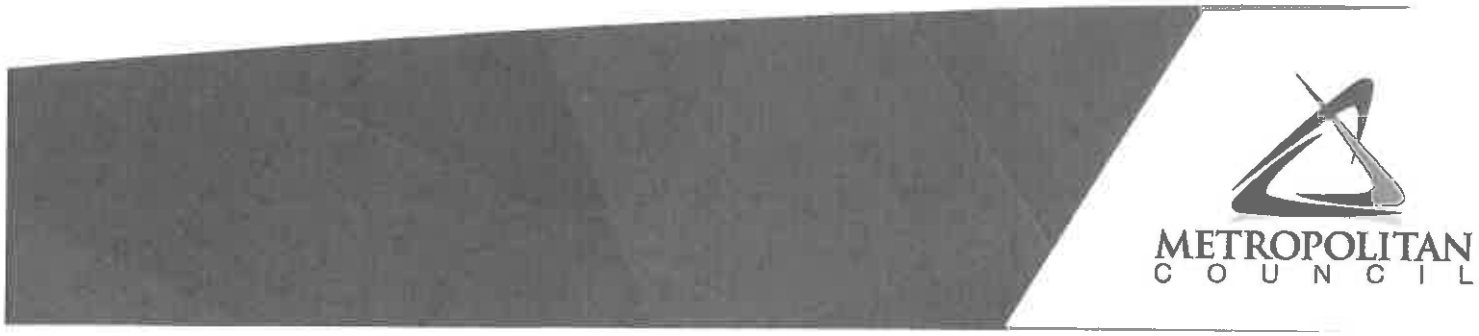
2015 Study of the Water Quality of 164 Metropolitan Area Lakes



October 2017

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The Metropolitan Council is the regional planning organization for the seven-county Twin Cities area. The Council operates the regional bus and rail system, collects and treats wastewater, coordinates regional water resources, plans and helps fund regional parks, and administers federal funds that provide housing opportunities for low- and moderate-income individuals and families. The 17-member Council board is appointed by and serves at the pleasure of the governor.

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2015 Study of the Water Quality of 164 Metropolitan Area Lakes

Report by

Brian Johnson

Senior Environmental Scientist

Metropolitan Council Environmental Services

October 2017

Executive Summary

This report is the latest in a continuing series of reports summarizing results of the annual lake monitoring program of the Metropolitan Council (METC) in the Twin Cities seven-county metropolitan area (TCMA). The METC has collected water quality data on area lakes since 1980. This report contains data from a total of 177 lake sites on 164 lakes monitored in 2015. The monitoring program in 2015 included 2 lakes and 3 newly established lake sites not previously monitored by the Council.

To date, the METC's lake monitoring program (including monitoring by METC staff and volunteers) has provided an important tool for making informed lake management decisions. Data from our regional lake monitoring program are frequently used to determine possible trends in lake water quality, estimate expected ranges in water quality of non-monitored lakes, examine intra-and inter-regional differences, determine potential water quality impairments, and investigate the relationships between land use and water quality.

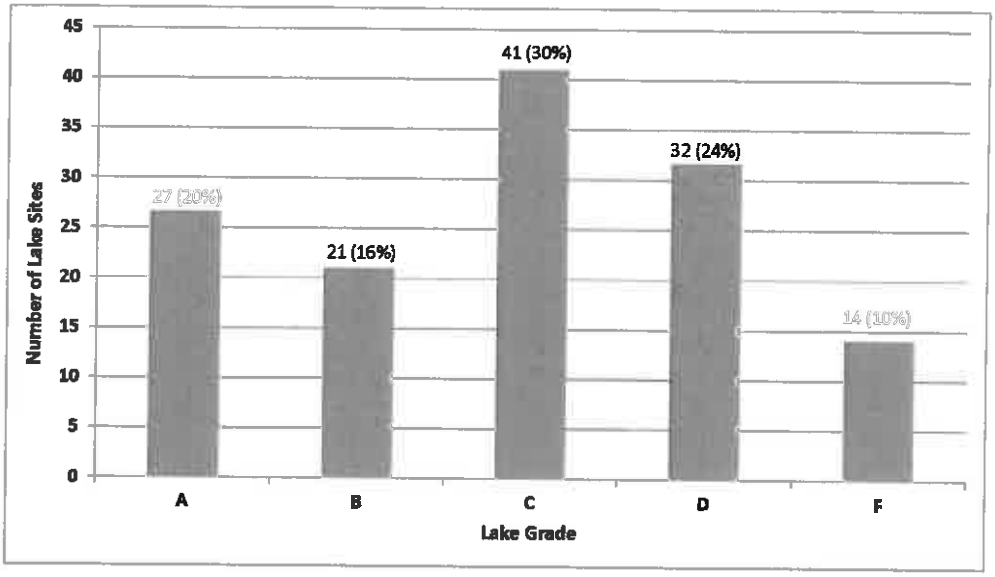
The objectives of this program are:

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 2015 marked the twenty-first year that the Citizen-Assisted Monitoring Program (CAMP) was used to increase our knowledge of the water quality of TCMA lakes. CAMP volunteers visited their assigned lake on a biweekly basis from mid April to mid October. The volunteers measured surface water temperature and water transparency, documented lake and weather conditions, and collected surface water samples. The samples were analyzed for total phosphorus, total Kjeldahl nitrogen, and chlorophyll-a by the METC's analytical laboratory located at the Metropolitan Wastewater Treatment Plant in St. Paul, MN. CAMP volunteers are sponsored by a local partner. In 2015, there were 26 sponsors who consisted of a mix of municipalities, watershed management organizations (WMOs), watershed districts (WDs), and counties.

Most lakes were given a lake grade which was calculated on the basis of three parameters: total phosphorus, chlorophyll-a (trichromatic), and Secchi depth (water clarity). Not all lake sites received a lake grade because of an insufficient quantity of data during the summer-time period of May through September. The distribution of lake grades for all the lake sites monitored in 2015 is shown in the following figure.

For those lake sites with sufficient data to calculate a lake grade, approximately one third of the lake sites (37%) received a lake grade of C. The water quality of these sites is considered average as compared to other lakes in the TCMA. Approximately one third of the lake sites (36%) were above average (A and B grades), and approximately one third (27%) were below average (D and F grades).



Lake Grades for the 2015 Monitoring Season

Since 1980, 385 TCMA lakes have been monitored through the METC's lake monitoring program. Since some of these lakes have multiple monitoring sites, a total of 424 lake sites have been monitored. The data from the METC's lake monitoring program are stored in the METC's Environmental Information Mangement System (EIMS), the Minnesota Pollution Control Agency's Environmental Quality Information System (EQuIS), and the U.S. EPA's national water quality data repository, called STORET (STOrage and RETrieval). Data for all METC lake monitoring sites can be conveniently retreived via the METC's web-based EIMS, at: http://es.metc.state.mn.us/eims/. While the METC 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 via the CAMP.

If you have questions pertaining to the lake data or descriptions contained in this report, inquiries about CAMP, or suggestions of lakes the METC 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.

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:

CAMP Volunteers and Local Partners

The enthusiastic participation of local sponsors and volunteers help make the CAMP successful. A list of sponsors and volunteers is shown in Appendix C. The following volunteers are given added appreciation for their multiple years of service:

12 to 23 years of service

23 years of service
Diane Coderre – Sunset Lake

22 years of service
Washington CD – multiple lakes

21 years of service
Carver Co. Env. Services staff – multiple lakes

20 years of service
John Ritter – Lake Alimagnet
Wargo Nature Center – George Watch

18 years of service
Wally Shaver – Lac Lavon Lake

17 years of service
Lakeville staff – multiple lakes

15 years of service
Gene Berwald – Pine Tree Lake
Tom Goodwin – Orchard Lake

14 years of service
Bonnie Juran – Klawitter Lake

13 years of service
Kitty Francy-Payton – Long Lake
Jim Kellogg – Cobblecrest Lake

12 years service
Bill Feely – Long Lake
David Florenzano – Riley Lake
Wayne Hubin – Swede Lake
Sue Morgan & Linda Scott – St. Joe Lake
Gordan & Fran Warner – Mitchell Lake

8 to 11 years of service

11 years of service
Carpenter Nature Center (volunteer coordinator: Mayme Johnson) – Lake St. Croix
Jim and Roberta Harper – Lake St. Croix
Jeff Keene – O'Connor Lake
Rick Meierotto – Lake St. Croix

10 years of service
David Bluhm – White Rock Lake
Minnesota DOT staff – Rest Area Pond
Joe Williamson – McMahon Lake

9 years of service
Sandy & Mike Boyce – Lake O'Dowd
John Burton – Wing Lake
Doug Hennes – Rogers Lake
Boe Meier — Olson Lake
Mendota Heights staff — Lemay Lake
Jim Nayes – Horseshoe Lake
Steve Schreiber — Little Comfort Lake
Curt Sparks – Sylvan Lake
Dan Stanek – Scout Lake
Robert White — Northwood Lake

8 years of service
Carolyn Dindorf – Magda Lake
Gary Gerding – Karth Lake
Steve Iverson – DeMontreville Lake
Tam and Dick McGehee – Langton Lake

6 to 7 years of service

7 years service
Jeff Christianson – Farquar Lake
Tim and Sharon McCotter – Lucy Lake
Mark McMullen – Reitz Lake
Wally Ostlie – Comfort Lake
Joe Reithmeyer – Lake Edith
Steve Schmaltz – Forest Lake, west basin
Jeff Sluiter – Cobblestone Lake
Tim Weber – La Lake

6 years of service
Steve Aldritt – Lake Minnewashta
Paul Bolstad – Fish Lake
Wendy Griffin – Lake Elmo
Marvin Groth – Bass Lake
David Nelson – Medicine Lake
James Stowell – Sunfish Lake
Douglas Toavs – Moody Lake

3 to 5 years of service

5 years service
Pat Barrett – Klawitter Lake
Paul Erdmann – Bush Lake
Lisa McIntire – Penn Lake
Karl Nelson – Medicine Lake
Diane Williamson – McMahon Lake

4 years service
Andrew Elmquist – Karth Lake
Lowell Mohn – Cedar Lake
Paul O'Brien – South Oak Lake
Joe Tranchilla – Crystal Lake
Judy Weninger – Forest Lake, east basin

3 years service
Jonathon Burris – Twin Lake
Thomas Chaklos – Haas Lake
Dakota SWCD staff – Pickerel Lake
Nancy Ebner – Westwood Lake
Elizabeth Erdmann – Bush Lake
Chris Foley – Laura Lake
Barrie Froseth – Lost Lake
Leif Hembre – Square Lake
Stephen Sando – Cornelia Lake
Curt Savstrom – Marion Lake
Mike Zytkovicz – Earley Lake

Metropolitan Council Staff

- The MCES Laboratory Services Section, for laboratory analysis of the lake samples.
- Craig Skone for creation of the lake maps.
- The MCES Electronic Lake Monitoring Report Team for the continued improvement of the automation of the annual lake report.

Contents

Introduction

This 2015 report continues a series of annual lake reports from 1980 to present. Since 1980, 385 lakes in the Twin Cities Metropolitan Area (TCMA) have been monitored through the Metropolitan Council's (METC) lake monitoring program. Since some of these lakes have multiple monitoring sites, a total of 424 lake sites have been monitored. This report contains data from 177 lake sites on 164 lakes that were monitored in 2015, including 2 lakes and 3 lake sites that have not been previously monitored by the METC lake monitoring program. Figure 1 shows the location of the lakes monitored in 2015 by MCES staff and by volunteers of the Citizen-Assisted Monitoring Program. A list of lakes that have been monitored by the METC's monitoring program is shown in Appendix A. Refer to Appendix B for morphometry and other lake characteristic data.

METC lake monitoring data are available via:

- the METC's Environmental Information Management System (EIMS), at http://es.metc.state.mn.us/eims/
- the Minnesota Pollution Control Agency's (MPCA) Environmental Data Access (EDA) system, at http://www.pca.state.mn.us/index.php/data/surface-water.html
- the STORET Data Warehouse, which is the U.S. EPA's national water quality data repository, at http://www.epa.gov/storet/dbtop.html

The objectives of the METC lake monitoring program are:

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 long-term goal of the METC lake monitoring program is to provide a comprehensive database to enable cities, counties, watershed management organizations (WMOs), and watershed districts (WDs) to better manage TCMA lakes. The Council believes that without such comprehensive lake data, the foundation of lake and watershed management plans is weakened. While the METC has provided a commendable lake monitoring program, monitoring by other organizations is also encouraged (Osgood 1989a).

To date, the METC lake monitoring program has been an important tool for making informed lake management decisions. The majority of the lakes have been visited on a rotating schedule over the past 30 years, so as to develop an historical database to help lake and watershed managers in decision making. Data from the METC lake monitoring program are frequently used to determine possible trends in lake water quality, estimate expected ranges in water quality of non-monitored lakes, examine intra-and interregional differences, and investigate the relationships between land use and water quality. A comprehensive regional lake monitoring program should ensure adequate spatial and temporal representation of water quality. However, due to cost and logistical problems, ground-based monitoring programs usually sacrifice spatial coverage (fewer lakes) in favor of more frequent sampling.

As is the case throughout the United States, the majority of lakes in the TCMA suffer from this lack of water quality data. Area lakes and watershed managers need a broad, comprehensive water quality database for regulatory and decision-making purposes. Because of the lack of public funding and the high ratio of area lakes to monitoring staff, very little data exist for the majority of TCMA lakes, and local decision-makers are forced to make management decisions lacking adequate information.

The METC addressed this lack of adequate lake water quality data by initiating a citizen-assisted monitoring program (CAMP) in 1993. The purpose of the CAMP is to provide a more complete and improved water quality database for TCMA lakes. This database gives local decision makers a better idea of the water quality of their lakes, thereby assisting them in decision making on water

quality issues. The METC's goal for the CAMP is to provide a means to gather as much information on TCMA lakes as is economically possible.

The METC lake monitoring program, especially the use of volunteer monitors through the CAMP, has played a key role in the METC's recent efforts to use satellite images to assess annual lake water clarity for the entire TCMA. The monitoring program provides the "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 TCMA's lake water quality from just the lakes involved in our ground-based programs to all the lakes in the region. Over time, 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.

The METC lake monitoring program began a volunteer annual ice-monitoring program in the winter of 2009 - 2010. The purpose of this program is to monitor the duration of annual ice cover on TCMA lakes over a long time period. This information is especially useful because the duration of ice cover is a good indicator of climate change.

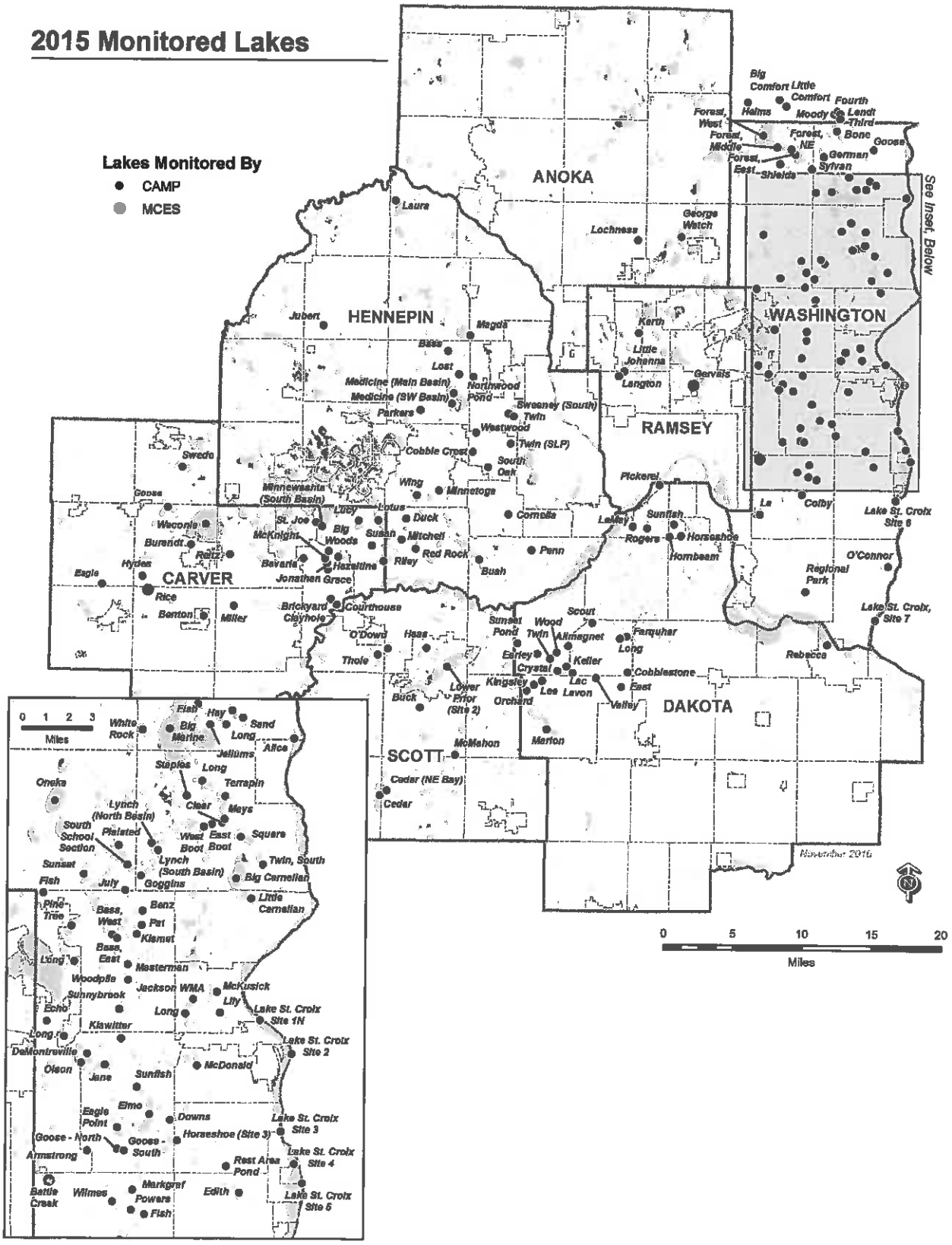


Figure 1. 2015 Monitored Lakes

METC Staff Monitoring Program

A description of the methods and results of monitoring conducted by METC staff during 2015 is provided in the following section.

Methods

Metropolitan Council staff monitored 3 lake sites on 3 lake during 2015 (Figure 1). The staff monitoring program consisted of monitoring two sites on Lake Byllesby for trophic conditions in 2015. The monitoring occurred during the open water season of May through October.

The lake monitoring sites were located generally over the deepest spot of the lake basin or a central location of a sub-basin. A hand-held Global Positioning System (GPS) receiver was used to determine the coordinates of a lake site, and to aid in relocating lake sites during subsequent monitoring events. Time, water surface conditions, weather, lake depth, and water transparency were recorded on a field data sheet. Water transparency was measured using a 20 cm black-and-white Secchi disk. Temperature, dissolved oxygen (DO), pH, specific conductivity, turbidity, and oxidation reduction potential (Redox) were measured at one-meter intervals throughout the water column. For depths below 10 m, the sampling interval was increased to every 2 m. These parameters were measured using a YSI 6920 multi-parameter sonde that was connected to a YSI 650 data logger.

The sonde probes for DO and pH were calibrated before each field trip. These probes were also calibrated again the same day after returning from the field, to check for calibration drift. The conductivity probe was calibrated on a weekly schedule. The turbidity and Redox probes were calibrated on a monthly schedule.

Water was collected from the lake surface (0-2 m) using a two-meter PVC pipe with a two-liter capacity. Two such samples were mixed in a 4-liter plastic jug. The surface sample was then decanted into an opaque polyethylene bottle. Subsurface samples were collected using a 2-liter Van Dorn sampler. All water samples were transported on ice in a dark cooler and processed and preserved within 12 hours of collection.

The surface and subsurface samples were analyzed for the standard parameters as shown in Table 1. Chlorophyll was not analyzed in the subsurface samples. Samples that were analyzed for total dissolved phosphorus (TDP) were filtered through a 0.45 µm membrane filter and then analyzed for TP. All chemical analyses were performed at the Metropolitan Council Environmental Services - Environmental Quality Assurance Department (MCES-EQA) laboratory.

The chlorophyll analysis results are reported by the laboratory according to two different equations: the trichromatic equation and the monochromatic equation. The trichromatic equation gives the following chlorophyll parameters:

- chlorophyll-a (CLA),
- chlorophyll-b,
- chlorophyll-c.

The monochromatic equation gives the following parameters:

- chlorophyll-a corrected for pheophytin,
- pheophytin-a.

The chlorophyll data in this annual report are reported as trichromatic CLA. However all the analytical results from the trichromatic and monochromatic equations can be accessed via the monitoring data databases as provided in the Introduction section.

Table 1. Summary of Analytical Methods

Parameters	Analytical Method
Chlorophyll	ASTM Method D3731–87
Kjeldahl Nitrogen, total (TKN)	U.S. EPA Method 351.2, Rev. 2.0

Parameters	Analytical Method
Phosphorous, total (TP)	U.S. EPA Method 365.4
Phosphorus, dissolved (TDP)	U.S. EPA Method 365.4

Results

The water quality of each staff-monitored lake is discussed in the following section. Each lake report includes a description of the lake's water quality condition and the year's water quality data shown in tables and figures. The water quality grades from 1980 through 2015 are shown for lake sites that were monitored for trophic status.

For data of samples collected at depth and of depth profile measurements, please refer to the METC's Environmental Information Management System (EIMS) at http://es.metc.state.mn.us/eims/ to access this additional data.

Any questions about the 2015 METC lake monitoring data should be directed to Brian Johnson at (651) 602-8743 or brian.johnson@metc.state.mn.us.

Lotus Lake (10–0006) *City of Chanhassen*

Volunteer: City of Chanhassen staff

Lotus Lake is located within the City of Chanhassen (Carver County). It is considered a Priority Lake by the Metropolitan Council for its high regional recreation value (METC 2007). It has a surface area of 246 acres. The MN DNR has designated the lake as being infested with Eurasion water milfoil (Myriophyllum*spicatum*). The MPCA listed the lake as impaired with respect to aquatic consumption (mercury in fish tissue) and aquatic recreational use (nutrient/eutrophication biological indicators) in 2002.

On each sampling day surface samples were collected for laboratory analysis of total phosphorus (TP), total Kjeldahl nitrogen (TKN), and chlorophyll including chlorophyll-a (CLA). Secchi transparency and surface temperature were measured during each monitoring visit. The resulting data are summarized in tables and figures on the following pages.

2015 summer (May - September) data summary

Parameter	Mean	Minimum	Maximum	Grade
TP (µg/l)				
CLA (µg/l))				
Secchi (m)				
TKN (mg/l)				
			Lake Grade	

There were less than 5 monitoring events during the summer-time period (May — September). At least 5 monitoring events are required during the summer-time period to determine a parameter grade. A lake grade was not given because all three parameter grades are required to issue a lake grade.

During each monitoring visit, the volunteer's opinions of the lake's physical condition and recreational suitability were ranked on a 1-to-5 scale. These user perception rankings are shown on the following page.

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) 259-5831 or by downloading the information off the Internet at http://www.dnr.state.mn.us/lakefind/.

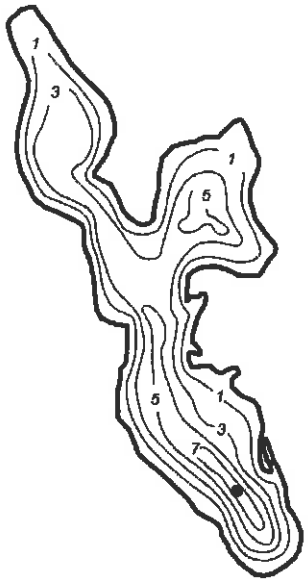
If you notice any errors in the lake's data or physical information, or are aware of any additional or missing information, please contact Brian Johnson of the Metropolitan Council at (651) 602-8743 or brian.johnson@metc.state.mn.us.

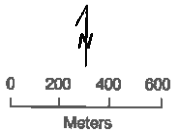
Lotus Lake
Chanhassen, Carver Co.

Lake ID: 100006-00

● Sampling site

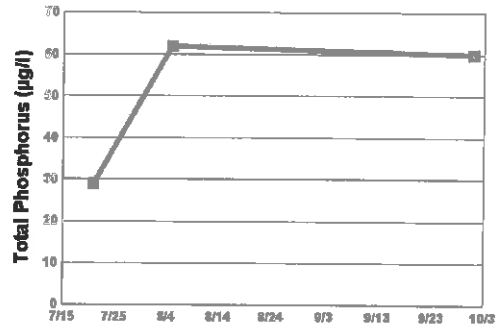
Contours in meters

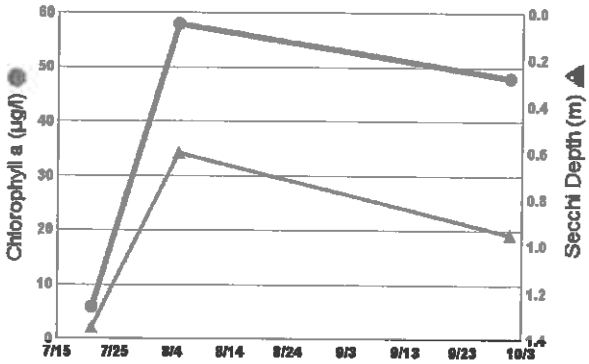


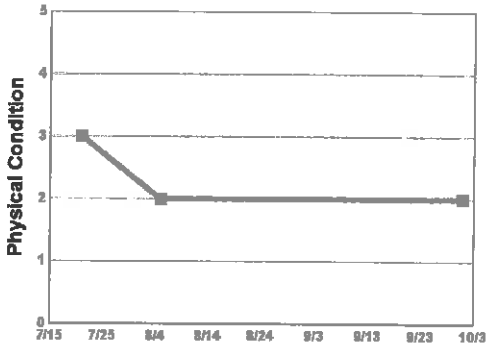


2015 Data

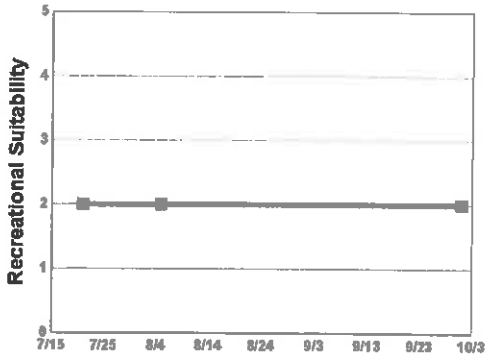
Date	SURF TEMP (°C)	SURF DO (mg/L)	CLA (µg/l)	SURF TP (µg/l)	Secchi (m)	PC	RS
7/21/15	25.3		5.9	29	1.4	3	2
8/5/15	26.3		58.0	62	0.6	2	2
10/1/15	18.4		48.0	60	1.0	2	2







1 = Crystal Clear
2 = Some Algae Present
3 = Definite Algal Presence
4 = High Algal Color
5 = Severe Algal Bloom



1 = Beautiful
2 = Minor Aesthetic Problem
3 = Swimming Impaired
4 = No Swimming; Boating OK
5 = No Aesthetics Possible

Lake Water Quality Grades Based on Summertime Averages

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TP						C						
CLA						C					C	
Secchi	D					C			D	C	C	C
Lake Grade						**C**						

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TP								C	C			D
CLA								C	C			C
Secchi								C	C			D
Lake Grade								**C**	**C**			**D**

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
TP	C	C	C	C	C	C	B	C				
CLA	C	C	C	C	C	B	C	C				
Secchi	C	C	C	C	C	C	C	C				
Lake Grade	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**				

Source: Metropolitan Council, EPA STORET, and/or MPCA EQuIS database(s)

Lucy Lake (10–0007) *City of Chanhassen*

Volunteer: Tim and Sharon McCotter

Lucy Lake is located within the City of Chanhassen (Carver County). It has a surface area of 87 acres and a maximum depth of 6.4 m (21 ft). More than 80 percent of the surface area is considered littoral zone, which is the 0 — 15 feet depth zone typically dominated by aquatic vegetation. The lake is defined as a shallow lake because of the dominance of the littoral zone. Since the lake is relatively shallow, it does not permanently stratify and maintain a thermocline which is a density gradient caused by changing water temperatures throughout portions of the water column.

The MPCA listed the lake as impaired with respect to aquatic consumption (mercury in fish tissue) in 2002. The MN DNR designated the lake as being infested with Eurasian water milfoil (*Myriophyllum spicatum*) in 2007.

On each sampling day surface samples were collected for laboratory analysis of total phosphorus (TP), total Kjeldahl nitrogen (TKN), and chlorophyll including chlorophyll-a (CLA). Secchi transparency and surface temperature were measured during each monitoring visit. The resulting data are summarized in tables and figures on the following pages.

2015 summer (May - September) data summary

Parameter	Mean	Minimum	Maximum	Grade
TP (µg/l)	54	28	89	C
CLA (µg/l))	41	3.0	84	C
Secchi (m)	1.1	0.5	2.3	D
TKN (mg/l)	1.59	1.10	2.30	
			Lake Grade	C

The lake received a lake grade of C this year, which is consistent with its historical water quality database. Continued monitoring is recommended to continue to build the water quality database.

During each monitoring visit, the volunteer's opinions of the lake's physical condition and recreational suitability were ranked on a 1-to-5 scale. These user perception rankings are shown on the following page.

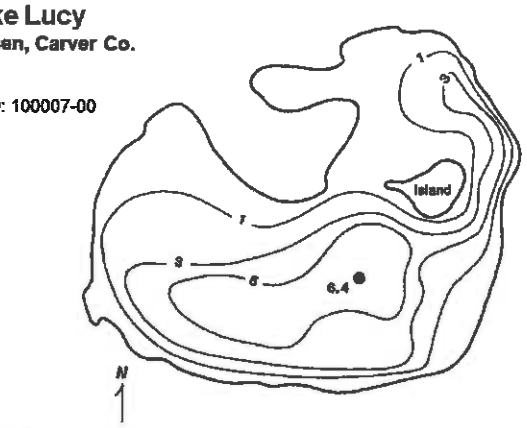
The Fisheries Section of the Minnesota Department of Natural Resources (MDNR) has conducted a fisheries survey on the lake. Information on the survey can be obtained through the MDNR Fisheries Section by calling (651) 259-5831 or by downloading the information off the Internet at http://www.dnr.state.mn.us/lakefind/.

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.

Lake Lucy

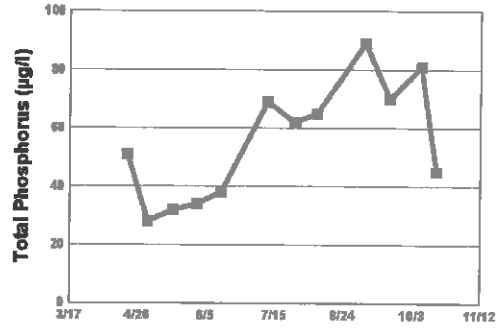
Chanhassen, Carver Co.

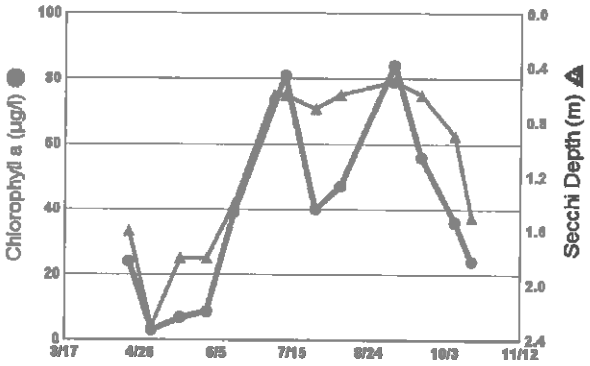
Lake ID: 100007-00

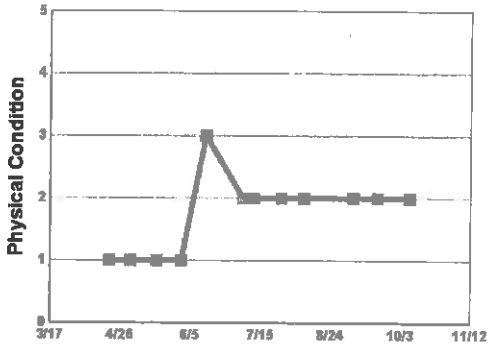


2015 Data

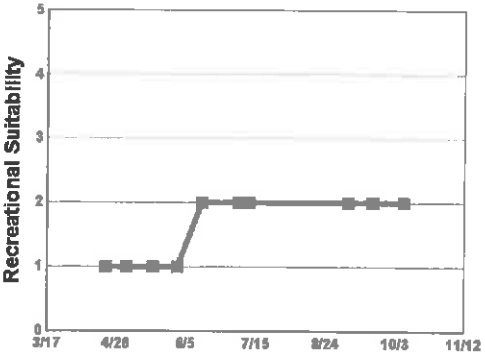
Date	SURF TEMP (°C)	SURF DO (mg/L)	CLA (µg/l)	SURF TP (µg/l)	Secchi (m)	PC	RS
4/20/15	15.2		24.0	51	1.6	1	1
5/2/15	17.5		3.0	28	2.3	1	1
5/17/15	18.4		6.8	32	1.8	1	1
5/31/15	19.3		8.6	34	1.8	1	1
6/14/15	24.7		39.0	38	1.4	3	2
7/5/15	24.6				0.6	2	2
7/11/15	25.7		81.0	69	0.6	2	2
7/27/15	27.7		40.0	62	0.7	2	
8/9/15	26.0		47.0	65	0.6	2	
9/6/15	28.1		84.0	89	0.5	2	2
9/20/15	20.7		56.0	70	0.6	2	2
10/8/15	15.5		36.0	81	0.9	2	2
10/17/15	12.5		24.0	45	1.5		







1 = Crystal Clear
2 = Some Algae Present
3 = Definite Algal Presence
4 = High Algal Color
5 = Severe Algal Bloom



1 = Beautiful
2 = Minor Aesthetic Problem
3 = Swimming Impaired
4 = No Swimming; Boating OK
5 = No Aesthetics Possible

Lake Water Quality Grades Based on Summertime Averages

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TP						C						
CLA						C						
Secchi						C					C	C
Lake Grade						**C**						

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TP												
CLA												
Secchi	C	C	C	C	C	C	D	C	C	C	C	C
Lake Grade												

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
TP						C	C	C	D	C	C	C
CLA						C	C	B	C	C	B	C
Secchi	D	D	C	C	D	C	C	C	C	C	C	D
Lake Grade						**C**	**C**	**C**	**C**	**C**	**C**	**C**

Source: Metropolitan Council, EPA STORET, and/or MPCA EQuIS database(s)

Minnewashta Lake [Site-2, South Bay] (10–0009) *City of Chanhassen*

Volunteer: Steve Aldritt

Minnewashta Lake is located in the city of Chanhassen (Carver County). The lake is considered a Priority Lake by the Metropolitan Council for its high regional recreational value. It is a relatively large lake with a surface area of 677 acres. The maximum depth of the lake is 21.3 m (70 feet).

The MPCA listed the lake as impaired with respect to aquatic consumption (mercury in fish tissue) in 2004. The MN DNR designated the lake as being infested with Eurasian water milfoil (*Myriophyllum spicatum*) in 1995 and zebra mussels (*Dreissena polymorpha*) in 2016.

On each sampling day surface samples were collected for laboratory analysis of total phosphorus (TP), total Kjeldahl nitrogen (TKN), and chlorophyll including chlorophyll-a (CLA). Secchi transparency and surface temperature were measured during each monitoring visit. The resulting data are summarized in tables and figures on the following pages.

2015 summer (May - September) data summary

Parameter	Mean	Minimum	Maximum	Grade
TP (µg/l)	16	13	21	
CLA (µg/l))	7.0	6.5	7.7	
Secchi (m)	2.4	2.2	2.6	
TKN (mg/l)	0.87	0.85	0.90	
			Lake Grade	

There were less than 5 monitoring events during the summer-time period (May — September). At least 5 monitoring events are required during the summer-time period to determine a parameter grade. Continued monitoring is recommended to continue to build the water quality database.

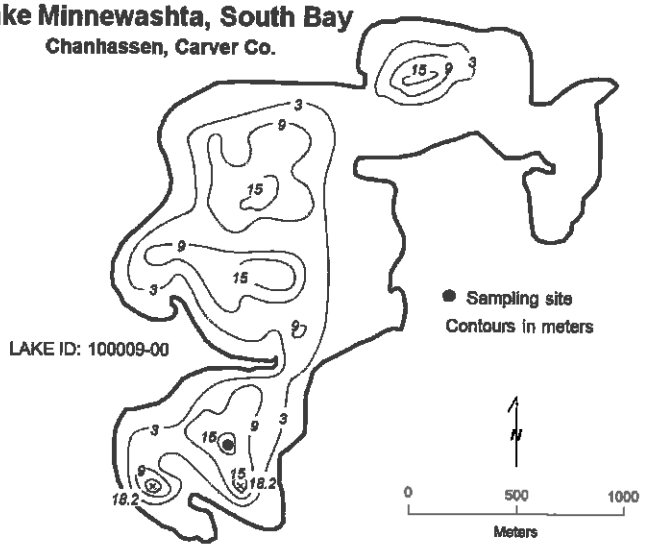
During each monitoring visit, the volunteer's opinions of the lake's physical condition and recreational suitability were ranked on a 1-to-5 scale. These user perception rankings are shown on the following page.

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) 259-5831 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.

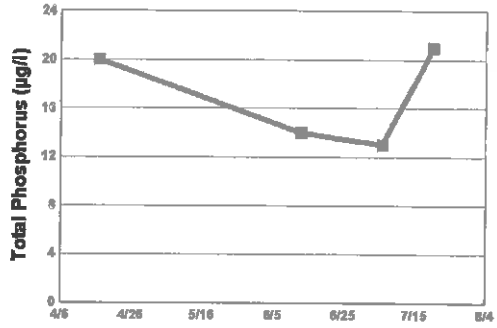
Lake Minnewashta, South Bay

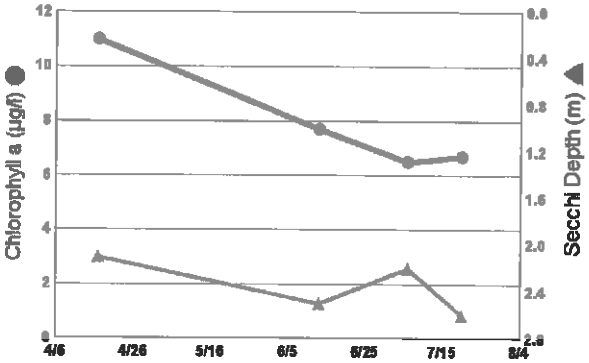
Chanhassen, Carver Co.

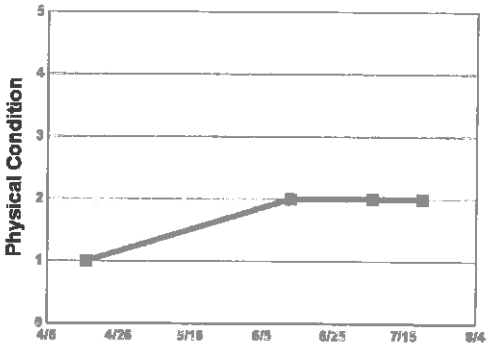


2015 Data

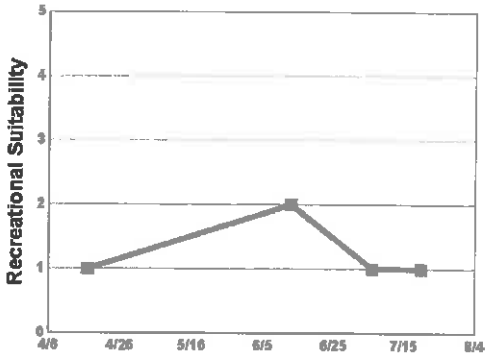
Date	SURF TEMP (°C)	SURF DO (mg/L)	CLA (µg/l)	SURF TP (µg/l)	Secchi (m)	PC	RS
4/17/15	11.2		11.0	20	2.1	1	1
6/13/15	21.6		7.7	14	2.5	2	2
7/6/15	26.2		6.5	13	2.2	2	1
7/20/15	26.8		6.7	21	2.6	2	1







1 = Crystal Clear
2 = Some Algae Present
3 = Definite Algal Presence
4 = High Algal Color
5 = Severe Algal Bloom



1 = Beautiful
2 = Minor Aesthetic Problem
3 = Swimming Impaired
4 = No Swimming; Boating OK
5 = No Aesthetics Possible

Lake Water Quality Grades Based on Summertime Averages

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TP												
CLA												
Secchi											B	B
Lake Grade												

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TP												
CLA												
Secchi	A	B	A	B	A	A	B	A	A	A		A
Lake Grade												

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
TP							A	A	C	A	A	
CLA							B	A	A	C	A	
Secchi			A				B	A	C	B	B	
Lake Grade							**B**	**A**	**B**	**B**	**A**	

Source: Metropolitan Council, EPA STORET, and/or MPCA EQuIS database(s)

Riley Lake (10—0002) *City of Chanhassen/City of Eden Prairie*

David Florenzano

Riley Lake is located with the cities of Chanhassen and Eden Prairie (Carver and Hennepin counties). The lake is considered a Priority Lake by the Metropolitan Council for its high regional recreational value. The maximum and mean depths are 15.0 m and 6.6 m, respectively.

The MPCA listed the lake as impaired with respect to aquatic recreational use (nutrient/eutrophication biological indicators) in 2002 and aquatic consumption (mercury in fish tissue) in 2002. The MN DNR designated the lake as being infested with Eurasian water milfoil (*Myriophyllum spicatum*) in 2007.

On each sampling day surface samples were collected for laboratory analysis of total phosphorus (TP), total Kjeldahl nitrogen (TKN), and chlorophyll including chlorophyll-a (CLA). Secchi transparency and surface temperature were measured during each monitoring visit. The resulting data are summarized in tables and figures on the following pages.

2015 summer (May - September) data summary

Parameter	Mean	Minimum	Maximum	Grade
TP (µg/l)	43	30	64	C
CLA (µg/l))	27	1.6	68	C
Secchi (m)	2.9	1.4	7.9	B
TKN (mg/l)	1.07	0.59	1.70	
			Lake Grade	C

The lake received a lake grade of C this year, which is consistent with most years of monitoring dating back to 1980.

During each monitoring visit, the volunteer's opinions of the lake's physical condition and recreational suitability were ranked on a 1-to-5 scale. These user perception rankings are shown on the following page.

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) 259-5831 or by downloading the information off the Internet at http://www.dnr.state.mn.us/lakefind/.

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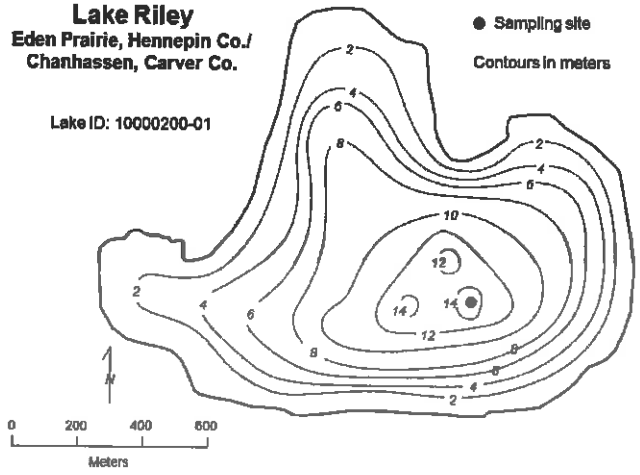
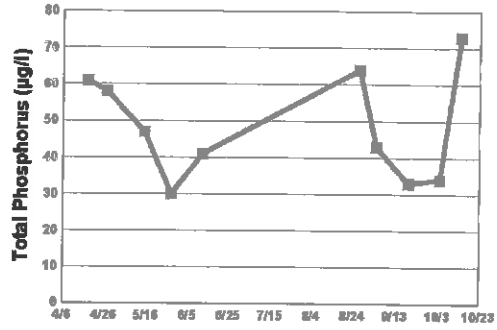
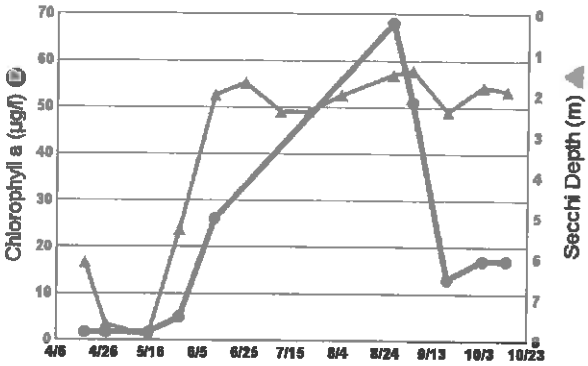
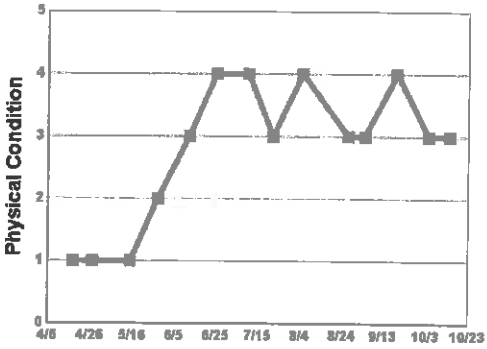


2015 Data

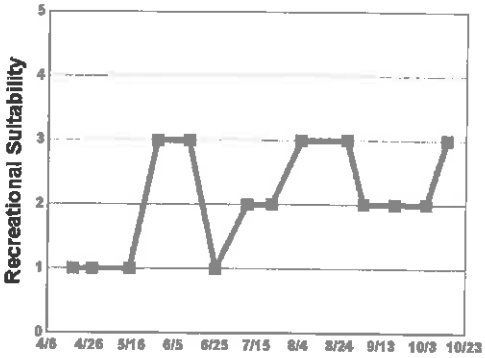
Date	SURF TEMP (°C)	SURF DO (mg/L)	CLA (µg/l)	SURF TP (µg/l)	Secchi (m)	PC	RS
4/18/15	10.6		1.6	61	6.1	1	1
4/27/15	12.3		1.6	58	7.6	1	1
5/15/15	16.1		1.6	47	7.9	1	1
5/28/15	19.3		4.9	30	5.3	2	3
6/12/15	22.1		26.0	41	2.0	3	3
6/25/15	26.0				1.7	4	1
7/10/15	25.2				2.4	4	2
7/22/15	27.1				2.4	3	2
8/5/15	26.4				2.0	4	3
8/27/15	21.6		68.0	64	1.5	3	3
9/4/15	24.2		51.0	43	1.4	3	2
9/19/15	20.8		13.0	33	2.4	4	2
10/4/15	18.2		17.0	34	1.8	3	2
10/14/15	15.2		17.0	73	1.9	3	3







1 = Crystal Clear
2 = Some Algae Present
3 = Definite Algal Presence
4 = High Algal Color
5 = Severe Algal Bloom



1 = Beautiful
2 = Minor Aesthetic Problem
3 = Swimming Impaired
4 = No Swimming; Boating OK
5 = No Aesthetics Possible

Lake Water Quality Grades Based on Summertime Averages

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TP	C	B	C	C	C	C	C	C				C
CLA	C	C	C	C	C	C	C	D			C	C
Secchi	C	C	C	C	C	C	C	C	C		C	C
Lake Grade	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**				**C**

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TP		C				C			C		C	C
CLA		C				C			C		C	D
Secchi		C				C			C		C	C
Lake Grade		**C**				**C**			**C**		**C**	**C**

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
TP	C	C	C	B	C	C	C	C	C	C	C	C
CLA	C	C	B	B	B	B	C	C	C	B	C	C
Secchi	B	C	B	C	C	C	C	B	C	C	C	B
Lake Grade	**C**	**C**	**B**	**B**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**

Source: Metropolitan Council, EPA STORET, and/or MPCA EQuIS database(s)

St. Joe Lake (10–0011) *City of Chanhassen*

Volunteer: Sue Morgan, Linda Scott

St. Joe Lake is a 14-acre lake located within the City of Chanhassen (Carver County). It has a maximum depth of 15.9 m (52 ft).

On each sampling day surface samples were collected for laboratory analysis of total phosphorus (TP), total Kjeldahl nitrogen (TKN), and chlorophyll including chlorophyll-a (CLA). Secchi transparency and surface temperature were measured during each monitoring visit. The resulting data are summarized in tables and figures on the following pages.

2015 summer (May - September) data summary

Parameter	Mean	Minimum	Maximum	Grade
TP (µg/l)	19	17	22	A
CLA (µg/l))	6.8	3.4	12	A
Secchi (m)	2.3	1.9	3.0	B
TKN (mg/l)	0.79	0.70	0.84	
			Lake Grade	A

The lake received a lake grade of A this year, which is consistent with its historical water quality database. The lake has varied in the A to B lake grade range over the past decade. Continued monitoring is recommended to continue to build the water quality database.

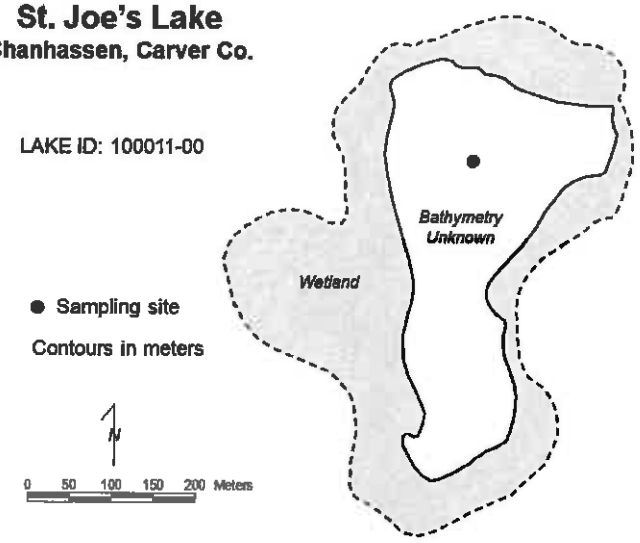
During each monitoring visit, the volunteer's opinions of the lake's physical condition and recreational suitability were ranked on a 1-to-5 scale. These user perception rankings are shown on the following page.

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) 259-5831 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.

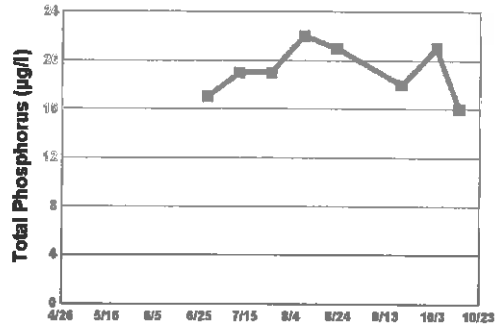
St. Joe's Lake
Chanhassen, Carver Co.

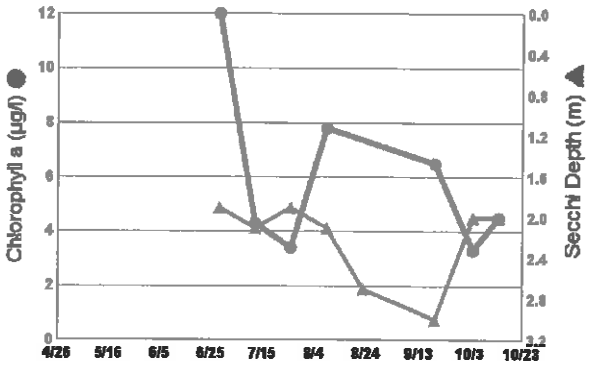
LAKE ID: 100011-00

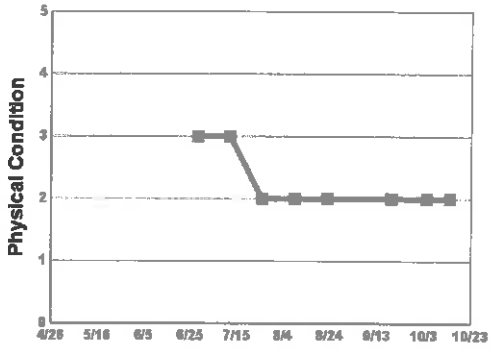


2015 Data

Date	SURF TEMP (°C)	SURF DO (mg/L)	CLA (µg/l)	SURF TP (µg/l)	Secchi (m)	PC	RS
6/28/15	27.2		12.0	17	1.9	3	1
7/12/15	27.3		4.3	19	2.1	3	1
7/26/15	29.1		3.4	19	1.9	2	1
8/9/15	25.4		7.8	22	2.1	2	1
8/23/15	21.1			21	2.7	2	1
9/19/15	20.5		6.5	18	3.0	2	1
10/4/15	18.4		3.3	21	2.0	2	1
10/14/15	17.5		4.5	16	2.0	2	1







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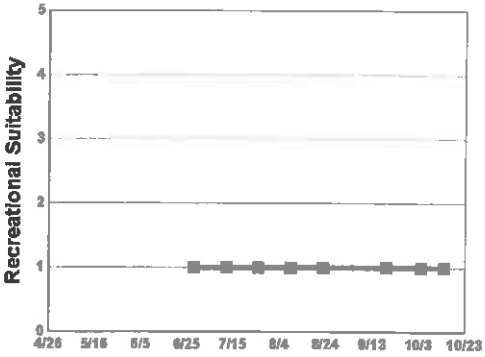
4 = High Algal Color
5 = Severe Algal Bloom



1 = Beautiful
2 = Minor Aesthetic Problem
3 = Swimming Impaired
4 = No Swimming; Boating OK
5 = No Aesthetics Possible

Lake Water Quality Grades Based on Summertime Averages

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TP												
CLA												
Secchi												
Lake Grade												

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TP												
CLA												
Secchi			C		B							
Lake Grade												

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
TP	A	A	C	A	A	C	A	A	A		A	A
CLA	A	A	A	A	A	A	A	A	A		A	A
Secchi	B	A	B	A	B	A	B	B	B		B	B
Lake Grade	**A**	**A**	**B**	**A**	**A**	**B**	**A**	**A**	**A**		**A**	**A**

Source: Metropolitan Council, EPA STORET, and/or MPCA EQuIS database(s)

Susan Lake (10–0013) *City of Chanhassen*

Volunteer: City of Chanhassen staff

Susan Lake, located in the City of Chanhassen (Carver County), covers an area of 93 acres and has a maximum depth of 5.2 m (17 feet). More than 80 percent of the surface area is considered littoral zone, which is the 0 — 15 feet depth zone typically dominated by aquatic vegetation.

The MPCA listed the lake as impaired with respect to aquatic consumption (mercury in fish tissue) in 1998aquatic recreational use (nutrient/eutrophication biological indicators) in 2010. The MN DNR designated the lake as being infested with Eurasian water milfoil (*Myriophyllum spicatum*) in 2007.

Susan Lake is involved in a study on the common carp (*Cyprinus carpio*), which is an invasive, non-native fish species, originally from central Asia. The study is being lead by Dr. Peter Sorensen of the the University of Minnesota. The purpose of the study is to develop an integrated management plan for the Riley chain-of-lakes (including Susan Lake) so as to improve the water quality of the lake chain. The activity and feeding behavior of the common carp can wreak havoc on the water quality and ecology of lakes by causing a litany of problems including reduced water clarity, decreased abundance of rooted aquatic vegetation, increase in algal populations, resuspension of sediment, increased internal loading of phosphorus, and negative changes in native fish populations. The long-term goal of the study is to develop a carp management strategy that can be applied to other lakes beyond the study lakes. For more information on this project, please refer to Dr. Sorensen's website at: http://sorensenlab.cfans.umn.edu/home/research/

On each sampling day surface samples were collected for laboratory analysis of total phosphorus (TP), total Kjeldahl nitrogen (TKN), and chlorophyll including chlorophyll-a (CLA). Secchi transparency and surface temperature were measured during each monitoring visit. The resulting data are summarized in tables and figures on the following pages.

2015 summer (May - September) data summary

Parameter	Mean	Minimum	Maximum	Grade
TP (µg/l)				
CLA (µg/l))				
Secchi (m)				
TKN (mg/l)				
			Lake Grade	

There were less than 5 monitoring events during the summer-time period (May — September). At least 5 monitoring events are required during the summer-time period to determine a parameter grade. A lake grade was not given because all three parameter grades are required to issue a lake grade. Continued monitoring is recommended to continue to build the water quality database.

During each monitoring visit, the volunteer's opinions of the lake's physical condition and recreational suitability were ranked on a 1-to-5 scale. These user perception rankings are shown on the following page.

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) 259-5831 or by downloading the information off the Internet at http://www.dnr.state.mn.us/lakefind/.

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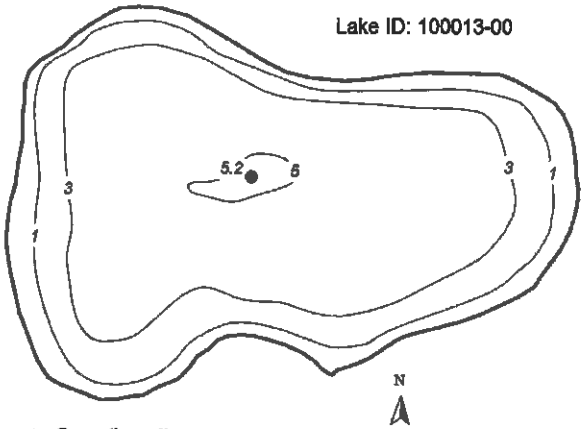
Lake Susan

Chanhassen, Carver Co.

Lake ID: 100013-00

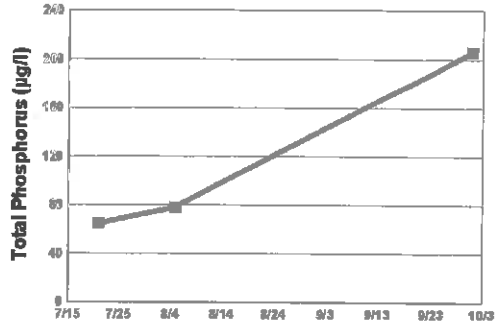


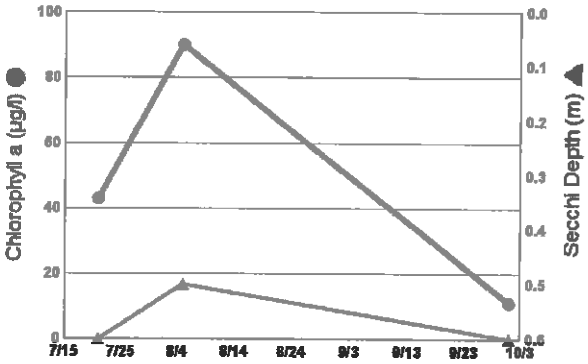
● Sampling site

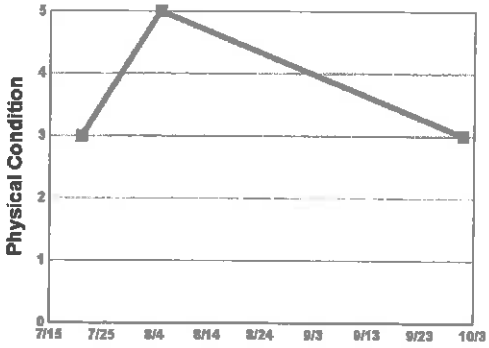
Contours in meters

2015 Data

Date	SURF TEMP (°C)	SURF DO (mg/L)	CLA (µg/l)	SURF TP (µg/l)	Secchi (m)	PC	RS
7/21/15	25.4		43.0	65	0.6	3	2
8/5/15	27.0		90.0	78	0.5	5	4
10/1/15	18.6		11.0	206	0.6	3	2







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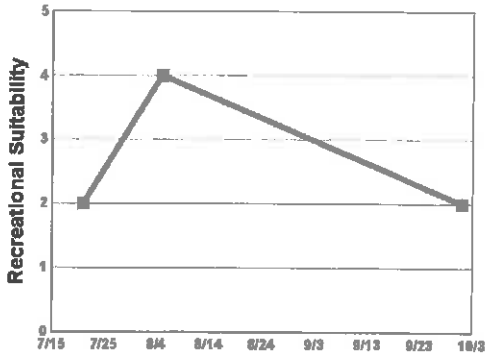

1 = Beautiful
2 = Minor Aesthetic Problem
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4 = No Swimming; Boating OK
5 = No Aesthetics Possible

Lake Water Quality Grades Based on Summertime Averages

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
TP												
CLA												
Secchi												
Lake Grade												

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
TP												
CLA												
Secchi												
Lake Grade												

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
TP			D	C	F	D	C	C	D	C	C	
CLA			C	C	D	C	C	C	C	C	C	
Secchi			C	C	D	C	C	C	D	C	C	
Lake Grade			**C**	**C**	**D**	**C**	**C**	**C**	**D**	**C**	**C**	

Source: Metropolitan Council, EPA STORET, and/or MPCA EQuIS database(s)