Pioneer and Sarah Creek Watershed Management Commission
Lake Water Quality Summaries
2012

Introduction

Pioneer and Sarah Creek Watershed Commission contracted Three Rivers Park District to monitor the trophic condition for several lakes in 2012. Three Rivers Park District monitored the water quality in Lake Independence, Spurzem Lake, Half Moon Lake, Lake Sarah and Whaletail Lake (west and east basins).

These lakes were sampled biweekly from April through October. 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). It should be noted that the MPCA's assessment for waterbody 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.*

Lake Independence

Lake Independence has exceeded the MPCA "deep lake" phosphorus standards since 2001. There have been slight improvements in water quality since the completion of the TMDL (2006) and implementation plan (2007). However, the total phosphorus concentrations appeared cyclic with gradual decreases and increases in total phosphorus since 1995 (Figure 1). The average phosphorus concentration in Lake Independencewas 45.6 in 2012. Total phosphorus concentration in 2012 ranged from 28.1 to 74.6µg/L (Figure 2). The fluctuations in phosphorus concentration for Lake Independence have often been attributed to the watershed and internal loading processes.

There was a slight decrease in phosphorus in 2012; however, this did not affect the chlorophyll-a concentrations or the secchi depth. The average chlorophyll-a concentration in 2012 was 26.3 µg/L(Figure 3). This average chlorophyll-a concentration is considerably higher than the MPCA water quality standard.Secchi depth transparency readings ranged from 0.64 to 5.16 meters in 2012 (Figure 4).The lake typically has a clear water phase in early spring that is followed by severe algal blooms that persist throughout the summer. There was an algal bloom in the middle of the summer which coincided with higher chlorophyll-a readings and poor transparency.Despite time periods with severe algal blooms, secchi depth transparency has met the state standards for the past several years. The average Secchi depth transparency for 2012 was 2.18 m (Figure 5). Typically, poor water clarity and high chlorophyll-a concentrations indicate algal production. Algae growth can be effected by numerous environmental factors including, but not limited to, phosphorus and nitrogen concentrations, oxygen, carbon dioxide, light and temperature.

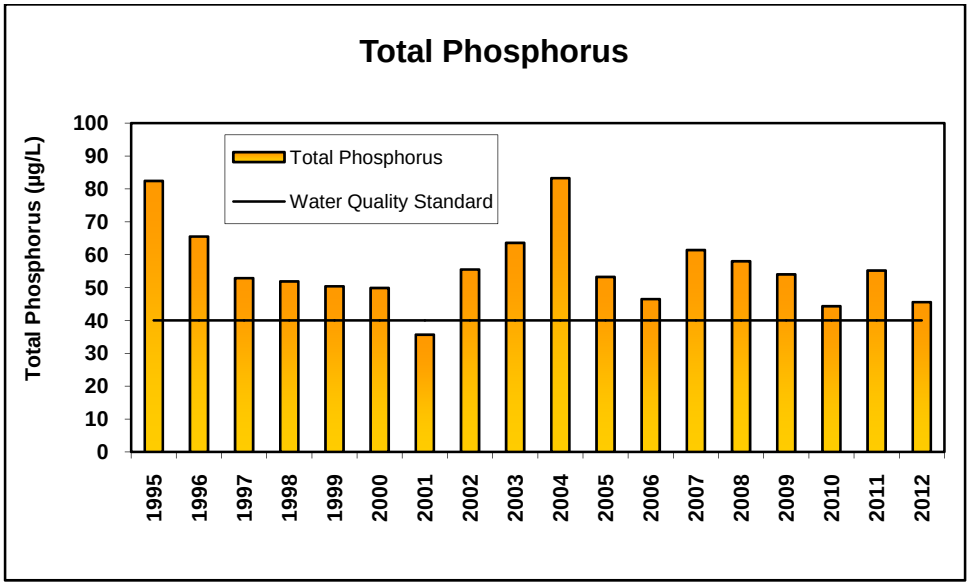

Figure 1. Lake Independence annual changes in average phosphorus concentration from 1995-2012.

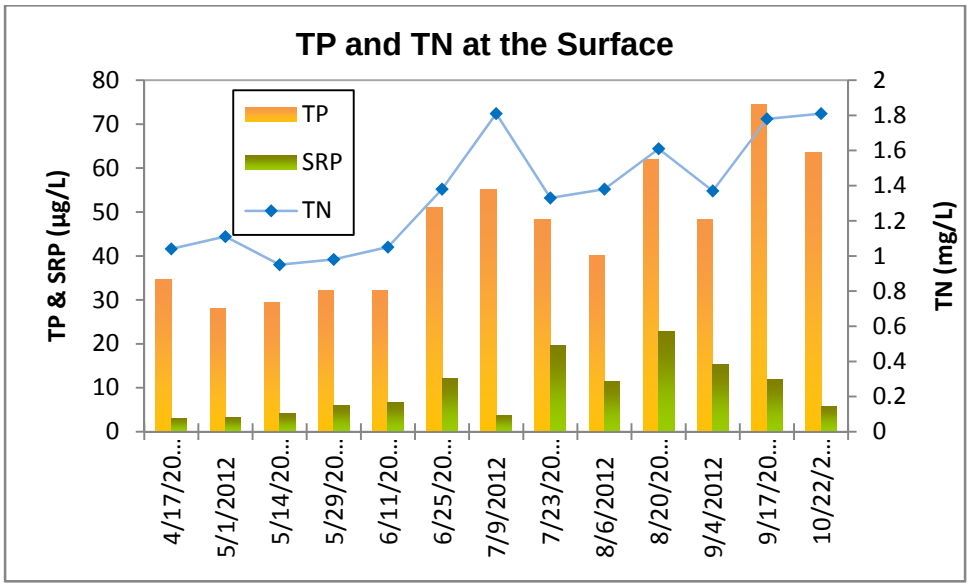

Figure 2. Lake Independence seasonal changes in total phosphorus, soluble reactive phosphorus, and total nitrogen concentrations in 2012.

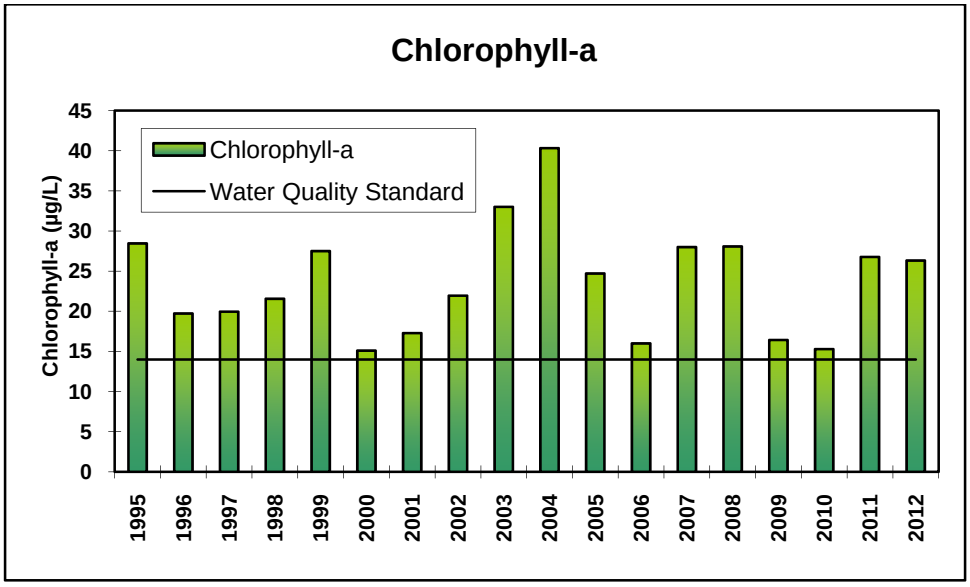

Figure 3. Lake Independence annual changes in average chlorophyll-a concentration from 1995-2012.

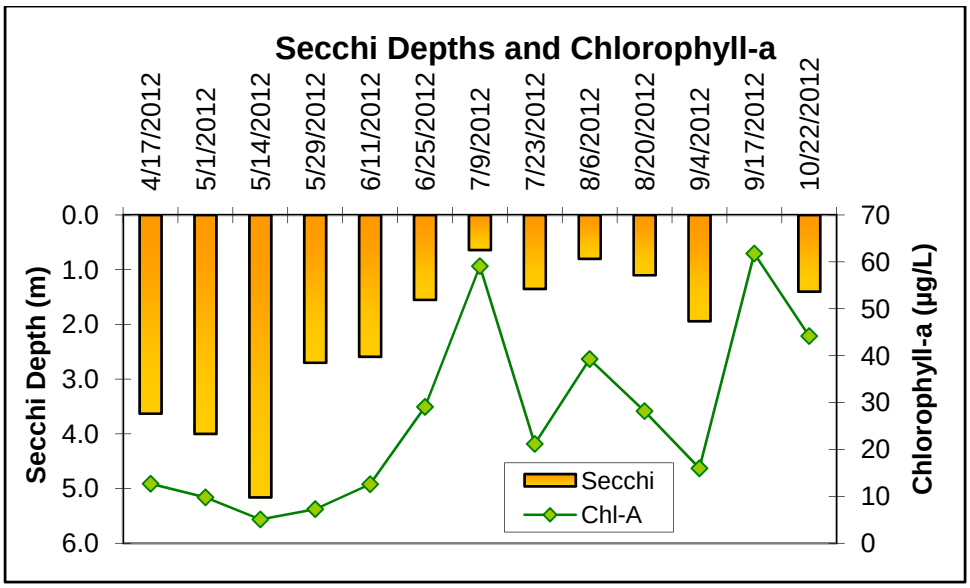

Figure 4. Lake Independence seasonal changes in Secchi depth and chlorophyll-a concentration in 2012.

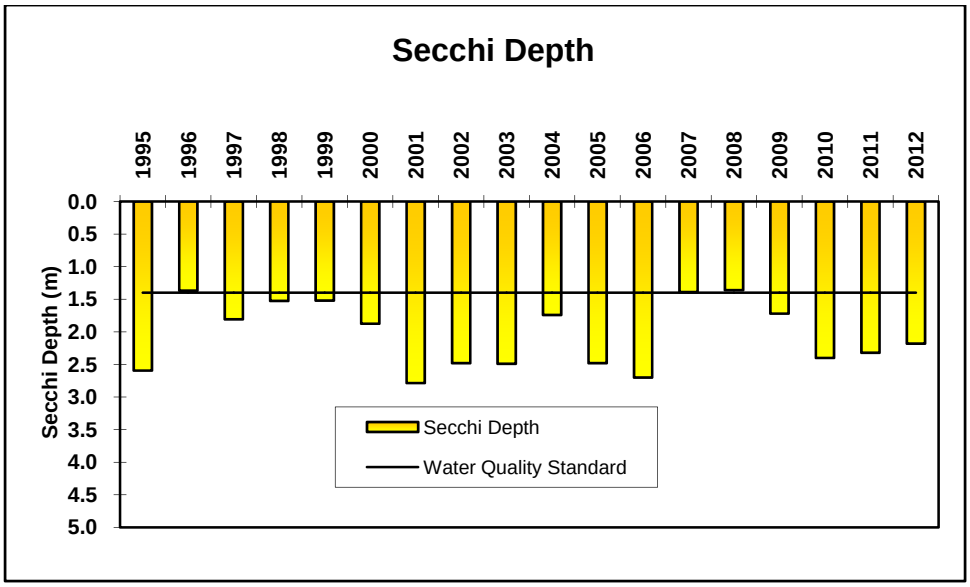

Figure 5. Lake Independence annual changes in average Secchi depth from 1995-2012.

Spurzem Lake

Spurzem Lake continues to exceed the impaired water criteria for the MPCA "deep lake" eutrophication standards. The total phosphorus concentration standard to support direct contact recreational use for Spurzem Lake is 40 µg/L. The average total phosphorus concentration in 2012 was 140.1 µg/L with values ranging between 60.2and 177.2 µg/L (Figures 6 & 7). These extremely high phosphorus concentrations are considered hypereutrophic with respect to other lakes within the ecoregion. The high phosphorus concentrations are attributed to significant sources of external and internal loading.

In the past, excess phosphorus concentrations in Spurzem Lake resulted in severe algal blooms with decreased water clarity. The average chlorophyll-a concentration in 2012was 50.0 µg/L (Figure 8). The highest chlorophyll-a concentrations corresponded with an increase in water temperatures at the end of June and beginning of July with values ranging between 62.9 µg/L and 118.9 µg/L. Despite these high chlorophyll-a concentrations, there were periods during the 2012 season with excellent water clarity conditions. During the period from April through June of 2012, chlorophyll0a concentrations ranged between 1.4 µg/L and 17.6 µg/L; and secchi depth transparency ranged between 1.49 m and 4.1 m. The extended period with excellent water clarity resulted in an average Secchi depth transparency of1.53 m (Figure 10). This is the first time since 2004 that the MPCA standard for Secchi Disk transparency has been met. The reason for this improvement in water clarity in 2012 is currently unknown.

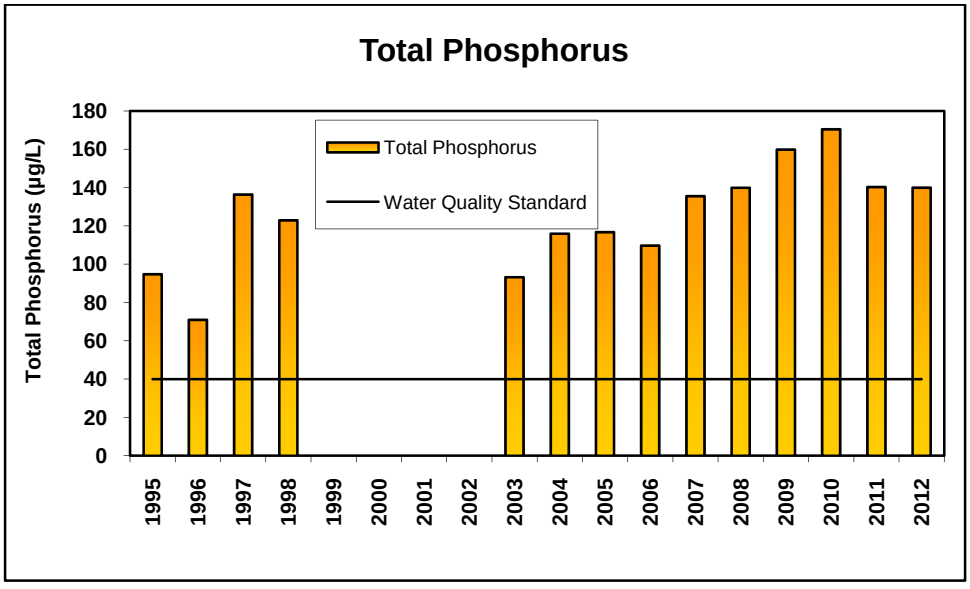

Figure 6. Spurzem Lake annual changes in average phosphorus concentration from 1995-2012.

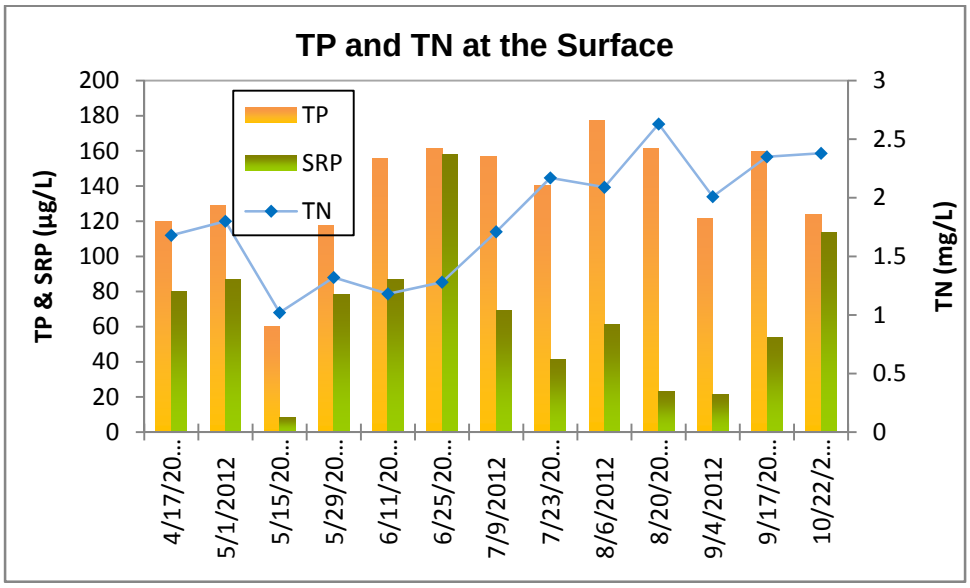

Figure 7. Spurzem Lake seasonal changes in total phosphorus, soluble reactive phosphorus, and total nitrogen concentrations in 2012.

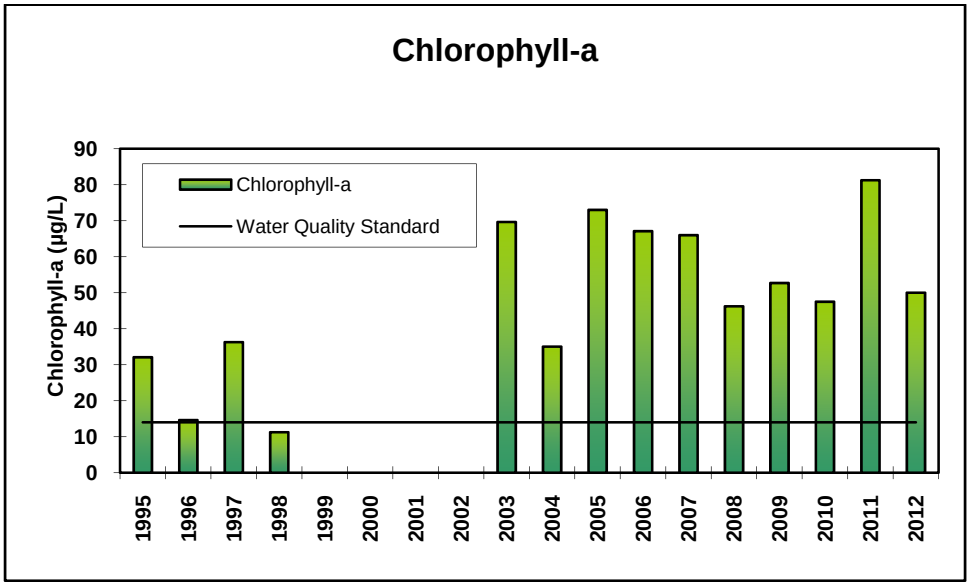

Figure 8.Spurzem Lake annual changes in average chlorophyll-a concentration from 1995-2012.

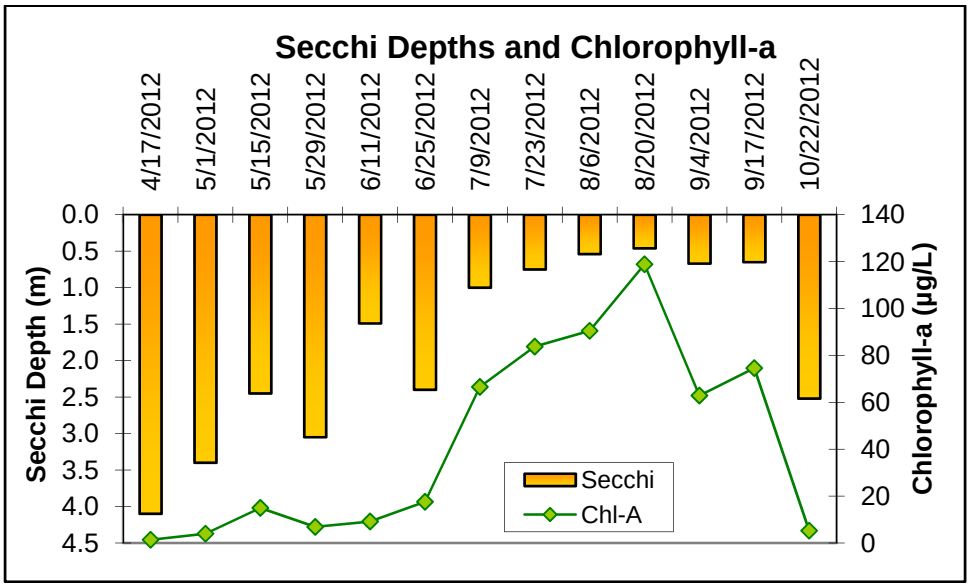

Figure 9. Spurzem Lake seasonal changes in Secchi depth and chlorophyll-a concentration in 2012.

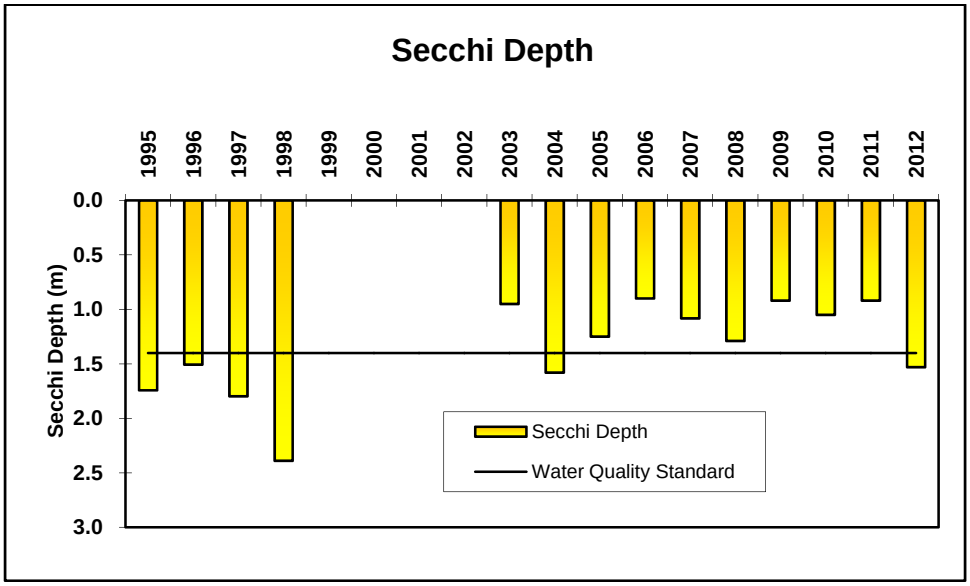

Figure 10.Spurzem Lake annual changes in average Secchi depth from 1995-2012.

Half Moon Lake

Half Moon Lake continues to exhibit degraded water quality conditions. Half Moon had an average phosphorus concentration of 120.8 µg/L with values ranging from 74.4 to 178.0 µg/L in 2012 (Figures 11&12).There has not been any improvement in phosphorus concentrations in comparison to the previous years that have been monitored. The average total phosphorus concentrations have been substantially higher than the MPCA "deep lake" standard of 40 µg/L to support aquatic recreational use.

The excessive phosphorus concentrations are conducive for the development of severe algal blooms that occurred during the middle of the summer. The average chlorophyll-a concentration in 2012 was 49.4 µg/L with values ranging from 6.8 to 88.7 µg/L (Figures13 and 14). Despite the severe algal blooms, the average Secchi depth of 1.45 m (Figure 15) met the MPCA standards. A clear water phase that persisted from April through June accounted for secchi depth transparencies ranging between 1.1 m and 2.76 m. This clear water phase most likely was attributed to an increase in zooplankton abundance.Water clarity gradually decreased in response to the development of algal blooms as water temperatures increased throughout the summer.

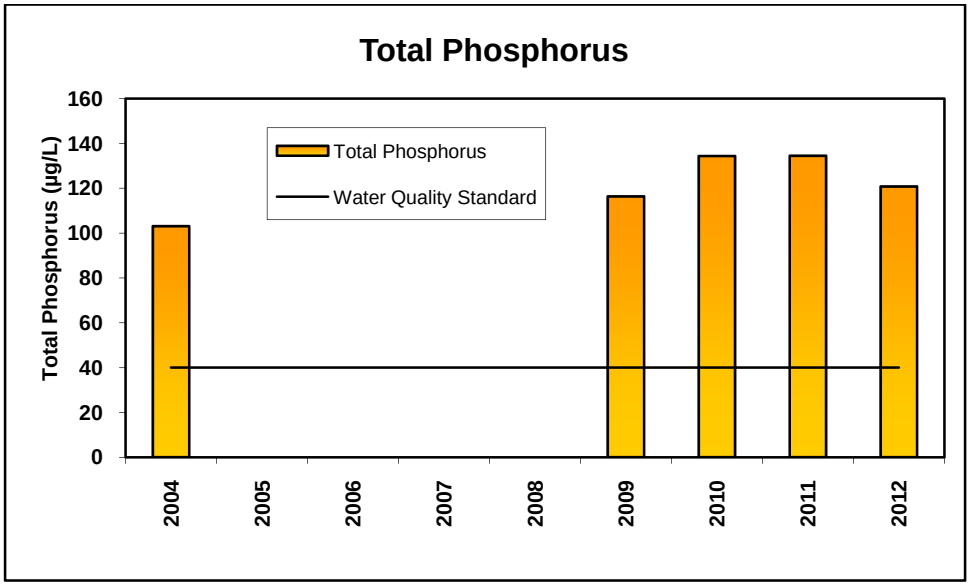

Figure 11. Half Moon Lake annual changes in average phosphorus concentration from 2004-2012.

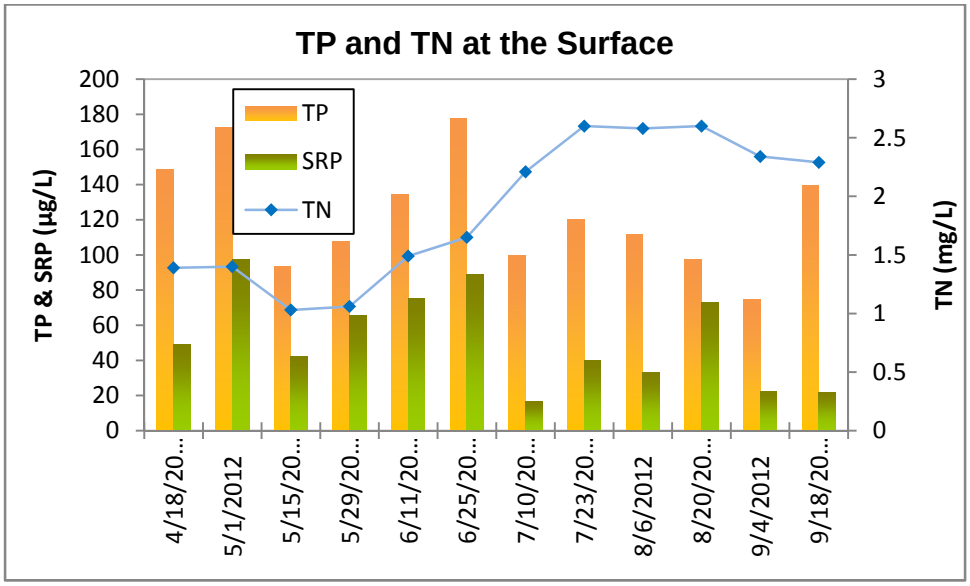

Figure 12. Half Moon Lake seasonal changes in total phosphorus, soluble reactive phosphorus, and total nitrogen concentrations in 2012.

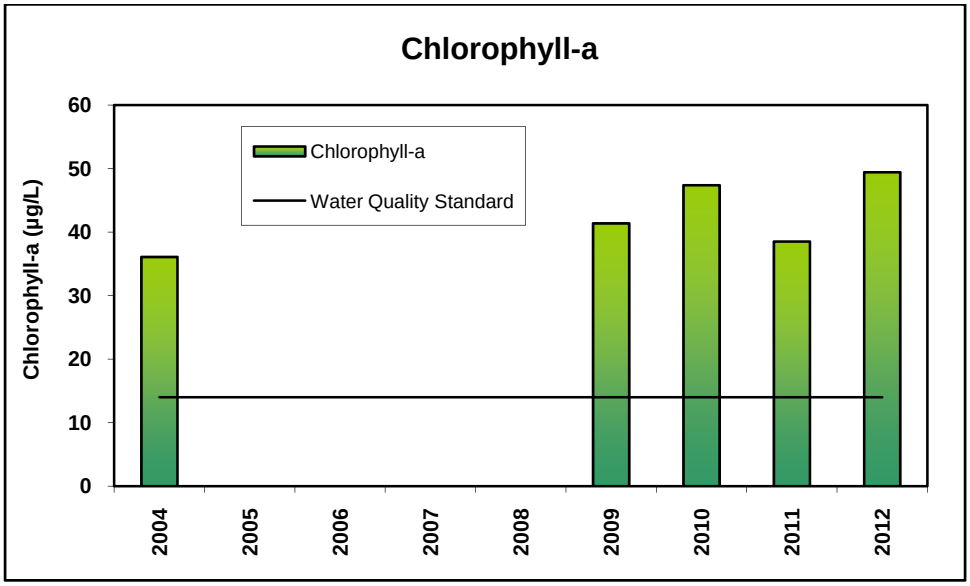

Figure 13.Half Moon Lake annual changes in average chlorophyll-a concentration from 2004-2012.

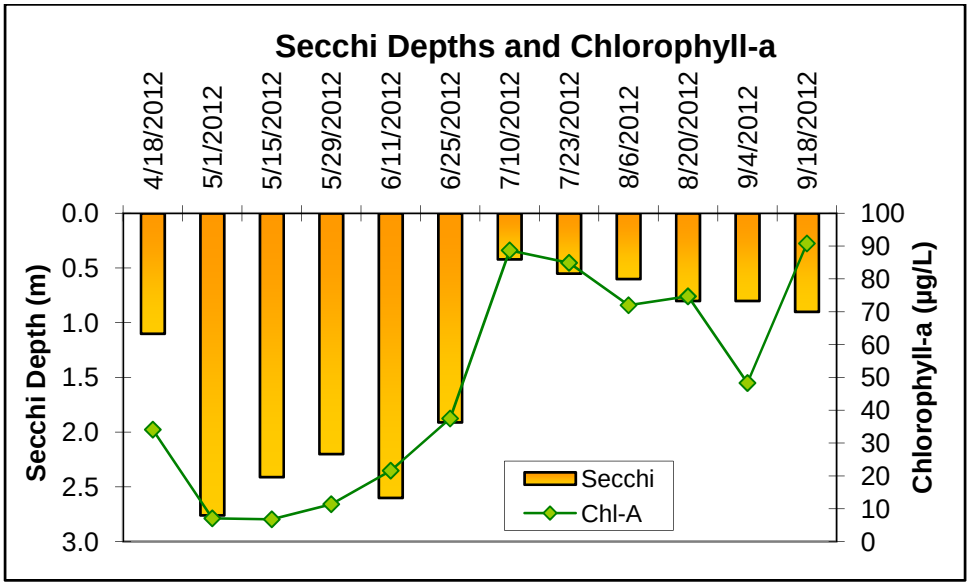

Figure 14. Half Moon Lake seasonal changes in Secchi depth and chlorophyll-a concentration in 2012.

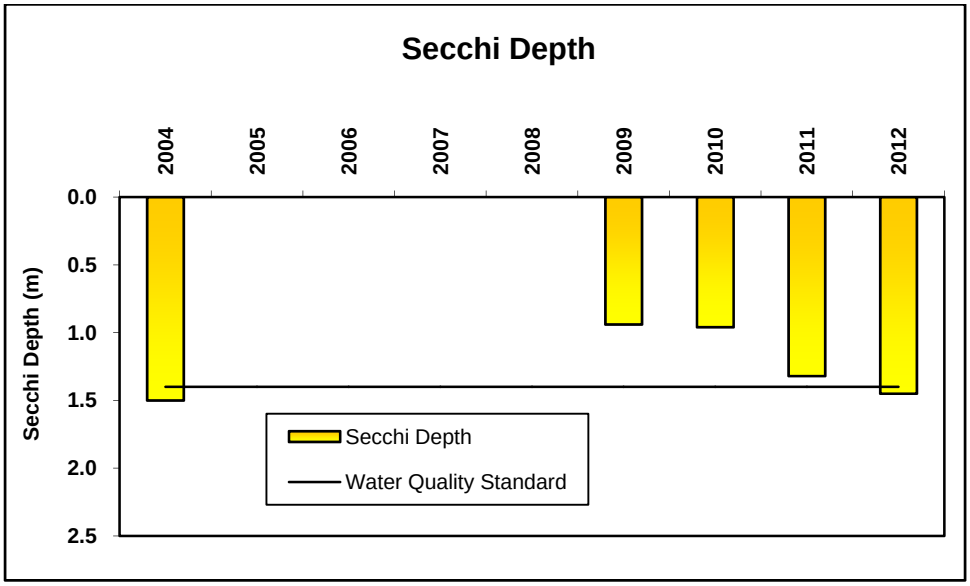

Figure 15.Half Moon Lake annual changes in average Secchi depth from 2004-2012.

Lake Sarah

Lake Sarah has exceeded MPCA "deep lake" standards for total phosphorus since 1996 (Figure 16). The average phosphorus concentration in 2012 was82.2µg/L. The high phosphorus concentrations are partially due to internal loading. A significant source of internal loading is the senescence of curly-leaf pondweed. There was a gradual increase in phosphorus concentration in June that corresponds with curly-leaf pondweed senescence. There are currently lake-wide management efforts proposed to control curly-leaf pondweed and provide water quality benefits for 2013.

The high phosphorus concentrations have been conducive for the development of algal blooms.Lake Sarah annual average chlorophyll-a concentration was49.6 µg/L in 2012 (Figure 18) which exceeds the MPCA "deep lake" standard for impairment of 14 µg/L.During the early summer, Lake Sarah exhibited a clear-water phase with relatively low chlorophyll-a concentrations that produced a maximum Secchi depth of 6.5 meters (Figure 19). During the early summer curly-leaf pondweed died off and created an algal bloom. The water clarity remained low for the remainder of the year (Figure 19).The average Secchi depth transparency for Lake Sarah was 1.79 meters in 2012 (Figure 20). The average Secchi depth transparency has met MPCA standards for the past two years despite high total phosphorus and chlorophyll-a concentrations (Figure 20).

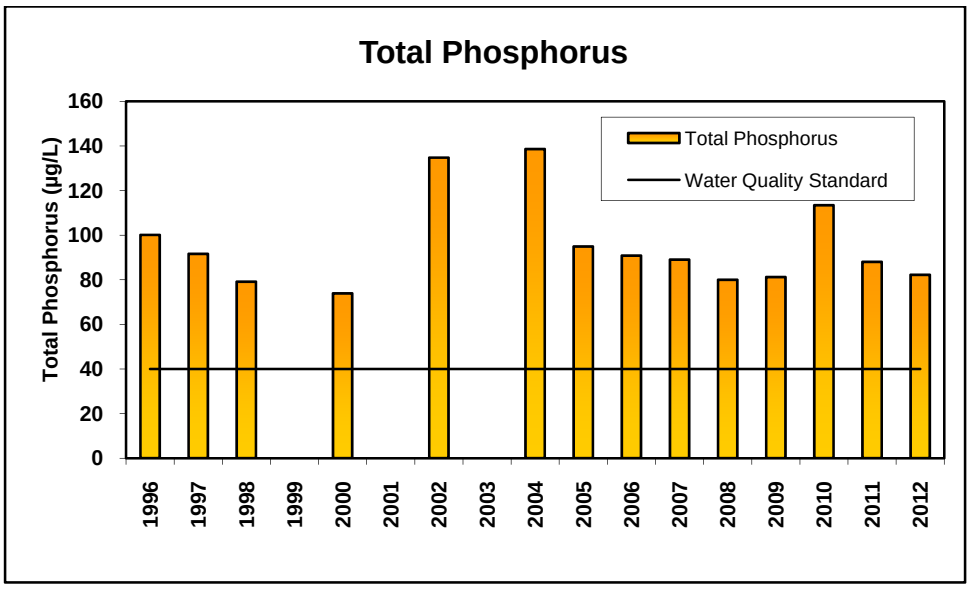

Figure 16. Lake Sarahannual changes in average phosphorus concentration from 1996-2012.

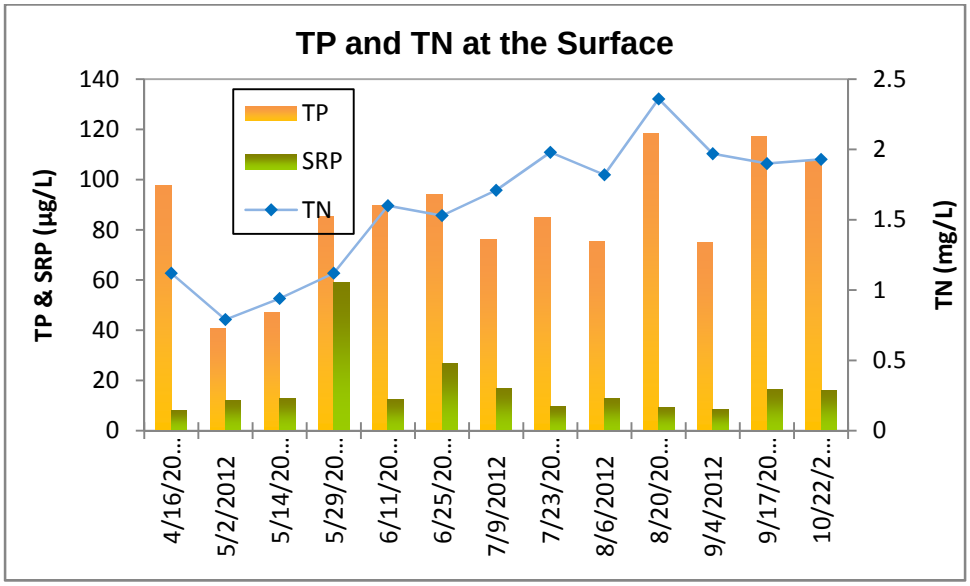

Figure 17. Lake Sarah seasonal changes in total phosphorus, soluble reactive phosphorus, and total nitrogen concentrations in 2012.

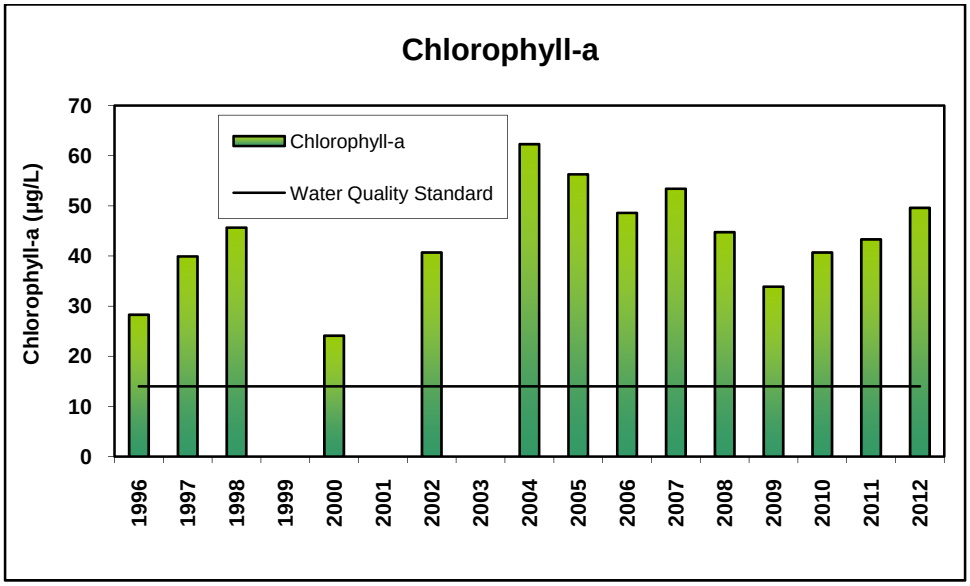

Figure 18.Lake Sarah annual changes in average chlorophyll-a concentration from 1996-2012.

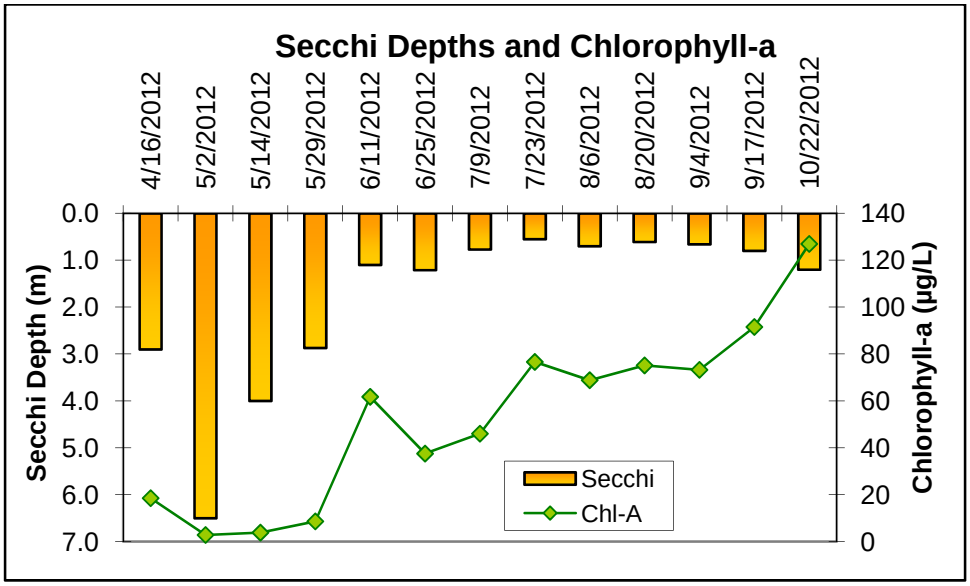

Figure 19. Lake Sarah seasonal changes in Secchi depth and chlorophyll-a concentration in 2012.

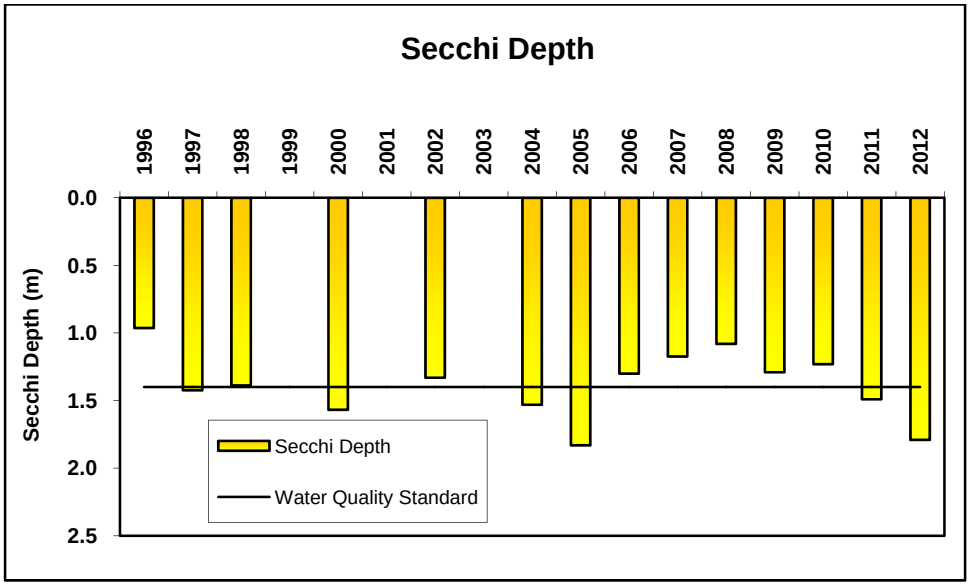

Figure 20.Lake Sarah annual changes in average Secchi depth from 1996-2012.

Whaletail Lake

Whaletail Lake has two distinct basins that have been monitored to assess water quality conditions.The west basin of Whaletail Lake has characteristics that are similar to a shallow lake, and the east basin has characteristics that are similar to a deep lake. The distinct differences in morphology have contributed to variations in water quality trophic conditions between the two basins. The water quality conditions were compared to the shallow lake and deep lake water nutrient criteria that are representative for each basin.

Whaletail-West Basin

The West Basin has impaired water quality conditions that currently do not meet the "shallow lake" standards to support recreational use. The west basin had an average annual total phosphorus concentration of 75.6 µg/L in 2012 (Figure 21) with values ranging between 59.6 µg/L to 95.6 µg/L (Figure 22).The high phosphorus concentrations have led to an increase in chlorophyll-a concentrations with an average of 34.4µg/L (Figure 23). Secchi depth transparency was consistently less than 1 m for the entire year (Figure 24). The average annual secchi depth of 0.57 m indicates that there has not been a significant improvement in water clarity conditions. The secchi depth transparency may not be algal dependent, but may be attributed to turbid conditions from re-suspension of sediment material.

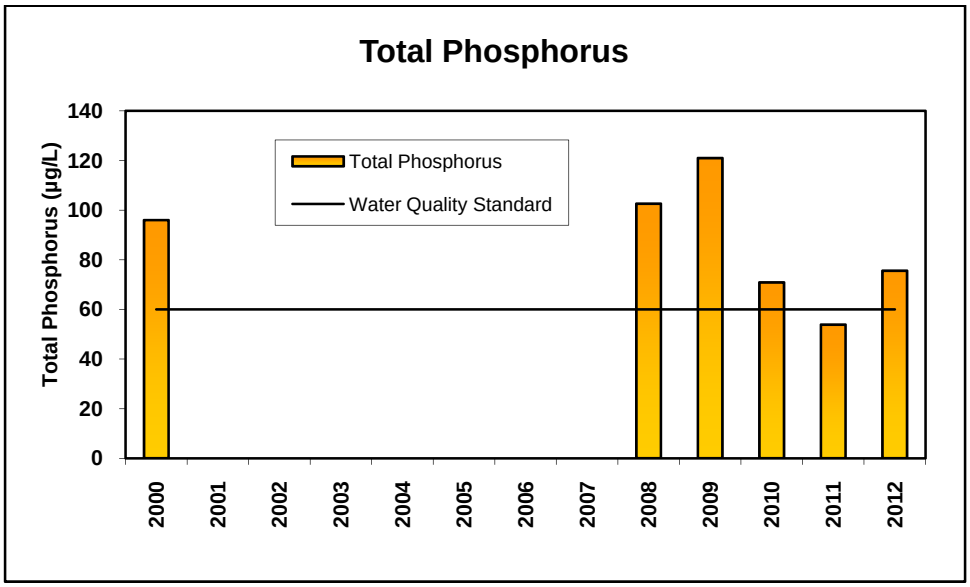

Figure 21. Whaletail-West Basin annual changes in average phosphorus concentration from 2000-2012.

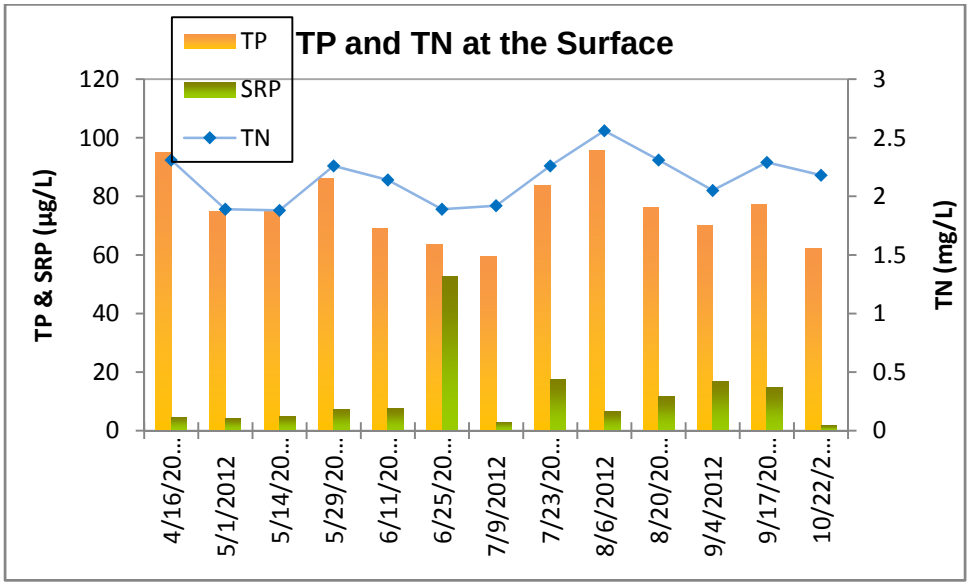

Figure 22. Whaletail-West Basin seasonal changes in total phosphorus, soluble reactive phosphorus, and total nitrogen concentrations in 2012.

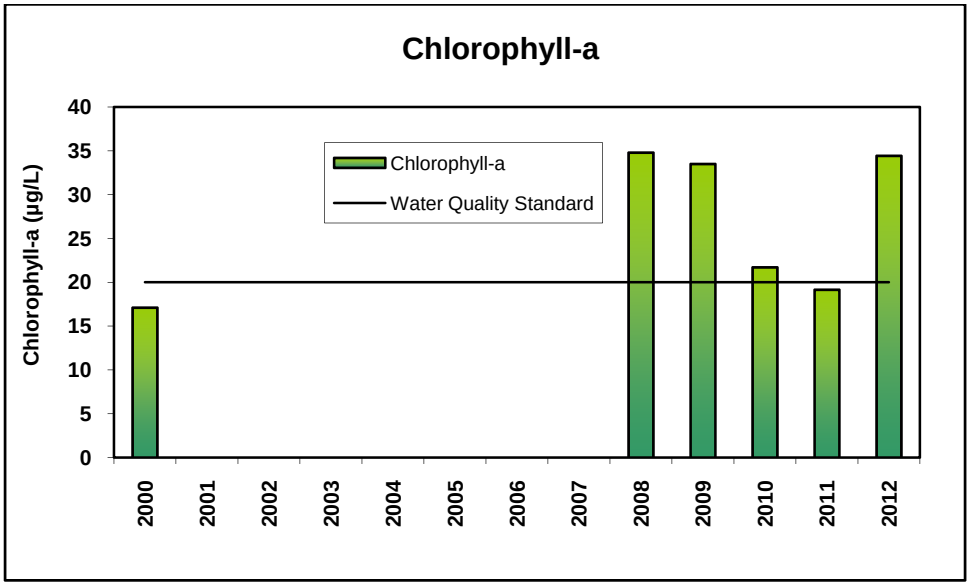

Figure 23.Whaletail-West Basin annual changes in average chlorophyll-a concentration from 2000-2012.

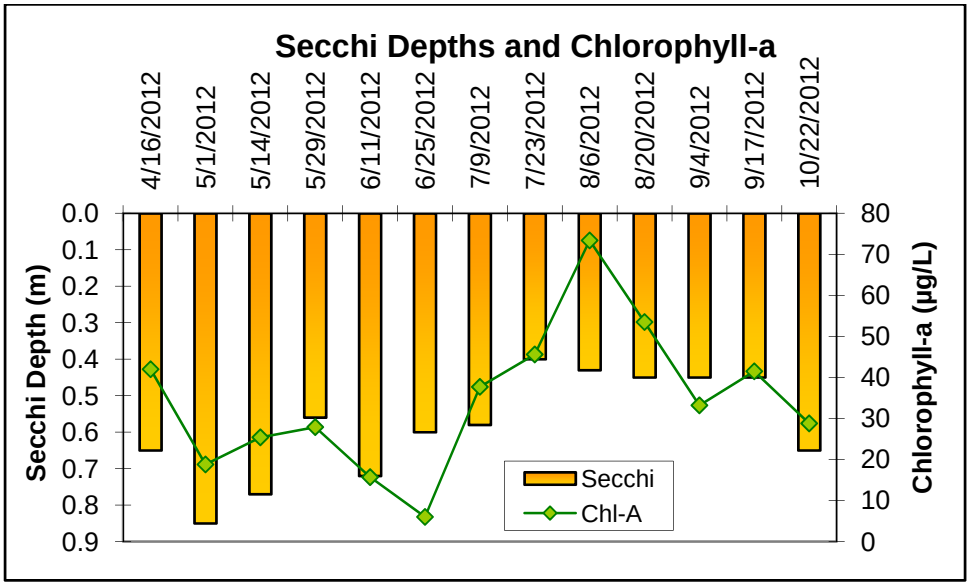

Figure 24. Whaletail-West Basin seasonal changes in Secchi depth and chlorophyll-a concentration in 2012.

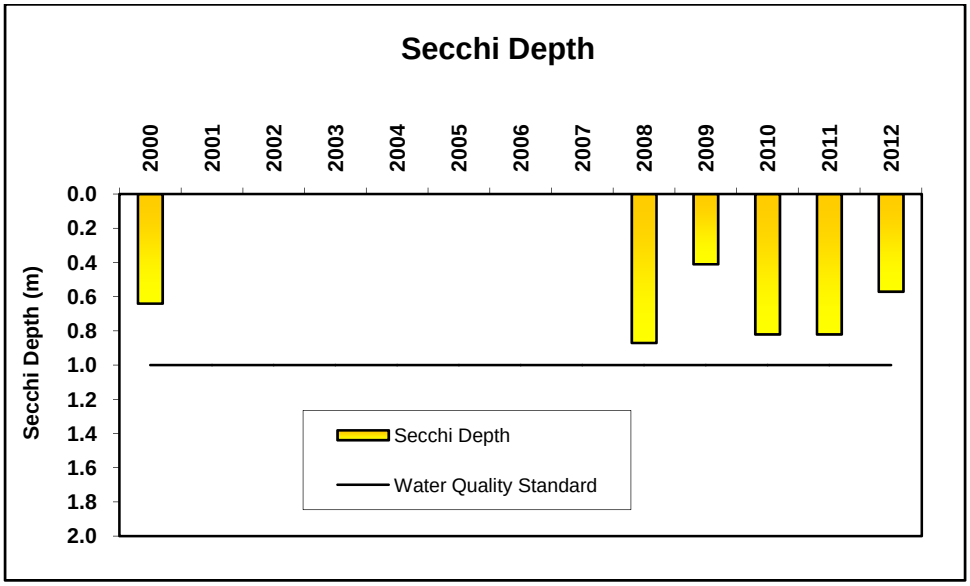

Figure 25.Whaletail-West Basin annual changes in average Secchi depth from 2000-2012.

Whaletail-East Basin

The east basin of Whaletail Lake typically has had better water quality in comparison to the west basin. The east basin has a maximum depth of 8 m that allows for the development of in-lake stratification during the summer. Stratification within the east basin typically persists throughout the summer (June-September) which confines the nutrients from sediment release within the hypolimnion. The west basins shallow morphology is more conducive for re0suspension of sediments and nutrients due to wind mixing. Based on the east basin water quality, the re-suspension of nutrients and sediments does not appear to occur as frequently as the west basin.

Although the east basin typically has better water quality, the water quality parameters typically do not meet MPCA standards. The average annual phosphorus concentrations within the east basin ranged between 44.6 µg/L to 55.0µg/L from 2000 to 2008. The phosphorus concentrations substantially increased to 71.9 µg/L in 2009. Since 2009, the annual average phosphorus concentration has gradually decreased each consecutive year. In 2012, the average annual phosphorus concentration was 39.7 µg/L with values ranging from 21µg/L to 62 µg/L. This was the first year in which phosphorus concentrations have met the MPCA standard since monitoring began in 2000. The improvements in phosphorus concentration are currently unknown.

Despite the recent noticeable improvements in phosphorus concentrations, the water clarity conditions have degraded in the past several years. The annual average chlorophyll-a concentrations have increased from 17.4 µg/L in 2010 to 27.2 µg/L in 2012, and secchi depth transparency has decreased from 1.61 m in 2010 to 1.11 m in 2012. The chlorophyll-a concentrations have never met the MPCA standards since monitoring began in 2000 (Figure 28). However, secchi depth transparency met MPCA standards in 2010 and 2011. Unfortunately, secchi depth transparency did not meet MPCA standards in 2012 (Figure 30). The past several years there doesn't seem to be a relationship between changes in the annual average phosphorus concentrations and water clarity. The changes in water clarity are most likely attributed to annual variations in zooplankton community.

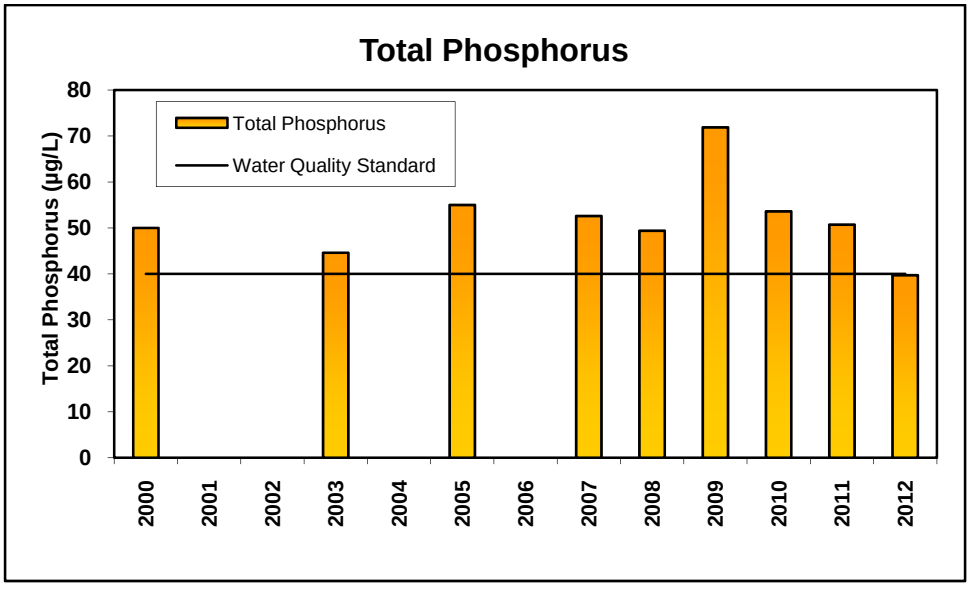

Figure 26. Whaletail-East Basin annual changes in average phosphorus concentration from 2000-2012.

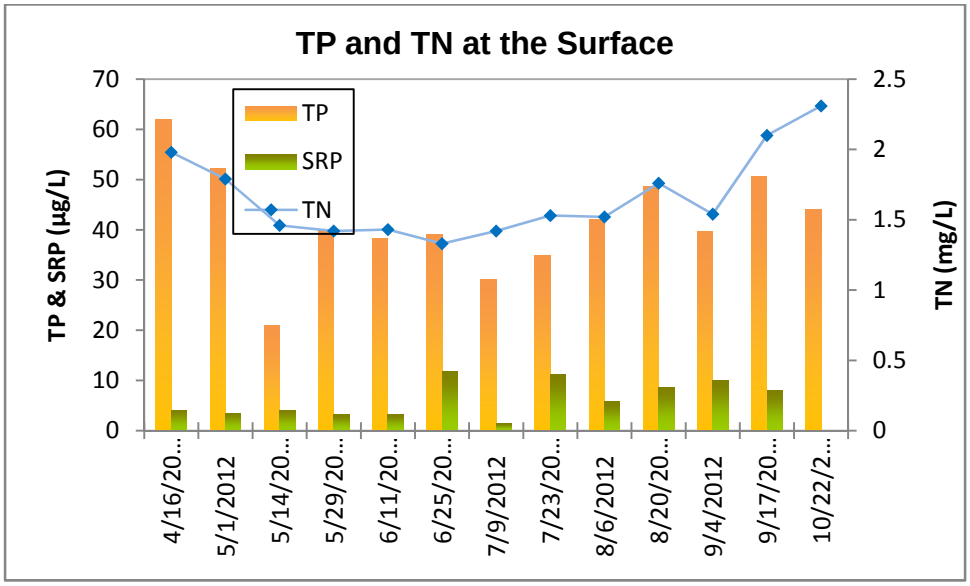

Figure 27. Whaletail-East Basin seasonal changes in total phosphorus, soluble reactive phosphorus, and total nitrogen concentrations in 2012.

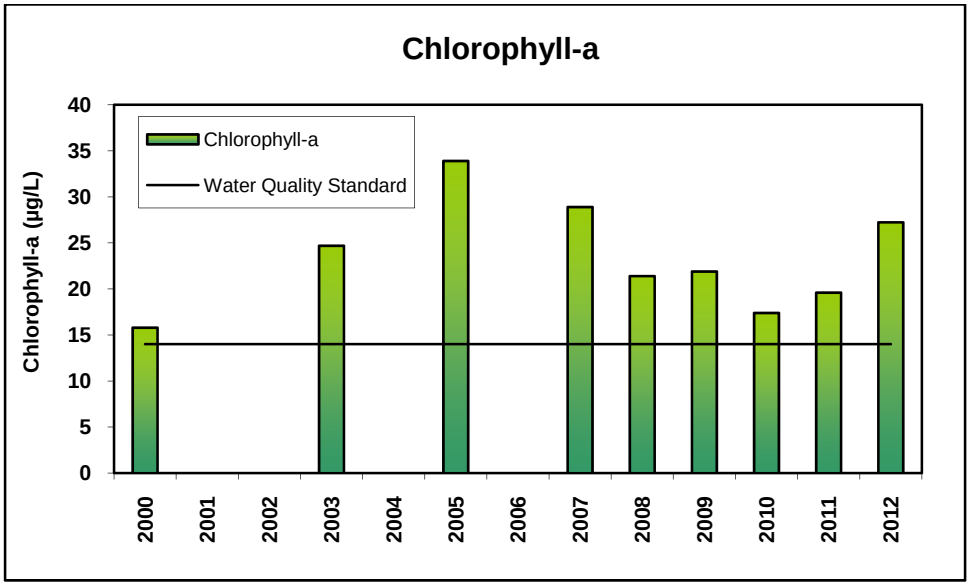

Figure 28.Whaletail-East Basin annual changes in average chlorophyll-a concentration from 2000-2012.

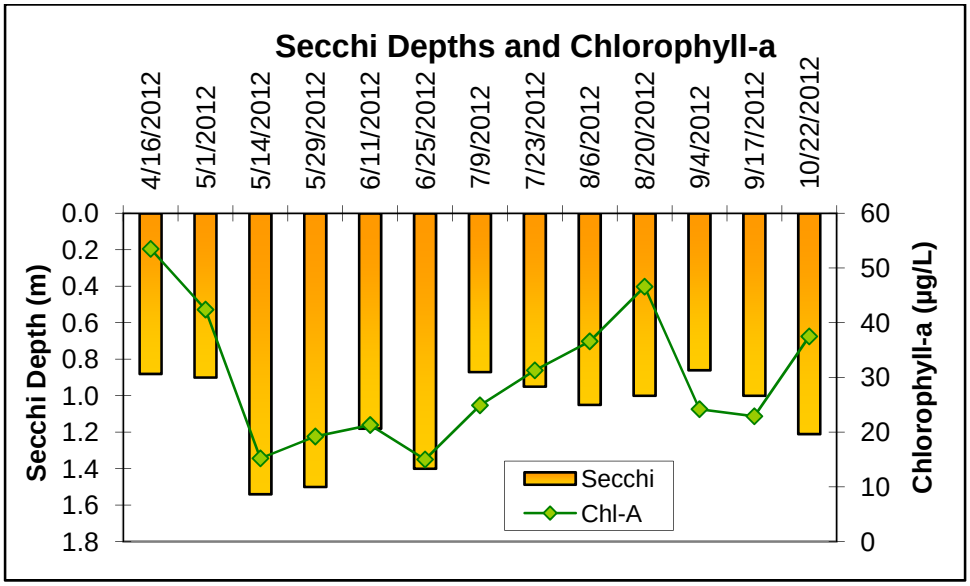

Figure 29. Whaletail-East Basin seasonal changes in Secchi depth and chlorophyll-a concentration in 2012.

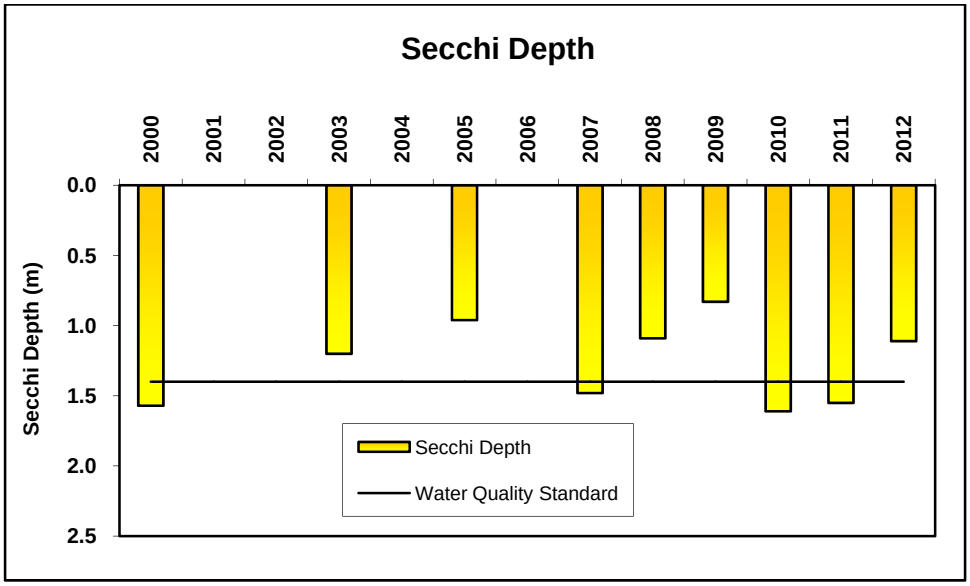

Figure 30.Whaletail-East Basin annual changes in average Secchi depth from 2000-2012.