Appendix B

Water Quality Monitoring

2008 Lake Water Quality Study

Sweeney Lake and Twin Lake

Prepared by
Bassett Creek Watershed Management Commission

February 2009

Executive Summary

Since 1970, water quality has been monitored in ten major lakes under the management of the Bassett Creek Watershed Management Commission (BCWMC). The main objective of this program is to detect changes or trends in lake water quality over time that will help determine the effects from changing land use patterns within the watershed as well as the BCWMC's efforts to maintain and improve water quality. The BCWMC adopted its current watershed management plan in 2004. The second generation plan complies with the provisions of the Minnesota Rules Chapter 8410, the Metropolitan Surface Water Management Act, the Water Resources Management Policy Plan, and other regional plans. The BCWMC's Plan sets the vision and guidelines for managing surface water within the boundaries of the BCWMC.

This report summarizes the results of water quality monitoring during 2008 in Sweeney and Twin Lakes in Golden Valley. The lakes were monitored for both chemical and biological water quality parameters, the latter including phytoplankton, zooplankton and macrophytes (aquatic plants). Monitoring results are summarized by lake and include a description of the results along with graphical representations of the data.

The conclusions from 2008 water quality monitoring are as follows:

Sweeney Lake

- Water quality status of Sweeney Lake was mesotrophic (moderate nutrients and good water quality) although the summer average phosphorus concentration was mildly eutrophic (nutrient rich and poor water quality) during the 2008 growing season.

- Vegetation (submerged and floating leaf) was found throughout the lake's littoral (shallow) zone to depths of 10 feet during June and 13 feet during August.

- Two undesirable non-native species, curlyleaf pondweed (*Potamogeton crispus*) and purple loosestrife (*Lythrum salicaria*), were observed during 2008. Both were also observed in 2005. No changes in coverage or density since 2005 are apparent.

- Sweeney Lake water quality has improved when compared to 2007 and 2005 because chlorophyll *a* and total phosphorus have decreased while Secchi depth has increased, and water quality is the best since monitoring began in 1972.

- Despite improvements, Sweeney Lake did not meet the BCWMC Level I water quality goal for total phosphorus (average summer concentration not to exceed 30 μg/L), although the 2008 average summer concentration (32 μg/L) was very close to the goal (within 2 μg/L). Chlorophyll *a* (average summer concentration not to exceed 10 μg/L) and Secchi disc transparency (average summer depth of at least 2.2 meters) goals were met in 2008.

- In 2008, Sweeney Lake water quality met the state water quality standards.

- Phosphorus buildup in the lake's bottom waters during 2008 resulted from internal loading. Because the aeration system was not in operation during 2008, lake mixing did not occur and the phosphorus pool was trapped in the lake's bottom waters during the summer.

- A comparison of 2005 and 2008 water quality data indicate the lake's aeration system causes mixing of the phosphorus from the lake's bottom waters into the surface waters.

- Because phosphorus from internal loading mixes during the fall and spring mixing events, this phosphorus contributes to the lake's annual phosphorus load which affects the lake's water quality during the subsequent growing season. The TMDL study that is underway should evaluate options to minimize internal loading and its impact upon the lake's spring and summer water quality.

To further evaluate the changes in lake water quality observed during 2008, it is recommended that the lake be monitored without the operation of the aeration system during 2009. Samples would be collected prior to ice-out and throughout the growing season.

Twin Lake

- The summer average of the total phosphorus concentrations indicates that Twin Lake is in the eutrophic category, while the summer average chlorophyll *a* concentration and Secchi disc transparency are within the upper limits of the mesotrophic classification. With the exception of the June measurement, 2008 Secchi disc data points are in the eutrophic category.

- In 2008, Twin Lake did not meet the BCWMC Level I water quality goal for total phosphorus (average summer concentration not to exceed 30 µg/L) or Secchi disc transparency (average summer depth of at least 2.2 meters). The lake's average summer total phosphorus concentration was 44 µg/L and Secchi disc transparency was 2.0 meters. The lake's average summer chlorophyll *a* concentration of 6.7 µg/L met the BCWMC Level I water quality goal (average summer concentration not to exceed 10 µg/L).

- In 2008, Twin Lake did not meet the state water quality standards. The lake's average summer total phosphorus concentration (44 µg/L) exceeded the state standard (maximum of 40 µg/L). However, the lake's average summer chlorophyll *a* (6.7 µg/L) and Secchi disc transparency (2.0 meters) both met the state standard (chlorophyll *a* maximum of 14 µg/L and Secchi disc minimum of 1.4 meters).

- Historical data indicate an improvement in water quality between 1982 and 1992 after which it remained relatively constant from 1992 to 2005. However all three nutrient-related parameters indicate that water quality has decreased greatly between 2005 and 2008 and the water quality of the lake during 2008 was at or near the poorest water quality observed since monitoring began.

- 2008 noted substantially higher numbers of phytoplankton (algae - microscopic plants) during the late summer as compared with 2000 and 2005. The higher numbers indicate the lake's water quality has decreased greatly between 2000 and 2008.

- A substantial decline in large-bodied zooplankters (microscopic crustaceans) occurred from early June to early July of 2008. Large-bodied zooplankters can improve a lake's water quality by eating substantial quantities of algae. A substantial decline in large-bodied zooplankters greatly reduces the quantity of algae that are consumed and results in decreased water quality. The reduced control by zooplankton during this period corresponded with a tripling of the number of phytoplankton in the lake despite declining phosphorus concentrations.

- A comparison of 2000, 2005, and 2008 zooplankton (microscopic crustaceans) indicates substantially higher numbers of zooplankton were observed during June of 2008 than were observed in June of 2000 and 2005. Because zooplankton consume algae, the lake's capacity to control algae through zooplankton consumption was higher during June of 2008 than during June of 2000 and 2005. Declines in zooplankton during June and July of 2008 resulted in similar numbers of zooplankton during August of 2008 as were observed during August of 2000 and 2005. The capacity of the lake's zooplankton to control algae was essentially the same during August of 2000, 2005, and 2008.

- A larger number of plant species was observed in 2008 than during 1996 through 2005. A total of 15 to 19 individual species were observed in 1996 through 2005 compared with 21 to 22 species in 2008.

- Curlyleaf pondweed, an undesirable non-native species, was observed in light density along the northeastern shore during June of 2000, was not observed during 2005, and was observed in light density at a single location along the southeastern shore during August of 2008. The August growth would be a new growth from turions (seeds) since the plant's growth cycle begins in late summer, continues through the winter, and concludes in late June each year.

- Purple loosestrife, an undesirable non-native species, was first observed growing along the south shoreline during 2000 and has been observed at this same location during 2005 and 2008. Although no increase in coverage has been observed, the presence of purple loosestrife is of concern because this plant typically displaces native vegetation and becomes the sole emergent species. It is recommended that the BCWMC work with the Minnesota Department of Natural Resources (MDNR) to manage purple loosestrife along Twin Lake's south shoreline.

To determine the cause of the high phosphorus concentration in Twin Lake, additional monitoring is recommended to determine changes in the lake's phosphorus concentrations before and after ice-out. Specifically, it is recommended that samples be collected prior to ice-out and that samples be collected throughout the growing season. In addition, lake level monitoring of both Sweeney Lake and Twin Lake is recommended immediately after ice-out to rule out the possibility that Sweeney flows into Twin during periods of high water levels such as following spring snowmelt.

2008 Lake Water Quality Study
Sweeney Lake and Twin Lake

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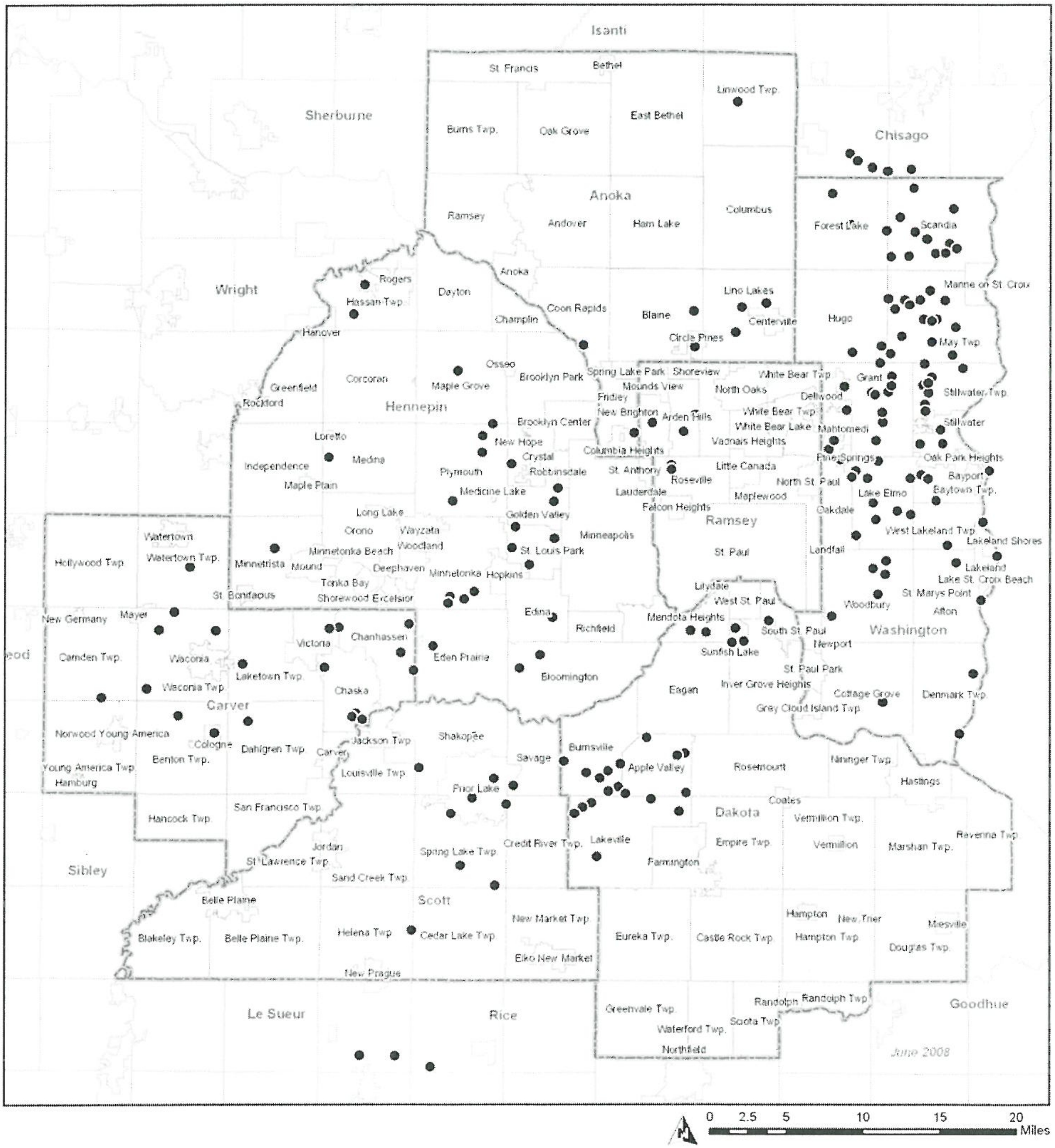
2007 Study of the Water Quality of 176 Metropolitan Area Lakes



By
Brian Johnson
Metropolitan Council
July 2008

EXECUTIVE SUMMARY

To date, the Metropolitan Council's lake monitoring programs (including the staff- and volunteer-monitoring programs) have provided an important tool for making informed lake management decisions. Data from our regional lake monitoring programs are frequently used to determine possible trends in lake water quality, estimate expected ranges in water quality of unmonitored lakes, examine intra-and inter-regional differences, determine potential impairments due to water quality, and investigate the relationships between land use and water quality.

This report is the latest in a continuing series of reports summarizing results of the Metropolitan Council's (Council's) annual lake monitoring program. The Council has collected water quality data on area lakes since 1980. This report contains data from a total of 181 lake sites on 176 lakes sampled in 2007. All of the lakes monitored in 2007 were monitored by volunteers through the Council's Citizen-Assisted Lake Monitoring Program (CAMP). Council staff did not monitor any Metropolitan Area lakes in 2007.

Seventy-one of the 176 lakes monitored in 2007 were listed by the MPCA as impaired waters due to excessive phosphorus, which affects the lakes' ability to support their designated recreational uses. To learn more about the impaired lakes listings and potential next steps, see http://www.pca.state.mn.us/water/tmdl/index.html.

The objectives of this study were to:

1. Provide lake water quality data to lake, watershed and water resource managers.
2. Advise managers of known or suspected threats to lake water quality.
3. Continue to compile a water quality database on the five area lakes that support a trout fishery.

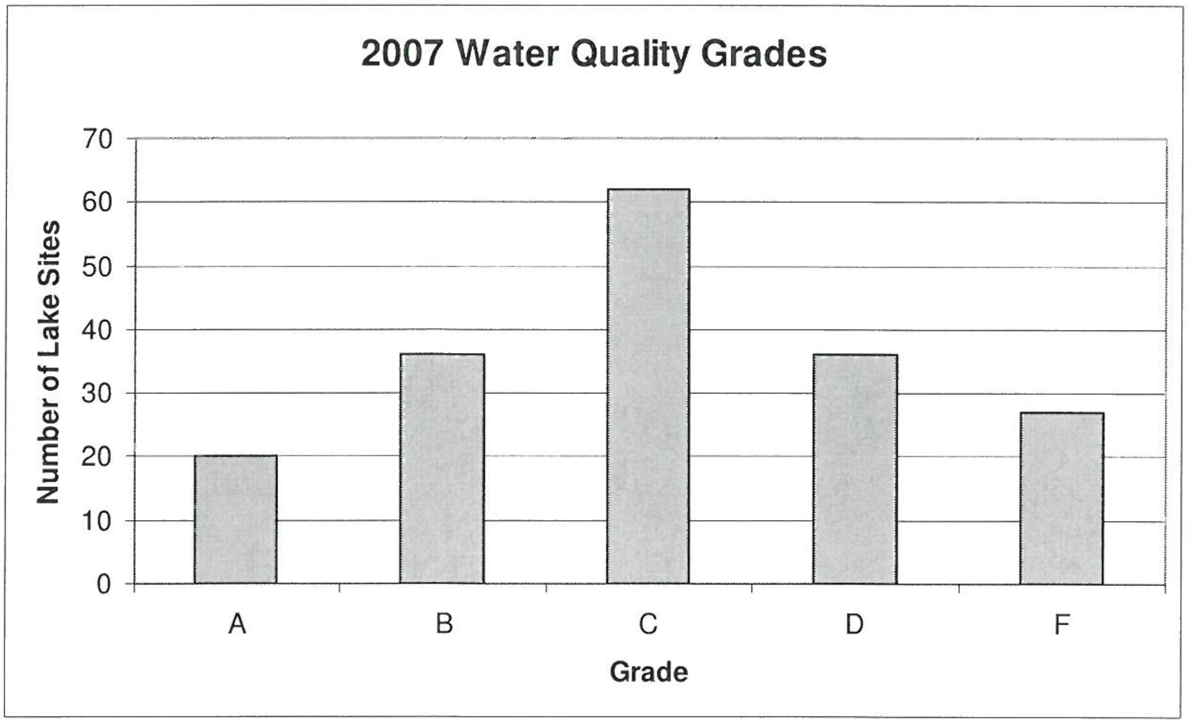
The year 2007 marked the fifteenth year that CAMP was used to increase our knowledge of the water quality of area lakes. Once again, volunteers measured surface water temperature and transparency, and collected surface water samples that were analyzed for total phosphorus, total Kjeldahl nitrogen, and chlorophyll-a on a biweekly basis from mid-April to mid-October (approximately 14 sampling events).

This year's monitoring program included 11 lakes never before monitored by the Council and volunteers. The 2007 lakes monitoring program included lakes from 36 municipalities, watershed management organizations/districts, and counties. Additionally, the 2007 CAMP program enrolled one new group (City of Mendota Heights), continuing to expand the list of monitoring partners.

Each lake was given an annual water quality grade. The spread of water quality grades for all of the lakes monitored in 2007 is as follows:

- A – 11% (20 lake sites).
- B – 20% (36 lake sites).
- C – 34% (62 lake sites).
- D – 20% (36 lake sites).
- F – 15% (27 lake sites).

The greatest percentage of the lake sites monitored through CAMP in 2007 received a water quality grade of "C" (34%). The water quality of these lakes is considered average as compared to others in the seven-county Metropolitan Area. When comparing the percentage of above-average lakes, those receiving grades of "A" or "B" (31%), to below-average lakes, those receiving "D" or "F" (35%), more lakes were below average.



Of the 159 lake sites previously monitored in 2006 with a sufficient database needed to generate annual grades:

- 19 lakes had a worse water quality grade in 2007 [Armstrong, Barker, Bass (west), Benz, Bush, Demontreville, Earley, Henry, Herber's, La, Long (May Township), MacDonald's, McDonald's, North Twin, O'Connor, Orchard, Rutz, South Oak, and Twin (St. Louis Park)];
- 34 lakes had a better water quality grade in 2007 [Alimagnet, Bass (May Township), Bass (east), Big Comfort, Big Marine, Carol, Colby, Cowley, Edith, Farquar, Fireman's, Fish (Scandia), Island, Jellum's, Keller, Kingsley, Little Comfort, Long (Pine Springs), Long (Stillwater), McMahon, Mitchell, Markgraffs, O'Dowd, Pat, Peltier, Reitz, Sand, St. Joes, Sunset Pond, Sweeney (site 1), Tamarack, Twin (Burnsville), Valley, and Woodpile]; and
- 106 lakes had the same water quality grade in both 2006 and 2007.

Water quality data from the 159 lake sites monitored in both 2006 and 2007 seem to indicate that the Metro Area lakes experienced slightly better water quality conditions in 2007 as compared to 2006. This observation indicates a reversal of a previous trend in which more lakes saw degradation in their water quality grades from 2004 to 2006.

The MPCA recently conducted a statewide statistical trend analysis on lakes with extensive Secchi transparency databases. The analysis revealed that the majority of assessed lakes showed no statistically significant trends in water clarity (either negative or improving). However, more lakes showed an improving trend than a degrading trend (MPCA 2008). There were 81 CAMP lakes monitored in 2007 which were included in the MPCA's trend analysis. The following is a summary of which lakes saw a statistically significant trend in water clarity:

- 24 lakes showed an improving trend in water clarity [Armstrong (south bay), Bass (Plymouth), Big Carnelian, Big Marine, Colby, Courthouse, DeMontreville, Earley, Elmo, Halfbreed (Sylvan), Hay, Kismet, Langton (site 2), Little Carnelian, Long (May Township), Marion, McKusick, Olson, Pine Tree, Silver (Stillwater), Sunset, Valentine, Waconia, and West Boot].
- 9 lakes showed a negative trend [Goggins, La, Little Long, Markgrafs, Pike (Maple Grove), Powers, Seidl, Shields, and Square].

Since 1980, 333 Metropolitan Area lakes have been monitored through the Council's lake monitoring program. Since some of these lakes have multiple monitoring sites, a total of 354 lake sites have been monitored. The list of lakes in the Council's monitoring database is shown in Appendix A. The resulting data from the Council's lake monitoring program are permanently stored in the U.S. EPA's national water quality data bank, STORET (STOrage and RETrieval). The Council's lake monitoring data are readily available via the Metropolitan Council Environmental Information Management System (EIMS), at: http://es.metc.state.mn.us/eims/lakes/index.asp. The majority of the 354 lake sites have been revisited on a rotating schedule throughout the past 28 years, to develop a working baseline to help determine possible water quality trends, and to aid lake and watershed managers in their decision making. While the Council has done its best to enhance and expand the region's lake water quality database, it is apparent that one of the most economical and efficient methods to expand knowledge of our lakes has been with the assistance of volunteers and the cooperation and financial support of local partners, including watershed management organizations, watershed districts, counties, and cities. So while the first 15 years of CAMP have been very successful, our future goal is to continue to expand the coverage of our lake monitoring program, in order to better understand and manage the region's water resources.

The Council's lake monitoring program, especially the use of volunteer monitors through CAMP, has played a key role in the Council's recent efforts to use satellite images to assess annual lake water clarity for the entire region. The monitoring program provides "ground-based" measurements used to calibrate mathematical models, which in turn are used to interpret the satellite images. The use of satellite technology provides a cost-effective way to extend the analysis of the region's lake water quality from just the lakes involved in our ground-based programs to all of the lakes in the region. The satellite–based information can be used to detect how lake trophic conditions (especially water clarity) have changed over time and space in relation to changes in land-use and land-cover conditions.

If you have questions pertaining to the lake data or descriptions contained in this report, inquiries about CAMP, or suggestions of lakes the Council should consider monitoring in the future, please contact Brian Johnson of the Metropolitan Council at (651) 602-8743 or brian.johnson@metc.state.mn.us.

Northwood Lake (27-0627) *Bassett Creek Watershed Management Organization*

Northwood Lake is a 15-acre lake located within the City of New Hope (Hennepin County). The mean and maximum depths of the lake are 0.8 m (roughly 2.5 feet) and 1.5 m (roughly five feet), respectively. The lake's size and mean depth results in an approximate lake volume of 41 ac-ft. Because of the shallowness of the lake, the entire area is considered littoral zone (area of aquatic plant dominance) and it does not maintain a thermocline (a density gradient owed to changing water temperatures throughout the lake's water column). The lake's 1,341-acre immediate watershed translates to a small watershed-to-lake size ratio of 89:1. The greater the ratio, the greater the potential stress on the lake from surface runoff.

This was the eighth year that Northwood Lake has been involved in CAMP. The lake was also enrolled in the program in 2000-2006. Other than the 2000-2006 CAMP data, a search through the STORET nationwide water quality database for data on the lake came up empty. Thus, 2000-2007 are the only years of available data.

The lake was monitored 10 times from mid-April to mid-October 2007. On each sampling day the lake was monitored for TP, CLA, TKN, and Secchi transparency, as well as the lake's perceived physical condition and recreational suitability. Results are presented in both graphs and data tables on the lake's information sheet on the following page.

2007 summer (May-September) data summary

Parameter	*Mean*	*Minimum*	*Maximum*	*Grade*
TP (µg/l)	268.9	145.0	477.0	F
CLA (µg/l)	29.9	13.0	59.0	C
Secchi (m)	1.0	0.9	1.3	D
TKN (mg/l)	2.03	0.87	2.70	
			Water Quality	D

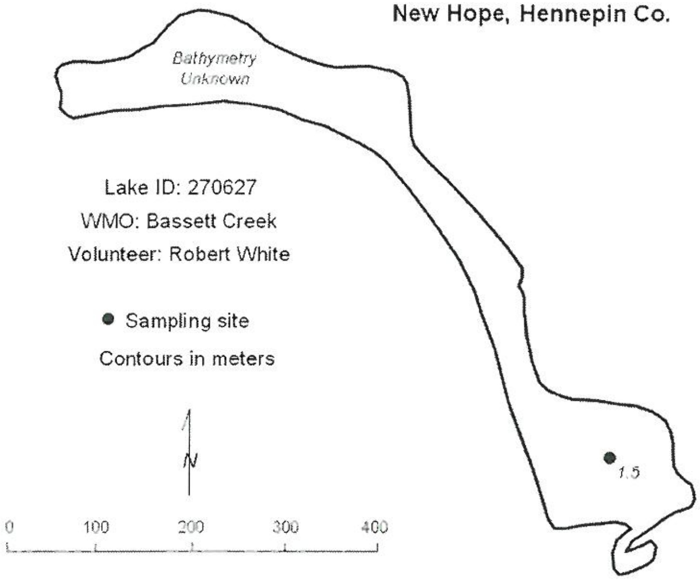
The lake's 2007 grade of D is similar to those recorded in 2000-2001, 2003, and 2006 (D) and worse than the C's recorded in 2002, and 2004-2005.

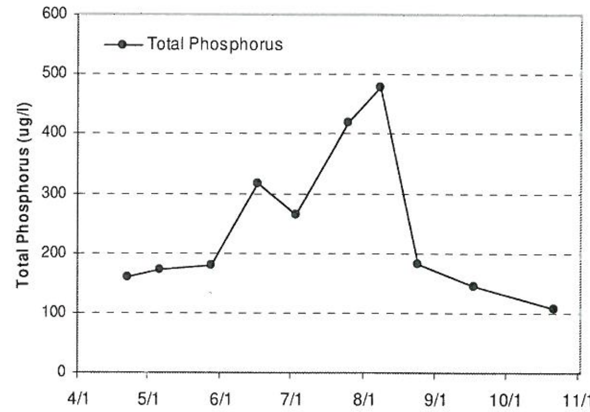
No long-term trend is apparent from the lake's water quality database. In the short-term however, the lake's quality seems well represented by an grade of D/C. To better understand the quality of the lake and what direction it may be heading, continued monitoring is suggested.

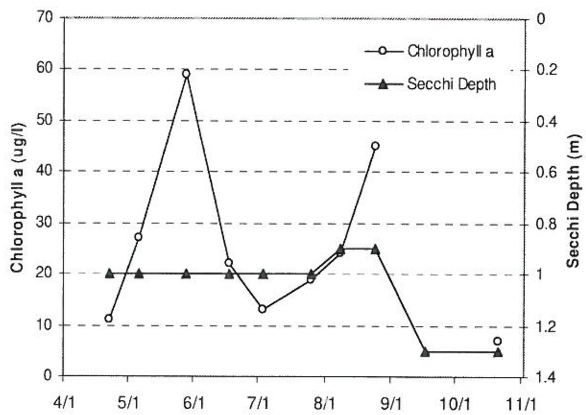
The last two graphs show seasonal variation in the lake's perceived physical condition and recreational suitability. The average user perception rankings, on a 1-to-5 scale, were 2.5 for physical condition (between 2- "some algae present" and 3- "definite algal presence"), and 4.1 for recreational suitability (roughly 4- "no swimming - boating ok").

If you notice any errors in the lake's data or physical information, or are aware of any additional or missing information, please contact Brian Johnson of the Metropolitan Council at (651) 602-8743 or brian.johnson@metc.state.mn.us.

Northwood Pond
New Hope, Hennepin Co.

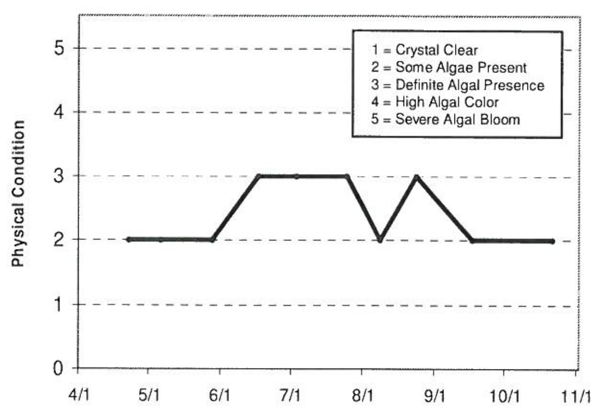






2007 Data

Date	Surf. Tmp C	Bot. Tmp C	Surf. DO (mg/L)	Bot. DO (mg/L)	CLA (ug/L)	Surf. TP (ug/L)	Bot. TP (ug/L)	Secchi (m)	PC 1 thru 5	RS 1 thru 5
04/22/07	19.8				11	160		1	2	4
05/06/07	20.7				27	171		1	2	4
05/28/07	22.1				59	179		1	2	4
06/17/07	24.5				22	315		1	3	4
07/03/07	25.7				13	264		1	3	5
07/25/07	29.7				19	418		1	3	4
08/08/07	27.5				24	477		0.9	2	4
08/24/07	26.4				45	182		0.9	3	4
09/17/07	22.1					145		1.3	2	
10/21/07	12.3				6.9	108		1.3	2	4

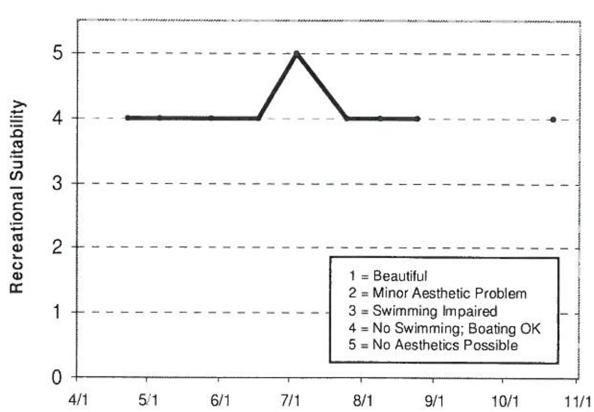


Lake Water Quality Grades Based on Summertime Averages

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Total Phosphorus														
Chlorophyll a														
Secchi Depth														
Overall														

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total Phosphorus							F	F	D	F	D	D	F	F
Chlorophyll a							B	C	B	C	B	B	B	C
Secchi Depth							D	D	D	D	D	D	D	D
Overall							**D**	**D**	**C**	**D**	**C**	**C**	**D**	**D**

Source: Metropolitan Council and STORET data



Parkers Lake (27-0107) *Bassett Creek Watershed Management Organization*

This was the seventh year that Parkers Lake has been involved in CAMP (it was first enrolled in 2000). The 97-acre lake, located within the City of Plymouth (Hennepin County), has a public access located within a city park on the lake's north end. One problem that may possibly hinder future recreational activity on the lake, however, is Eurasian Water Milfoil (*Myriophyllum spicatum*), which has been reported in the lake.

The mean and maximum depths of the lake are 3.7 m (roughly 12 feet) and 11.3 m (roughly 37 feet), respectively. The lake's size and mean depth result in an approximate lake volume of 1,164 ac-ft. Approximately 70 percent of the lake's surface area is considered littoral zone (area of aquatic plant dominance). The lake's 950-acre immediate watershed translates to a moderate watershed-to-lake size ratio of 10:1. The greater the ratio, the greater the potential stress on the lake from surface runoff.

The lake was monitored 14 times from mid-April to mid-October 2007. Results are presented in both graphs and data tables on the lake's information sheet on the following page.

2007 summer (May-September) data summary

Parameter	*Mean*	*Minimum*	*Maximum*	*Grade*
TP (µg/l)	26.3	13.0	51.0	B
CLA (µg/l)	9.9	1.2	26.0	A
Secchi (m)	2.4	1.0	4.7	B
TKN (mg/l)	1.60	1.40	2.10	
			Water Quality	B

While the lake's 2007 grade, similar to those recorded in 2003-2006, is better than the C's recorded in 1980, 1995, and 1999, it is worse than the recent A's recorded in 2000 and 2002.

A search through the STORET nationwide water quality database for data on the lake resulted in nutrient and Secchi transparency information for 1980, 1990, 1995, and 1999. The 2000 and 2002-2007 water quality years represent the lake's best-monitored water quality. The lake's water quality shows an improvement in water quality from 2000 to 2002, before slipping a little in 2003-2007. To better understand the lake's water quality and where it truly may be heading, continued monitoring is suggested.

The last two graphs show seasonal variation in the lake's perceived physical condition and recreational suitability. The average user perception rankings, on a 1-to-5 scale, were 3.1 for physical condition (roughly 3- "definite algae present"), and 3.2 for recreational suitability (between 3- swimming slightly impaired" and 4- "no swimming; boating ok").

The Fisheries Section of the Minnesota Department of Natural Resources (MDNR) has conducted a fisheries survey on the lake. Information on the survey can be obtained through the MDNR Fisheries Section by calling (651) 297-4916 or by downloading the information off the Internet at http://www.dnr.state.mn.us/lakefind/.

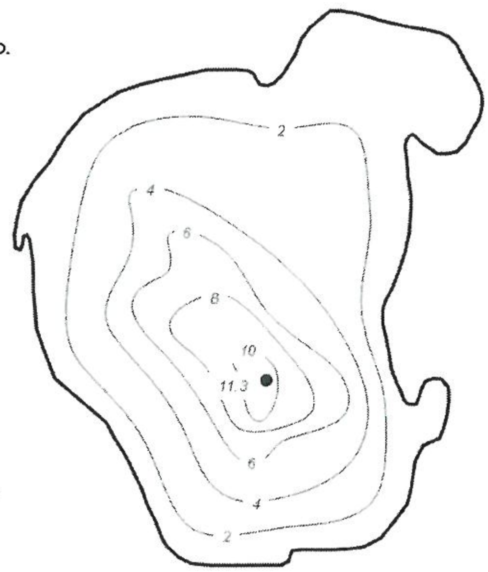
If you notice any errors in the lake's data or physical information, or are aware of any additional or missing information, please contact Brian Johnson of the Metropolitan Council at (651) 602-8743 or brian.johnson@metc.state.mn.us.

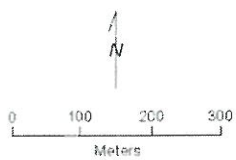
Parkers Lake
Plymouth, Hennepin Co.

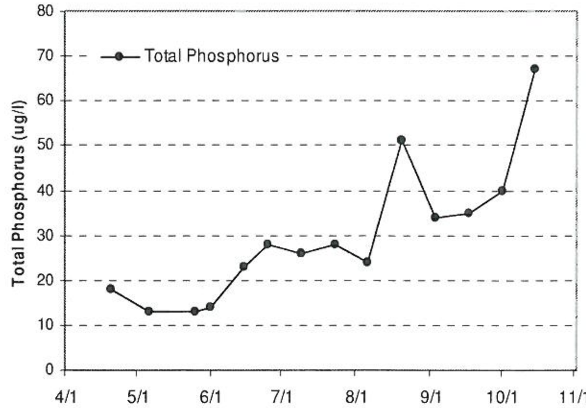
Lake ID: 270107
WMO: Bassett Creek
Volunteer: Bob Videen

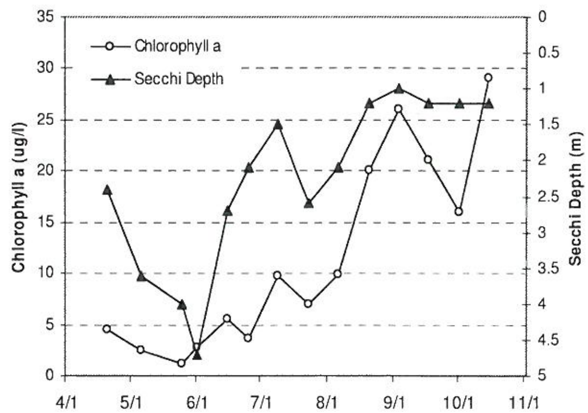
● Sampling site

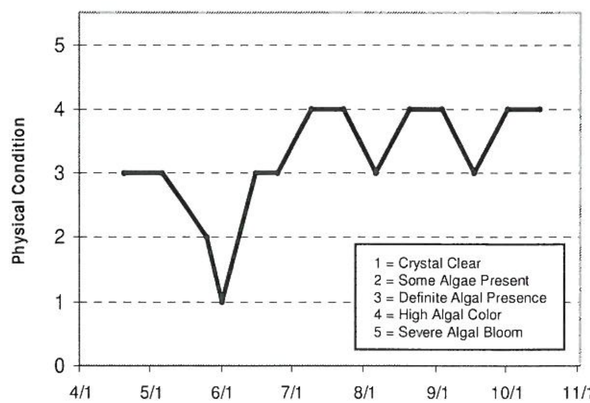
Contours in meters





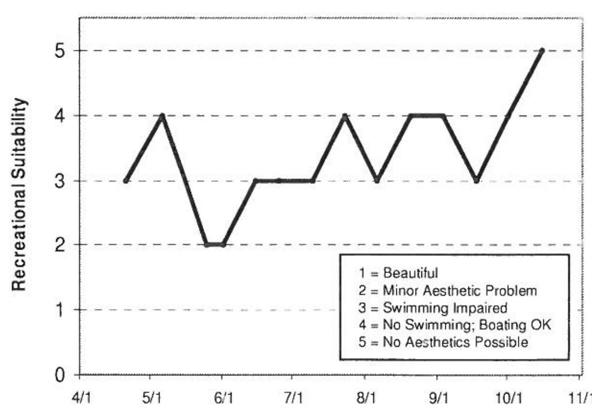






2007 Data

	Surf. Tmp	Bot. Tmp	Surf. DO	Bot. DO	CLA	Surf. TP	Bot. TP	Secchi	PC	RS
Date	C	C	(mg/L)	(mg/L)	(ug/L)	(ug/L)	(ug/L)	(m)	1 thru 5	1 thru 5
04/20/07	12				4.5	18		2.4	3	3
05/06/07	16				2.5	13		3.6	3	4
05/25/07	21				1.2	13		4	2	2
06/01/07	22.5				2.8	14		4.7	1	2
06/15/07	27				5.5	23		2.7	3	3
06/25/07	22				3.6	28		2.1	3	3
07/09/07	27				9.8	26		1.5	4	3
07/23/07	24				7	28		2.6	4	4
08/06/07	28				9.9	24		2.1	3	3
08/20/07	24.5				20	51		1.2	4	4
09/03/07	24.5				26	34		1	4	4
09/17/07	17				21	35		1.2	3	3
10/01/07	17.5				16	40		1.2	4	4
10/15/07	13.5				29	67		1.2	4	5



Lake Water Quality Grades Based on Summertime Averages

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Total Phosphorus	C													
Chlorophyll a	C										B			
Secchi Depth	C										B			
Overall	**C**													

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total Phosphorus		C				C	A		A	B	B	C	C	B
Chlorophyll a		B				B	A		A	B	A	B	A	A
Secchi Depth		C				C	B		A	B	C	B	A	B
Overall		**C**				**C**	**A**		**A**	**B**	**B**	**B**	**B**	**B**

Source: Metropolitan Council and STORET data

South Rice Lake (27-0645) *Bassett Creek Watershed Management Organization*

South Rice Lake is a 3.2-acre lake located within the City of Golden Valley (Hennepin County). The maximum and mean depths of the lake are 2.5 m (roughly 8 feet) and 0.5 m (one-and-a-half feet), respectively. The mean depth of the lake and its surface area translate to an approximate lake volume of 5.4 ac-ft. Because of the shallowness of the lake, the entire area is considered littoral zone (area of aquatic plant dominance) and it does not maintain a thermocline (a density gradient owed to changing water temperatures throughout the lake's water column).

The lake's 63-acre immediate watershed and surface area translates to a watershed-to-lake size ratio of 20:1 (the greater the ratio, the greater the potential stress on the lake from surface runoff). When including the lake's whole contributing watershed (including flow from Grimes Pond and North Rice Lake), however, the size increases to 514 acres (160:1) (Barr 1997).

This was the eighth year that South Rice Lake has been involved in CAMP (it was also involved in 2000-2005). Other than the 2000-2007 CAMP data, a search through the STORET nationwide water quality database for data on the lake came up empty. The lake was monitored 12 times between mid-April and mid-October 2007. The resulting data and graphs appear on the next page.

2007 summer (May-September) data summary

Parameter	*Mean*	*Minimum*	*Maximum*	*Grade*
TP (µg/l)	203.1	50.0	376.0	F
CLA (µg/l)	32.7	16.0	72.0	C
Secchi (m)	0.7	0.4	1.0	D
TKN (mg/l)	1.57	0.82	2.00	
			Water Quality	D

It is apparent that the lake experienced its best water quality in 2004 and its worst water quality was recorded in 2000. The lake received grades of F in 2000, D in 2001-2003 and 2005-2007, and C in 2004.

A recent in-lake alum treatment (applied at ice-off in mid-April, 2002) was meant to lower phosphorus levels, control algal growth and improve water clarity. It was reported in the 2002 Lake Report that the alum treatment was successful in reducing in-lake TP and CLA (indicating a reduction in algal biomass) in 2002. While, the lake's 2002, and 2004-2005 water quality conditions were better than pre-alum treatment, the 2003, 2006, and 2007 water quality was not. Additional years of monitoring are needed to determine the effectiveness and long-term efficiency of the alum treatment.

The last two graphs show seasonal variation in the lake's perceived physical condition and recreational suitability. The average user perception rankings, on a 1-to-5 scale, were 3.8 for physical condition (between 3- "definite algae present" and 4- "high algal color"), and 4.7 for recreational suitability (between 4- "no swimming - boating ok" and 5- "no aesthetics possible").

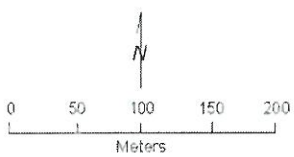
If you notice any errors in the lake's data or physical information, or are aware of any additional or missing information, please contact Brian Johnson of the Metropolitan Council at (651) 602-8743 or brian.johnson@metc.state.mn.us.

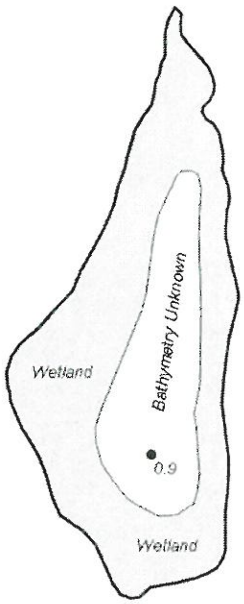
South Rice Pond

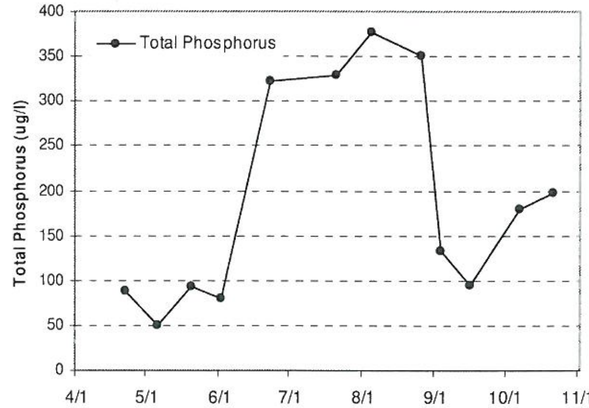
Golden Valley, Robbinsdale, Hennepin Co.

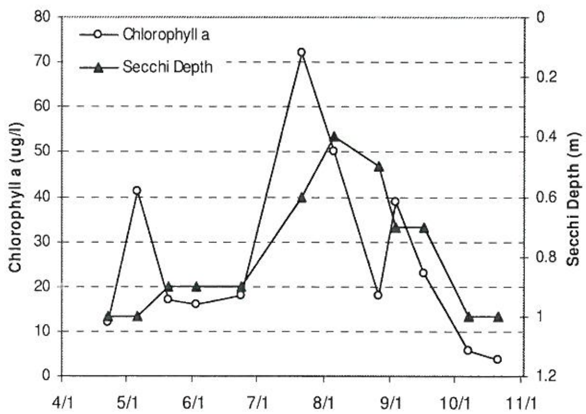
Lake ID: 270645
WMO: Bassett Creek
Volunteer: Steve Streff

● Sampling site
Contours in meters



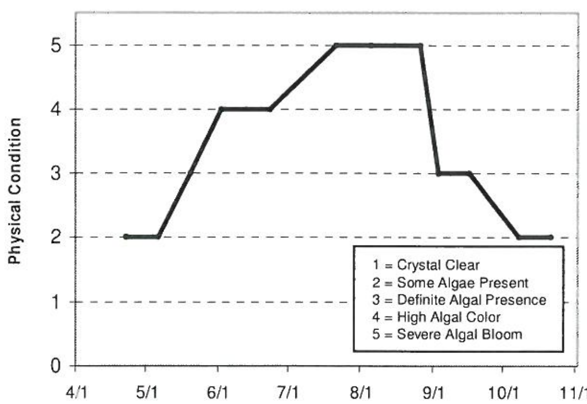






2007 Data

	Surf. Tmp	Bot. Tmp	Surf. DO	Bot. DO	CLA	Surf. TP	Bot. TP	Secchi	PC	RS
Date	C	C	(mg/L)	(mg/L)	(ug/L)	(ug/L)	(ug/L)	(m)	1 thru 5	1 thru 5
04/22/07	18				12	88		1	2	3
05/06/07					41	50		1	2	4
05/20/07					17	93		0.9	3	4
06/02/07					16	80		0.9	4	5
06/23/07					18	322		0.9	4	5
07/21/07					72	328		0.6	5	5
08/05/07					50	376		0.4	5	5
08/26/07					18	351		0.5	5	5
09/03/07					39	133		0.7	3	5
09/16/07					23	95		0.7	3	4
10/07/07					5.8	179		1	2	4
10/21/07					3.5	198		1	2	3

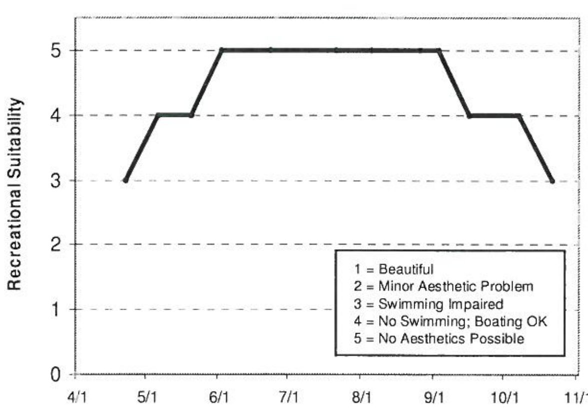


Lake Water Quality Grades Based on Summertime Averages

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Total Phosphorus														
Chlorophyll a														
Secchi Depth														
Overall														

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total Phosphorus							F	F	D	F	D	D	F	F
Chlorophyll a							F	B	B	C	A	C	C	C
Secchi Depth							F	F	F	F	D	D	D	D
Overall							**F**	**D**	**D**	**D**	**C**	**D**	**D**	**D**

Source: Metropolitan Council and STORET data



Sweeney Lake (27-0035) ***Bassett Creek Watershed Management Organization***

This was the eighth year of CAMP monitoring in Sweeney Lake, which is located in the City of Golden Valley (Hennepin County). The 66-acre lake has a mean and maximum depth of 3.6 m (11.8 feet) and 8.0 m (26.0 feet), respectively. The mean depth of the lake and its surface area translate to an approximate lake volume of 790 ac-ft. The lake has two separate depressions each reaching a maximum depth of approximately 8 meters (26 feet). Roughly 52 percent of the lake's area is considered littoral zone (the 0-15 foot depth area dominated by aquatic vegetation). Additionally, the lake's surface area and 2,400-acre watershed translates to a rather large 36:1 watershed-to-lake size ratio. The greater the ratio, the greater the potential stress on the lake from surface runoff.

The Sweeney Lake branch of Bassett Creek flows into the lake on the south and outlets at the north over a dam. Sweeny Lake is connected to Twin Lake during periods of high lake levels by a meandering channel through a cattail marsh between the northeast shore of Sweeny and the north shore of Twin Lake. The surface elevations of the two lakes are about the same, indicating a minimal flow between the two lakes except during periods of heavy runoff when transfer of water between the two lakes increases. The west and south shoreline of Sweeny Lake consists of privately owned single family homes. The east shore is bordered by the Glenwood Hills Hospital and park consisting of a lawn, a golf course, and a wooded area (Barr, 1994).

While the lake has been monitored at two separate sites (north end and south end) in the past, only one site (the southern site) was monitored in 2007. The lake was monitored 15 times between mid-May and mid-October, 2006. Results are presented on graphs and data tables on the following page. During each monitoring event, the lake was monitored for TP, CLA, TKN, Secchi transparency, as well as the perceived physical condition and recreational suitability.

2007 summer (May-September) data summary

Parameter	*Mean*	*Minimum*	*Maximum*	*Grade*
TP (µg/l)	48.4	24.0	107.0	C
CLA (µg/l)	15.5	3.6	27.0	B
Secchi (m)	1.1	0.8	1.6	D
TKN (mg/l)	2.30	1.60	3.30	
			Water Quality	C

The lake's 2006 grade (C) is similar to the grades received in 2000-2005, and an improvement over the grade of D received in 2006. No long-term trend is apparent from the lake's water quality database. In the short-term however, the lake's quality seems well represented by an grade of C. To better understand the quality of the lake and what direction it may be heading, continued monitoring is suggested.

Throughout the monitoring period, the volunteers' opinions of the lake's physical and recreational conditions were ranked on a 1-to-5 scale. The 2004 mean perceived physical condition of the lake was 1.4 (between 1- "crystal clear" and 2- "some algae present"), while the mean recreational suitability was 1.3 (between 1- "beautiful" and 2- "minor aesthetic problem").

The Fisheries Section of the Minnesota Department of Natural Resources (MDNR) has conducted a fisheries survey on the lake. Information on the survey can be obtained through the MDNR Fisheries Section by calling (651) 297-4916 or by downloading the information off the Internet at http://www.dnr.state.mn.us/lakefind/.

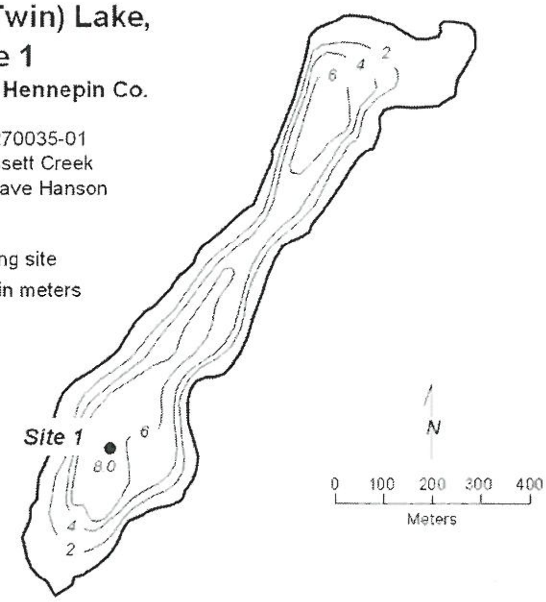
If you notice any errors in the lake's data or physical information, or are aware of any additional or missing information, please contact Brian Johnson of the Metropolitan Council at (651) 602-8743 or brian.johnson@metc.state.mn.us.

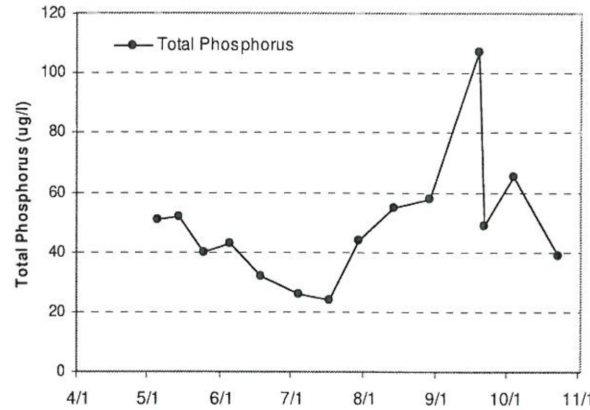
Sweeney (Twin) Lake, Site 1

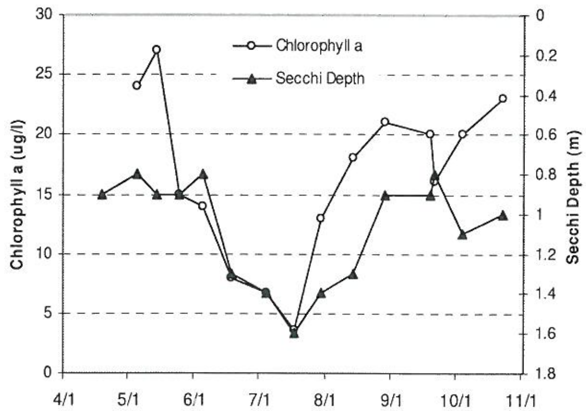
Golden Valley, Hennepin Co.

Lake ID: 270035-01
WMO: Bassett Creek
Volunteer: Dave Hanson

● Sampling site
Contours in meters

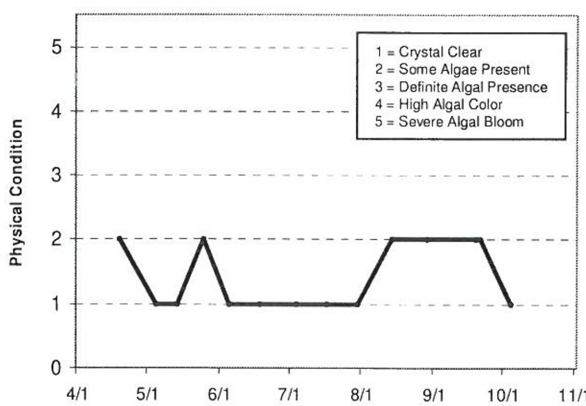






2007 Data

	Surf. Tmp	Bot. Tmp	Surf. DO	Bot. DO	CLA	Surf. TP	Bot. TP	Secchi	PC	RS
Date	C	C	(mg/L)	(mg/L)	(ug/L)	(ug/L)	(ug/L)	(m)	1 thru 5	1 thru 5
04/19/07	13.9	6.2	14.3	8.7				0.9	2	2
05/05/07	16.4	6.8	10.5	1.9	24	51		0.8	1	1
05/14/07	19	7.7	10.2	0.21	27	52		0.9	1	1
05/25/07	20.6	8	8.9	0.18	15	40		0.9	2	2
06/05/07	21	8	7.3	0.17	14	43		0.8	1	1
06/18/07	25.8	9.5	6.7	0.25	8	32		1.3	1	1
07/04/07	25	13	6.5	0.23	6.7	26		1.4	1	1
07/17/07	27.6	12.4	8.6	0.16	3.6	24		1.6	1	1
07/30/07	28.2	16	8.3	0.15	13	44		1.4	1	1
08/14/07	27.1	18.5	7.9	0.11	18	55		1.3	2	1
08/29/07	24	17.5	10.6	0.16	21	58		0.9	2	2
09/19/07	18.7	18.3	6.27	3	20	107		0.9	2	
09/21/07	18.8	17.4	5.8	1.75	16	49		0.8	2	2
10/04/07	17.1	16.6	6.14	5.9	20	65		1.1	1	1
10/23/07	12.8	12.6	7.9	7.1	23	39		1		



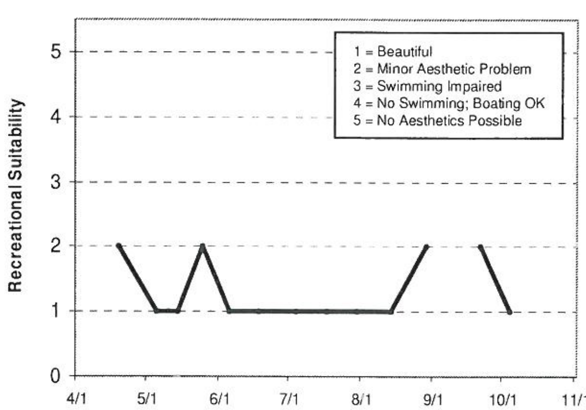
Lake Water Quality Grades Based on Summertime Averages

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Total Phosphorus													
Chlorophyll a													
Secchi Depth													
Overall													

Year	1993	1994	1995	1996	1997	1998	1999	2000 Site 1	2000 Site 2	2001 Site 1	2001 Site 2	2002 Site 1	2002 Site 2
Total Phosphorus								C	C	C	C	C	
Chlorophyll a								C	C	B	C	B	
Secchi Depth								D	D	C	C	C	
Overall								**C**	**C**	**C**	**C**	**C**	

Year	2003 Site 1	2003 Site 2	2004 Site 1	2004 Site 2	2005 Site 1	2005 Site 2	2006 Site 1	2006 Site 2	2007 Site 1	2007 Site 2
Total Phosphorus	C		C		C		D		C	
Chlorophyll a	B		B		C		C		B	
Secchi Depth	C		C		C		D		D	
Overall	**C**		**C**		**C**		**D**		**C**	

Source: Metropolitan Council and STORET data



Westwood Lake (27-0711) ***Bassett Creek Watershed Management Organization***

This was the ninth year of CAMP monitoring in Westwood Lake (1993 and 2000-2006 being the others), which is located in the City of St. Louis Park (Washington County). The 41-acre lake has a maximum depth of 2.0 m (six-and-a half feet). Because of the shallowness of the lake, it is entirely considered littoral zone (the 0-15 foot depth area dominated by aquatic vegetation), and it does not maintain a thermocline (a density gradient owed to changing water temperatures throughout the lake's water column).

Westwood Lake was monitored eight times between late-April and mid-September 2007. Results from the monitoring are presented on the information sheet on the next page.

2005 summer (May-September) data summary

Parameter	*Mean*	*Minimum*	*Maximum*	*Grade*
TP (µg/l)	35.2	28.0	44.0	C
CLA (µg/l)	10.2	1.8	23.0	B
Secchi (m)	1.3	0.9	1.7	C
TKN (mg/l)	2.10	1.50	2.60	
			Water Quality	C

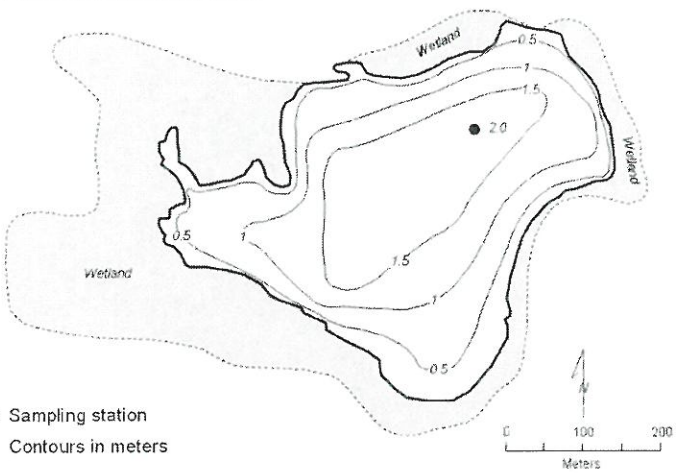
Because there is a limited amount of historic data available for Westwood Lake, it is not possible to determine any long-term trends. In the short-term however, the lake's water quality shows a wide range of fluctuation (grade of D in 1982, C in 1993, 2001-2002, 2005-2007, and B in 2000 and 2003-2004). To better understand the lake's water quality and where it may be heading, continued monitoring is suggested.

Throughout the monitoring period, the volunteers' opinions of the lake's physical and recreational conditions were ranked on a 1-to-5 scale. These user perception rankings are shown on the lake information sheet. The average user perception rankings, on a 1-to-5 scale, were 3.0 for physical condition (3- "definite algal color"), and 4.2 for recreational suitability (between 4- "no swimming – boating ok" and 5- "no aesthetics possible").

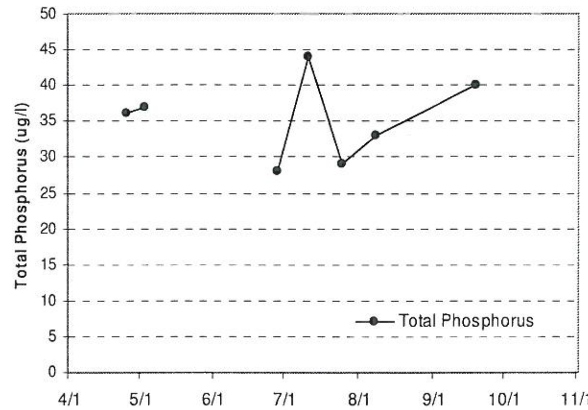
If you notice any errors in the lake's data or physical information, or are aware of any additional or missing information, please contact Brian Johnson of the Metropolitan Council at (651) 602-8743 or brian.johnson@metc.state.mn.us.

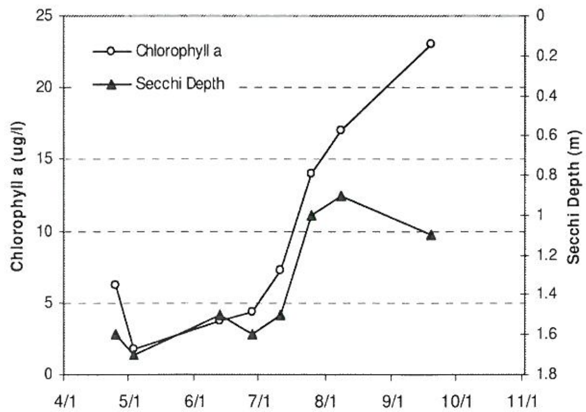
Lake ID: 270711
WMO: Bassett Creek
Volunteer: The Westwood Nature Center

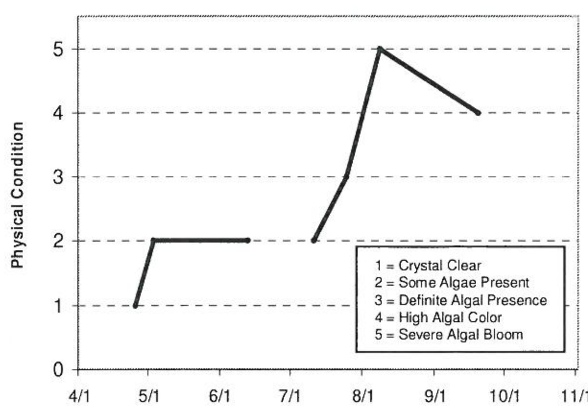
Westwood Lake,
St. Louis Park, Hennepin Co.

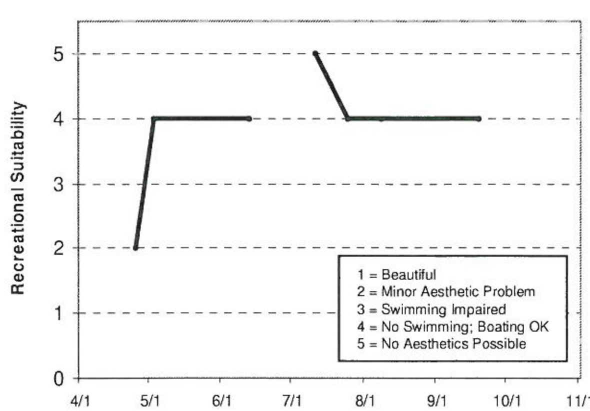


● Sampling station
Contours in meters









2007 Data

	Surf. Tmp	Bot. Tmp	Surf. DO	Bot. DO	CLA	Surf. TP	Bot. TP	Secchi	PC	RS
Date	C	C	(mg/L)	(mg/L)	(ug/L)	(ug/L)	(ug/L)	(m)	1 thru 5	1 thru 5
04/25/07	15.5				6.2	36		1.6	1	2
05/03/07	18				1.8	37		1.7	2	4
06/13/07	28.1				3.7			1.5	2	4
06/28/07	28				4.4	28		1.6		
07/11/07	25				7.3	44		1.5	2	5
07/25/07	29.5				14	29		1	3	4
08/08/07	28.6				17	33		0.9	5	4
09/19/07	19.9				23	40		1.1	4	4

Lake Water Quality Grades Based on Summertime Averages

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Total Phosphorus			F											C
Chlorophyll a			C											C
Secchi Depth			D											C
Overall			**D**											**C**

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total Phosphorus							B	B	C	C	C	D	D	C
Chlorophyll a							B	C	B	A	A	C	B	B
Secchi Depth							C	C	C	C	C	C	C	C
Overall							**B**	**C**	**C**	**B**	**B**	**C**	**C**	**C**

Source: Metropolitan Council and STORET data

ACKNOWLEDGMENTS

This report represents the coordinated efforts of many individuals. The author would like to acknowledge the following people for their technical and supportive contributions to the preparation of this report:

A. The various watershed management organizations (WMOs), participating agencies, and volunteers involved in the citizen-assisted monitoring program (CAMP). Without their enthusiastic participation, CAMP would not be successful. A list of involved WMOs, agencies, and volunteer lake monitors is shown in Appendix B. The following volunteers should be given added thanks for their multiple years of service:

15 years of service
Diane and Bob Coderre - Sunset Lake

14 years of service
Washington Co. SWCD- Multiple

13 years of service
Bill Aamadt- Wilmes Lake
Carver Co. Env. Services- Multiple
Wayne LeBlanc- Lake Peltier

12 years of service
City of Circle Pines- Golden Lake
John Ritter - Lake Alimagnet
Wargo Nature Center- George Watch

11 years of service
Anoka Co. Parks- Multiple

10 years of service
Glen Gramse- Keller Lake
Wally Shaver- Lac Lavon Lake
City of Prior Lake- Markley Lake

9 years of service
Philip Goodrich- Pike Lake
Lakeville- Valley and Lee lakes
John Ryski- Bavaria Lake
Westwood Nature Center- Westwood Lake

8 years of service
Dave Hanson-Sweeney Lake

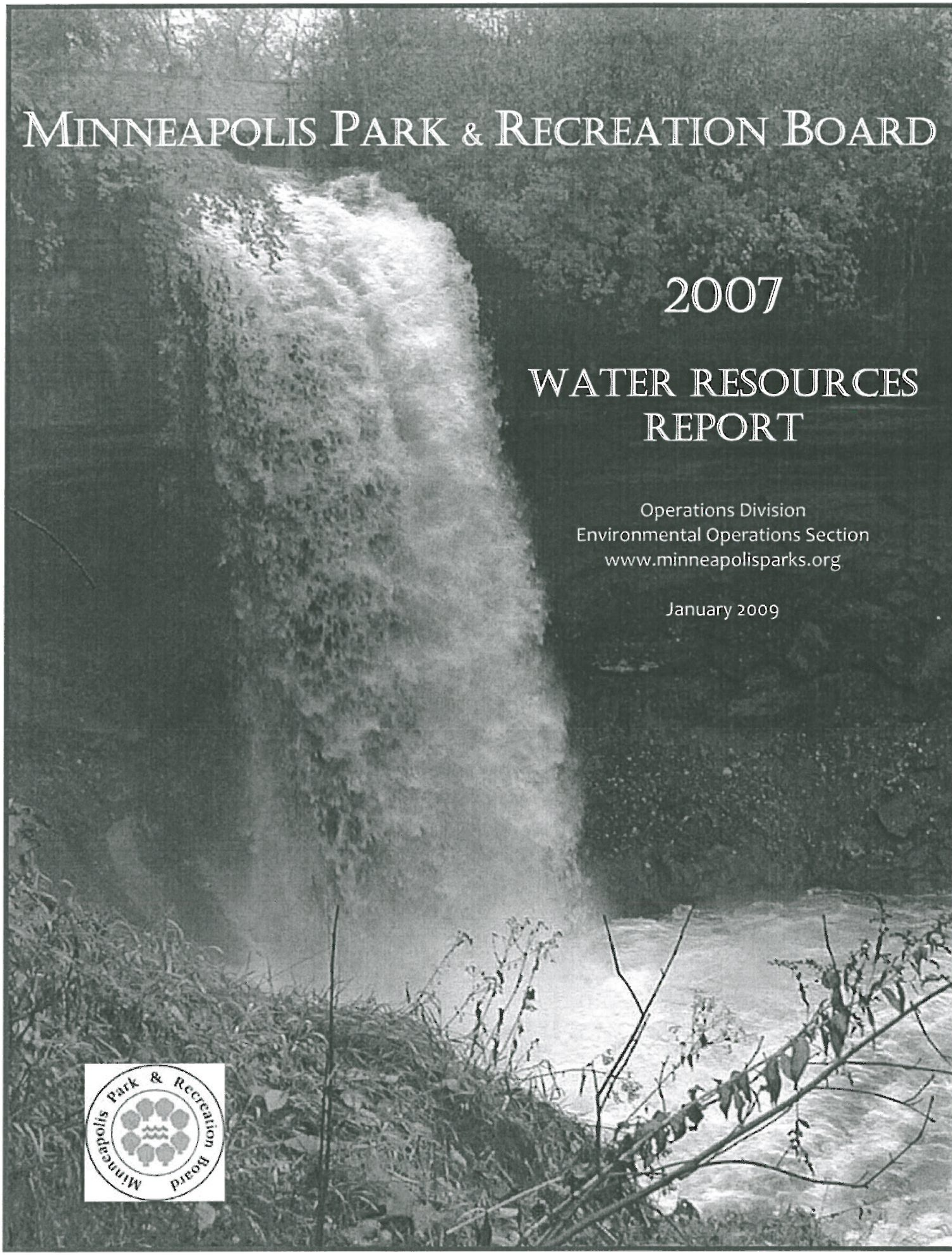
7 years of service
Arnett Family- Crystal Lake
Gene Berwald- Pine Tree Lake
Kevin Bjork- Cloverdale Lake
Tom/Dorothy Goodwin- Orchard Lake
Dale Wahlstrom – Schmidt Lake
Wally Potter- Marion Lake
Rice Creek WD- Multiple
Terry Riley- Markgrafs Lake
Mike Shouldice- Tamarack Lake
Sly Family- Downs Lake
Streff Family- South Rice Lake
Bob Videen- Parkers Lake

6 years of service
Bonnie Jurand- Klawitter Lake
Al Kettlekamp- Long Lake (A.V.)
Tom Sletta- Cates Lake

5 years of service
Walt Burris- Lower Prior Lake
Conservation League of Edina-Cornelia Lake
Bill Feely- Long Lake
Kellogg Family- Cobblecrest Lake
Kitty Francy-Payton- Long Lake

4 years service
David Bess- Wood Lake
David Florenzano- Riley Lake
Wayne Hubin- Swede Lake
Shelly Strohmaier- Lotus Lake
Chuck Taylor- Jane Lake
Gordan Warner- Mitchell Lake
Jim Kellog – Cobblecrest Lake
Sue Morgan & Linda Scott – St. Joe Lake
Bob Kistler – Valentine Lake

3 years service
Marvin Groth – Bass Lake
Steve Pierson – Fish Lake
Jeff Keene & Ken Nieman – O'Connor Lake
Arnie Johnson – Sunnybrook Lake



MINNEAPOLIS PARK & RECREATION BOARD

2007

WATER RESOURCES REPORT

Operations Division
Environmental Operations Section
www.minneapolisparks.org

January 2009

Minneapolis Park & Recreation Board

2007
WATER RESOURCES REPORT

Prepared by:

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EXECUTIVE SUMMARY

As part of its stewardship of the lakes and other water bodies within the City of Minneapolis, the Minneapolis Park and Recreation Board (MPRB) monitors lakes, streams, and stormwater flows for contaminants and other water quality indicators. This report presents the results for the 2007 monitoring season. The report is primarily based on data collected by the MPRB Environmental Operations Section.

The MPRB monitors the water quality of Brownie, Calhoun, Cedar, Diamond, Grass, Harriet, Hiawatha, Isles, Loring, Nokomis, Powderhorn, Spring, Webber, and Wirth lakes. Historical data from 1991 – 2007 are used to calculate trophic state index (TSI) trends and estimate fertility for each lake. Based on the trophic state report for 2007 the following observations are made.

Lakes with increasing water quality indicators (decreasing TSI trend)	Lakes with stable trend	Lakes with decreasing water quality indicators (increasing TSI trend)
➢ Lake Calhoun	➢ Lake Hiawatha	➢ Diamond Lake
➢ Lake Harriet	➢ Lake of the Isles	➢ Loring Pond
➢ Powderhorn Lake	➢ Lake Nokomis	➢ Spring Lake
➢ Webber Pond	➢ Cedar Lake	
➢ Wirth Lake		

Water Quality Highlights

The water quality of Lake Calhoun and Lake Harriet continues to be outstanding for lakes in urban settings.

For the first time since monitoring began Powderhorn Lake met MPCA nutrient criteria for both secchi depth and chlorophyll-*a*. Aquatic plants have also begun to establish themselves in Powderhorn. These plants indicate an improving lake ecosystem because they require a certain level of water clarity to survive. Powderhorn Lake received its fourth year of barley straw treatment toward improving water clarity. This treatment combined with many other water quality improvement efforts to improve water quality in this stormwater challenged lake.

In 2007 Wirth Lake continued its increasing water quality trend. Wirth Lake currently meets the MPCA guidelines for phosphorus, chlorophyll-*a*, and secchi depth and has for most years since 2000.

Lake of the Isles, Nokomis, and Cedar Lake all exhibit a stable TSI. These shallow lakes have received significant improvements in stormwater treatment within the last decade. They exhibited a resulting improvement in water quality for the 1990's and have stabilized over the last five years at a higher level of water quality under current conditions.

The water quality at Lake Hiawatha is controlled by the large inflow from Minnehaha Creek. The water quality in the lake has shown a very gradual decrease over the last 15 years.

Diamond and Spring Lakes are very shallow water bodies which are more properly classified as wetlands. These water bodies receive high volumes of untreated stormwater which leads directly to decreasing water quality.

The MPRB monitored 12 public beaches for *Escherichia coli* (*E. coli*, as recommended by the US Environmental Protection Agency). These bacteria are used as indicators of pathogens in water. Except Lake Hiawatha, all public beach bacteria levels were below state guidelines and remained open for the entire season. Lake Hiawatha's beach was closed from July 10th to July 19th due to high bacteria levels.

Eurasian watermilfoil harvesting was carried out on Calhoun, Harriet, Isles, Nokomis, and Wirth Lakes in 2007. An invasive species new to Minnesota, *Egeria densa*, was identified by the MPRB in Powderhorn Lake and was chemically treated by the MDNR in 2007 resulting in its apparent extermination.

The MPRB monitors storm sewers within Minneapolis to comply with the federal National Pollutant Discharge Elimination System (NPDES) permit. The purpose of this monitoring is to characterize the impacts of stormwater discharges to receiving waters and review the effectiveness of treatment best management practices. The results of the 2007 data were typical for stormwater as compared to reports from other cities. The MPRB also monitored the Heritage Park redevelopment at Olson Memorial Highway. This monitoring will be used to with future data to determine the effectiveness of the storm water treatment system there.

This report also presents precipitation and temperature data collected by the National Weather Service each year from the rain gage located at the Twin Cities International airport. In all but two months 2007 average monthly temperatures were warmer than normal. The average annual temperature for 2007 was 47.8° F which is 2.5° F above normal. Spring and summer had below normal amounts of precipitation. The summer drought broke in August with precipitation 9.32 inches above normal. The annual recorded rainfall total for 2007 was 34.32 inches which is 0.41 inches above normal. The majority of the growing season had droughty conditions but unusually large precipitation events in late summer and fall resulted in a near normal amount of precipitation for the entire year.

2. Birch Pond

History

Birch Pond is a small water body (approximately 6 acres) on the east side of Theodore Wirth Parkway, in Theodore Wirth Regional Park. It was named on June 6, 1910 for the white birch trees which grew along its shores and hillsides. The pond lies within the original section of Theodore Wirth Regional Park (then Glenwood Park) near the present day Eloise Butler Wildflower Garden and Bird Sanctuary. It has no public access or fishing docks. Today, Birch pond is fairly protected from winds by large hills and mature trees surrounding the pond. Its main recreational values are its aesthetics and bird watching opportunities.

During 2006 buckthorn was removed from the understory of the Birch Pond basin as a part of vegetation restoration efforts for the centennial anniversary in 2007 of the Eloise Butler Wildflower Garden and Bird Sanctuary. Buckthorn (*Rhamnus cathartica* and *Rhamnus frangula*) is a non-native invasive species that threatens native woodlands.

The Minneapolis Park & Recreation Board (MPRB) currently does not include Birch Pond in its regular lake sampling program.

Figure 2A. Birch Pond after 2006 buckthorn removal.

Winter Ice Cover

Ice came off Birch Pond on March 30, 2007, which is just three days earlier than average ice off. Ice came on the pond November 22, 2007, which was also three days earlier than average. See **Section 18** ice monitoring data.

15. Spring Lake

History

Spring Lake is located to the west of Loring Pond adjacent to Kenwood Parkway and the Parade Stadium grounds in central Minneapolis. Although today it seems secluded at the time of its purchase the Spring Lake was the park's focal point. Highway 394 borders the northwest portion of the riparian zone. The lake is surrounded by parkland and a spur of the Kenilworth/Cedar Lake trail lies near the northern edge of the lake. Spring Lake is situated within a 195-acre subwatershed within the larger Bassett Creek watershed. Spring Lake is a small, meromictic lake. Meromictic lakes do not mix completely so that the deeper layers of the lake remain continually stratified.

Spring Lake was acquired by the MPRB in 1893 through a special assessment requested by several citizens. In an unusual move for the time a 2-acre area including the lake and surrounding land was designated as a bird sanctuary and kept in a natural state. Depictions from the time of acquisition show that the north side of the lake was a lumberyard.

In 2006 Blake School, Target Corporation, and neighbors removed invasive buckthorn and mulberry around the perimeter of Spring Lake. In 2007 MPRB removed more invasive species from the parkland surrounding the lake.

Table 15A. Spring Lake morphometric data. OHW=ordinary high water level.

Surface Area (acres)	Mean Depth (m)	Maximum Depth (m)	Volume (m^3)	Watershed Area (acres)	Watershed: Lake Area (ratio)	OHW (ft msl)
3	3.0	8.5	$3.65x10^4$	45	15.0	820.46

Water Quality Trends (TSI)

Figure 15A shows the Spring Lake linear regression to be roughly increasing as the TSI scores increase. A detailed explanation of TSI can be found in **Section 1**.

Spring Lake's TSI scores and trend line must be viewed with caution as both are based on a limited number of samples, and the number of samples collected in a season has changed over time. From 1999–2001 samples were collected quarterly, and only one sample per year was during the growing season. During 2002, 2003, 2005, and 2007, Spring Lake was sampled monthly in order to calculate a TSI score. Although all of the data cannot be weighted equally because of sampling differences the overall trend in Spring Lake appears to be towards increased productivity and higher TSI scores, and lower water quality.

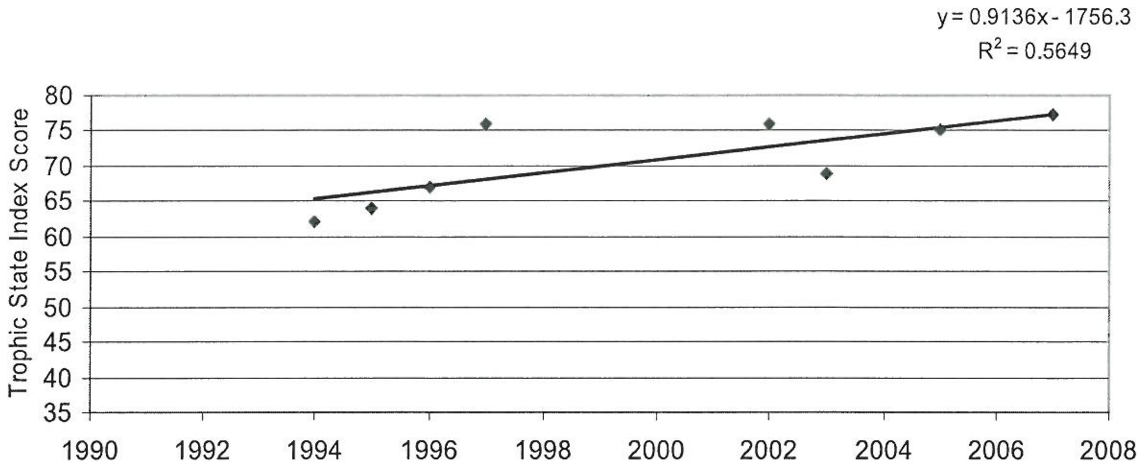


Figure 15A. Spring Lake TSI scores and regression analysis.

Box and Whisker Plots

The box and whisker plots show the data distribution for the Secchi, chlorophyll-*a* and total phosphorus in more detail. The current sampling schedule calls for monitoring Spring Lake every other year. **Figure 15B** shows the box and whisker plots of TSI data. A detailed explanation of box and whisker plots can be found in **Section 1**.

Spring Lake is eutrophic with considerable amounts of algae. The Spring Lake box plot is composed of only three data points prior to 2002. Since 2002 the lake has been sampled every other year on a monthly basis and these plots can be considered more representative of the state of the lake. The limited number of samples available are best viewed as snapshots of the lake's water quality with the understanding that lakes vary within each year, as well as from year to year. It is difficult to compare meromictic lakes with dimictic or polymictic lakes, since their chemical, physical, and trophic structures are much different.

Chl-*a* and total phosphorus concentrations seem to be highly variable within Spring Lake. Secchi depths are generally shallow and have been stable at about 1 meter in recent years. In 2007, secchi depths were shallower than average, at just over 0.5 meters, this is probably due to the very dry summer where the less-brackish layer of water at the surface of the lake was very thin and not replenished by rain. Dissolved oxygen observations confirm that oxygen exists only in the top meter of the lake. It's likely that most lake productivity occurs within this layer.

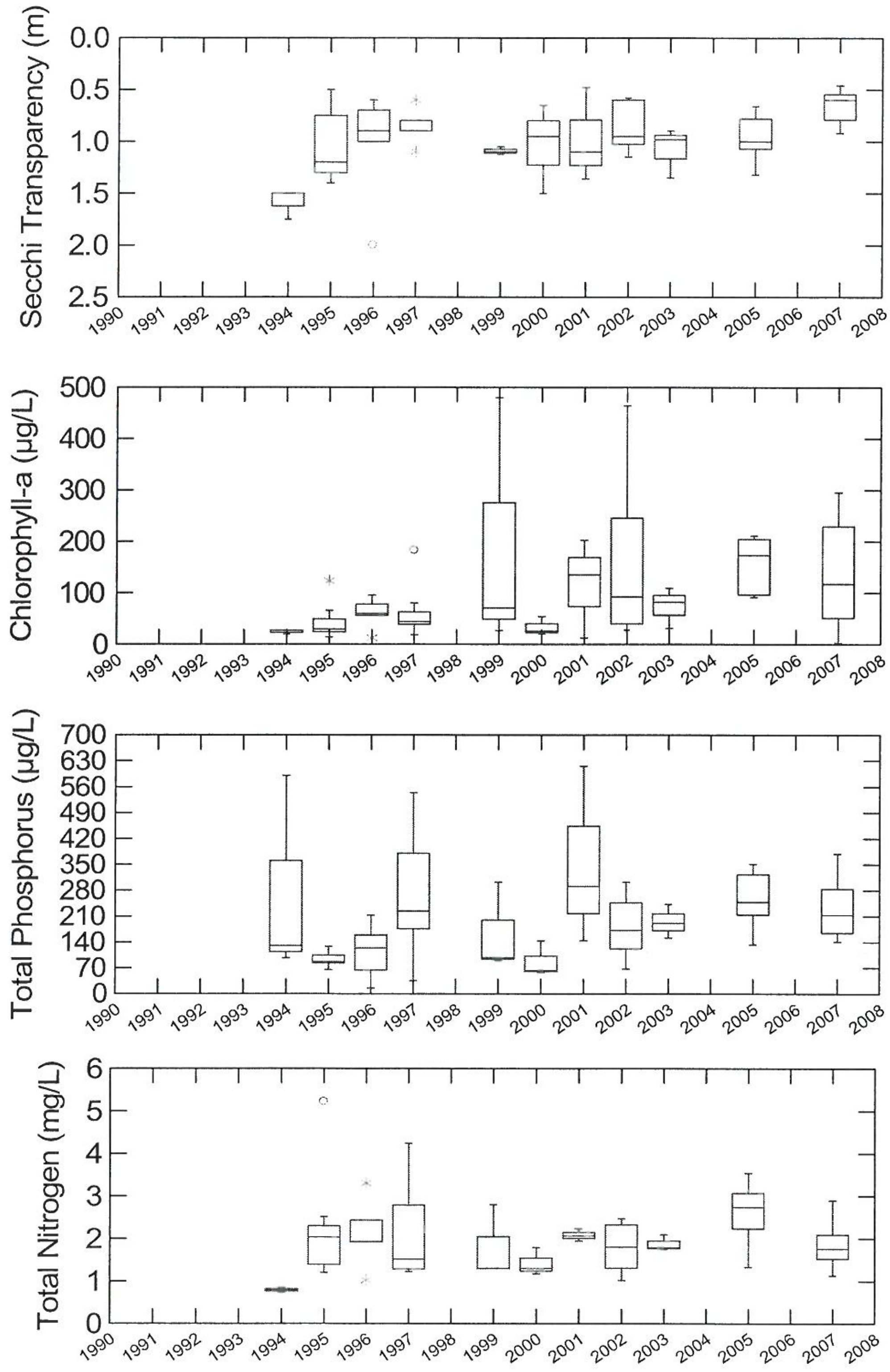


Figure 15B. Box and whisker plots of Spring Lake TSI data: 1994-2007.

WINTER ICE COVER

The ice came off Spring Lake on March 26, 2007 which is five days earlier than the average for this lake. Ice covered Spring Lake on November 27, 2007 which is two days earlier than average. See **Section 1** for details on winter ice cover records and **Section 18** for a comparison with other lakes.

PHYTOPLANKTON AND ZOOPLANKTON

Phytoplankton and zooplankton are the microscopic plant and animal life that form the foundational food web of lake ecology. The fertility of a lake is indicated by chlorophyll-*a* (chl-*a*) as an expression of the phytoplankton present. **Figures 15C** and **15D** show the phytoplankton and chlorophyll-*a* data, respectively.

Unlike many of the other lakes in the system, Spring Lake had no strongly dominant phytoplankton division present. In January, chlorophytes (green algae), cryptophytes (cryptomonads), cyanophyta (blue-green algae), and pyrrhophyta (dinoflaggelates) were present in roughly equal numbers. Later in the season, the blue-green algae and cryptomonads retained dominance while dinoflagellates and green algae diminished. At the end of the season, green algae gained in dominance and cryptomonads were only present in minor numbers. Spring Lake was the only lake where xanthophyta were present. Xanthophytes are also called yellow-green algae and contain chlorophyll-*c*. They are most closely related to brown algae, like kelp, and grow well in low-pH iron-rich environments.

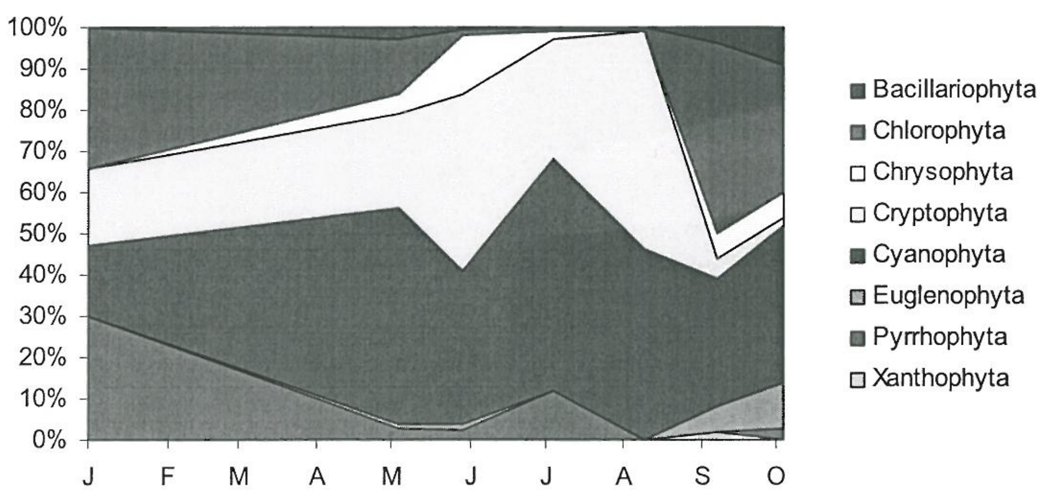


Figure 15C. Phytoplankton community distribution in Spring Lake during the 2007 sampling season. Phytoplankton were sampled once in January then monthly from May through October.

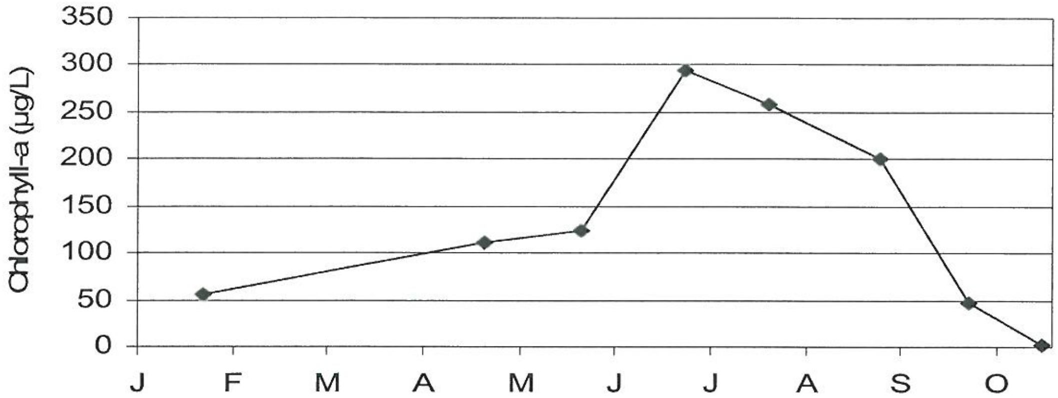


Figure 15D. Chlorophyll-*a* concentrations in Spring Lake during 2007.

Three zooplankton samples were collected in 2007 from Spring Lake, **Figure 15E**. Each sample had extremely low numbers of zooplankton compared to other lakes in the system, despite the high-nutrient environment found in Spring Lake. This is likely due to the fact that zooplankton require oxygen and in Spring Lake the only oxygenated environment occurs in approximately the top meter. In two of the three samples there were more rotifers than arthropods, with very low species diversity among the arthropods. A horizontal zooplankton tow within the upper meter may be better able to characterize the zooplankton population within Spring Lake.

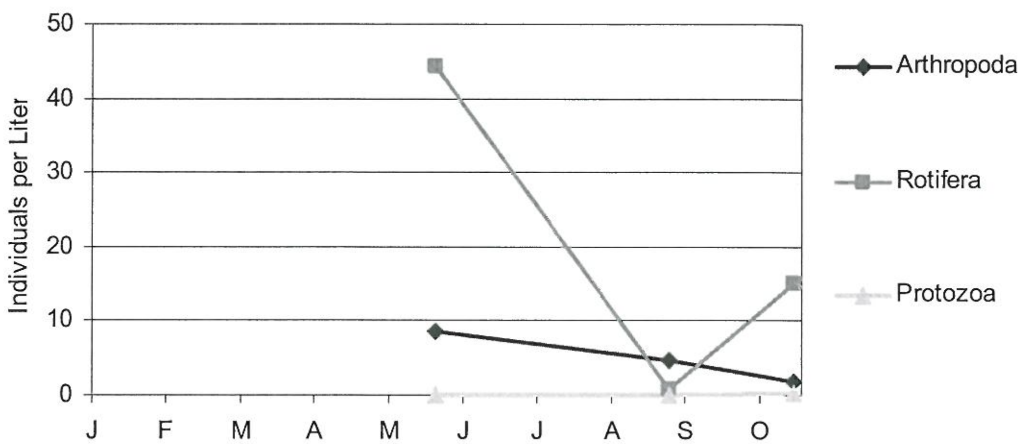


Figure 15E. Spring Lake zooplankton sample results collected in April, August, and October 2007.

17. WIRTH LAKE

HISTORY

Wirth Lake was historically known as Keegan's Lake and renamed Glenwood Lake in 1890. It was acquired by the Minneapolis Park and Recreation Board (MPRB) in 1909 and named after Theodore Wirth in 1938 at the end of his tenure as park superintendent. This 38-acre purchase enlarged the previously owned area of 64 acres that was purchased in 1889. An MPRB nursery was established in 1910 on the west side of the lake and provided the system with plantings through 1980. As with most other lakes in the MPRB system thousands of cubic yards of sediment from Wirth were dredged. The spoils were used to raise the parkland near Glenwood Avenue. Wirth Lake Beach was constructed with sand purchased from sources outside of the MPRB.

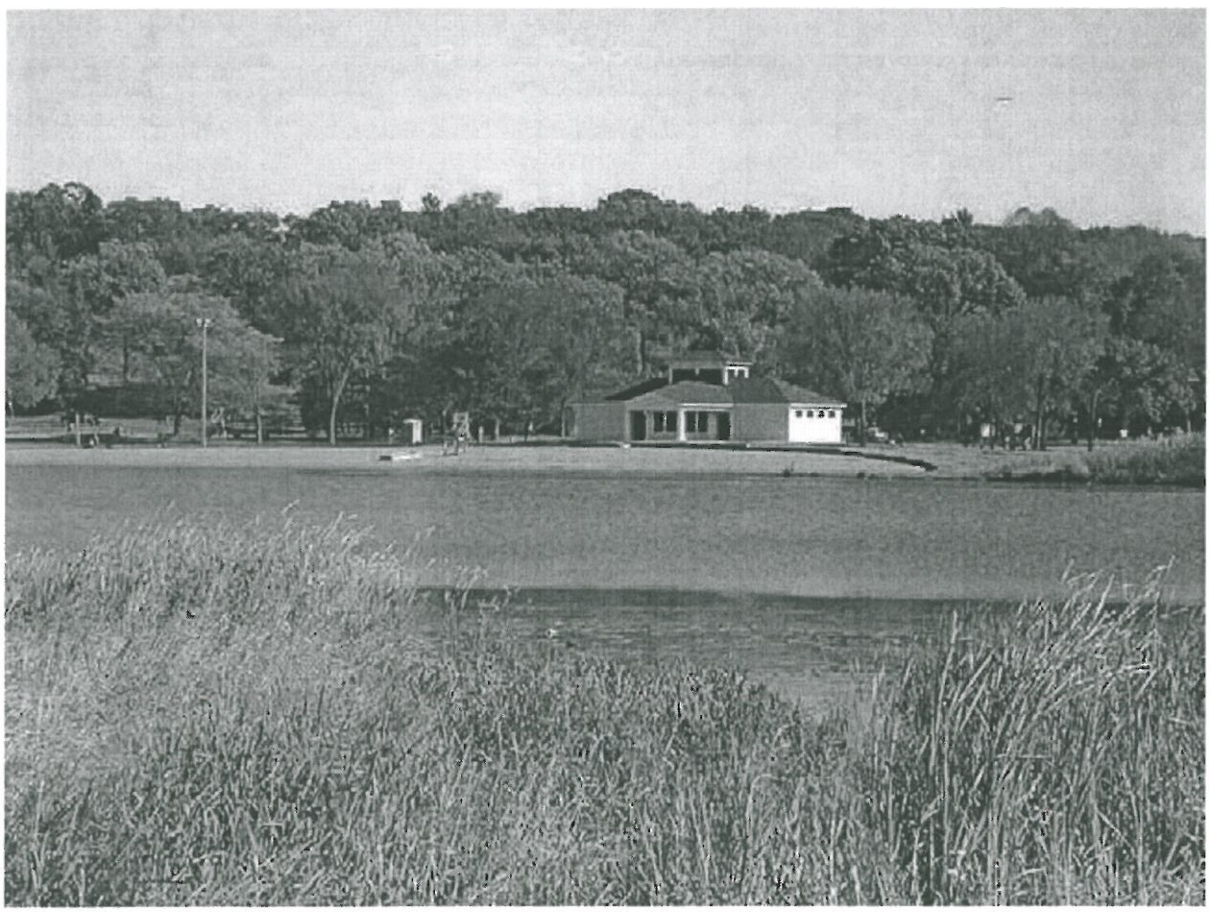


Figure 17A. Wirth Lake looking east toward the beach house.

Wirth Lake is generally dimictic but may mix during extreme events during the summer. Historically, the lake was considered infertile to moderately fertile. Early restoration projects included Rotenone in 1977 to remove rough fish, and subsequent stocking of channel catfish, largemouth bass, walleye, and blue gills. A summer aerator was in operation beginning in the early 1980s but was no longer in use by 1991. A portable winter aerator was used for a few years before a permanent hypolimnetic aeration system was put in place in 2002. This was done in cooperation with the Minnesota Department of Natural Resources (MnDNR). **Figure 17B** shows a bathymetric map of Wirth Lake. The stage and bleachers described on the map were used for the Aquafollies from 1941–1964 but are no longer present. **Table 17A** shows the Wirth Lake morphometric data.

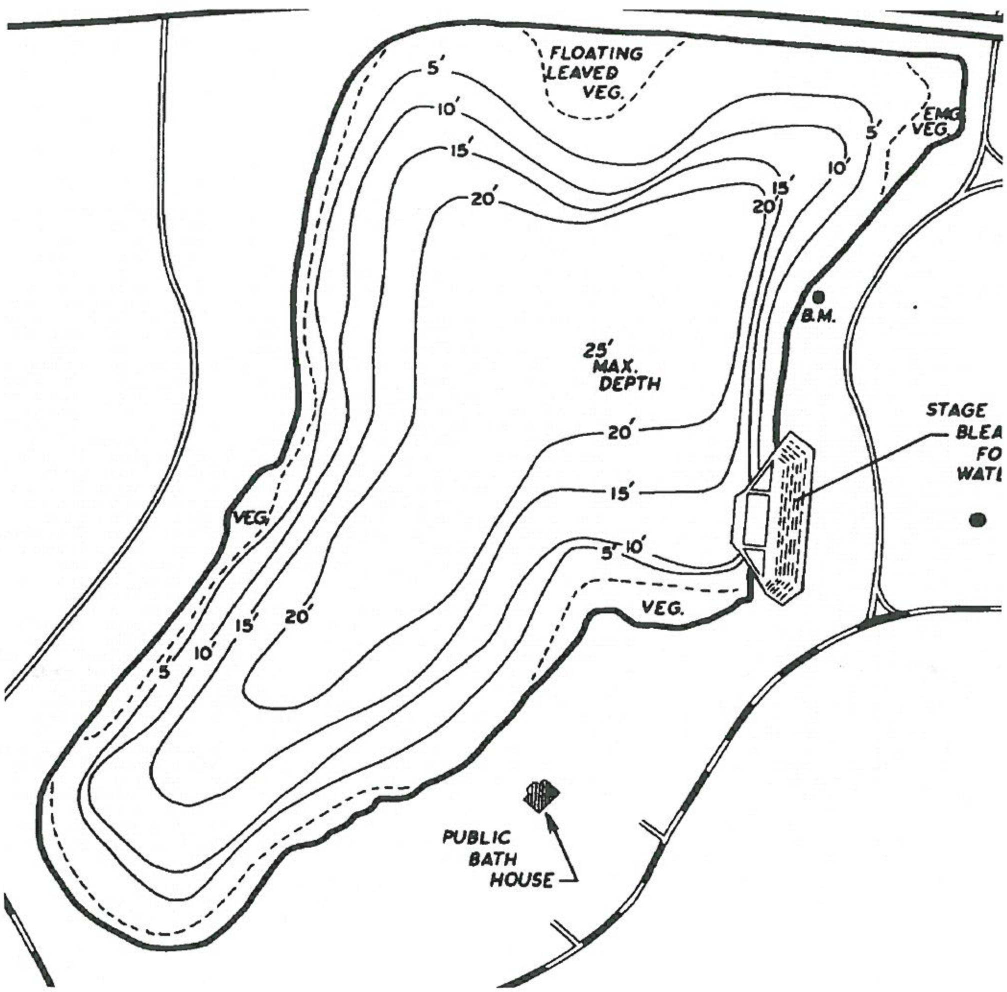


Figure 17B. Bathymetric map of Wirth Lake. Map courtesy of the MDNR.

Table 17A. Wirth Lake morphometric data.

Surface Area (acres)	Mean Depth (m)	Maximum Depth (m)	Littoral Area*	Volume (m^3)	Watershed Area (acres)	Watershed: Lake Area (ratio)
39	4.3	7.9	61%	6.70×10^5	348	9.4

* Littoral area was defined as less than 15 feet deep.

LAKE LEVEL

Wirth Lake levels are recorded weekly during ice free conditions. The historical lake levels for Wirth Lake are shown in **Figure 17C** for the entire period of record. The MnDNR has not designated an ordinary high water level (OHW) for Wirth Lake. See **Section 18** for a comparison between other MPRB lake levels.

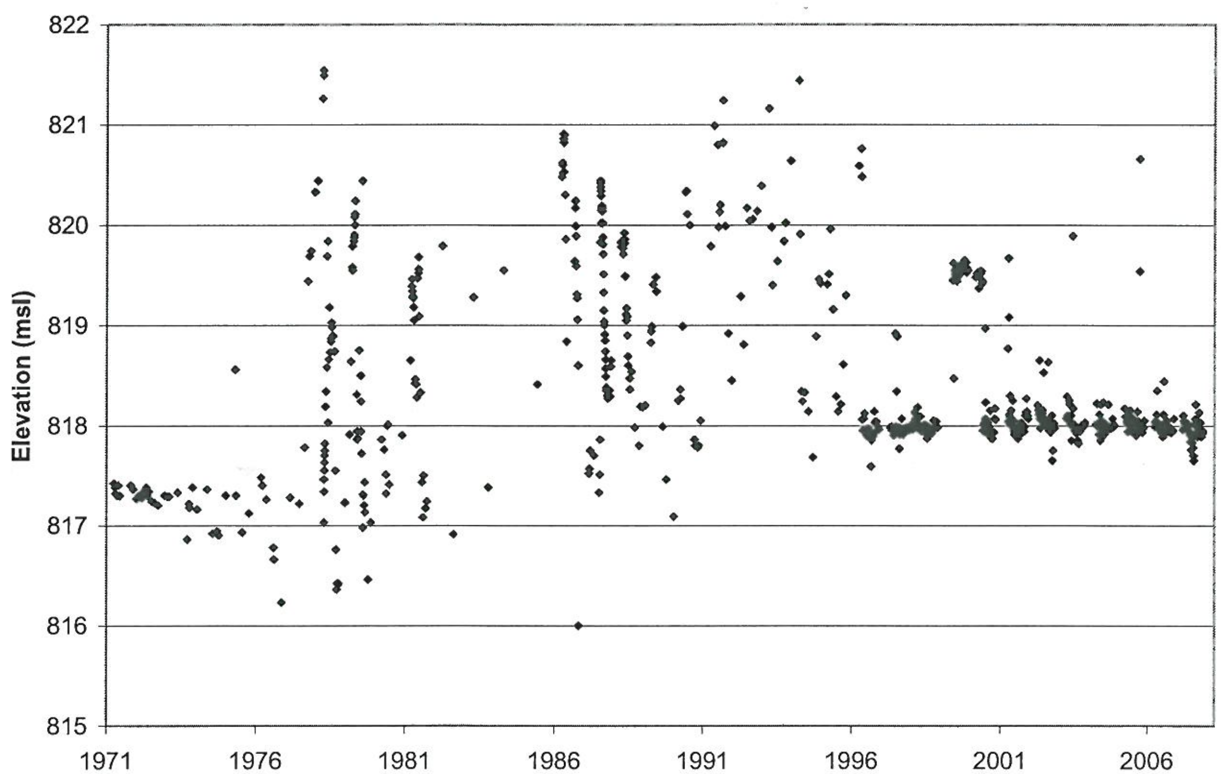


Figure 17C. Historical lake levels for Wirth Lake.

WATER QUALITY TRENDS (TSI)

Figure 17D shows the Wirth Lake linear regression to be decreasing as the TSI scores fall. A detailed explanation of TSI can be found in **Section 1**.

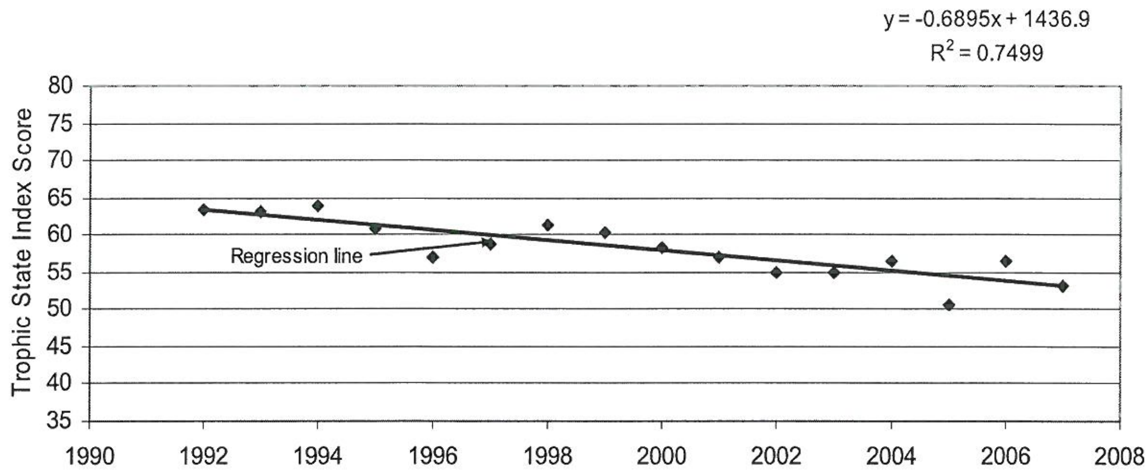


Figure 17D. Wirth Lake TSI scores and regression line.

Water quality is generally improving at Wirth Lake. The regression correlation is strong with an R^2 of 0.75. Wirth Lake has a TSI score that is average for this ecoregion. It falls slightly above the 50th percentile category for lakes in this ecoregion (based on calculations from the Minnesota Pollution Control Agency, using the Minnesota Lake Water Quality Data Base Summary, 1998).

BOX AND WHISKER PLOTS

The box and whisker plots show the distribution of data for the Secchi, chlorophyll-*a*, total phosphorus, and total nitrogen sampling. **Figure 17E** shows box and whisker plot data from 1992-2007. A detailed explanation of box and whisker plots can be found in **Section 1**.

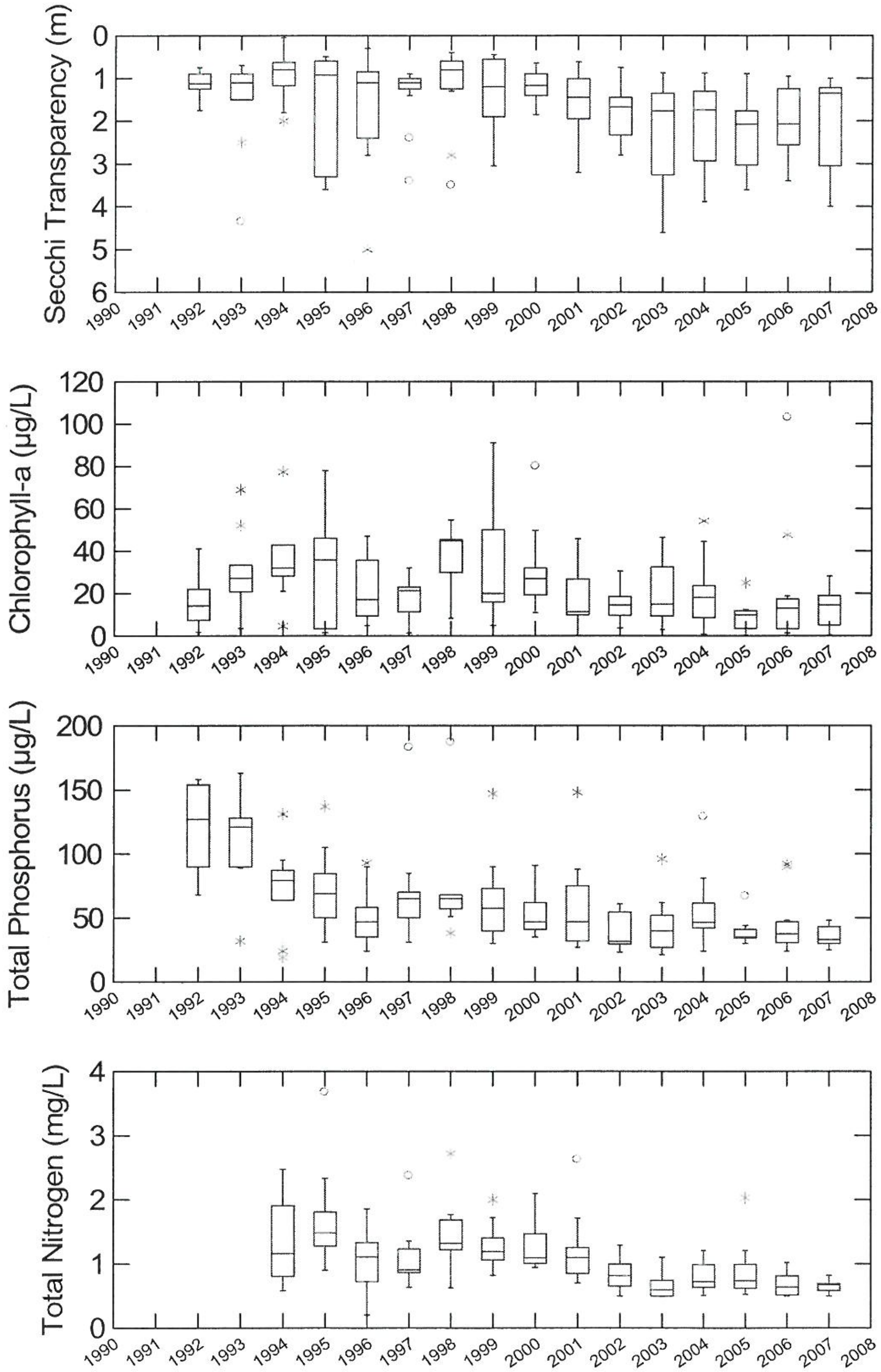


Figure 17E. Box and whisker plots of Wirth Lake.

Since the early 1990s the median phosphorus levels appear to be decreasing and have less scatter to the data for With Lake. Upstream water quality improvements in the Wirth Lake watershed are partly responsible for the drop in phosphorus levels. Secchi transparency is increasing with deeper average readings, and more deep readings, possibly pointing to a longer and clearer "clear water phase". Total nitrogen levels also appear to be decreasing for the period of record. This could be due to upstream water quality improvements and/or changes in the growth patterns blue-green algae in the lake.

BEACH MONITORING

Bacteria levels were monitored at one location on Wirth Lake at Wirth Beach. Wirth Beach had a low season long geometric mean and a low median value for *E. coli.* The beach was open for the entire season. The values are listed in **Table 17B**. **Figure 17F** illustrates the box and whisker plot of *E. coli* sampling results (per 100 mL) for 2003–2007. The box and whisker plot shows in more detail the scatter for individual years of the data set.

Table 17B. Summary of *E. coli* results (per 100 mL) for Wirth Beach in 2007.

Data Statistics	Wirth Beach
Minimum Value	2
Maximum Value	220
Median Value	8
Geometric Mean	8
Standard Deviation	63
Number of Samples Taken	19

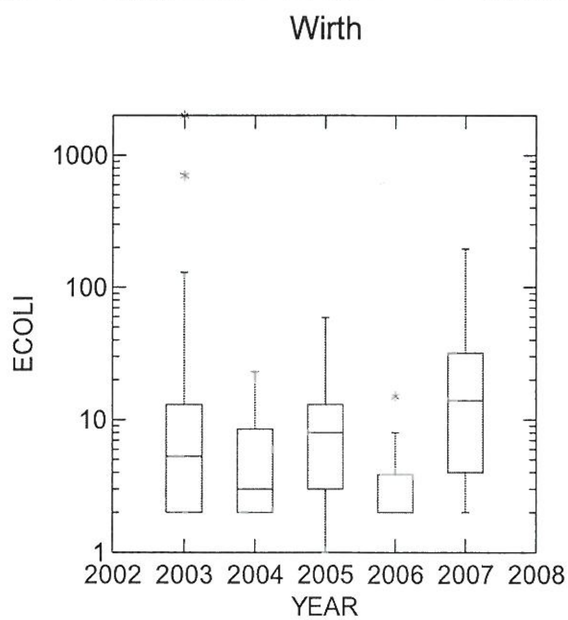


Figure 17F. Box and whisker plot of Wirth Beach *E. coli* results (colonies per 100 mL), for 2003–2007.

Table 17C gives the parameters that correlated best with the *E. coli* at Wirth beach. Positive correlations existed between *E. coli* and the temperature of the air and water. A negative correlation exists with wind speed. During the 2007 sampling season there were not enough rain events to calculate accurate correlations with rain, rainfall intensity, and rainfall duration.

Table 17C. Selected correlations (r) between *E. coli* and select variables in 2007.

Variables	Wirth Beach
Air Temperature	0.269
Water Temperature	0.597
Wind Speed	-0.36

Lake Aesthetic and User Recreation Index (LAURI)

The LAURI for Wirth Lake is shown in **Figure 17G**. Wirth Lake scored "excellent" for aesthetics, "good" for clarity, and "poor" for aquatic plant interferences. The lake also scored "excellent" for public health due to the extremely low *E. coli* values at the beach. Details on the LAURI can be found in **Section 1**.

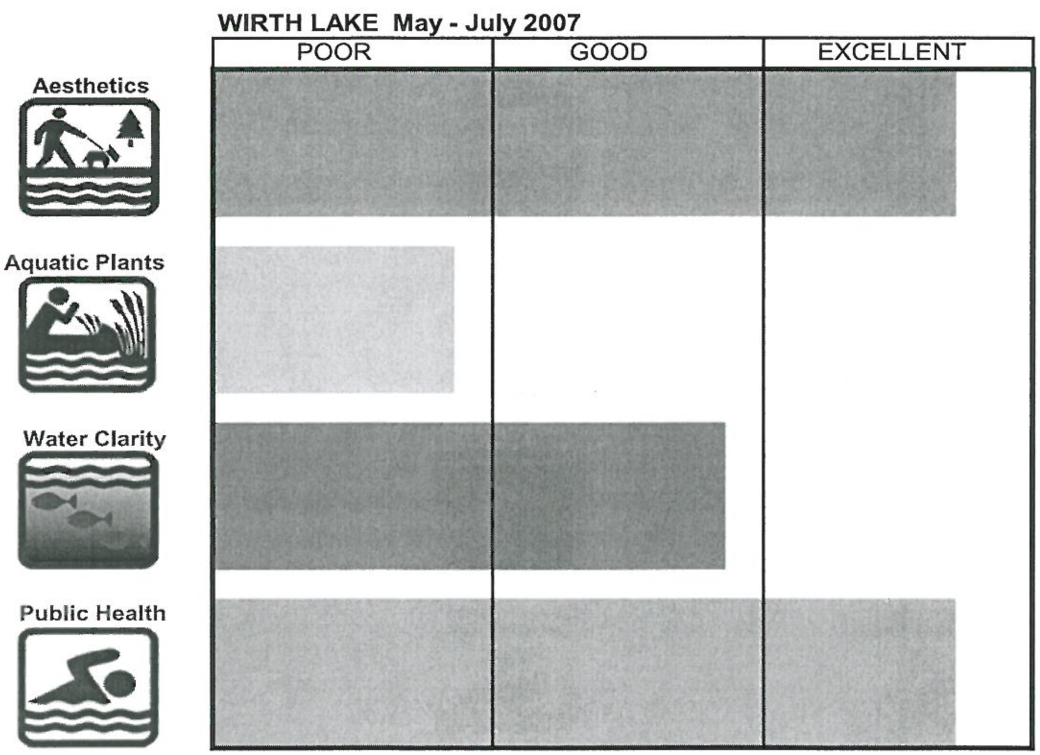


Figure 17G. Wirth Lake LAURI for 2007.

Winter Ice Cover

Ice came off Wirth Lake on March 27, 2007, which is five days earlier than the average ice off date. Ice came on to the lake for the winter on December 4, 2007, which is a week later than is average for this lake. Details on winter ice cover records can be found in **Section 1** and a comparison with other lakes can be found in **Section 18**.

Exotic Aquatic Plant Management

The MDNR requires a permit to remove or control Eurasian watermilfoil. These permits limit the area from which milfoil can be harvested to protect fish habitat. The permits issued to the MPRB allowed for harvesting primarily in swimming areas, boat launches and in shallow areas where dense growth occurred. The permitted area on Wirth Lake was 11.5 acres, which is 29% of the total lake surface area. Wirth Lake was harvested for Eurasian watermilfoil in late–June of 2007 due to nuisance milfoil growth near the beach. See **Section 1** for details on aquatic plants.

Phytoplankton and Zooplankton

Phytoplankton and zooplankton are the microscopic plant and animal life that form the foundational food web of lake ecology. The fertility of a lake is indicated by chlorophyll-*a* (chl-*a*) as an expression of the phytoplankton present. **Figures 17H** and **17I** show the phytoplankton and Chlorophyll-*a* data, respectively.

During the 2007 sampling season bacillariophyta (diatoms), chrysophyta (golden algae), cryptophyta (cryptomonads), and pyrrhophyta (dinoflagellates) were present in spring. Pyrrhophyta (dinoflagellates) peaked in June then crashed in late-June and recovered to remain 10-20% of the plankton population through September. After the dinoflagellate crash, chlorophyta (green algae) were important contributors for several weeks and then cyanophyta (blue-green algae) gained dominance for the remainder of the season. Chl-a values were lower this summer in Wirth Lake than in 2006.

There were several chl-*a* peaks in 2007; in April, late May, and in August when cyanobacteria dominated. Zooplankton populations fluctuated in Wirth Lake in 2007 (**Figure 17J**). Both arthropod and rotifer populations peaked in May, when there were many nutritious phytoplankton present. Rotifers peaked again in July and populations of zooplankton remained stable but low for the remainder of the sampling season. Protozoa were not present at detectable levels. High numbers of zooplankton corresponded to the deepest secchi transparencies, conversely lowest zooplankton numbers corresponded to times when relatively inedible cyanobacteria species were dominant and secchi transparencies were shallowest (see **Figure 17J**).

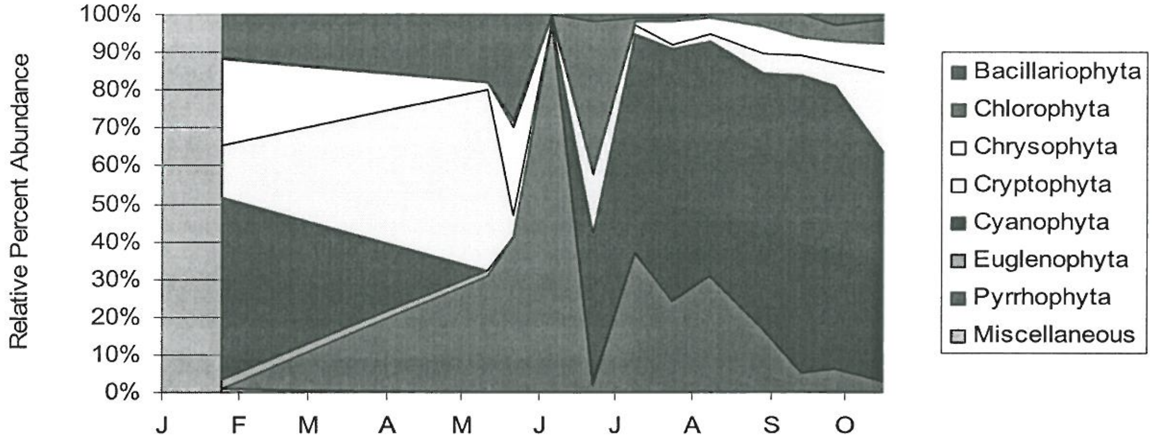


Figure 17H. Wirth Lake dominant phytoplankton divisions during the 2007.

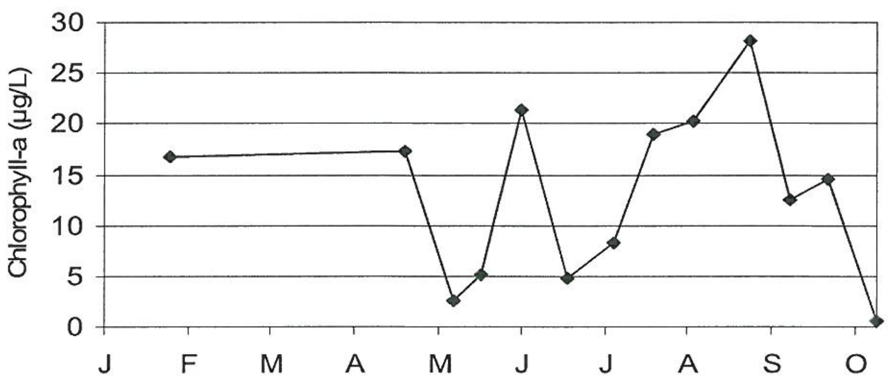


Figure 17I. Wirth Lake 2007 chlorophyll-*a* data.

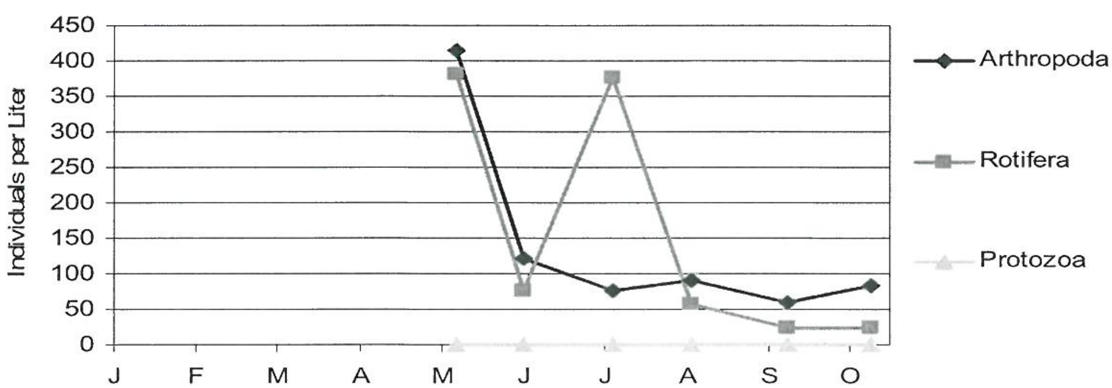


Figure 17J. Wirth Lake 2007 zooplankton distribution.

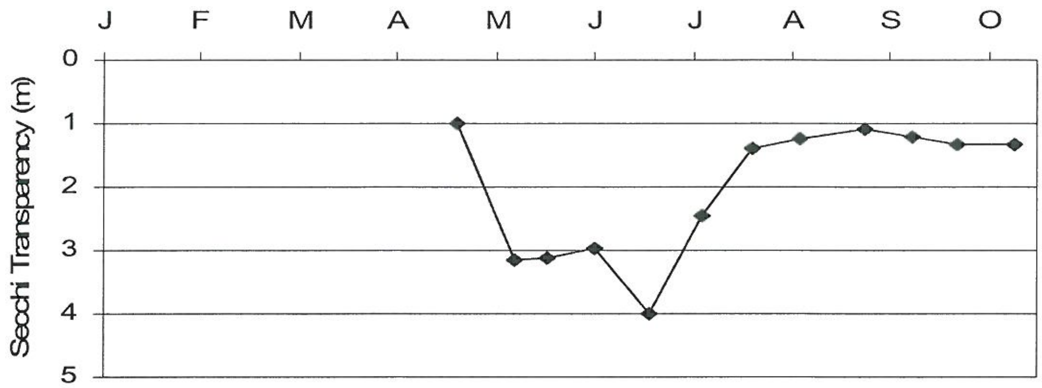


Figure 17K. Secchi depths in Wirth Lake during 2007.

FISH STOCKING

Additional information and a definition of fry, fingerling, yearling, and adult fish sizes can be found in **Section 1**.

Wirth Lake was stocked by MDNR in:

1998 with 290 adult Black Crappie 258 adult Bluegill Sunfish.

1999 with 1,900 fingerling Channel Catfish.

2000 with 1,900 fingerling Channel Catfish.

2001 with 2,304 yearling Channel Catfish.

2003 with 600 adult Walleye.

2007 with 23,000 fry Walleye.

WATER QUALITY PROJECTS

In 2006 two species of emergent plants, *Sagittaria latifolia* and *Pontederia cordata* (broad-leaved arrowhead and pickerelweed), were planted as part of a small-scale lakeshore restoration project. The plot selected for the planting was located on the northeast corner of the lake just south of Highway 55. In 2007 it appears that the *Sagittaria latifolia* (broad-leaved arrowhead) has matured and is increasing in numbers.

The Wirth Beach bathhouse underwent an extensive rehabilitation in 2004–2005. The new bathhouse used the footings from the 1957 bathhouse. This is part of a larger renovation project for the Wirth Beach area with different phases being implemented at different times due to installment funding from the legislature and the Metropolitan Council. More details on the project can be found at: http://www.minneapolisparks.org/default.asp?PageID=738

18. COMPARISON AMONG LAKES

MORPHOMETRIC DATA

Table 18A presents the morphometric data for Minneapolis lakes. The largest and deepest lake is Calhoun and the smallest and shallowest lake is Webber Pond.

Table 18A. Minneapolis lakes morphometric data.

Lake	Surface Area (acres)	Mean Depth (m)	Maximum Depth (m)	Littoral Area*	Volume (m^3)	Watershed Area (acres)	Watershed/ Lake Area (ratio)	Residence Time (years)
Birch	5.8	NA	NA	NA	NA	NA	NA	NA
Brownie	18	6.8	15.2	67%	$4.98x10^5$	369	20.5	2.0
Calhoun	421	10.6	27.4	31%	$1.80x10^7$	2,992	7.1	4.2
Cedar	170	6.1	15.5	37%	$4.26x10^6$	1,956	11.5	2.7
Diamond	41	0.9	2.1	100%	$7.15x10^4$	669	16.3	NA
Grass	27	0.6	1.5	NA	NA	386	14.3	NA
Harriet	353	8.7	25.0	25%	$1.25x10^7$	1,139	3.2	3.4
Hiawatha	54	4.1	7.0	26%	$8.95x10^5$	115,840	2,145	0.03
Isles	103	2.7	9.4	89%	$1.11x10^6$	735	7.1	0.6
Loring	8	1.5	5.3	NA	$4.88x10^4$	24	3.0	NA
Nokomis	204	4.3	10.1	51%	$3.54x10^6$	869	4.3	4.0
Powderhorn	11	1.2	6.1	99%	$5.43x10^4$	286	26.0	0.2
Ryan	18	NA	10.7	50%	NA	5,510	306	NA
Spring	3	3.0	8.5	NA	$3.65x10^4$	45	15.0	NA
Webber	3	0.9	2.0	NA	$1.10x10^4$	2	0.7	NA
Wirth	39	4.3	7.9	61%	$6.70x10^5$	348	9.4	NA

* Littoral area defined as less than 15 feet deep. NA= No Data Available

- Largest Lake: Lake Calhoun at 421 acres.
- Smallest Lake: Webber Pond at 3 acres.
- Deepest Lake: Lake Calhoun at 89 feet 11 inches.

WATER QUALITY TRENDS (TSI)

Changes in lake water quality can be tracked by analyzing long-term trends in Trophic State Index (TSI) scores. The Minneapolis Park and Recreation Board (MPRB) uses TSI scores to assess changes in water quality and evaluate the effectiveness of restoration and management activities on the trophic state of the lakes. Detailed information on TSI scores can be found in **Section 1**.

Lakes in the North Central Hardwood Forest (NCHF) ecoregion frequently fall into the eutrophic category and the lowest trophic status lakes typically fall into the mesotrophic category. All the sampled lakes in Minneapolis are either eutrophic or mesotrophic with one lake, Calhoun, bordering on oligotrophic due to restoration activities. TSI scores dating back to 1991 are presented in **Table 18B**. TSI trends over time for the Minneapolis Lakes are shown in **Figures 18B** and **18C**. For more detailed information on TSI scores and nutrient related water quality parameters, see the individual lake **Sections 2-17**.

Table 18B. Average Carlson TSI scores for Minneapolis lakes.

	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07
Brownie	NS	NS	55	55	55	56	58	ID	ID	ID	ID	58	NS	58	NS	56	NS
Calhoun	54	59	50	46	48	47	43	48	47	46	46	43	43	40	37	42	42
Cedar	54	54	62	52	58	51	45	43	45	47	48	48	49	47	48	54	47
Diamond	NS	67	59	66	71	60	68	73	67	71	68	60	71	73	79	76	76
Grass	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	77	80	61	NS	62	NS
Harriet	47	50	45	47	51	52	43	47	49	48	45	44	45	43	40	48	46
Hiawatha	NS	58	58	57	59	59	58	58	59	65	58	59	58	60	56	58	65
Isles	55	64	65	58	59	55	52	56	56	53	58	59	62	58	54	60	59
Loring	NS	60	59	61	65	65	NS	63	71	73	71	70	69	65	63	67	69
Nokomis	NS	65	57	60	58	61	60	58	60	61	60	57	57	64	57	63	62
Powderhorn	NS	66	68	66	68	69	75	73	73	75	72	70	63	68	61	62	58
Spring	NS	NS	NS	62	64	67	76	ID	ID	ID	ID	76	69	NS	75	NS	77
Webber	NS	58	57	58	58	59	49	51	46	56	61	62	67	67	52	61	47
Wirth	NS	63	63	64	61	57	59	61	60	58	57	55	55	57	51	57	53

ID = insufficient data, NS = not sampled.

In 2007 MPRB water quality scientists monitored 12 of the city's most heavily used lakes. The data collected were used to estimate the TSI, or fertility of the lakes. Changes in lake water quality can be tracked by looking for trends in TSI scores over time. These values are especially important for monitoring long-term trends (5-10 years). Historical trends in TSI scores are used by lake managers to assess improvement or degradation in water quality.

Table 18C shows the slope and regression line "R^2" for data at each individual lake. A negative slope is seen as decreasing fertility and positive slope as increasing fertility. R^2 indicates how well the trend fits the data (with 1.00 being a perfect fit). Details on TSI scores and linear regression analysis can be found in **Section 1**. Individual Lake sections contain linear regressions for the lakes. TSI scores over time are shown in **Figures 18B** and **18C**.

Lakes with decreasing TSI trends and decreasing fertility include:

- Lake Calhoun,
- Cedar Lake,
- Lake Harriet,
- Powderhorn Lake (since 2001),
- Wirth Lake,

Lakes with stable TSI trends include:

- Lake Hiawatha,
- Lake of the Isles,
- Lake Nokomis,
- Webber.

Lakes with increasing TSI trends and increasing fertility include:

- Spring Lake (limited data points),
- And Loring Pond (disturbed by dredging during 2007).

Table 18C. 2007 slope and R^2 values for trend lines calculated from average growing season TSI scores.

Lake	Slope of Regression	R^2
Calhoun	-0.850	0.693
Cedar	-0.482	0.240
Harriet	-0.284	0.211
Hiawatha	0.132	0.073
Isles	-0.073	0.010
Loring	0.476	0.289
Nokomis	0.027	0.002
Powderhorn	-0.459	0.186
Spring	0.914	0.565
Webber	0.083	0.003
Wirth	-0.690	0.7500

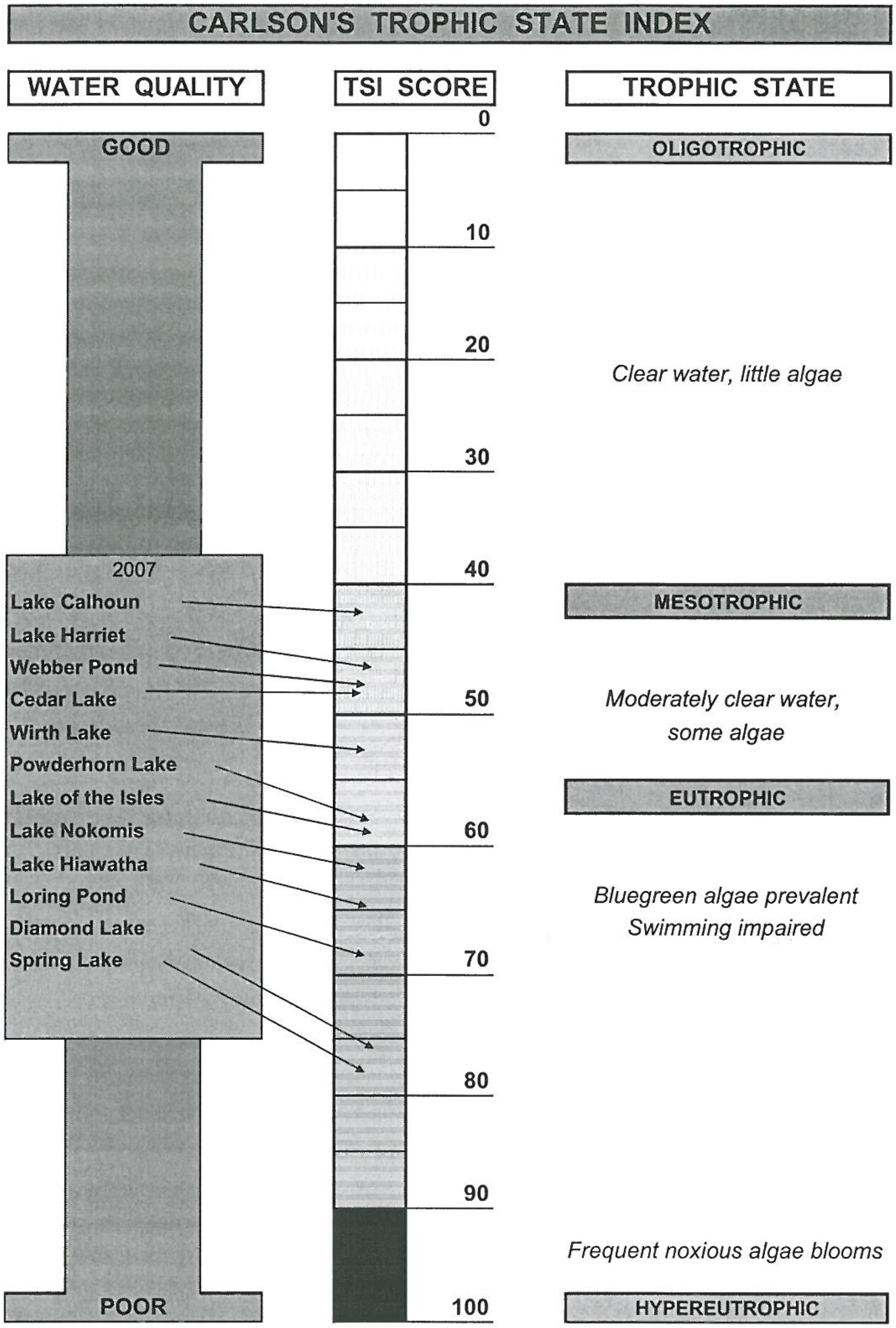


Figure 18A. 2007 lake trophic state comparison.

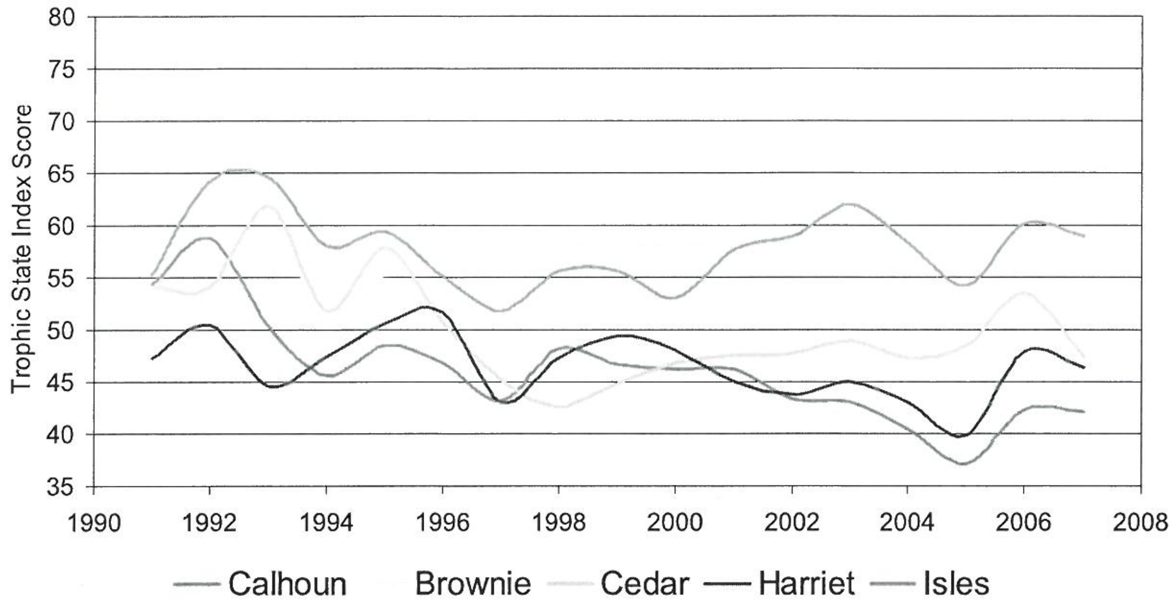


Figure 18B. TSI scores for selected Minneapolis lakes 1992–2007. Restoration efforts can be seen in the scores for Lake Calhoun and Lake Harriet.

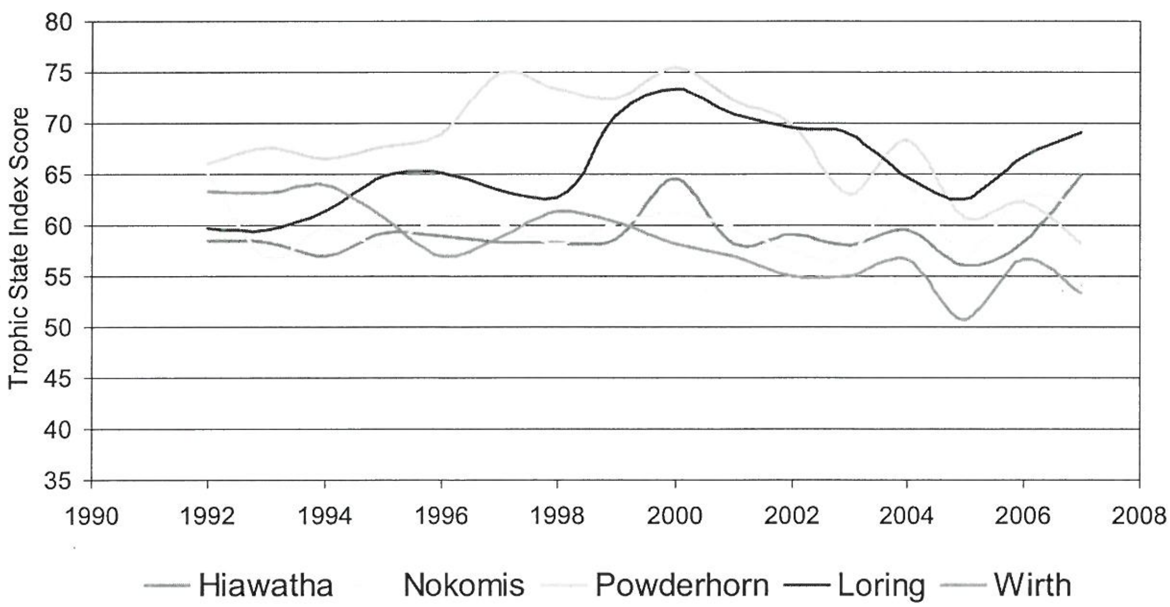


Figure 18C. TSI scores for selected Minneapolis lakes 1992–2007. Restoration efforts can be seen in the Powderhorn Lake scores. Wirth Lake's scores are also dropping, likely due to upstream storm water treatment.

LAKE LEVELS

Lake levels are recorded weekly for Calhoun, Isles, Cedar, Brownie, Harriet, Hiawatha, Nokomis, Loring, Powderhorn and Wirth lakes from ice out to ice on. The lake level for the Upper Chain of Lakes (Brownie, Calhoun, Cedar and Isles) is taken at Lake Calhoun. Channels connect the lakes which makes the level representative of all four lakes. The Chain of Lakes (Upper Chain and Lake Harriet) water levels are illustrated in **Figure 18E**. The remaining lakes' levels are shown in **Figure 18F**. Average annual lake levels for each lake with a staff gauge are shown in **Table 18D**. Fixed staff gauges are used at all locations.

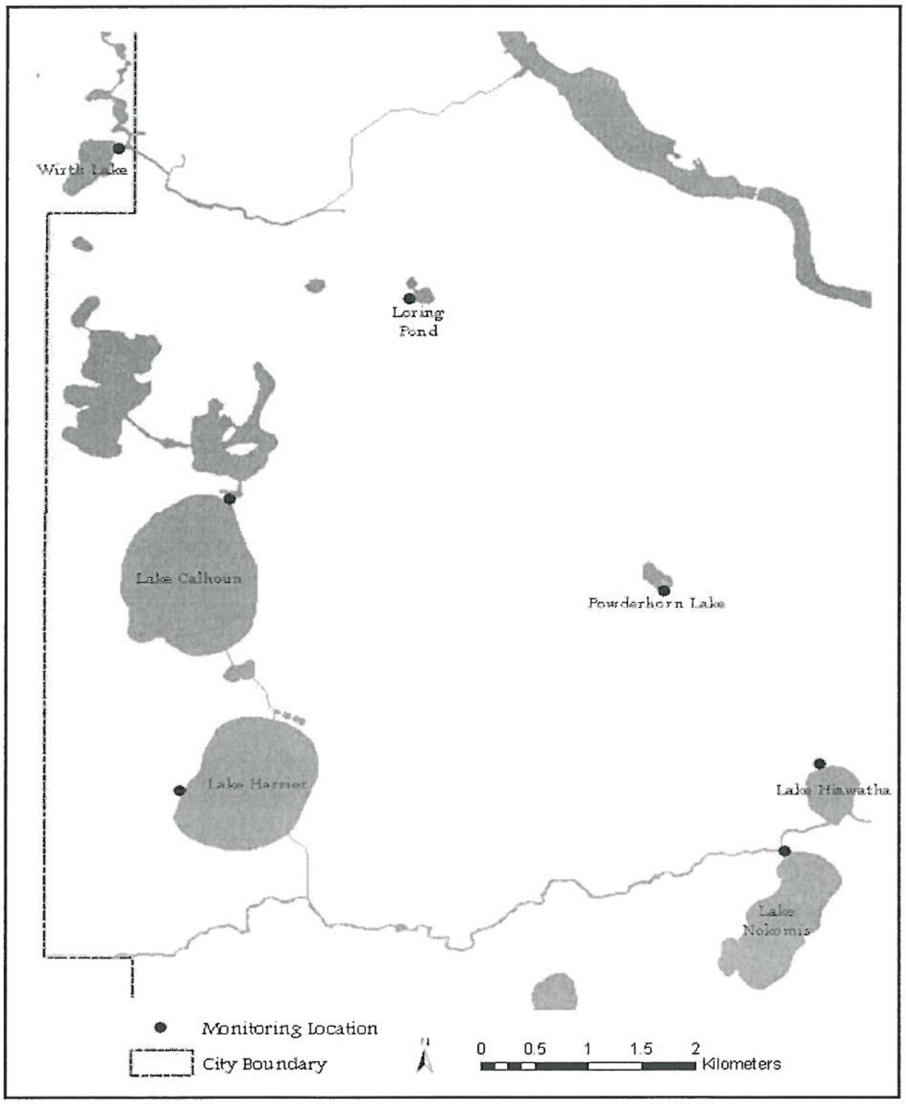


Figure 18D. Minneapolis lake level monitoring locations.

Lake levels vary annually based on precipitation, stream flow, and stormwater inflow. The 2007 average lake levels were comparable to 2006. The summer of 2007 was dry as seen in dropping lake level data from approximately May through August. Large August storms filled most lakes with the effects particularly visible in Powderhorn and Nokomis Lakes.

Powderhorn and Loring levels are often augmented via groundwater wells periodically to maintain a consistent level. During 2007 equipment malfunction at Powderhorn Lake made it difficult to maintain the level during the droughty summer while staying within DNR-set pumping limits. At Loring Pond the north bay dredging project necessitated a spring drawdown of approximately 1.5 feet which was difficult to recover using the limited pumping allotment.

Lake Hiawatha levels are influenced by the inflow of Minnehaha Creek which fluctuates depending on the operation of the Lake Minnetonka outlet dam. The average lake level at Wirth Lake is very consistent over the years of record due to a large volume of groundwater recharge into the lake.

Lake level trends are tracked for lake management purposes as high water can cause shoreline erosion and habitat loss while low levels can impede recreation. Historical lake levels for the entire period of record can be found in the individual lake **Sections 2-17**.

Table 18D Average annual lake levels in feet above msl.

Lake	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Chain of Lakes**	852.37	852.07	851.93	853.23	853.39	852.69	852.35	852.90	852.85	852.53
Harriet	847.17	847.16	847.04	847.53	847.63	847.81	847.43	847.31	847.11	847.37
Hiawatha	812.48	812.48	811.76	812.74	813.59	812.53	812.58	812.92	812.61	812.31
Loring*	818.08	818.43	818.66	818.53	818.59	818.21	818.01	818.23	816.68	817.63
Nokomis	ND	816.60	814.22	814.57	814.84	814.42	813.28	812.89	812.96	813.00
Powderhorn	ND	817.83	818.31	818.35	817.28	818.09	818.48	818.35	818.40	817.43
Wirth	817.98	817.97	818.02	818.11	818.08	818.06	818.01	818.13	817.81	817.95

* Where Loring records were below recordable stage the minimum recorded value was used.
ND = no data available.
** The Chain of lakes includes: Calhoun, Cedar, Isles, & Brownie.

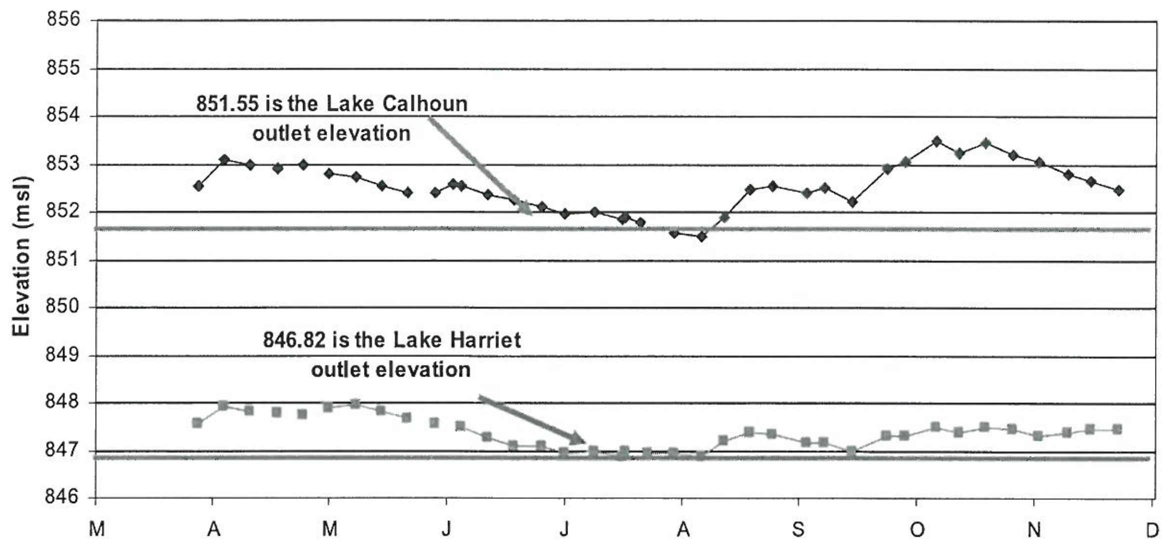


Figure 18E. 2007 Lake levels for the Minneapolis Upper Chain of Lakes (Brownie, Cedar, Isles, and Calhoun), top graph, and Lake Harriet, bottom graph.

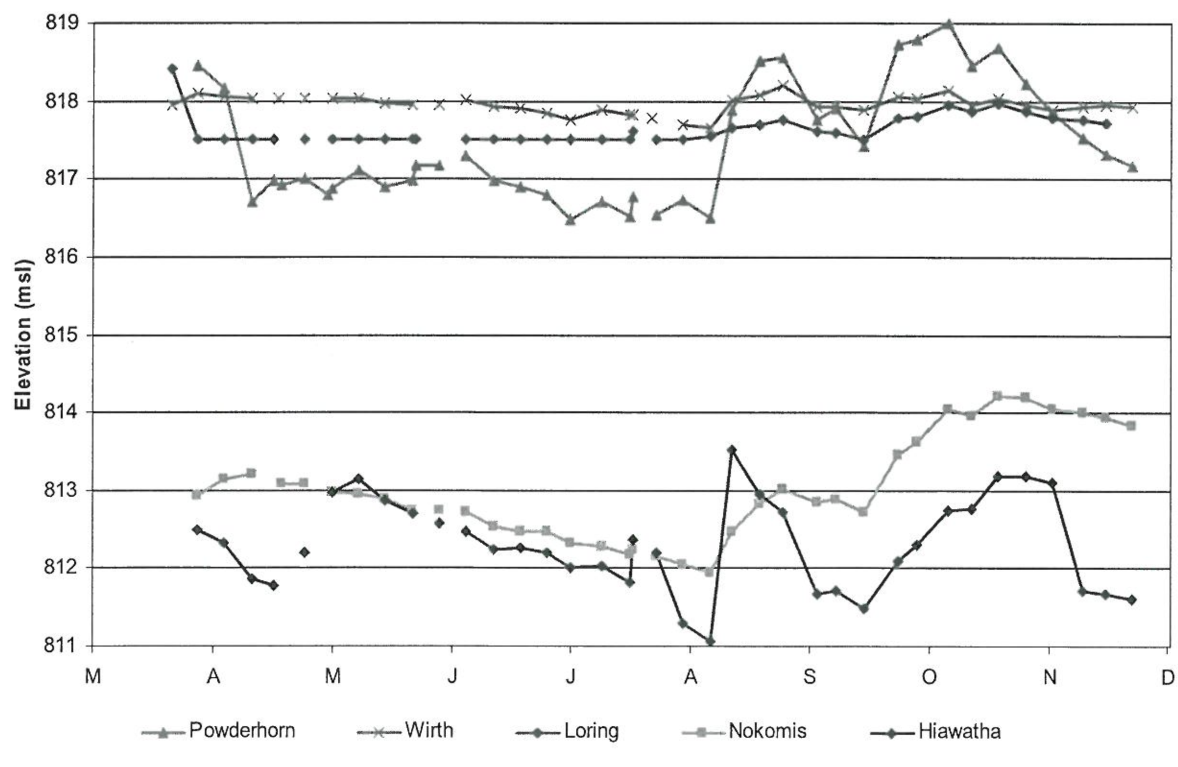


Figure 18F. 2007 Lake levels for Powderhorn Lake, Loring Pond, Wirth Lake, Lake Nokomis, and Lake Hiawatha.

LAKE AESTHETIC AND USER RECREATION INDEX (LAURI)

The LAURI was developed to provide recreational users with an additional source of information about the health of MPRB lakes. Previously TSI scores were used to indicate the all round environmental health of lakes without considering its suitability for recreation. The LAURI provides lake users with an easily understandable recreational suitability indicator for MPRB lakes. Background information on the LAURI can be found in **Section 1**. **Table 18E** shows the LAURI scores of each lake for 2007. Scores for Aesthetics, Aquatic Plant Interferences, and Public Health are on a scale of 0 to 10, with 0 being the best possible and 10 being the worst possible score. Water clarity scores are for the growing season (May – Sept) and mean Secchi depth is measured in feet (higher scores are clearer water).

Table 18E. 2007 average scores and classifications for each LAURI category.

Lake	Aesthetics	Aquatic Plant Interferences	Public Health	Water Clarity
Calhoun	0.8	8.5	1.0	4.4
Cedar	0.8	7.5	1.0	3.2
Harriet	1.3	7.5	1	3.4
Hiawatha	2.8	5.8	3	0.9
Isles*	1.1	10	NB	1.7
Loring*	1.3	0.8	NB	0.6
Nokomis*	2.0	2.5	1.0	1.1
Powderhorn*	2.6	2.5	NB	1.8
Webber*	1.1	5.0	NB	ND
Wirth	1.3	7.5	1.0	2.4

LEGEND

Excellent	Good	Poor

* Denotes shallow lake, at least 85% or more littoral.
NB = no swimming beach.
ND = no data collected due to shallow depths.

In general, lakes with excellent clarity often have recreational interferences from aquatic plants. Lakes with less clarity have less aquatic plants and therefore less recreational interferences from plants. Hiawatha, Loring, and Powderhorn were not rated for the public health category because these lakes do not have swimming beaches. All the lakes with beaches scored excellent for public health, as rated for swimming by bacteria levels.

WINTER ICE COVER

Ice-off dates in 2007 were about a week earlier than average (**Table 18F**). Ice-on dates for the smaller lakes were within days of average in 2007. The larger lakes were frozen about two weeks earlier than their average during 2007 which was also several days to a week earlier than their median freeze-up dates (**Table 18G**). All of the lakes remained frozen for the entire season once they were completely ice-covered. For further information on winter ice cover records see **Section 1** and individual lake sections.

Table 18F. Statistics related to ice off dates.

Lake	Earliest Ice Off	Year Occurred	Latest Ice Off	Year Occurred	Mean	Median	Years of Record
Birch	3/8	2000	4/15	1996	4/3	4/4	22
Brownie	3/9	2000	4/18	1996	4/3	4/3	26
Calhoun	3/9	2000	4/28	1965	4/9	4/10	56
Cedar	3/9	2000	4/26	1975	4/6	4/6	34
Diamond	3/6	2000	4/13	1963	3/31	3/31	15
Harriet	3/9	2000	4/28	1965	4/7	4/7	40
Hiawatha	3/8	2000	4/25	1965	4/4	4/4	33
Isles	3/8	2000	4/26	1965	4/5	4/5	38
Loring	3/6	2000	4/19	1996	4/2	4/3	27
Nokomis	3/8	2000	4/25	1965	4/4	4/4	36
Powderhorn	3/8	2000	4/27	1965	4/4	4/3	28
Spring	3/6	2000	4/15	1996	3/31	4/2	17
Webber	3/6	2000	4/18	1996	3/31	4/1	18
Wirth	3/7	2000	4/18	1996	4/1	4/3	31

Table 18G. Statistics related to ice on dates.

Lake	Earliest Ice On	Year Occurred	Latest Ice On	Year Occurred	Mean	Median	Years of Record
Birch	11/1	1991	12/16	1998	11/25	11/27	22
Brownie	11/5	1991	12/20	2001	11/28	12/1	26
Calhoun	11/25	1996	1/16	2006-07	12/21	12/11	38
Cedar	11/18	1989	12/21	1998, 1999, 2001	12/18	12/4	26
Diamond	11/20	2000	12/20	2001	12/2	12/1	13
Harriet	11/25	1996	1/16	2006-7	12/22	12/11	35
Hiawatha	11/1	1991	1/31	2006-7	12/1	12/2	27
Isles	11/5	1991	1/2	2006-7	11/30	12/2	33
Loring	11/1	1991	12/21	1999, 2001	12/16	12/3	23
Nokomis	11/1	1991	12/20	2001	11/29	12/1	28
Powderhorn	11/1	1991	12/20	2001	11/28	11/30	23
Spring	11/10	1995	12/20	2001	11/29	11/30	17
Webber	11/10	1995	12/20	2001	11/29	11/30	18
Wirth	11/5	1991	12/21	2001	11/28	12/1	27

22. Bassett Creek
Watershed Outlet Monitoring Program (WOMP) Station

Background

Stormwater runoff carries non-point source pollutants from diverse and widely scattered sources to Twin Cities area streams and rivers. Monitoring is necessary to determine the extent of non-point source pollutant loading from tributaries to the Mississippi River. It also provides information for the development of target pollutant loads for the watershed and helps evaluate the effectiveness of best management practices; all in an effort to improve water quality in streams and rivers.

In 1997 the Minnesota Legislature provided $575,000 to the Metropolitan Council Environmental Services (MCES), via the *Interagency Water Monitoring Initiative* (IWMI), for expansion of MCES water quality monitoring efforts. With this funding the Metropolitan Area Watershed Outlet Monitoring Program (WOMP) 2 was implemented in early 1998. The new WOMP2 program expanded the existing MCES WOMP stream-monitoring network in the metro area. The Metropolitan Council is mandated by state law (MN Statute 473.157) to establish target pollutant loads for TCMA watersheds. Long-term stream monitoring data are critical for understanding non-point source pollutant impacts on water quality and for documenting water quality improvements as non-point source best management practices are implemented. The Minneapolis Park and Recreation Board (MPRB) operates the Bassett Creek station in cooperation with the Metropolitan Council. The Bassett Creek Watershed Management Commission (BCWMC) provided additional funding assistance to operate the station in 2004 and 2005. The Bassett Creek station is located at 100 Irving Avenue North, near the Minneapolis Impound Lot (**Figure 22A**).

The Bassett Creek Watershed is slightly larger than 40 square miles and is divided into four major subwatersheds:

Main Stem: The Main Stem of Bassett Creek originates in Medicine Lake and generally flows east through parts of Plymouth, Golden Valley and Minneapolis to the Mississippi River.

Medicine Lake Branch: The Medicine Lake Branch drains portions of Plymouth that discharge to Plymouth Creek. Plymouth Creek originates in western Plymouth and generally flows southeast through Plymouth to Medicine Lake.

North Branch: The North Branch of Bassett Creek drains portions of northern Plymouth, southern New Hope, and Crystal and joins the Main Stem immediately upstream of Highway 100.

Sweeney Lake Branch: The Sweeney Lake Branch drains portions of northern St. Louis Park and southern Golden Valley and joins the Main Stem in Theodore Wirth Park, near Golden Valley Road.

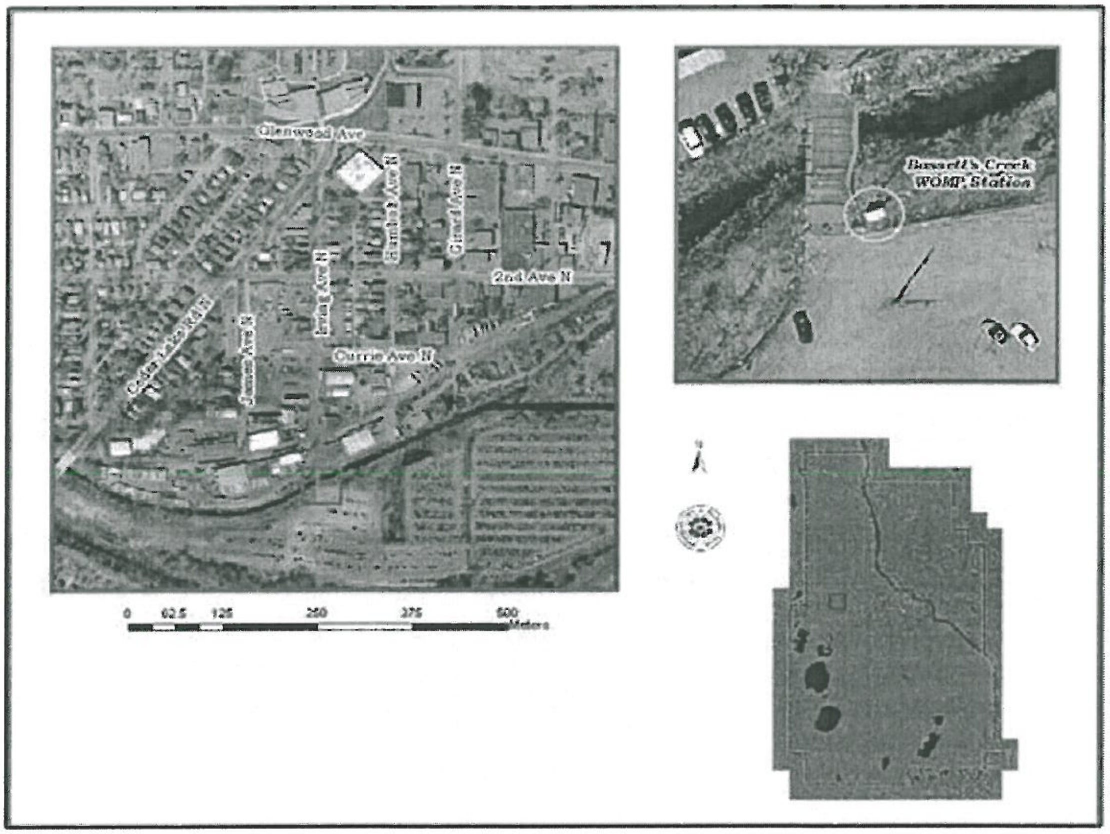


Figure 22A. Map of the Bassett Creek WOMP2 station, Minneapolis, MN.

Methods

The Bassett Creek WOMP2 station is located approximately ¼ mile upstream of where the creek enters a City of Minneapolis storm sewer tunnel. The creek eventually empties into the Mississippi River.

In July 2001 the MPRB began monitoring the WOMP2 station at Bassett Creek. The WOMP2 station previously began operation under the MCES in early 2000. The Bassett Creek station is operated in cooperation with the BCWMC and MCES. The BCWMC gathers data to build the rating curve for the station and participates with the MPRB for support and operation of the Bassett Creek station. The MCES laboratory analyzes all the samples that are collected and maintains, repairs, and coordinates larger aspects of the station.

The Bassett Creek station shelter is equipped with electricity, heat, and telephone modem. The station measures stage using a bubbler which is connected to a Campbell datalogger. The datalogger records and calculates the conversion of stage (ft) readings into discharge (cfs) using a rating curve polynomial. The data are averaged over 15-minute intervals and are downloaded via modem. The Bassett Creek station also uses an ultrasonic transducer, mounted under a bridge to measure stage. The station is equipped with a non-heated tipping bucket rain gauge. An automatic Sigma™ sampler, equipped with 24 one-liter sample bottles is also housed at the station. When stream stage increases to the trigger depth the datalogger controls and activates flow pacing to the sampler. The sampler multiplexes (four - 200 mL samples per bottle) to collect up to 96 flow-weighted samples per storm. A Campbell Scientific 247 conductivity/temperature probe was installed in the stream and continually records data. The Campbell conductivity probes are cleaned monthly and calibrated at each visit or when a new program is downloaded. An Oakton Con 100 series conductivity probe and Oakton TDS 1413 single calibration standards are used.

The individual flow paced samples are collected by the automatic sampler for runoff events and combined into one large sample. When possible grab samples were taken monthly all year during baseflow conditions. To comply with holding times water quality parameters were selected for analysis based on the elapsed time since the end of sample collection.

Remote access to the site via modem allow MPRB Environmental Operations staff to manage and check many aspects of the site without having to physically travel there. Staff used a desktop computer and modem to download data, reprogram the datalogger in anticipation of storm events, and trouble shoot. Data were downloaded and imported into spreadsheets for analysis and reporting. The MCES also downloads the data each evening from each of its stations.

Since the sampler creates flow paced composites, it is important to have accurate rating curves at Bassett Creek. Stream gauging is conducted by Barr Engineering. The stream gauge information is used to develop a scatter plot and multiple regression equation or power curve through the points. The resulting polynomial equation is programmed into the datalogger at the station. This allows for accurate flow pacing of the sampler and for total discharge volumes to be summed which result in accurate load calculations.

When samples were collected from the station a measurement was made from a fixed point on the top downstream side of the bridge railing (surveyed at 814.86 feet on 7-29-02) to the water surface. The stage reading plus this measurement must equal the distance from the creek bed to the bridge railing of 12.03 feet. This provides a quick check as to the bubbler stage accuracy at the station.

Results

Discharge and level were monitored when the creek is ice free year round. The Bassett Creek 2007 stage hydrograph is shown in **Figure 22B**. It should be noted that this figure attenuates instantaneous storm peaks because data points represent are 15 minute stage averages. Gaps in stage data were due to the probe being out of the water, equipment failure, or ice conditions.

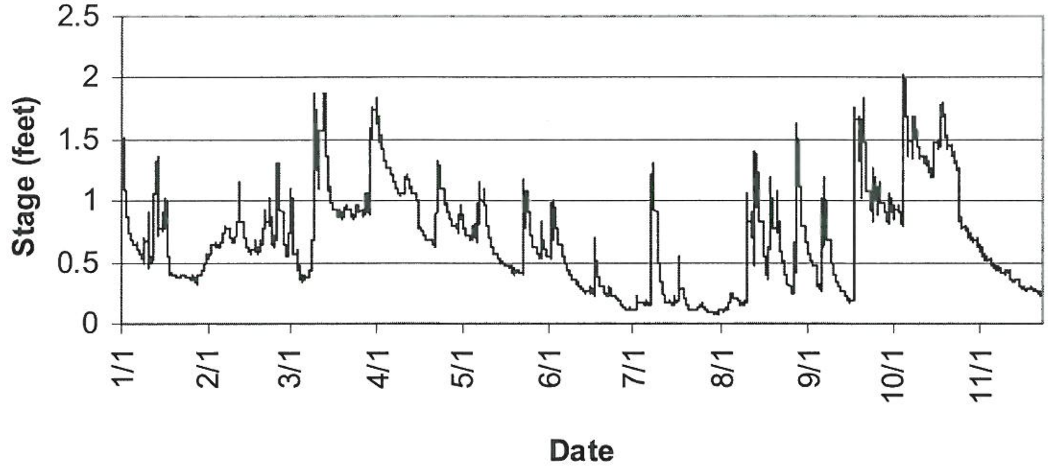


Figure 22B. Bassett Creek 2007 stage in 15-minute average intervals.

Figure 22C shows the daily average stage hydrograph for the period of record. The year 2007 shows reduced peaks when compared to previous years likely due to drought in late July and early August of 2007. The regression line shows a slight downward trend of stage over time. This may be due to construction BMP's (ponding) used in the watershed during recent development. See **Section 26** for weather details.

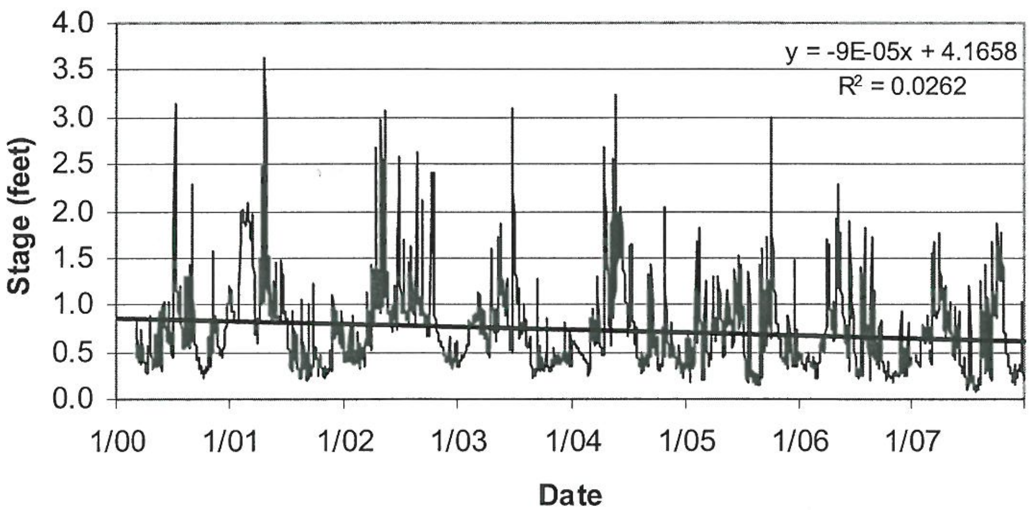


Figure 22C. Bassett Creek average daily stage for 2000-2007.

The Bassett Creek WOMP2 station was used to continually monitor the discharge, level and water chemistry of the creek. These data can be used to assess the effects of stormwater runoff from the surrounding watershed. The MCES used the FLUX watershed model to calculate flow-weighted mean concentrations for the Bassett Creek station. The station will allow natural resource managers to track changes in the creek through long-term data collection as well as document differences between creeks in the metro area with varying watershed characteristics. **Table 22A** shows the 2007 Bassett Creek monthly average stage, discharge, temperature and conductivity. The peak monthly discharge in 2007 occurred in October for the Bassett Creek WOMP2 station. A total of nine runoff events and 12 baseflows were collected in 2007 at Bassett Creek. **Section 26** provides a summary of 2007 weather.

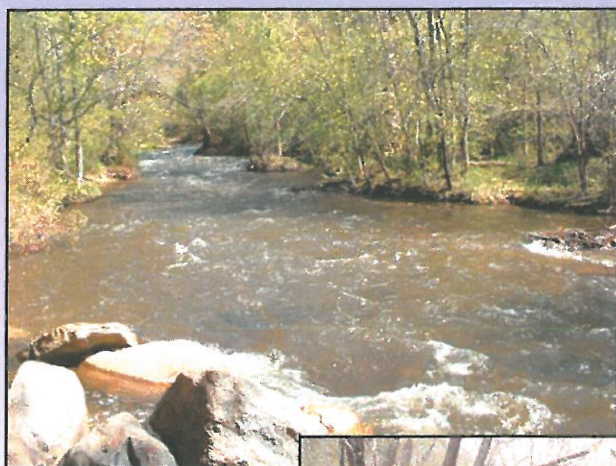
Table 22A. Bassett Creek monthly average data for 2007.

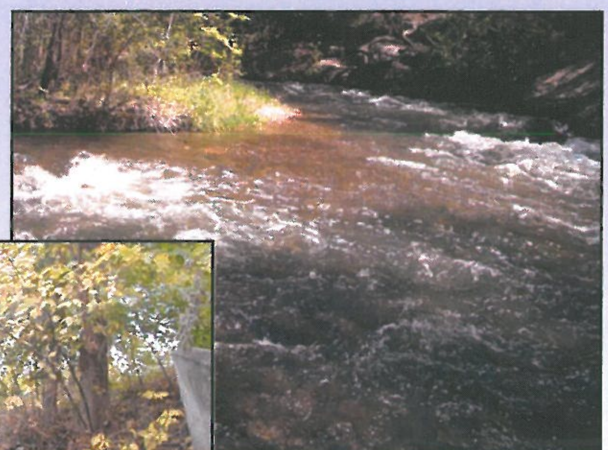
Month	Stage (feet)	Flow (cfs)	Conductivity (µmohos/cm)	Water Temp (°C)
January	0.62	16.93	1082	0.46
February	0.72	19.72	1312	0.04
March	0.95	38.83	1124	3.35
April	1.05	43.84	909	10.32
May	0.67	17.38	928	18.69
June	0.37	6.34	862	22.66
July	0.22	3.25	716	23.21
August	0.56	16.73	672	22.53
September	0.73	26.37	574	19.17
October	1.24	62.77	611	13.39
November	0.36	4.91	879	3.36
December	0.34	5.39	1335	-0.12

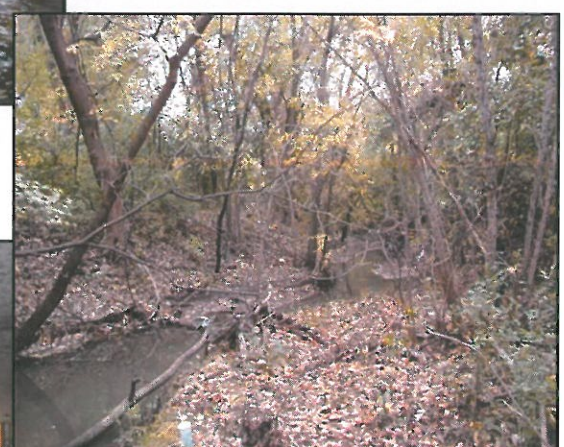
The MCES will continue to use the FLUX computer model to develop flow-weighted mean concentrations for Bassett Creek. These data will likely be important in creating future Total Maximum Daily Loads (TMDL's) for the watershed. See the MCES Stream Monitoring Report for further information:

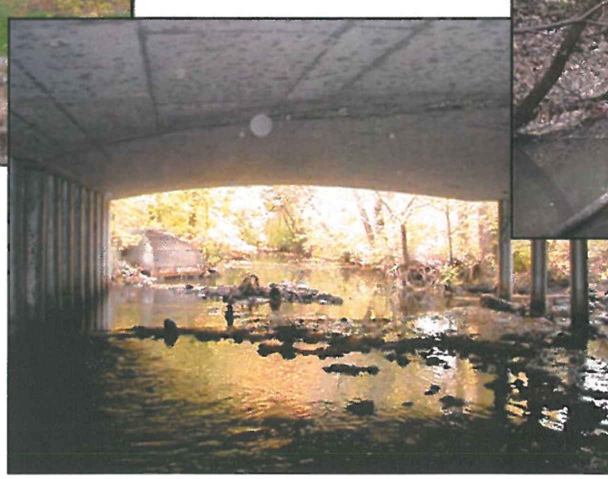
http://es.metc.state.mn.us/eims/support_information/data_catalog_detail.asp?optn=42&catID=5

River Watch 2008



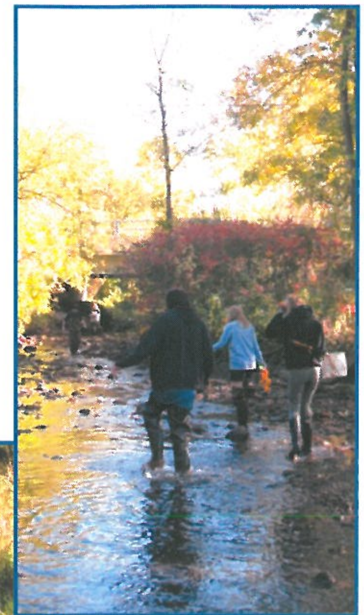


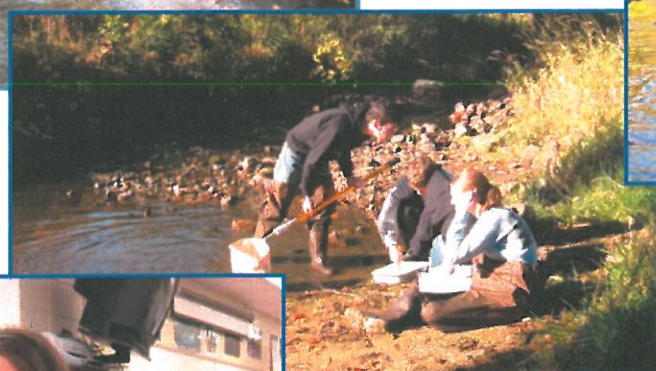




Hennepin County Environmental Services

Bassett Creek Watershed





For more information about the Hennepin County River Watch program, please contact:

Mary Karius
Hennepin County Environmental Services
417 N. 5th Street, Suite 200
Minneapolis, MN 55401
612-596-9129

Bassett Creek Watershed

River Watch is a program of Hennepin County Environmental Services sponsored by:

Bassett Creek Watershed Management Commission

Pioneer-Sarah Creek Watershed Management Commission

elm creek Watershed Management Commission

Minnehaha Creek Watershed District
IMPROVING QUALITY OF WATER, QUALITY OF LIFE

Shingle Creek

West Mississippi Watershed Management Commission

Bassett Creek Watershed

Every spring and fall students and their teachers go out into a Hennepin County stream to monitor for bugs. It's an eye-opening experience for everyone. The resulting data helps us to understand the health of the stream but doesn't always tell of the fun. From riding a bike (or trying to) found in the stream, to making the local paper, River Watch provides a whole lot more than data. Thanks to everyone who participated this year!

Lakeshore Weekly News

Covering The Greater Lake Minnetonka Area

The more bugs the better

Hopkins High School students wade into a creek to monitor water quality

Top, a small fish and an invertebrate collected by Hopkins AP science students in Minnehaha Creek. Above, Hopkins High School science teacher John Semmler, in red, and AP students, from left, Robbie Shapiro, Eshann Rao and Nikki Janssen collect biological samples in Minnehaha Creek next to Knollwood Mall Friday, Oct. 3

By David Schueller

Wearing waders and with nets in hand, Hopkins High School science students sloshed into a cool Minnehaha Creek searching for spineless creatures in the water.

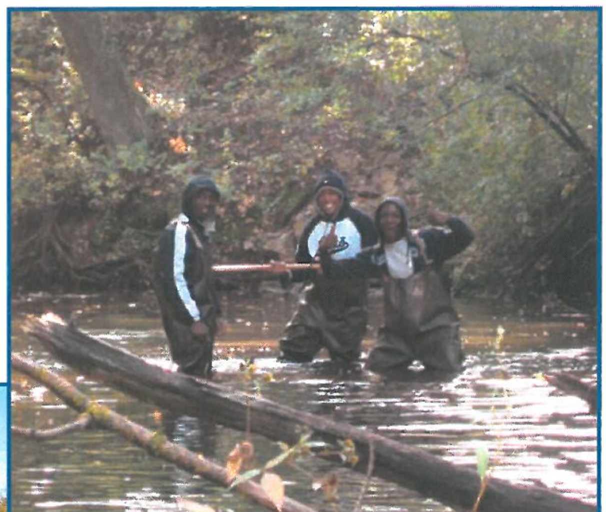
"It's an invertebrate!" said Robyn Pokorny, while using tweezers to hold the tiny black thing. "Ta-da."

"It's a little shrimpy thing," said Alyssa DeRubeis

The students found what they were looking for, and Hennepin County and the Minnehaha Creek Watershed District (MCWD) will reap the benefits of the data collected on Oct. 3 by Hopkins science teacher John Semmler's own advanced placement environmental science classes.

...

Wayzata students ace ACT, PSAT | Where will all



Bassett Creek Watershed

MONITORING GROUPS

School	Site	Teacher	Since
Benilde St. Margaret St. Louis Park	Minnehaha Creek #11	John Porisch	1998
Blake School Minneapolis	Bassett Creek BC#1	Dan Trockman	2007
Carondelet Minneapolis	Minnehaha Creek #25	Cece Cope	2004
Champlin High School Brooklyn Park	Elm Creek #26 Rush Creek #6	Pete Ockuly Jackie Paul	2004 2007
Cooper High School Robbinsdale	Bassett Creek #13	Jon Ong	1999
Highview Alternative School Crystal	Shingle Creek #27	Dustin Dobitz	2007
Hopkins High School Hopkins	Minnehaha Creek #9, #19 Bremer Bank site	Tom Nelson John Sammler	2007 New 2008
Kaleidoscope Charter School Rogers	Rush Creek #4	Paula Nelson	2005
Maple Grove High School Maple Grove	Elm Creek #5	Todd Martin	2008
Minnesota Transition Charter School Minneapolis	Minnehaha Creek #32	Wendy Anderson	2005
Newayee Center School Minneapolis	Minnehaha Creek	Cindy Ward Jim Lorenz	 2007
Park Center High School Brooklyn Park	Shingle Creek #10	Cindy Jahnke	1996
Patrick Henry High School Minneapolis	Shingle Creek #28	Charlene Ellingson	New 2008
Rockford High School Rockford	Pioneer Creek #24 Crow River #12	Jason Hester	2001
Saint Louis Park High School	Minnehaha at Izaak Walton Park, St. Louis Park	Al Wachutka	New 2008
South High School Minneapolis	Mattson Brook #20	Cindy Ward Staci Marshall	 2007
St. Michael—Albertville High School	Crow River #23	Kay Nowell	2004
Wayzata High School Wayzata	Elm Creek #17	Susie Newman	2006
West Lutheran High School Plymouth	Crow River #12	Steve Merten	1999

Hennepin County Stream Evaluations

Stream Grading Scale					
Family Biotic Index	Grade	EPT	Grade	Number of Families	Grade
0.00 – 4.00	A	9-12	A	12 - 15	A
4.01 – 5.75	B	6.0 - 8.9	B	9.1 - 11.9	B
5.76 – 6.50	C	3 - 5.9	C	6 - 9	C
> 6.50	D	< 3	D	< 6	D

Letter Grading Scale	
3.83 - 4.00	A
3.50 - 3.82	A-
3.17 - 3.49	B+
2.83 - 3.16	B
2.50 - 2.82	B-
2.17 - 2.49	C+
1.83 - 2.16	C
1.50 - 1.82	C-
1.17 - 1.49	D+
0.83 - 1.16	D
0.50 - 0.82	D-
0.00 - 0.49	F

The grading scale used in River Watch takes into account three major biotic indices used routinely in biological monitoring programs. The first component is the Family Biotic Index which measures the overall community of invertebrates and their tolerance to pollution levels. The scale ranges from 0 to 10 with the lower values indicating high sensitivity and good water quality if present.

EPT stands for Ephemeroptera, Plecoptera, and Trichoptera or mayflies, stoneflies, and caddisflies. These three families include the most sensitive individuals and is looked at for indications of presence or absence. Higher scores indicate better water quality.

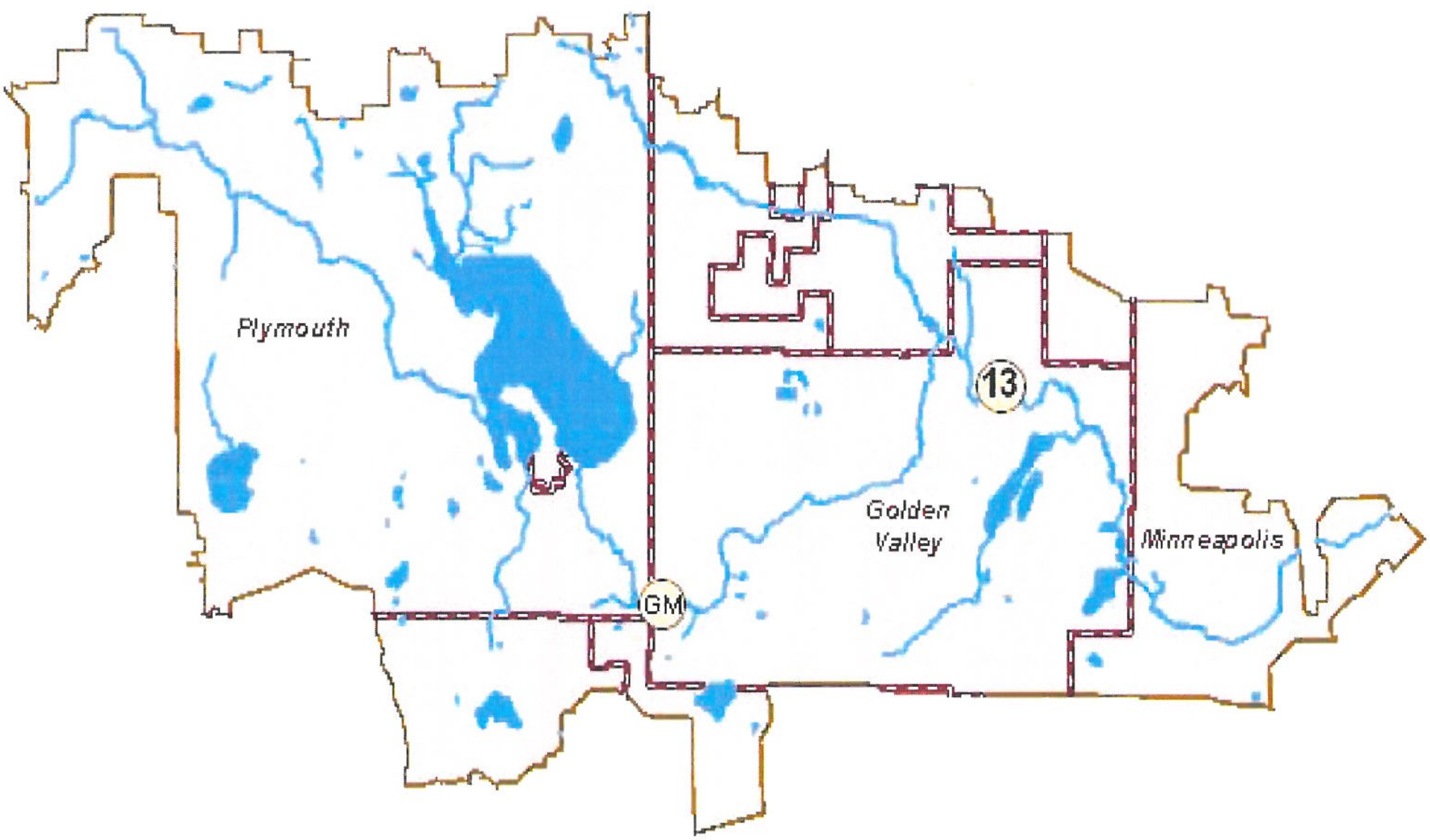
Finally, number of families measures the overall abundance of families or total diversity of family units. Again, with this index, the higher the number the better.

2008 Sites

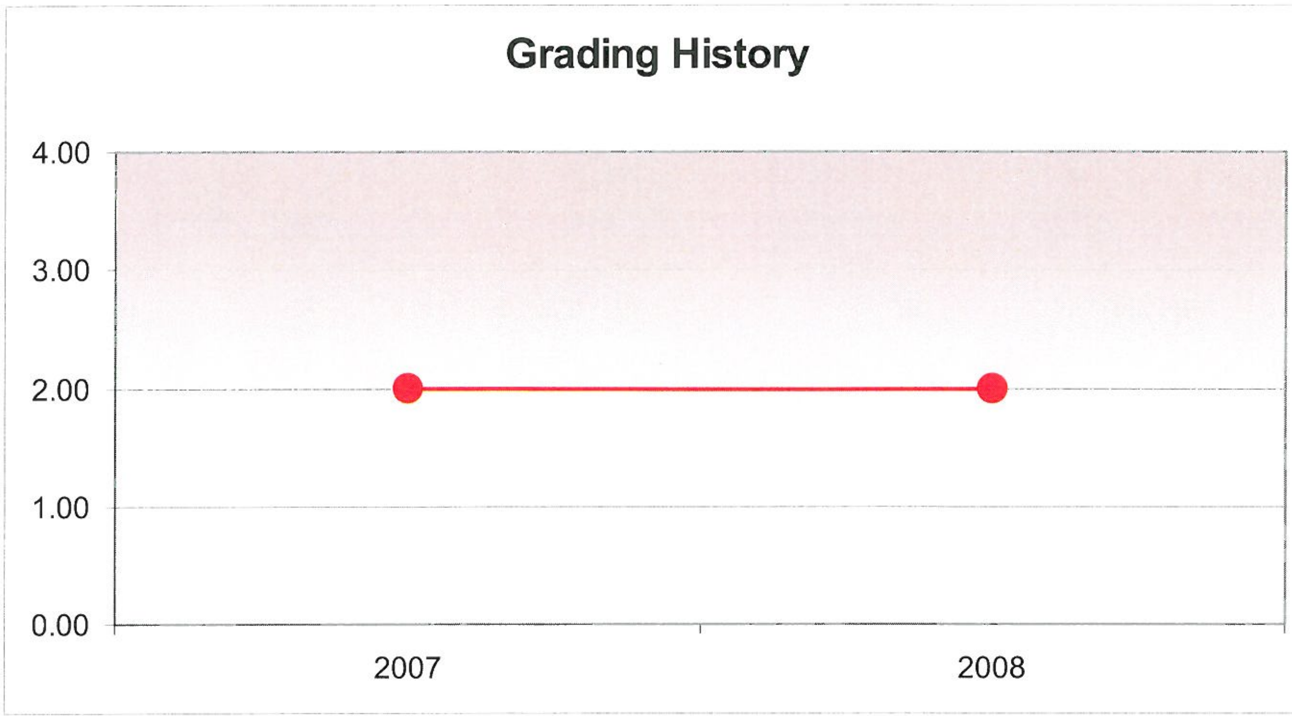
1. Bassett Creek at General Mills Park (GM), Golden Valley - Blake High School

2. Bassett Creek at Bassett Creek Drive (#13), Robbinsdale - Cooper High School

Students have been monitoring Bassett Creek since 1999. Jon Ong and his students at Cooper High School started their involvement in River Watch in 1999 at Site #13. They have monitored every year since for one of the longest data records in the program. New to the program in 2007, Blake High School continues to monitor the area designated as the General Mills Natural Area which is part of the Golden Valley park system.

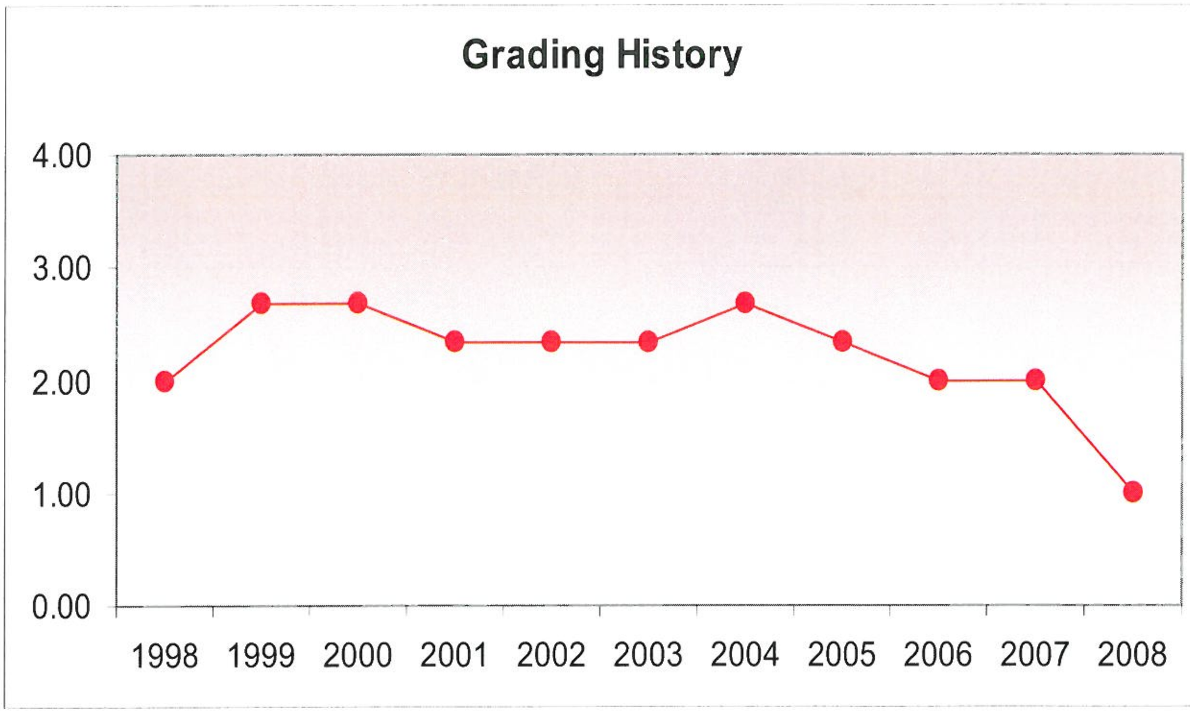


Bassett Creek Site GM
Golden Valley



Bassett Creek Site GM Grading History	
Year	Grade
2008	**C**
2007	C

Bassett Creek Site #13
Noble Avenue



Bassett Creek Site #13 Grading History	
Year	Grade
2008	**D**
2007	C
2006	C
2005	C+
2004	B-
2003	C+
2002	C+
2001	C+
2000	B-
1999	B-
1998	C

Average grade over 11 years = 2.21

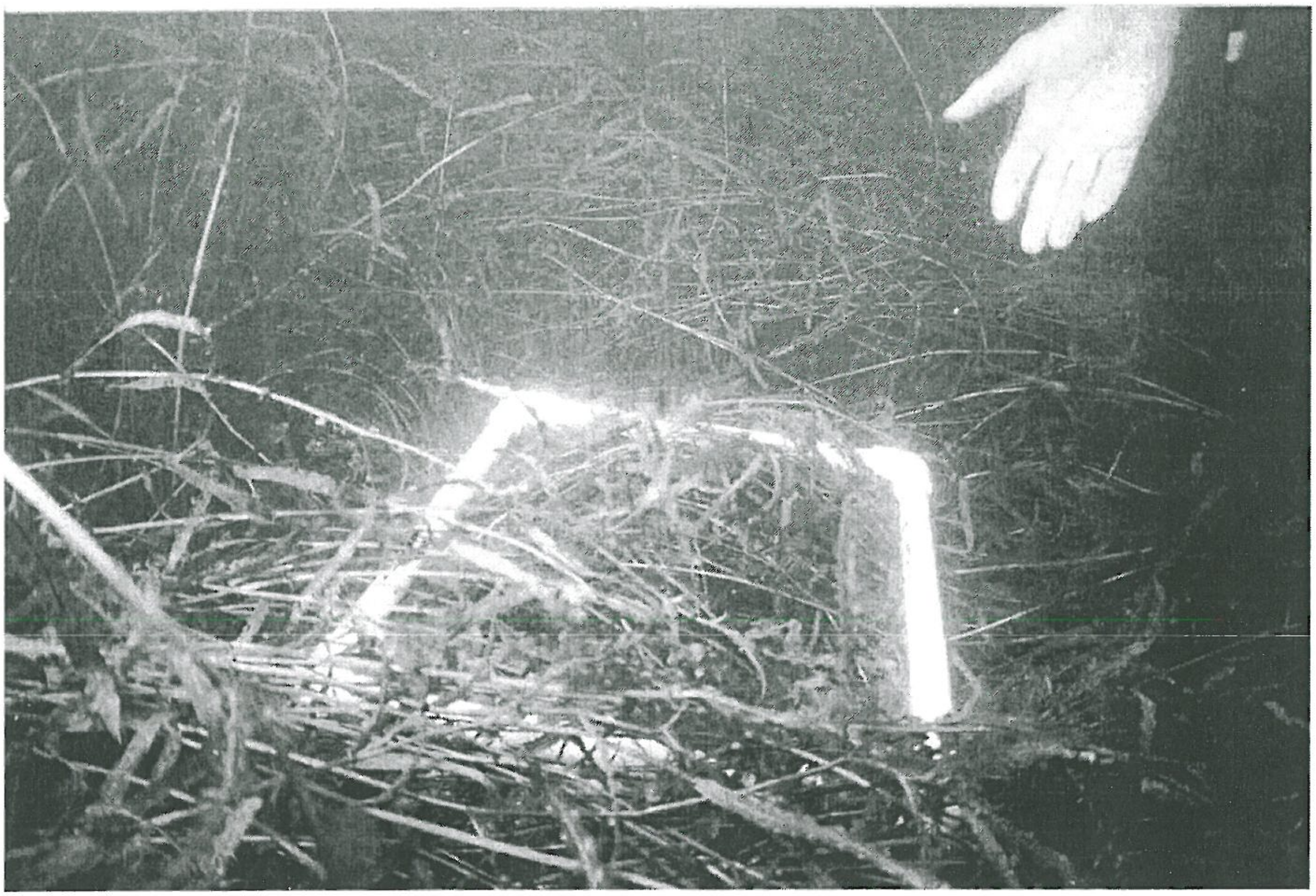
C+

Bassett Creek Watershed

Photographs of participants were supplied by the school groups and Fortin Consulting.

For additional copies of this report contact Hennepin County Environmental Services at: 612-596-9129

Hennepin



Curlyleaf Pondweed in Medicine Lake on June 9, 2008 at Site 3

Response of Curlyleaf Pondweed to Herbicide Treatments from 2004-2008 in Medicine Lake, Plymouth, Minnesota

	2004	2005	2006	2007	2008
Herbicide Application:	May 8-11	April 19, 21	April 18	no herbicide	May 12
Pre-Herbicide Plant Evaluation:	May 6	April 22	April 24	April 17	May 4
Post Herbicide Plant Evaluation and/or Curlyleaf Assessment	June 14	June 2	May 25	April 27, May 30	June 9
Herbicide Use:	1,668 gallons, 317 ac treated	1,400 gallons, 325 ac treated	1,400 gallons 325 ac treated	0 gallons (no herbicides used)	345 gallons 80 ac treated

Prepared for:
City of Plymouth
Plymouth, Minnesota

Prepared by:
Steve McComas
Blue Water Science
St. Paul, MN 55116
651.690.9602

Condensed Report: November 2008

Response of Curlyleaf Pondweed to Herbicide Treatments from 2004-2008 in Medicine Lake, Plymouth, Minnesota

Summary

Annual aggressive herbicide treatments treated at least 300 acres of curlyleaf in Medicine Lake in 2004, 2005, and 2006 with the objective to achieve long-term control of nuisance curlyleaf pondweed growth. The herbicide treatment, using Aquathol K, significantly reduced the spring density of curlyleaf pondweed at four monitoring sites in Medicine Lake following the application, indicating good annual control (Table 1). It was also observed that pre-treatment stem densities had decreased in 2005, 2006, and 2007 compared to pre-project stem densities taken in 2004 (Table 1).

In 2007, there was no herbicide treatment. Early season stem densities on April 17 were low at all four sample sites (Table 2). When re-sampling occurred about six weeks later, curlyleaf stem densities had increased at three of the four sample sites, reaching nuisance densities (arbitrarily set at 150 stems/m^2) at several individual quadrat locations.

In 2008, the early season curlyleaf stem density assessment was conducted on May 4, 2008. Curlyleaf stem densities had increased compared to 2007 early season (April 17) stem densities, but were still far below the early season stem densities recorded at the start of the project in 2004. On May 4, 2008 the early season survey, it was observed that curlyleaf runner formation had started but there were only two to three stems per turion. Because additional runner formation could result in substantial increases in curlyleaf stem densities herbicide treatments were conducted on known "hot spots" on the north and south ends of Medicine Lake totaling 80 acres.

Herbicide was applied on or about May 12, 2008 and the curlyleaf status was reevaluated on June 9, 2008. No viable stems were observed in the treated areas, although non-living stems were present. Two untreated areas were also monitored. In one untreated site, curlyleaf was abundant in density, but had a small distribution. In the second untreated site, curlyleaf growth was sparse.

It appears that selective herbicide treatments of 80 acres in Medicine Lake controlled the main areas of heavy growth in 2008. Because the north and south ends of Medicine Lake seem to be conducive to heavy curlyleaf growth, annual herbicide applications may be necessary to control heavy growth in these areas. In the future, the acreage treated could be further reduced to target just the areas of nuisance growth.

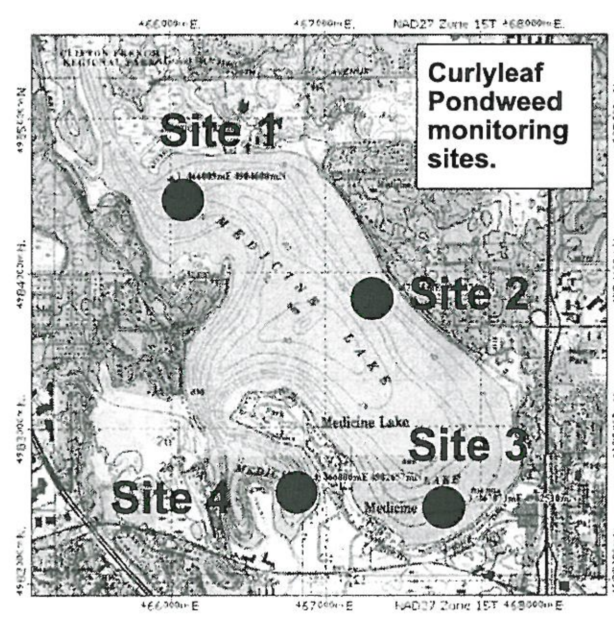
Curlyleaf Pondweed Densities in 2008: Curlyleaf stem densities were monitored on two dates in 2008, an early May conditions and a June condition (Table 1). Curlyleaf stem densities increased from May to June in seven out of eight sites. Herbicides were applied on May 12 in Sites 1 and 3. On June 9, stems were still present, but had died back and were brownish in color. They did not appear to be viable. However, stem counts were still taken. Stem densities had increased from May to June even though herbicides were added on May 12. It appears there may have been additional curlyleaf growth before the herbicide application took effect.

Stem densities at the two untreated areas were mixed. At Site 2, curlyleaf growth was light. At Site 4, curlyleaf growth was heavier but restricted to a narrow band because of the slope from 6 feet to 9 feet was steep and light growth was observed in shallower and deeper water.

Table 1. Curlyleaf pondweed stem densities at four sites in Medicine Lake in 2008.

		May 4, 2008	June 9, 2008	
		Curlyleaf Stems (stems/m^2)	Curlyleaf Stems (stems/m^2)	Upright Viable Stems (stems/m^2)
Site 1	6 ft	149	236	0
	9 ft	116	197	0
Site 2	6 ft	32	59	59
	9 ft	133	58	58
Site 3	6 ft	17	115	0
	9 ft	19	134	0
Site 4	6 ft	25	323	323
	9 ft	15	480	480
Average		63	200	115
6 ft average		55	183	96
9 ft average		71	217	135

Curlyleaf dieback at Site 3 on June 9, 2008 after a herbicide treatment on May 12, 2008. No viable stems were observed at this location.



Curlyleaf Pondweed Densities from 2004 - 2008: On May 6, 2004, curlyleaf stem densities were high. Curlyleaf was treated and stem densities were dramatically reduced by June 14, 2004 (Table 1 and Figure 1). Subsequent pre-treatment stem densities in 2005 and 2006 continued to decline. They were at an all time low on April 17, 2007. No herbicide treatment was conducted in 2007 and stem densities in some areas of Medicine Lake increased by May 30, 2007 (Table 2 and Figure 1). In 2008, early summer stem densities were higher than 2007, but substantially lower than densities in 2004, which was the start of the control program. Two sites (north and south) were treated in May of 2008 and by June, viable curlyleaf was sparse. A summary for all four sites (including the treated sites) is shown in Table 2 and Figure 1).

Table 2. Summary of curlyleaf pondweed stem densities for both pre and post herbicide treatment conditions. Stem densities represent averages from four sites on Medicine Lake.

	Stem Density (#/m²)				
Pre-Herbicide Conditions					
	2004 (May 6)	**2005 (April 22)**	**2006 (April 24)**	**2007 (April 17)**	**2008 (May 4)**
6 ft	643 (n=40)	419 (n=40)	127 (n=40)	13 (n=40)	55 (n=40)
9 ft	472 (n=40)	143 (n=40)	44 (n=40)	14 (n=40)	71 (n=40)
Post Herbicide Conditions					
	2004 (June 14)	**2005 (June 2)**	**2006 (May 25)**	**2007 (May 30)**	**2008 (June 9)**
6 ft	1 (n=40)	0 (n=40)	33 (n=40)	43 (n=40)	96 (n=40)
9 ft	1 (n=40)	0 (n=40)	24 (n=40)	111 (n=40)	135 (n=40)

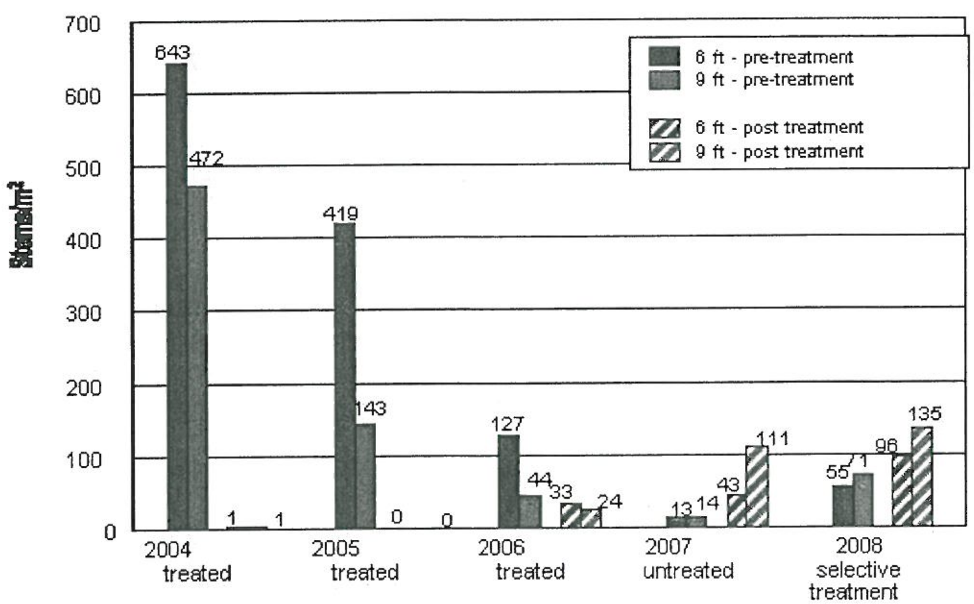


Figure 1. Pre-treatment and post treatment of Medicine Lake curlyleaf pondweed stem densities representing an average from four sites in 2004, 2005, 2006, 2007, and 2008 at 6-foot and 9-foot water depths.

Medicine Lake Curlyleaf Conditions in May and June, 2008

May 4, 2008	June 9, 2008
	
	
	
	

Long-term Curlyleaf Control Is a Challenge

In Medicine it appears it will be difficult to achieve long term control of curlyleaf pondweed. Even if it was possible to destroy all curlyleaf turions in a lake there would still be a potential for curlyleaf reestablishment. Seed germination has the potential to repopulate a lake in 3 to 4 years (Table 3). Therefore, because curlyleaf can come back from seeds it is probable that long term control of curlyleaf is unlikely.

From data on Medicine Lake as well as other lakes, if sediment conditions are conducive to growth, curlyleaf will grow. Therefore, annual treatments are still an option, but since long-term control with existing techniques is unlikely, we should consider treating only areas that produce nuisance growth and leave other areas alone.

Selective treatments would achieve nearly the same results as whole lake treatments and are less expensive.

Table 3. Curlyleaf regrowth from seeds. Assume seed density of 1,445 seeds/m^2 and a germination rate of 0.001%. After turion production is re-established, assume 60% germination rate of turions (from Rogers and Breen 1980).

	Year 1	Year 2	Year 3
Early Season Stem Density (stems/m^2)	**0.01445 stems/m^2** (assume 0.001% germination of seeds and a seed density of 1,445 seeds/m^2)	**0.87 stems/m^2** (assume 60% germination of 1.445 turions/m^2 from Year 1)	**52 stems/m^2** (assume 60% germination of 87 turions/m^2 from Year 2)
Late Season Stem Density (stems/m^2)	**0.1445 stems/m^2** (runners produce 10 stems)	**8.70 stems/m^2** (each sprouted turion produces runners and results in 10 stems/turion)	**520 stems/m^2** (each sprouted turion produces 10 stems. 520 stems/m^2 in year 3 represents heavy growth of curlyleaf)
Turions Produced (turions/m^2)	**1.445 turions/m^2** (each of the 10 stems produces 10 turions)	**87 turions/m^2** (each of the 10 stems produces 10 turions)	**5,200 turions/m^2** (each of the 10 stems produces 10 turions. There is a potential for nuisance growth conditions from here on.)

Medicine Lake Curlyleaf Pondweed Observations and Speculation

- The three year annual application of the herbicide, Aquathol K, eliminated nuisance aquatic plant conditions on an annual basis in Medicine Lake.
- Use of herbicides that kill curlyleaf before it produces turions appears to reduce the stem density of next year's curlyleaf "crop".
- Continued use of herbicides will continue to artificially induce a lower stem density condition the following year.
- Three years of aggressive herbicide treatment, where all curlyleaf areas were treated, eliminated nuisance curlyleaf growth in the season of treatment, but did not eliminate curlyleaf regrowth the following year in Medicine Lake.
- It is uncertain how many years of aggressive treatment are necessary to eliminate nuisance growth on a long term basis.
- In Medicine Lake when treatment was discontinued in areas where repeated herbicide applications had produced lower stem densities, curlyleaf stem densities increased over the growing season in areas where sediment conditions were conducive to abundant growth.
- Curlyleaf growth is substrate dependent. If stem densities are artificially reduced, as can occur with herbicides, and herbicide applications cease, curlyleaf will grow to satisfy substrate characteristics within a year or two.
- Long-term nuisance control of curlyleaf may be difficult to achieve unless substrate composition changes occur that limits curlyleaf growth.
- Curlyleaf stem densities may be correlated with sediment conditions. Under the right sediment conditions, stem densities will be naturally high. Under less hospitable sediment conditions, stem densities will be naturally low.
- Herbicide treatments that target areas of heavy curlyleaf growth while leaving areas of light growth untreated is a management option.

Review of Curlyleaf Management Strategies

After a solid decade of curlyleaf management research two major management strategies have emerged. The first is an aggressive curlyleaf control strategy where the whole lake is treated (or at least all the curlyleaf areas are treated) for a number of years and then spot treatments are implemented. The second strategy involves treating just the nuisance growth of curlyleaf pondweed on an annual basis. Advantages, disadvantages, and costs for the two strategies are shown below.

	Strategies	
	1. Whole Lake Curlyleaf Control	**2. Nuisance Curlyleaf Control**
Approach	Treat all curlyleaf pondweed for up to 8 consecutive years to reduce turions and limit growth. Then after the whole lake treatment program is completed, only treat nuisance areas.	Treat only nuisance areas and leave non-nuisance areas alone. Treatment can be guided based on lake sediment testing to determine areas of potential nuisance growth.
Advantages	There will rarely be any heavy growth of curlyleaf, especially through the whole lake treatment years. If all areas of growth are nuisance growth, then whole lake treatments are cost-effective too.	Theoretically, areas of nuisance growth should be limited with the spot treatment applications. Also, harvesting can be used for spot control.
Disadvantages	It is uncertain how many years of whole lake aggressive treatments are needed. Because curlyleaf can germinate from seeds, it is unlikely curlyleaf will be eradicated even if all turions are destroyed. After an aggressive program is completed.	Curlyleaf growth from year to year is variable. Trying to treat areas early, before curlyleaf reaches full maturity, may miss some areas. Conversely, in some years, areas could be treated that wouldn't produce nuisance growth. In these cases, over treatment would occur.
10-year Cost	Assume there are 300 acres of curlyleaf in a lake. Assume a herbicide cost of $400/acre. Then a whole lake treatment is $120,000/year. Assume an annual treatment for 7 years = $840,000. Assume no treatment is needed for the next three years (although spot treatments would be needed in the fourth year (year 11). Total 10-year cost: $840,000.	Assume 300 acres of curlyleaf with 80 acres of nuisance growth. Assume a herbicide cost of $400/acre. Then a nuisance treatment cost is 80 acres x $400 = $32,000. Assume an annual treatment for 10 consecutive years = $320,000. Total 10-year cost: $320,000.

Conclusions: Whole lake treatments should continue, in some settings, for research benefits. However for Medicine Lake, the nuisance control strategy is the more cost-effective option for curlyleaf management. It could save over $500,000 over a 10-year period.

Recommendations

Based on results of the Medicine Lake curlyleaf control program, curlyleaf control options for 2009 fall into three categories: 1) only treat the nuisance areas as defined by surveys conducted by the US ACE, Three Rivers Park District, or the MnDNR and verified by Blue Water Science; 2) re-establish a whole lake herbicide treatment program as was done in 2004, 2005, and 2006 and continue for the next several years; or 3) use no herbicides in 2009 and then monitor curlyleaf densities.

I recommend Option 1 as the project approach for 2009. Results of monitoring curlyleaf growth patterns over the last few years indicate it has the potential to grow to nuisance conditions in several locations around Medicine Lake with coverage of a total of 40 to 85 acres. These nuisance growth locations are primarily in the north and south ends of the lake. Surveys in April of 2009 should be used to specifically delineate treatment areas for an early May herbicide application.

Jay Connaway: *Lobsterman in Heavy Seas*

Aquatic Plant Surveys for Parker's Lake, Plymouth, Minnesota, 2008

Early Summer Survey: May 27, 2008
Late Summer Survey: August 14, 2008

Prepared for:
City of Plymouth
Plymouth, Minnesota

Prepared by:
Steve McComas and Jo Stuckert
Blue Water Science
St. Paul, MN 55116

November 2008

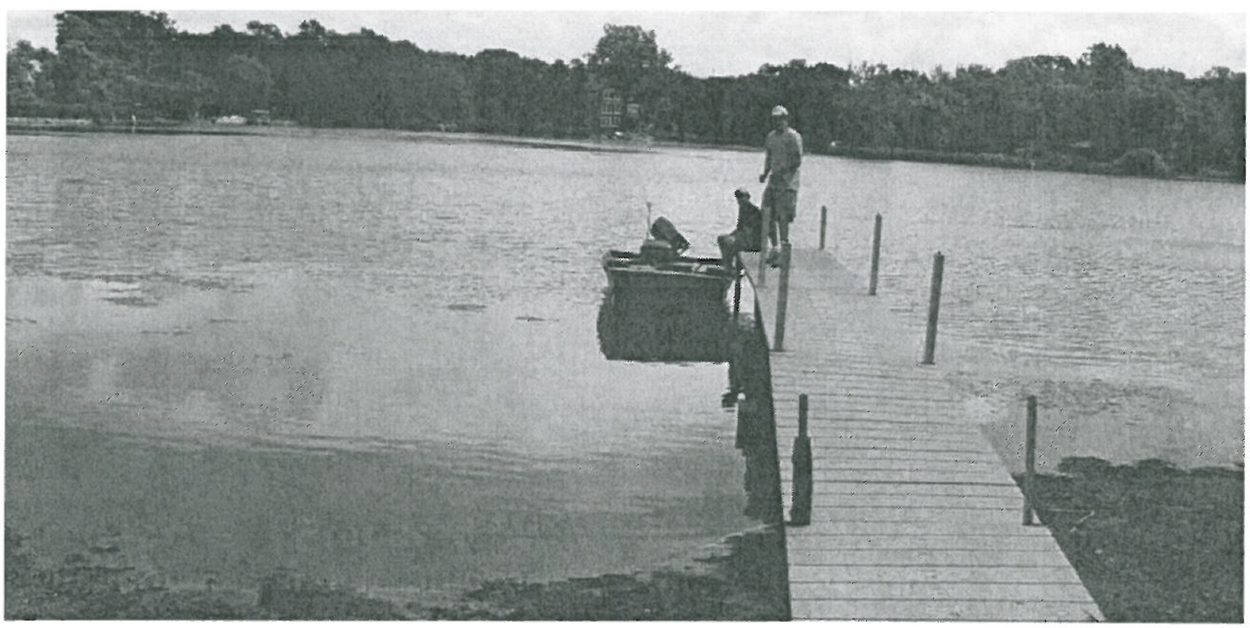
Aquatic Plant Surveys for Parkers Lake, Plymouth, Minnesota, 2008

Summary

Two plant surveys were conducted on Parkers Lake in 2008. The first survey was conducted on May 27, 2008 and consisted of 16 transects around Parkers Lake. Aquatic plants cover about 58% of the lake bottom (56 out of 97 acres). Nine plant species were identified in Parkers Lake with curlyleaf pondweed being the most common plant (Table I). Curlyleaf pondweed grew out to a water depth of 14 feet but at low densities and did not create surface matting.

The second aquatic plant survey was conducted later in the summer, on August 14, 2008 and consisted of 16 transects around Parkers Lake. By this time of the summer, curlyleaf pondweed and stringy pondweed had died back, although aquatic plants still covered about 57% of the lake bottom. Thirteen plant species were identified in Parkers Lake with coontail being the most common plant. Eurasian watermilfoil and the milfoil hybrid were common (Table II). Plants grew out to a water depth of 15 feet.

Eurasian watermilfoil (EWM) occurrence increased in Parkers Lake in 2008 was reduced compared to the distribution in 2007. Several acres of matted growth of EWM was observed in the 2008 August survey.



In late summer of 2008, aquatic plant growth in Parkers Lake was mostly subsurface. In 2007, milfoil was much more abundant.

A comparison of plant occurrence for early and late summer surveys from 1951 through 2008 is shown in Tables 1 and 2. Plant diversity has fluctuated over the years. One significant new species has been Eurasian watermilfoil (first discovered in 1991), but other species have come and gone as well. The herbicide, fluridone (trade name Sonar) was applied to Parkers Lake in 1994. In 2007, there was a significant increase in distribution and abundance of Eurasian watermilfoil, but in 2008, milfoil distribution and abundance was significantly lower.

Table 1. Parkers Lake aquatic plant frequency for transect occurrence (%) in early summer.

EARLY SUMMER SURVEYS Aquatic Plants	5.2. 1951	6.10. 1985	6.23. 1992	5.23. 1994 (sonar added)	5.30. 1995	5. 1996	6.14. 2000*	6.18. 2002	6.9. 2003	6.14. 2005	5.19. 2006	5.30. 2007	5.27. 2008
Coontail (*Ceratophyllum demersum*)		A	24				20	75	22	16	25	13	40
Chara (*Chara sp*)			2		7	23	47	50	11	4	6	2	
Elodea (*Elodea canadensis*)	X**	C	2				20	6					
Star duckweed (*Lemna trisulca*)												2	23
Northern watermilfoil (*Myriophyllum sibiricum*)			11				13	6	4	4			4
Eurasian watermilfoil (*Myriophyllum spicatum*)			32	19		7	40	81	49	11	6	89	21
Hybrid watermilfoil (*M. sp*)													15
Naiad (*Najas flexilis*)			8				33						
Curlyleaf pondweed (*Potamogeton crispus*)		C	47	70	97	93	73	56	47	47	50	54	66
Illinois pondweed (*P. illinoensis*)													2
Stringy pondweed (*P. foliosus/pusillus*)	X			15		7	80	100	67	76	94	26	21
Narrowleaf pondweed (*P. strictifolius*)			3				20						
Flatstem pondweed (*P. zosteriformis*)	X	R	32	52			67	69	60	69	94	7	13
Narrowleaf pondweed (*P. sp*)		C											
White water buttercup (*Ranunculus sp.*)			12	22		7	20	6	4	2			
Yellow water buttercup (*Ranunculus flagellaris*)			3										
Sago pondweed (*Stuckenia pectinata*)	X	A	21	37	13	23	60						
Water stargrass (*Zosterella dubia*)		A		4	13	47	93						
Number of Species	**4**	**7**	**12**	**7**	**3**	**6**	**13**	**9**	**8**	**8**	**6**	**7**	**9**
Investigator	**DNR**	**DNR**	**BCWMC**	**DNR**	**DNR**	**DNR**	**BCWMC**	**BWS**	**BWS**	**BWS**	**BWS**	**BWS**	**BWS**

* Data points from the Barr survey were assigned to transects set up by Blue Water Science.

** Referred to as western waterweed (*Anacharis occidentalis*)

Eurasian watermilfoil (EWM) was discovered in Parkers Lake in 1991 and in 1994 the MnDNR conducted a whole lake test of the herbicide fluridone (trade name: Sonar) to reduce the presence of milfoil. The herbicide application reduced Eurasian watermilfoil and several other plant species and their densities for about a year. EWM did come back and after 2 years from the fluridone treatment, its occurrence was close to pretreatment occurrence. It does not appear that any species were lost due to the herbicide treatment except maybe northern watermilfoil.

From 1975, the aquatic plant community has fluctuated over the years. For example, chara and stringy pondweed came in strong in 2000, but have decreased in the last few surveys.

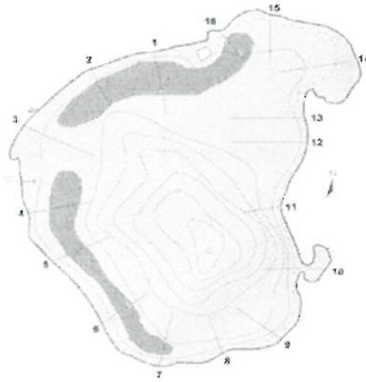
The aquatic plant community remains dynamic from the view that species abundance is variable from year to year.

Table 2. Parkers Lake aquatic plant frequency for transect occurrence (%) in late summer.

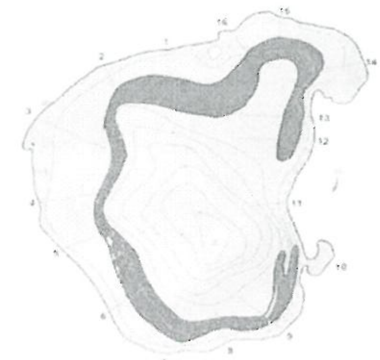
LATE SUMMER SURVEYS **Aquatic Plants**	**8.7. 1975**	**8.19. 1992**	**7.15. 1993**	**8.24. 1993**	**7.1. 1994 (sonar added)**	**8.22. 1994**	**8.22. 1995**	**8.22. 1996**	**8.24. 2000***	**10.26. 2002**	**8.13. 2003**	**9.6. 2005**	**8.9. 2006**	**7.16. 2007**	**8.14. 2008**
Coontail (*Ceratophyllum demersum*)	A	48	53	63	10				33	63	42	11	27	46	77
Chara (*Chara sp*)			3		17	13	20	47	80	44	4	16	9		30
Elodea (*Elodea canadensis*)							3	7	27					2	
Star duckweed (*Lemna trisulca*)														15	26
Northern watermilfoil (*Myriophyllum sibiricum*)		9	30	37					13	19	7				9
Eurasian watermilfoil (*Myriophyllum spicatum*)		43	87	37			3	30	60	75	60	13	82	93	16
Hybrid watermilfoil (*M. sp*)															43
Naiad (*Najas flexilis*)		11	23				10	10	47						
Nitella (*Nitella sp*)															2
Berchtold's pondweed (*Potamogeton berchtoldi*)		7													
Curlyleaf pondweed (*P. crispus*)		2	73		7	13	47	27							5
Stringy pondweed (*P. foliosus/pusillus/sp*)			67	3	10		13	30	80		31		29		11
Narrowleaf pondweed (*P. strictifolius*)		4							27	31				2	
Flatstem pondweed (*P. zosteriformis*)		44	87	93	33	7	7	7	67	50	62	60	40	30	23
Narrowleaf pondweed (*P. sp*)															
White water buttercup (*Ranunculus sp.*)		9	47	30			7	10	27						
Yellow water buttercup (*Ranunculus flagellaris*)															
Sago pondweed (*Stuckenia pectinata*)		17	37		13		50	40	60		7	4	13	4	5
Water celery (*Vallisneria americana*)											2		4	4	7
Water stargrass (*Zosterella dubia*)				13	17	17	47	53	93	81	9	60	15		5
Number of Species	**1**	**10**	**9**	**7**	**6**	**3**	**9**	**9**	**12**	**7**	**9**	**6**	**8**	**8**	**13**
Investigator	DNR	BCW MC	DNR	DNR	DNR	DNR	DNR	DNR	BCW MC	BWS	BWS	BWS	BWS	BWS	BWS

* Data points from the Barr survey were assigned to transects set up by Blue Water Science.
** Referred to as western waterweed (*Anacharis occidentalis*)

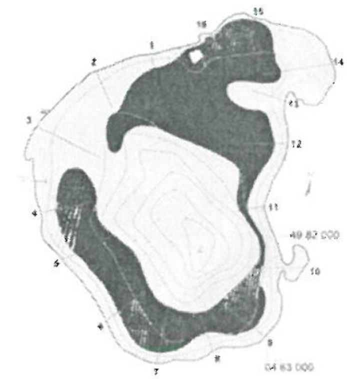
Distribution of Curlyleaf Pondweed in Parkers Lake in Early Summer



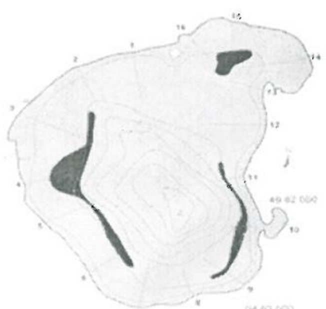
Curlyleaf pondweed coverage on June 18, 2002 was about 11 acres (shown in green). Curlyleaf did not "top out" in 2002.



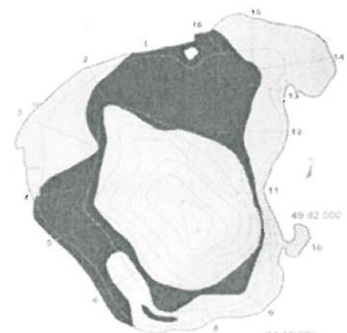
Curlyleaf pondweed coverage on June 9, 2003 was about 18 acres (shown in green). Curlyleaf topped out on Transect 15 in about 4 feet of water.



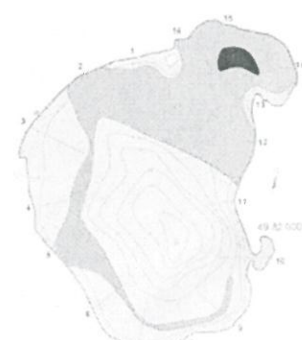
Curlyleaf pondweed coverage on June 14, 2005 increased to about 36 acres (shown in green). Curlyleaf did not "top out" in 2005.



Curlyleaf pondweed coverage on May 19, 2006 was estimated at 6 acres.



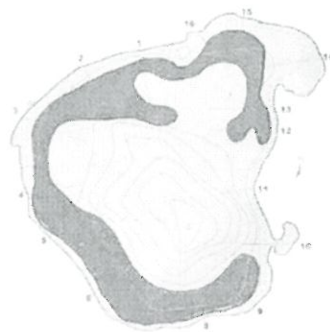
Curlyleaf pondweed coverage on May 30, 2007 was estimated at 36 acres. Curlyleaf did not grow to the surface in 2007, although Eurasian watermilfoil did on Transects 1, 2, and 8.



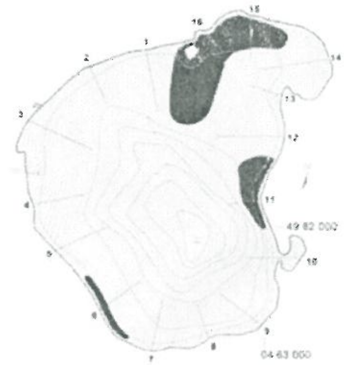
Curlyleaf pondweed coverage on May 27, 2008 was estimated at 39 acres with nuisance curlyleaf growth estimated at 1.5 acres (shown in red).

Distribution of Eurasian Watermilfoil in Parkers Lake in Late Summer

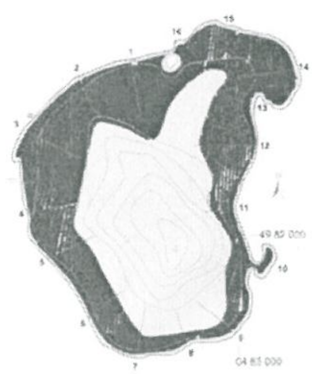
EWM distribution on October 26, 2002 was fairly widespread (shown in green) and covered 32 acres. Areas where Eurasian watermilfoil was topping out are shown in red shading (about 6 acres).



EWM distribution on August 13, 2003 was fairly widespread (shown in green) and covered 31 acres. There was no topping out of EWM in 2003.

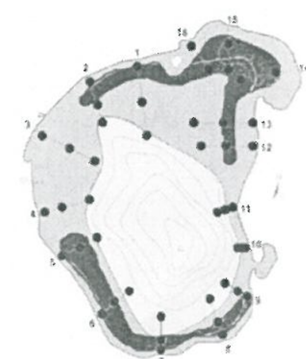


EWM distribution on September 6, 2005 (shown in green) decreased compared to 2002 and 2003. EWM covered about 13 acres in 2005, at a low density.



EWM distribution on August 8, 2006 was widespread (shown in green) and covered 57 acres. Some of the EWM growth was heavy by the end of the summer.

EWM distribution on July 16, 2007 was widespread (shown in red and green) and covered 63 acres total. Areas where EWM was a nuisance are shown in red and covered 40 acres.



EWM distribution on August 14, 2008 was estimated at 17 acres (shown in dark green). Nuisance growth of EWM was estimated at 2.6 acres (shown in red).

Aquatic Plant Recommendations for 2008: Eurasian watermilfoil continues to change in Parkers Lake. Because nuisance growth of Eurasian watermilfoil was observed in 2006 and 2007 it may need management in 2008. It is recommended to continue conducting spring and fall aquatic plant surveys to characterize dynamics of curlyleaf pondweed, Eurasian watermilfoil, nuisance native plants, as well as the rest of the native plant species. Either herbicides or harvesting nuisance vegetation are options if nonnative plants interfere with swimming or boating in the area by the public access.

Mechanical harvesting is an option for managing nuisance aquatic plant growth and was used in 2006, 2007, and 2008.

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Technical Memorandum

To: Bassett Creek Watershed Management Commissioners
From: Barr Engineering Company (Matt Hernick)
Subject: 2008 Bassett Creek Fish Index of Biological Integrity (IBI)
Date: December 11, 2008
Project: 23/27-0051.08-2008-503
c: Len Kremer

In the summer of 2008 Minnesota Pollution Control Agency (MPCA) staff conducted electro-fishing at four locations in Bassett Creek and its tributaries. Backpack electro-fishing units were used to stun fish in the creek, which were classified, measured, weighed, and released. The data that MPCA gathered (see Table 2) were forwarded to Barr Engineering Co. and used to calculate the Index of Biological Integrity (IBI) for fish in Bassett Creek. The calculations followed the standard methods defined in the *Index of Biological Integrity Guidance for Coolwater Rivers and Streams of the Upper Mississippi River Basin*, published by the MPCA Biological Monitoring Program in 2002. An entire stream is considered impaired for fish if the IBI for fish in any section is below 46.

Results of the IBI calculation are shown in Table 1. Two of the four sites do not meet the MPCA standard (i.e. IBI less than 46), thus Bassett Creek is impaired. All of the 2008 fish data for the creek are listed in Table 2, and Tables 3 – 6 display the components of the IBI calculation at each site.

Table 1: IBI Calculation Results

Site Evaluated in 2008	Site #	Fish IBI	Impaired?
Downstream of Penn Ave. in Minneapolis	00UM105	53	No
Upstream of Douglas Drive in Crystal	00UM094	0	Yes
Downstream of Hwy 55 in Golden Valley	08UM074	56	No
At Dresden Lane in Golden Valley	97UM006	44	Yes
Bassett Creek		--	**Yes**

Table 2: 2008 Bassett Creek Fish Data

Waterbody Name & Location	Visit Date	Station Length (m)	Fish Species Common Name	# of Individuals	Weight (g)	Length Min (mm)	Length Max (mm)	Anomalies
Bassett Creek Downstream of Penn Ave. Minneapolis	6/17	420	creek chub	16	259	95	119	
			johnny darter	14	26	42	64	
			black crappie	11	639	155	165	1 lesion
			spotfin shiner	2	9	70	77	
			blacknose dace	1	6	80	80	
			bluntnose minnow	30	75	47	84	
			fathead minnow	1	3	68	68	
			bluegill	5	195	98	151	
			green sunfish	13	120	55	85	
			hybrid sunfish	1	5	63	63	
			yellow bullhead	1	42	138	138	
			black bullhead	20	2683	114	232	1 lesion
			white sucker	20	968	30	443	
North Branch of Bassett Creek Upstream of Douglas Drive	6/19	150	black bullhead	60	3435	66	226	
			common carp	11	632	115	180	2 eroded fins, 1 lesion
			goldfish	1	137	175	175	
Bassett Creek Downstream of Hwy 55 Golden Valley	7/28	192	common carp	27	275	51	116	1 lesion
			creek chub	12	256	52	154	
			bigmouth shiner	2	0.5	40	47	
			Iowa darter	3	2	46	58	
			fathead minnow	11	39	36	71	
			white sucker	3	78	61	142	
			blacknose dace	6	52	37	96	
			green sunfish	1	0.5	29	29	
			johnny darter	21	53	29	67	
			central mudminnow	1	6	75	75	
			yellow bullhead	1	0.5	36	36	
Bassett Creek at Dresden Ln Golden Valley	7/28	175	white sucker	69	8275	51	366	2 lesions, 1 deformity
			creek chub	82	3606	47	193	
			common carp	1	9	75	75	
			brook stickleback	1	1	46	46	
			fathead minnow	12	13	39	44	
			central mudminnow	9	54	39	85	
			green sunfish	15	215	61	100	
			johnny darter	35	49	31	67	
			northern pike	3	995	165	495	

Table 3

00UM105 Bassett Creek Downstream of Penn Ave. in Minneapolis

Year	Sample Date	IBI Metrics	IBI Metric Scores	Fish IBI
2008	6/17/2008	**Species Richness and Composition Metrics**		
		Total Number of Species (12)	7	
		Number of wetland species* (1)	5	
		Number of minnow species* (1)	2	
		Number of intolerant species (0)	0	
		Percent tolerant species (75%)	2	
		Percent dominant two species (37%)	10	
		Trophic and Reproductive Function Metrics		
		Number of invertivore species* (3)	5	
		Percent simple lithophils (16%)	2	
		Fish Abundance and Condition Metrics		
		Number of fish per 100 meters* (8.1)	10	
		Percent DELT anomalies (1%)	10	
		Fish IBI (Total Metric Score)	53	**53**

Table 4

00UM094 North Branch of Bassett Creek Upstream of Douglas Drive in Crystal

Year	Sample Date	IBI Metrics	IBI Metric Scores	Fish IBI
2008	6/19/2008	**Species Richness and Composition Metrics**		
		Total Number of Species (2)	0	
		Number of wetland species* (0)	0	
		Number of minnow species* (0)	0	
		Number of intolerant species (0)	0	
		Percent tolerant species (100)	0	
		Percent dominant two species (100)	0	
		Trophic and Reproductive Function Metrics		
		Number of invertivore species* (0)	0	
		Percent simple lithophils (0)	0	
		Fish Abundance and Condition Metrics		
		Number of fish per 100 meters* (1)	0	
		Percent DELT anomalies (4%)	0	
		Fish IBI (Total Metric Score)	0	**0**

*Number of wetland species, number of minnow species, number of invertivore species, and number of fish per 100 meters do not include tolerant species.

Table 5

08UM074 Bassett Creek Downstream of Hwy 55 in Golden Valley

Year	Sample Date	IBI Metrics	IBI Metric Scores	Fish IBI
2008	7/28/2008	**Species Richness and Composition Metrics**		
		Total Number of Species (11)	7	
		Number of wetland species* (2)	5	
		Number of minnow species* (1)	2	
		Number of intolerant species (1)	5	
		Percent tolerant species (69%)	5	
		Percent dominant two species (55%)	7	
		Trophic and Reproductive Function Metrics		
		Number of invertivore species* (3)	5	
		Percent simple lithophils (10%)	0	
		Fish Abundance and Condition Metrics		
		Number of fish per 100 meters* (14.1)	10	
		Percent DELT anomalies (1%)	10	
		Fish IBI (Total Metric Score)	56	**56**

Table 6

97UM006 Bassett Creek At Dresden Lane in Golden Valley

Year	Sample Date	IBI Metrics	IBI Metric Scores	Fish IBI
2008	7/28/2008	**Species Richness and Composition Metrics**		
		Total Number of Species (9)	5	
		Number of wetland species* (1)	5	
		Number of minnow species* (0)	0	
		Number of intolerant species (0)	0	
		Percent tolerant species (83%)	2	
		Percent dominant two species (67%)	5	
		Trophic and Reproductive Function Metrics		
		Number of invertivore species* (1)	2	
		Percent simple lithophils (30%)	5	
		Fish Abundance and Condition Metrics		
		Number of fish per 100 meters* (21.7)	10	
		Percent DELT anomalies (1%)	10	
		Fish IBI (Total Metric Score)	44	**44**

*Number of wetland species, number of minnow species, number of invertivore species, and number of fish per 100 meters do not include tolerant species.

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Technical Memorandum

To: Bassett Creek Watershed District Commissioners
From: Barr Engineering Company (Matt Hernick)
Subject: Bassett Creek E. Coli Bacteria Monitoring 2008
Date: 12/11/2008
Project: 23/27-0051.08-2008-507
c: Len Kremer

During the months of July, August, and September 2008 Barr Engineering Co. collected water samples at six locations along Bassett's Creek (see last page of memo) to determine the presence and quantity of bacteria in the steam. The samples were analyzed at the Minnesota Department of Health (MDH) Lab in St. Paul for E. Coli bacteria. All samples tested contained E. Coli, ranging from 23 MPN (Most Probable Number) per 100 ml to a maximum of more than 2,400 MPN / 100ml. Test results for all samples are in Table 1, all values are in MPN / 100ml. Figure 1 is a graphical representation of the E. Coli data.

Samples were collected in 250ml plastic bottles provided by MDH directly from the stream, utilizing disposable gloves. The bottles were uncapped and filled underwater, temporarily capped and brought to the surface, then excess water poured off to reach the 'fill line'. Samples were put on ice immediately after collection and delivered directly to the MDH lab after completion of sampling at the sixth site.

The density of E. Coli bacteria appears to be influenced by rainfall and runoff; the greatest number of E. Coli bacteria occurred on July 8 and September 24, when 3-4 times as much bacteria was present than the other days samples. In both cases significant rainfall was observed the day prior to sampling, as shown in Table 2. Stream velocity also likely influences the number of bacteria observed. This is apparent in a comparison of the bacterial counts from Site #3 and Site #6, a very slow-flowing pool with soil banks, and a swift-flowing rip-rapped section, respectively.

Under the State Standard (7050 Rule), E. Coli is not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31.

Table 1: E. Coli Data, MPN / 100ml

STORET ID	s005-012	s005-013	s005-014	s005-015	s005-016	s005-017	
Date	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	Avg. by Date
7/8/2008	770	2400	2400	1100	1600	820	1515
7/17/2008	410	100	650	190	290	43	281
7/23/2008	78	490	770	120	170	35	277
8/6/2008	250	220	650	330	300	100	308
8/12/2008	710	370	710	520	310	23	441
8/20/2008	250	96	580	1300	280	120	438
9/9/2008	820	820	250	650	920	130	598
9/16/2008	140	360	710	210	580	130	355
9/24/2008*	2400	2400	2400	2400	2400	2400	2400
Avg. by Site	648	806	1013	758	761	422	735

* all samples 9/24/08 were >2400 MPN/100 ml, displayed as 2400

Table 2: Additional Site and Weather Data

Date	Barr Sampler	Sampler's Recorded Weather	Day of Sampling Rainfall [in]	Previous Day Rainfall [in]	E. Coli MPN/100ml Avg. by Date
7/8/2008	IJH & MAH2	75F, Clear, light breeze, Rain last night	0	0.47	1515
7/17/2008	IJH	80F, cloudy w/chance of rain, lt. breeze	0.17	0	281
7/23/2008	IJH	75F, clear, calm	0	0	277
8/6/2008	IJH	85F, clear	0.05	0	308
8/12/2008	IJH	70F, cloudy, rainy	0.4	T	441
8/20/2008	IJH	80F, sunny & beautiful	0	0	438
9/9/2008	MAH2	50F, clear and cool	0	0	598
9/16/2008	MAH2	50F, clear	0	0	355
9/24/2008	MAH2	55F, clear, rain yesterday and last night	0	0.61	2400

* Rainfall data from http://climate.umn.edu/doc/twin_cities/msp2000's.htm

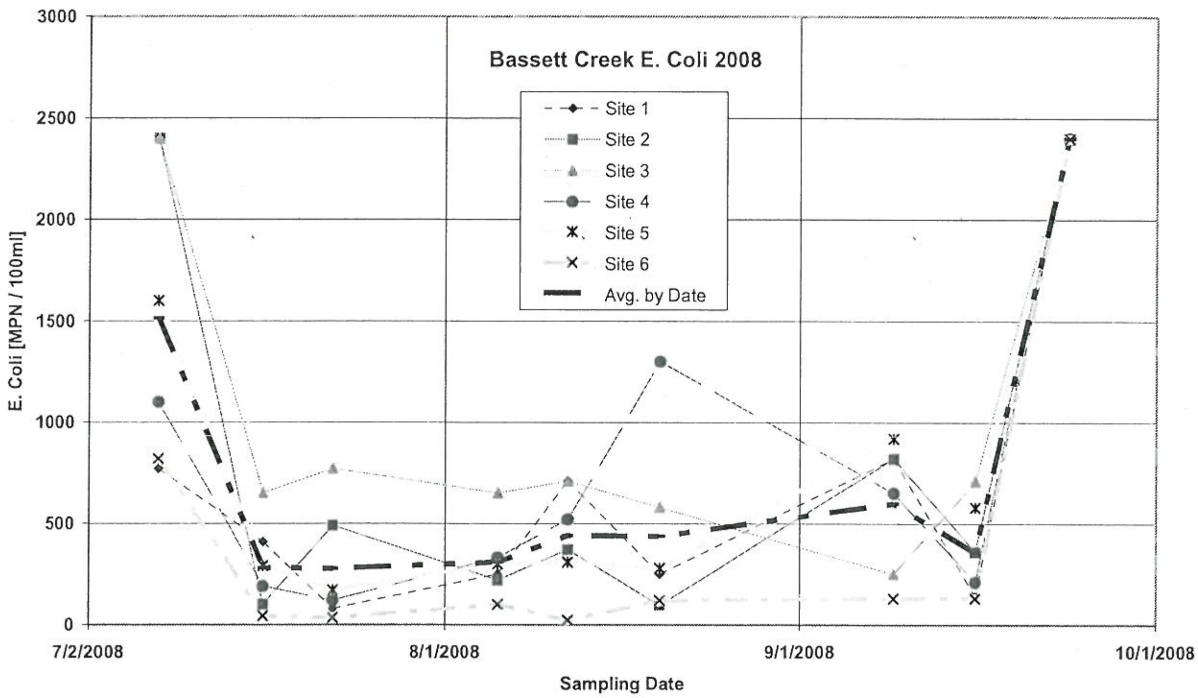

Figure 1: E. Coil Sampling Results

Sampling Locations:

#1 (STORET ID s005-012)

Location: Plymouth Creek, north of parking lot of building at north corner of Industrial Park Bvld and Teakwood Ln., Plymouth.

Stream conditions: Gravel and silt bottom, often shallow flow

#2 (STORET ID s005-013)

Location: Bassett Creek Main Stem, south of end of Rhode Island Ave., 1 block south of Phoenix St., Golden Valley. Downstream of culverts under railroad embankment.

Stream conditions: Gravel and silt bottom, often shallow flow

#3 (STORET ID s005-014)

Location: North Branch of Bassett Creek, just north of 32nd Ave N between Brunswick Ave and Adair Ave, Crystal.

Stream conditions: Silt bottom, very slow to almost stagnant flow in pool caused by woody debris dam in front of box culverts under 32nd Ave N.

#4 (STORET ID s005-015)

Location: Bassett Creek Main Stem, ~1000ft upstream of junction with Bassett Creek North Branch, near a red house near Golden Valley / Crystal boundary.

Stream conditions: Generally fast flowing, gravel/sand bottom. Waterfowl often present near sampling site.

#5 (STORET ID s005-016)

Location: Bassett Creek Main Stem, back yard of 3900 Bassett Creek Drive, Golden Valley.

Stream conditions: Silt and sand bottom, usually gently flowing.

#6 (STORET ID s005-017)

Location: Bassett Creek Main Stem, at Met Council WOMP station at (closed) Irving Ave. bridge north of city impound lot, Minneapolis.

Stream conditions: Rip rap bottom, generally fast flowing.