Section 2.3
Report on Watershed Resources in the Clean Water District

2.3.1 Lakes

2.3.1 LAKES

2.3.1.1 Status of Lakes in the Clean Water District

The purpose of the Stillaguamish CWD includes monitoring, managing, protecting, and restoring lakes (see Snohomish County Code 25A.05.010 (3)). Lakes are standing bodies of fresh water deeper that six feet and usually greater than one acre in size. There are upwards of two hundred lakes located within the boundaries of the CWD -- most in the forested upper portions of the Stillaguamish Basin on land under the jurisdiction of the state and federal governments.

Snohomish County is the only jurisdiction actively involved in managing lakes in the lowlands of the CWD. Several lakes have formal or informal homeowners' associations that have some degree of involvement in lake management. The Ketchum Shores Improvement Club manages aquatic plants, algae, and water levels in Lake Ketchum. The Sunday Lake Community Club works to control aquatic plants within the western portion of Sunday Lake. Lake Crabapple citizens have an informal organization that monitors the water quality of the lake. The Lake Goodwin Community Club and the Normanna Park association at Lake Riley represent lake residents but are not active in lake management.

Snohomish County's Lake Management Program

Since 1992, Snohomish County's Surface Water Management Division (SWM) has worked with citizen volunteers and homeowners' associations to monitor and protect the quality of lakes in the county. Volunteers and SWM staff monitor water clarity, total phosphorus, chlorophyll *a* (algae), toxic algae, temperature, dissolved oxygen, aquatic plants, and shoreline changes from May through October each year.

The goals of lake monitoring are to assess the current health of lakes, identify any long-term trends in water quality, detect specific water quality problems, and educate and involve citizens in lake stewardship. In addition to regular monitoring of lake conditions, the Lake Management Program helps citizens develop and implement management plans and control invasive aquatic plants.

Currently, 14 lowland lakes in the CWD are being monitored by SWM, with the assistance of citizen volunteers (see Figure 2.3.1-1). These include all lowland lakes with public access and the private lakes where citizens have expressed interest in lake monitoring. The monitored lakes are located primarily in the lower Mainstem watershed, in the Tulalip Creek sub-basin, and in the smaller sub-basins that drain directly to marine waters. The lakes range in size from 20 acres (Rowland) to 542 acres (Goodwin). Some are deep (Ki and Martha are 70 feet deep); some are quite shallow (Spring Lake is only 10 feet deep).

Twelve of the monitored lakes have public access facilities, usually boat launches owned by the Washington State Department of Fish and Wildlife. Lake Goodwin has both a county and a state park on its shores. Two lakes have no public access. Table 2.3.1-1 lists the sizes, watershed areas, depths, volumes, shoreline lengths, and public access availability for the 14 CWD lakes monitored by SWM.

Lake Function

Lakes are valuable natural resources that provide numerous benefits for the people of Snohomish County. Lakes are important elements of the natural drainage system, detaining runoff and reducing the downstream impacts of storm water on local streams. Some lakes, in particular Lake Crabapple, also serve as sources of domestic water for lake residents..

Lakes provide habitat for fish, a variety of birds, and numerous small animals. The dominant fish species in the monitored lakes are rainbow trout (stocked by the state in all the public access lakes but Bryant and Sunday), largemouth bass (found in at least 9 lakes), smallmouth bass (Goodwin and Shoecraft lakes), cutthroat trout (Goodwin), black crappie (5 lakes), yellow perch (7 lakes), and brown bullhead catfish (Sunday). Several lakes also support bluegill and pumpkinseed sunfish. (See Washington State Department of Fish and Wildlife website -- www.wdfw.wa.gov.)

Lakes in the CWD also support a variety of swimming, fishing, and boating activities. Water skiing and power boating are permitted at Lake Goodwin and Lake Shoecraft. Motor boats can also be used at Lake Ki, but speed is restricted to 8 mph. On all the other monitored lakes, gasoline-powered boats are prohibited. Lakes are also highly prized as residential locations. As noted below in Table 2.3.1-2, there has been on-going residential development around most of the lakes in the CWD. Only a few lakes have substantial amounts of undeveloped shoreline remaining.

Lake Health

Water Sources

All the lowland lakes in the CWD were formed by glaciers during the most recent ice age. Glaciers gouged out depressions in soil or bedrock or deposited large ice blocks whose melting created lake basins. None of the lakes developed along a major stream. Instead, each of the monitored lakes is fed by a combination of small streams, local drainage channels, and ground water. This means that the residence time of water moving through these lakes is long, even for lakes with large watersheds, and that pollution entering a lake is likely to remain there. Several of the lakes have small outlet structures that control the lake levels and restrict the amount of water flowing out of the lakes. Spring Lake and Lake Shoecraft have man-made dams that raise or maintain the water levels.

Except for limited monitoring of stream flows into Ketchum, Crabapple, and Sunday lakes described below under “SWM Lake Projects”, there are no data evaluating the quality or quantity of water sources for CWD lakes.

Lake Ecology

The interactions of nutrients, algae, and aquatic plants are the primary drivers in the ecology of all lakes. Nutrients, such as phosphorus and nitrogen, are essential for the growth of algae and aquatic plants. Some algae and aquatic plants are also essential for healthy lakes. Algae form the basis of the food web in lakes. Aquatic plants provide food and shelter for fish and other aquatic animals, stabilize the shoreline and bottom sediments, and can increase water clarity.

While nutrients are essential to keep a lake healthy, too many nutrients flowing into a lake from its immediate surroundings or overall watershed can pollute it. This leads to excessive growths of algae, especially blue-green algae, which can cloud the water, coat docks and pipes, deplete the lake’s oxygen supply, sicken or kill aquatic life living in or on the lake, form unsightly scums, and sometimes release toxins. These episodes of excess algae are known as algal blooms.

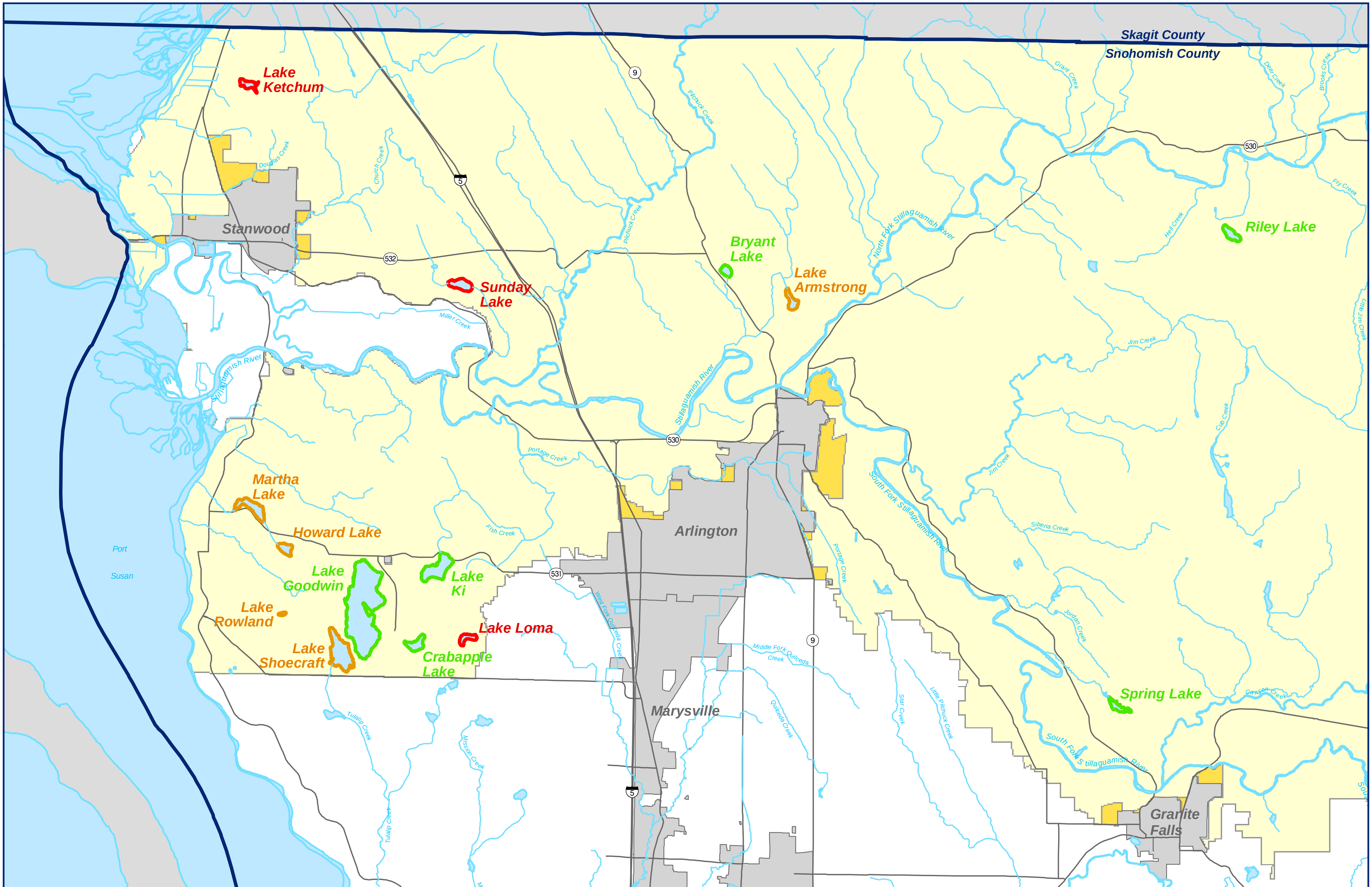

Figure 2.3.1-1 Health Assessment of Lakes Monitored by Snohomish County in the CWD

Healthy
At Risk
Impaired

Major Roads
Rivers & Streams
Lakes & Bays

Cities
Stillaguamish CWD
Stillaguamish CWD UGA

N S E W

0 1 2 3
Miles

Snohomish County
PUBLIC WORKS
SURFACE WATER MANAGEMENT
(425) 388-3464

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Table 2.3.1-1 Physical Characteristics of Monitored CWD Lakes

Lake Name	Lake Area (acres)	Watershed Area (acres)	Watershed/ Lake Area Ratio	Maximum Depth feet (meters)	Average Depth feet (meters)	Lake Volume (acre-feet)	Shoreline Length (miles)	Public Access
ARMSTRONG	30	369	12.3	28 (8.5)	19 (5.7)	561	1.1	WDFW (APR-OCT)
BRYANT	21	468	22.3	23 (7.0)	14 (4.3)	295	0.7	WDFW (Walk-in)
CRABAPPLE	38	690 [862]*	19.7 [24.6]*	49 (14.9)	18 (5.5)	650	1.2	WDFW (Year-round)
GOODWIN	542	2604 [3466]*	4.9/6.5*	50 (15.2)	23 (7.0)	13,000	5.6	COUNTY & STATE PARKS
HOWARD	27	265	10.2	50 (15.2)	29 (8.8)	790	0.9	WDFW (APR-OCT)
KETCHUM	25	352	14.7	21 (6.4)	12 (3.7)	296	1.3	WDFW (Year-round)
KI	101	452	4.7	70 (21.3)	33 (10.1)	3300	1.9	WDFW (Year-round)
LOMA	23	172	8.2	28 (8.5)	11 (3.4)	230	0.9	WDFW (Year-round)
MARTHA N.	62	801 [1066]*	13.6 [18.1]*	70 (21.3)	33 (10.1)	2000	1.8	WDFW (Year-round)
RILEY	32	273	9.1	45 (13.7)	22 (6.7)	670	1.0	WDFW (APR-OCT)
ROWLAND	20	404	44.9	25 (7.6)	6 (1.8)	115	1.2	NO
SHOECRAFT	132	763 [4230]*	5.8 [32.0]*	35 (10.7)	18 (5.5)	2400	2.4	WDFW (Year-round)
SPRING	25	620	23.8	10 (3.0)	NA	NA	1.3	NO
SUNDAY	47	790	20.8	20 (6.1)	8 (2.4)	305	1.3	WDFW (Year-round)

**Notes: For lakes located downstream in a chain of lakes, the first watershed acreage figure and the first watershed/lake area ratio refer to the watershed immediately draining to that lake; the acreage figures and ratios in brackets refer to the total watershed draining to that lake (including the watershed of any upstream lake(s)). WDFW = Washington State Department of Fish and Wildlife boat launch*

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Unfortunately, human activities around lake shores and throughout lake watersheds often contribute excess nutrients. Sources of nutrients include lawn and garden fertilizers, eroded soil, road runoff, poorly maintained septic systems, decomposing yard wastes, pet and animal wastes, and waterfowl droppings. Almost all lake protection efforts require actions to control nutrient runoff from the watershed.

Although every lake goes through a process of enrichment by nutrients and sediment called eutrophication, the natural process takes thousands of years. In contrast, when lakes receive excess nutrients from human activities, the eutrophication process is greatly accelerated, leading to nuisance growths of algae and aquatic plants that fill the lakes with organic matter and sediments.

Water Quality Parameters

The three key lake water quality parameters being measured by SWM and volunteers are water clarity, total phosphorus, and chlorophyll *a*. Water clarity is a measure of how far down into the water one can see. It is perhaps the most important indicator of lake conditions because it reflects the overall impacts of pollution and is meaningful to lake users. Phosphorus is the key nutrient feeding algal growth. More phosphorus usually leads to increased algae and plant growth. Chlorophyll *a* is a measure of the amount of algae in the water.

Current Lake Conditions

Determining the health of lakes in the CWD involves looking at current conditions as well as trends over time. In particular, it means looking to see if a lake shows evidence of accelerated eutrophication. That is, does a lake show signs of having more nutrients, more algae (especially blue-green algae), and more aquatic plants than it should have naturally.

Table 2.3.1-2 describes the current trophic state (the stage of eutrophication), the significant water quality problems, and the level of shoreline development for CWD lakes. Detailed water quality monitoring data for each CWD lake for all years from the early 1990s through 2006 are available on SWM's web site at www.data.surfacewater.info by clicking on "Lake Quality

Table 2.3.1-2 Current Lake Conditions

Lake	Trophic State	Identified Lake Quality Problems	# of Nearshore Homes per 1000 feet of Shoreline	% Change in # of Nearshore Homes (1970s to 2007)
Armstrong	Meso-Eutrophic	Blue-green algal blooms	2.3	63
Bryant	Meso-Eutrophic		0	0
Crabapple	Mesotrophic		7.1	33
Goodwin	Oligo-Mesotrophic	Eurasian watermilfoil infestation	11.8	-9
Howard	Mesotrophic		8.2	68
Ketchum	Eutrophic	Blue-green algal blooms; toxic algae; excess aquatic plants	8.8	7
Ki	Oligotrophic		10.4	29

Lake	Trophic State	Identified Lake Quality Problems	# of Nearshore Homes per 1000 feet of Shoreline	% Change in # of Nearshore Homes (1970s to 2007)
Loma	Eutrophic	Blue-green algal blooms; toxic algae	14.4	36
Martha	Mesotrophic		8.1	75
Riley	Meso-Eutrophic		3.3	29
Rowland	Eutrophic	Excess aquatic plants	1.6	1000
Shoecraft	Oligo-Mesotrophic	Eurasian watermilfoil infestation (now controlled)	9.3	21
Spring	Mesotrophic		3.3	1050
Sunday	Eutrophic	Nuisance algal blooms; Excess aquatic plants	4.9	39

Data". This web site shows monitoring results for water clarity, phosphorus, and chlorophyll *a*, as well as summer averages for these parameters for each year.

Figures 2.3.2-2 through 2.3.2-5 visually compare the water quality conditions of the 14 monitored lakes in the CWD. The graphs illustrate the range of summer averages and the long-term averages for water clarity, phosphorus (both upper waters—epilimnion—and bottom waters—hypolimnion), and chlorophyll *a* for each lake. The lakes are arranged from high nutrients and algae on the left to low nutrients and algae on the right.

This table and the graphs show that there are several lakes in the CWD that are eutrophic (shallow, with abundant plants and algae, high nutrient concentrations, and limited water clarity). These are Ketchum, Loma, Rowland, and Sunday lakes. Armstrong, Bryant, and Riley lakes may be classified as meso-eutrophic, meaning they are approaching eutrophic.

Crabapple, Howard, Martha, and Spring lakes are mesotrophic lakes. They have moderate amounts of nutrients, plants, and algae. Lake Ki may be classified as oligotrophic, having clear water, low nutrients, and few aquatic plants and algae. The remaining lakes—Goodwin and Shoecraft—are oligo-mesotrophic, meaning they are between oligotrophic and mesotrophic, with low to moderate plants and algae.

2.3.1.2 Trends in Water Quality

To get a clearer picture of the condition of lakes in the CWD, it is necessary to look at changes in water quality over time. If water clarity declines through the years, or if the levels of phosphorus or algae increase, these are signs that a lake is in trouble. Although Figures 2.3.2-2 through 5 show that there is considerable variability in the summer averages from year to year (much of which may be natural variability in response to rainfall and temperature patterns), any consistent change in one direction is an important indicator of lake health.

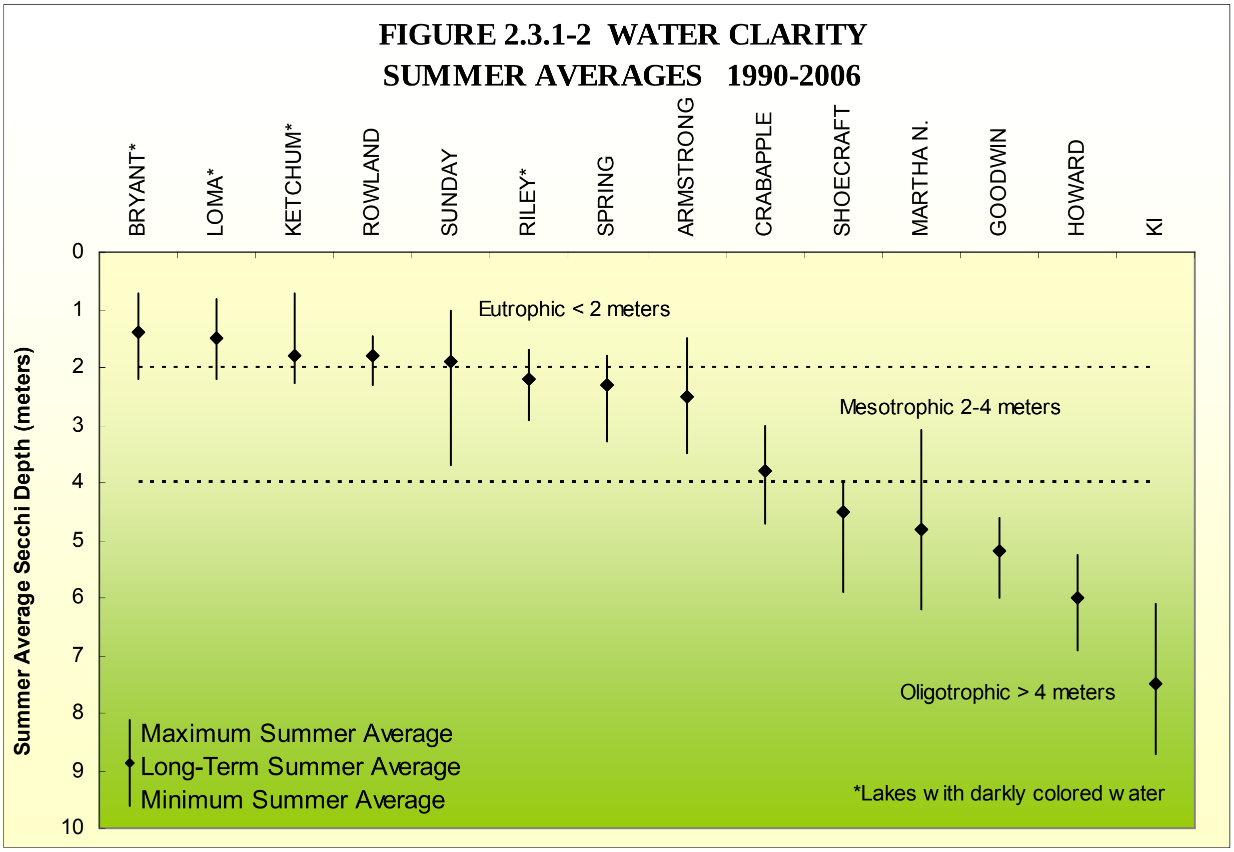
FIGURE 2.3.1-2 WATER CLARITY
SUMMER AVERAGES 1990-2006
BRYANT*
LOMA*
KETCHUM*
ROWLAND
SUNDAY
RILEY*
SPRING
ARMSTRONG
CRABAPPLE
SHOECRAFT
MARTHA N.
GOODWIN
HOWARD
KI
Summer Average Secchi Depth (meters)
0
1
2
3
4
5
6
7
8
9
10
Eutrophic < 2 meters
Mesotrophic 2-4 meters
Oligotrophic > 4 meters
Maximum Summer Average
Long-Term Summer Average
Minimum Summer Average
*Lakes w ith darkly colored w ater

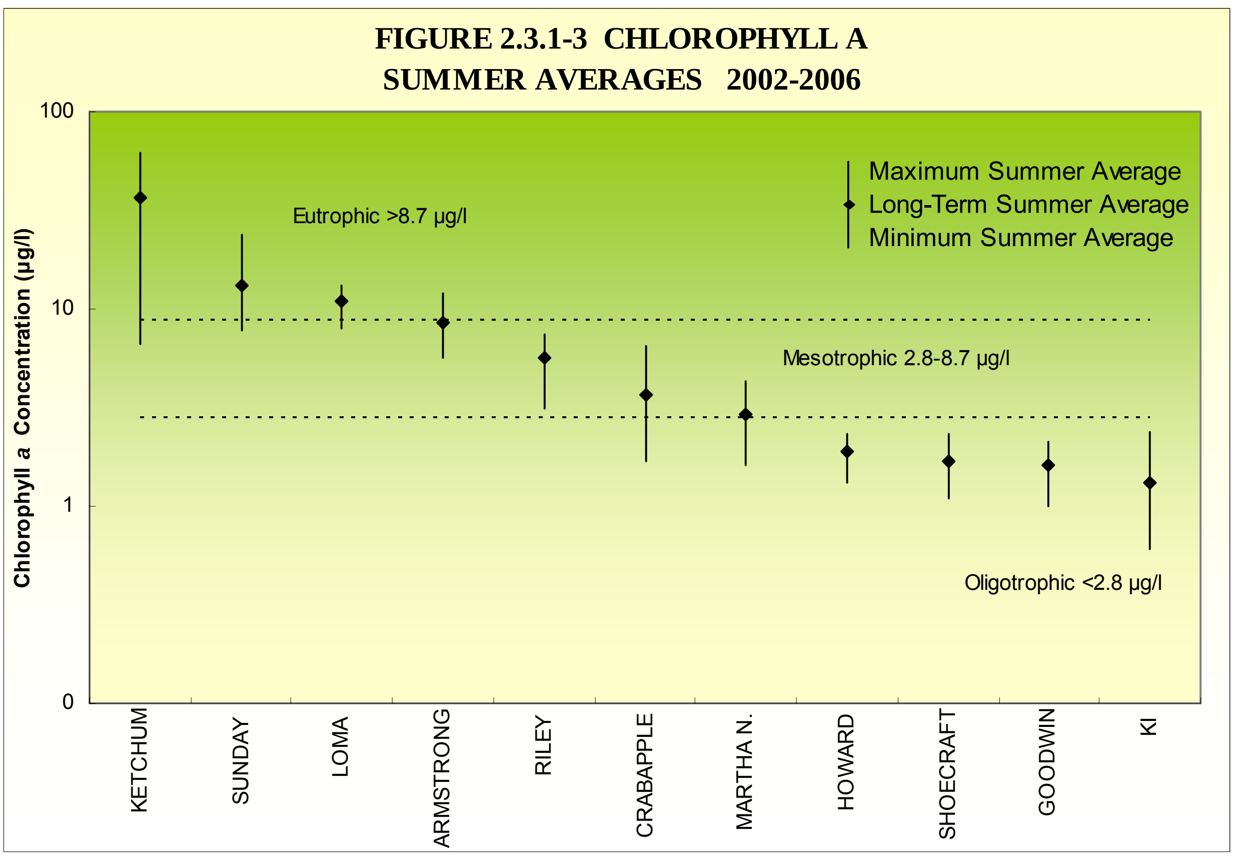
FIGURE 2.3.1-3 CHLOROPHYLL A
SUMMER AVERAGES 2002-2006
Chlorophyll a Concentration (µg/l)
100
10
1
0
Eutrophic >8.7 µg/l
Mesotrophic 2.8-8.7 µg/l
Oligotrophic <2.8 µg/l
Maximum Summer Average
Long-Term Summer Average
Minimum Summer Average
KETCHUM
SUNDAY
LOMA
ARMSTRONG
RILEY
CRABAPPLE
MARTHA N.
HOWARD
SHOECRAFT
GOODWIN
KI

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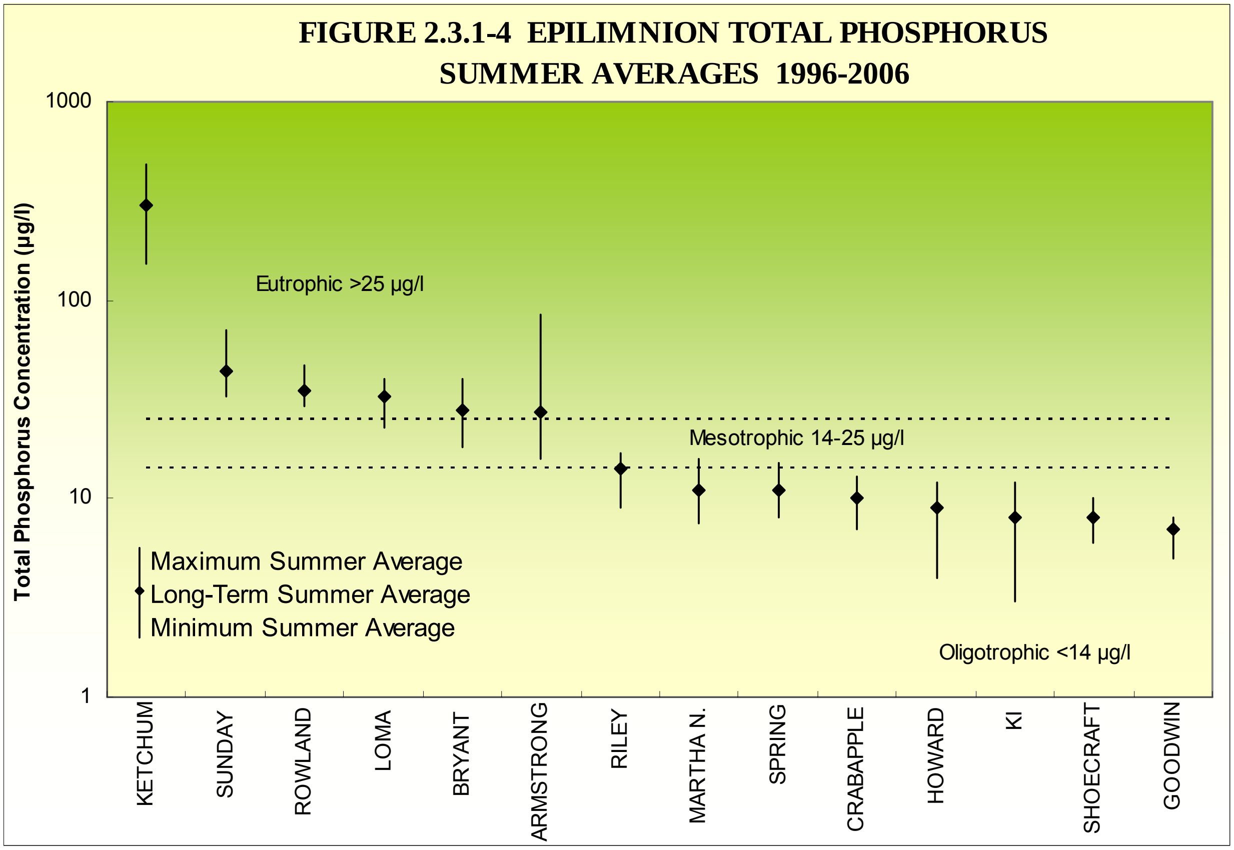
FIGURE 2.3.1-4 EPILIMNION TOTAL PHOSPHORUS
SUMMER AVERAGES 1996-2006
Total Phosphorus Concentration (µg/l)
1000
100
10
1
Eutrophic >25 µg/l
Mesotrophic 14-25 µg/l
Oligotrophic <14 µg/l
Maximum Summer Average
Long-Term Summer Average
Minimum Summer Average
KETCHUM
SUNDAY
ROWLAND
LOMA
BRYANT
ARMSTRONG
RILEY
MARTHA N.
SPRING
CRABAPPLE
HOWARD
KI
SHOECRAFT
GOODWIN

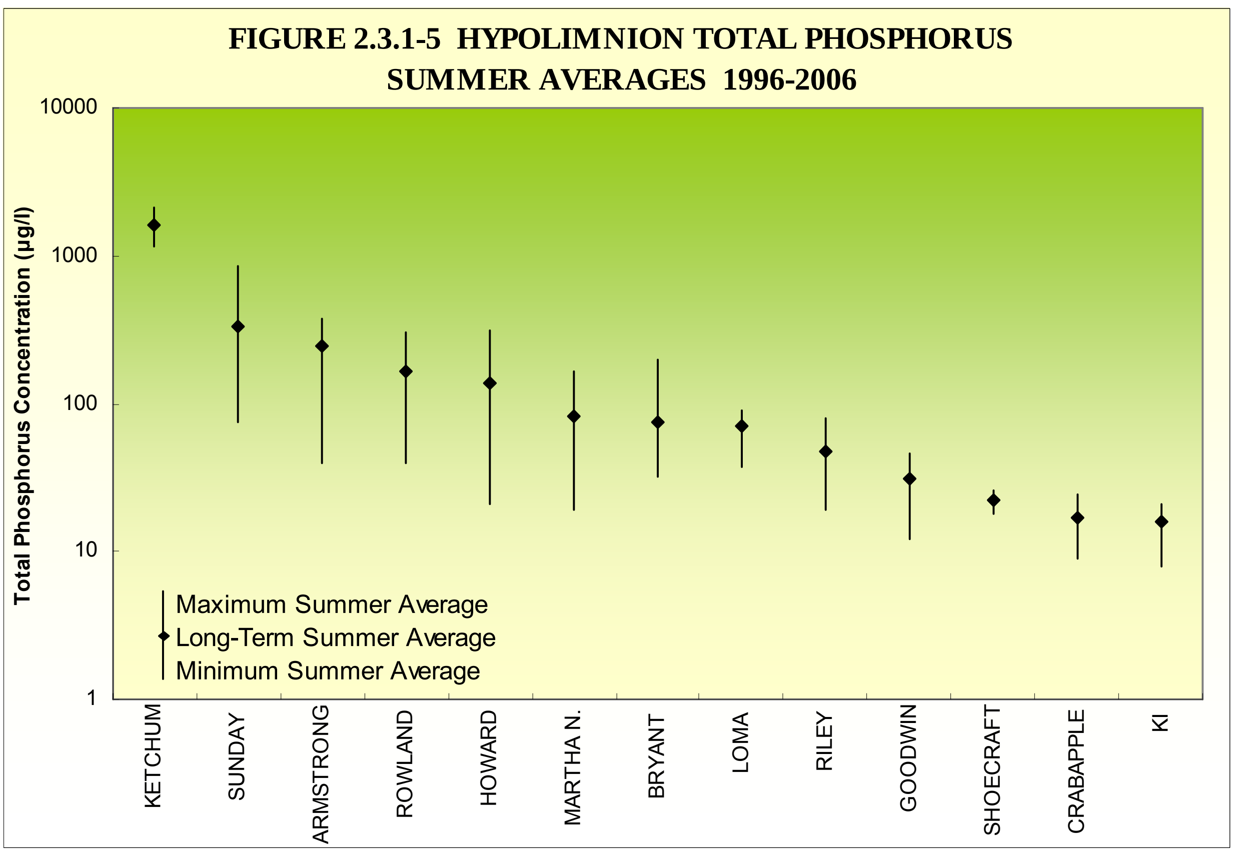
FIGURE 2.3.1-5 HYPOLIMNION TOTAL PHOSPHORUS
SUMMER AVERAGES 1996-2006
Total Phosphorus Concentration (µg/l)
10000
1000
100
10
1
Maximum Summer Average
Long-Term Summer Average
Minimum Summer Average
KETCHUM
SUNDAY
ARMSTRONG
ROWLAND
HOWARD
MARTHA N.
BRYANT
LOMA
RILEY
GOODWIN
SHOECRAFT
CRABAPPLE
KI

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Table 2.3.1-3 shows the results of a statistical analysis of water clarity, phosphorus, and chlorophyll *a* averages for lakes in the CWD. One positive result is that Lake Riley shows a statistically significant trend toward improving water clarity since 1994. The other good news is that three lakes—Armstrong, Goodwin, and Sunday—show improved levels of phosphorus in their upper waters since 1996.

However, Howard, Ki, and Shoecraft lakes show deteriorating conditions from increasing phosphorus in their upper waters. In addition, five lakes—Armstrong, Martha, Riley, Rowland, and Sunday—exhibit increasing phosphorus concentrations in their bottom waters. This build-up of nutrients in the lake bottoms is an early sign of accelerated eutrophication which may result in greater algal growth in coming years.

Finally, Lake Shoecraft shows a trend toward increased chlorophyll *a* (algae) levels. The monitoring record for chlorophyll a is fairly short, so this trend may be the result of natural variation. However, the combination of an increasing level of phosphorus in the upper waters and increasing algal growth is a warning sign for Lake Shoecraft.

One factor that may contribute to these water quality trends is the trend toward increasing development around lake shores. Table 2.3.1-2 shows that several lakes have experienced very rapid shoreline development since the 1970s. In particular, many new homes have been built around Howard and Martha lakes. Armstrong, Rowland, and Spring lakes also show rapid growth rates of shoreline development, mainly because they had only a few homes in the 1970s.

It should also be noted that Lake Goodwin has experienced a decline in the number of homes around the lake. However, this is because many small, seasonal cabins have been replaced with fewer much larger permanent homes. New development at a lake increases the potential for water quality impacts unless property owners are conscientious about reducing fertilizer and pesticide use, maintaining their septic systems, and preserving natural vegetation by the shore.

Table 2.3.1-3 Lake Quality Trends from 1996 to 2006

Lake	Water Clarity 1990-2006	Phosphorus in Upper Waters (Epilimnion) 1996-2006	Phosphorus in Lower Waters (Hypolimnion) 1996-2006	Chlorophyll *a* 2002-2006
Armstrong	None	Improving	Worsening	None
Bryant	None	None	None	Insufficient data
Crabapple	None	None	None	None
Goodwin	None	Improving	None	None
Howard	None	Worsening	None	None
Ketchum	None	None	None	None
Ki	None	Worsening	None	None
Loma	None	None	None	None
Martha	None	None	Worsening	None
Riley	Improving	None	Worsening	None
Rowland	None	None	Worsening	No data
Shoecraft	None	Worsening	None	Worsening
Spring	None	None	None	No data
Sunday	None	Improving	Worsening	None

None = No statistically significant trend up or down

Overall Lake Health

Evaluating both current conditions and long-term trends helps to reach overall assessments of the health of lakes in the CWD. These assessments, summarized in Table 2.3.1-4 and illustrated earlier in Figure 2.3.1-1, are based on the best judgments of SWM staff, lake scientists, and feedback from citizens.

Each lake is given a designation of "healthy", "at risk", or "impaired". "Healthy" lakes show few signs of declining water quality. Conditions in these lakes fully support recreation and other uses. Lakes designated as "at risk" show some signs of declining water quality, such as increasing nutrients, nuisance algal blooms, excess aquatic plants, or depleted oxygen levels. Lakes that are "impaired" exhibit excess nutrients, nuisance levels of aquatic plants, or other problems that affect the use and enjoyment of these lakes.

Because all lakes have a limited capacity to absorb impacts from human activity, even "healthy" lakes need to be protected from pollution. Lakes that are "at risk" need conditions to stabilize or improve to avoid threats to their future function as well as human use and enjoyment. "Impaired" lakes need restoration to address the problems and return the lakes to a healthier state.

These health designations should not be confused with trophic state, which is a measure of nutrient enrichment and biological productivity. It is possible for a eutrophic lake to be in "healthy" condition if it is naturally shallow and does not show signs of increasing nutrients or nuisance algal blooms. Conversely, a lake can be mesotrophic in terms of trophic state and still be assessed as "impaired" if it has poorer water clarity and higher nutrient levels than it should have naturally.

One general conclusion is that the condition of most lakes in the CWD is adequate to support public use and enjoyment. Even lakes that are "at risk" or "impaired" still provide many benefits to local residents and lake users and serve as valuable habitat for fish and wildlife.

However, three lakes are designated as "impaired" (Ketchum, Loma, Sunday) and five lakes are designated "at risk" for further water quality declines (Armstrong, Howard, Martha, Rowland, Shoecraft). These lakes are in need of property owner and public investments to continue providing the full functions and benefits that lakes can offer.

State-Listed Lakes

In a manner similar to the overall lake assessments described above, Washington State has reviewed water quality data for lakes in the CWD in order to develop the State's 303d list of "impaired" water bodies. The most recent 303d list (2004) includes Ketchum, Loma, and Sunday lakes. Each of these lakes is officially listed as impaired by excess phosphorus levels. In addition, Sunday Lake is listed for high nitrogen levels that can cause nuisance algal blooms in the spring. The consequence of these 303d listings is that the State of Washington is mandated to develop a plan (known as a TMDL – Total Maximum Daily Load) to reduce nutrient levels and restore the full benefits and uses of these lakes. It is not known when the State will begin to develop these plans.

Table 2.3.1-4 Overall Lake Health

Lake	Lake Health Assessment	Designation
Armstrong	Lake Armstrong shows signs of increasing eutrophication. Water clarity is low to moderate, and there are regular blue-green algal blooms. Phosphorus levels have been declining in the upper waters, but increasing in the bottom waters, which poses a risk of future water quality declines.	At Risk
Bryant	Based on limited monitoring data, Lake Bryant appears to be in healthy condition for a meso-eutrophic lake. The low water clarity is partly the result of darkly-colored water. There are also occasional algal blooms, but lake uses are not yet affected.	Healthy
Crabapple	Lake Crabapple appears to be in stable condition, with moderate water clarity and relatively low phosphorus concentrations. However, there are occasional nuisance algal blooms and some years of lower water clarity. Continued watershed development has the potential to impact water quality.	Healthy
Goodwin	Lake Goodwin has high water clarity, low nutrient levels, and low amounts of algae. Phosphorus in the upper waters is declining, although very slightly. Phosphorus in the bottom waters has been elevated in some years, but this is not currently a concern.	Healthy
Howard	Lake Howard has high water clarity and low phosphorus levels in the upper waters. However, the phosphorus concentrations in the upper waters show a steadily increasing trend, and the bottom waters occasionally have very high phosphorus levels. Combined with regular algal blooms, these conditions indicate that the lake is at risk of future declines in water quality.	At Risk
Ketchum	Lake Ketchum has low water clarity, extremely high phosphorus levels, severe algal blooms, toxic algal blooms, and dense aquatic plants. These problems are serious enough to, at times, impair the use and enjoyment of the lake. Runoff from a former dairy farm must be cleaned up and nutrients in the lake bottom must be neutralized to restore the lake.	Impaired
Ki	Lake Ki has high water clarity, low phosphorus, and low levels of algae and aquatic plants. There is some evidence of a trend toward a small increase in the levels of phosphorus in the upper waters. The lake remains in healthy condition, but should be watched closely for signs of declining water quality.	Healthy
Loma	Lake Loma has low water clarity, high phosphorus levels, and high concentrations of algae. The lake has also experienced blooms of toxic algae. At times these problems impair the use and enjoyment of the lake. Controlling nutrients from the surrounding properties is key to improving lake conditions.	Impaired
Martha	Lake Martha shows signs of increasing eutrophication. Although water clarity is good, phosphorus levels are increasing in the bottom waters, and there are occasional blue-green algal blooms. If phosphorus levels continue to increase, this may lead to more algal blooms and a risk of future water quality declines.	At Risk
Riley	Lake Riley has low water clarity because of darkly colored water. There is a trend toward a small increase in clarity. On the other hand, phosphorus levels in the bottom waters have increased in recent years. Although Lake Riley remains in healthy condition, the increasing phosphorus may be a sign of future problems.	Healthy
Rowland	Lake Rowland has low water clarity, high phosphorus levels, and abundant plants and algae. There is a trend toward increasing levels of phosphorus in the bottom waters. The lake is very shallow and shows signs of accelerated eutrophication.	At Risk

Lake	Lake Health Assessment	Designation
Shoecraft	Lake Shoecraft has good water clarity and relatively low nutrient levels. However, there is a small, but statistically significant, trend toward higher phosphorus levels in the upper waters. Combined with an apparent trend toward higher chlorophyll *a* concentrations and occasional algal blooms, there are signs that future water quality in the lake is at risk.	At Risk
Spring	Spring Lake has moderate water clarity for a very shallow lake. Phosphorus levels are low, and there are few reports of nuisance algae. The lake supports abundant growths of aquatic plants. Based on limited data, the lake seems to be in healthy condition.	Healthy
Sunday	Sunday Lake has low water clarity, high phosphorus levels, and excess aquatic plants and algae. Phosphorus levels are declining in the upper waters, but have increased in bottom waters in recent years. And, there is some evidence that water clarity may be getting worse. The dense aquatic plants and algal blooms are serious enough to impair the use and enjoyment of the lake at times.	Impaired

SWM Lake Projects

In addition to on-going monitoring and public education, SWM's Lake Management Program has worked on several special lake projects in recent years (described in Table 2.3.1-5). These projects were developed in response to specific problems at certain lakes and to citizen concerns.

Table 2.3.1-5 Recent Lake Projects

Lake	Recent SWM Projects
Armstrong	A new, more detailed, bathymetric map of the lake was created which showed that the lake is several feet deeper than previously believed. This map will serve as a baseline to monitor how quickly the lake fills with sediment.
Crabapple	Residents of the lake were concerned about protecting water quality, particularly in light of severe algal blooms in spring of 2005. SWM helped the residents develop a plan to expand monitoring efforts to get a more complete picture of conditions in the lake and the contributions from the watershed. The additional information will help in developing a water and nutrient model of the lake that can be used to recommend additional measures from new development to protect the lake. Residents are performing and paying for the additional monitoring.
Goodwin	SWM has worked since 1997 to control invasive Eurasian watermilfoil plants in the lake. The primary methods have been diver surveys and hand-pulling, but a herbicide treatment of one large area was completed in 2006. The milfoil is under control, but on-going work is needed to prevent its spread. Lake residents agreed to pay higher SWM fees to fund this work. SWM coordinates volunteer efforts to monitor and control the lake levels (with Lake Shoecraft) to mitigate winter flooding and minimize the impacts of summer low water.
Ketchum	A detailed lake study in the late 1990s identified the primary sources of phosphorus polluting the lake and developed a plan to clean up the lake. Although funding has not been available to control the pollution from a former dairy farm or from the lake bottom, SWM has continued monitoring runoff from the farm. Results show that nutrient levels in the runoff are dropping, but that restoration actions are still needed or the lake will not recover.

	Lake Ketchum has also experienced toxic algal blooms on at least two occasions in recent years. SWM has tested for toxins and worked with the Health District and lake residents to inform the public of potential risks.
Loma	Lake Loma also experienced a serious toxic algal bloom in 2005. SWM worked with the Health District to notify all lake residents and discourage water contact. SWM continues to monitor the lake for toxic blooms.
Rowland	A detailed bathymetric map was created. There was no map previously. This map will help lake residents manage aquatic plants and water quality.
Shoecraft	SWM performed a herbicide treatment in 2000 to control invasive Eurasian watermilfoil plants. The treatment has been extremely successful, with no milfoil found during diving surveys in subsequent years. Lake residents pay higher SWM fees to fund this work. SWM coordinates volunteer efforts to monitor and control the lake levels (with Lake Goodwin) to mitigate winter flooding and minimize the impacts of summer low water.
Sunday	Phosphorus levels in the main inflowing streams were monitored for two years to determine if upstream uses were a major source of high nutrients in the lake. (No major impacts were identified.) Also, a detailed bathymetric map was created to help in managing excess aquatic plants and in monitoring the speed with which the lake is filling with sediment.

2.3.1.3 Problems and Gaps

Explained below are the existing problems regarding lakes, as well as any gaps in data or analysis, and gaps in SWM's programs regarding lake management.

Nuisance Algal Blooms

Nuisance algal blooms, mainly caused by blue-green algae, occur in response to too many nutrients in a lake. In most cases, these nutrients originate from human activity around the lake shore and throughout the watershed. To reduce the nutrients getting into lakes will require changes in day-to-day property owner actions, such as limiting fertilizers, maintaining septics, restoring native vegetation along the shore, and preventing soil erosion.

Toxic Algal Blooms

Toxic algal blooms also happen in response to excess nutrients, but the occurrence of toxic blooms is very unpredictable. When toxic blooms appear, the use of a lake by people and animals must be curtailed to avoid potential health impacts. The main way to prevent toxic blooms is to reduce nutrients reaching the lake through improved stewardship by property owners.

Excess Aquatic Plants

Excess aquatic plants are problems in some of the shallow lakes. To an extent, this is a natural consequence of eutrophication. However, when plant densities get to the stage where access to the water and use of the water is significantly affected, this becomes a serious problem. Too many nutrients entering a lake will accelerate the growth of aquatic plants. But, usually the lake sediments already contain enough nutrients to support dense plant growth. Remedies for excess aquatic plants include selective removal by mechanical or chemical means, or dredging the shallowest areas.

Invasive Aquatic Plants

Invasive aquatic plants can cause the same headaches as excess plants, but are more problematic because non-native plants have the ability to out-compete native plants. They can form dense canopies that take over large areas, degrade fish habitat, and reduce water quality. Control of invasive plants, such as Eurasian watermilfoil and fragrant water-lily, requires aggressive action that may include chemical herbicides.

Lack of Restoration Funding

One of the primary gaps facing lakes in the CWD is lack of funding to implement restoration measures. There is no public funding available to implement the steps that have been identified to control nutrients at Lake Ketchum (farm clean-up and chemical binding of phosphorus in lake sediments) or to control aquatic plants in Sunday Lake (selective dredging and harvesting). These costs are too high for lake residents to bear alone.

Property Owners Reluctant to Change their Behaviors

The second primary gap facing all lakes in the CWD is the difficulty in getting individual property owners to make changes that will protect water quality. It requires on-going education, technical assistance, and monetary incentives or unprecedented land use regulations to motivate property owners to take such actions. Maintaining native vegetation by the shore or converting a portion of lawn to native vegetation, dramatically curtailing fertilizer use, and filtering all runoff before it reaches the lake are important steps. However, they require investments of time and money as well as changes in the current perception and behaviors associated with lakeshore living. SWM will continue to provide education and technical assistance, but effective stewardship of CWD lakes ultimately depends on individual citizens.

Lack of Homeowner Associations

Another need for lakes in the CWD is the creation of more homeowners' associations. These associations can be very effective in addressing water quality problems, educating property owners about lake protection actions, advocating for conditions on new development, providing a common voice, and resolving neighborhood conflicts. Associations can be formal or informal, and they can pursue various options for raising money when funds are needed. With homeowners' associations, lake residents will be more successful in addressing the problems facing lakes in the CWD and in getting individuals to take the steps necessary to protect water quality.

Stream Flow, Lake Level and Nutrient Sampling Measurements Needed

The principal data gap for lakes in the CWD is the need for stream flow measurements (both inflowing tributaries and outlet streams), year-round lake level readings, and nutrient sampling of inlet streams. This set of data would allow SWM to develop water and nutrient budgets for individual lakes. Knowing the total amounts of nutrients entering each lake, leaving each lake, and recycling within the lake would identify the sources of pollution and help citizens and SWM target clean up efforts. The current lake monitoring program does not have adequate funding to address this data gap.

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