LAKE LOMA

REPORT DESCRIPTION

This report is an update on the health of Lake Loma based on water quality data collected from 1992 through 2016 by local volunteers and Snohomish County Surface Water Management (SWM) staff. For additional background on the information provided here or to find out more about Lake Loma, please visit www.lakes.surfacewater.info or call SWM at 425-388-3464.

LAKE DESCRIPTION

Lake Loma is a 23-acre lake located in the Seven Lakes area north of the Tulalip Indian Reservation. Lake Loma is the first lake in a four-lake chain. It drains into Lake Crabapple, which flows into Lake Goodwin and Lake Shoecraft, and ultimately into Tulalip Bay. The lake is relatively shallow, with a maximum depth of 8.5 meters (28 feet) and an average depth of 3.4 meters (11 feet). The shoreline is densely developed with single family homes. The watershed, which is the land area that drains to the lake, is relatively small—only six times the size of the lake. This means that the lake should have fewer sources of pollution compared to lakes with larger watersheds.

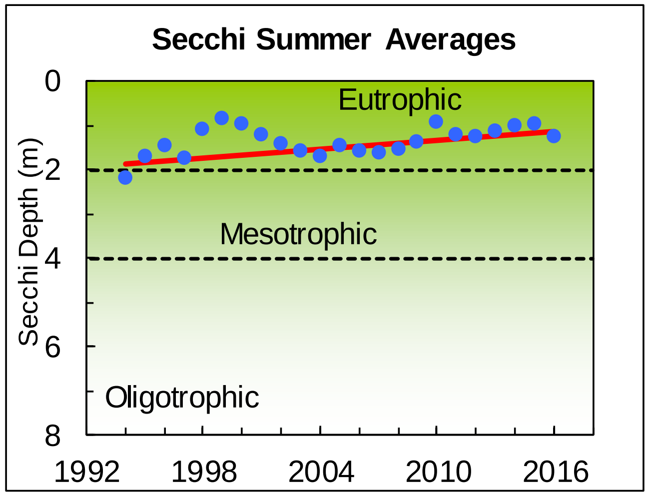
LAKE CONDITIONS

The following graphs illustrate the summer averages and trend lines (shown in red) for water clarity, total phosphorus, and chlorophyll *a* for Lake Loma. Please refer to the table at the end of this 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 Loma is low, with a 1992 - 2016 long-term summer average of 1.4 meters (4.6 feet). Over this time period, there has been a statistically significant trend toward declining water clarity (p=0.01). In recent years, there have been individual water clarity measurements of only 1.0 meter or less. Declining water clarity could be related to the high levels of algae, as indicated by high chlorophyll *a* summer averages, and/or because of darker water color in recent years.



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 Loma averaged 116 platinum-cobalt color units in 2010-2011, which is relatively dark compared to other lakes in Snohomish County. This is an increase in darkness from the 1994 – 1995 average of 77 pcu and could be a factor in the trend of decreasing water clarity over the same time period.

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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 May through October 2016, temperature data were collected at each meter throughout the Lake Loma water column. Temperature profiles for 2016 (see graph on following page) show that from May through September the lake was strongly thermally stratified. 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 May the upper waters measured about 65° F (18°C) in temperature, and by August had reached their peak at 74° F (23°C). At the same time, bottom water temperatures changed only a little and remained between 46 – 48°F (8-9°C). Each fall the surface waters will begin to cool until the temperatures are almost equal from top to bottom. The October profile shows that the temperatures were almost the same from the surface to near the bottom. As stratification weakens, the lake water will turn over (or mix). The lake will stay mixed during the winter until springtime, when the upper waters began 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.

The depth profiles of dissolved oxygen measured in 2016 generally correspond with the temperature profiles seen during that time period (see graph). Oxygen levels were relatively high in the upper waters from May to August, and the bottom waters contained much less oxygen. From June through September, there was essentially no oxygen in the water below about 10 feet deep. During the stratified 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 is not replenished by the overlying oxygen-rich upper waters or the atmosphere. Lake Loma has a thick layer of organic material at the bottom of the lake that consumes oxygen from almost the entire water column. The lake water will remain devoid of oxygen until the lake begins to mix, which started in September and had mixed completely by October. The lake then remains mixed until springtime when the upper waters begin to warm and dissolved oxygen begins to decline again in the bottom.

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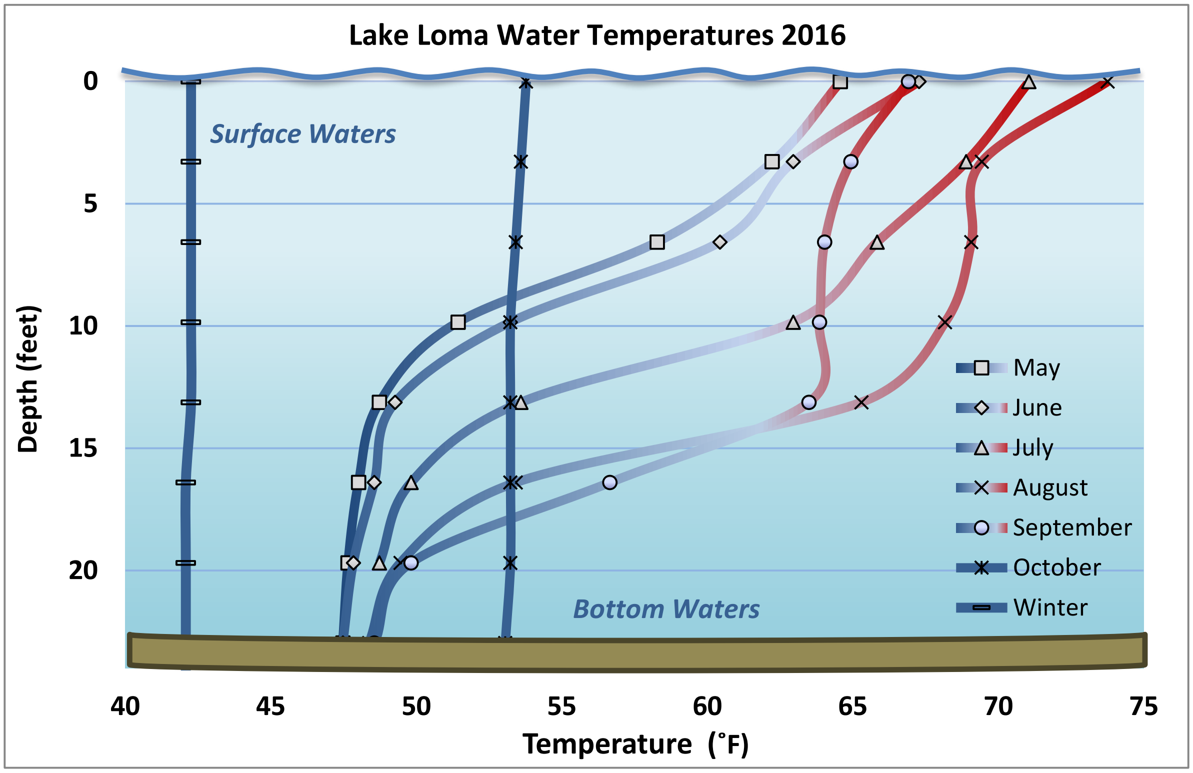
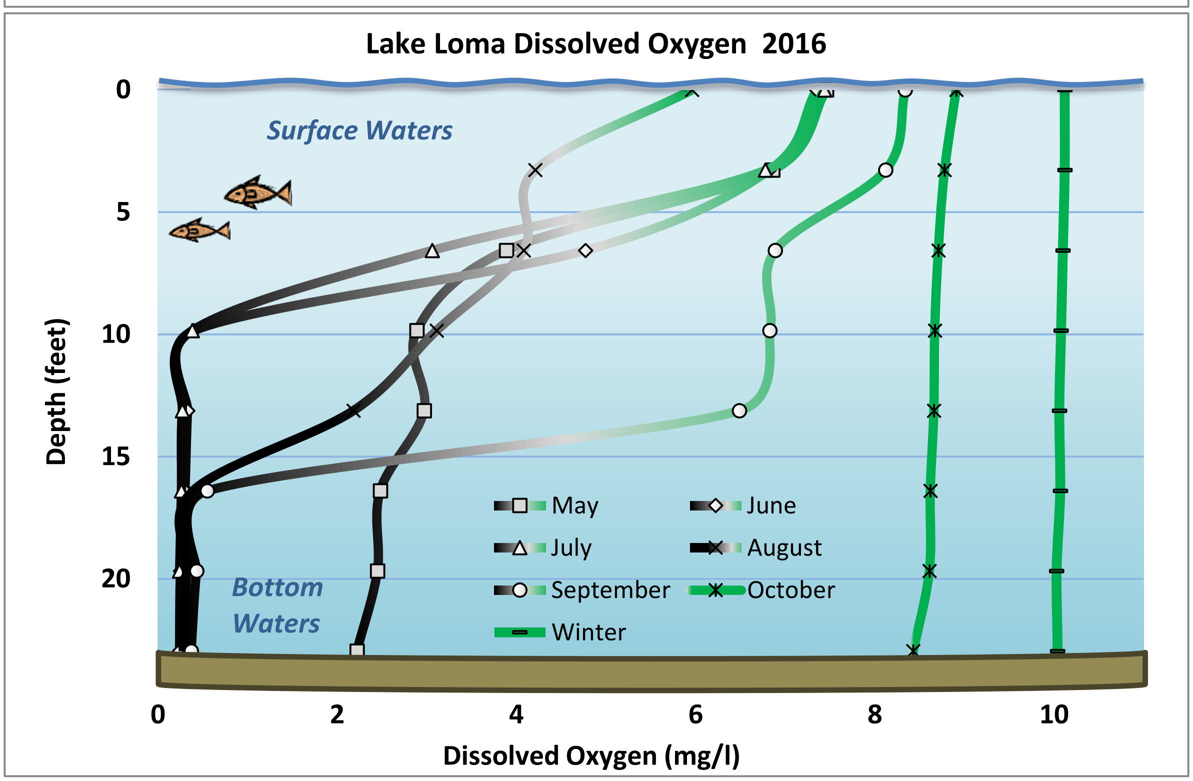

Lake Loma Water Temperatures 2016
Surface Waters
Bottom Waters
Depth (feet)
0
5
10
15
20
40
45
50
55
60
65
70
75
Temperature (˚F)
May
June
July
August
September
October
Winter


Lake Loma Dissolved Oxygen 2016
Surface Waters
Bottom Waters
Depth (feet)
0
5
10
15
20
0
2
4
6
8
10
Dissolved Oxygen (mg/l)
May
June
July
August
September
October
Winter

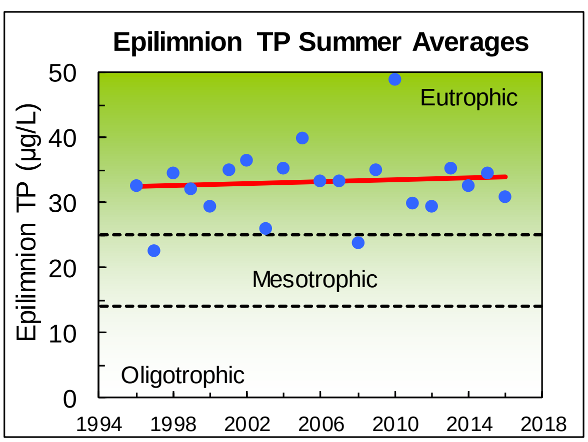
LAKE LOMA

Total 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.

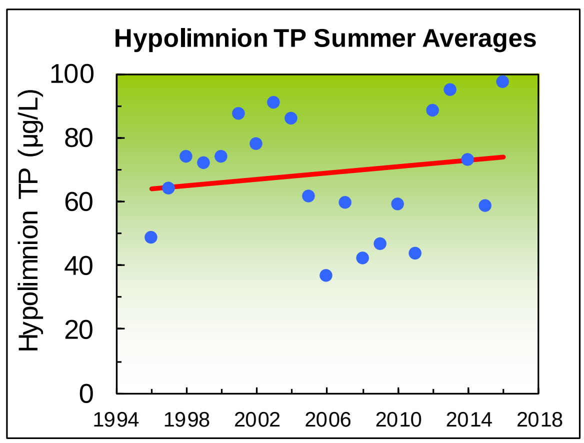
Total phosphorus (TP) concentrations in the epilimnion (upper waters) are high, with a 1996 - 2016 long-term summer average of 33 µg/L (micrograms per liter, which is equivalent to parts per billion). Phosphorus averages in the upper waters are also quite variable, ranging from 23 µg/L in 1997 to 49 µg/L in 2010. The peak in 2010 corresponds with low water clarity and high chlorophyll *a* that year. Because of the year-to-year variability, there has been no statistically significant trend in total phosphorus in the epilimnion between 1996 and 2016.

High phosphorus levels contribute to the growth of nuisance algae in the lake and are the reason that Lake Loma is listed as "impaired" in Washington State's official 2012 water quality assessment. The Department of Ecology drafted a Straight-to-Implementation Plan in 2013 to address phosphorus in Lake Loma.



Summertime phosphorus averages in the hypolimnion (bottom waters) are also high. The 1996 to 2016 long-term average is 68 µg/L. Until 2004, there had been a trend toward increasing phosphorus levels in the hypolimnion. However, phosphorus levels dropped from 2005 through 2011. Then, in 2012 and 2013, the summer averages were some of the highest on record (89 µg/L and 95 µg/L respectively). The 2014 and 2015 summer averages were somewhat lower, but the 2016 summer average was the highest on record at 97 µg/L. Overall, between 1996 and 2016 there has not been a statistically significant trend in phosphorus levels in the bottom waters.

The data also show that phosphorus concentrations in the hypolimnion steadily increase through the summer and fall of each year. This indicates that phosphorus is being released from the lake bottom sediments and building up in the bottom waters. This source of phosphorus appears to be a major contributor to algae growth in the lake.

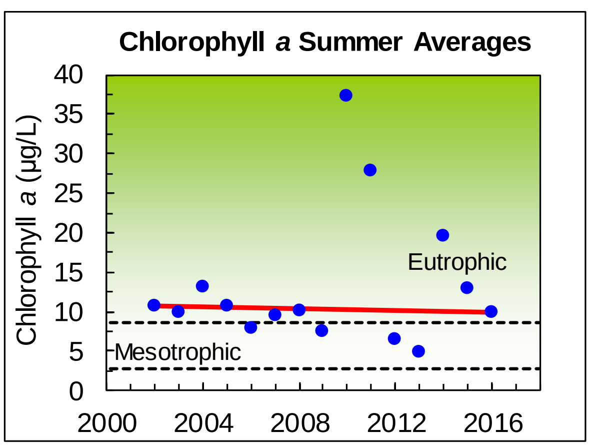


LAKE LOMA

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 and nitrogen, 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 in Lake Loma are high, indicating that there are abundant algae in the lake. The 2002 to 2016 long-term summer average for chlorophyll *a* is 13.2 µg/L. Between 2002 and 2009 there was little year-to-year variability in chlorophyll *a* concentrations, but in 2010 the summer average spiked to 37 µg/L and remained high in 2011, with an average of 28 µg/l. The 2012 and 2013 summer averages were much lower at 6.4 µg/L and 4.8 µg/L, respectively, but the average climbed to 20 µg/L in 2014 and have lowered in 2015 and 2016. These higher levels may be a warning of poorer lake conditions in future years. More years of monitoring will help determine if the chlorophyll *a* concentrations will remain low or jump back up to a higher range.



Toxic Blue-Green Algae (Cyanobacteria)

Lake Loma experiences periods of intense blue-green algae growth called blooms. Blooms often look like blue or green paint floating on the surface or like dense specks in the water column. Blue-green algae, also known as cyanobacteria, are a type of algae capable of producing toxins during blooms. The toxins can cause serious illness in people and pets that come into contact with affected water. Lake users should avoid contact with the water and keep pets away from the lake when it is experiencing a blue-green algae bloom. If a bloom has been identified as toxic, the lake will have postings at the public boat launch.

Since 2005, volunteers and SWM staff have screened algae at Lake Loma for potentially toxic blooms. In 2009, SWM staff and citizen volunteers conducted weekly monitoring to better assess the frequency and toxicity of blue-green algae blooms at Lake Loma through a grant funded by the Washington State Department of Ecology. When blooms were found, water samples were tested for two types of toxins: microcystin (a liver toxin) and anatoxin-*a* (a neurotoxin). Signs were also posted at the public access during blooms to warn lake users of the dangers. If a bloom was found to exceed State recreational guidelines (6 ug/L for microcystin and 1 ug/L for anatoxin-*a*), lakefront residents were also warned through emails (if provided by homeowner) and direct mailings.

Limited testing was done on potentially toxic blue-green algae blooms in Lake Loma from 2005 through 2013 (see table). No potentially toxic blue-green algae blooms were reported in 2014. Intermittent blooms of blue-green algae were reported beginning in November 2015, but testing has shown very low levels of toxins. Blooms were reported in Fall 2016, and one week had concentrations above the recreational guideline. Algae monitoring will continue in 2017 to alert the public to potential health risks from toxic algae at Lake Loma.

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Lake Loma Toxic Algae Testing Results

Year	# Weeks Sampled	# Weeks Toxic*	Microcystin Range (µg/L)
2005-2008	2	0	0.69 to >3
2009	12	2	0.01 to **74.1**
2011	3	0	0 to 0.13
2012	13	0	0 to 4.62
2013	3	0	0 to **>6**
2015	2	0	0 to **>6**
2016	5	1	0.01 to 9.8

**number of weeks where toxin levels were above the State recreational guideline of 6 µg/L for microcystin*

Nitrogen (another essential nutrient for algae)

Nitrogen is another important nutrient for plant and algae growth. Similar to phosphorus, lakes with high levels of nitrogen typically have more aquatic plants and algae. In 2014, Lake Loma had high levels of total nitrogen (summer average of 977 µg/L). This is consistent with the high chlorophyll *a* concentrations measured in the lake in 2014. Total nitrogen was lower in 2015 and 2016 (759 µg/L and 742 µg/L respectively), corresponding with somewhat lower algae levels. Overall from 2014 to 2016, Lake Loma had relatively high levels of total nitrogen (summer average was 765 µg/L).

The relative abundance of nitrogen and phosphorus can also be a useful indicator of lake conditions. This is referred to as the nitrogen to phosphorus ratio or N:P ratio. When lakes have low N:P ratios (typically less than 20), algae growth is often high and harmful blue-green algae blooms may be a problem. Low N:P ratios may also indicate that fertilizers, septic systems, polluted runoff from developed areas, and release of phosphorus from the lake bottom sediments are contributing most of the nutrients to the lake. Lake Loma had a relatively low average N:P ratio of 23 in 2016, and blue green algae blooms have been problematic in the past.

In contrast, when lakes have higher N:P ratios (greater than 20), algae growth will be limited by the amount of phosphorus available, and blue-green algae are usually less of a problem.

SHORELINE CONDITION

Lake shoreline conditions are 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.

Lake Loma is one of the most densely developed lakes in Snohomish County. There were 58 homes or cabins around the shore in the mid-90s. There are also 52 docks present on the lake covering 0.35 acres. The shoreline is somewhat intact given the high level of development on the lake. Of the roughly mile-long shoreline, only 16% is armored with bulkheads or rock revetments. However, the zone of native vegetation along the shoreline has been significantly altered. Only 45% of the shoreline has a buffer of native grasses, shrubs, or trees immediately adjacent to the lake. The amount of old logs and branches remaining in the lake is also low (about 6 pieces). These old logs and branches are valuable for fish and wildlife habitat. The overall amount of shoreline modification at Lake Loma leaves the lake vulnerable to pollution from the watershed, eliminates the buffer of native vegetation that can filter out pollution, makes the shoreline more susceptible to erosion, and limits the amount of habitat available for fish and wildlife.

LAKE LOMA

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 the long-term monitoring data, Lake Loma may be classified as eutrophic, with low water clarity, high phosphorus levels, regular blue-green algae blooms, and dense aquatic plants. This is likely the natural state of this shallow lake.

Condition and Trends

Lake Loma is not meeting the water quality targets to improve water clarity and reduce phosphorus levels. Instead, Lake Loma shows a statistically significant trend toward declining water clarity and no improvement in phosphorus levels in either the epilimnion or hypolimnion. As noted above, Lake Loma is listed in the State of Washington's water quality assessment as being "impaired" because of excess phosphorus in the water.

Overall, Lake Loma is in poorer condition than it should be. The lake needs restoration to reduce phosphorus levels and the frequency of algae blooms. Because of the high amount of phosphorus being released into the water from lake-bottom sediments, for restoration to be successful it should include treatment of the sediments to inactivate the reservoir of phosphorus there. Reducing the level of nutrients entering the lake from development or human activities is also critical for restoration. To find out more about ways to protect lake water quality and information on the causes and problems of elevated lake nutrient levels visit www.lakes.surfacewater.info.

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DATA SUMMARY FOR LAKE LOMA						
		Water Clarity (Secchi depth	Total Phosphorus (µg/L)		Total Nitrogen (µg/L)	Chlorophyll *a* (µg/L)
Source	**Date**	**in meters)**	**Surface**	**Bottom**	**Surface**	**Surface**
Menasveta, 1961	**Summer 1959**	1.8 - 2.1 (2.0) *n = 4*	-	-	-	-
McConnell, et al, 1976	**Summer 1973**	1.1 - 1.4 (1.2) *n = 3*	19 - 30 (26) *n = 3*	24 - 39 (32) *n = 3*	-	2.2 - 8.5 (5.7) *n = 3*
Sumioka and Dion,1985	**6/30/81**	1.5	40	60	-	8
Entranco, 1986	**1983**	1.5 - 2.0 (1.7) *n = 5*	11 - 17 (14) *n = 5*	23 - 41 (31) *n = 5*	-	3.8 - 8.3 (5.8) *n = 5*
Volunteer	**1992**	1.8 - 2.2 (2.0) *n = 4*	-	-	-	-
Volunteer or DOE	**1993**	1.6 - 2.6 (2.1) *n = 16*	-	-	-	7.2 - 70 (38) *n = 2*
SWM Staff, Volunteer or DOE	**1994**	1.4 - 2.9 (2.2) *n = 13*	-	-	-	2.6 - 5.6 (4.0) *n = 4*
SWM Staff	**1995**	1.7	-	-	-	37
SWM Staff, Volunteer or DOE	**1996**	1.3 - 2.0 (1.4) *n = 5*	24 - 41 (33) *n = 2*	33 - 64 (49) *n = 2*	-	15 -16 (15) *n = 2*
SWM Staff	**1997**	1.7 - 1.8 (1.8) *n = 2*	19 - 26 (23) *n = 2*	43 - 85 (64) *n = 2*	-	-
Volunteer	**1998**	0.9 - 1.3 (1.1) *n = 11*	20 - 58 (35) *n = 4*	43 - 107 (74) *n = 4*	-	-
Volunteer	**1999**	0.6 - 1.0 (0.8) *n = 8*	30 - 36 (32) *n = 4*	46 - 95 (72) *n = 4*	-	-
SWM Staff or Volunteer	**2000**	0.7 - 1.1 (1.0) *n = 9*	12 - 37 (29) *n = 4*	18 - 111 (74) *n = 4*	-	-
Volunteer	**2001**	0.9 - 1.5 (1.2) *n = 8*	25 - 61 (35) *n = 4*	65 - 133 (88) *n = 4*	-	
SWM Staff	**2002**	1.2 - 1.8 (1.4) *n = 5*	32 - 42 (37) *n = 4*	48 - 121 (78) *n = 4*	-	3.5 - 19 (11) *n = 4*
SWM Staff	**2003**	1.3 - 2.1 (1.6) *n = 4*	4 - 35 (26) *n = 4*	53 - 129 (91) *n = 4*	-	7.7 - 14 (9.9) *n = 4*
SWM Staff	**2004**	1.5 - 2.1 (1.7) *n = 4*	32 - 38 (35) *n = 4*	43 - 143 (86) *n = 4*	-	6.9 - 30 (13) *n = 4*

LAKE LOMA

DATA SUMMARY FOR LAKE LOMA						
		Water Clarity (Secchi depth in meters)	**Total Phosphorus (µg/L)**		**Total Nitrogen (µg/L)**	**Chlorophyll *a* (µg/L)**
Source	**Date**		**Surface**	**Bottom**	**Surface**	**Surface**
SWM Staff	**2005**	1.0 - 1.7 (1.5) *n = 4*	29 - 60 (40) *n = 4*	51 - 71 (62) *n = 4*	-	1.8 - 29 (11) *n = 4*
Volunteer	**2006**	1.2 - 1.8 (1.6) *n = 5*	28 - 39 (33) *n = 4*	27 - 60 (37) *n = 4*	-	2.1 - 14 (7.9) *n = 4*
Volunteer	**2007**	1.2 - 1.8 (1.6) *n = 4*	28 - 44 (33) *n = 4*	43 - 106 (60) *n = 4*	-	5.3 - 17 (9.4) *n = 4*
Volunteer	**2008**	1.2 - 1.8 (1.5) *n = 12*	23 - 24 (24) *n = 4*	35 - 52 (42) *n = 4*	-	3.5 - 22 (10) *n = 4*
Volunteer	**2009**	1.2 - 1.8 (1.4) *n = 19*	28 - 47 (35) *n = 4*	34 - 54 (47) *n = 4*	-	3.5 - 11 (7.5) *n = 4*
Volunteer	**2010**	0.6 - 1.4 (0.9) *n = 5*	27 - 90 (49) *n = 4*	34 - 73 (59) *n = 4*	-	5.9 - 69 (37) *n = 4*
Volunteer	**2011**	1.0 - 1.6 (1.2) *n = 4*	25 - 33 (30) *n = 4*	39 - 52 (44) *n = 4*	-	1.6 - 65 (28) *n = 4*
SWM Staff	**2012**	1.0 - 1.9 (1.3) *n = 11*	25 - 36 (29) *n = 11*	40 - 144 (89) *n = 9*	557 - 876 (703) *n = 11*	2.1 - 15 (6.4) *n = 10*
Volunteer	**2013**	1.0 - 1.3 (1.1) *n = 9*	23 - 53 (35) *n = 4*	46 - 164 (95) *n = 4*	-	2.7 - 6.9 (4.8) *n = 4*
Volunteer	**2014**	0.8 - 1.2 (1.0) *n = 12*	27 - 40 (33) *n = 4*	43 - 106 (73) *n = 4*	616 - 1620 (977) *n = 4*	2.1 - 67 (20) *n = 4*
Volunteer	**2015**	*0.7 - 1.1* *(1.0)* *n = 13*	*28 - 43* *(35)* *n = 4*	*27 - 96* *(59)* *n = 4*	*632 - 899* *(759)* *n = 4*	*2.7 - 30* *(13)* *n = 4*
Volunteer	**2016**	1.1 - 1.4 (1.3) *n = 6*	25 - 38 (31) *n = 6*	33 - 171 (97) *n = 5*	593 - 874 (742) *n = 6*	5.4 - 15 (10.0) *n = 6*
Long Term Avg		**1.4** **(1992-2016)**	**33** **(1996-2016)**	**68** **(1996-2016)**	**765** **(1996-2016)**	**13** **(2002-2016)**
TRENDS		**Decreasing**	**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.
- DOE = Washington Department of Ecology
- "Surface" samples are from 1 meter depth and "bottom" samples are from 1-2 meters above the bottom.