LAKE KI

REPORT DESCRIPTION

This report is an annual update to the 2003 State of the Lakes Report and includes water quality data collected from 2003 through 2009. For additional background on the information provided here or to find out more about Lake Ki visit www.lakes.surfacewater.info or call Snohomish County Surface Water Management (SWM) at 425-388-3464.

LAKE DESCRIPTION

Lake Ki is a 100-acre lake located in the Seven Lakes area north of the Tulalip Reservation. The lake is fed mainly by groundwater. The outlet flows north to Fish Creek and eventually to the Stillaguamish River.

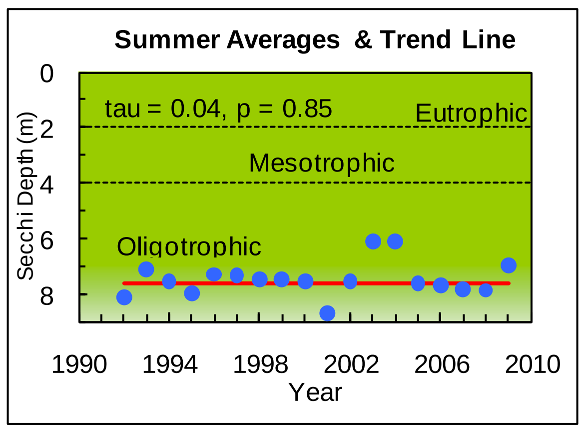
Lake Ki is one of the deepest lakes in the county, with a maximum depth of 21 meters and an average depth of 10.1 meters. The watershed is small, only 5.2 times the size of the lake, so there should be less potential for pollution from the watershed compared to a lake with a large watershed. However, there is dense development around the shoreline of Lake Ki, which can affect water quality. Development is also increasing in the watershed.

LAKE CONDITIONS

The following graphs illustrate the summer averages and trend lines (in red) for water clarity, total phosphorus, and chlorophyll for Lake Ki. 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 in Lake Ki is high (the best in the county), with a long-term 1992 - 2009 summer average of 7.5 meters. During the summers of both 2003 and 2004, the water clarity averages declined to only 6.1 meters, but from 2005 to 2009 the averages have improved. Overall, there has been no significant trend in water clarity between 1992 and 2009.



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Temperature

From May through October 2009, temperature and dissolved oxygen data were collected by volunteer monitors at each meter throughout the Lake Ki water column. Temperature profiles (see graph on page 3) show that the lake was fairly strongly thermally stratified as early as late May. Through June and July, Lake Ki became increasingly stratified. This means that there was a strong temperature difference between the warm upper waters and the cool bottom waters, and that mixing did not occur between these layers. During the stratified period, warmer water extended from the surface down to about 6 meters. By July the upper waters were significantly warmer than the lower waters, with a 11.5°C (21°F) temperature difference. The upper waters reached their peak in temperature in August and September at about 22°C (71° F). At the same time, bottom water temperatures varied only a little and remained between 6 and 9°C (42-48°F). In October, the surface waters cooled to about 14° C. Then, through the fall, the upper waters would continue to cool until the temperatures in the lake were almost equal from top to bottom. As stratification weakens, the lake water will turn over (or mix) sometime in late fall. The lake stays mixed during the winter until springtime, when the upper waters began to warm again.

Dissolved Oxygen

The depth profiles of dissolved oxygen measured in 2009 partially reflect the temperature profiles seen during that time period (see graph on page 3). Oxygen levels were generally high near the surface and lower near the bottom. Through the summer, dissolved oxygen declined in the bottom layers of the lake, although not as much as in many other lakes. By July there was little oxygen in the water at 18 meters. During the stratified summer period, oxygen in the lower waters is consumed by the decomposition of organic material (dead algae and plants) within the lake. Oxygen is not replenished from the overlying oxygen-rich upper waters or the atmosphere because stratification prevents the upper and lower waters from mixing.

During the fall as temperatures cool, eventually the entire lake mixes, creating uniform temperature and dissolved oxygen throughout the water column. Dissolved oxygen levels remain high until springtime when the upper waters begin to warm and dissolved oxygen begins to decline again in the bottom waters.

One notable pattern throughout the summer was that dissolved oxygen levels were substantially higher between 6 and 9 meters depth. This is likely due to vigorous algal growth at the interface between the upper and lower waters. Algae often thrive in this zone because there is more light in the upper waters and higher nutrients available in the lower waters.

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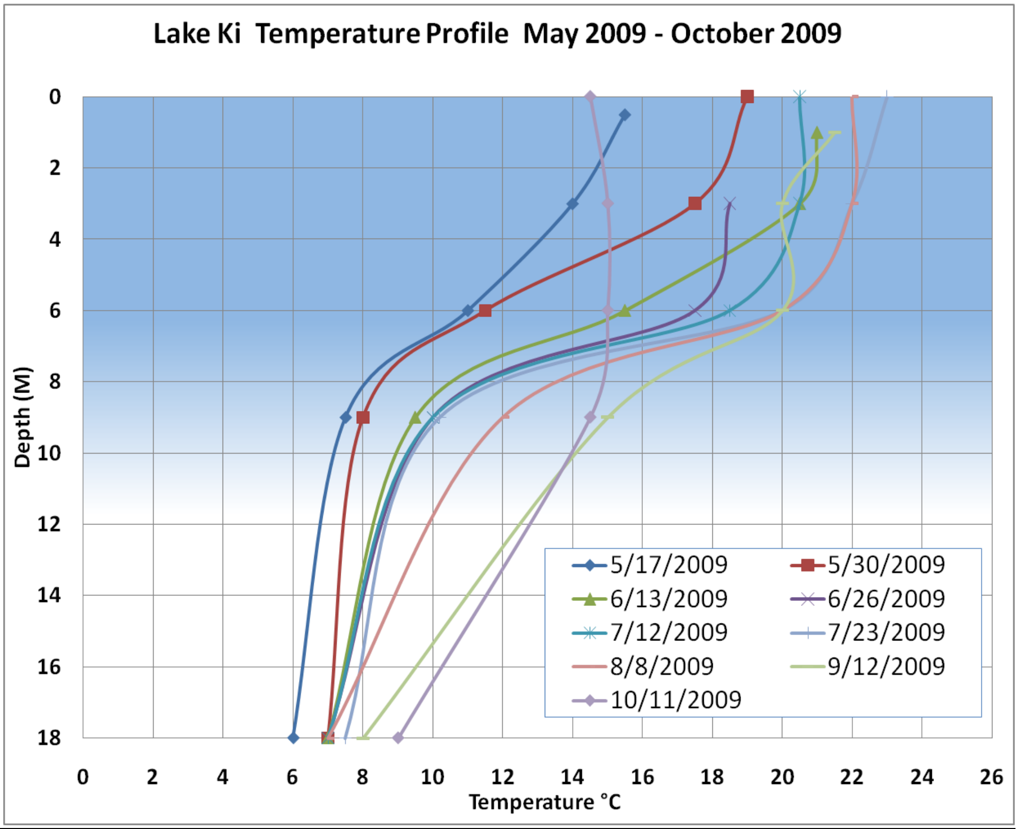
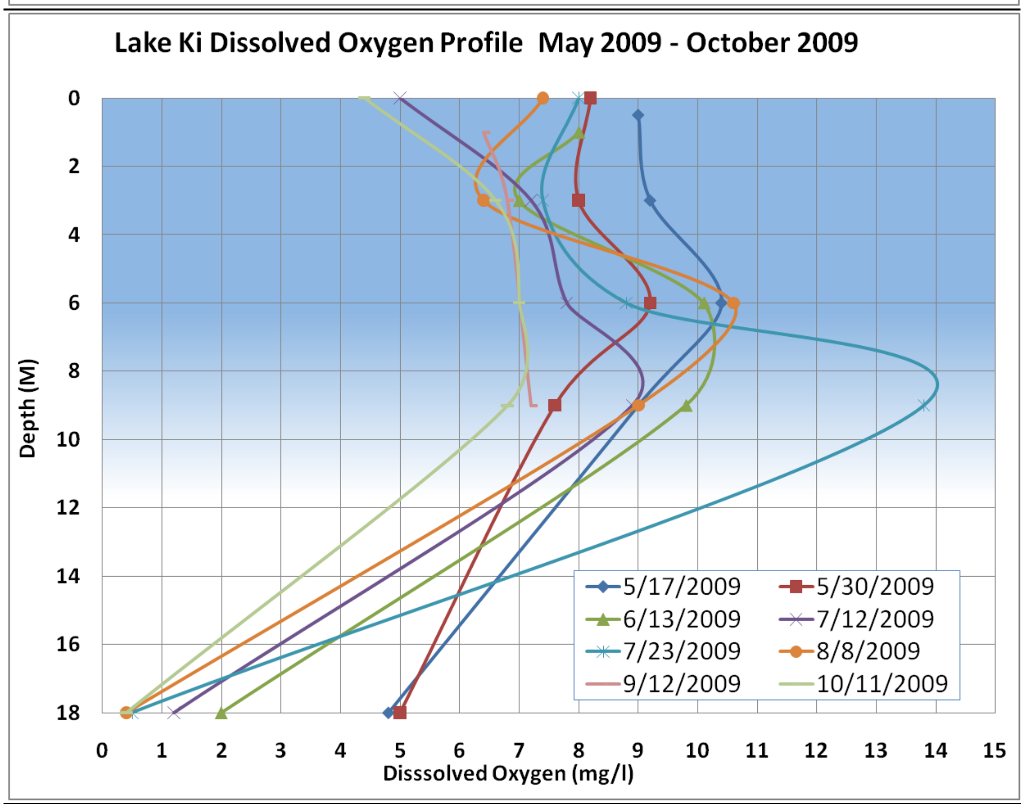
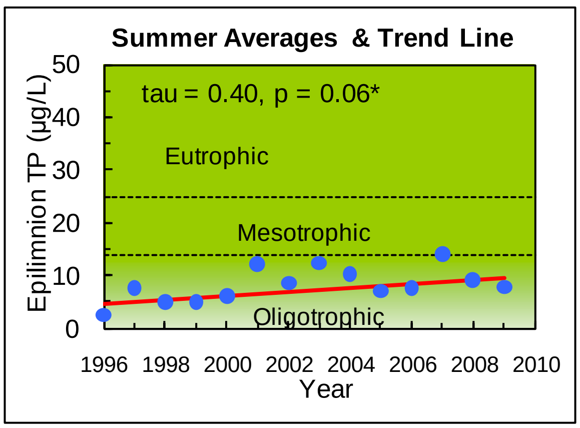

Lake Ki Temperature Profile May 2009 - October 2009
Depth (M)
Temperature °C
0
2
4
6
8
10
12
14
16
18
20
22
24
26
5/17/2009
5/30/2009
6/13/2009
6/26/2009
7/12/2009
7/23/2009
8/8/2009
9/12/2009
10/11/2009


Lake Ki Dissolved Oxygen Profile May 2009 - October 2009
Depth (M)
Disssolved Oxygen (mg/l)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
18
5/17/2009
5/30/2009
6/13/2009
7/12/2009
7/23/2009
8/8/2009
9/12/2009
10/11/2009

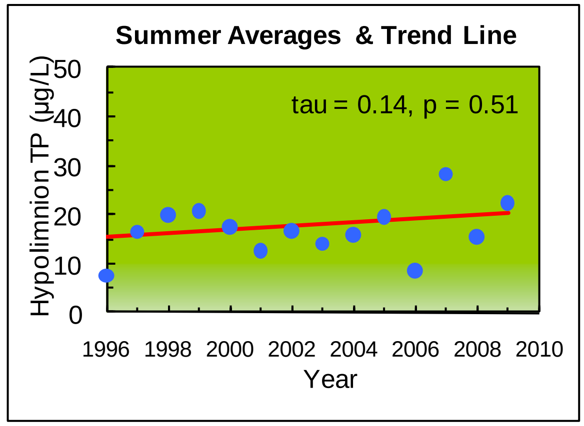
LAKE KI

Total Phosphorus (key nutrient for algae)

Total phosphorus concentrations in the epilimnion (upper waters) are low, with a long-term 1996 to 2009 summer average of 8 µg/l. The graph indicates that phosphorus concentrations have been increasing over time, and this trend is statistically significant. Higher phosphorus levels can lead to excess algal growth in the lake and lower water clarity. This pattern does not yet show up in water clarity measurements, but algae levels may be increasing, as described below. Monitoring over the next few years will be important to determine if this trend continues.

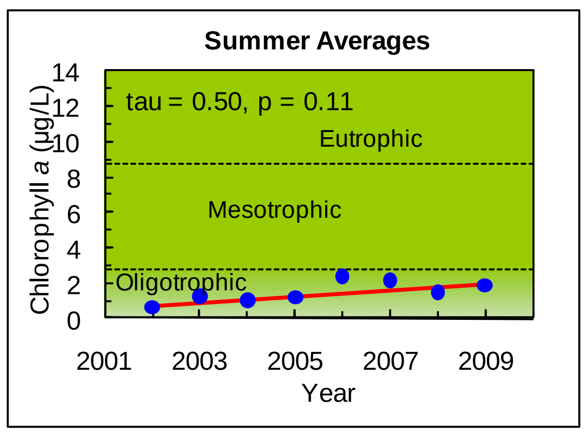


Summertime phosphorus averages in the hypolimnion (bottom waters) are higher than in the epilimnion, but still lower than in most lakes. The 1996 - 2009 long-term average for the hypolimnion is 17 µg/l. Between 1997 and 2005, there was little variability in the summer averages. However, the summer average was much lower in 2006 (only 9 µg/l), and the average in 2007 was much higher (28 µg/l, the highest on record). There are no obvious explanations for this fluctuation, but it could indicate the potential for a build-up of phosphorus in the bottom waters. Unlike the upper waters, there is no significant trend in phosphorus levels in the hypolimnion.



Chlorophyll a (Algae)

Chlorophyll *a* values showed low levels of algae in the summers of 2002 through 2009, with a long-term average of 1.5 µg/l. However, there appears to be a very slight increase in chlorophyll *a* over time. This trend is not yet statistically significant. There have been a few observations of moderate algal blooms in the lake through the years. If a trend toward higher algal levels becomes more pronounced, this may be a concern for Lake Ki.



LAKE KI

SHORELINE CONDITION

The Lake Ki shoreline was surveyed in 2009 (see map on page 6). The lake shoreline condition is important in understanding overall lake health. Frequently, lake shorelines are modified through removal of natural vegetation, the installation of bulkheads or other hardening structures, and/or removal of partially submerged logs and branches. These types of alterations 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.

The Lake Ki shoreline is highly developed. There were 82 homes or cabins around the lake in 1974. By the mid-90s, there were 90 homes bordering the lake. Although homes were not surveyed in 2009, 93 docks were counted around the lake. Accompanying the high development, there were significant structural modifications to the shoreline. Fifty percent of the 2.0 mile shoreline has been armored with either bulkheads (48% of the armoring), wood or rock revetments (25%), or fill material and boat ramps (26%). The vegetation zone immediately adjacent to the shoreline has also been significantly altered, with only 32% of the native vegetation remaining intact. In many cases, the native vegetation has been replaced by lawns down to the water. Lawns can be a source of nutrients and do not protect the lake as well as a buffer of native vegetation. There is only a small amount of large wood (about 41 pieces) remaining in the lake. These old logs and branches are valuable for fish and wildlife habitat.

The overall amount of shoreline modification leaves the lake more susceptible to pollution from the watershed, eliminates the buffer of native vegetation that can filter out pollution, and limits the amount of habitat available for fish and wildlife.

SUMMARY

Trophic State

Lake Ki may be classified as oligotrophic based on high water clarity and low phosphorus and chlorophyll *a* concentrations. The lake produces low amounts of algae and aquatic plants.

Condition and Trends

Overall, Lake Ki remains in healthy condition, although there is some evidence of water quality changes. While there are no significant long-term trends in water clarity in Lake Ki, the long-term average has fallen slightly below the target of 7.7 meters established in the 2003 State of the Lakes Report. This is mainly because of reduced clarity in 2003 and 2004.

The nutrient targets for the lake are to maintain stable total phosphorus levels of 7 µg/l in the epilimnion and 16 µg/l in the hypolimnion. The long-term epilimnetic average is now 8 µg/l, and there has been a significant trend toward increasing total phosphorus concentrations. The phosphorus levels in the hypolimnion, though variable in recent years, have not changed significantly over the long run, having a current long-term average of 17 µg/l. Chlorophyll a averages appear to be increasing slightly. Although the changes in phosphorus and chlorophyll *a* are small, they may be a sign of increasing eutrophication that could fuel the growth of more plants and algae and endanger this naturally clear lake.

In order to protect the quality of Lake Ki, actions should be taken to prevent any future negative impacts to the lake. Increased levels of nutrients in the lake can be caused by development and other human activities. Nutrients enter the lake through stormwater runoff or streams flowing into the lake. Sources of nutrients include fertilizers, pet wastes, and erosion from land clearing and construction. Nutrients may also directly enter the lake through poorly maintained septic systems. To find out more about the causes and problems of elevated lake nutrient levels and tips to improve lake water quality visit www.lakes.surfacewater.info.

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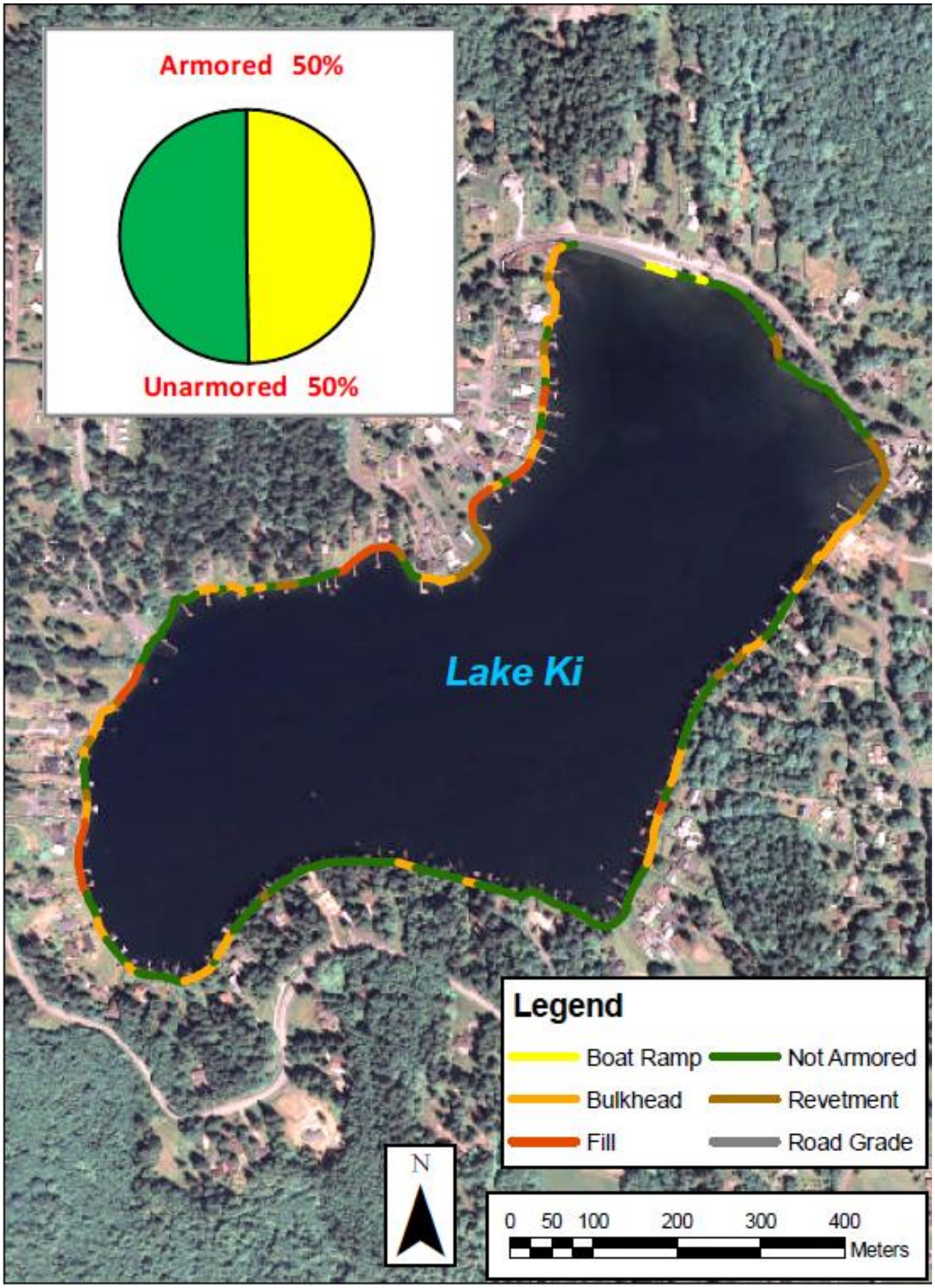
Armored 50%
Unarmored 50%
Lake Ki
Legend
Boat Ramp
Not Armored
Bulkhead
Revetment
Fill
Road Grade
N
0 50 100 200 300 400
Meters

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DATA SUMMARY FOR LAKE KI					
		Water Clarity (Secchi depth	Total Phosphorus (*ug*/l)		Chlorophyll *a* (*ug*/l)
Source	**Date**	**in meters)**	**Surface**	**Bottom**	**Epilimnion**
Bortleson, et al, 1976	**6/20/74**	3.7	7	19	-
Sumioka and Dion, 1985	**7/6/81**	4.3	10	90	2.2 -
Entranco, 1986	**1983**	4.8 - 6.5 (5.8) *n = 5*	<5 (<5) *n = 5*	7 - 14 (10) *n = 5*	0.4 - 2.9 (1.8) *n = 5*
Volunteer	**1992**	7.0 - 9.8 (8.1) *n = 6*	-	-	-
Volunteer or DOE	**1993**	6.1 - 9.3 (7.1) *n = 13*	-	-	1.7 - 3.0 (2.4) *n = 2*
SWM Staff or DOE	**1994**	7.0 - 8.9 (7.6) *n = 14*	-	-	1.9 - 10 (4.9) *n = 3*
SWM Staff or DOE	**1995**	7.0 - 9.4 (8.0) *n = 12*	-	-	1.3 - 2.0 (1.7) *n = 3*
SWM Staff or DOE	**1996**	6.7 - 8.1 (7.3) *n = 11*	<2 - 3 (2) *n = 2*	7 - 8 (8) *n = 2*	1.8 - 2.1 (2.0) *n = 2*
SWM Staff or DOE	**1997**	4.2 - 8.8 (7.4) *n = 9*	4 - 11 (8) *n = 2*	16 - 17 (17) *n = 2*	-
SWM Staff	**1998**	6.8 - 8.2 (7.5) *n = 4*	3 - 10 (5) *n = 4*	15 - 26 (20) *n = 4*	-
SWM Staff	**1999**	6.0 - 8.6 (7.5) *n = 4*	4 - 6 (5) *n = 4*	15 - 30 (21) *n = 4*	-
SWM Staff	**2000**	7.1 - 7.9 (7.6) *n = 4*	4 - 10 (6) *n = 4*	15 - 21 (18) *n = 4*	-
Volunteer	**2001**	8.0 - 9.5 (8.7) *n = 7*	8 - 18 (12) *n = 4*	6 - 26 (13) *n = 4*	-
SWM Staff or Volunteer	**2002**	6.3 - 9.2 (7.6) *n = 5*	5 - 10 (9) *n = 4*	8 - 27 (17) *n = 4*	0.1 - 1.6 (0.6) *n = 4*
SWM Staff or Volunteer	**2003**	4.6 - 7.3 (6.1) *n = 5*	10 - 15 (12) *n = 4*	10 - 18 (14) *n = 3*	0.8 - 2.1 (1.3) *n = 4*
SWM Staff or Volunteer	**2004**	2.0 - 8.5 (6.1) *n = 5*	6 - 13 (10) *n = 4*	7 - 22 (16) *n = 4*	0.5 - 1.6 (1.0) *n = 4*

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DATA SUMMARY FOR LAKE KI					
		Water Clarity (Secchi depth	**Total Phosphorus (*ug*/l)**		**Chlorophyll *a* (*ug*/l)**
Source	**Date**	**in meters)**	**Surface**	**Bottom**	**Epilimnion**
SWM Staff or Volunteer	**2005**	7.2 - 8.3 (7.6) *n = 5*	4 - 10 (7) *n = 4*	4 - 44 (20) *n = 4*	1.0 - 1.3 (1.2) *n = 4*
SWM Staff or Volunteer	**2006**	6.9 - 8.2 (7.7) *n = 5*	7 - 9 (8) *n = 4*	5 - 14 (9) *n = 4*	1.3 - 4.3 (2.4) *n = 4*
SWM Staff or Volunteer	**2007**	7.7 - 8.0 (7.9) *n = 5*	10 - 26 (14) *n = 4*	14 - 42 (28) *n = 4*	0.8 - 4 (2.2) *n = 4*
Volunteer	**2008**	6.0 - 9.9 (7.9) *n = 5*	6 - 11 (9) *n = 4*	9 - 26 (16) *n = 4*	1.1 - 2.1 (1.5) *n = 4*
Volunteer	**2009**	5.1 - 8.3 (7.0) *n = 11*	6 - 10 (8) *n = 4*	19 - 25 (22) *n = 4*	1.3 - 3.2 (1.9) *n = 4*
Long Term Avg		**7.5 (1992-2009)**	**8 (1996-2009)**	**17 (1996-2009)**	**1.5 (2002-2009)**
TRENDS		**None**	**Increasing**	**None**	**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.
- DOE = Washington Department of Ecology
- "Surface" samples are from 1 meter depth and "bottom" samples are from 1-2 meters above the bottom.