Green Lake Monitoring Report 2016

What: LID volunteers collected Total Phosphorus (TP), Chlorophyll-a (Chl-a), and Transparency information every two weeks from May through September in the deepest part of the lake (see map). SWCD Staff collected Dissolved Oxygen and Temperature information throughout the water column, once a month, from May through August at the same location. SWCD Staff provided training, equipment and coordinated lab testing.

Why: Green Lake was added to the MN impaired waters list in 2008 for having high nutrients. The listing triggered the completion of a Total Maximum Daily Load (TMDL) study. TMDL's are studies that quantify the TP reduction necessary in order to make the lake healthy again. The study identified that a 39% TP reduction is required for Green Lake.

The monitoring data collected in 2016, the first year of the monitoring partnership between the SWCD and GLID, will help us get a better understanding of the driving factors behind high nutrient levels. Furthermore, we will use the data to track trends over time and track progress and the effectiveness of projects that are meant to improve lake health (i.e. raingardens, lakeshore restorations).

Green Lake samples are summarized in this report.

Lake Data for Green Lake	
Township	Wyanett
MN Lake ID	30013600
# of Public Boat Access	1
Aquatic Invasive Species	CLPW & EWM
Surface Area	822 acres
Maximum Depth	28ft
Lake Meets Clean Water Goals	Total Phosphorus: **No**
	Chlorophyll-a: **No**
	Transparency: **YES**

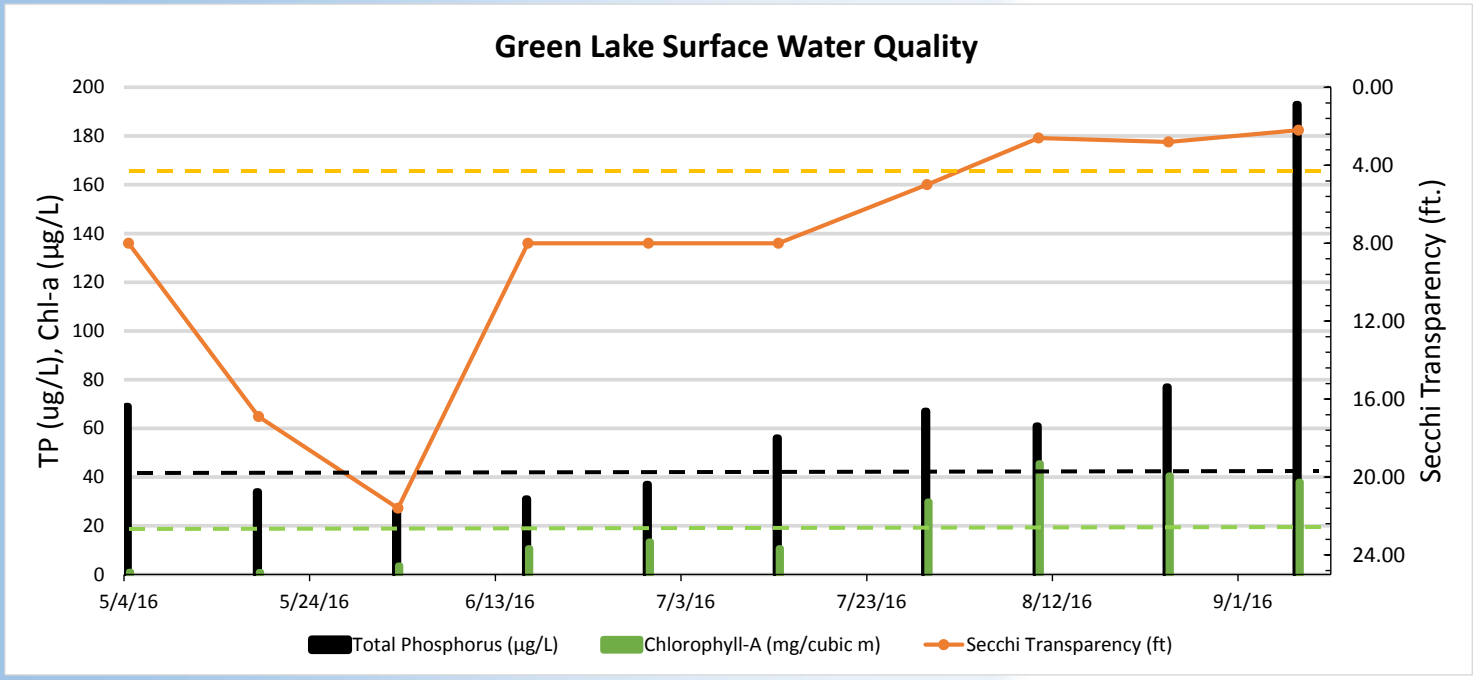
Green Lake Monitoring Results 2016

Total Phosphorus (TP), Chlorophyll-a (Chl-a) and Secchi Transparency

MN Clean Water Goals for Deep Lakes:

Total Phosphorus (TP): ≤ 40 ug/L Chlorophyll-a: ≤ 14mg/m3 Secchi Depth: ≥ 4.59 feet

Growing season average (June-September)	68.50 (TP)	24.08 (Chl-a)	7.28 (Secchi)



Green Lake has a maximum depth of 28ft and the majority of the lake is greater than 15 feet deep which means this the lake should have characteristics of a deep lake. Deep lakes tend to stratify or form layers, especially during summer, because the density of water changes as its temperature changes. The layers mix in the spring and fall. When the layers mix, nutrients trapped on the bottom of the lake can get released into the water column (termed internal loading). The phenomenon can be seen on the dissolved oxygen and temperature graphs on page 3. The monitoring results for Green Lake are compared to the State goals for deep lakes in this area.

When compared to deep lake water quality goals, Green Lake meets the goals for transparency but not for Chl-a or TP. This information is what was used to classify the lake as "impaired".

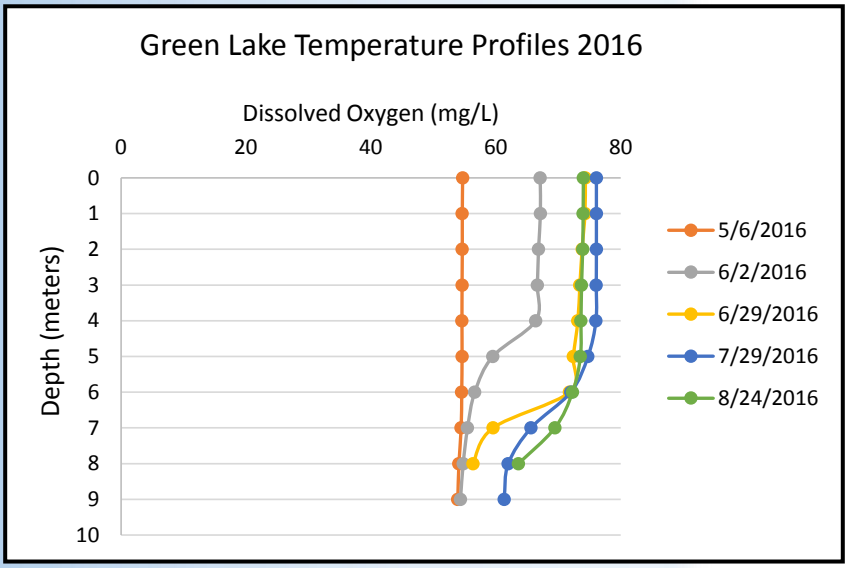
In 2016 TP was the highest early and late in the season. This result corresponds to the periods of time when the lake water column was mixed, meaning nutrients sitting at the bottom of the lake could have been released into the water above. These nutrients could be from a combination decaying vegetation and/or an accumulation of nutrients built up over time from land runoff. It is Important to note that heavy rains, which began mid-July, would have also contributed to the climbing TP and Chl-a levels. Rain runoff would have carried high nutrients from the lake tributaries, verified by monitoring data, and surrounding land. The aforementioned occurrence highlights the importance of implementing storm water practices to treat the runoff before it reaches the lake.

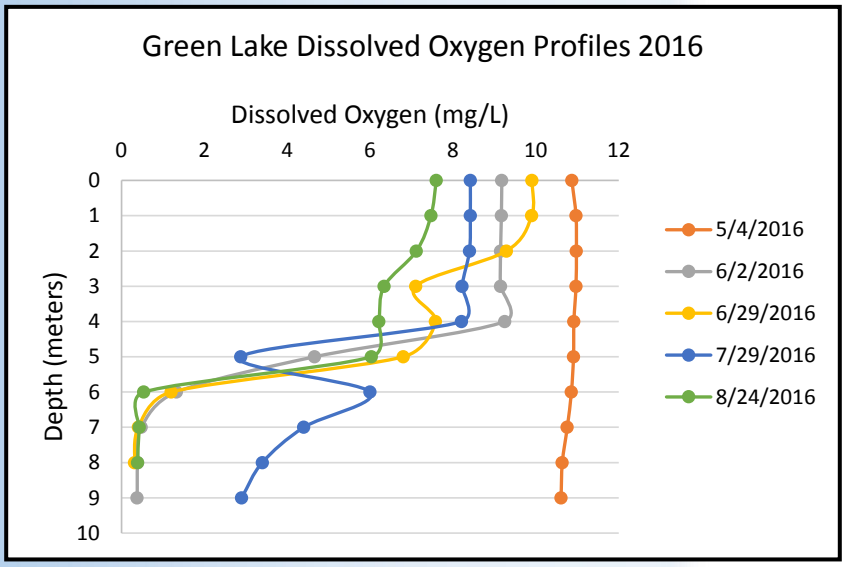
General Definitions

Phosphorus (TP): an essential plant nutrient in which an excess can cause severe algal blooms, measures all usable forms.
Chlorophyll-a (Chl-a): a pigment found in green plants, used to estimate amounts of algae in a lake.
Secchi Transparency: a measure of light penetration in water, an indication to the amount of algae in the water.

2016 Lake Stratification

In 2016 we measured temperature and dissolved oxygen profiles starting at the surface of the water and then at one meter increments to the bottom of the lake. This information adds to the story when we analyze lake water quality data. The graphs below are representations of the data collected.





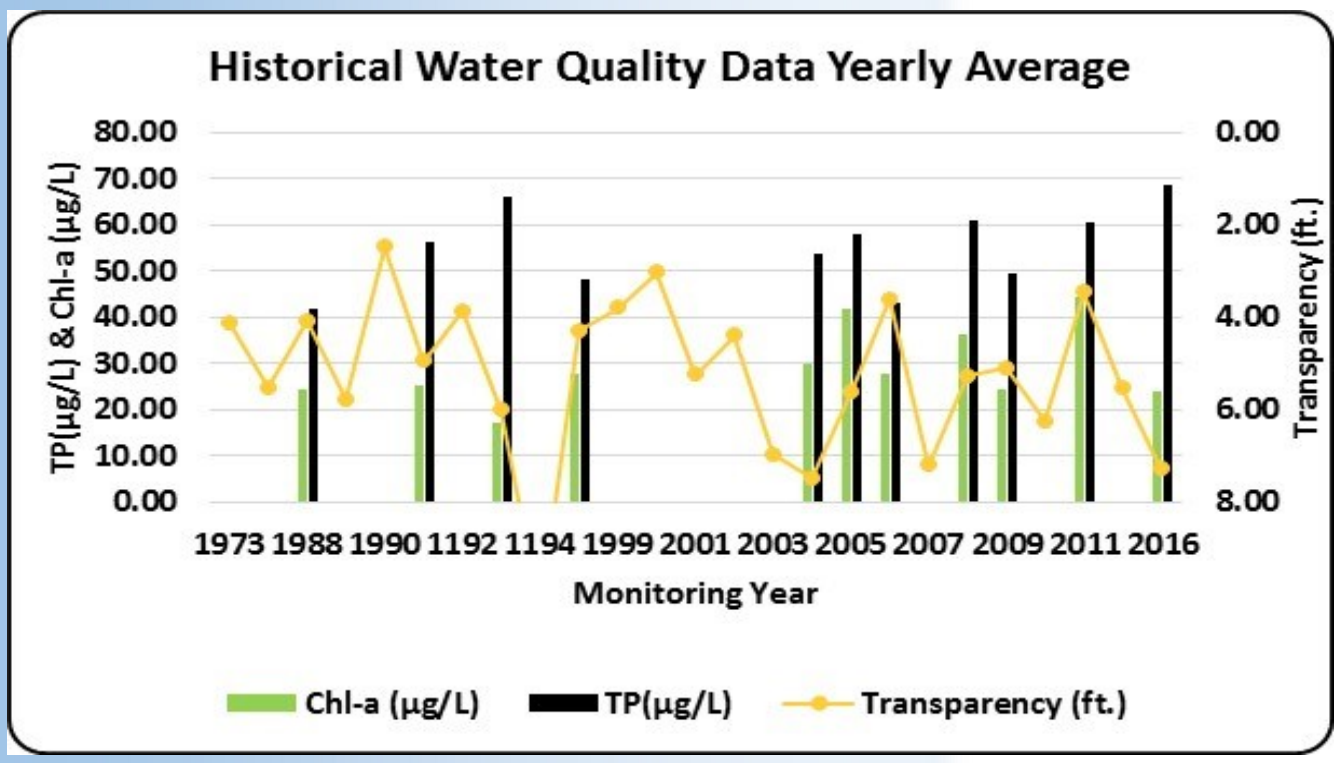
Green Lake: Temperature is consistent throughout the water column early and late in the year and forms layers of water with different temperatures from June to late August. This process is called thermal stratification and is expected in a deep lake. The cool water acts as a barrier between the lake bottom and the warm waters above. Dissolved oxygen periodically decreases to near zero at the lake bottom. This phenomenon is typical in deep, nutrient rich lakes and occurs as the supply of oxygen is consumed by bacteria and decaying matter over the summer months. When the lake mixes (during fall turnover or because of other events such as heavy rains or winds) the nutrients are allowed to escape into the surface water and can stimulate an algal bloom.

Green Lake Historical Water Quality Data

In order to get an idea of lake health trends over time, we compiled historic TP, Chl-a and Secchi transparency data from the MPCA website. Paired TP, Chl-a and secchi transparency data are periodically available for Green Lake since 1988. Note: this information is beneficial for tracking general trends but there was a minimal amount of data available for each year (i.e. 3 samples per year). The dataset for secchi transparency is much more extensive and dates back to 1973.

The graph below illustrates the that lake averages exceed the TP and Chl-a goals for every year monitored. Average Secchi values do not exceed the goals; in fact, over time it appears that the lake may be getting clearer. The increase in clarity may reflect aquatic vegetation shifts.

2016 data showed record high transparency which is consistent with the weather conditions and nutrient concentrations observed early in the year.

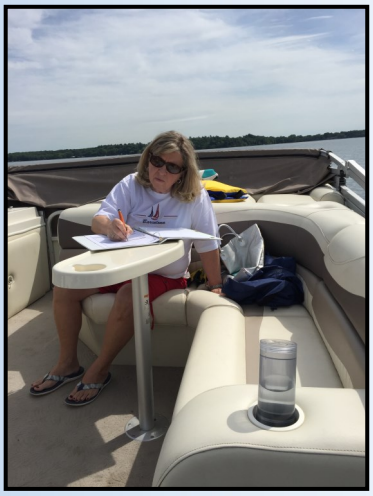


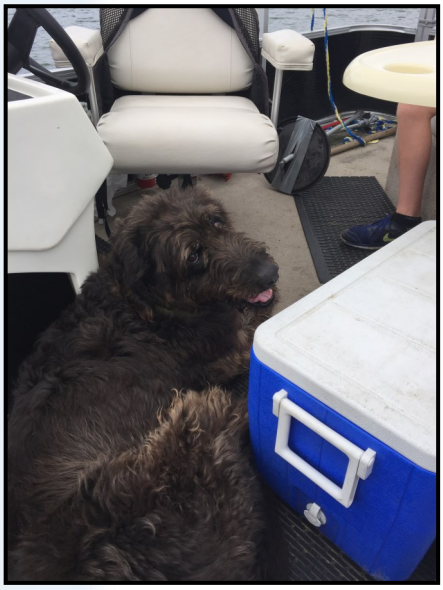
2017 Monitoring Recommendations

It is difficult to draw any hard conclusions from the limited monitoring data available. The data collected in 2016 did give us valuable insight into water health and how the lake responds over the season. We recommend the LID to continue lake and stream monitoring as planned. Additionally, the LID should work with the SWCD to identify ways to minimize runoff from the lake tributaries and lake shore properties prior to investigating any in-lake activities.

Below are key points and recommendations for lake monitoring in 2017:

- Continue monitoring as planned.
- Continue collecting temperature and dissolved oxygen profiles during each sample event.**-add a profile measurement in September.**
- Make note periods of heavy boat traffic on the lake.





For more information contact: Isanti SWCD 763-689-3271

Tiffany Determan, District Mgr Tiffany.Determan@mn.nacdnet.net or

Todd Kulaf, Conservation Tech todd.kulaf@mn.nacdnet.net

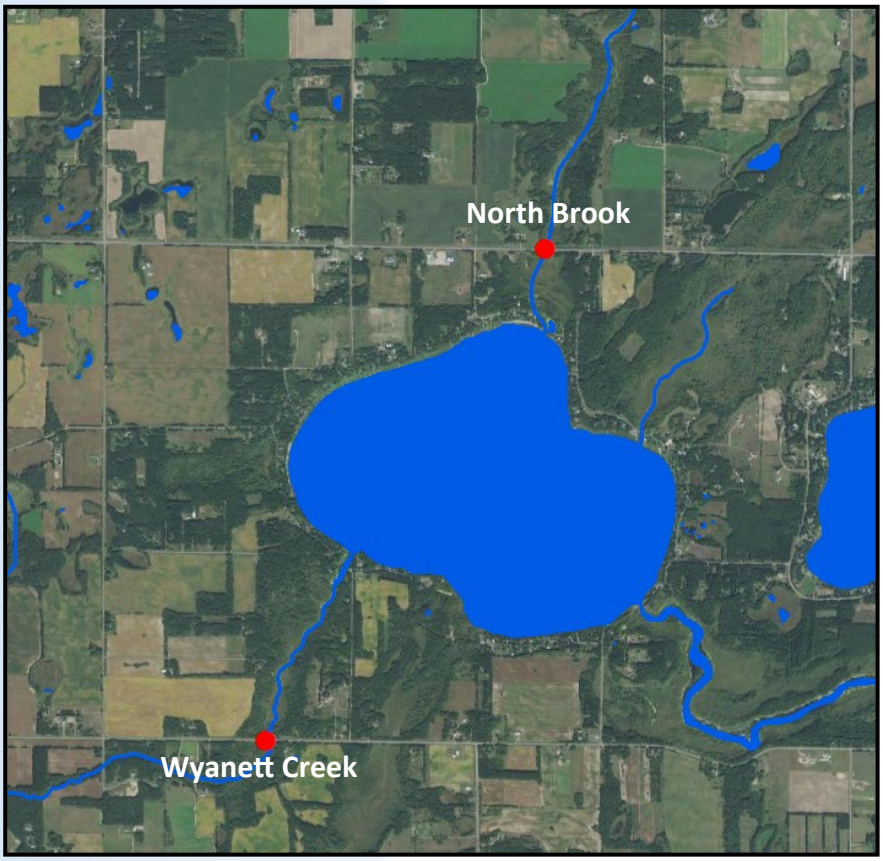
Thanks to the GLID members who have assisted with lake monitoring.

Green Lake Tributary Monitoring 2016

Introduction

2016 was the first year the Green Lake Improvement District (GLID) partnered with the Isanti Soil and Water Conservation District (SWCD) to monitor the health of two tributaries that empty into Green Lake:

- North Brook at highway 95
- Wyanett Creek at 325th Ave.



Tributary ID's were developed by the Isanti SWCD

Tributary Monitoring

What: In 2016 eight sample events were conducted at both major tributaries targeting four samples during rain events and four during base flow. The samples were tested for total phosphorus (TP), total suspended solids (TSS) and transparency. Dissolved oxygen, temperature, conductivity, pH and water flow were also measured in the field. TP concentrations were paired with flow to help us get a better understanding of how much water and nutrients are being carried from the tributaries and into the lake (i.e. pounds of phosphorus per day).

Why: The information collected is being used in the development of the Subwatershed Assessment for North Brook and Wyanett Creek (underway). The data will help us determine which tributary should be a higher priority for water quality projects. In theory, the stream that delivers the most nutrients to the lake would be the highest priority. Additionally, this information will be used to track trends, determine how well water quality improvement projects are working, and track progress towards the goals set for the steams in the Green Lake Total Maximum Daily Load Study (TMDL).

Total Phosphorus: an essential plant nutrient in which an excess can cause severe algal blooms.

Orthophosphate: the amount of phosphorus that is immediately available for algae and plant growth.

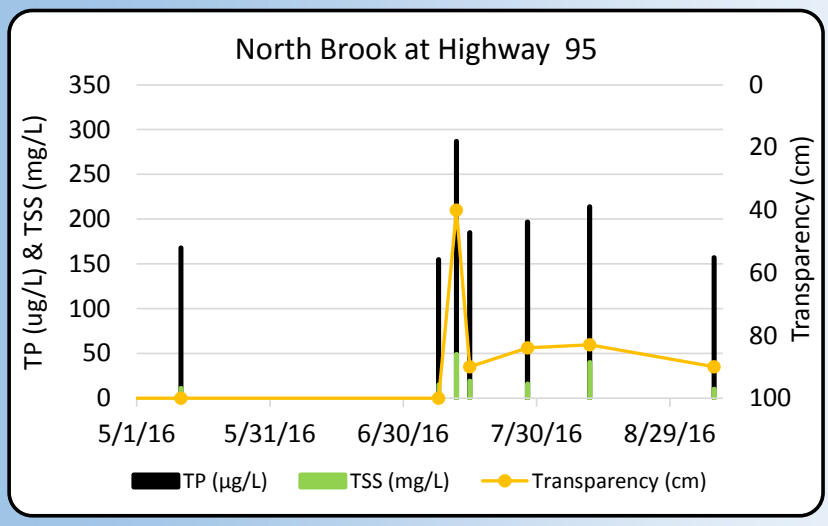
Total Suspended Solids: tiny particles of soil and other matter that remain suspended in water making it cloudy. Particles include sediment and organic matter.

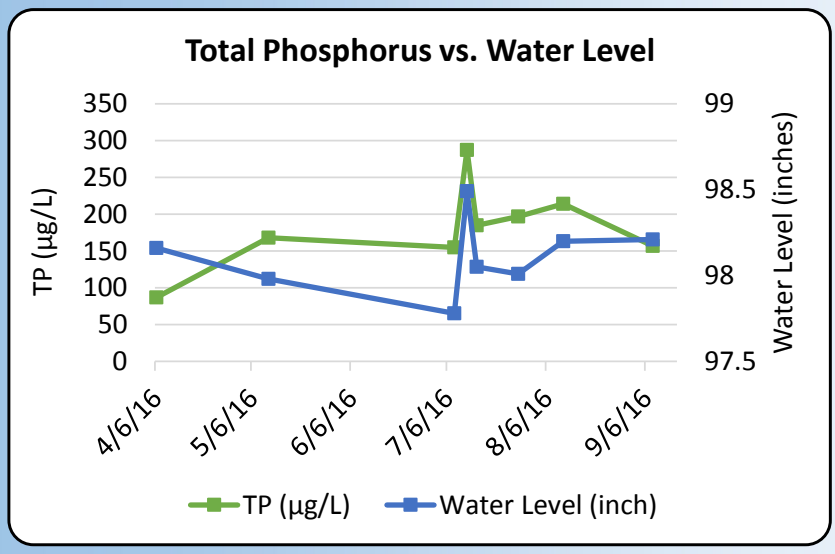
Transparency: an indirect measure of suspended and dissolved materials (soil particles and tea color caused by organic materials) in the water.

2016 Tributary Monitoring Results

Total Suspended Solids (TSS), Total Phosphorus (TP) and Transparency Tube

Eco-region Concentrations		
	TP (µg/L)	TSS (mg/L)
Typical Range	60 to 150	4.8 to 16
2016 Average	181.25	20.65
Goal	100µ/L	NA





Site:

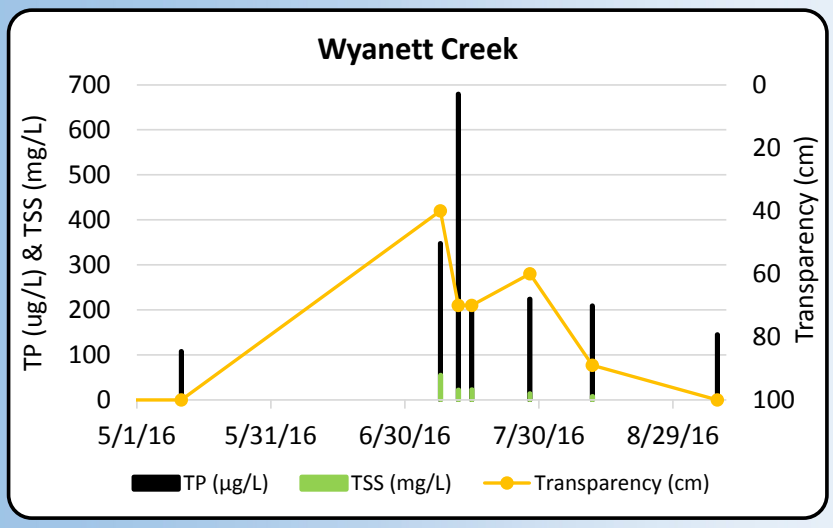
North Brook at Highway 95

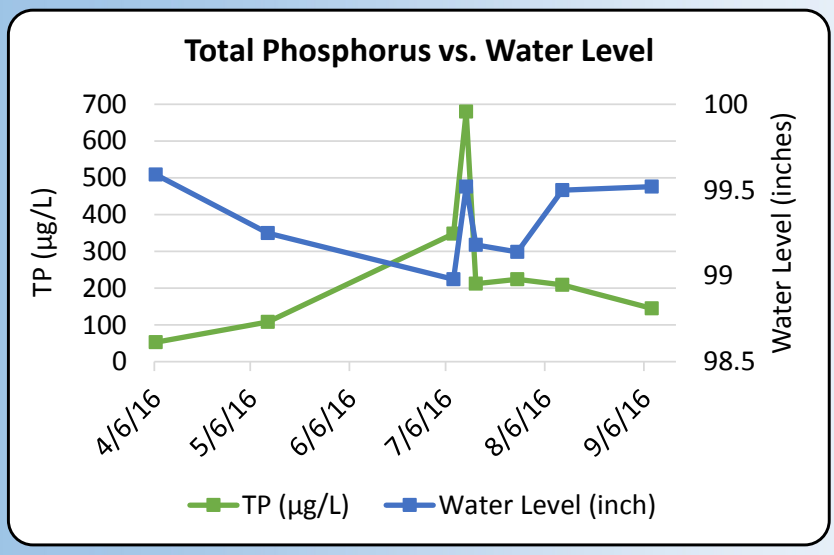
- The average concentration of TP at this location was 181.25. This concentration is above the expected range of concentrations for this region.
- The TMDL Study set a TP goal of 100 µg/L as a concentration for North Brook.
- The average concentration of TSS detected at this location was 20.65 mg/L. This concentration is above the expected range of concentration for this region.
- Based on one year of paired flow and sample information, we believe North Brook may contribute less nutrients to the lake than Wyanett Creek. More information is needed.
- Transparency readings averaged 85.87 cm (Transparency tubes only measure to 100 cm) this means the water is typically quite clear.
- The high concentration of TP found in the July 12th sample correspond with a high rain event that proceeded a moderate drought period.
- Water quality does fluctuate in relation to rain-fall at this location; the most likely causes are a combination of flushing of nutrients from the wetland-dominated watershed following dry spells and rain water runoff from land.

2016 Tributary Monitoring Results

Total Suspended Solids (TSS), Total Phosphorus (TP) and Transparency Tube

Eco-region Concentrations		
	TP (µg/L)	TSS (mg/L)
Typical Range	60 to 150	4.8 to 16
2016 Average	247	17.5
Goal	100µ/L	NA





Site:
Wyanett Creek

- The average concentration of TP at this location was 247 µg/L; significantly higher than the range of expected concentrations for this ecoregion.
- The TMDL Study set a TP goal of 100 µg/L as a concentration for Wyanett Creek.
- The average concentration of TSS detected at this location was 17.5 mg/L. This concentration is above the expected range of concentrations for this region.
- Based on one year of paired flow and sample information, we believe Wyanett Creek may contribute more nutrients to lake than North Brook. More information is needed.
- Transparency readings averaged 78.67 cm (Transparency tubes only measure to 100 cm) this means the water is typically quite clear.
- The high concentration of TP found in the July 12th sample correspond with a high rain event that proceeded a moderate drought period.
- Water quality does fluctuate in relation to rain-fall at this location; the most likely causes are a combination of flushing of nutrients from the wetland-dominated watershed following dry spells and rain water runoff from land.

2016 Results and Recommendations

Nutrient concentrations were consistently high throughout the sample season at both Wyanett Creek and North Brook. The highest observed concentrations occurred following a large rain event that was preceded by a dry spell. We suspect that the increase in TP was a result of one or a combination of the following: 1) flushing of nutrients and organic material from the large wetland-dominated watersheds and/or 2) runoff of nutrients from nearby agricultural land.

Interestingly, TP was also high during base-flow events. This characteristic is often observed downstream of wetlands that become anoxic (low –no oxygen) during periods of low flow. Anoxic conditions cause phosphorus to release from sediments. If the wetland is in fact a source of pollution a wetland restoration/treatment may be key to lake restoration.

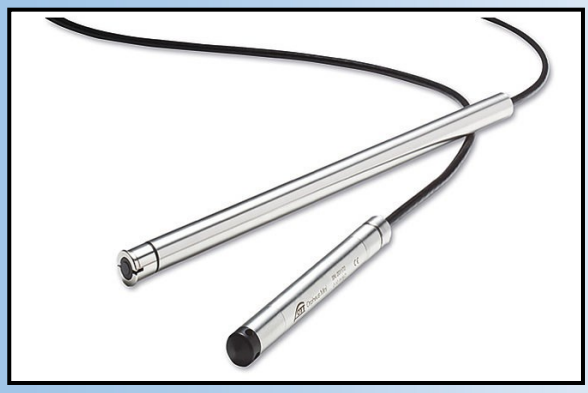
The subwatershed assessment for North Brook and Wyanett, along with additional monitoring data, will help locate and determine appropriate projects to reduce nutrient contributions from both of the major tributaries.

Because weather conditions and other environmental factors can vary so drastically from year to year it is recommended to continue monitoring at each of the tributaries as planned. Continued monitoring will give us a better understanding of how the streams and lake respond to environmental conditions and therefore how we might best be able to work together to protect the quality of the lake.

Below are key points and recommendations for monitoring in 2017 at each of the two tributaries:

- Sample as planned (same as 2016): 8 grab samples at highest and lowest water levels (peak flow and low flow); water level measurements; flow; dissolved oxygen; temperature; pH.
- Continue monitoring stream flow: collect stream flow data during 4 peak flow and 4 low flow stream conditions.
- **NEW:** Implement surface water equipment to continuously record steam water level data at programmable intervals. This information will allow us to more accurately determine nutrient loading variables and conditions.

OTT Orpheus Mini Water Level Logger:



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