LAKE WAGNER

REPORT DESCRIPTION

This report is an update on the health of Lake Wagner based on water quality data collected from 1993 through 2016. For additional background on the information provided here or to find out more about Lake Wagner, please visit www.lakes.surfacewater.info or call Snohomish County Surface Water Management (SWM) at 425-388-3464.

LAKE DESCRIPTION

Lake Wagner is a 21-acre lake located three miles northeast of Monroe. The lake outlet flows south to Woods Creek and the Skykomish River. The lake is relatively shallow, with a maximum depth of 6.7 meters (22 feet) and an average depth of 4.0 meters (13 feet).

Much of the shoreline of Lake Wagner is still covered with native vegetation. About a dozen homes on large lots surround the lake. The watershed, which is the land area that drains to the lake, is relatively large—almost 18 times the size of the lake—which means there is more potential for pollution to affect lake water quality than at lakes with smaller watersheds.

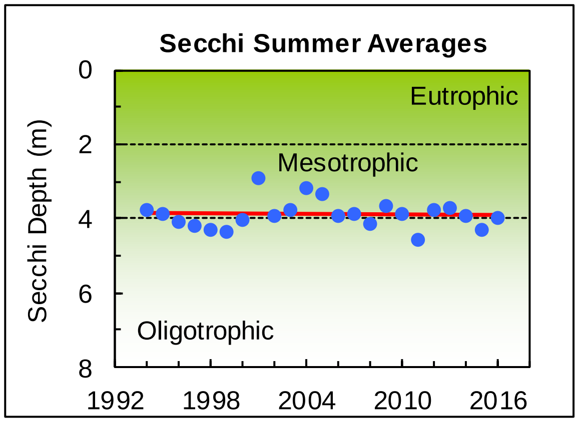
LAKE CONDITIONS

The following graphs illustrate the summer averages and trend lines (in red) for water clarity, total phosphorus, and chlorophyll *a* for Lake Wagner. Please refer to the table at the end of the report for long-term averages and for averages and ranges for individual years.

Water Clarity

The water clarity of a lake, measured with a Secchi disk, is a reading of how far one can see into the water. Water clarity is affected by the amount of algae and sediment in the lake, as well as by water color. Lakes with high water clarity usually have low amounts of algae, while lakes with poor water clarity often have excessive amounts of algae.

Water clarity in Lake Wagner is moderate, with a long-term 1993 - 2016 summer average of 3.9 meters (12.8 feet). Except for a few years, the summer averages have been fairly consistent through the years. The highest average on record was 4.6 meters in 2011; the lowest was 2.9 meters in 2001.



Water Color

The color of lake water affects water clarity and the depths at which algae and plants can grow. In many lakes, the water is naturally brown, orange, or yellow. This darker color comes from dissolved humic compounds from surrounding wetlands and does not harm water quality. Measurements of true water color provide clues to changes in water clarity. True water color is only the color from dissolved materials and not of the color of algae or sediment suspended in the water.

The water color of Lake Wagner averaged 19 pcu (platinum-cobalt color units) in 2010 - 2011. This indicates a slight to moderate amount of color in the lake, which would not have a significant effect on water clarity or algae growth.

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Temperature

The temperature of lake water changes with the seasons and varies with depth. During spring and summer, the sun warms the upper waters. Because warmer water is less dense, it floats above the cooler, denser water below. The temperature and density differences create distinct layers of water in the lake, and these layers do not mix easily. This process is called stratification and occurs during the warm months. The warm, upper water layer is called the epilimnion. The colder, darker bottom zone is called the hypolimnion. These layers will stay separated until the fall when the upper waters cool, the temperature differences decrease, and the entire lake mixes, or turns over.

From June through September 2016, temperature data was collected monthly at each meter throughout the lake water column (see graph on the next page). Temperature profiles for 2016 show that throughout the sampling season the lake became thermally stratified during the summer months. This means that there was a large temperature difference between the warm upper waters and the cool bottom waters, and mixing did not occur between these layers. In June the upper waters measured about 70˚F (21.3°C) in temperature, and by August had reached their peak at 75°F (23.8°C). Bottom water temperatures changed at similar intervals as the upper waters, and ranged from 55°F (12.5°C) in June to 60°F (15.6°C) in August. In September, the surface waters began to cool and by mid-September temperatures were almost the same from top to bottom. Because the lake is relatively shallow, the stratification weakened earlier than most lakes, and the entire lake turned over (or mixed) by mid-September. The lake will stay mixed during the winter until springtime, when the upper waters begin to warm again.

Dissolved Oxygen

Oxygen dissolved in the water is essential for life in a lake. Most of the dissolved oxygen comes from the atmosphere. Like temperature, dissolved oxygen levels vary over time and with depth. During the warm months, the upper waters receive oxygen from the atmosphere, but the lower waters cannot be replenished with oxygen because of the separation between water layers. Meanwhile, bacteria in the lake bottom are consuming oxygen as they decompose organic matter. Eventually oxygen is depleted in the bottom waters. Low dissolved oxygen in the bottom waters can lead to a release of nutrients from the lake sediments.

Dissolved oxygen was also measured at every meter throughout the Lake Wagner water column from June to September 2016 (see graph on the next page). Oxygen levels were relatively high in the upper waters from June through August. In July, there was also a sharp increase in dissolved oxygen levels between about 8 and 10 feet deep. This indicates vigorous algae growth at that depth which added oxygen to the water. Meanwhile, the bottom waters contained much less dissolved oxygen. During the summer period, oxygen in the lower waters is consumed by the decomposition of organic material within the lake. When the lake is stratified, the oxygen in the bottom waters is not replenished by the overlying oxygen-rich upper waters or the atmosphere. The bottom of the lake will remain devoid of oxygen until the lake mixes, which started to occur in mid-September in 2016. The lake then remains mixed until springtime when the upper waters begin to warm and dissolved oxygen begins to decline near the lake bottom.

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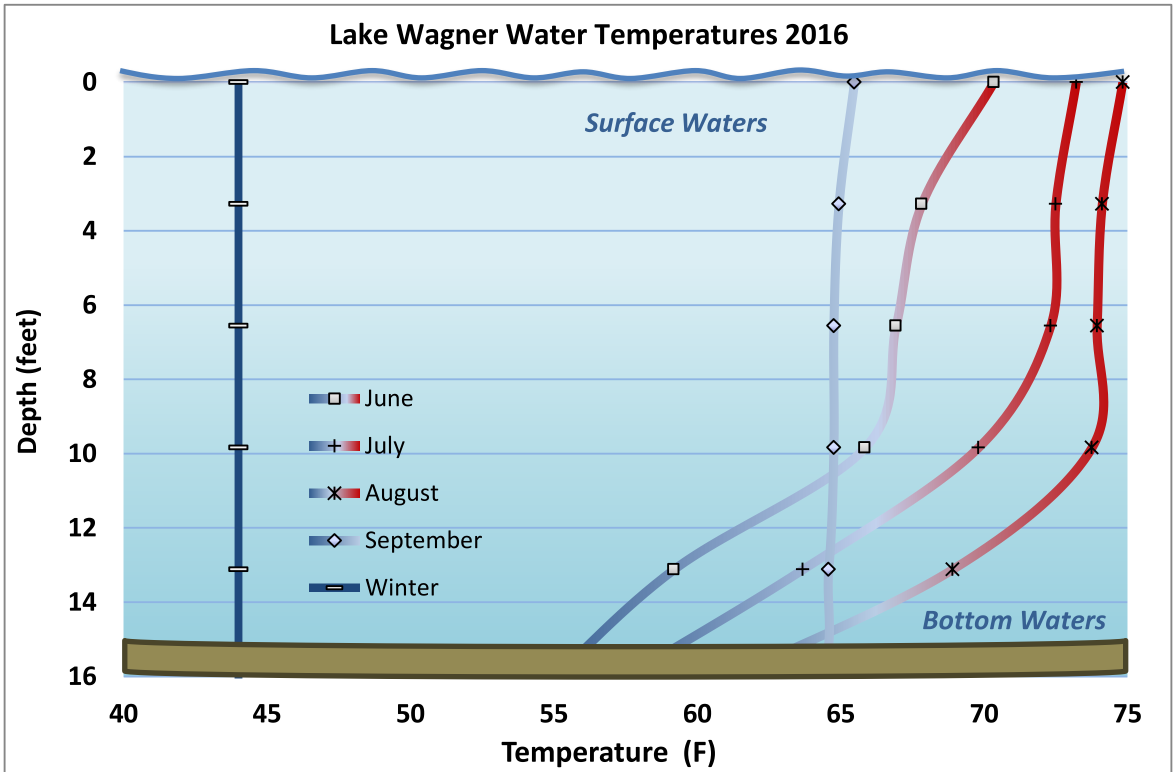
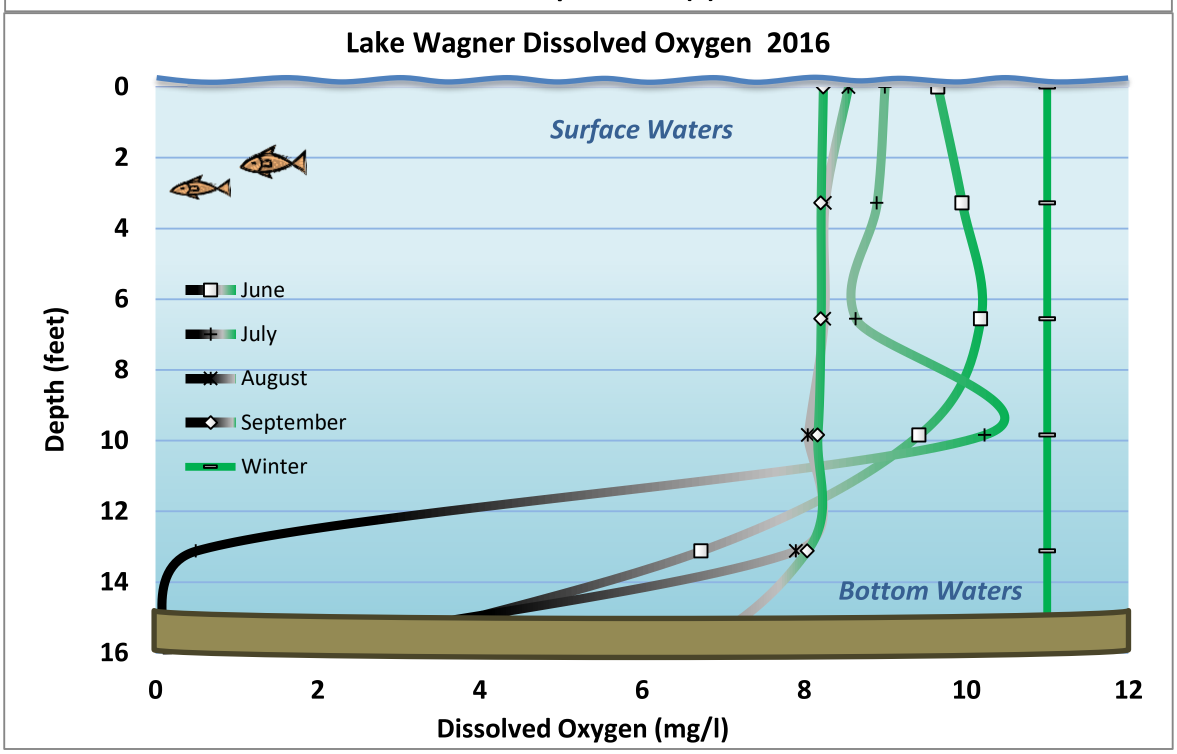

Lake Wagner Water Temperatures 2016
Surface Waters
Bottom Waters
June
July
August
September
Winter
Depth (feet)
0
2
4
6
8
10
12
14
16
40
45
50
55
60
65
70
75
Temperature (F)

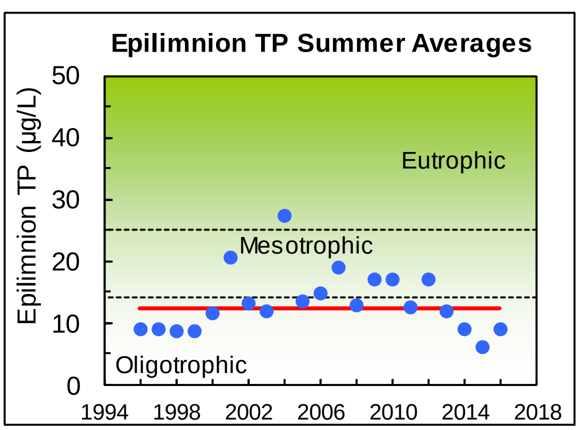

Lake Wagner Dissolved Oxygen 2016
Surface Waters
Bottom Waters
June
July
August
September
Winter
Depth (feet)
0
2
4
6
8
10
12
14
16
0
2
4
6
8
10
12
Dissolved Oxygen (mg/l)

LAKE WAGNER

Phosphorus (key nutrient for algae)

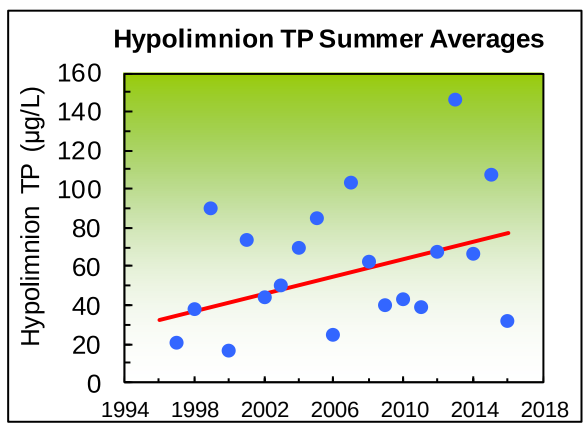
Nutrients are essential for the growth of algae, fish, and aquatic plants in a lake. However, too many nutrients, especially phosphorus, can pollute a lake and lead to unpleasant algae growth. Nutrients enter the lake through stormwater runoff or from streams flowing into the lake. Sources of nutrients include fertilizers, pet and animal wastes, poorly-maintained septic systems, and erosion from land clearing and construction. Monitoring of phosphorus levels over time helps to identify changes in nutrient pollution.

Total phosphorus concentrations in the epilimnion (upper waters) are low to moderate, with a long-term summer average of 13 µg/l (micrograms per liter which is equivalent to parts per billion). In 2001 and 2004, phosphorus levels were much higher than the long-term average. Between 1996 and 2012 there was a steady, and statistically significant, increase in phosphorus levels in the epilimnion. From 2012 to 2015 there was a sharp decrease in phosphorus concentrations, although not a statistically significant trend. Phosphorus levels increased in 2016 compared to the previous year. Any increases in phosphorus can lead to more algae growth in the lake.



Summertime phosphorus levels in the hypolimnion (bottom waters) are higher and much more variable. The long-term 1996 – 2016 summer average is 59 µg/l. It appears that phosphorus concentrations in the bottom waters may be increasing over time. The years 2013-2015 showed statistically significant increases of hypolimnion phosphorus levels. 2016 had low averages of phosphorus in the hypolimnion (25 µg/l), so there is no longer evidence of an increasing trend. However, the long-term average has increased from the 42 µg/l that was reported in the 2003 State of the Lakes Report to 59 µg/l currently.

Higher phosphorus in the hypolimnion comes, in part, from releases of phosphorus built up in the bottom sediments. Release of phosphorus from the sediments occurs in the summer when dissolved oxygen levels decline in the bottom waters. This phosphorus release can eventually lead to more algae growth in the lake and is a sign of increasing eutrophication.



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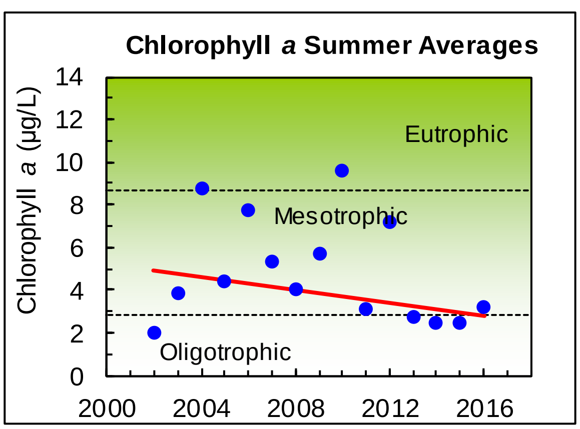
Chlorophyll a (Algae)

Algae are tiny plant-like organisms that are essential for a healthy lake. Fish and other lake life depend on algae as the basis for their food supply. However, excessive growths of algae, called algae blooms, can cloud the water, form unsightly scums, and sometimes release toxins. Excess nutrients, such as phosphorus, are the main cause of nuisance algae growth in a lake. Chlorophyll *a* measurements are one method for tracking the amount of algae in a lake.

Chlorophyll *a* values showed moderate algae declines in the summers of 2012 through 2016, and moderate algae growth from 2002-2012. From 2002-2016, values show a long-term summer average of 4.8 µg/l, while the average reported in the 2012 State of the Lakes Report was 5.6 µg/l. It appears that chlorophyll *a* levels may be decreasing over time. The 2010 summer average of 9.6 µg/l was the highest on record. Overall, between 2002 and 2016, there has not been a statistically significant trend toward decreasing algae. In the past, Lake Wagner has often experienced dense blooms of blue-green algae in the summer when algae levels similar to those in nutrient-enriched lakes.



SHORELINE CONDITION

The condition of the lake shoreline is important to understanding overall lake health. As development on a lake increases, lake shorelines typically are modified either through removal of natural vegetation, the installation of bulkheads or other hardening structures, and/or removal of partially submerged logs and branches. This type of alteration can be harmful to the lake ecosystem because natural shorelines protect the lake from harmful pollution, prevent bank erosion, and provide important habitat for fish and wildlife.

Lake Wagner still has a relatively undeveloped shoreline. Surveys conducted in the mid-90s identified 11 homes bordering the lake. There were also 6 docks counted around the lake shore. Approximately 17% of the shoreline has been armored with revetments or fill, which is lower than at many other lakes in the County. The majority (66%) of the shoreline was also bordered by intact vegetation in 2008. Intact vegetation means there is a significant amount of native grasses, shrubs, or trees bordering the lake. There is also a relatively high amount of large wood still remaining in the lake (about 79 pieces). These old logs and branches are valuable for fish and wildlife habitat.

Maintaining and improving the state of the shoreline is important to protecting the water quality of Lake Wagner. The buffer of shoreline vegetation, in particular, reduces pollution sources, filters out pollution before it reaches the lake, protects the shoreline from erosion, and provides valuable aquatic habitat for fish and wildlife.

LAKE WAGNER

SUMMARY

Trophic State

All lakes go through a process of enrichment by nutrients and sediment. In this process, known as eutrophication, nutrients and sediment contribute to the ever-increasing growth of algae and aquatic plants. Over thousands of years, lakes will gradually fill up with organic matter and sediments.

Lakes can be classified by their degree of eutrophication, also known as their trophic state. There are three primary trophic states for lakes—oligotrophic, mesotrophic, and eutrophic—as well as intermediate states. Oligotrophic lakes are usually deep, with clear water, low nutrient concentrations, and few aquatic plants and algae. Mesotrophic lakes are richer in nutrients and produce more algae and aquatic plants. Eutrophic lakes are often shallow and characterized by abundant algae and plants, high nutrient concentrations, limited water clarity, and low dissolved oxygen in the bottom waters.

The trophic state classification of a lake does not necessarily indicate good or bad water quality because eutrophication is a natural process. However, human activities that contribute sediment and excess nutrients to a lake can dramatically accelerate the eutrophication process and result in declining water quality.

Based on long-term monitoring data, Lake Wagner may be classified as mesotrophic, with moderate water clarity, phosphorus levels, and chlorophyll *a* concentrations, and moderate productivity of plants and algae.

Condition and Trends

The water quality targets for Lake Wagner set forth in the 2003 State of the Lakes Report were to maintain stable water clarity and total phosphorus levels. The lake is meeting the water clarity target because the long-term average is still 3.9 meters.

Lake Wagner is not meeting the phosphorus targets in the upper or lower waters. The long-term phosphorus concentrations have increased from 12 to 13 µg/l in the upper waters and from 42 to 59 µg/l, in the lower waters. There is no longer evidence of a statistically significant increasing trend in summer average phosphorus concentrations in the upper waters and some evidence of higher levels in the bottom waters. These increases suggest that more nutrients may be entering the lake from the watershed and are warning signs of future problems.

Overall, Lake Wagner appears to be at risk of future water quality declines. Human activities in the watershed are likely the primary sources of elevated phosphorus levels in the lake. Measures to control nutrients in the watershed should be taken now to prevent any future negative impacts to the lake. To find out more about the causes and problems of increased phosphorus levels and for tips to improve lake water quality, visit www.lakes.surfacewater.info.

DATA SUMMARY FOR LAKE WAGNER						
		Water Clarity (Secchi depth in meters)	**Total Phosphorus (µg/L)**		**Total Nitrogen (µg/L)**	**Chlorophyll *a* (µg/L)**
Source	**Date**		**Surface**	**Bottom**	**Surface**	**Surface**
Sumioka and Dion, 1985	**7/7/81**	3.0	10	<10	-	6.6
Volunteer	**1993**	2.7 - 3.9 (3.2) *n = 8*	-	-	-	-
SWM Staff or Volunteer	**1994**	2.9 - 4.9 (3.8) *n = 7*	-	-	-	2.6 - 2.9 (2.8) *n = 2*
SWM Staff or Volunteer	**1995**	3.3 - 4.7 (3.9) *n = 4*	-	-	-	3.2
SWM Staff	**1996**	3.2 - 5.0 (4.1) *n = 2*	3 - 15 (9) *n = 2*	8 - 12 (10) *n = 2*	-	-
SWM Staff	**1997**	3.7 - 4.7 (4.2) *n = 2*	7 - 11 (9) *n = 2*	20 - 22 (21) *n = 2*	-	-
SWM Staff or Volunteer	**1998**	4.0 - 5.0 (4.3) *n = 9*	6 - 13 (9) *n = 4*	14 - 65 (38) *n = 4*	-	-
SWM Staff or Volunteer	**1999**	4.0 - 4.9 (4.4) *n = 9*	8 - 10 (9) *n = 4*	63 - 145 (90) *n = 4*	-	-
SWM Staff	**2000**	3.9 - 4.2 (4.1) *n = 4*	5 - 16 (12) *n = 4*	6 - 22 (16) *n = 4*	-	-
SWM Staff	**2001**	1.8 - 3.4 (2.9) *n = 4*	11 - 42 (21) *n = 4*	51 - 127 (74) *n = 4*	-	-
SWM Staff	**2002**	3.4 - 4.6 (4.0) *n = 4*	7 - 18 (13) *n = 4*	35 - 62 (45) *n = 4*	-	1.6 - 2.7 (2.0) *n = 4*
SWM Staff	**2003**	3.1 - 4.1 (3.8) *n = 4*	7 - 17 (12) *n = 4*	17 - 68 (50) *n = 4*	-	1.9 - 8.5 (3.9) *n = 4*
SWM Staff or Volunteer	**2004**	2.2 - 4.1 (3.2) *n = 4*	13 - 47 (27) *n = 4*	36 - 108 (70) *n = 4*	-	2.1 - 27 (8.8) *n = 4*
SWM Staff or Volunteer	**2005**	2.6 - 4.0 (3.3) *n = 4*	9 - 18 (14) *n = 4*	27 - 173 (85) *n = 4*	-	2.7 - 6.7 (4.4) *n = 4*
SWM Staff	**2006**	3.7 - 4.3 (4.0) *n = 4*	10 - 23 (15) *n = 4*	16 - 43 (24) *n = 4*	-	3.2 - 19 (7.8) *n = 4*
SWM Staff	**2007**	3.3 - 4.7 (3.9) *n = 4*	14 - 28 (19) *n = 4*	45 - 181 (104) *n = 4*	-	3.7 - 6.4 (5.3) *n = 4*

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DATA SUMMARY FOR LAKE WAGNER						
		Water Clarity (Secchi depth in meters)	**Total Phosphorus (µg/L)**		**Total Nitrogen (µg/L)**	**Chlorophyll *a* (µg/L)**
Source	**Date**		**Surface**	**Bottom**	**Surface**	**Surface**
Volunteer	**2008**	3.7 - 4.5 (4.1) *n = 8*	8 - 16 (13) *n = 3*	29 - 116 (63) *n = 3*	-	1.6 - 8.0 (4.0) *n = 3*
Volunteer	**2009**	2.9 - 4.3 (3.7) *n = 6*	13 - 26 (17) *n = 4*	33 - 50 (40) *n = 4*	-	4.0 - 9.3 (5.7) *n = 4*
Volunteer	**2010**	3.1 - 4.6 (3.9) *n = 5*	8 - 28 (17) *n = 4*	26 - 79 (44) *n = 4*	-	2.7 - 26 (9.6) *n = 4*
Volunteer	**2011**	4.3 - 4.9 (4.6) *n = 4*	10 - 15 (13) *n = 4*	24 - 53 (39) *n = 2*	-	0.50 - 7.2 (3.1) *n = 4*
SWM Staff	**2012**	4.0 - 5.0 (4.3) *n = 9*	11 - 22 (17) *n = 4*	20 - 115 (68) *n = 4*	-	2.9 - 16 (7.2) *n = 4*
Volunteer	**2013**	2.8 - 4.2 (3.7) *n = 6*	10 - 14 (12) *n = 4*	81 - 198 (146) *n = 4*	-	1.6 - 5.9 (2.8) *n = 4*
SWM Staff	**2014**	3.9 - 4.1 (3.9) *n = 4*	10 - 14 (12) *n = 4*	81 - 198 (146) *n = 4*	267 - 394 (329) *n = 4*	1.6 - 5.9 (2.8) *n = 4*
SWM Staff	**2015**	*4.1 - 4.5* *(4.3)* *n = 4*	*3 - 9* *(6)* *n = 4*	*13 - 276* *(108)* *n = 4*	*189 - 342* *(283)* *n = 4*	*1.6 - 2.7* *(2.4)* *n = 4*
SWM Staff	**2016**	3.4 - 4.6 (4.0) *n = 4*	6 - 11 (9) *n = 4*	9 - 66 (32) *n = 4*	264 - 461 (387) *n = 4*	2.1 - 4.2 (3.2) *n = 4*
Long Term Avg		**3.9** **(1993-2016)**	**13** **(1996-2016)**	**59** **(1996-2016)**	**333** **(2014-2016)**	**4.8** **(2002-2016)**
TRENDS		**None**	**None**	**None**	**NA**	**None**

NOTES

- Table includes summer (May-Oct) data only.
- Each box shows the range on top, followed by summer average in ( ) and number of samples (*n*).
- Total phosphorus data are from samples taken at discrete depths only.
- "Surface" samples are from 1 meter depth and "bottom" samples are from 1-2 meters above the bottom.