Elm Creek Watershed Management Commission
Lake Water Quality Summaries
2012

Introduction

Elm Creek Watershed Management Commission contracted with Three Rivers Park District to monitor several lakes in 2012. Three Rivers Park District monitored the water quality in Fish Lake, Weaver Lake, Diamond Lake, French Lake, and Mill Pond. These lakes were sampled biweekly from late April through late October, with the exception of Diamond Lake and French Lake, which were sampled monthly. The seasonal and annual changes in water quality parameters were monitored for total phosphorus, soluble reactive phosphorus, total nitrogen, chlorophyll-a, and Secchi depth transparency. To assess changes in water quality trophic conditions, annual growing season averages were calculated for total phosphorus, chlorophyll-a, and Secchi depth transparency using data collected from May through September. The annual average for each trophic assessment parameter was compared to the MPCA state nutrient standards used for determination of recreational use impairment (Table 1). The MPCA's assessment for water body impairments are based on a conservative average that is estimated from data collected from June through September. This report is an assessment of overall trophic condition during the time period of primary recreational use (growing season from May through September) and is compared to MPCA state standards as a reference point.

Table 1: Minnesota Pollution Control Agency lake eutrophication standards for aquatic recreational use assessments.

North Central Hardwood Forest Ecoregion			
Classification	TP µg/L	Chl-a µg/L	Secchi m
Aquatic Recreation Use (Class 2b) Deep Lakes	< 40	< 14	> 1.4
Aquatic Recreation Use (Class 2b) Shallow Lakes	< 60	< 20	> 1.0

Note: ***Deep Lakes*** *are enclosed basins filled or partially filled with fresh water that have a maximum depth > 15 feet.*
Shallow Lakes *are enclosed basins filled or partially filled with fresh water that have a maximum depth < 15 feet or a littoral zone (area shallow enough to support emergent and submerged vegetation) that is ≥ 80% of the lake surface area.*

Fish Lake

The phosphorus concentration in Fish Lake has steadily decreased in the past five years; however, Fish Lake has consistently had an average phosphorus concentration above the MPCA "deep lake" impaired water eutrophication standard of 40 µg/L. The average phosphorus concentration for Fish Lake in 2012 was 41.87 µg/L (Figure 1). The highest in-lake phosphorus concentrations coincided with the senescence of curly-leaf pondweed and the fall and spring turnover cycles. During the senescence of curly-leaf pondweed the phosphorus concentration was 57.8 µg/L. The process of lake turnover re-suspended nutrients in the water column and contributed to high concentrations in October (62.8 µg/L). There was also a spike in phosphorus concentration that occurred late in June that coincided with a 1.5 inch rain event.This spike may be due to high inputs of external loading from the watershed.The total phosphorus concentrations have fluctuated between 30.9 and 58.7 µg/L throughout the growing season (May-September) (Figure 2).

The excessive amount of phosphorus has been conducive for the development of severe algal blooms during the summer.The severity of these algal blooms has often been in response to the changes in phosphorus concentration. Although phosphorus concentrations may influence algal biomass, the impact phosphorus had on the severity of the algal blooms after 2007 does not appear to be as significant. In 2012, the average chlorophyll-a concentration was 25.5 µg/L with values ranging from 6.9 to 62.2 µg/L (Figure 3). Although the chlorophyll-a concentration increased in 2012, the Secchi depth still met MPCA standards. The average Secchi depth transparency in 2012was 1.68 m (Figure 4) with values ranging from 0.5 m to 3.88 m (Figure 5).

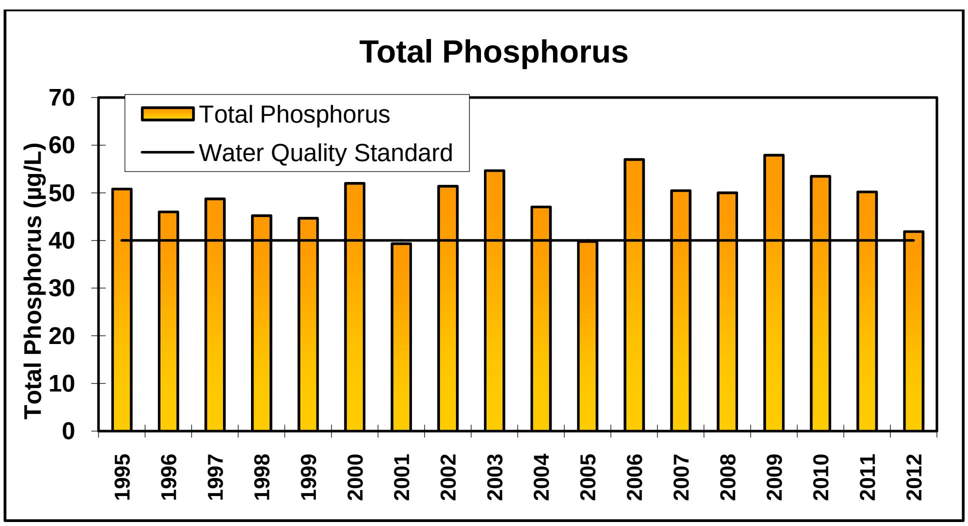

Figure 1. Fish Lake average annual total phosphorus concentrations.

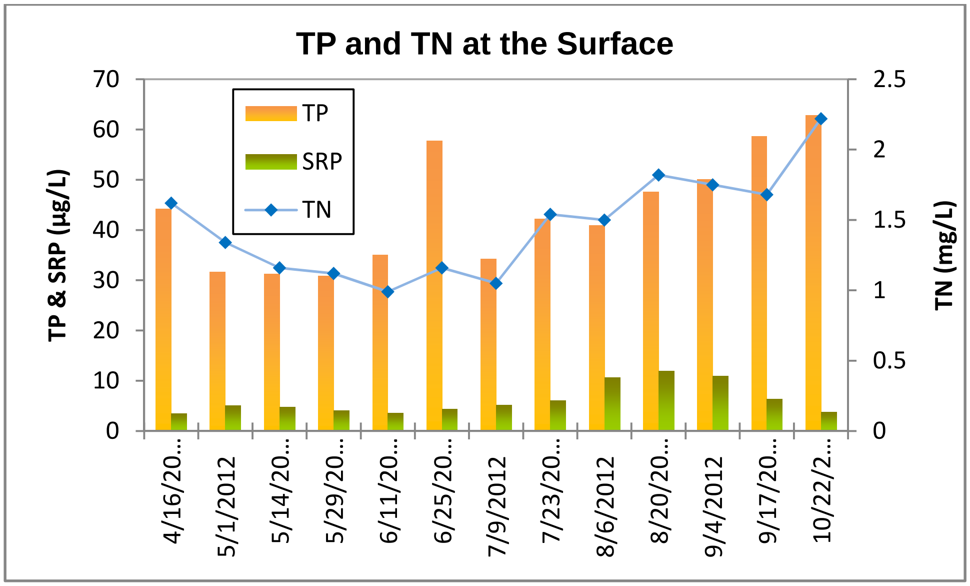

Figure 2. Fish Lake seasonal changes in total phosphorus, soluble reactive phosphorus, and total nitrogen in 2012.

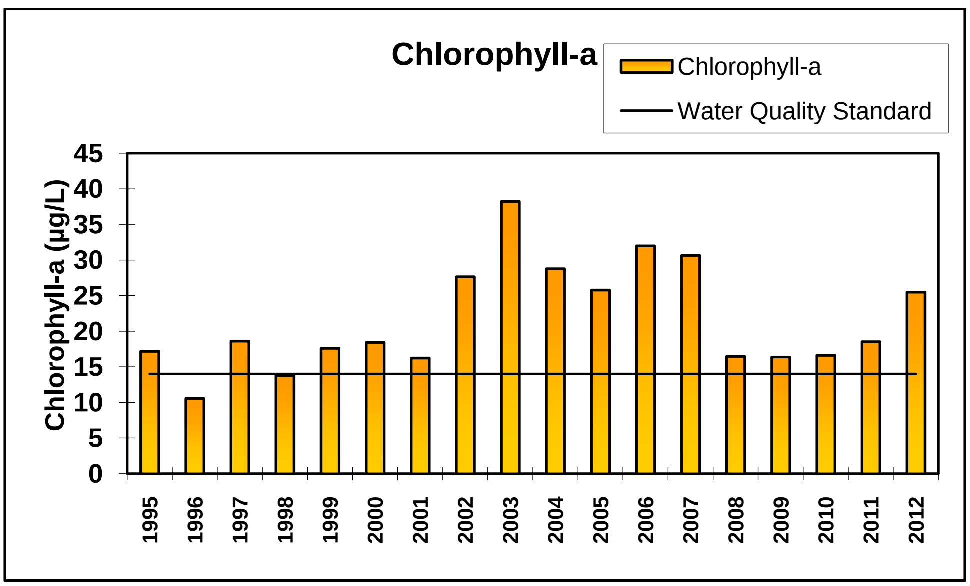

Figure 3. FishLake average annual chlorophyll-a concentrations.

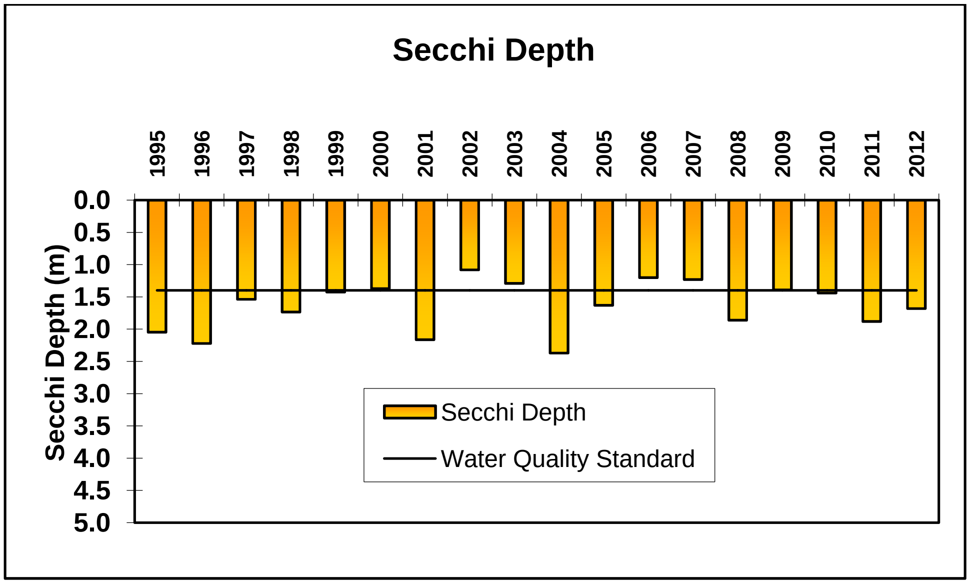

Figure 4. Fish Lake average annual Secchi depth concentrations.

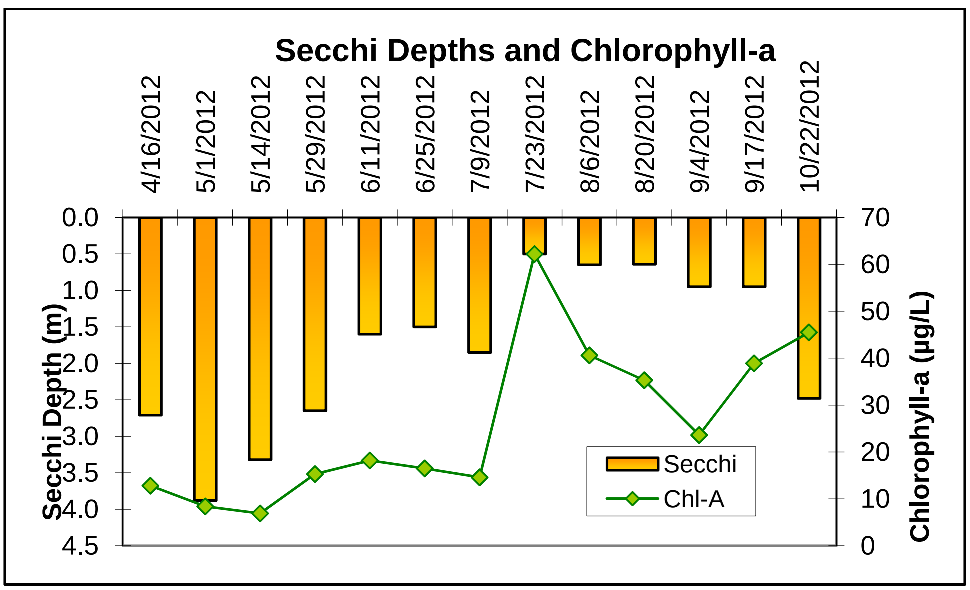

Figure 5. Fish Lake seasonal changes in Secchi depth and chlorophyll-a concentrations in 2012.

Weaver Lake

The Weaver Lake water quality conditions have continued to meet MPCA standards for phosphorus, chlorophyll-a, and secchi depth transparency. Prior to 2005, the lake frequently had phosphorus concentrations that were above the MPCA "deep lake" impaired water criteria of 40 µg/L. Since 2005, Weaver Lake has achieved the MPCA "deep lake" standards for total phosphorus. The average phosphorus concentrations from 2005 through 2012 have consistently averaged between 20 to 35 µg/L (Figure 6). The average annual phosphorus concentration in 2012 was 31.4 µg/L (Figure 6) with values ranging from 25.4 to 69.7 µg/L in 2012 (Figure 7). The upper range of the phosphorusdid not occur during the growing season and corresponds with the fall turnover. These concentrations are considerably lower in comparison to other lakes within the ecoregion.

The low phosphorus concentrations have significantly improved water clarity conditions by reducing the frequency of algal blooms. In 2012, the low chlorophyll-a concentrations have corresponded with improvements in water clarity (Secchi depths) (Figures 8&9). The average chlorophyll-a concentration was 10.58µg/L in 2012(Figure 8). Weaver Lakehad an average Secchi depth transparency of 2.52 m (Figure 9) with values ranging from 1.35 to 4.35 meters during the growing season (Figure 10). The low chlorophyll-a concentrations and excellent water clarity conditions suggests that Weaver Lake does not appear to have severe algal blooms that inhibit recreational use.

The improvements in water quality conditions for Weaver Lake correspond with a lake-wide effort to control curlyleaf pondweed. Historically, Weaver Lake has had nuisance growth conditions of curlyleaf pondweed that inhibited recreational use and degraded water quality. Weaver Lake typically developed algal blooms after the senescence of curlyleaf pondweed. In an attempt to control curly leaf pondweed, herbicide applications occurred throughout the littoral area of the lake with fluridone from 2005 through 2007 and with endothall from 2008 and 2009. The herbicide treatments were successful in controlling curlyleaf pondweed in Weaver Lake. There were also noticeable improvements in water quality that corresponded with the first year of treatment in 2005. Management efforts to control curlyleaf pondweed may have reduced the amount of internal loading associated with senescence.

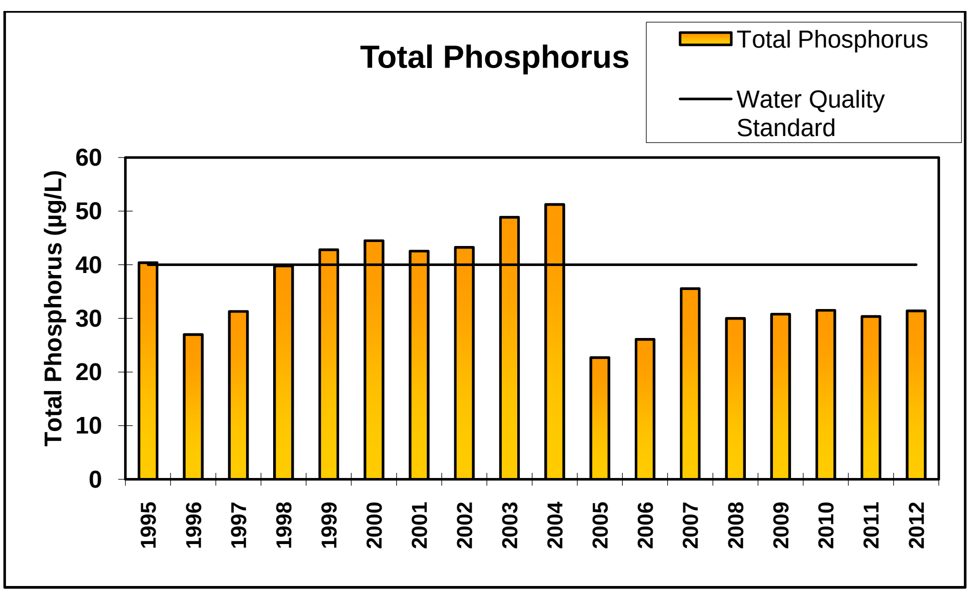

Figure 6.Weaver Lake average annual total phosphorus concentrations.

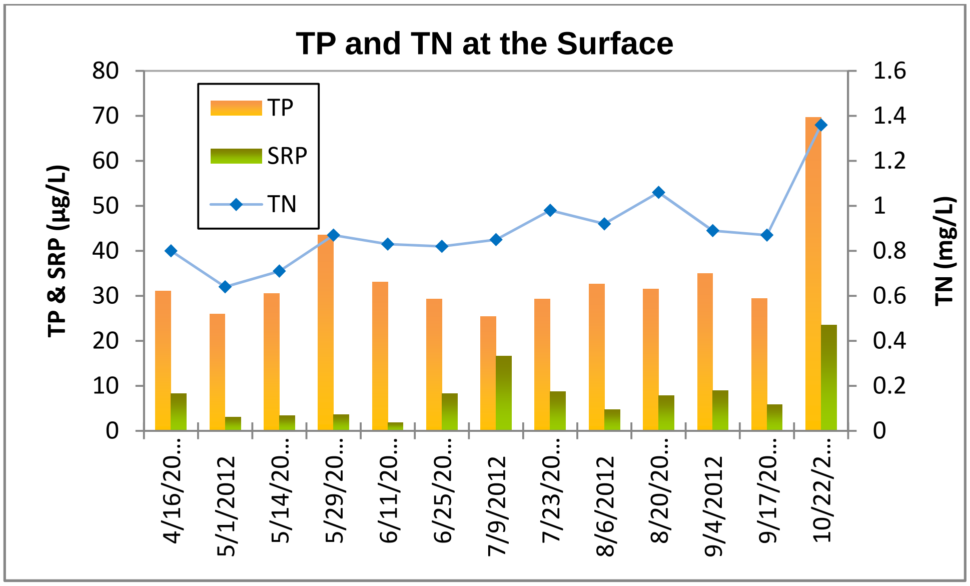

Figure 7. Weaver Lake seasonal changes in total phosphorus, soluble reactive phosphorus, and total nitrogen in 2012.

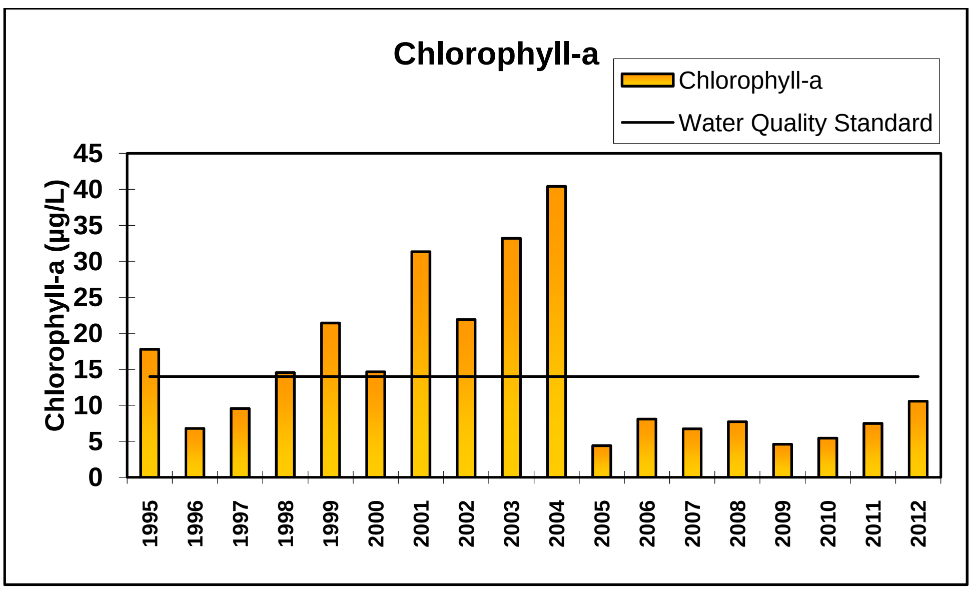

Figure 8. Weaver Lake average annual chlorophyll-a concentrations.

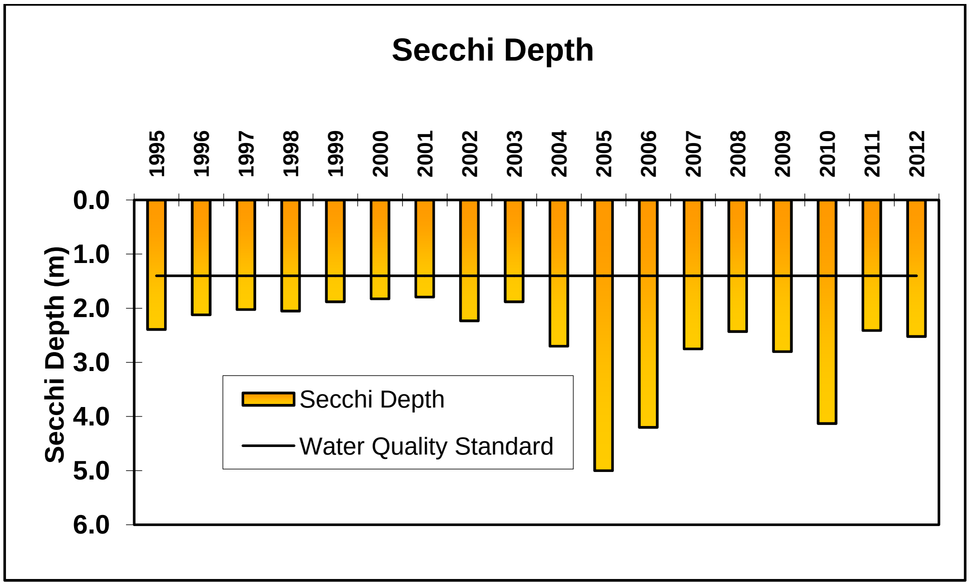

Figure 9. Weaver Lake average annual Secchi depth concentrations.

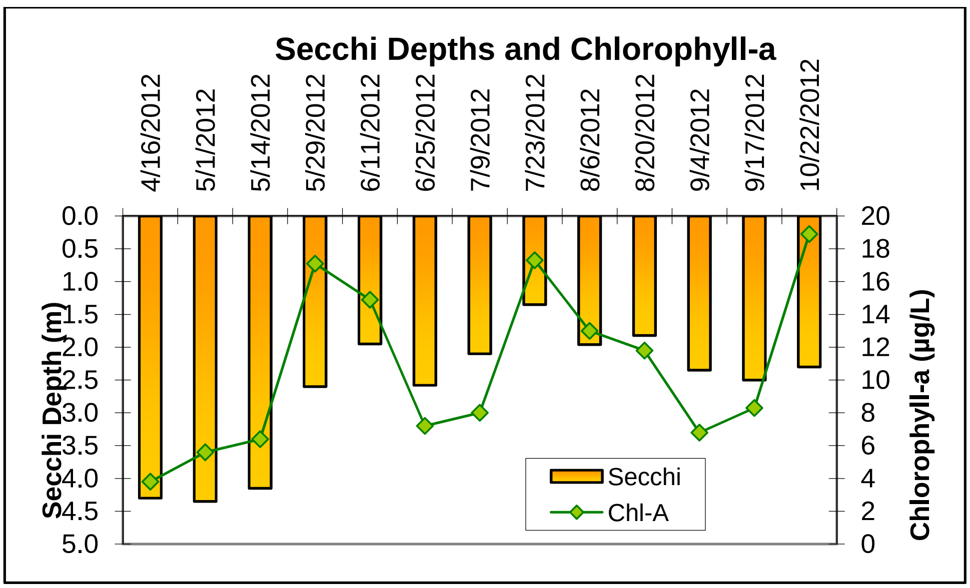

Figure 10. Weaver Lake seasonal changes in Secchi depth and chlorophyll-a concentrations in 2012.

Diamond Lake

Diamond Lake continues to have impaired water quality conditions for excessive nutrients. Diamond Lake is a “shallow lake” that has a total phosphorus standard of 60 μg/L. The lake is considered hyper-eutrophic with phosphorus concentrations ranging from 148.7 μg/L to 255.3 μg/L prior to 2008 (Figure 11). Despite the excessive phosphorus concentrations, the average total phosphorus concentrations significantly decreasedfrom 210 μg/L in 2008 to 96 μg/L in 2011. Unfortunately, the decreasing trend in phosphorus concentration did not continue in 2012.The average phosphorus concentration increased to 119.2 μg/L (Figure 11) with monthly concentrations ranging between 46.6 to 206 μg/L in 2012 (Figure 12).

The excessive phosphorus concentrations have been conducive for the development of severe algal blooms. The severity of algal blooms in Diamond Lake corresponded with the fluctuations in phosphorus concentrations. Diamond Lake typically had extremely poor water clarity prior to 2008 due to severe algal blooms that resulted in annual average chlorophyll-a concentrations ranging from 46.3 to 87.8 μg/L and average secchi depth measurements ranging from 0.24 to 0.55 m (Figures 13 and 14). Water clarity conditions significantly improved from 2008 to 2011; and secchi depth measurements increased from 0.78 m in 2008 to 1.7 m in 2011 (Figure 14).The average chlorophyll-a concentrationin 2011metthe MPCA “shallow lake” standard of 20 μg/L; and secchi depth transparency has met MPCA standards of 1.0 m since 2009 (Figure 14). Despite these improvements in water clarity, the chlorophyll-a concentration and secchi depth transparency slightly degraded in 2012. The average chlorophyll-a concentration increased to 52.9 μg/L, and the secchi depth transparency decreased to 1.13 m (Figures 13 and 14). The increase in phosphorus in 2012 most likely caused severe algae bloomsresulting in areduction in water clarity (Figure 15).

The improvements in water quality in Diamond Lake may have been attributed to a shift from an algal dominated to a plant dominated condition. Typically, Diamond Lake is dominated by curly-leaf pondweed growth in the spring, and shifts to a more algal dominated condition after curly-leaf pondweed senescence occurs at the end of June and beginning of July. The most recent point-intercept aquatic vegetation surveys for Diamond Lake indicated there has been a substantial increase in nuisance growth of native coontail and elodea in the past several years after curly-leaf pondweed senescence.The establishment of a native aquatic plant community can reduce the potential for nutrient re-suspension by stabilizing in-lake sediments and improving water quality conditions. These conditions may have contributed to the improvements in phosphorus concentration and water clarity from 2008 through 2011. Unfortunately, an increase in curly-leaf pondweed growth in shallow lakes has the potential to off-set any water quality improvements. The absence of snow-cover and poor ice conditions in the winter of 2011 and 2012 were conducive for curly-leaf pondweed growth. Consequently, there was a substantial increase in nuisance growth of curly-leaf pondweed in 2012, which most likely contributed to an increase in internal loading through senescence and resulted in poor water quality conditions.

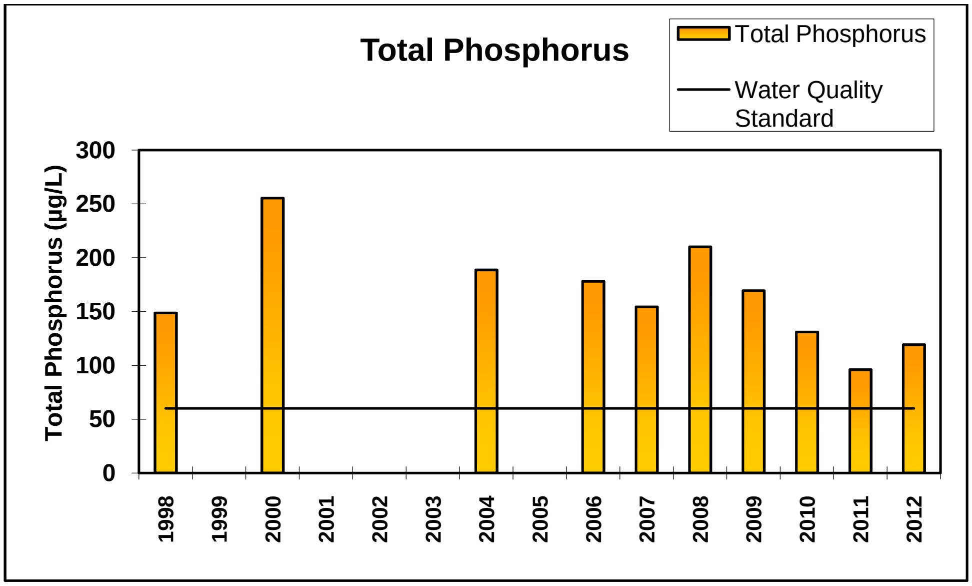

Figure 11.Diamond Lake average annual total phosphorus concentrations.

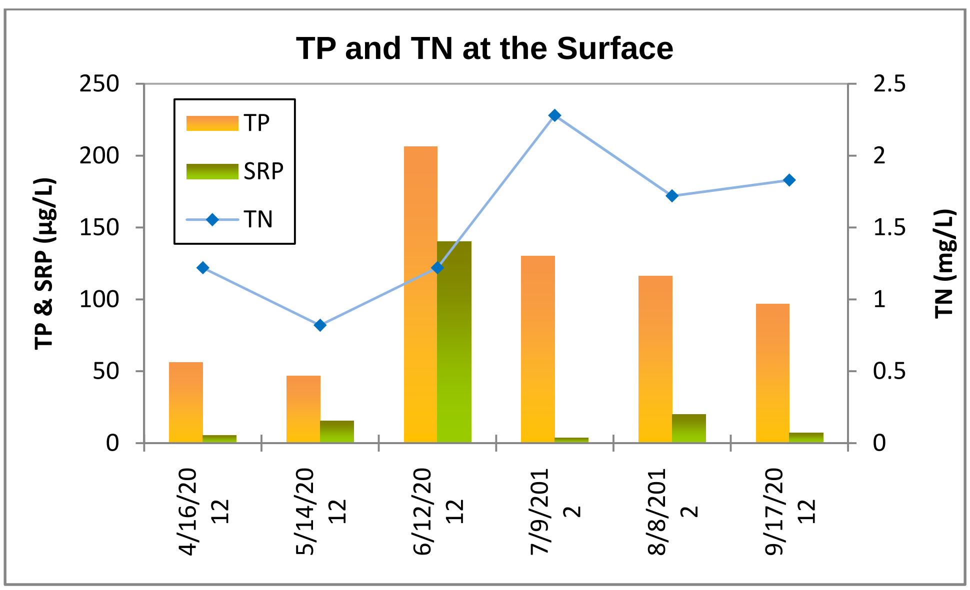

Figure 12. Diamond Lake seasonal changes in total phosphorus, soluble reactive phosphorus, and total nitrogen in 2012.

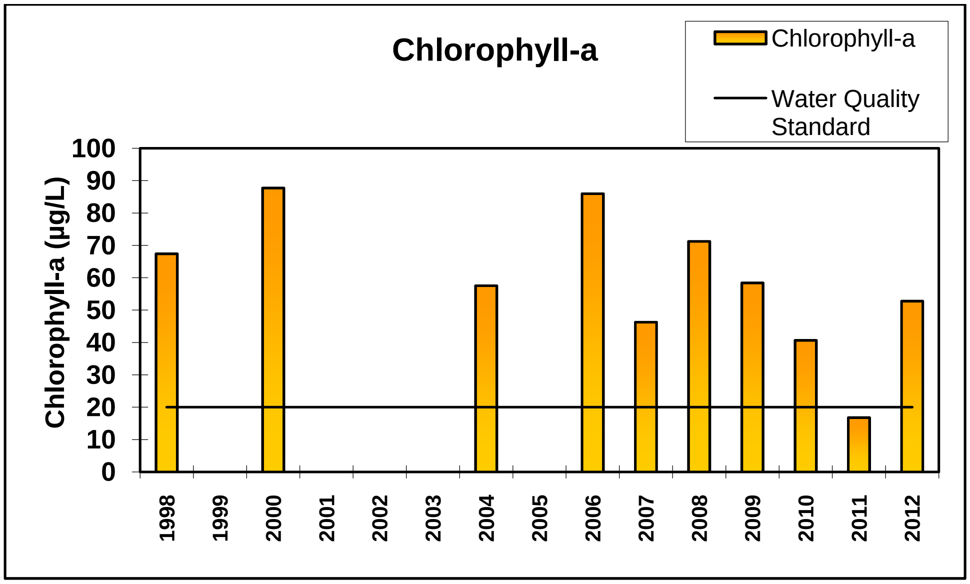

Figure 13. Diamond Lake average annual chlorophyll-a concentrations.

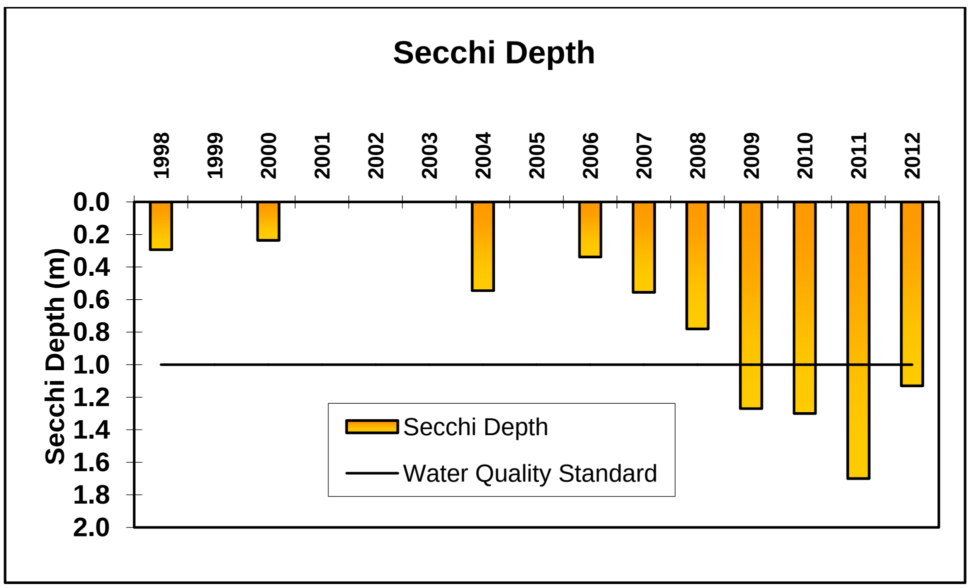

Figure 14. Diamond Lake average annual Secchi depth concentrations.

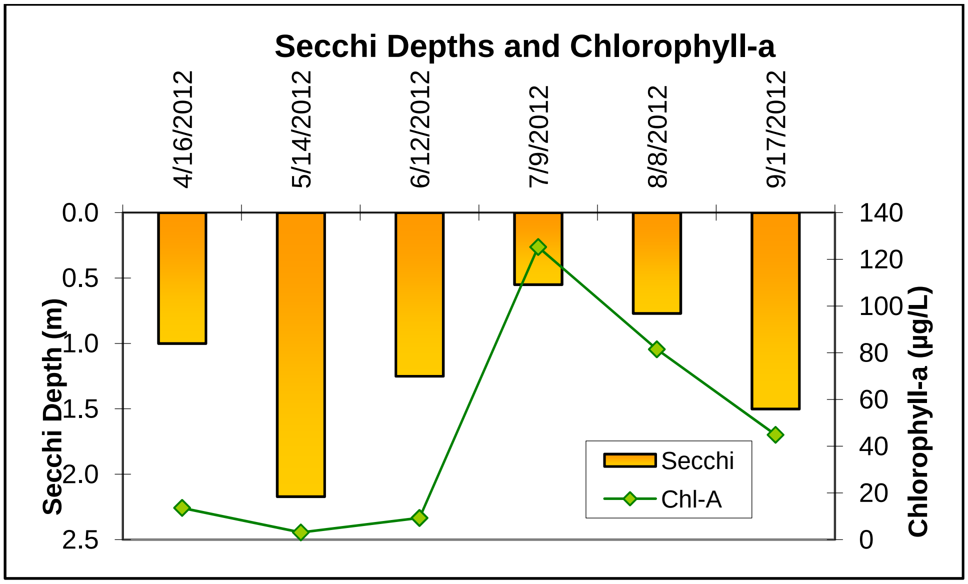

Figure 15. Diamond Lake seasonal changes in Secchi depth and chlorophyll-a concentrations in 2012.

French Lake

French Lake is currently defined as a "shallow lake" that has impaired water quality conditions. However, the lake has morphological characteristics that are similar to a Type 3 and 4 wetland that has a maximum depth of 3.8 feet with a cattail marsh perimeter. Consequently, the lake has poor water quality conditions that are similar to an open wetland with a significant source of internal loading. The classification of the water body is currently being reviewed by the MPCA for potential re-classification as a wetland.

The lake is hypereutrophic with phosphorus concentrations above the MPCA "shallow lake" standard of 60 µg/L (Figure 16). Since 2005, the average phosphorus concentrations have ranged from 154.8 µg/L and 347.2 µg/L. The average phosphorus concentration in 2012 was 179.7 µg/L (Figure 16) with values ranging between 121.6 µg/L and 200.8 µg/L (Figure 17). These phosphorus concentrations are extremely high and are conducive for the development of severe algal blooms.

French Lake has severe algal blooms that reduced water clarity conditions during the summer. Typically, French Lake has chlorophyll-a concentrations ranging from 44.7 µg/L and 260.4 µg/L; and secchi depth measurements ranging from 0.22 m to 0.77 m. In 2012, the average chlorophyll-a concentration was220.7 µg/L with values ranging from 82.4 µg/L to 470.7 µg/L (Figures 18 & 19). The average Secchi depth transparency in 2011 was 0.22 m (Figure 20) with values ranging from 0.17 to 0.3 (Figure 19).The chlorophyll-a concentration and Secchi depth did not meet the MPCA "shallow lake" water quality standards.

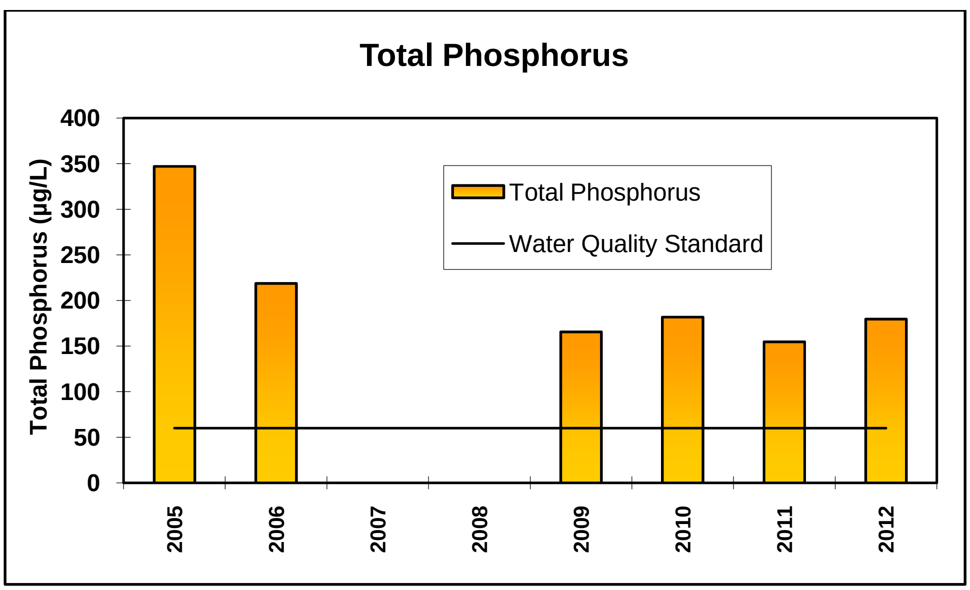

Figure 16.French Lake average annual total phosphorus concentrations.

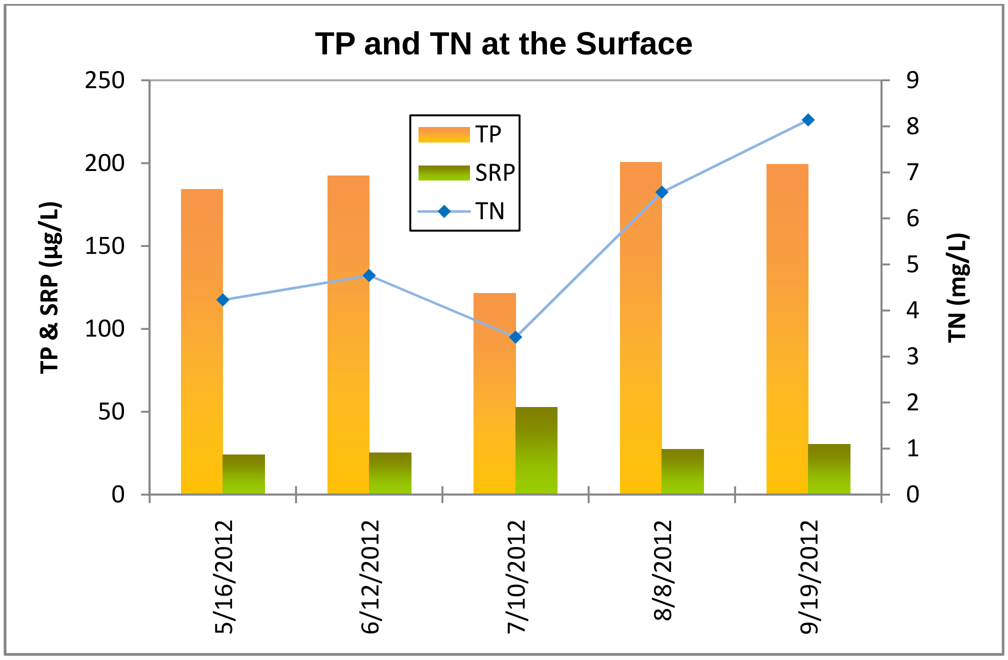

Figure 17. French Lake seasonal changes in total phosphorus, soluble reactive phosphorus, and total nitrogen in 2012.

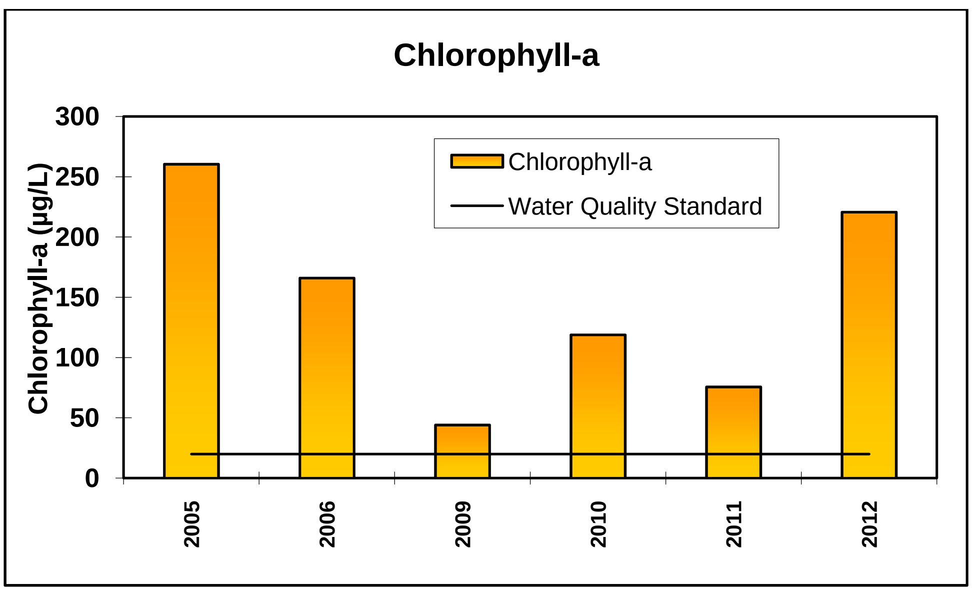

Figure 18. French Lake average annual chlorophyll-a concentrations.

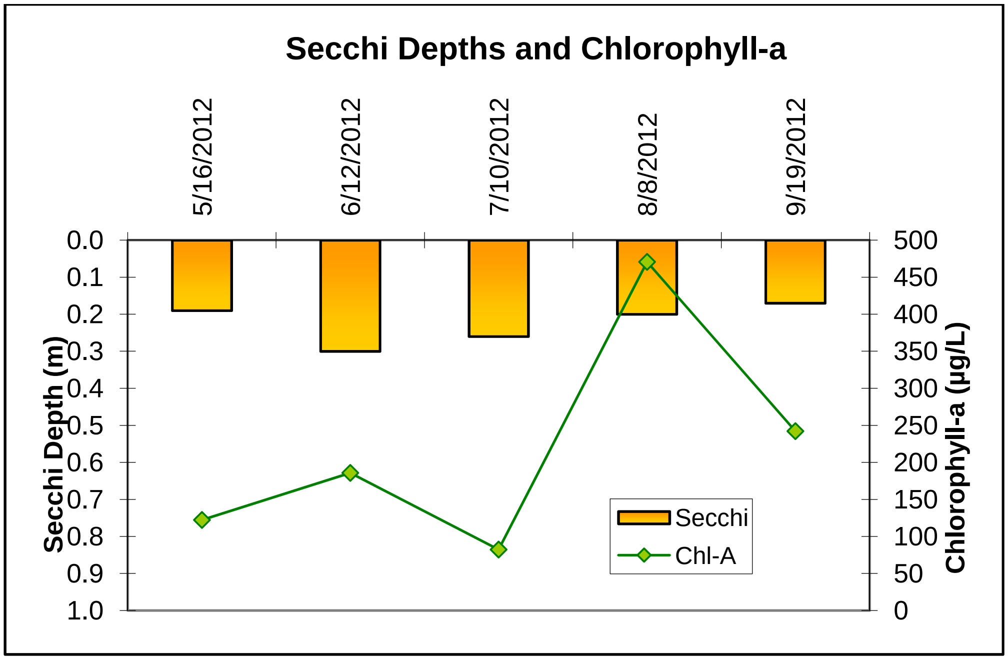

Figure 19. French Lake seasonal changes in Secchi depth and chlorophyll-a concentrations in 2012.

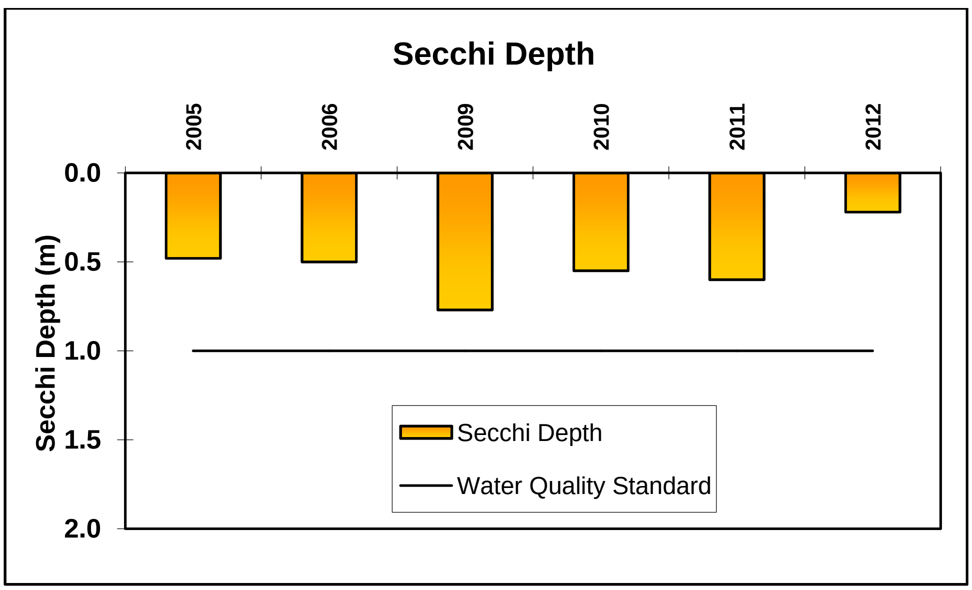

Figure 20. French Lake average annual Secchi depth concentrations.

Mill Pond

Mill Pond is part of the Elm Creek flowage prior to draining to the Mississippi River. It is uncertain as to whether Mill Pond meets the hydraulic residence time (a minimum of 14 days) to be classified as a shallow lake. Currently, the water quality conditions of Mill Pond are similar to that of Elm Creek, and water quality parameters were not compared to the shallow lake standards. The MPCA is currently reviewing the classification of Mill Pond.

The average annual phosphorus concentration for Mill Pond ranged from 184.3 µg/L to 379 µg/L. In 2012, the average annual phosphorus concentration was 213.06 µg/L with values ranging from 118 µg/L to 324.4 µg/L (Figures21 &22). The soluble reactive phosphorus portion represents approximately 70% of the total phosphorus concentration. These concentrations in Mill Pond are highly indicative of the phosphorus loading exhibited by Elm Creek. Consequently, seasonal changes in phosphorus concentration become dependent upon storm-event run-off volume and loading from Elm Creek.

Despite high phosphorus concentrations, Mill Pond does not appear to have severe algal blooms. The average annual chlorophyll-a concentration ranged from 4.8 µg/L to 10.4 µg/L. In 2012, the average annual chlorophyll-a concentration was the lowest reported(4.8 µg/L) with values ranging from 1.9 µg/L to 21.8 µg/L (Figure 23 &24). Secchi depth transparency was not measured throughout the summer, butwater transparency was frequently on the bottom. The residence time within Mill Pond is relatively short since the impounded area is essentially part of the Elm Creek flowage. Consequently, Mill Pond has chlorophyll-a concentrations that are more indicative of Elm Creek. The reduced residence time is not conducive for the development of algal blooms despite the high phosphorus concentrations.

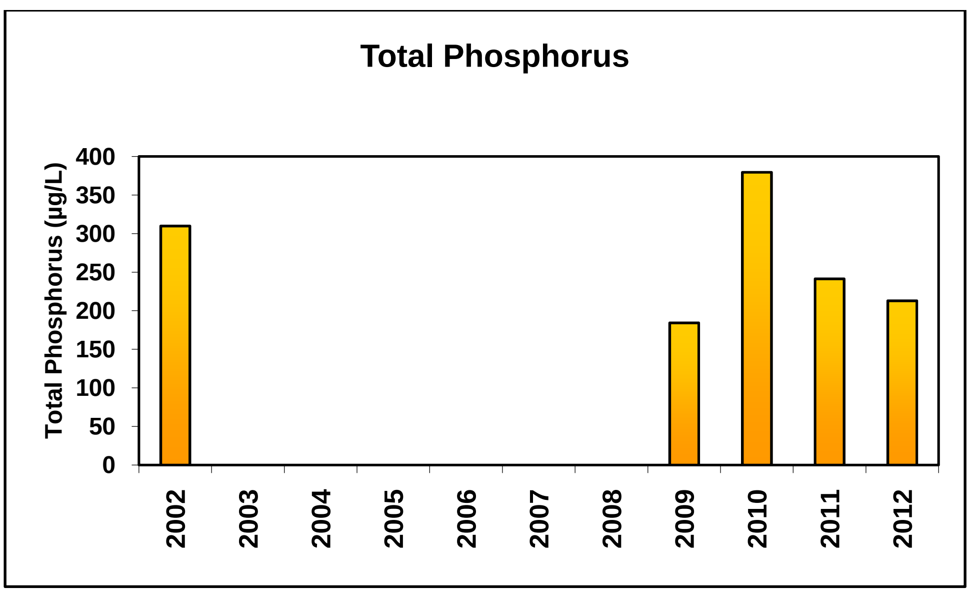

Figure 21.Mill Pond average annual total phosphorus concentrations.

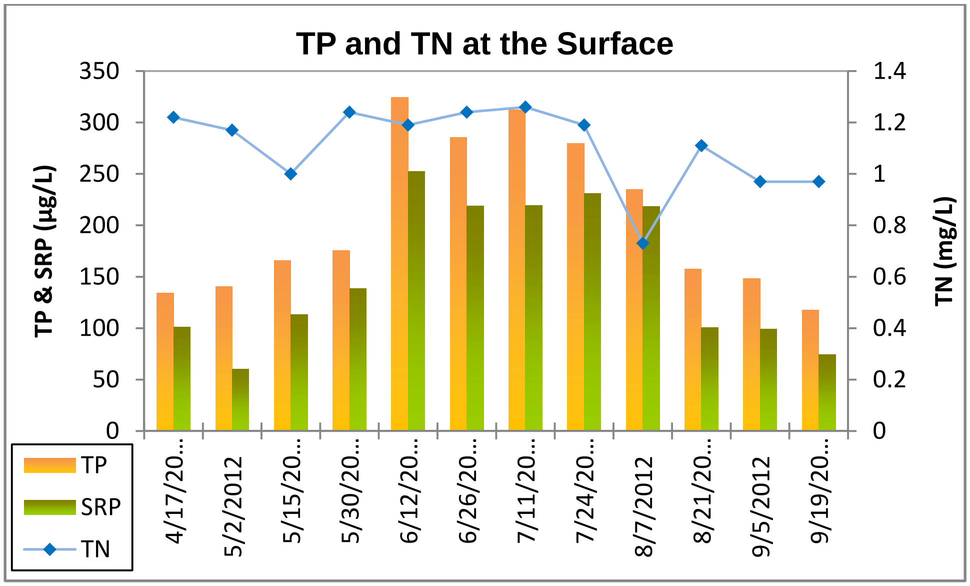

Figure 22. Mill Pond seasonal changes in total phosphorus, soluble reactive phosphorus, and total nitrogen in 2012.

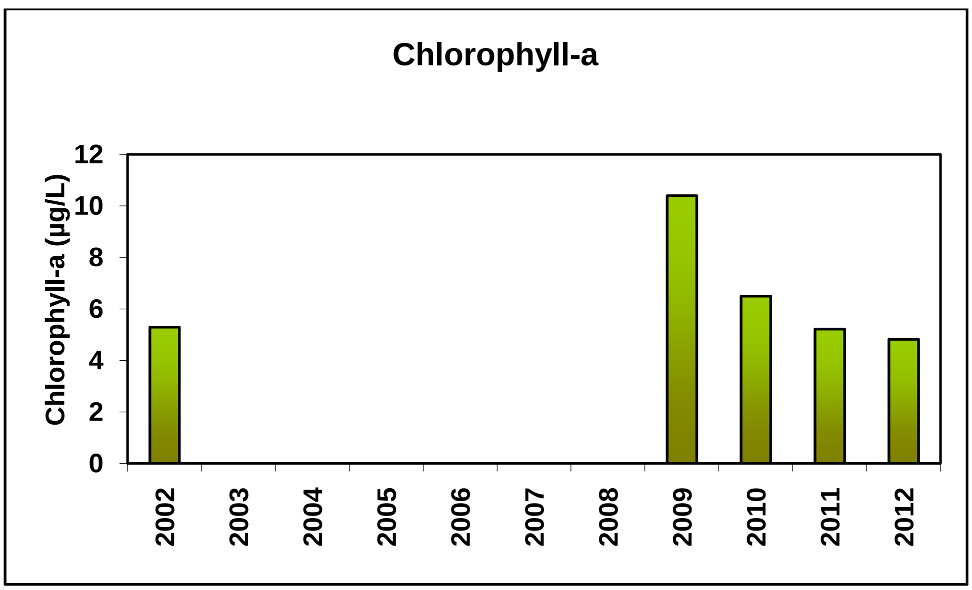

Figure 23. Mill Pond average annual chlorophyll-a concentrations.

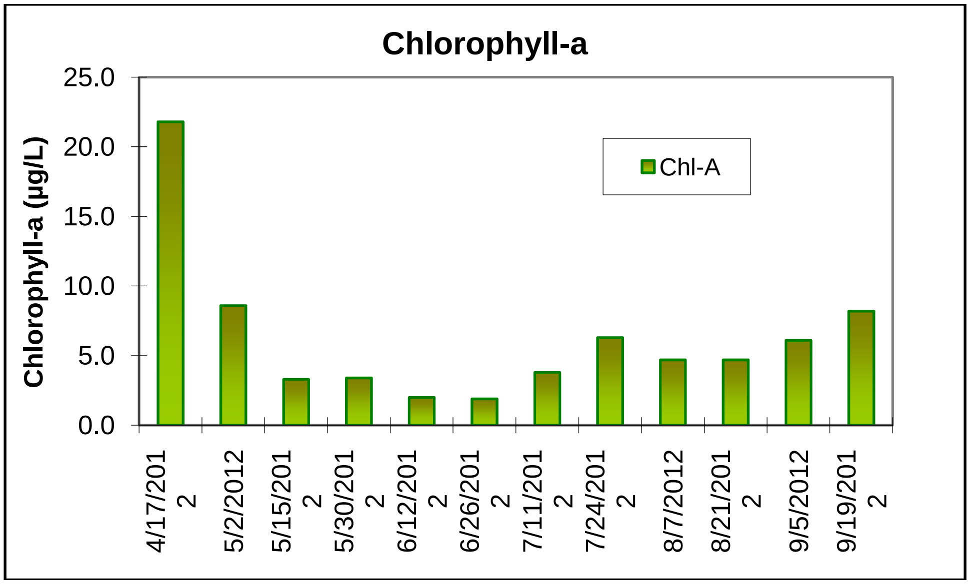

Figure 24. Mill Pondseasonal changes in chlorophyll-a concentrations in 2012.

2012 Lake Monitoring - CAMP

Lakes Dubay, Medina and Sylvan were monitored through the 2012 Citizens Assisted Monitoring Program (CAMP). The 2012 annual CAMP report will be available in summer 2013 at http://www.metrocouncil.org/environment/Rivers/ Lakes/index.htm

CAMP was initiated by the Metropolitan Council to supplement the water quality monitoring performed by Met Council staff and to increase the knowledge of water quality of area lakes. Volunteers monitor the lakes semi-monthly from mid-April to mid-October. They note natural and cultural observations and general perceptions of the lakes' condition and suitability for recreation. They take a water transparency reading using a Secchi disk, measure surface water temperature, and collect surface water samples that are analyzed for total phosphorous, total Kjeldahl nitrogen, and chlorophyll-a.

Data from each lake's sampling forms and lab analyses are entered into a data management and statistical analysis program called Statistical Analysis System (SAS). Various quality control methods are used throughout the program to ensure that proper sampling and data analysis techniques were used. Suspect data are excluded from the databases or conclusions.

Dubay Lake:

Lake Medina:

Sylvan Lake:

Appendix 3

Lake Monitoring History

	Cook	*Cowley*	*Diamond*	*Dubay*	*Fish*	*French*	*Henry*	*Jubert*	*Medina*	*Mill Pond*	*Mud*	*Rice*	*Sylvan*	*Weaver*
2012			T	C	T	T			C	T			C	T
2011			T	C	T	T	C			T		C		T
2010		C	T		T	T	C			T	T	C/T		T
2009		C	T		T	T	C			T		C		T
2008			T		T		C					C	C	T
2007		C	T		T		C					C		T
2006		C			T	T	C							T
2005					T	T	C							T
2004			T		T	T								T
2003														
2002					T	C				T				T
2001	T				T	C								T
2000					T			C						T
1999					T					T				T
1998			T		T									T
1997					T								T	T
1996					T									T
1995					T		C							T
1994			C		T									T
1993					T									T
1992	T		T		T									T
1991					T			T		T				T
1990	T				T	T								T
1989			T	T	T			T						T
1988	T				T					T				T
1987					T			T						T
1986	T		T	T	T						T			T

T = monitored by Three Rivers Park District **C** = monitored through CAMP program