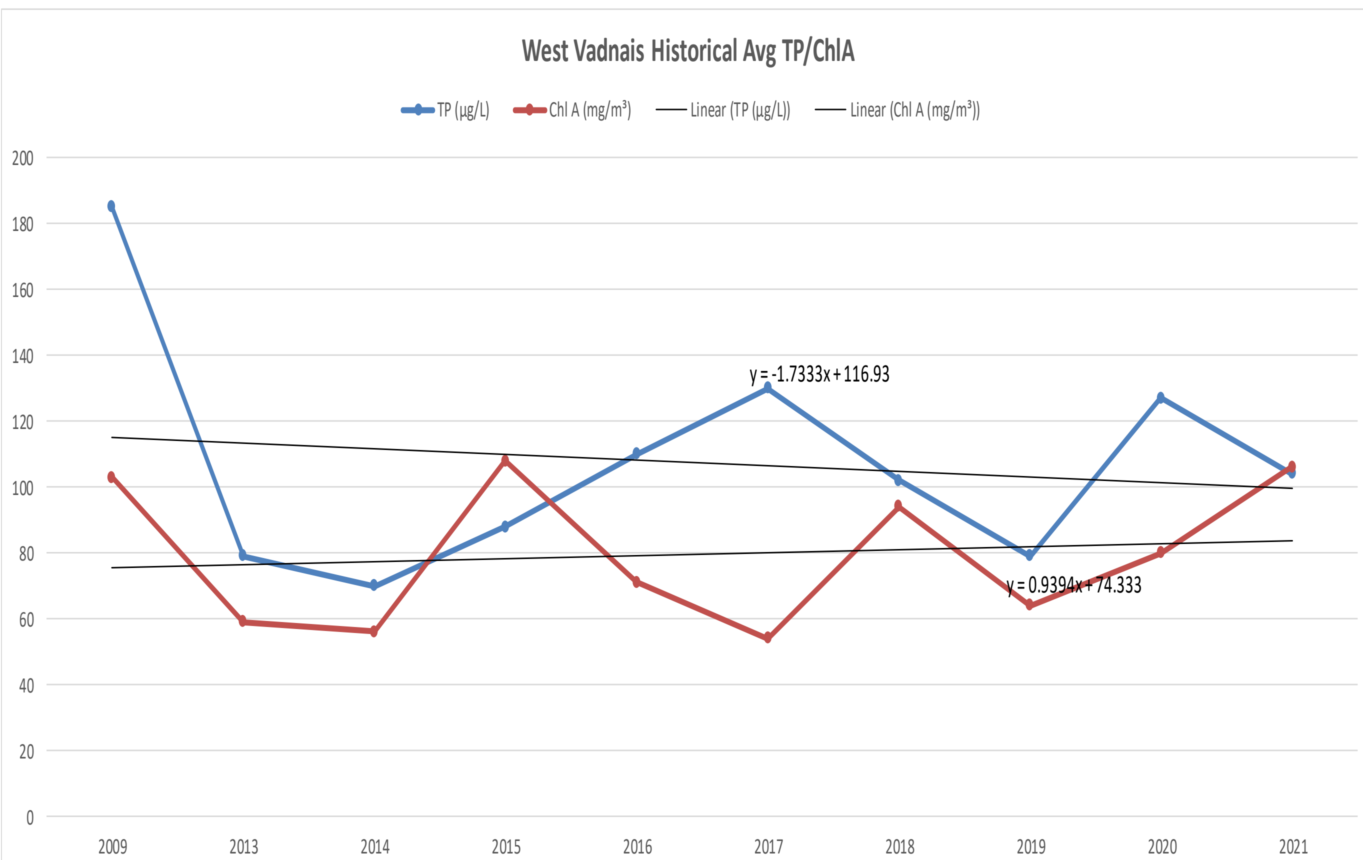
West Vadnais Lake is located in the southwest corner of the watershed. Its neighbor, East Vadnais Lake, receives in lake treatment by the Saint Paul Water Authority (SPRWS) as a measure to protect the drinking water supply. Even though these lakes are right next to each other they are not connected and have drastically different water quality. The SPRWS monitors East Vadnais Lake. VLAWMO monitored West Vadnais for part of 2009 and began full monitoring in 2013. West Vadnais is on the 2014 impaired waters list for nutrients.



West Vadnais

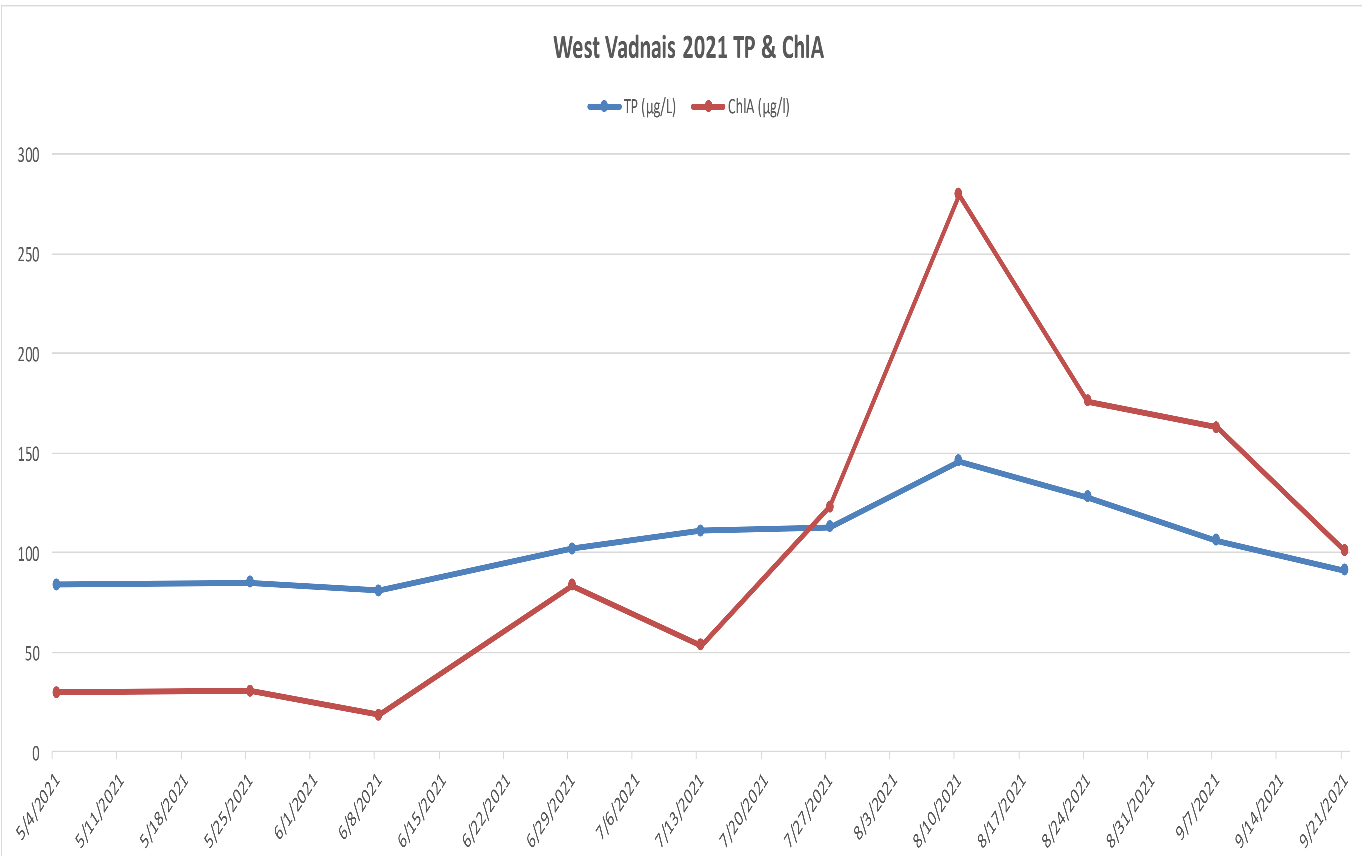
West Vadnais Historical Avg TP/Chl A/SDT			
Year	TP (µg/L)	Chl A (mg/m³)	Secchi (m)
2009	185	103	0.4
2013	79	59	0.4
2014	70	56	0.5
2015	88	108	0.3
2016	110	71	0.3
2017	130	54	0.4
2018	102	94	0.4
2019	79	64	0.5
2020	127	80	0.5
2021	104	106	0.5

Date	Reading Depth (Bottom/Top)	Temp °C	Conductivity (mS/cm)	DO (mg/L)	pH
5/25/2021	b	23.05	0.474	5.21	7.42
5/25/2021	t	23.17	0.471	5.29	7.43
6/29/2021	b	23.99	0.459	4.92	8.03
6/29/2021	t	24.48	0.454	5.89	8.06
7/27/2021	b	26.5	0.449	3.98	7.7
7/27/2021	t	26.91	0.441	5.23	7.73
9/21/2021	b	19.32	0.513	4.12	7.86
9/21/2021	t	18.86	0.477	4.58	7.86



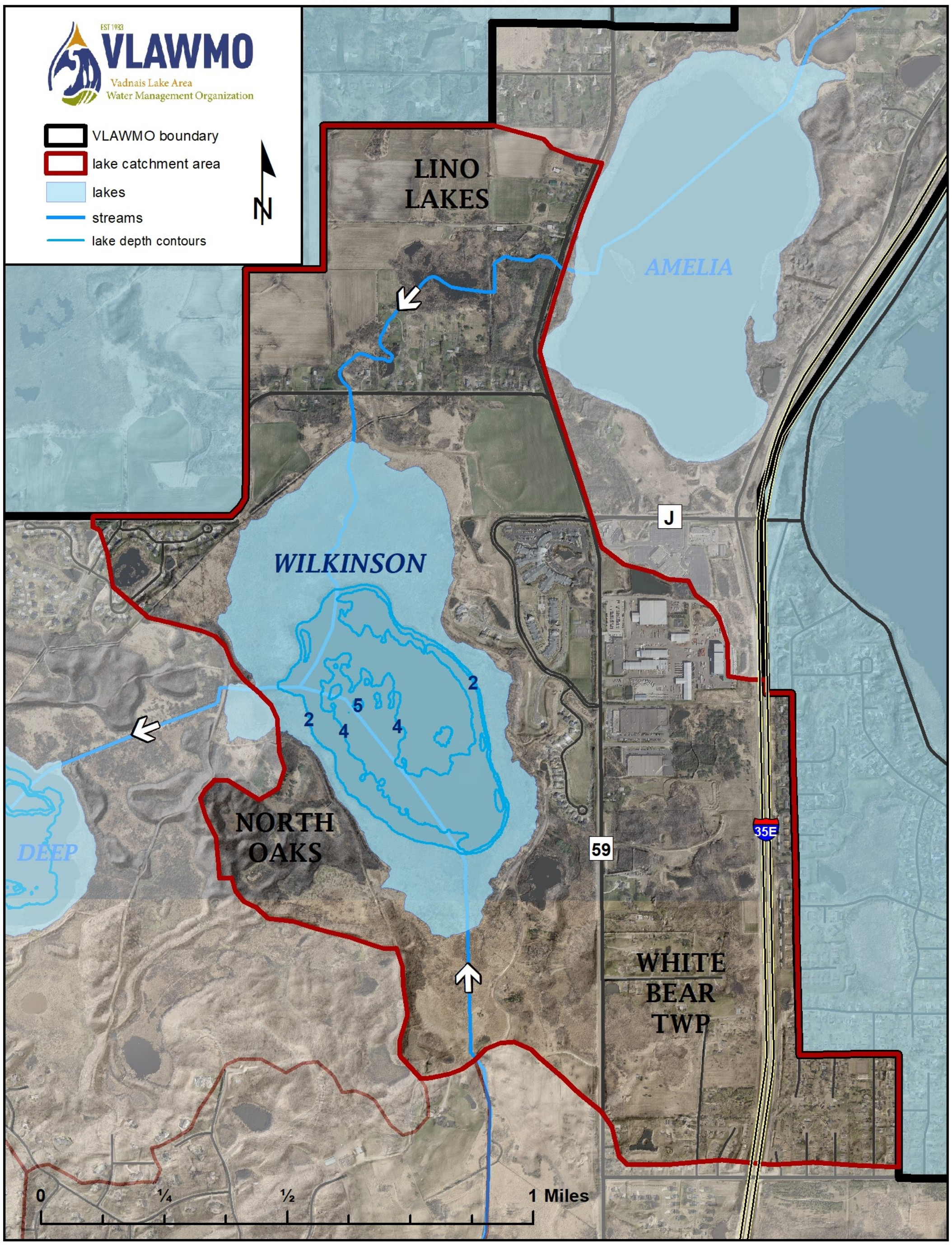
West Vadnais

SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/l)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
west vadnais	4/6/2021								59
west vadnais	5/4/2021	4.5	84	0.007	29.9	1.45	0.09	0.13	
west vadnais	5/25/2021	1.5	85	0.006	30.7				
west vadnais	6/8/2021	2	81	0.007 [2]	18.4	1.39	0.03	<0.03	
west vadnais	6/29/2021	1.5	102	<0.003	83.7				
west vadnais	7/13/2021	1.25	111	0.004	53.4	2.35	<0.02	<0.03	
west vadnais	7/27/2021	1	113	<0.003	123				
west vadnais	8/10/2021	0.5	146	0.003	280		0.03	<0.03	
west vadnais	8/24/2021	0.75	128	0.004 [1]	176				
west vadnais	9/7/2021	0.5	106	0.005	163	3.19	0.04	<0.03 [2]	
west vadnais	9/21/2021	1	91	0.003 [1]	101				



Wilkinson Lake

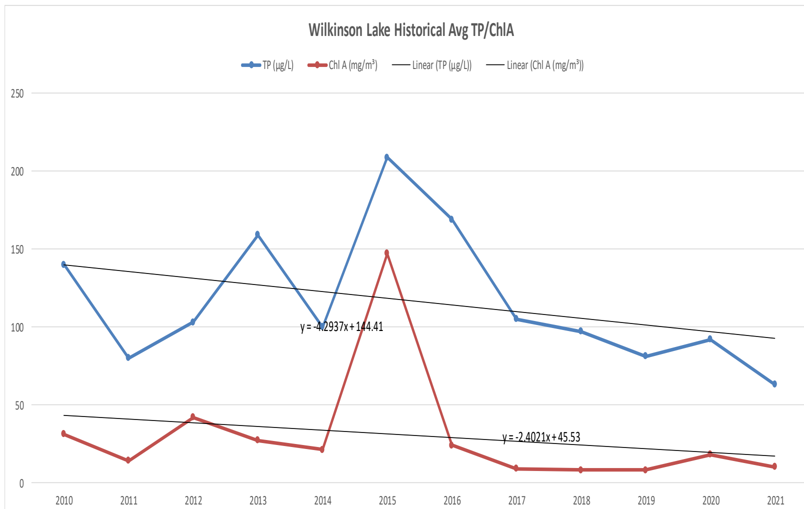
Wilkinson Lake was part of the James J. Hill experimental farm and is now part of the Minnesota Land Trust, which preserves the land in a natural condition. The City of North Oaks required 150-foot buffer between the lake edge and any structures. The property on the northwest side of the lake is currently being developed. The North Oaks Company has spent considerable time and effort over the years to restore the lake including the installation of a fish barrier to attempt to keep the rough fish from destroying the natural vegetation and waterfowl habitat and to improve water quality. The lake has also had two drawdowns to kill the carp. Wilkinson is the fourth lake within VLAWMO to be on the 2010 impaired waters list for nutrients and is part of the ongoing Lambert Creek TMDL study. Farmland runoff and internal loading seem to be the main factors to the poor water quality. Nutrient levels have shown a down trend since spiking in 2015.



Wilkinson Lake

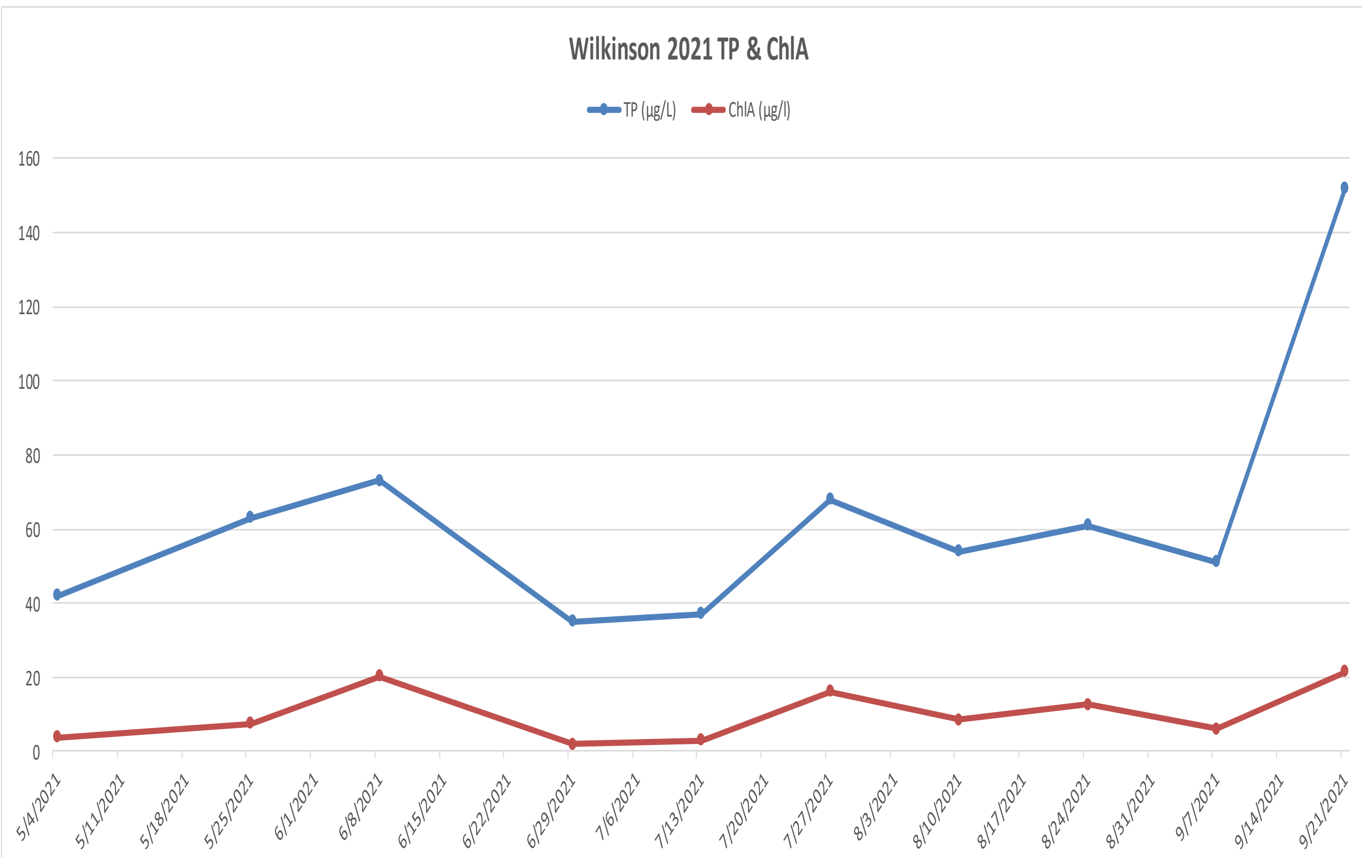
Wilkinson Lake Historical Avg TP/Chl A/SDT			
Year	TP (µg/L)	Chl A (mg/m³)	Secchi (m)
1998	48	26	1.1
1999	62	8	0
2000	38	34	0
2001	299	99	0.2
2002	107	40	0
2003	130	18	0
2004	72	0	0
2005	183	52	0
2006	96	10	0
2007	104	18	0.9
2008	64	8	0.3
2009	125	17	1
2010	140	31	0.8
2011	80	14	1
2012	103	42	0.9
2013	159	27	0.9
2014	100	21	0.9
2015	209	147	0.5
2016	169	24	1.1
2017	105	9	1.2
2018	97	8	1.2
2019	81	8	1.1
2020	92	18	1.1
2021	63	10	1.1

Date	Reading Depth (Bottom/ Top)	Temp °C	Conduc-tivity (mS/cm)	DO (mg/L)	pH
5/25/2021	b	23.65	0.416	7.11	7.37
5/25/2021	t	24.28	0.416	6.37	7.41
6/29/2021	b	23.77	0.444	5.11	7.38
6/29/2021	t	23.71	0.439	4.83	7.39
7/27/2021	b	24.92	0.516	1.33	7.45
7/27/2021	t	25.29	0.514	1.68	7.48
9/21/2021	b	19.02	0.573	4.34	7.5
9/21/2021	t	19.1	0.572	2.89	7.51



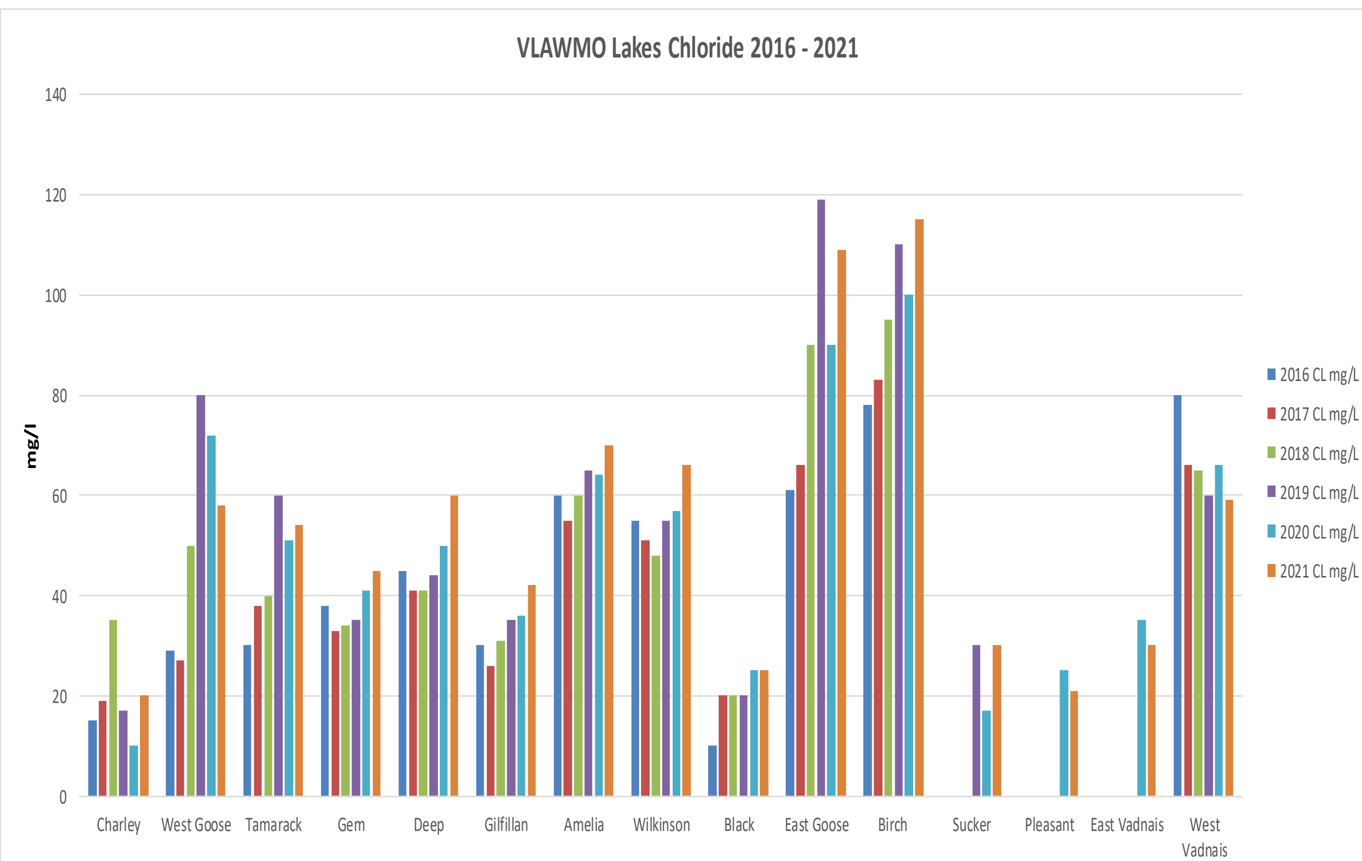
Wilkinson Lake

SITE	DATE	Secchi (ft)	TP (µg/L)	SRP (mg/L)	ChlA (µg/l)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
wilkinson	4/6/2021								66
wilkinson	5/4/2021	4.5	42	0.007	3.74	0.74	0.03	<0.03	
wilkinson	5/25/2021	4	63	0.013	7.42				
wilkinson	6/8/2021	4	73	0.008 [2]	20.3	1.25	0.03	<0.03	
wilkinson	6/29/2021	4.5	35	0.008	1.88				
wilkinson	7/13/2021	4	37	0.004	3	1.03	<0.02	<0.03	
wilkinson	7/27/2021	4.5	68	<0.003	16				
wilkinson	8/10/2021	4	54	0.004	8.54		0.05	<0.03	
wilkinson	8/24/2021	4	61	0.005 [1]	12.7				
wilkinson	9/7/2021	4	51	0.008	6.01	1.11	0.06	<0.03	
wilkinson	9/21/2021	2.5	152	0.008 [1]	21.4				



Lake Comparison Chloride

	2011 Cl mg/L	2012 Cl mg/L	2013 Cl mg/L	2014 Cl mg/L	2015 Cl mg/L	2016 CL mg/L	2017 CL mg/L	2018 CL mg/L	2019 CL mg/L	2020 CL mg/L	2021 CL mg/L
Charley	20	22	30	25	20	15	19	35	17	10	20
West Goose	44	29	53	44	20	29	27	50	80	72	58
Tamarack	34	32	35	35	36	30	38	40	60	51	54
Gem	40	44	45	40	42	38	33	34	35	41	45
Deep	45	35	44	43	35	45	41	41	44	50	60
Gilfillan	41	40	26	25	30	30	26	31	35	36	42
Amelia	75	71	68	66	66	60	55	60	65	64	70
Wilkinson	54	57	66	60	60	55	51	48	55	57	66
Black	10	8	5	5	9	10	20	20	20	25	25
East Goose	95	76	83	77	76	61	66	90	119	90	109
Birch	100	89	89	80	89	78	83	95	110	100	115
Sucker									30	17	30
Pleasant										25	21
East Vadnais										35	30
West Vadnais			90	82	85	80	66	65	60	66	59



Lake Comparison Chloride

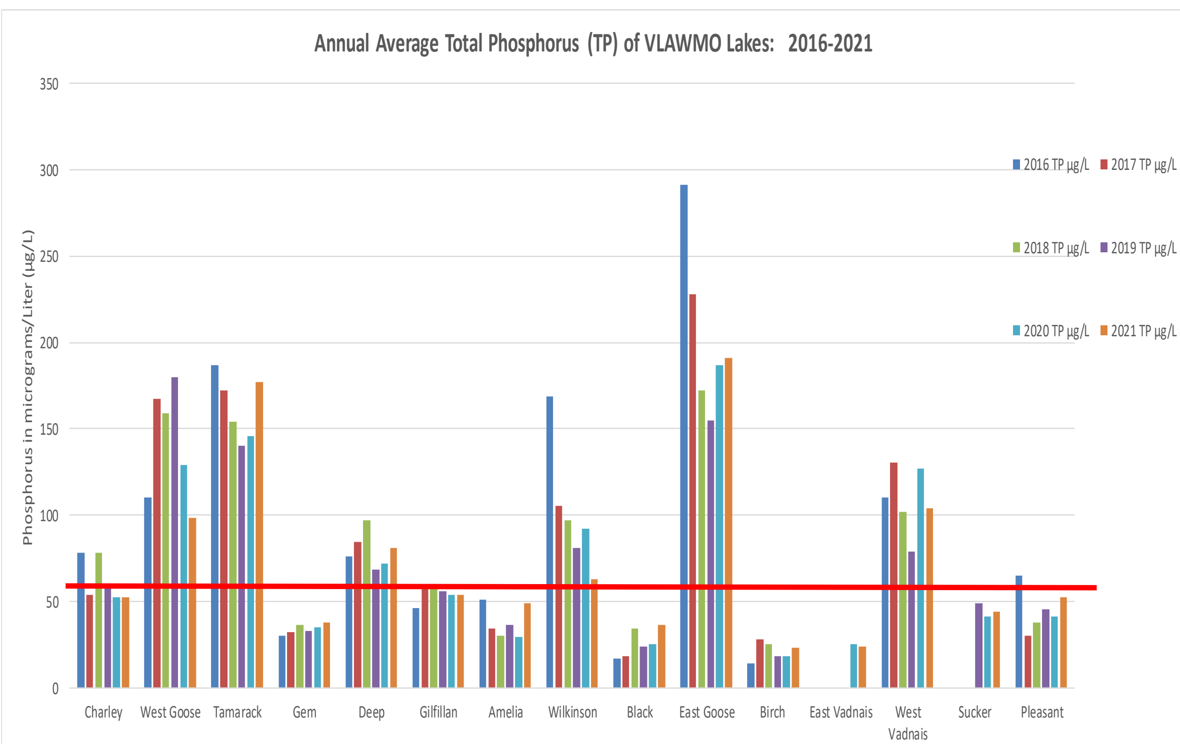
- **Chloride Standards**

Chronic Exposure Standard—4 day average > 230 mg/l
Acute Exposure Standard—1 hour > 860 mg/l
Impairment Threshold—Two or more exceedances in a three year period having at least five data points

- VLAWMO staff takes Lake Chloride readings in the spring right after ice-off. The samples are taken from the middle of the lake. 2021 was the 12th year of VLAWMO's chloride program. The lakes with the highest chloride levels are typically the lakes that receive the most street/storm water runoff. Most of our cities have gone to an all salt mix for winter ice control and future monitoring will be interesting to see how that will affect the chloride levels in VLAWMO lakes.

Lake Comparison Total Phosphorus (TP)

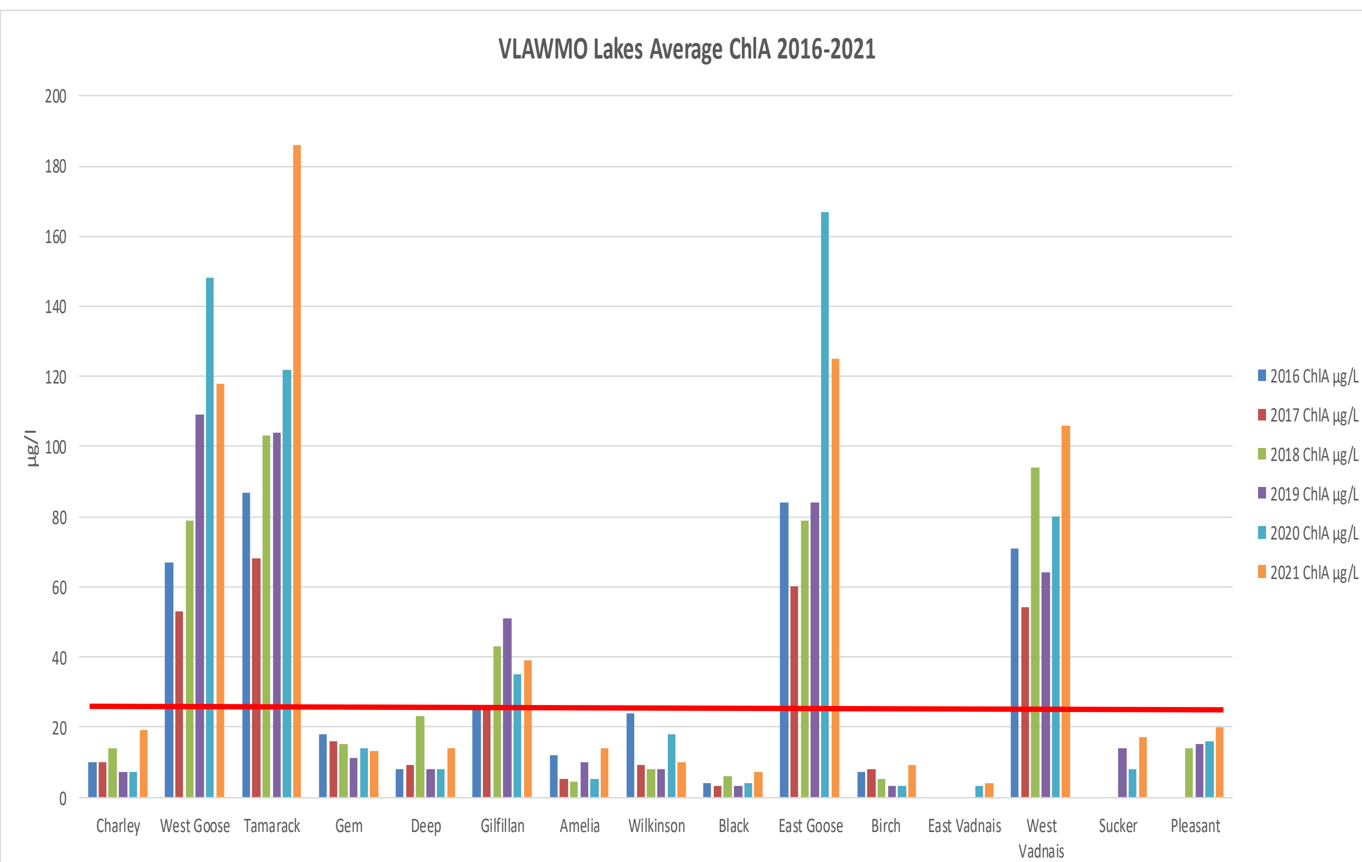
Lake	2011 TP µg/L	2012 TP µg/L	2013 TP µg/L	2014 TP µg/L	2015 TP µg/L	2016 TP µg/L	2017 TP µg/L	2018 TP µg/L	2019 TP µg/L	2020 TP µg/L	2021 TP µg/L
Charley	87	74	57	59	57	78	54	78	60	52	52
West	126	200	104	172	149	110	167	159	180	129	98
Tamarack	120	129	119	141	183	187	172	154	140	146	177
Gem	32	41	35	31	38	30	32	36	33	35	38
Deep	95	87	121	136	89	76	84	97	68	72	81
Gilfillan	123	70	38	38	55	46	58	60	56	54	54
Amelia	38	39	39	48	28	51	34	30	36	29	49
Wilkinson	80	103	159	100	209	169	105	97	81	92	63
Black	44	31	32	21	18	17	18	34	24	25	36
East	164	277	265	207	231	291	228	172	155	187	191
Birch	29	30	30	26	21	14	28	25	18	18	23
East										25	24
West			79	70	88	110	130	102	79	127	104
Sucker									49	41	44
Pleasant			24	35	47	65	30	38	45	41	52



The red line marks the State Standard; when a water body becomes impaired.

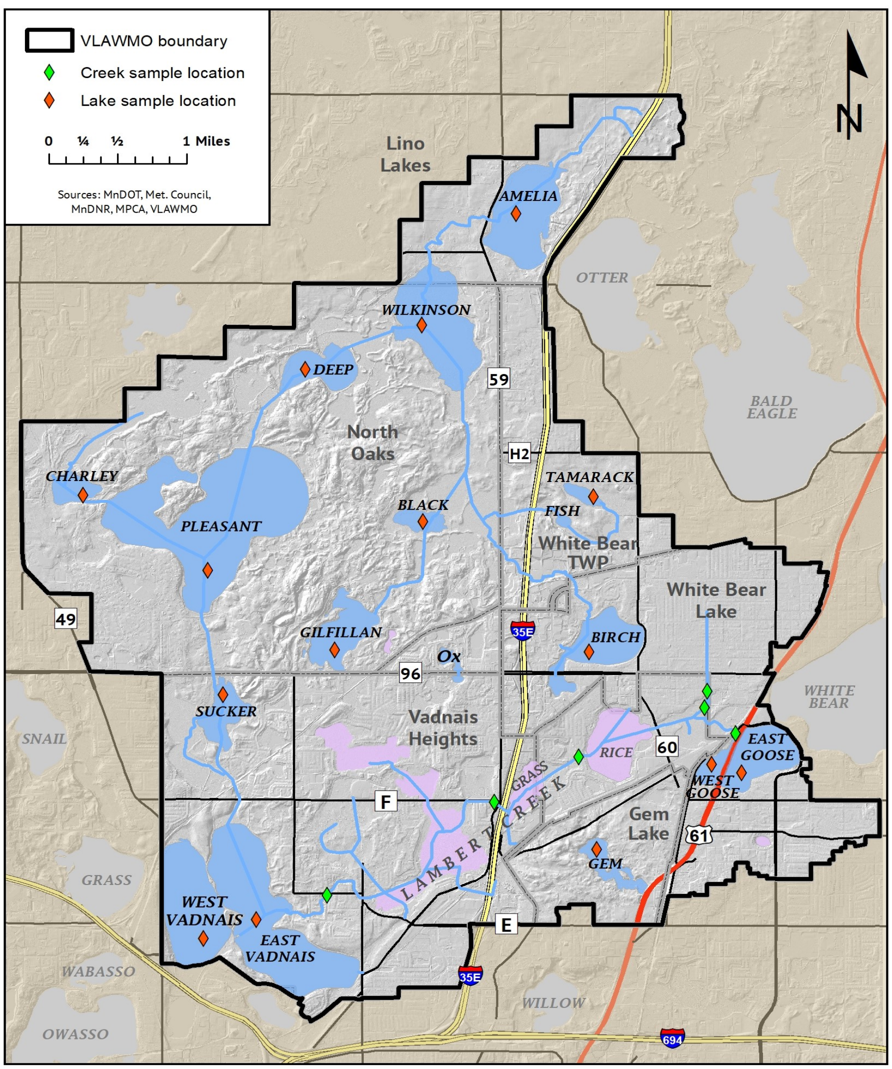
Lake Comparison ChlA

	2011 ChlA µg/L	2012 ChlA µg/L	2013 ChlA µg/L	2014 ChlA µg/L	2015 ChlA µg/L	2016 ChlA µg/L	2017 ChlA µg/L	2018 ChlA µg/L	2019 ChlA µg/L	2020 ChlA µg/L	2021 ChlA µg/L
Charley	9.3	13	11	10	14	10	10	14	7	7	19
West Goose	27	51	32	68	97	67	53	79	109	148	118
Tamarack	28	64	50	72	119	87	68	103	104	122	186
Gem	6.4	11	17	8	23	18	16	15	11	14	13
Deep	12	12	21	13	23	8	9	23	8	8	14
Gilfillan	25	17	15	20	36	25	25	43	51	35	39
Amelia	8	9	19	7.5	21	12	5	4.5	10	5	14
Wilkinson	14	42	27	21	147	24	9	8	8	18	10
Black	6.9	6	6	8	14	4	3	6	3	4	7
East Goose	48	96	112	67	115	84	60	79	84	167	125
Birch	3	3	3	3	1	7	8	5	3	3	9
East Vadnais										3	4
West Vadnais			59	56	108	71	54	94	64	80	106
Sucker									14	8	17
Pleasant								14	15	16	20



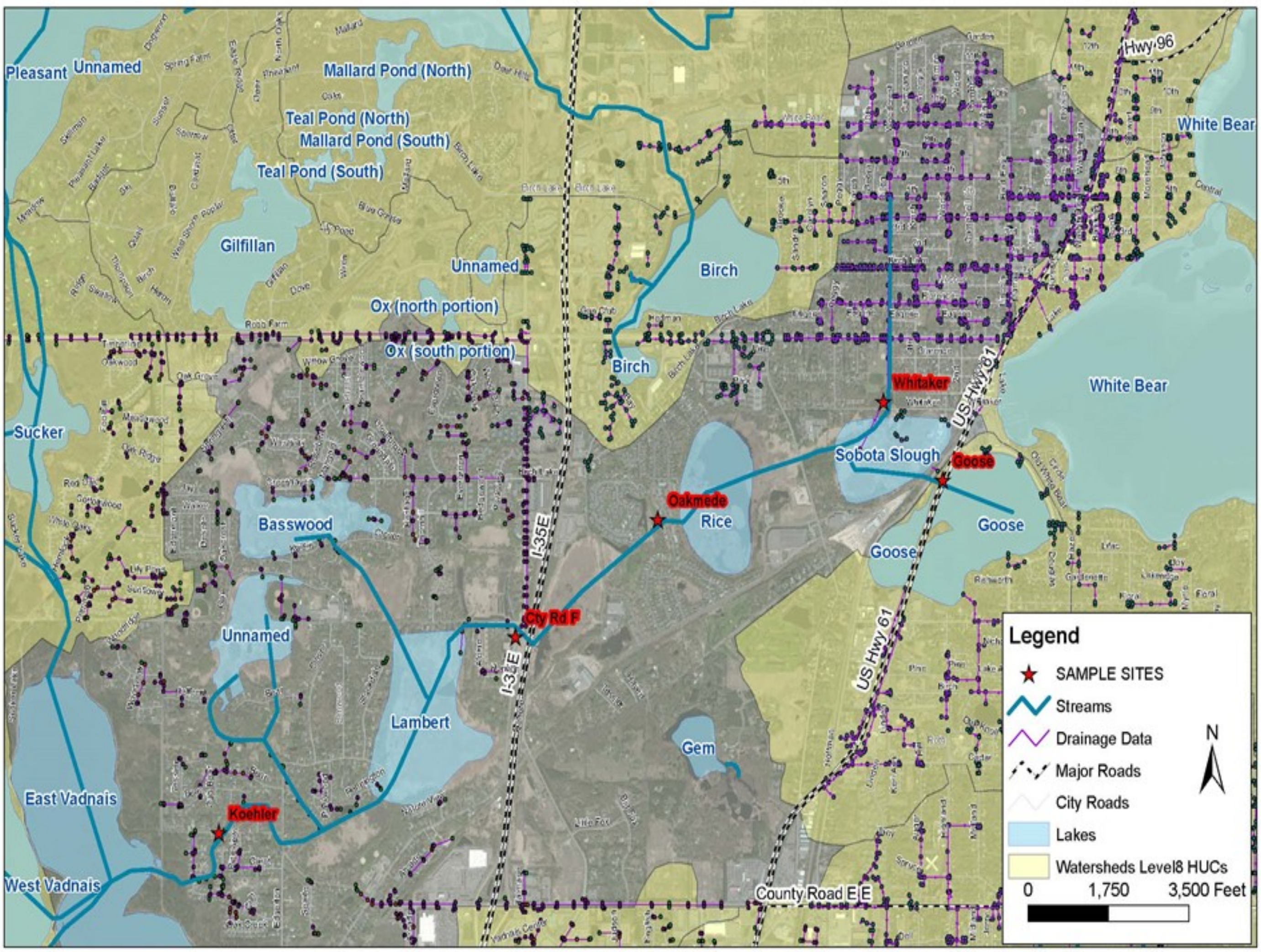
Lake Levels

Lake Elevations 2021					
NAVD88	**Gilfillan**	**Birch**	**Gem**	**Goose**	**Wilkinson**
gauge reading	1	0.9	1.9	0.4	1.7
lake level start	910.81	919.54	947.31	924.35	
0.00 out	909.91	918.64	945.41	923.95	893.48
5/4/2021	910.81	919.34	947.31	924.22	895.19
5/25/2021	910.86	919.43	947.20	924.21	895.28
6/8/2021	910.31	919.24	947.08	924.11	895.06
6/29/2021	910.81	918.94	946.79	923.83	894.86
7/13/2021	910.79	918.71	946.56	923.77	894.68
7/27/2021	910.85	918.76	946.52	923.91	894.56
8/10/2021	910.90	918.65		924.01	894.46
8/24/2021	910.91	918.52		924.00	894.28
9/7/2021	910.93	918.87	946.70	924.21	894.58
9/21/2021	910.80	918.77	946.62	924.14	894.56
10/22/2021	910.59	918.59		924.03	
yearly increase/	**0.22**	**0.75**	**0.79**	**0.19**	**0.63**



Lambert Creek

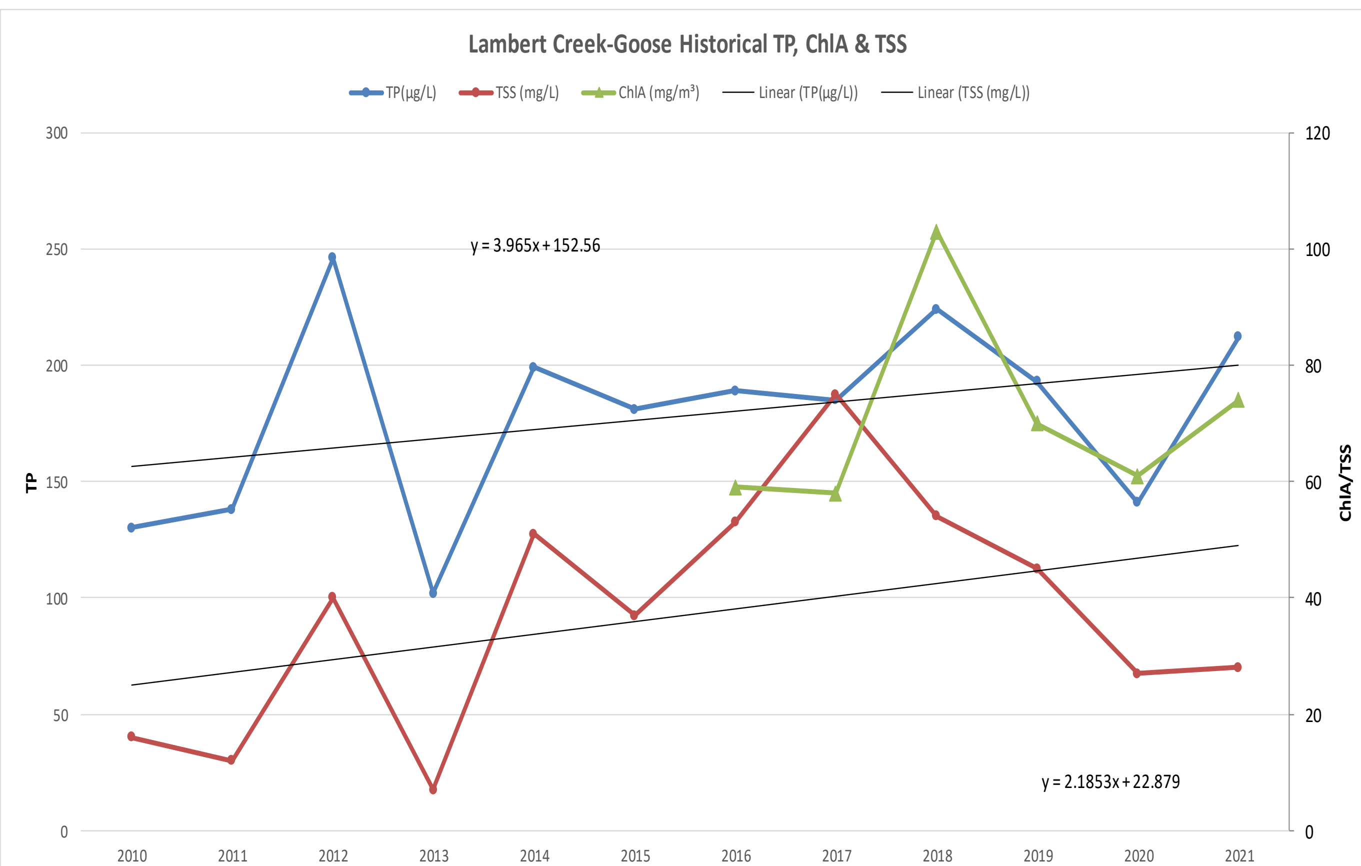
Samples are collected by VLAWMO staff at six sites along Lambert Creek on a bi-weekly basis May through September. The six sites noted in charts and graphs are: Goose Lake, WBL storm sewer, Whitaker Pond, Oakmede, County Rd F, and Kohler Rd. The samples are analyzed by RMB Environmental for TP, ChlA, SRP, TKN, NH3, N03, TSS. VLAWMO volunteers collect pH, conductivity, DO and temperature readings at all locations except the WBL storm sewer. Creek flow is also collected at the flumes along with automated flow meters at 4 locations. This information will help with the TMDL process and allows us to set baselines to compare with future monitoring data.



Lambert Creek—Goose

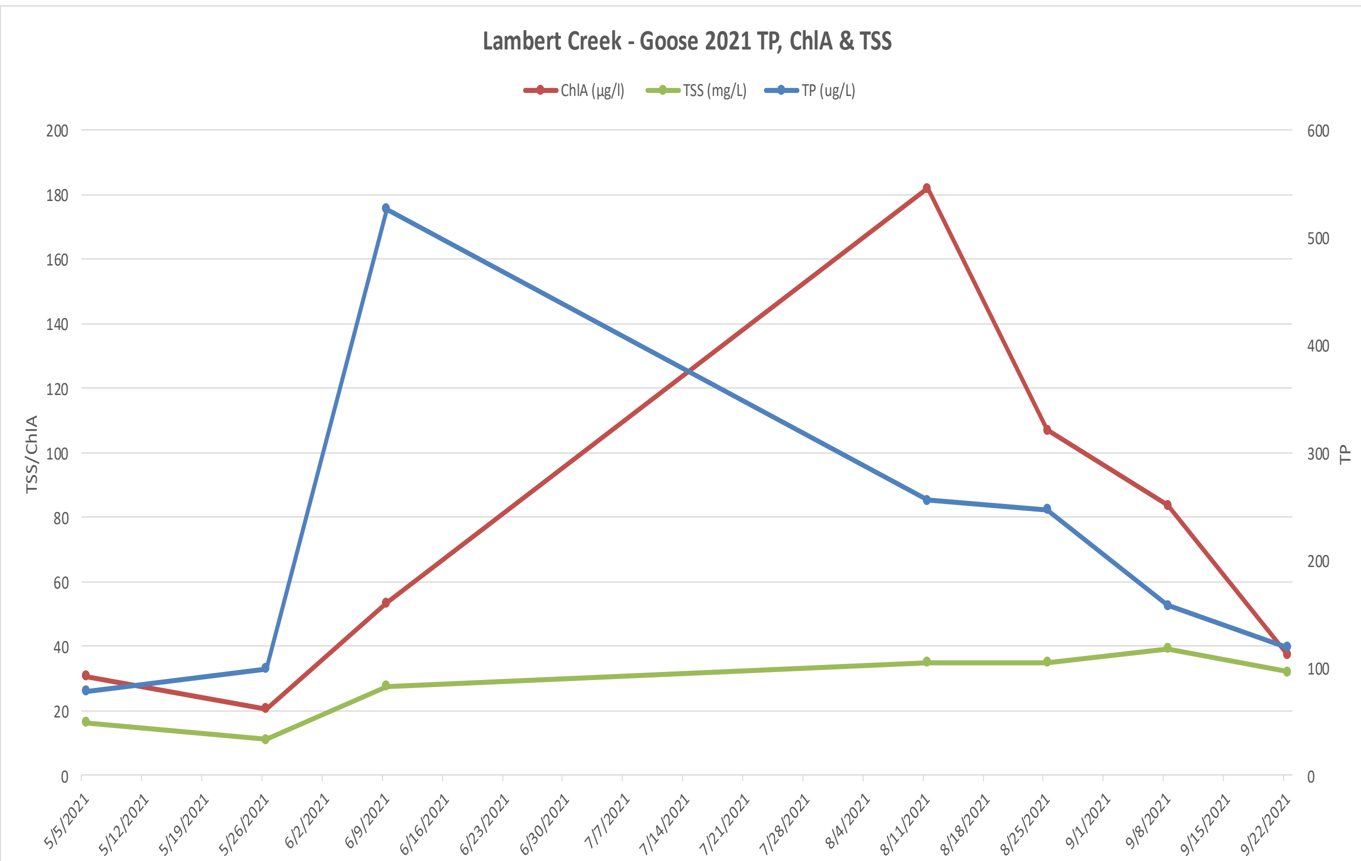
Lambert Creek-Goose			
Year	TP(µg/L)	TSS (mg/L)	ChlA (mg/m³)
2009	230	22	
2010	130	16	
2011	138	12	
2012	246	40	
2013	102	7	
2014	199	51	
2015	181	37	
2016	189	53	59
2017	185	75	58
2018	224	54	103
2019	193	45	70
2020	141	27	61
2021	212	28	74

Date	Temp °C	Conductivity (mS/cm)	DO (mg/L)	pH
5/7/2021	19.6	0.765	9.93	8.98
5/21/2021	20.8	0.765	7.78	8.90
6/9/2021	26.2	0.763	1.25	8.34
6/18/2021	dry	dry	dry	dry
7/7/2021	dry	dry	dry	dry
7/19/2021	24.1	0.767	2.31	8.66



Lambert Creek—Goose

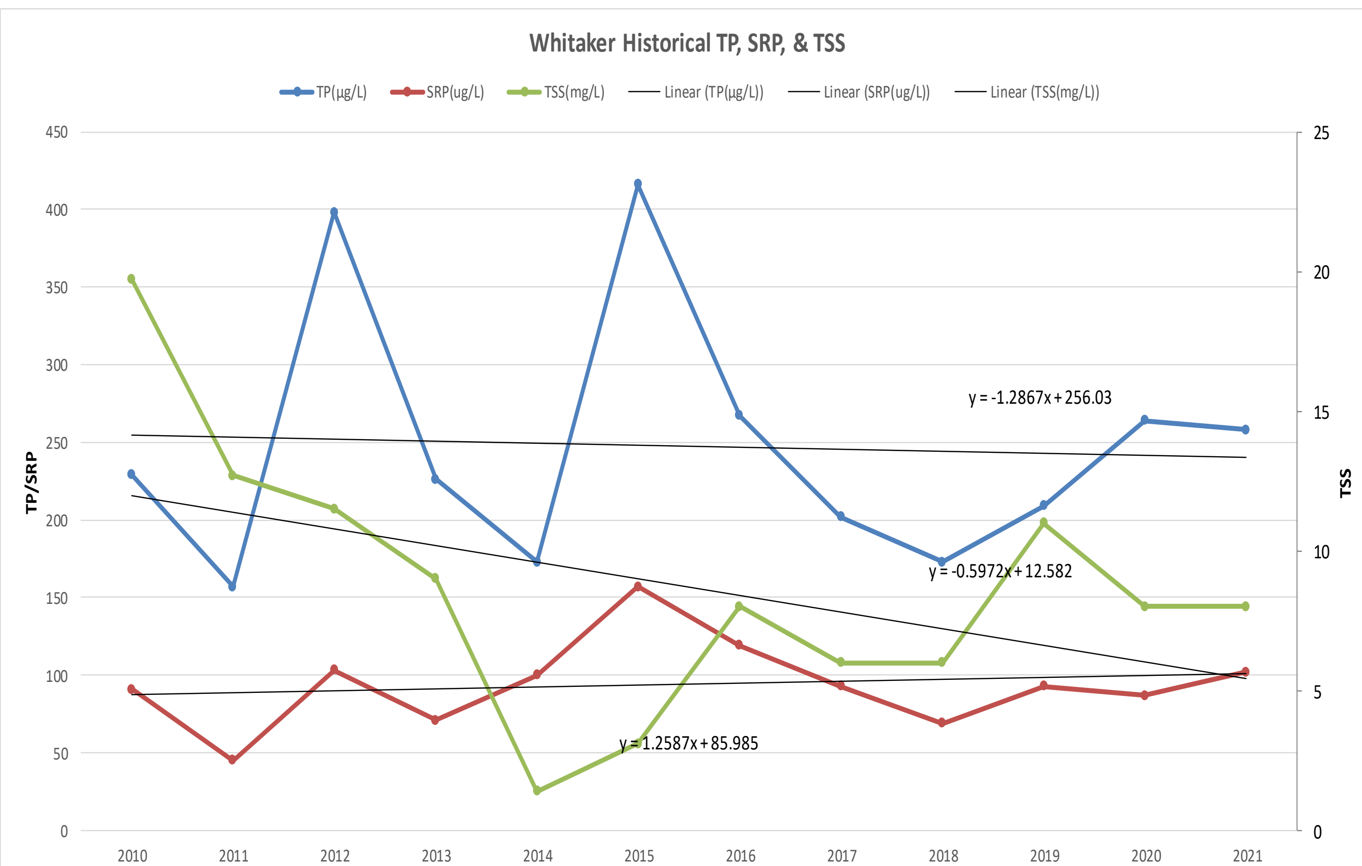
SITE	DATE	TP (ug/L)	ChlA (µg/l)	TSS (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
lc-goose	4/6/2021							63
lc-goose	5/5/2021	78	30.7	16.4	1.54	0.1	0.06	
lc-goose	5/26/2021	99	20.7	11.2				
lc-goose	6/9/2021	527	53.4	27.7		4.19	<0.03	
lc-goose	8/11/2021	256	182	35	2.98	0.14	<0.03	
lc-goose	8/25/2021	247	107	35				
lc-goose	9/8/2021	158	83.7	39.3	2.79	0.06	<0.03	
lc-goose	9/22/2021	119	37.4	32				



Lambert Creek—Whitaker

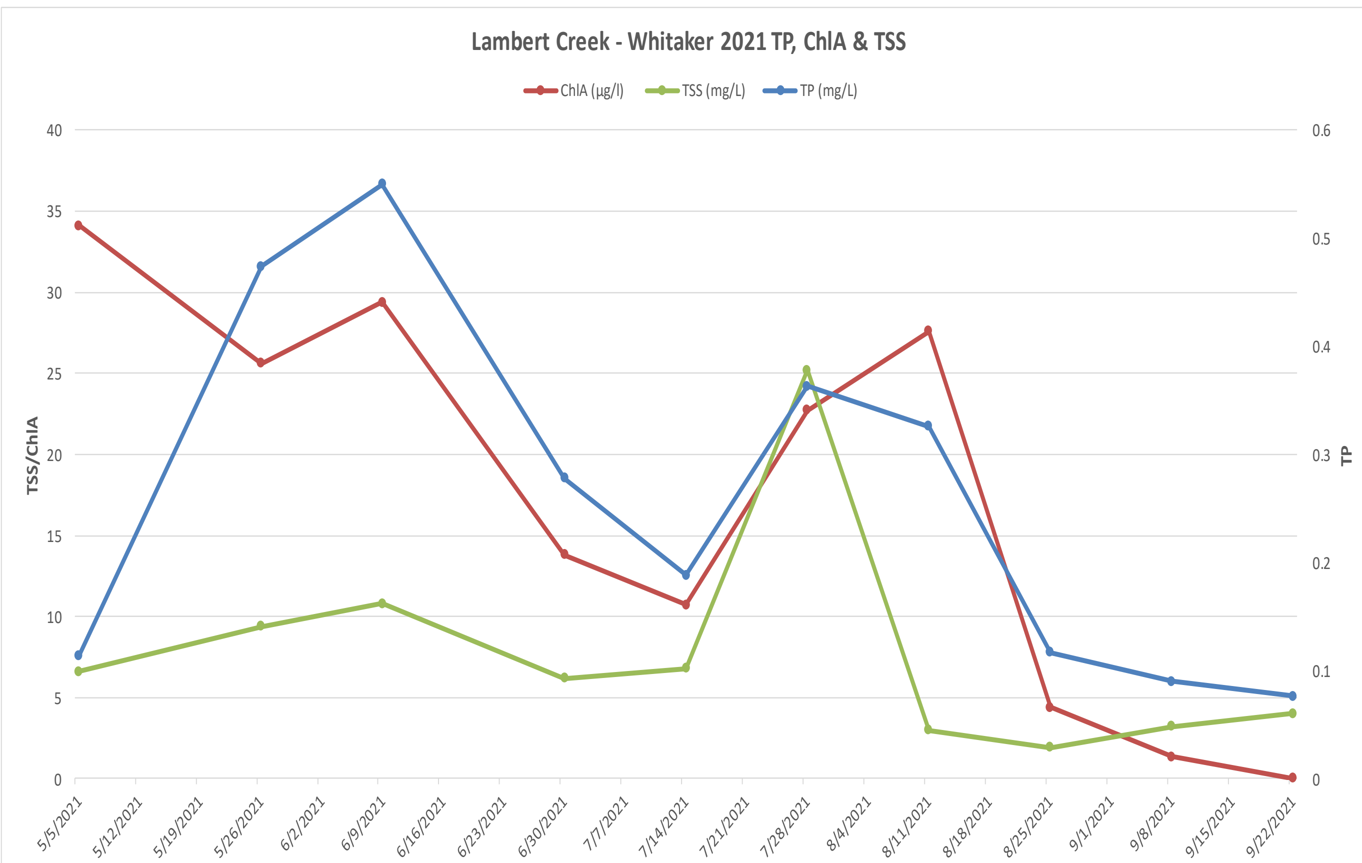
Whitaker				
Year	TP(µg/L)	SRP(ug/L)	TSS(mg/L)	ChlA (mg/m³)
2009	240		11	
2010	229	91	19.7	
2011	157	45	12.7	
2012	398	103	11.5	
2013	226	71	9	
2014	173	100	1.4	
2015	416	157	3.1	
2016	267	119	8	8
2017	202	93	6	3
2018	173	69	6	21
2019	209	93	11	35
2020	264	87	8	62
2021	258	102	8	18

Date	Temp °C	Conductivity (mS/cm)	DO (mg/L)	pH
5/7/2021	16	0.765	10.83	8.57
5/21/2021	18.1	0.766	4.95	8.63
6/9/2021	26.8	0.763	1.39	8.42
6/18/2021	24	0.759	1.56	8.54
7/7/2021	21.1	0.763	1.33	8.72
7/19/2021	26.0	0.767	1.85	8.80



Lambert Creek—Whitaker

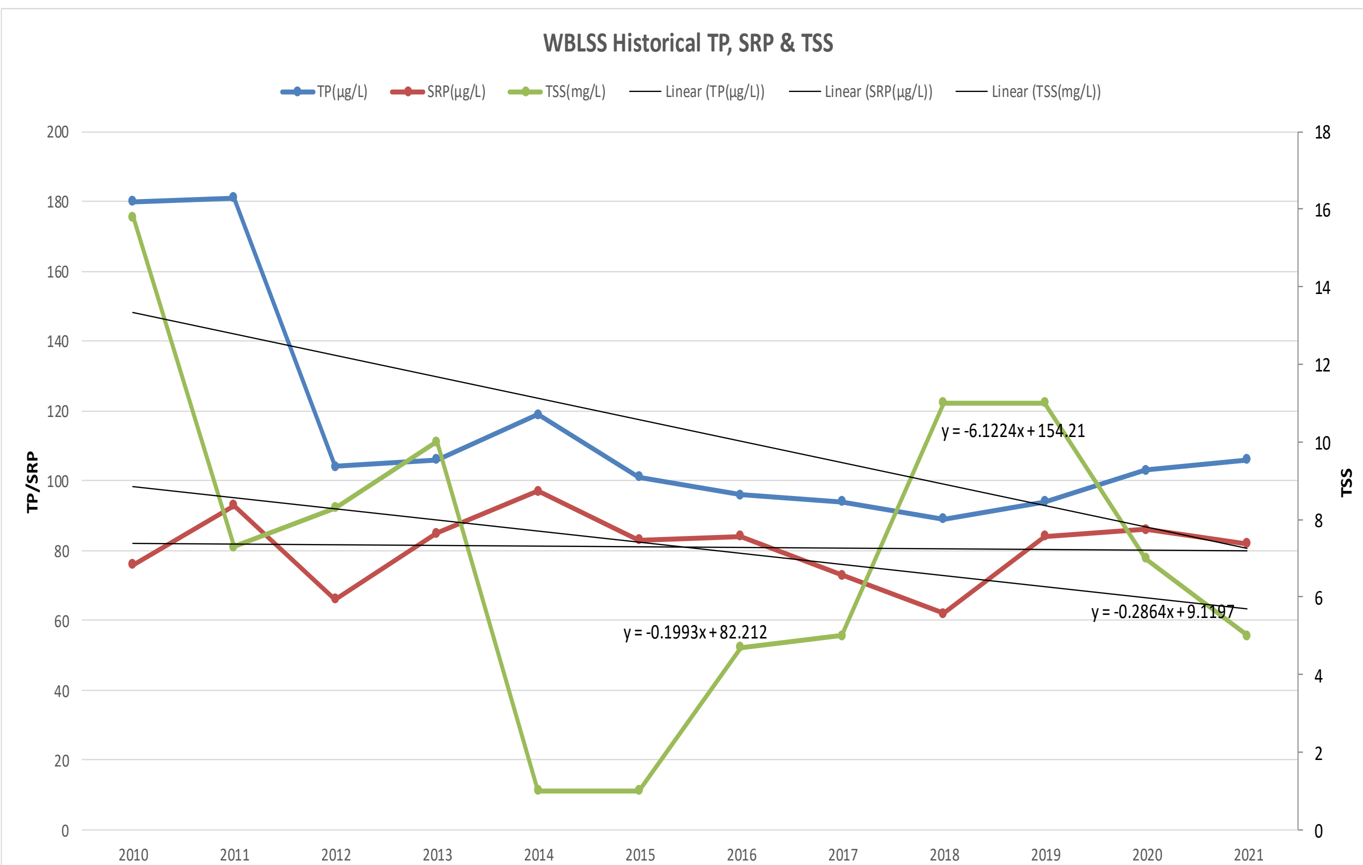
SITE	DATE	TP (mg/L)	ChlA (µg/l)	TSS (mg/L)	SRP (µg/L)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	Cl (mg/L)
whitaker	4/6/2021								81
whitaker	5/5/2021	0.114	34.1	6.6	0.013	0.81	0.17	0.61	
whitaker	5/26/2021	0.474	25.6	9.4	0.195				
whitaker	6/9/2021	0.55	29.4	10.8	0.172 [2]		1.24	<0.03	
whitaker	6/30/2021	0.278	13.8	6.2	0.157				
whitaker	7/14/2021	0.188	10.7	6.8	0.068	1.51	0.74	0.15	
whitaker	7/28/2021	0.363	22.7	25.2	0.134				
whitaker	8/11/2021	0.326	27.6	3	0.125	1.66	0.55	<0.03	
whitaker	8/25/2021	0.117	4.4	1.9	0.038 [1]				
whitaker	9/8/2021	0.09	1.34	3.2	0.025	0.91	0.5	0.44	
whitaker	9/22/2021	0.076	<2.22	4	0.037 [1]				



Lambert Creek—WBLSS

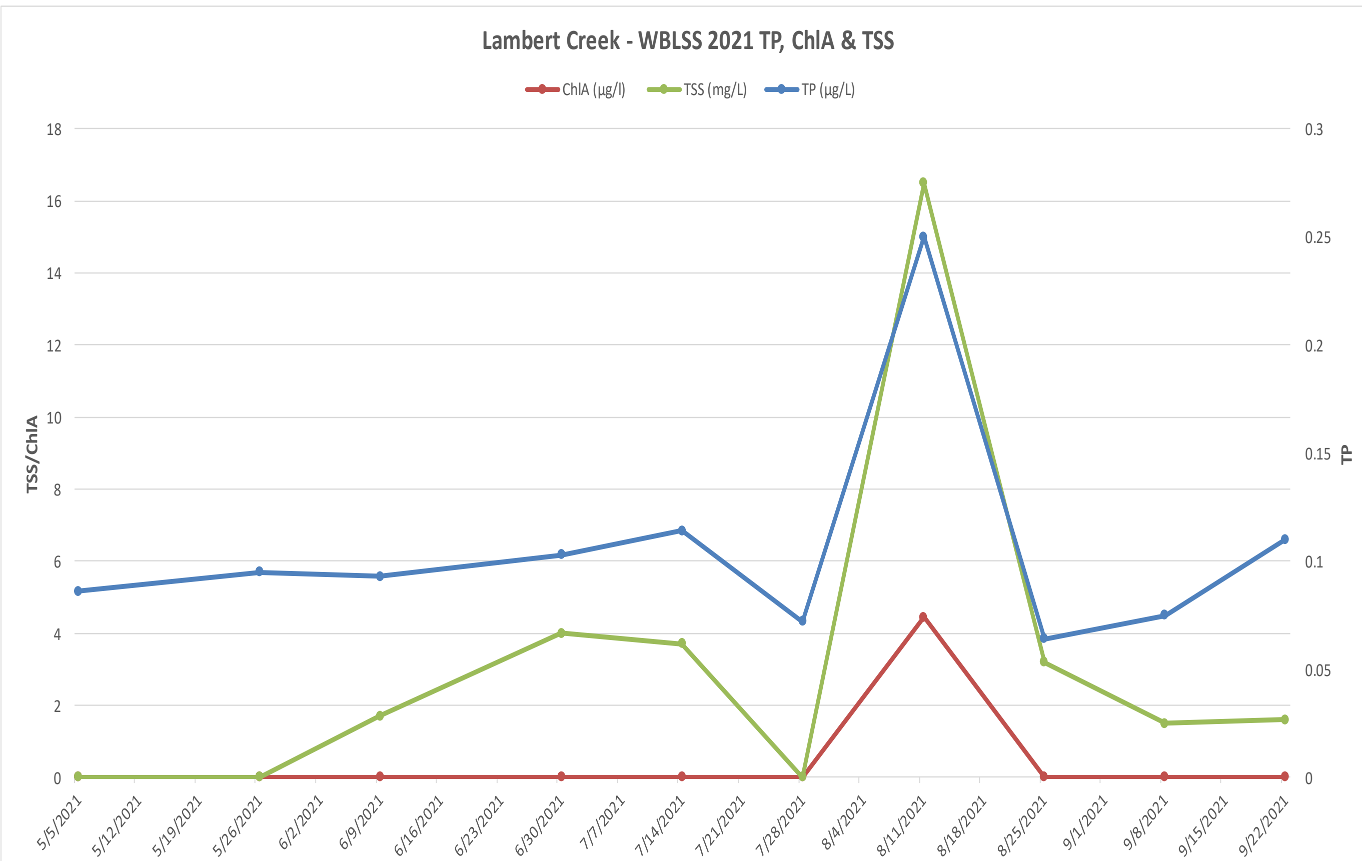
White Bear Lake Storm Sewer				
Year	TP(µg/L)	SRP(µg/L)	TSS(mg/L)	ChlA (mg/m³)
2009	110		5.9	
2010	180	76	15.8	
2011	181	93	7.3	
2012	104	66	8.3	
2013	106	85	10	
2014	119	97	1	
2015	101	83	1	
2016	96	84	4.7	5
2017	94	73	5	1
2018	89	62	11	4
2019	94	84	11	2
2020	103	86	7	2
2021	106	82	5	4

Date	Temp °C	Conductivity (mS/cm)	DO (mg/L)	pH
5/7/2021	9.1	0.765	11.66	8.58
5/21/2021	16.9	0.765	8.51	8.89
6/9/2021	13.8	0.763	7.64	8.60
6/18/2021	14.3	0.758	6.41	8.67
7/7/2021	11.5	0.763	3.79	8.70
7/19/2021	16.2	0.768	4.89	8.73



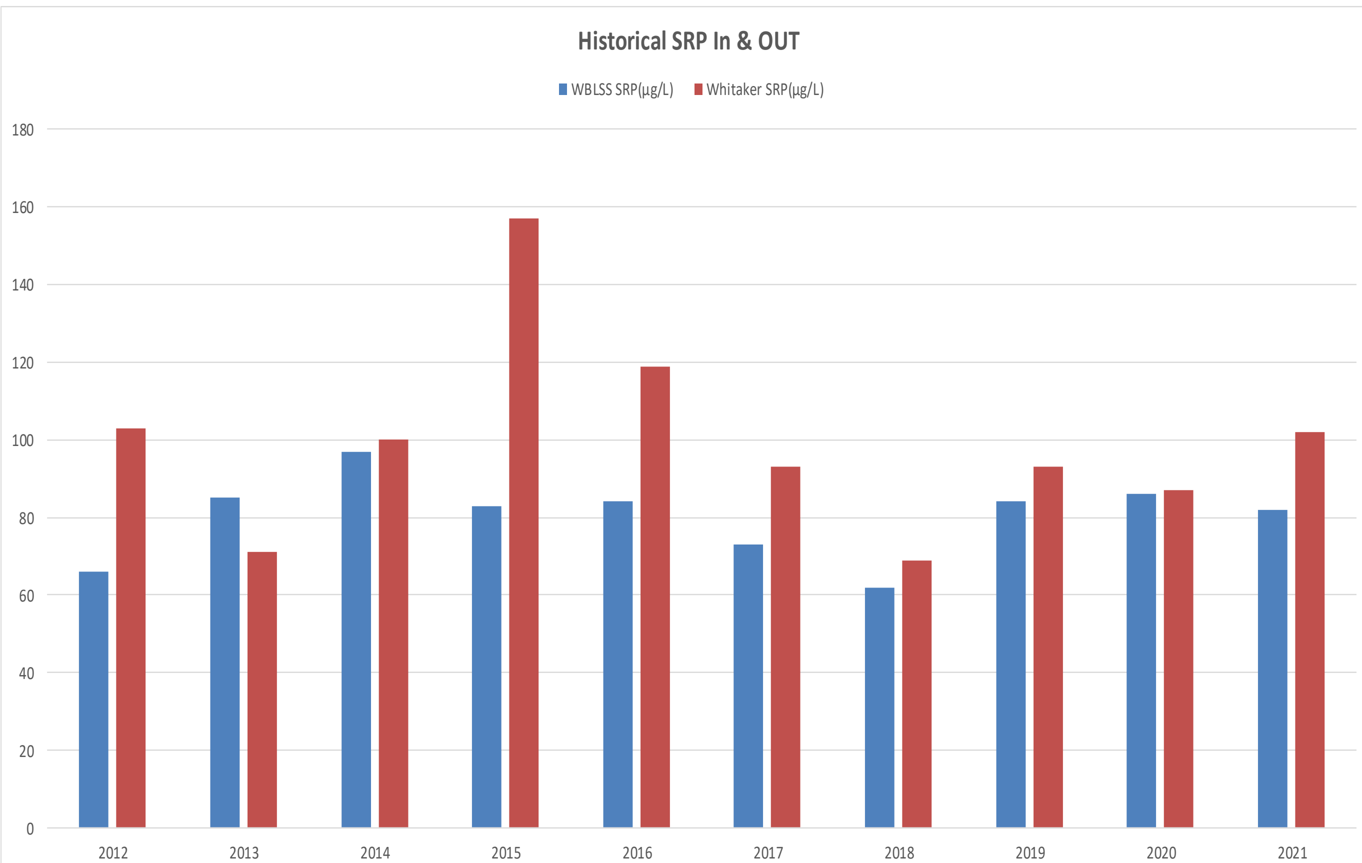
Lambert Creek—WBLSS

SITE	DATE	TP (µg/L)	ChlA (µg/l)	TSS (mg/L)	SRP (µg/L)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
WBLSS	4/6/2021								36
WBLSS	5/5/2021	0.086	<1.11	<1.0	0.094	0.4	0.05	4.8	
WBLSS	5/26/2021	0.095	<1.11	<1.1	0.098				
WBLSS	6/9/2021	0.093	<2.22	1.7	0.101 [2]		0.05	4.72	
WBLSS	6/30/2021	0.103	<2.86	4	0.061				
WBLSS	7/14/2021	0.114	<1.11	3.7	0.077	0.65	0.17	2.13	
WBLSS	7/28/2021	0.072	<1.11	<1.0	0.066				
WBLSS	8/11/2021	0.25	4.45	16.5	0.108	1.65	0.65	0.95	
WBLSS	8/25/2021	0.064	<1.11	3.2	0.073 [1]				
WBLSS	9/8/2021	0.075	<1.25	1.5	0.068	<0.30	0.03	3.32	
WBLSS	9/22/2021	0.11	<1.11	1.6	0.055 [1]				



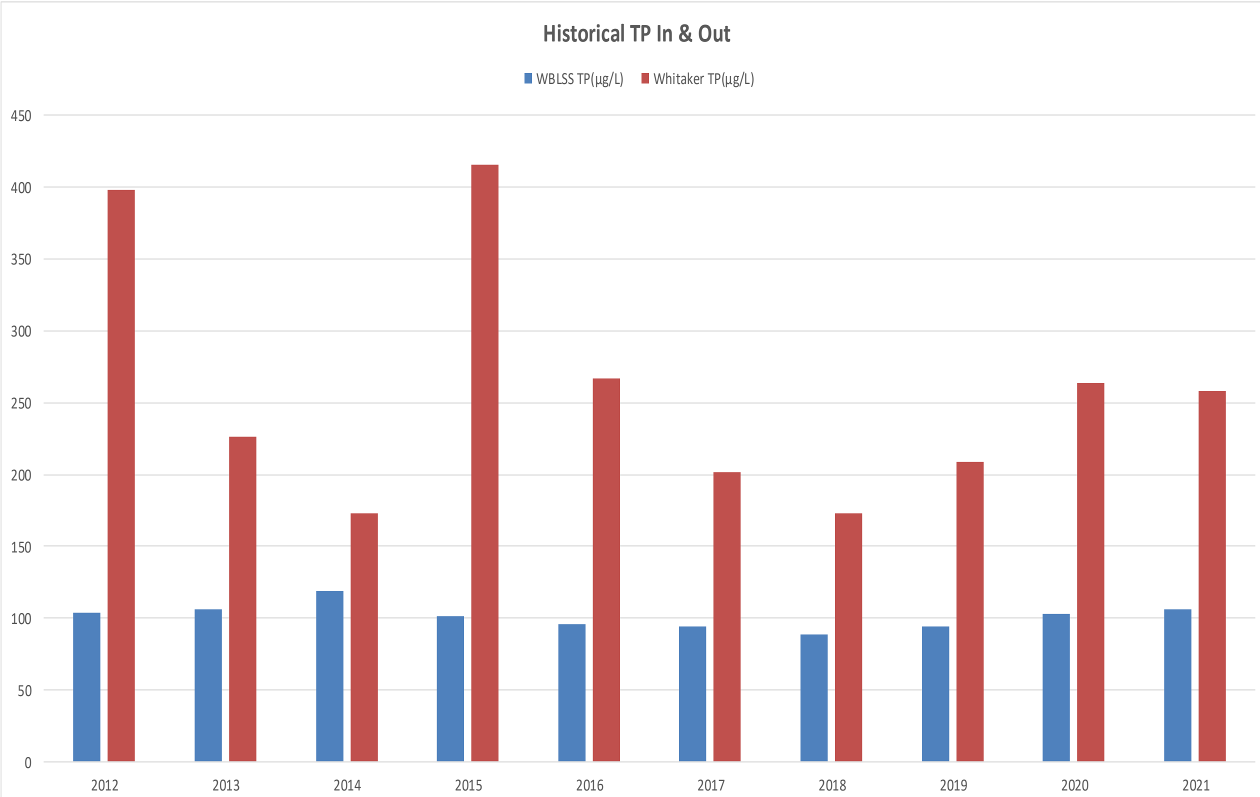
Lambert Creek—WBLSS

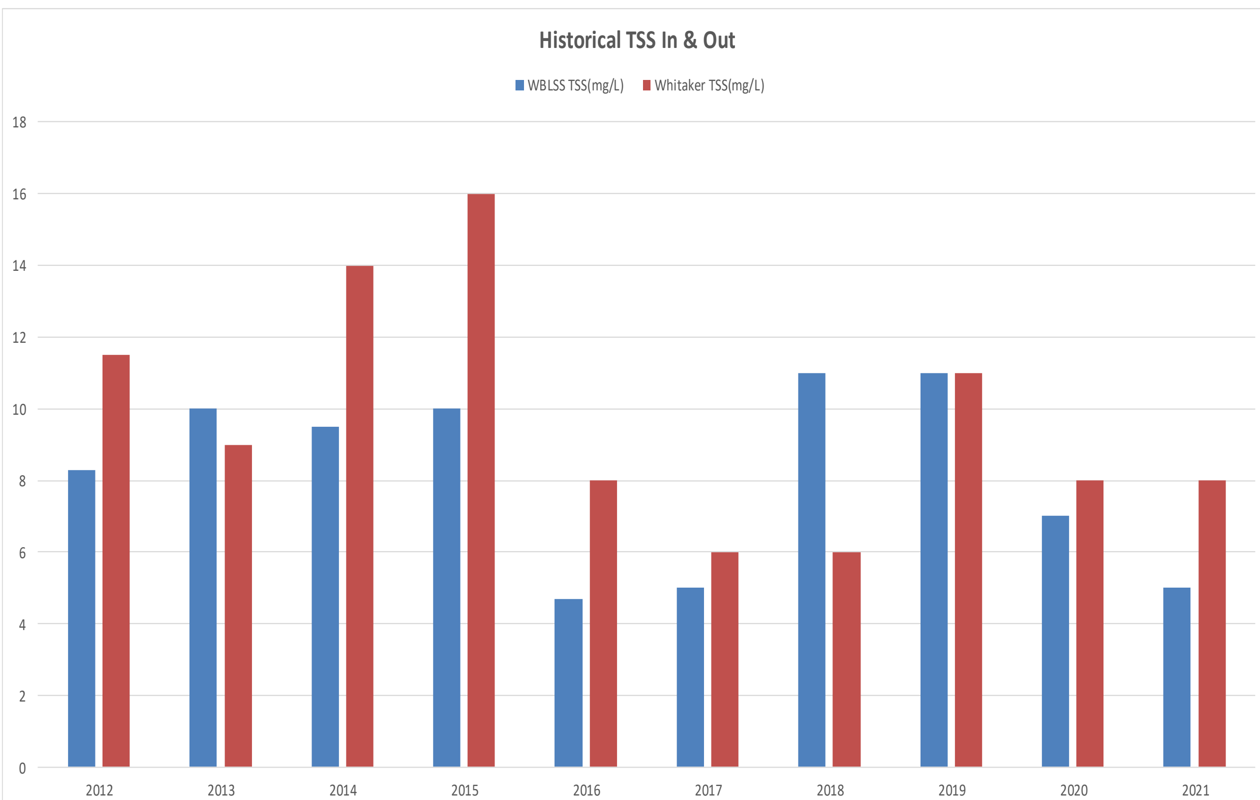
	WBLSS TP (µg/L)	Whitaker TP (µg/L)		WBLSS SRP (µg/L)	Whitaker SRP(µg/L)		WBLSS TSS (mg/L)	Whitaker TSS(mg/L)
2009	110	240	**2009**			**2009**	5.9	11
2010	180	229	**2010**	76	91	**2010**	15.8	19.7
2011	181	157	**2011**	93	45	**2011**	7.3	12.7
2012	104	398	**2012**	66	103	**2012**	8.3	11.5
2013	106	226	**2013**	85	71	**2013**	10	9
2014	119	173	**2014**	97	100	**2014**	9.5	14
2015	101	416	**2015**	83	157	**2015**	10	16
2016	96	267	**2016**	84	119	**2016**	4.7	8
2017	94	202	**2017**	73	93	**2017**	5	6
2018	89	173	**2018**	62	69	**2018**	11	6
2019	94	209	**2019**	84	93	**2019**	11	11
2020	103	264	**2020**	86	87	**2020**	7	8
2021	106	258	**2021**	82	102	**2021**	5	8



- The above graphs are the average year to year comparisons of nutrient levels entering Whitaker Pond from the WBLSS and leaving Whitaker Pond.

Lambert Creek—WBLSS



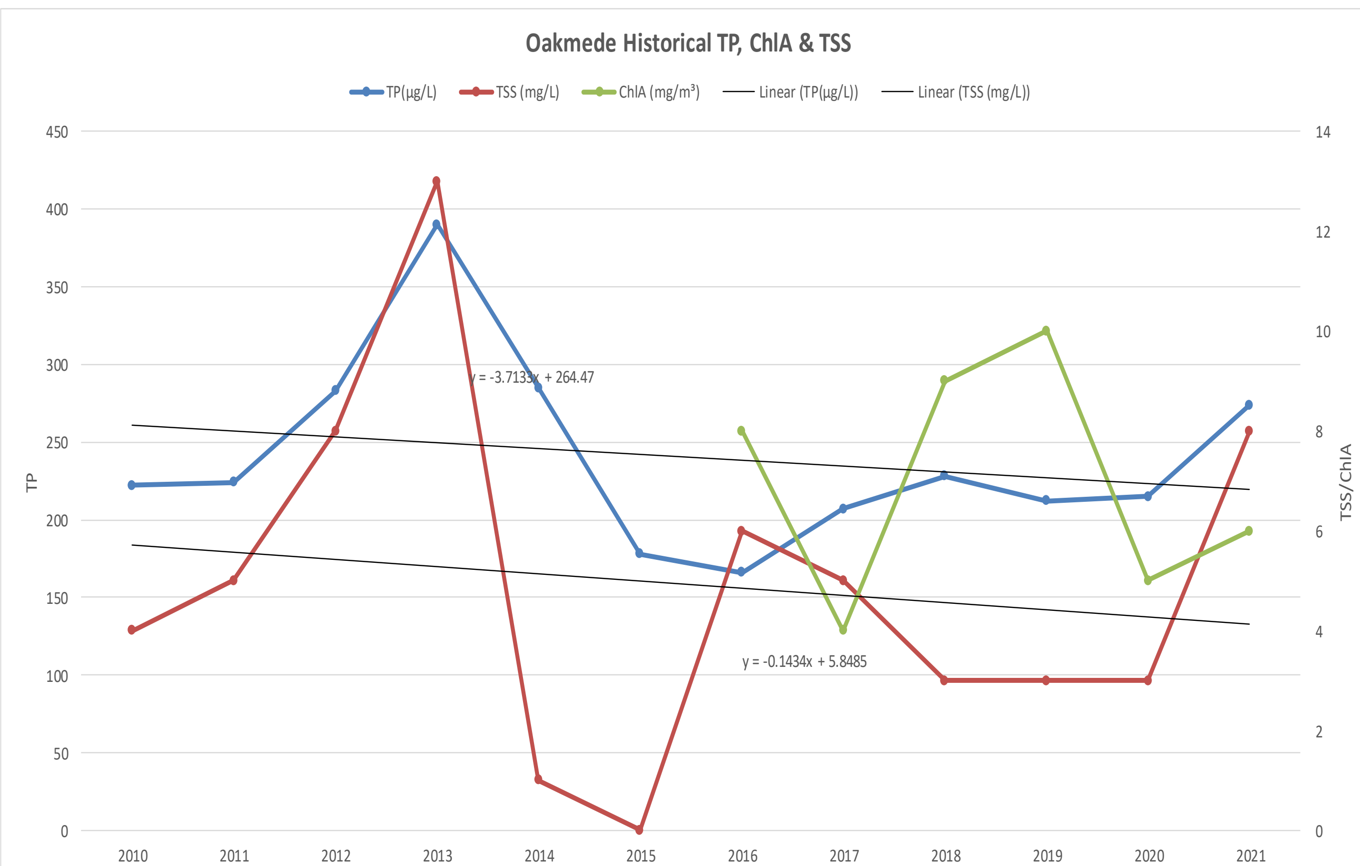


- The above graphs are the average year to year comparisons of nutrient levels entering Whitaker Pond from the WBLSS and leaving Whitaker Pond.

Lambert Creek—Oakmede

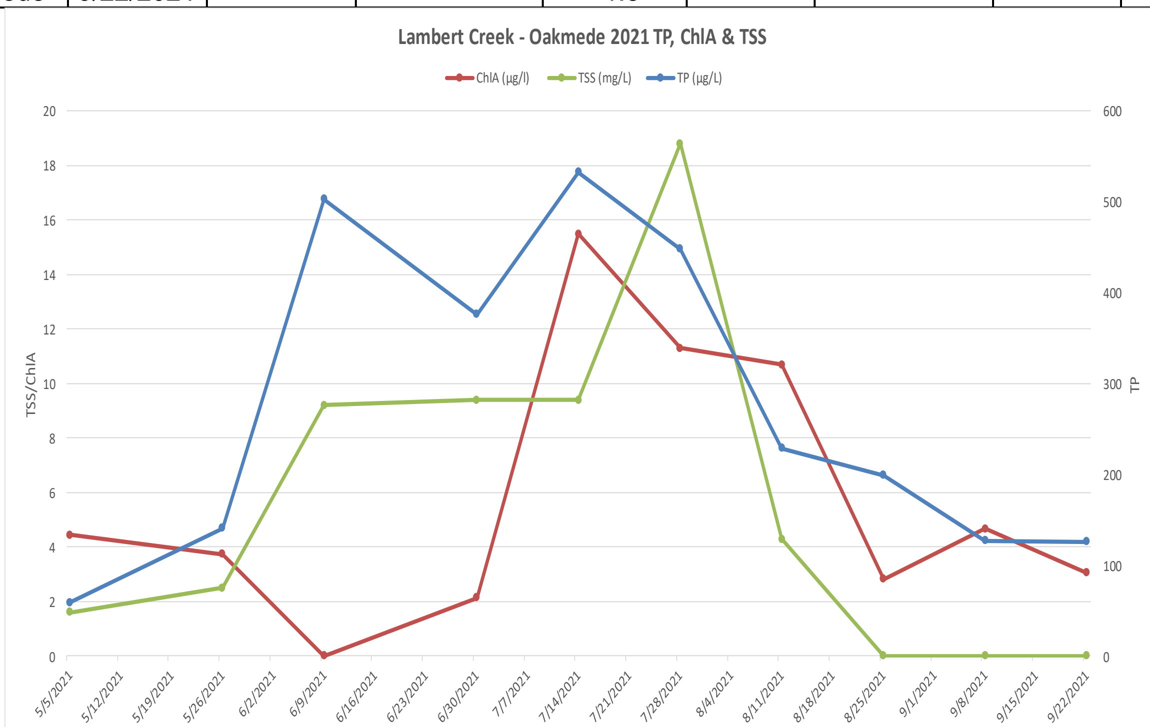
Oakmede			
Year	TP(µg/L)	TSS (mg/L)	ChlA (mg/m³)
2009	210	6	
2010	222	4	
2011	224	5	
2012	283	8	
2013	390	13	
2014	285	1	
2015	178	0	
2016	166	6	8
2017	207	5	4
2018	228	3	9
2019	212	3	10
2020	215	3	5
2021	274	8	6

Date	Temp °C	Conductivity (mS/cm)	DO (mg/L)	pH
5/7/2021	16.7	0.765	10.49	8.53
5/21/2021	20.1	0.766	5.09	8.51
6/9/2021	26.2	0.763	1.91	8.53
6/18/2021	19.8	0.759	2.65	8.77
7/77/21	17.4	0.763	3.26	8.81
7/19/2021	25.2	0.768	2.8	8.83

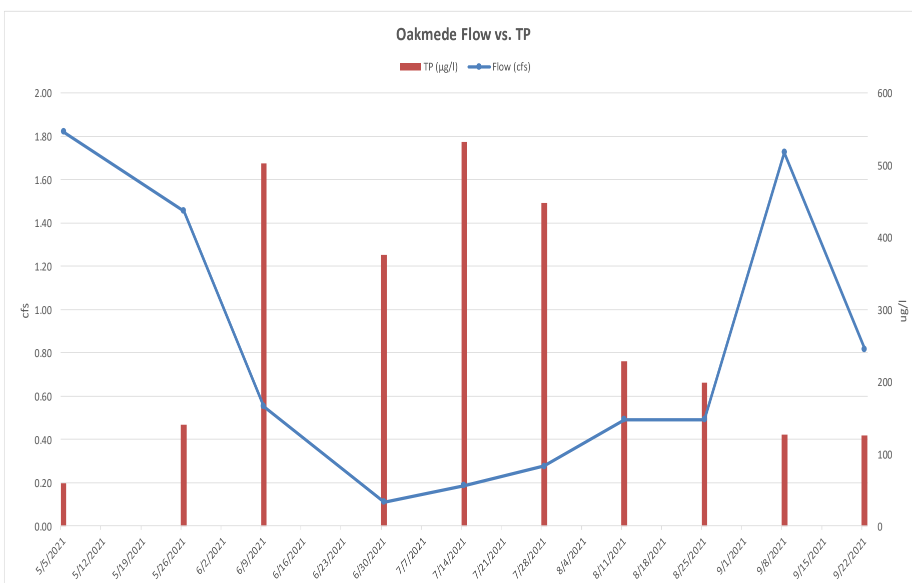


Lambert Creek—Oakmede

SITE	DATE	TP (µg/L)	ChlA (µg/l)	TSS (mg/L)	TKN (mg/ L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
oakmede	4/6/2021							135
oakmede	5/5/2021	59	4.45	1.6	0.56	0.08	0.05	
oakmede	5/26/2021	141	3.74	2.5				
oakmede	6/9/2021	503	<2.00	9.2		1.42	<0.03	
oakmede	6/30/2021	376	2.14	9.4				
oakmede	7/14/2021	533	15.5	9.4	3.4	2.44	<0.03	
oakmede	7/28/2021	448	11.3	18.8				
oakmede	8/11/2021	229	10.7	4.3	1.03	0.41	<0.03	
oakmede	8/25/2021	199	2.83	<1.7				
oakmede	9/8/2021	127	4.67	<1.2	0.64	0.09	<0.03	
oakmede	9/22/2021	126	3.05	<1.3				



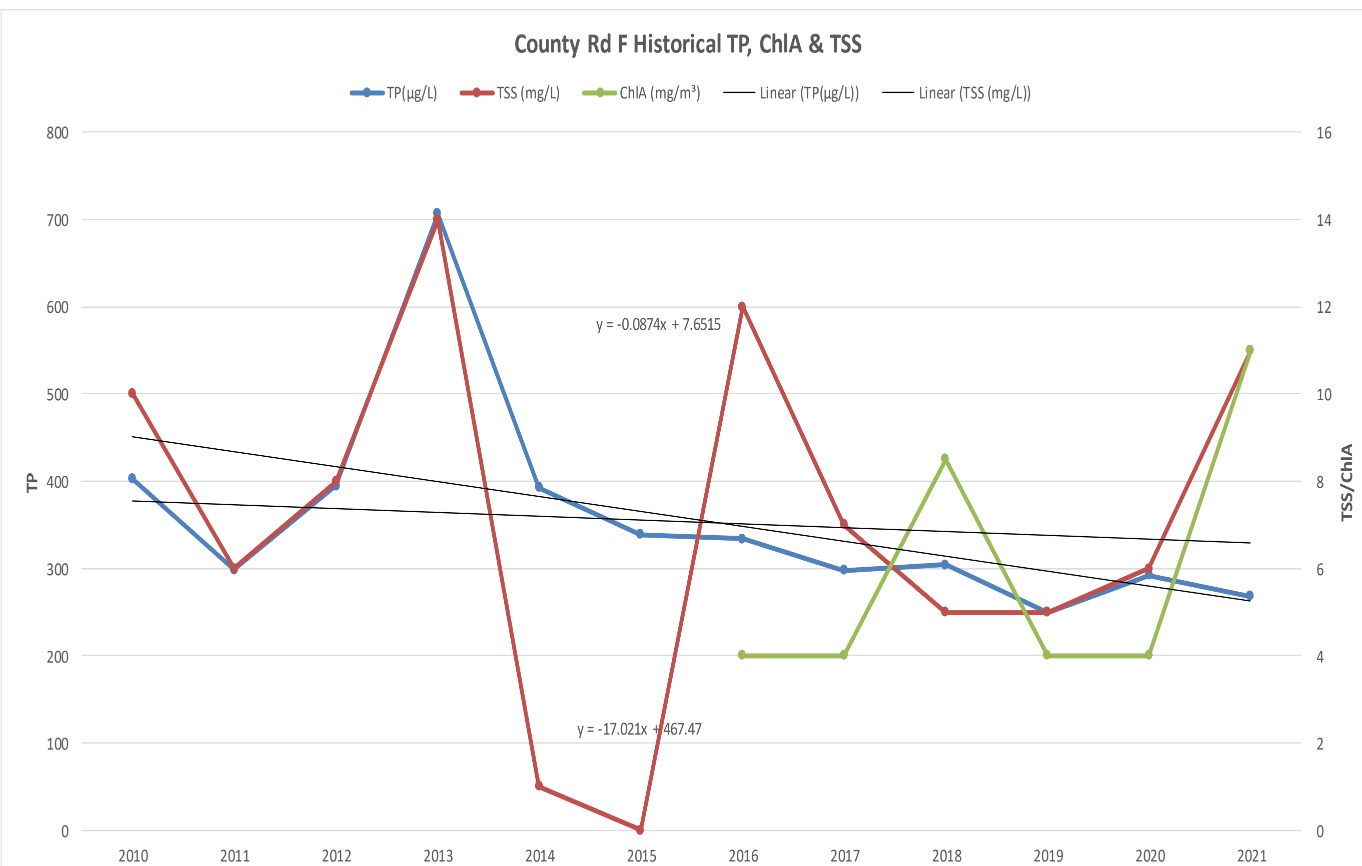
Date	Flow (cfs)	TP (µg/l)
5/5/2021	1.82	59
5/26/2021	1.46	141
6/9/2021	0.55	503
6/30/2021	0.11	376
7/14/2021	0.19	533
7/28/2021	0.28	448
8/11/2021	0.49	229
8/25/2021	0.49	199
9/8/2021	1.73	127
9/22/2021	0.82	126



Lambert Creek—Cty Rd F

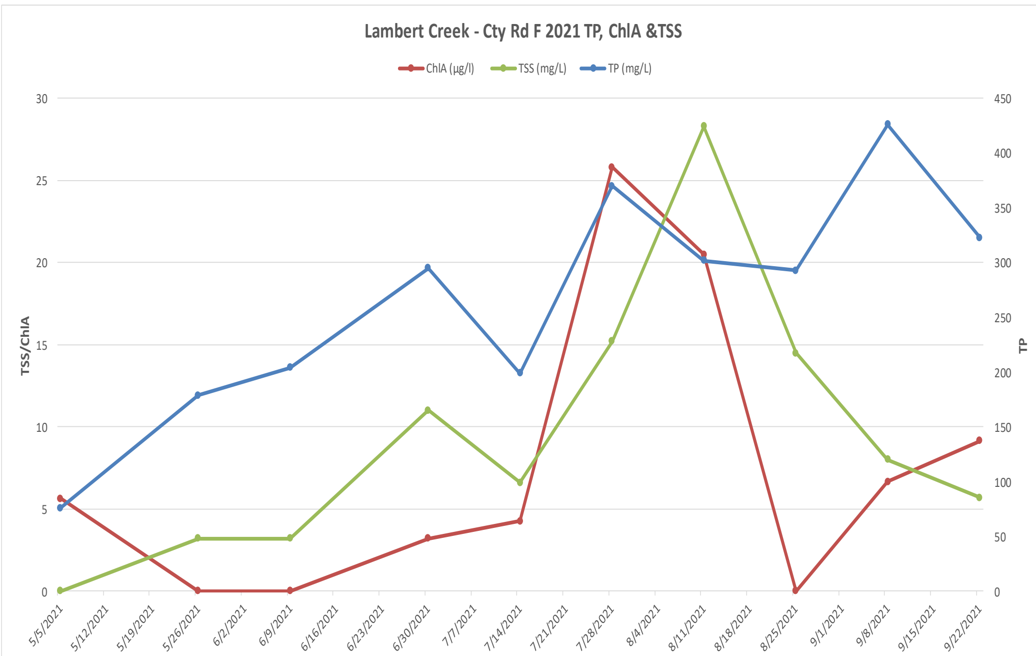
County Road F			
Year	TP(µg/L)	TSS (mg/L)	ChlA (mg/m³)
2009	190	11	
2010	403	10	
2011	299	6	
2012	395	8	
2013	707	14	
2014	393	1	
2015	339	0	
2016	334	12	4
2017	298	7	4
2018	304	5	8.5
2019	250	5	4
2020	292	6	4
2021	268	11	11

Date	Temp °C	Conductivity (mS/cm)	DO (mg/L)	pH
5/7/2021	15.0	0.765	11	8.53
5/21/2021	19.1	0.766	7.06	8.47
6/9/2021	26.4	0.764	5.34	8.51
6/18/2021	20.3	0.759	4.32	8.71
7/7/2021	15.9	0.764	3.85	8.65
7/19/2021	21.9	0.768	4.03	8.83

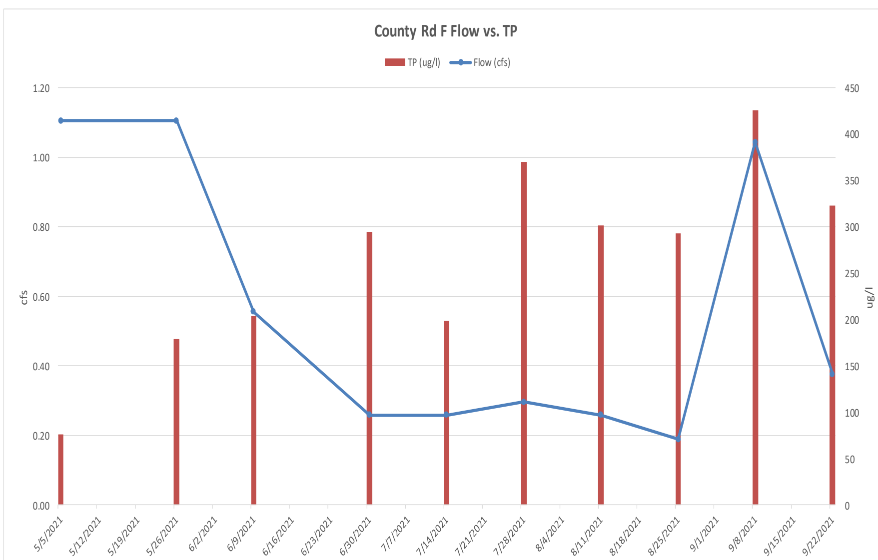


Lambert Creek—Cty Rd F

SITE	DATE	TP (mg/L)	ChlA (µg/l)	TSS (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
cty rd F	4/6/2021							138
cty rd F	5/5/2021	76	5.64	<2.2	0.62	0.09	<0.03	
cty rd F	5/26/2021	179	<2.50	3.2				
cty rd F	6/9/2021	204	<2.00	3.2		0.23	0.06	
cty rd F	6/30/2021	295	3.2	11				
cty rd F	7/14/2021	199	4.27	6.6	1.36	0.45	0.26	
cty rd F	7/28/2021	370	25.8	15.2				
cty rd F	8/11/2021	302	20.5	28.3	4.25	1.6	0.4	
cty rd F	8/25/2021	293	<6.67	14.5				
cty rd F	9/8/2021	426	6.68	8	1.1	0.15	<0.03	
cty rd F	9/22/2021	323	9.15	5.7				



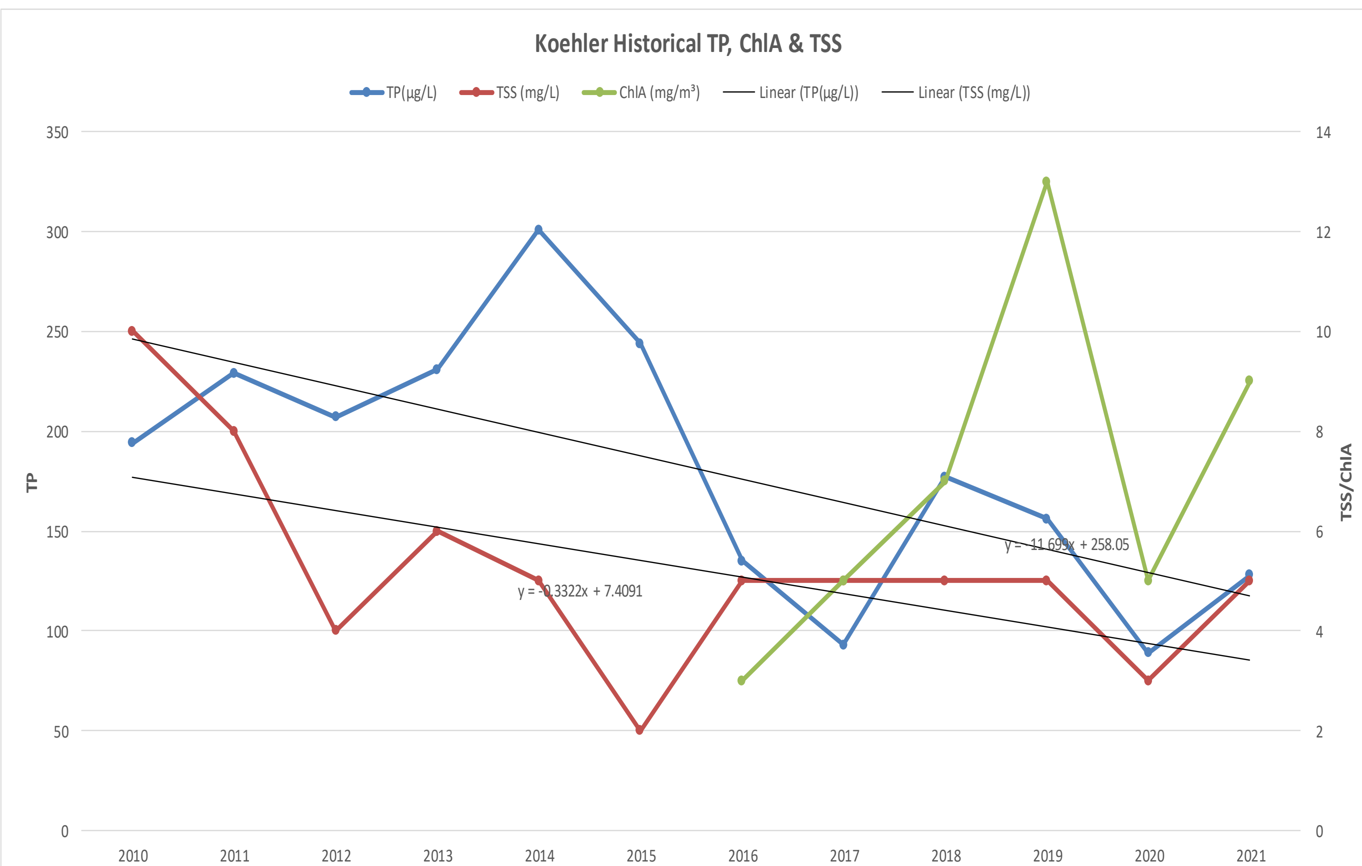
Date	Flow (cfs)	TP (ug/l)
5/5/2021	1.11	76
5/26/2021	1.11	179
6/9/2021	0.56	204
6/30/2021	0.26	295
7/14/2021	0.26	199
7/28/2021	0.30	370
8/11/2021	0.26	302
8/25/2021	0.19	293
9/8/2021	1.04	426
9/22/2021	0.38	323



Lambert Creek—Koehler

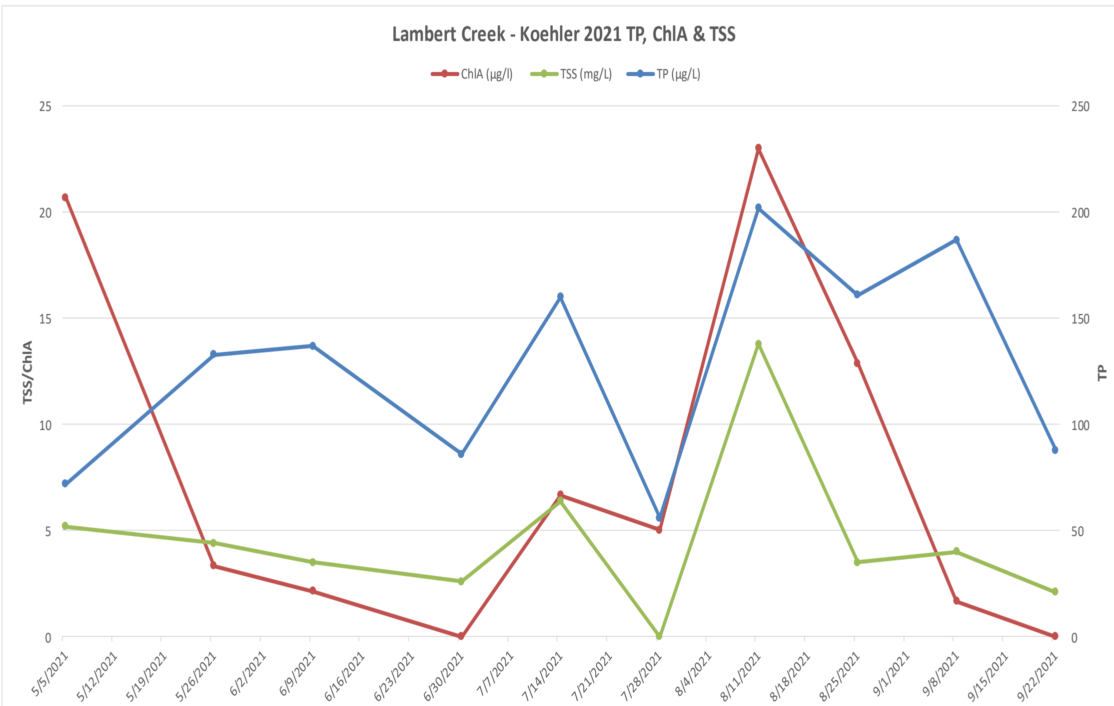
Koehler			
Year	TP(µg/L)	TSS (mg/L)	ChlA (mg/m³)
2009	120	9	
2010	194	10	
2011	229	8	
2012	207	4	
2013	231	6	
2014	301	5	
2015	244	2	
2016	135	5	3
2017	93	5	5
2018	177	5	7
2019	156	5	13
2020	89	3	5
2021	128	5	9

Date	Temp °C	Conductivity (mS/cm)	DO (mg/L)	pH
5/7/2021	14.0	0.766	15.4	8.47
5/21/2021	17.1	0.766	6.34	8.44
6/9/2021	23.5	0.764	4.14	8.52
6/18/2021	19.1	0.759	6.11	8.85
7/7/2021	16.8	0.764	7.41	8.82
7/19/2021	21.4	0.768	6.65	9.05

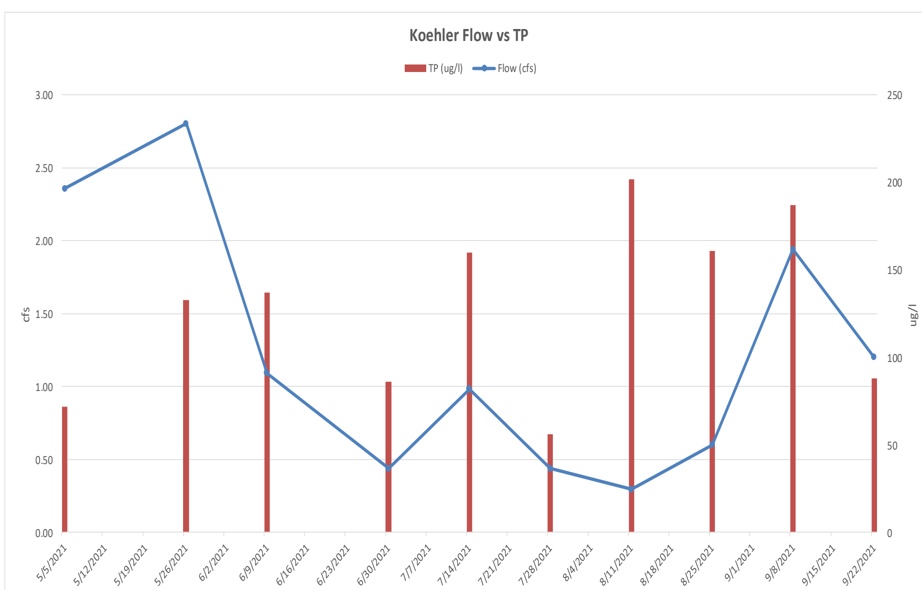


Lambert Creek—Koehler

SITE	DATE	TP (µg/L)	ChlA (µg/l)	TSS (mg/L)	TKN (mg/L)	NH3 (mg/L)	NO2+NO3 mg/L	CL (mg/L)
koehler	4/6/2021							155
koehler	5/5/2021	72	20.7	5.2	1.22	0.43	0.13	
koehler	5/26/2021	133	3.34	4.4				
koehler	6/9/2021	137	2.14	3.5		0.5	0.69	
koehler	6/30/2021	86	<2.22	2.6				
koehler	7/14/2021	160	6.68	6.4	1.58	0.47	0.17	
koehler	7/28/2021	56	5.04	<2.0				
koehler	8/11/2021	202	23	13.8	1.05	0.29	1.02	
koehler	8/25/2021	161	12.9	3.5				
koehler	9/8/2021	187	1.67	4	1.06	0.25	0.21	
koehler	9/22/2021	88	<1.43	2.1				

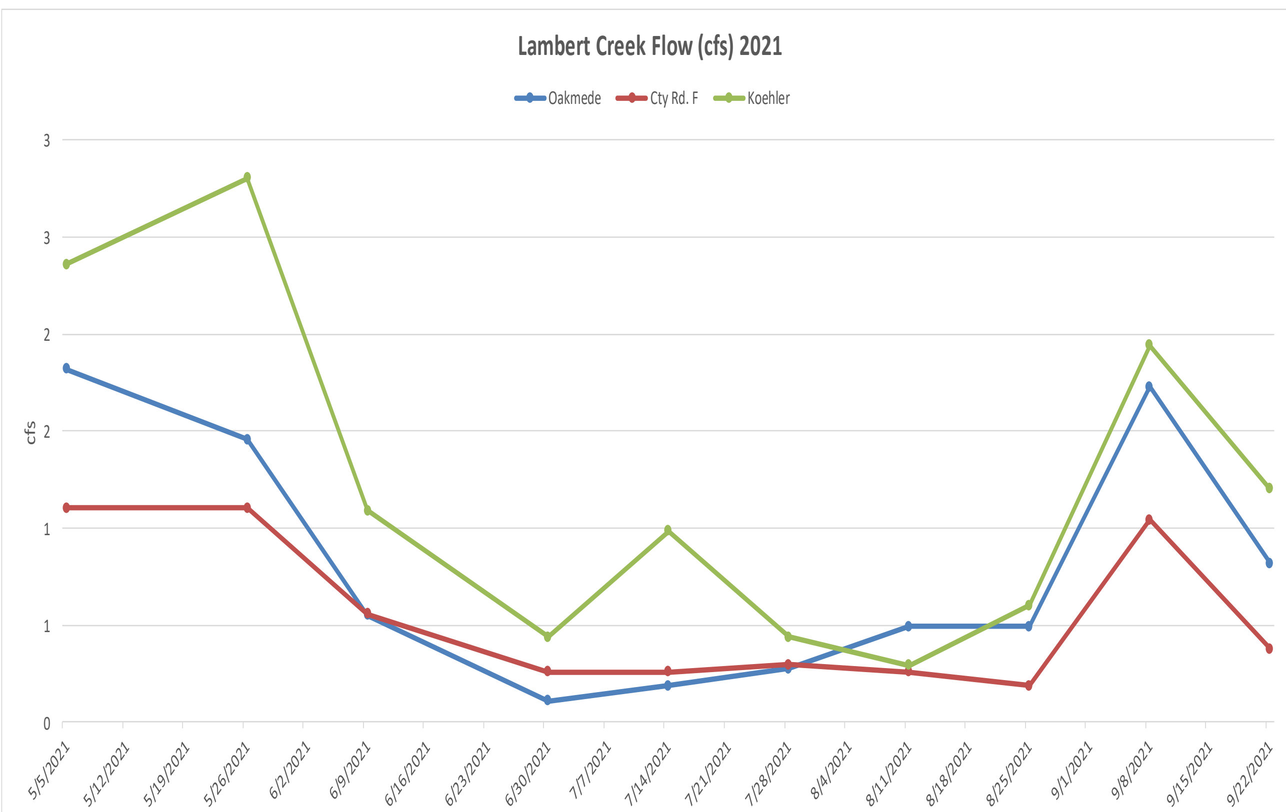


Date	Flow (cfs)	TP (ug/l)
5/5/2021	2.36	72
5/26/2021	2.80	133
6/9/2021	1.09	137
6/30/2021	0.44	86
7/14/2021	0.99	160
7/28/2021	0.44	56
8/11/2021	0.29	202
8/25/2021	0.60	161
9/8/2021	1.94	187
9/22/2021	1.20	88



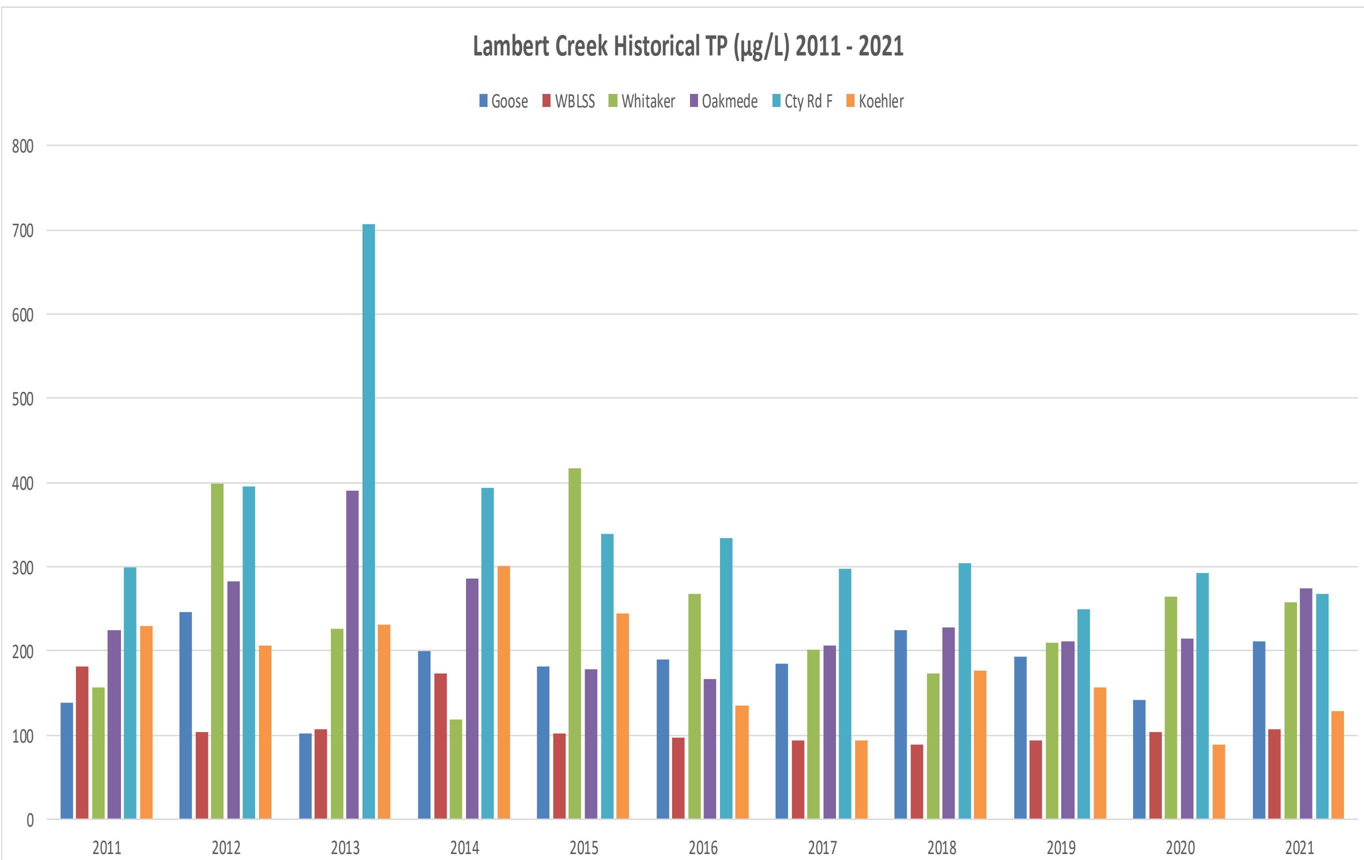
Lambert Creek Flow

Creek Flow 2021			
Date	**Oakmede**	**Cty Rd. F**	**Koehler**
5/5/2021	1.82	1.11	2.36
5/26/2021	1.46	1.11	2.80
6/9/2021	0.55	0.56	1.09
6/30/2021	0.11	0.26	0.44
7/14/2021	0.19	0.26	0.99
7/28/2021	0.28	0.30	0.44
8/11/2021	0.49	0.26	0.29
8/25/2021	0.49	0.19	0.60
9/8/2021	1.73	1.04	1.94
9/22/2021	0.82	0.38	1.20



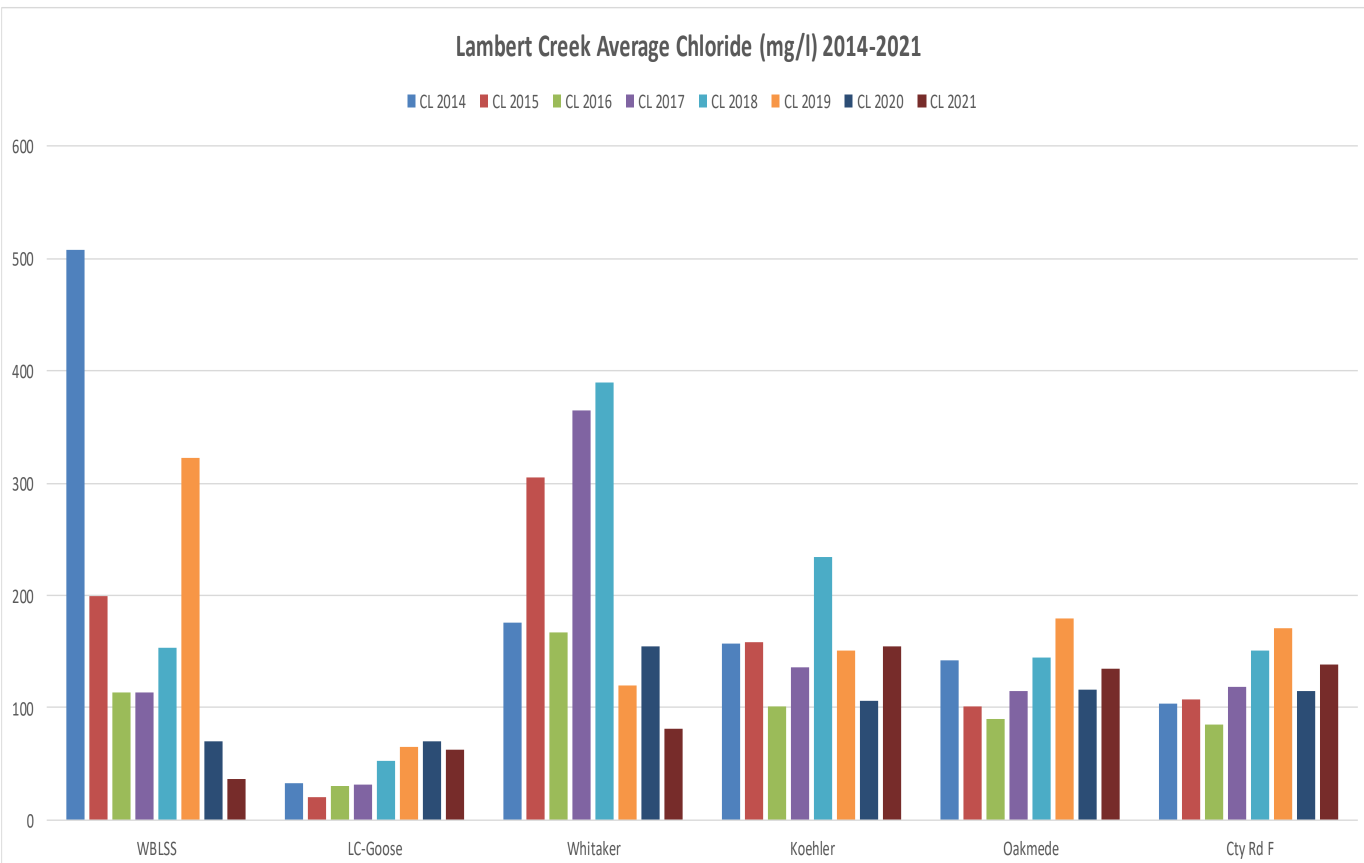
Lambert Creek Comparison

Lambert Creek Average Yearly Tp (µg/L) 2011-2021											
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Goose	138	246	102	199	181	189	185	224	193	141	212
WBLSS	181	104	106	173	101	96	94	89	94	103	106
Whita-ker	157	398	226	119	416	267	202	173	209	264	258
Oak-mede	224	283	390	285	178	166	207	228	212	215	274
Cty Rd F	299	395	707	393	339	334	298	304	250	292	268
Koehler	229	207	231	301	244	135	93	177	156	89	128



Lambert Creek Comparison

SITE	CL 2012	CL 2013	CL 2014	CL 2015	CL 2016	CL 2017	CL 2018	CL 2019	CL 2020	CL 2021
WBLSS	11.1	76	507.5	200	113	113	153	322	70	36
LC-Goose	30.9	40.5	32.75	20	30	31	53	65	70	63
Whitaker	67.5	52	175.5	305	167	365	390	120	155	81
Koehler	79.2	107.5	157	158	101	136	234	151	106	155
Oakmede	84.0	85.5	141.75	101	90	115	145	180	116	135
Cty Rd F	92.4	90.5	104	107	85	119	151	171	115	138



2020 Monitoring Highlights

- **Pleasant & East Vadnais Lake:** VLAWMO added Pleasant and East Vadnas lake to the sampling program in 2020. East Vadnais water quality continues to be very good and well below state standards. Pleasant lake nutrients increased on average from 2020.
- **Remote Monitoring Devices:** 2021 was the second full year of automated creek flow monitoring. Live information can be found here for the 4 sites monitored on the creek. http://monitormywatershed.org/
- **Goose Lake:** East Goose and West Goose have exceptionally high nutrient levels. VLAWMO is working with local partners and stakeholders to discuss plans for future management activities to help address the high nutrient levels.
- **Lambert Creek:** Creek flow was very low in 2021. Rainfall was 5.5 inches below average for the season. Nutrient levels were similar to 2020.
- **Ash Street Pond:** Spent lime study was done on Ash Street pond in Lino Lakes to test if the lime would reduce TP levels. Preliminary results showed some decrease in TP levels after the lime applications.
- **Lake Nutrient Levels:** Nutrient levels in all 15 lakes VLAWMO monitors were similar to 2020 even with the below average rainfall.
- **Chloride (Road Salt):** Chloride levels overall were similar compared to 2020. VLAWMO has been sampling lake chloride for 12 years and while slight rises are documented, there have been no major changes within the lakes. Black Lake has the lowest levels. Birch Lake and East Goose are the highest, which coincides with their proximity to major roads and storm drainage. All of the lakes are below the current State standard of 230 mg/L. Creek samples are attempted, but are confined to times when water is flowing from streets into the creek.
- **Monitoring Data:** The VLAWMO monitoring data was used for multiple subshed studies and grant applications in 2021 to aid in possible water quality projects moving forward in 2022.
- **Lambert Lake Meander:** A portion of Lambert Creek in Vadnais Heights was meandered winter of 2021 to help reduce flooding issues and reduce nutrient levels in the area. Monitoring should begin in 2022 on effectiveness.

2021 Monitoring Highlights

Multi-year summary graphs