Twin Cities Metropolitan Area Chloride Total Maximum Daily Load Study

Minnesota Pollution Control Agency

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TMDL Summary Table

EPA/MPCA Required Elements	Summary	TMDL Page #
Location	Twin Cities Metro Area; Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington Counties, Minnesota: See Section 1.2 & Section 1.3	Page 1 Appendix A-1
303(d) Listing Information	The 2013 TCMA chloride assessment resulted in 29 new chloride impairments (6 streams, 19 lakes, and 4 wetlands) added to the 2014 draft 303(d) list, resulting in a total of 37 chloride impairments in the TCMA. Shingle Creek and Nine Mile Creek were previously listed as impaired with completed chloride TMDLs. See Section 3.5 Current and Historic Concentrations	Page 6
Applicable Water Quality Standards/ Numeric Targets	The MPCA has adopted the United States Environmental Protection Agency's (EPA) recommended water quality criteria for chloride (EPA 440/5-88-001 available at: water.epa.gov/scitech/swguidance/standards/criteria/upload/chloride1988.pdf). The allowable chloride concentration to protect for acute exposure is 860 mg/L. The allowable chloride concentration to protect for chronic exposure is 230 mg/L. See Section 2. Applicable Water Quality Standards and Numeric Water Quality Targets	Page 5
Loading Capacity (expressed as daily load)	TMDL = WLA(categorical MS4's) + WLA (wastewater sources) + LA (natural background) + LA (categorical non-permitted entities) + MOS + RC See Section 4.6 TMDL Summary	Page 28

<table>
<tr><td rowspan="4">Wasteload Allocation</td><td colspan="3"><u>MS4 Wasteload Allocation (WLA) - Runoff</u>
A categorical WLA has been established for the permitted MS4's within each impaired watershed.
<u>Wasteload Allocation (WLA) – Wastewater Sources</u>
Wastewater treatment plant discharges are included in the WLA where applicable. The WLA for these entities is calculated based on the mean discharge from the facility.
<u>Reserve Capacity (RC)</u>
There is no additional load set aside for reserve capacity.</td><td>Section 4.2
Page 26
Appendix A-4</td></tr>
<tr><td>Source</td><td>Permit #</td><td>Individual WLA</td><td></td></tr>
<tr><td>NPDES Permitted MS4</td><td>See Appendix A-2</td><td>See Appendix A-4</td><td></td></tr>
<tr><td>NPDES Permitted Wastewater Dischargers</td><td>See Appendix A-3</td><td>See Appendix A-4</td><td></td></tr>
<tr><td></td><td>Reserve Capacity</td><td>NA</td><td>0</td><td>Section 5
Page 34</td></tr>
<tr><td rowspan="4">Load Allocation</td><td colspan="3">Natural background is represented in the load allocation and is considered to be 8% (18.7 mg/L) of the chronic criterion.
An aggregate load allocation has been established for the non-permitted watershed runoff sources within each impaired watershed. This consists of townships, cities, counties, and MnDOT outside of the urban boundary and not covered under an MS4 permit.</td><td>Section 4.3
Page 27</td></tr>
<tr><td>Source</td><td colspan="2">LA</td><td></td></tr>
<tr><td>Natural Background</td><td colspan="2">18.7 mg/L * Runoff Volume</td><td></td></tr>
<tr><td>Non-permitted entity runoff</td><td colspan="2">See Appendix A-4</td><td></td></tr>
<tr><td>Margin of Safety</td><td colspan="3">An explicit margin of safety of 10% has been applied to account for scientific uncertainty.

See Section 4.4 Margin of Safety</td><td>Page 28</td></tr>
</table>

Seasonal Variation	Lakes and Wetlands Chloride loadings to lakes and wetlands vary seasonally. Lake and wetland water quality responds to loadings on an annual or longer term basis. Therefore, the TMDLs for lakes and wetlands have been developed to achieve an annual average daily load. Streams Chloride loadings to streams vary seasonally. Stream water quality responds to loadings on a seasonal basis and the highest chloride concentrations tend to occur during the spring snowmelt. Therefore, the TMDL has been developed to achieve an annual average daily load based on spring snowmelt conditions. See Section 4.5 Seasonal Variation	Page 28
Reasonable Assurance	MS4 entities will implement chloride reduction BMPs, which will have a positive impact on waterbodies in the TCMA. See Section 6 Reasonable Assurance	Page 34
Monitoring	A monitoring plan has been developed to assess progress towards TMDL goals and attainment of beneficial uses. See Section 7 Monitoring	Page 37
Implementation	Implementation will be based on a set of performance BMPs as defined in the TCMA Chloride Management Plan. This report includes a rough estimation of the overall cost of implementation to achieve the TMDL. See Section 8 Implementation and Section 8.4 Cost	Page 39
Public Participation	Extensive stakeholder involvement was conducted throughout the monitoring, impaired waters assessment, TMDL development, and implementation plan development. Public Comment Period: See Section 9 Public Participation	Page 51

Acronyms

AUID	Assessment Unit identification
BMP	Best Management Practice
BWSR	Board of Water and Soil Resources
CMP	Chloride Management Plan
EOC	Education and Outreach Committee
EPA	Environmental Protection Agency
EQuIS	Environmental Quality Information System
gpm	Gallons Per Minute
IPP	Industrial Pretreatment Program
LA	Load Allocation
lbs	Pounds
MCES	Metropolitan Council Environmental Services
MDH	Minnesota Department of Health
mg/L	Milligrams Per Liter
MnDOT	Minnesota Department of Transportation
MOS	Margin of Safety
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer System
NaCl	Sodium Chloride
NLCD	National Land Cover Dataset
NPDES	National Pollutant Discharge Elimination System
RC	Reserve Capacity
RO	Reverse Osmosis
str	Stream
SWPPP	Storm Water Pollution Prevention Plan
TCMA	Twin Cities Metropolitan Area (Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, Washington Counties)
TMDL	Total Maximum Daily Load
UMiss	Upper Mississippi River
UMN	University of Minnesota
US	United States
USGS	United States Geological Survey
WD	Watershed District
WLA	Wasteload Allocation
WMO	Watershed Management Organization
WMAt	Winter Maintenance Assessment tool
WQBELs	Water Quality Based Effluent Limits
WQT	Water Quality Target (in this TMDL, Minnesota's chronic water quality standard for chloride, 230 mg/L)
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

Executive Summary

The Twin Cities 7-county metropolitan area (TCMA) includes 186 cities and townships and a population of approximately 3,000,000 people. It covers approximately 3,000 square miles with about one-third in urbanized areas. It is a vibrant and growing community. The area is fortunate to be home to nearly 1,000 lakes and wetlands, small streams and large rivers, as well as shallow and deep groundwater aquifers. These water resources hold high value to the community and visitors to the area.

Twin Cities Metropolitan Area (TCMA)

The Twin Cities receives approximately 54 inches of snow each year on average. The thousands of miles of streets and highways in the TCMA, along with parking lots and sidewalks, must be maintained to provide safe conditions throughout the winter. Winter maintenance of these surfaces currently relies heavily on the use of salt, primarily sodium chloride (NaCl), to prevent ice build-up and remove ice where it has formed. The chemical properties of sodium chloride make it effective at melting ice, but these properties also result in the chloride dissolving in water and persisting in the environment. The dissolved chloride moves with the melted snow and ice, largely during spring warm-ups, and ends up in the water resources.

Residential water softener use is also a significant source of chloride. Residential water softeners use chloride to remove hardness, which is typically caused by high levels of calcium and/or magnesium. In areas with hard water, residential water softeners which use salt are common. The chloride from water softeners makes its way to the environment either through discharge to a septic system or by delivery to a municipal wastewater treatment plant (WWTP). Chloride is not removed from wastewater using treatment methods.

Elevated chloride concentrations have been found in waterbodies throughout the TCMA. At levels exceeding the WQS, chloride is toxic to aquatic life. Water samples from lakes, wetlands, streams and groundwater show high chloride levels in urban areas across the state. While monitoring has only been conducted for about 10% of the surface waterbodies in the TCMA, the available data indicates 39 waterbodies in the TCMA currently exceed chloride levels protective of the aquatic community. Two of these impaired waterbodies, Shingle Creek and Nine Mile Creek, already have approved Total Maximum Daily Loads (TMDLs). This report presents the development of the TMDLs for the remaining 37 waterbodies in the TCMA impaired for chloride.

A TMDL quantifies the allowable pollutant loading to a lake or stream that will result in water quality standards being attained. The water quality target (WQT) for the TMDLs was set to the chronic water quality criterion for chloride of 230 mg/L. The total allowable load, or TMDL, is allocated to the various sources contributing chloride as well as consideration of a margin of safety (MOS) and reserve capacity (RC). A simple 0-dimensional, steady-state modeling approach was selected through consultation with a Technical Advisory Committee for calculating the allowable load from runoff, including permitted Municipal Separate Storm Sewer System (MS4) areas and non-permitted areas. This approach assumes that chloride from winter maintenance activities and all other sources eventually makes its way to surface waterbodies through runoff. This approach was chosen for the following reasons: 1) chloride is a conservative substance and is in the dissolved phase in the water environment; therefore, complex fate and transport assessments are not needed; 2) determining the time for a system to respond to reduced chloride loads was not necessary to inform the TMDL or Chloride Management Plan (CMP); and 3) the large number of lakes and streams needing a TMDL and the limited data available for a significant portion of them prohibited a more complex approach. This approach assumes eventual complete flushing in an impaired waterbody over the long-term.

Deicing salt is the most common and the preferred method for meeting the public's winter travel expectations. There is currently no environmentally safe and cost-effective alternative that is effective at melting ice. Therefore, continued use of salt as the predominant deicing agent for public safety in the TCMA is expected. Setting a specific chloride load reduction target for each individual winter maintenance chloride source is challenging, as is measuring actual chloride loads entering our surface and groundwater from deicing salt and other nonpoint sources in the TCMA. Therefore, priority should be put on improving winter maintenance practices to use only a minimal amount of salt, also referred to as smart salting, across the entire TCMA. With these considerations in mind, the implementation approach for achieving the TMDLs and protecting all waters in the TCMA is to focus on performance of improved winter maintenance practices as well as continuing to monitor trends in local waterbodies. The Minnesota Pollution Control Agency (MPCA) and stakeholders worked together to develop a plan to achieve the TCMA chloride TMDLs. The CMP incorporates **water quality assessment, source identification**, **implementation strategies, monitoring recommendations**, and **measurement and tracking of results** into a performance-based adaptive approach for the TCMA. The goal of the plan is to develop the framework to assist local partners in minimizing salt (chloride) use and provide safe and desirable conditions for the public. The CMP also includes performance-based strategies to reduce salt (chloride) from other sources such as water softening, wastewater discharges, and agricultural sources.

1. Project Overview

1.1 Purpose

The TCMA includes Anoka, Hennepin, Ramsey, Washington, Carver, Scott, and Dakota counties, 186 cities and townships and a population of approximately 3,000,000 people. It covers approximately 3,000 square miles with about one-third in urbanized areas. The area is fortunate to be home to nearly 1,000 lakes, creeks, and rivers. These water resources hold high value to the community and visitors to the area.

The TCMA receives approximately 54 inches of snow each year on average. The thousands of miles of streets and highways in the TCMA, along with parking lots and sidewalks, must be maintained to provide safe conditions throughout the winter. Winter maintenance of these surfaces currently relies heavily on the use of salt, primarily sodium chloride (NaCl), to prevent ice build-up and remove ice where it has formed. The chemical properties of sodium chloride make it effective at melting ice, but these properties also result in the chloride dissolving in water and persisting in the environment. The dissolved chloride moves with the melted snow and ice, largely during spring warm-ups, and ends up in the nearby lakes, streams, wetlands and groundwater. Residential water softener use is also a significant source of chloride. In areas with high hardness in their water supply, residential water softeners which use salt are common. The chloride from water softeners makes its way to the environment either through discharge to a septic system or by delivery to a municipal WWTP. Chloride is not removed from wastewater using conventional treatment methods.

At levels exceeding the WQS, chloride is toxic to aquatic life. Water samples from lakes, streams, wetlands, and groundwater show an increasing trend in chloride levels in urban areas across the state. Available monitoring data indicates 39 waterbodies in the TCMA currently exceed chloride levels protective of the aquatic community. This trend calls for immediate attention to the issue, the development of a plan to restore waters already impaired, and protection of waters at risk of further degradation.

The goal of this TMDL study is to:

1. Determine the allowable chloride loading to impaired lakes, wetlands and streams in the TCMA;
2. Allocate the allowable loading to the various sources of chloride and establish reasonable and practical expectations for meeting reduction goals; and
3. Provide stakeholders and chloride users with guidance and tools to improve practices, reduce chloride use, and ultimately attain chloride criteria in all waterbodies in the TCMA.

1.2 Identification of Waterbodies

The TCMA Chloride Special Assessment conducted by the MPCA from 2013-2014 includes 39 waterbodies listed as impaired for chloride in the TCMA. Previously, two streams that had been listed as impaired by chloride had TMDLs developed and approved by the United States Environmental Protection Agency (EPA) (Nine Mile Creek and Shingle Creek). The lakes, streams, and wetlands included on the MPCA's 303(d) list of impaired waters for chloride are shown in Figure 1 and listed in Table 1 and Table 2. High Risk waters are also shown in Figure 1; however, this TMDL has been developed to address only the impaired waters. See the TCMA Chloride Management Plan for protection strategies.

Table 1: Lakes and wetlands impaired by chloride in the TCMA

Waterbody Name	Waterbody Description	Year Added to List	Basin	Lake or Wetland AUID (County + Lake)	TMDL Target Start	TMDL Target Completion
Battle Creek	Lake	2014	UMiss	82-0091-00	2009	2015
Brownie	Lake	2014	UMiss	27-0038-00	2009	2015
Carver	Lake	2014	UMiss	82-0166-00	2009	2015
Como	Lake	2014	UMiss	62-0055-00	2009	2015
Diamond	Wetland	2014	UMiss	27-0022-00	2009	2015
Kasota Pond North	Wetland	2014	UMiss	62-0280-00	2009	2015
Kasota Pond West	Wetland	2014	UMiss	62-0281-00	2009	2015
Kohlman	Lake	2014	UMiss	62-0006-00	2009	2015
Little Johanna	Lake	2014	UMiss	62-0058-00	2009	2015
Loring (South Bay)	Lake	2014	UMiss	27-0655-02	2009	2015
Mallard Marsh	Wetland	2014	UMiss	62-0259-00	2009	2015
Parkers	Lake	2014	UMiss	27-0107-00	2009	2015
Peavey	Lake	2014	UMiss	27-0138-00	2009	2015
Pike	Lake	2014	UMiss	62-0069-00	2009	2015
Powderhorn	Lake	2014	UMiss	27-0014-00	2009	2015
Silver	Lake	2014	UMiss	62-0083-00	2009	2015
South Long	Lake	2014	UMiss	62-0067-02	2009	2015
Spring	Lake	2014	UMiss	27-0654-00	2009	2015
Sweeney	Lake	2014	UMiss	27-0035-01	2009	2015
Tanners	Lake	2014	UMiss	82-0115-00	2009	2015
Thompson	Lake	2014	UMiss	19-0048-00	2009	2015
Valentine	Lake	2014	UMiss	62-0071-00	2009	2015
Wirth	Lake	Proposed 2016*	UMiss	27-0037-00	2009	2015

*Recent local water quality data indicates multiple exceedances of the standard. A formal assessment and listing process will be conducted when the data are received.

** The 2014 list is currently draft and has not yet been approved by EPA.

Table 2. Streams impaired by chloride in the TCMA

Waterbody Name	Waterbody Description	Year Added to List	Basin	River AUID	TMDL Target Start	TMDL Target Completion
Bass Creek	Unnamed wetland (27-0096-00) to Eagle Cr	2002	UMiss	07010206-784	2009	2015
Bassett Creek	Medicine Lk to Mississippi R	2010	UMiss	07010206-538	2009	2015
Battle Creek	Battle Creek Lk to Pigs Eye Lk	2008	UMiss	07010206-592	2009	2015
Elm Creek	Headwaters (Lk Medina 27-0146-00) to Mississippi R	2014	UMiss	07010206-508	2009	2015
Judicial Ditch 2	Headwaters to Sunrise R	2012	StC	07030005-525	2009	2015
Minnehaha Creek	Lk Minnetonka to Mississippi R	2008	UMiss	07010206-539	2009	2015
Ninemile Creek	Headwaters to Minnesota R	2004	MnR	07020012-518	*	*
Raven Stream	E Br Raven Str to Sand Cr	2010	MnR	07020012-716	2009	2015
Raven Stream, East Branch	Headwaters (Lk Pepin 40-0028-00) to Raven Str	2010	MnR	07020012-543	2009	2015
Rush Creek, South Fork	Unnamed lk (27-0439-00) to Rush Cr	2014	UMiss	07010206-732	2009	2015
Sand Creek	Porter Cr to Minnesota R	2014	MnR	07020012-513	2009	2015
Sand Creek	T112 R23W S23, south line to Raven Str	2010	MnR	07020012-662	2009	2015
Shingle Creek	Headwaters (Eagle Cr /Bass Cr) to Mississippi R	1998	UMiss	07010206-506	**	**
Unnamed creek	Headwaters to Medicine Lk	2014	UMiss	07010206-526	2009	2015
Unnamed creek	Unnamed ditch to wetland	2014	UMiss	07010206-718	2009	2015
Unnamed creek	Unnamed lk (62-0205-00) to Little Lk Johanna	2014	UMiss	07010206-909	2009	2015

* TMDL plan approved 2010 – EPA TMDL ID #40253

** TMDL plan approved 2007 – EPA TMDL ID #32032

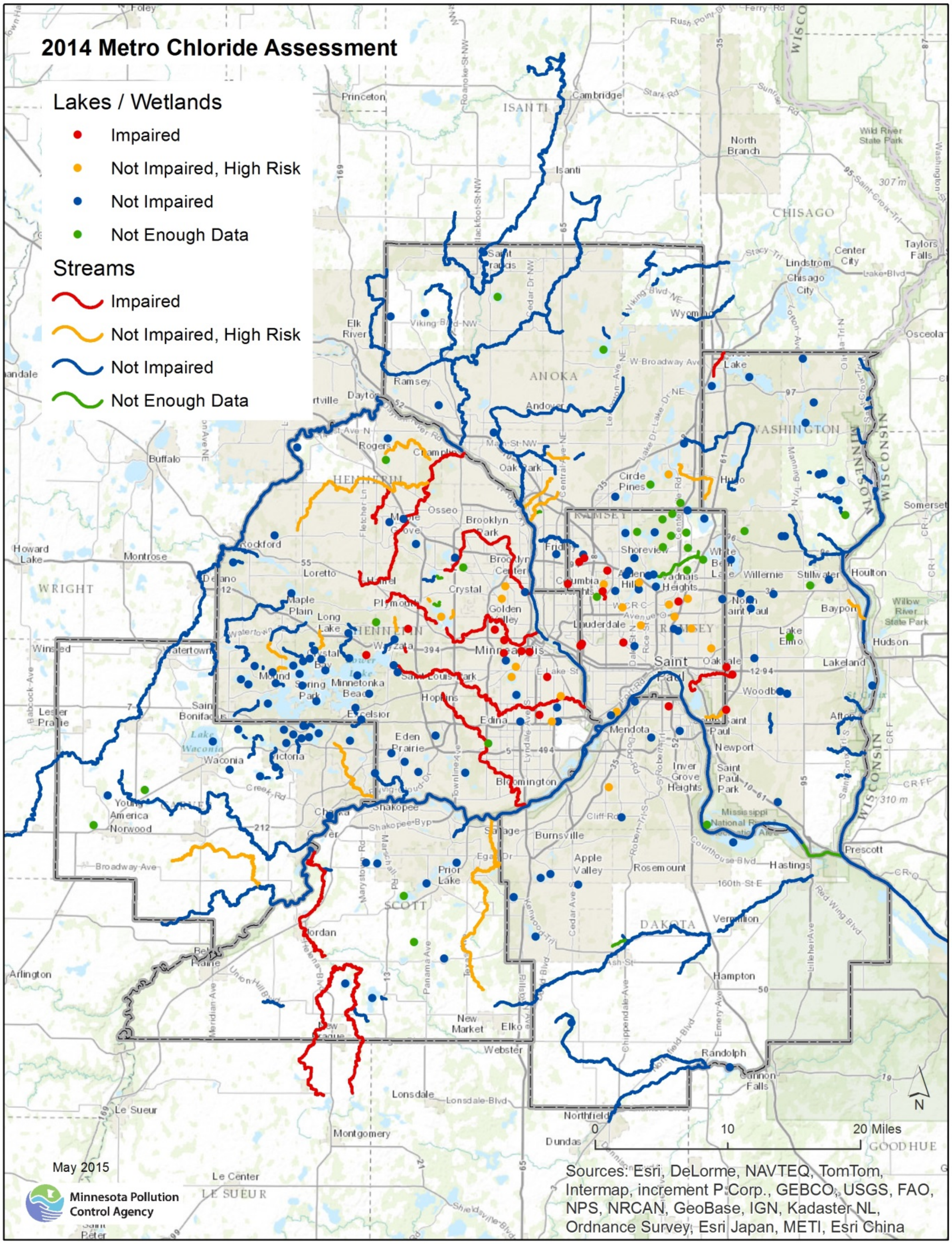

Figure 1: 2014 Twin Cities Metro Chloride Assessment

1.3 Priority Ranking

The MPCA's projected schedule for the TMDL completions, as indicated on the 303(d) impaired waters list and Table 1 and Table 2, implicitly reflects Minnesota's priority ranking of this TMDL. Ranking criteria for scheduling TMDL projects include, but are not limited to: impairment impacts on public health and aquatic life; public value of the impaired water resource; likelihood of completing the TMDL in an expedient manner, including a strong base of existing data and restorability of the waterbody; technical capability and willingness locally to assist with the TMDL; and appropriate sequencing of TMDLs within a watershed or basin.

2. Applicable Water Quality Standards and Numeric Water Quality Targets

The applicable water quality standards for the TCMA lakes, wetlands, and streams are included in Minn. R. ch. 7050. The lakes, streams and wetlands listed as impaired for chloride are classified as 2B for protection of cool and warm water sport fish and 3C waters for protection of industrial consumption. Minn. R. 7050.0222 and 7050.0223 define the aquatic life and recreation and industrial consumption use classifications:

> Minn. R. 7050.0222, subp. 4. **Class 2B waters.** The quality of Class 2B surface waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water sport fish or commercial fish and associated aquatic life, and their habitats. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface water is not protected as a source of drinking water.
>
> Minn. R. 7050.0223, subp. 4. **Class 3C waters.** The quality of Class 3C waters of the state shall be such as to permit their use for industrial cooling and materials transport without a high degree of treatment being necessary to avoid severe fouling, corrosion, scaling, or other unsatisfactory conditions.

The chronic standard for chloride to protect for 2B uses is 230 mg/L. The chronic standard is defined in Minn. R. 7050.0218, subp. 3.I., as "the highest water concentration of a toxicant to which organisms can be exposed indefinitely without causing chronic toxicity." The 230 mg/L value is based on a 4-day exposure of aquatic organisms to chloride. The maximum standard to protect for 2B uses is 860 mg/L. The maximum standard is defined in Minn. R. 7050.0218, subp. 3.T., as "the highest concentration of a toxicant in water to which organisms can be exposed for a brief time with zero to slight mortality." The 860 mg/L value is based on a 24-hour exposure of aquatic organisms to chloride. These criteria are adopted from the EPA's recommended water quality criteria for chloride. The industrial consumption chloride standard to protect for 3C uses is 250 mg/L.

The MPCA's approach to determining whether or not a stream, lake or wetland is impaired by chloride is outlined in the MPCA document Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List (2014). The MPCA conducted an assessment for chloride in the TCMA waterbodies in 2013. Two or more exceedances of the chronic criterion within a three-year period are considered an impairment. One exceedance of the acute criterion is considered an impairment. This TMDL has been developed with the goal of eliminating these exceedances. The chronic standard of 230 mg/L has been applied as the numeric WQT for the chloride TMDLs for all impaired lakes, wetlands and streams.

3. Watershed and Waterbody Characterization

This section presents a brief description of the impaired lakes, wetlands and streams addressed in this TMDL. Watersheds, land use, water quality conditions, and sources of chloride are discussed.

3.1 Lakes and Wetlands

Table 3 presents the impaired lakes and wetlands and general characteristics of each waterbody and watershed, including watershed area, percent impervious, lake area, mean depth, and volume. Percent impervious was derived using the National Land Cover Database (NLCD) from 2011 and is discussed further in Section 3.4.

Table 3: Impaired Lake and Wetland Characterization in the TCMA

Waterbody Name	Watershed Area (ac)	% Impervious (NLCD, 2011)*	Lake Area (ac)	Mean Depth (ft)	Volume (ac-ft)
Battle Creek Lake	4,326	33%	93	4	372
Brownie Lake	452	53%	18	22	404
Carver Lake	2,242	31%	48	15	720
Como Lake	1,850	36%	69	6	414
Diamond Lake	744	45%	51	3	57
Kasota Pond North	10	45%	1.4	n/a	n/a
Kasota Pond West	6	69%	0.9	n/a	n/a
Kohlman Lake	7,533	33%	82	4	328
Little Johanna Lake	1,703	50%	17	10	170
Loring Pond (South Bay)**	34	17%	7	7.5	52.5
Mallard Marsh	16	43%	2.9	n/a	n/a
Parkers Lake	1,064	41%	93	11	1,023
Peavey Lake	776	15%	9.7	n/a	n/a
Pike Lake	5,735	43%	36	7	252
Powderhorn Lake	332	45%	12	4	73

Waterbody Name	Watershed Area (ac)	% Impervious (NLCD, 2011)*	Lake Area (ac)	Mean Depth (ft)	Volume (ac-ft)
Silver Lake	655	38%	71	6	426
South Long Lake	114,785	12%	186	16	2,976
Spring Lake	39	25%	3	9.5	28.5
Sweeney Lake	2,439	41%	69	12	828
Tanners Lake	1,732	31%	69	19	1,311
Thompson Lake	178	53%	7	8	56
Valentine Lake	2,404	32%	55	4	220
Wirth Lake	426	13%	37	11	407

* Source: 2011 NLCD

** Loring Pond receives runoff from the MnDOT I-35W tunnel on occasion due to surcharging.

3.2 Streams

Table 4 presents the impaired streams and watershed area and percent impervious cover of the watershed.

Table 4: Impaired Stream Characterization in the TCMA

Waterbody Name	Watershed Area (ac)	% Impervious (2011)*
Bass Creek	5,434	30.9%
Bassett Creek	25,209	33.8%
Battle Creek	7,246	32.6%
Elm Creek	66,382	9.7%
Judicial Ditch 2	1,587	20.6%
Minnehaha Creek	109,151	14.4%
Raven Stream	42,750	2.0%
Raven Stream, East Branch	14,751	4.5%
Rush Creek, South Fork	13,844	4.7%
Sand Creek (includes AUIDs: 07020012-513 and 07020012-662)	175,578	2.0%
Unnamed creek (Headwaters to Medicine Lk)	6,447	37.6%
Unnamed creek (Unnamed ditch to wetland)	793	37.6%
Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna)	1,627	51.6%

* Source: 2011 NLCD

3.3 Subwatersheds

Watershed maps for each impaired waterbody are included in Appendix A-1.

3.4 Land Use

The land use in the TCMA is largely urban in the core of Minneapolis and St. Paul with a transition to rural and agricultural moving outward through the suburbs. This land use pattern can be seen in Figure 2 which is based on the NLCD from 2011, the most recent national land cover product. This data is based on 2011 Landsat satellite data. Road densities by watershed are presented in Figure 3 based on road density information provided by the Minnesota Department of Transportation (MnDOT) and watershed catchments developed by Minnesota Department of Natural Resources (DNR). The NLCD also includes a layer for percent impervious (Xian et al., 2011). The impervious layer is comprised of 30m x 30m pixels each with a percent impervious value. The pixels for each drainage area are averaged to calculate a percent impervious for each impaired watershed. The percent impervious for the TCMA is shown in Figure 4 below. Similar to the land use pattern, both road densities and percent impervious are shown to decline moving outward from the TCMA core through the suburbs. The percent impervious for each impaired watershed is listed above in Table 3 and Table 4.

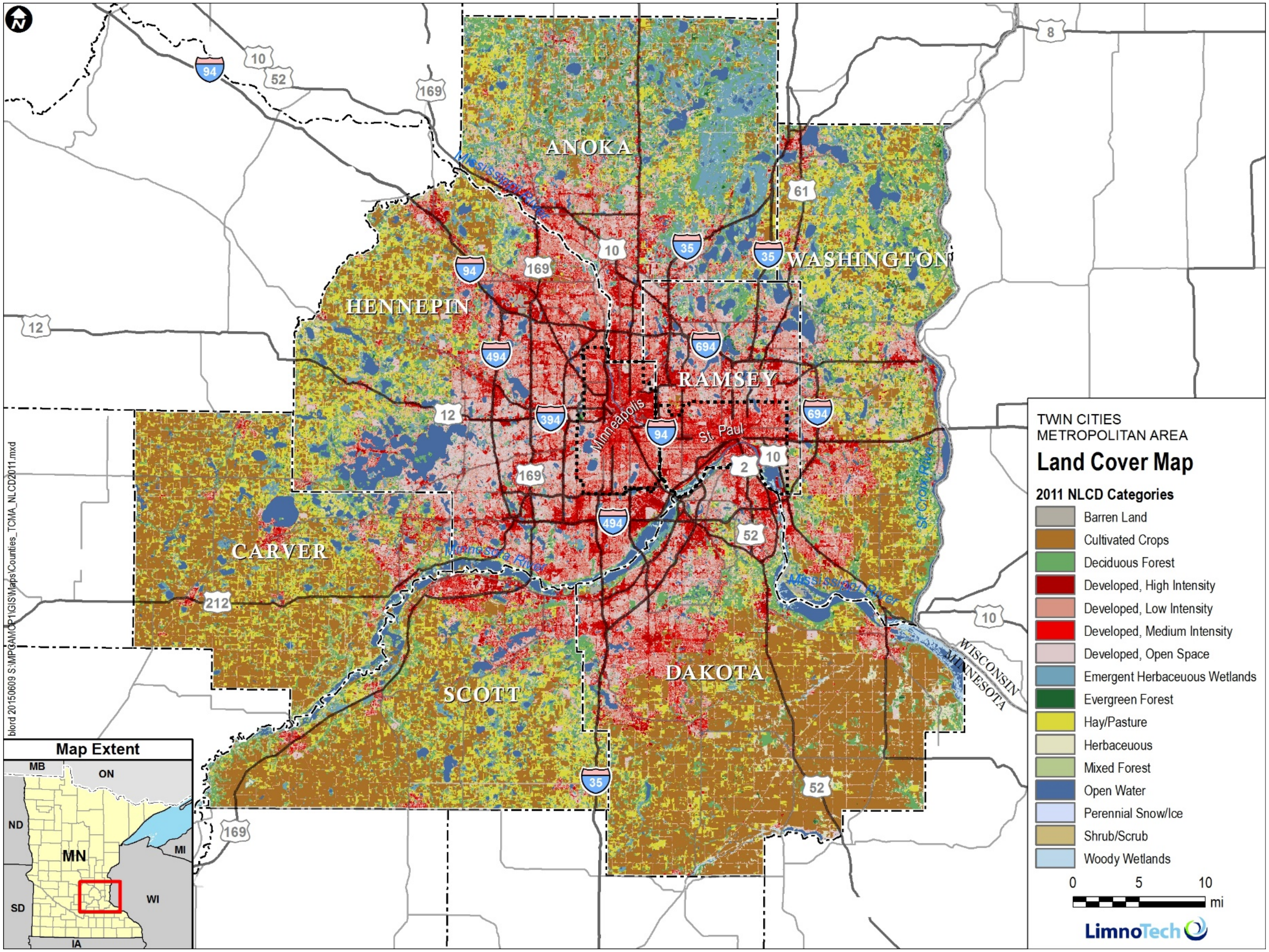

Figure 2. Land Use in the TCMA

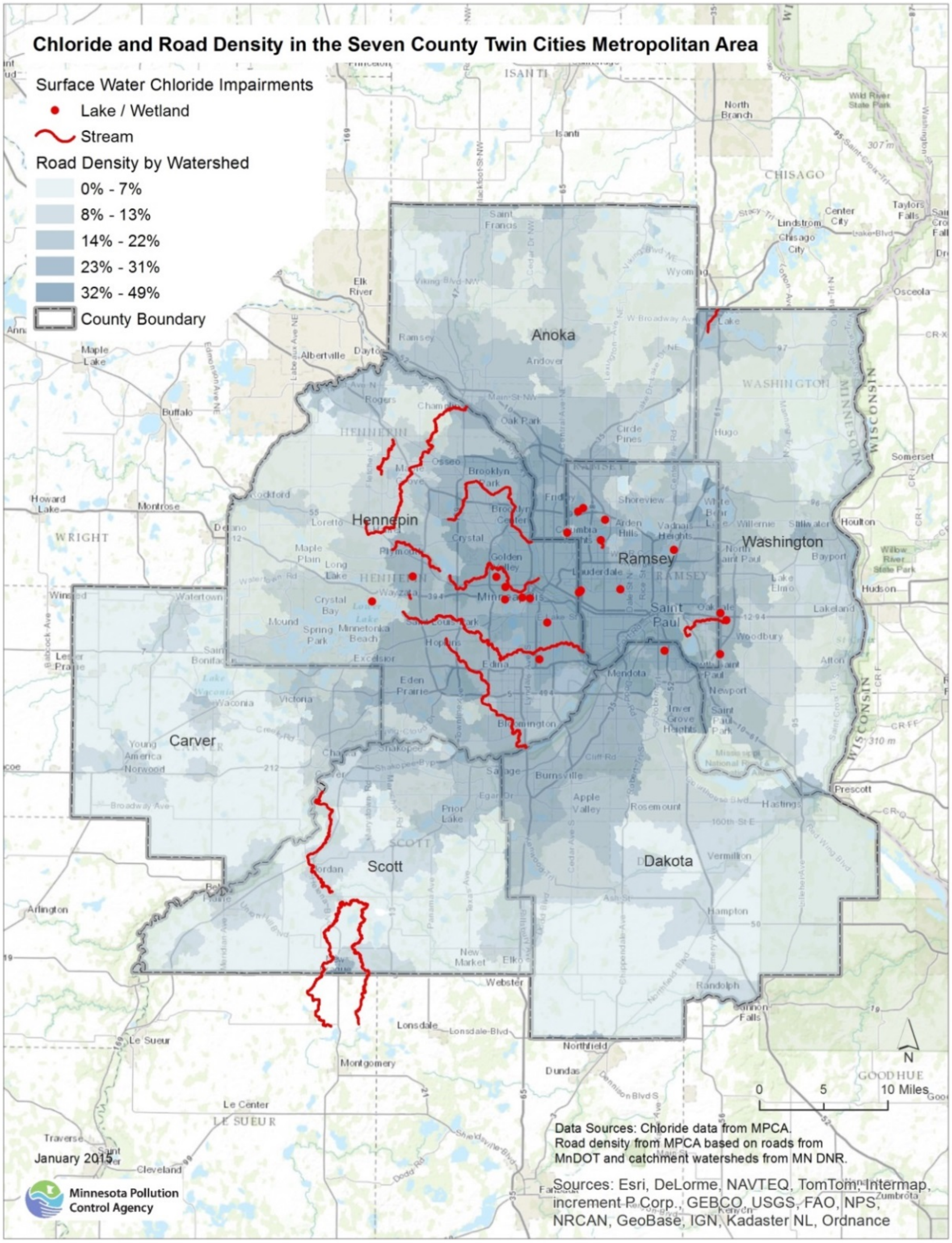

Figure 3. Chloride Impairments and Road Density in the TCMA

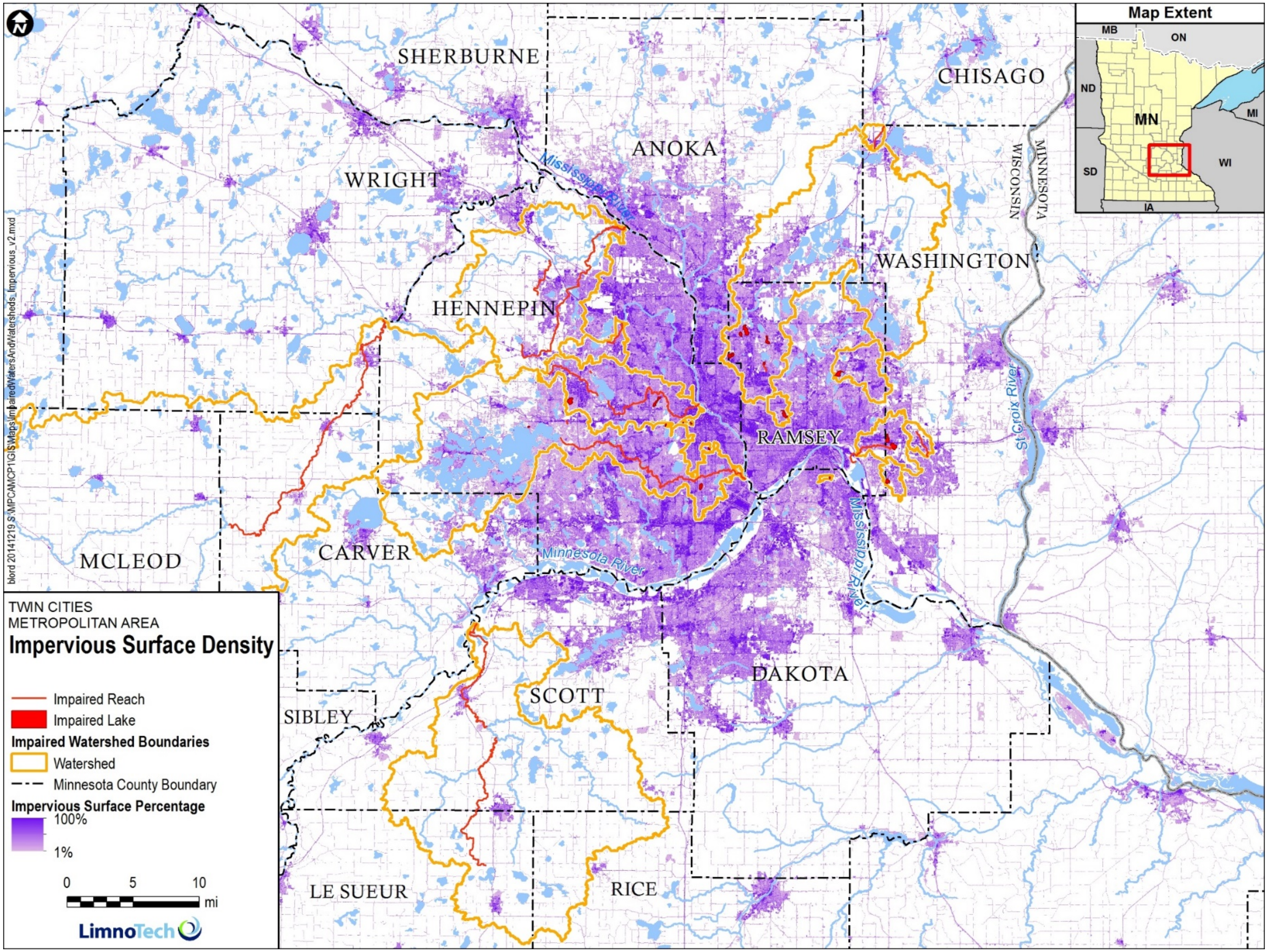

Figure 4. Percent Impervious in the TCMA

3.5 Current and Historic Chloride Concentrations

Ambient chloride data for each impaired waterbody were compiled and assessed to understand current and historic water quality. A summary of the assessment is presented in Appendix A-1. As stated in Section 2, the chronic chloride standard of 230 mg/L has been applied as the numeric WQT for this TMDL. The impaired lakes, wetlands, and streams were compared in terms of the concentrations of chloride measured and ranked from highest concentrations to lowest. These rankings are presented in Figure 5 and Figure 6. These figures are not a direct reflection of the 303(d) listing assessment; rather they are intended to make a relative comparison of the extent of impairment across impaired waters. The values presented in these figures were calculated by first identifying the maximum chloride concentration measured in a waterbody on individual sampling days, and then averaging all the individual sampling day maximums that exceed the target of 230 mg/L for the period from 2003-2013. These figures indicate the variability in one waterbody or watershed to the next in terms of the severity of the impairment. This information may be used to target priority areas for reductions in chloride loads. Table 5 and Table 6 show the number of days with samples exceeding the chronic and acute standard within the last 10 years for lakes and streams, respectively. More information about the chloride trends in the TCMA can be found in section 2.3 of the TCMA Chloride Management Plan.

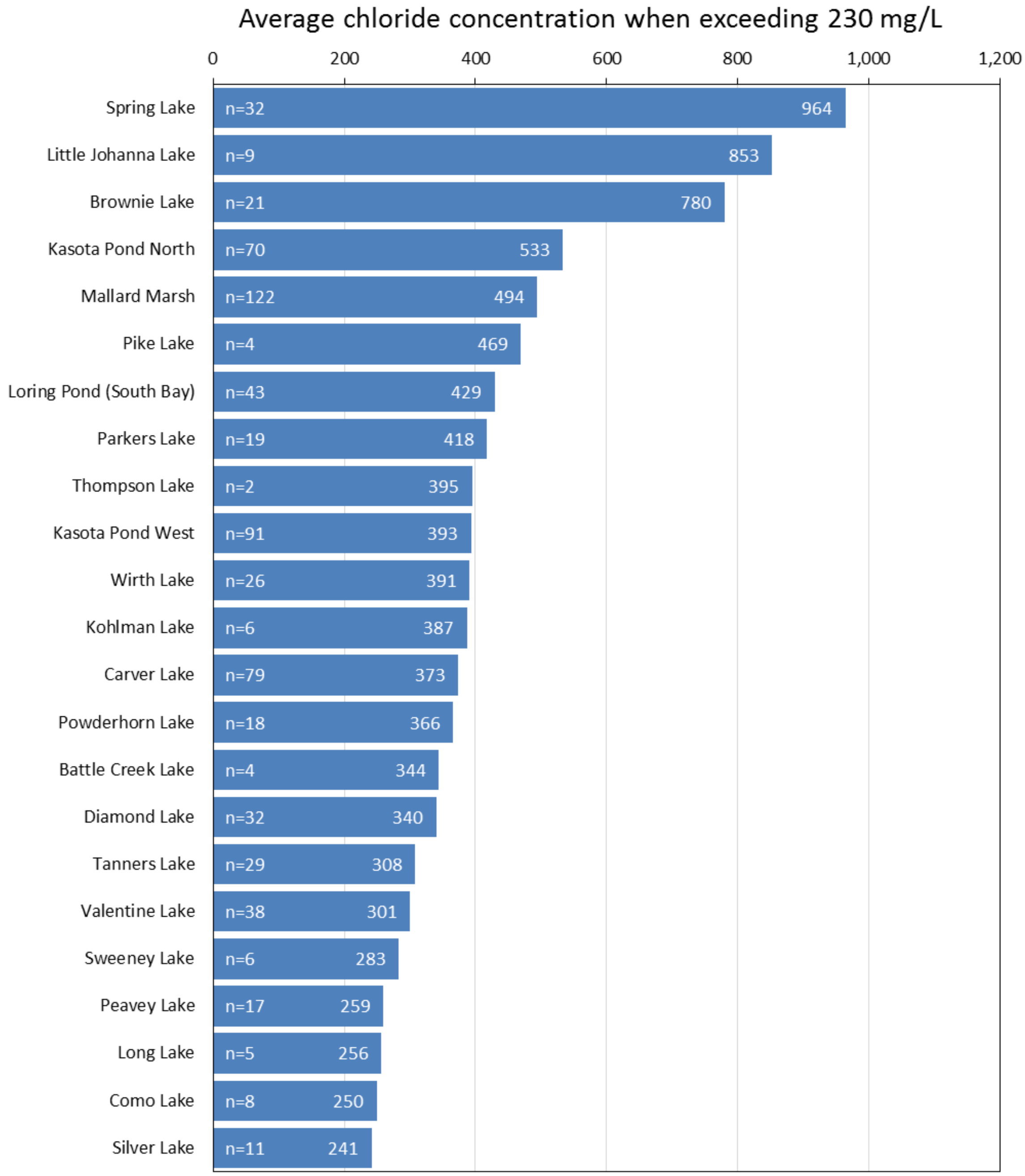

Figure 5. Comparison of Impaired Lakes and Wetlands in the TCMA from 2003-2013 (average chloride concentration of samples exceeding 230 mg/L, n is the number of days with samples exceeding 230 mg/L).

Table 5: Number of days with lake and wetland samples exceeding the chronic and acute criterion in the TCMA, 2003-2013.

Lake	Number of Individual Days with Samples	Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	Number of Days with Samples Exceeding 860 mg/L Acute Criterion
Battle Creek Lake	81	4	0
Brownie Lake	27	21	5
Carver Lake	138	79	0
Como Lake	84	8	0
Diamond Lake	117	32	1
Kasota Pond North	91	70	8
Kasota Pond West	91	91	0
Kohlman Lake	80	6	1
Little Johanna Lake	9	9	5
Loring Pond (South Bay)	65	43	3
Mallard Marsh	122	122	0
Parkers Lake	30	19	0
Peavey Lake	20	17	0
Pike Lake	9	4	0
Powderhorn Lake	67	18	0
Silver Lake	78	11	0
South Long Lake	149	5	0
Spring Lake	32	32	20
Sweeney Lake	44	6	0
Tanners Lake	128	29	0
Thompson Lake	18	2	0
Valentine Lake	76	38	0
Wirth	68	17	0

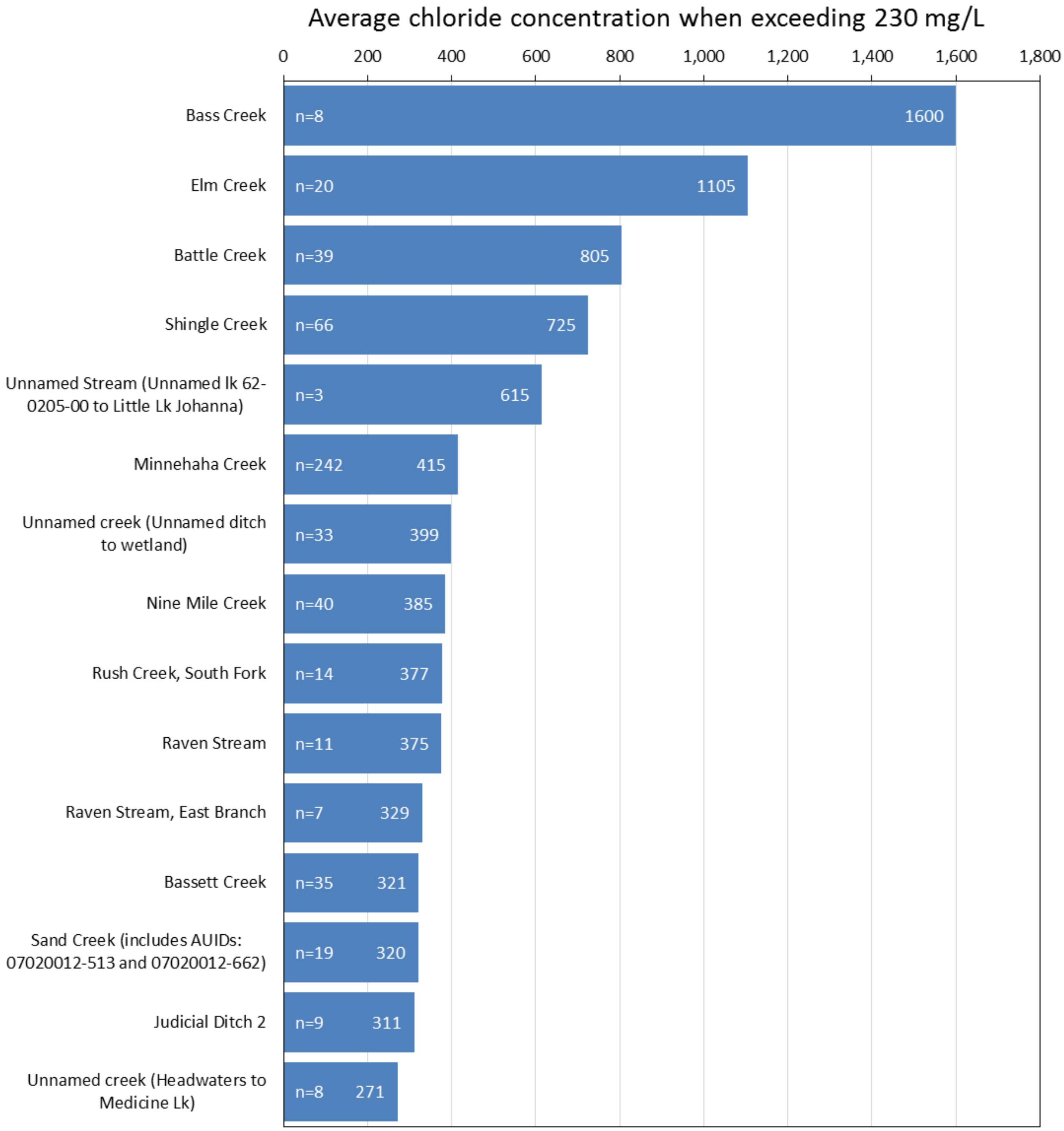

Figure 6. Comparison of Impaired Streams in the TCMA 2003-2013 (average chloride concentration of samples exceeding 230 mg/L, n is the number of days with samples exceeding 230 mg/L).

Stream	Number of Individual Days with Samples	Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	Number of Days with Samples Exceeding 860 mg/L Acute Criterion
Bass Creek	26	8	2
Bassett Creek	273	35	0
Battle Creek	366	39	10
Elm Creek	209	20	14
Judicial Ditch 2	45	9	0
Minnehaha Creek	1,281	242	12
Nine Mile Creek	304	40	1
Raven Stream	48	11	0
Raven Stream, East Branch	39	7	0
Rush Creek, South Fork	87	14	0
Sand Creek (includes AUIDs: 07020012-513 and 07020012-662)	389	19	0
Shingle Creek	330	66	15
Unnamed creek (Headwaters to Medicine Lk)	27	8	0
Unnamed creek (Unnamed ditch to wetland)	35	33	0
Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna)	6	3	1

Table 6: Number of days with stream samples exceeding the chronic and acute criterion in the TCMA, 2003-2013.

3.6 Chloride Source Summary

Chloride enters the TCMA lakes, streams, wetlands, and groundwater from a variety of sources. A conceptual model diagram of the primary anthropogenic sources is shown in Figure 7. A study of chloride fate and transport in the TCMA estimated that approximately 22%-30% of the chloride applied in the TCMA was exported out of the TCMA via streamflow in the Mississippi, Minnesota, and St. Croix Rivers (Stefan et al., 2008). Therefore, 70%-78% of the applied chloride was estimated to remain in the TCMA soils, lakes, wetlands, and groundwater. Since chloride does not break down, this potentially high percentage retained in the TCMA suggests that chloride may continue to accumulate locally and eventually make its way to the deep aquifers. This implies that, on average, chloride concentrations in the TCMA waterbodies are increasing with time. If the chloride loading remains steady, the concentrations will level out when equilibrium develops between loadings and transport out of the TCMA. By the same token, if loadings are reduced sufficiently and persistently, the chloride concentrations in TCMA waterbodies will begin to decrease and will continue to decrease until a new equilibrium is reached. Each of the sources in Figure 7 is briefly described below.

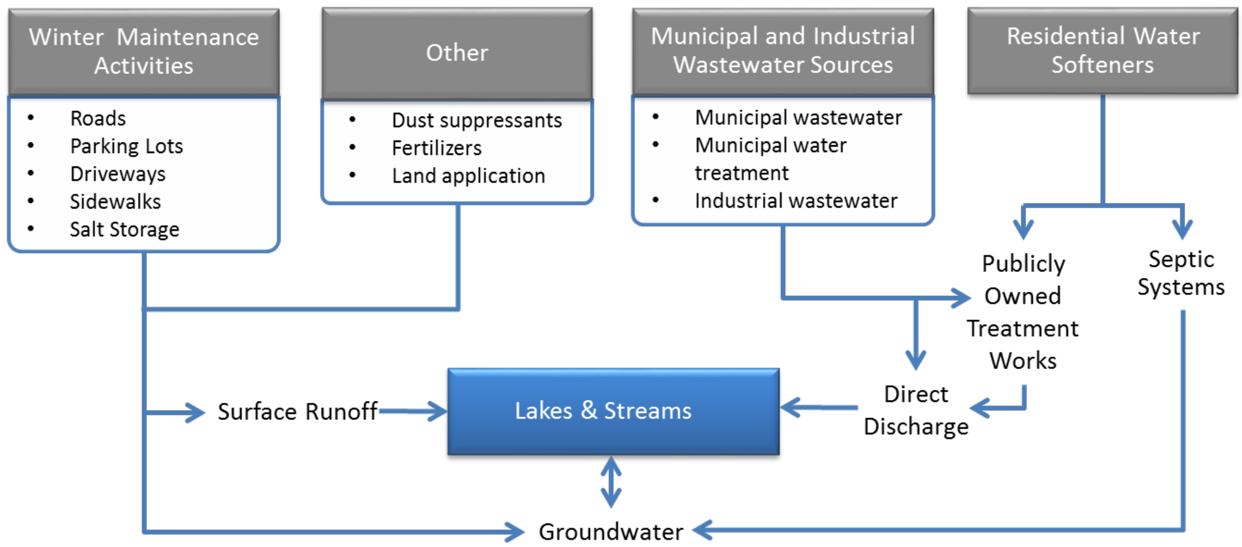

Figure 7. Conceptual model of anthropogenic sources of chloride and pathways

3.7 Permitted Sources

3.7.1 Municipal Separate Storm Sewer System (MS4) Winter Maintenance Activities

Winter maintenance activities include snow and ice removal. Application of deicing and anti-icing chemicals, primarily salt, is common. Salt is applied to a variety of surfaces such as roads, parking lots, driveways, and sidewalks. The chemical properties of sodium chloride, most commonly salt, make it effective at melting ice, but these properties also result in chloride dissolving in water and being transported with snow melt and stormwater runoff to lakes, streams and wetlands. The dissolved chloride moves with the melted snow and ice, during melting events, and ends up in the local water resources. Because salt is typically applied on impervious surfaces during frozen ground conditions, the snow melt and stormwater runoff carrying the chloride has little opportunity to infiltrate and the majority will flow overland into local surface waters. However, chloride laden runoff that does infiltrate will enter shallow groundwater eventually and either flow via subsurface flow into local surface waters or into deep aquifers. Runoff from salt storage facilities is another potential source of salt. Chloride sources related to runoff from winter maintenance activities are largely covered under the MS4 permitting program. The St. Anthony Falls Laboratory at the University of Minnesota (UMN) developed an inventory of road salt uses in the TCMA for the MnDOT (Sander et al., 2007). The inventory estimated the total amount of road salt used for winter maintenance activities in the TCMA to be 349,000 tons per year. Estimates of use by various entities included: cities ~ 33%; MnDOT ~ 23%; counties ~ 20%; commercial operators ~ 19%; and packaged ~ 5%.

3.7.1.1 Roads

The TCMA is estimated to have over 26,000 lane miles of roadways (Sander et al., 2007). Based on salt purchasing records and number of lane miles for the MnDOT, counties, and cities in the TCMA, the application rates range from 3 – 35 tons of road salt per lane mile per year (Wenck, 2009). These TCMA application rate estimates are consistent with national estimates of 10 to 30 tons per lane mile per winter season (Mullaney, 2009).

A survey of municipal winter maintenance professionals in the TCMA, found that typical application rates range from 100 to 600 lbs. of salt applied per lane mile per event, which is consistent with previous evaluations of road salt application rates (LimnoTech, 2013). However, rates can be much higher on hills, near intersections, and other ice problem areas. Higher speed roadways will typically have higher salt application rates. Some events may require multiple passes of salt application and increase the application rate per event.

A list of MS4 permittees within each impaired watershed area is included in Appendix A-2.

3.7.1.2 Parking Lots, Driveways, and Sidewalks

MS4s also provide winter maintenance on parking lots, driveways, and sidewalks. Estimates of application rates for this source are shown in more detail in Section 3.8.1.

3.7.2 Municipal and Industrial Wastewater Sources

Municipal wastewater, backwash from municipal water treatment facilities, and industrial facilities with waste streams may contain chloride. The concentration of chloride present in the waste stream will vary for every facility and is dependent on the source of chloride. The major source of chloride to municipal wastewater treatment plants (WWTP) is from residential water softeners (>90% in some municipalities). Industrial facilities may discharge directly to surface waters following treatment, or may discharge to a sanitary sewer system which transports the wastewater to a WWTP for further treatment prior to discharge to surface water. A range of industrial facilities discharge directly to waters impaired by chloride. These include food processing facilities, manufacturing, pipeline terminals, biofuel facilities, and groundwater treatment systems. Discharge of chloride from municipal and industrial wastewater sources are covered by individual or general permits. Monitoring data for the WWTP are not widely available at this point in time. However, chloride concentrations in the WWTP effluent for three WWTPs in the Sand Creek impaired watershed average from 521 mg/L to 618 mg/L.

A list of National Pollutant Discharge Elimination System (NPDES) wastewater dischargers and chloride allocations within each impaired watershed area is included in Appendix A-3 and Appendix A-4, respectively. They include both individual permits (denoted by NPDES permit numbers with an MN00 prefix) and general permits (denoted by an MNG prefix). The MNG25 general permit covers untreated noncontact cooling water discharges. The MNG255 general permit covers treated noncontact cooling water discharges. The MNG64 general permit covers water treatment facility filter backwash discharges. Individual industrial permits include discharges of noncontact cooling water, geothermal cooling water, reverse osmosis reject water, industrial process water and industrial stormwater.

3.8 Non-permitted Sources

Non-permitted sources refer to sources outside of the jurisdiction of permitted MS4s. These include runoff from winter maintenance activities outside of permitted MS4s, residential water softeners, agricultural runoff, natural sources, and others. Brief descriptions of these sources are provided below.

3.8.1 Parking Lots, Driveways, and Sidewalks – Non-permitted Runoff from Winter Maintenance Activities

Commercial sources of deicing salt can vary greatly between different watersheds and includes salt applied to parking lots, driveways, and sidewalks on commercial property. The land owner or tenant may conduct winter maintenance activities, or winter maintenance may be contracted with private winter maintenance providers. After evaluating all available literature sources, it is estimated that between 5% and 45% of the total deicing salt used is from commercial sources. The amount of chloride coming from commercial sources is variable, and is dependent on the characteristics of the watershed, including the amount of impervious area. To provide more accurate and Minnesota specific estimates of the amount of chloride coming from that source, small commercial applicator rates have been quantified by the MPCA (Fortin, 2012a). Application rates of salt on parking lots are estimated to range from 0.1 to 1 ton per acre per event, and typically 6.4 tons per acre per year. For sidewalks, the application rate is estimated to range from 8 to 25 lbs per 1,000 square feet per event (0.2 to 0.5 tons per acre per event).

Residential winter maintenance salt use has been estimated from purchasing records. Packaged deicer for home and commercial use is estimated to account for 5% of the total in the TCMA, while bulk deicing salt applied by commercial snow and ice control companies accounted for 19% of the total salt used in the TCMA (Sander et al. 2007).

More area specific residential and commercial estimates of chloride usage can be determined on a watershed basis by digitizing all of the residential and commercial impervious surfaces and multiplying by the application rates. This will also identify specific areas within the watershed to target training and education efforts. While this will provide a range, a more accurate chloride usage value could be obtained by talking with each individual residential and commercial chloride user to determine how much salt they use during each event and summing up these values over the individual watershed.

3.8.2 Residential Water Softeners

Hardness is a measure of the calcium and magnesium carbonate concentration in water. The use of water softeners is common in areas where the water supply is considered to be "hard". Most water softeners use chloride ions to replace calcium and magnesium ions. Chloride from this salt is delivered to the environment either through discharge to a septic system or by delivery to a WWTP. Septic systems become more prevalent in the rural areas outside of the TCMA urban core. The chloride that comes from septic systems enters either the shallow groundwater or local streams through subsurface flow. Chloride loading from any individual home water softener is dependent on many variables and is specific to the individual homeowner's water chemistry, water use, hardness preferences and softener efficiency. At this time the exact chloride loading from residential water softeners is not available. However, where the primary source of household water is hard (as it is throughout the metro) and it is not softened by municipal water utility, residential water softeners are the primary source of chloride to the WWTPs. The Sand Creek watershed is an example of this; chloride concentrations in the WWTP effluent for three WWTPs located in the watershed average from 521 mg/L to 618 mg/L.

3.8.3 Agriculture

Agricultural crop land may be a source of chloride to lakes and streams. Agricultural land uses increase in the areas outside the urban core of the TCMA. Fertilizers and biosolids from food processing and publicly owned treatment works contain chloride. The application of fertilizers and biosolids on crop land can result in chlorides being transported to lakes and streams through surface runoff as well as infiltration into shallow groundwater and subsequent recharge of lakes and streams. Potassium chloride (KCl) is the most commonly used fertilizer containing chloride. While not currently suspected to be a significant source of chloride, estimates of the amount of chloride in land-applied fertilizers and biosolids in the TCMA are not available. An on-going evaluation by North Dakota State University – Department of Agriculture and Biosystems Engineering indicates that chloride concentrations from agricultural drainage can range from 8.6 mg/L to 37.4 mg/L [the final results of this study have not been published].

3.8.4 Natural Background Sources of Chloride

Chloride occurs naturally in soil, rock, and mineral formations. Chloride is naturally present in Minnesota's groundwater due to the natural weathering of these formations. Glacial deposits from eroded igneous rocks and clay minerals with chloride ions attached are potential sources in the TCMA. Natural background levels of chloride in surface runoff and groundwater vary depending on the geology. The natural background concentration in small streams in the TCMA has been estimated to be 18.7 mg/L (Stefan et al., 2008). A natural background concentration for lakes has not been estimated; however, the natural background load from surface runoff to lakes was assumed to be at a concentration of 18.7 mg/L as well. This background concentration characterizes runoff that is not impacted by current or historical applications of other anthropogenic sources of chloride. Concentrations of chloride in precipitation are estimated to be 0.1 mg/L to 0.2 mg/L (Chapra et al., 2009).

3.8.5 Other Potential Sources

Sources of chloride to the TCMA lakes and streams other than those discussed above exist but are considered to be small. One such source of chloride is the use of dust suppressants on gravel roads and parking areas. Chloride is a common constituent found at high concentrations in dust suppressants. Landfill leachate has also been shown to contain elevated levels of chloride (Mullaney et al., 2009). The use of aluminum chloride for treatment of lake sediments, or ferric chloride for treatment of stormwater are also sources of chloride, and should be avoided in waters and watersheds with chloride impairments.

4. TMDL Development

This section presents the methodology used to develop the TCMA chloride TMDLs and the resulting load capacity and various components of the TMDL, including load allocations (LA), wasteload allocations (WLA), MOS, seasonal variation, and future growth/reserve capacity.

4.1 Chloride TMDL Methodology

The TMDLs were developed for each of the lakes, wetlands and streams in the TCMA impaired by chloride. A TMDL quantifies the allowable pollutant loading to a lake or stream that will result in water quality standards being attained. The WQT for the TMDLs was set to the chronic water quality criterion for chloride of 230 mg/L. The total allowable load, or the TMDL, is allocated to the various sources contributing chloride as well as a MOS and, in general, a RC. The TMDL equation can be written as:

TMDL = WLA + LA + MOS + RC

Where:

WLA = wasteload allocation for permitted sources, including MS4s and treatment facilities

LA = load allocation for natural background and other non-permitted sources (mainly, runoff from rural and non-permitted areas)

MOS = margin of safety

RC = reserve capacity

Several approaches were considered for developing the TMDLs. A simple 0-dimensional, steady-state modeling approached was selected through consultation with the Technical Advisory Committee for calculating the allowable load from runoff, including the permitted MS4 areas and non-permitted areas. This approach assumes that chloride from winter maintenance activities and all other sources eventually makes its way to surface waterbodies through runoff. This approach was chosen for the following reasons: 1) chloride is a conservative substance and is in the dissolved phase in the water environment; therefore, complex fate and transport assessments are not needed; 2) determining the time for a system to respond to reduced chloride loads was not necessary to inform the TMDL or the CMP; and 3) the large number of lakes and streams needing a TMDL and the limited data available for a significant portion of them prohibited a more complex approach. This approach assumes eventual complete flushing in an impaired waterbody over the long-term.

The WQT for the waterbodies included in this TMDL is Minnesota's chronic water quality standard for chloride, 230 mg/L. On this basis, the TMDL components were calculated as described below, with additional discussion following later in this section. It should be noted that the "WLA for MS4 areas" and "LA for runoff from non-permitted areas" are exclusive and do not overlap.

Total allowable runoff load = runoff volume$_{TOTAL}$ x WQT

Margin of Safety (MOS) = 10% of the total allowable runoff load (both MS4 and non-permitted areas)

= 10% x runoff volume x WQT

LA for natural background sources (LA_{BG}) = runoff volume$_{TOTAL}$ x natural background concentration

WLA for MS4 areas (WLA_{MS4}) = runoff volume$_{MS4}$ x WQT - LA_{BG} - MOS

WLA for WWTPs (WLA_{WWTP}) = WWTP design flow x WQT

LA for runoff from non-permitted areas ($LA_{non\text{-}permitted}$)= runoff volume$_{non\text{-}permitted}$ x WQT - LA_{BG} - MOS

Reserve Capacity (RC) = set to zero for this TMDL

In light of the above, the Metro Area chloride TMDL is more explicitly expressed as below:

$TMDL = WLA_{MS4} + WLA_{WWTP} + LA_{non\text{-}permitted} + LA_{BG} + MOS$

A simple schematic of the modeling approach for lakes and wetlands is shown in Figure 8 and for streams in Figure 9. The primary differences between the approaches for lakes and streams was that annual runoff was considered for lakes because of the longer retention times in lakes and subsequent mixing, whereas only winter-season runoff was considered for streams. Since the winter-season runoff was considered for the streams, the runoff coefficients were set to 0.98 to account for frozen ground conditions based on best professional judgment. The basic premise of this approach is to constrain runoff from having greater than 230 mg/L of chloride on average throughout the year in an impaired lake, and throughout the winter and spring snow melt season in an impaired stream. To express the TMDLs on an average daily basis, the annual lake and seasonal stream allowable loadings are divided by 365 days per year and by 151 days per winter season (November-March), respectively (see below).

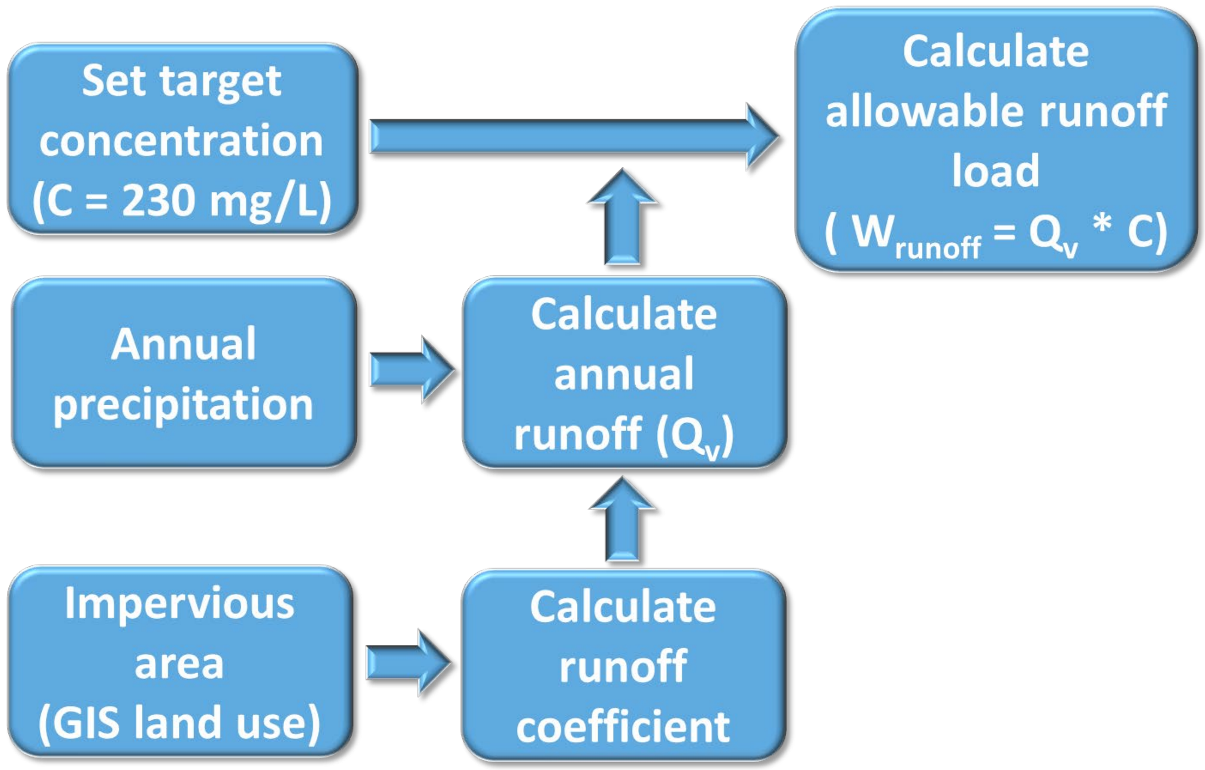

Figure 8. Model schematic for allowable runoff load for lake and wetland TMDLs in the TCMA

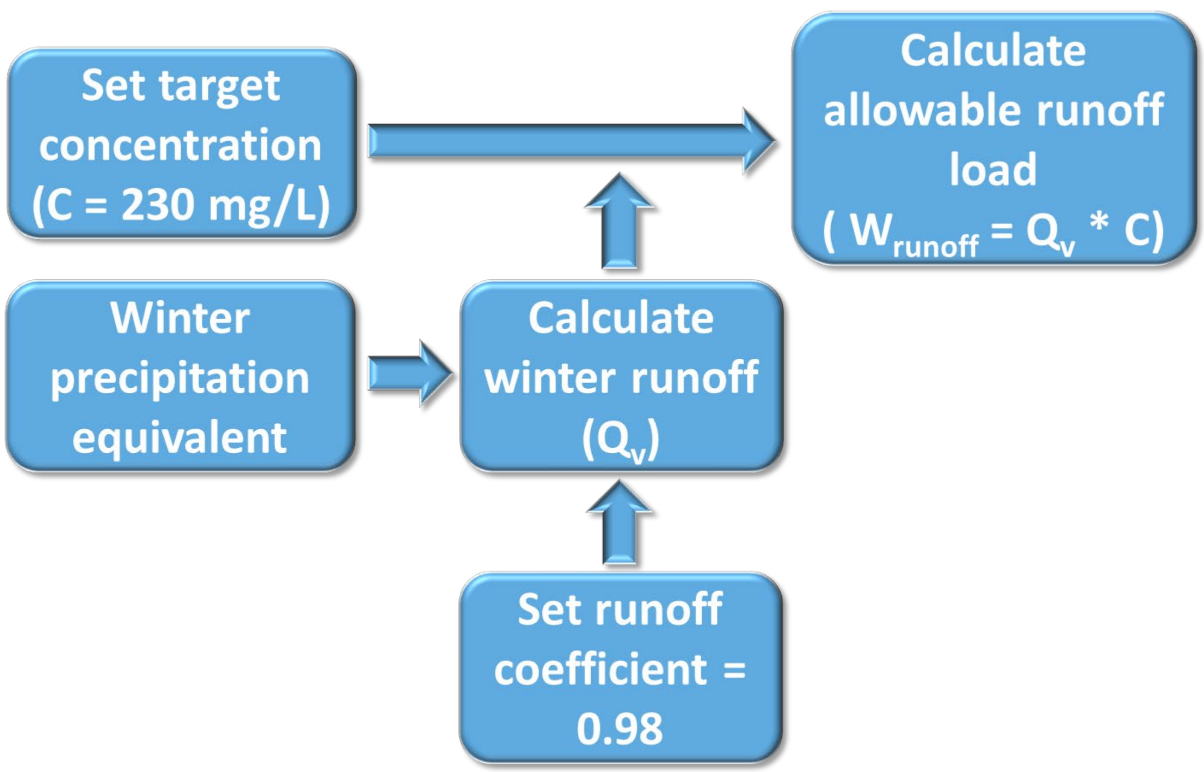

Figure 9. Model schematic for allowable runoff load for stream TMDLs in the TCMA

Modeling approach – Lakes and Wetlands

The 0-dimensional modeling approach for lakes and wetlands takes into account the total tributary watershed area, percentage of impervious surface within the watershed area, and average annual precipitation. Based on these variables, an average annual runoff was calculated using the Simple Method (Schueler, 1987). The allowable runoff load was then calculated by multiplying the average annual runoff by the chronic water quality standard for chloride (230 mg/L).

Runoff coefficient

$$R_v = 0.05 + 0.9 \times I_a$$

Where: I_a = impervious fraction

R_v = runoff coefficient

Average annual runoff

$$R = P \times P_j \times R_v$$

Where: P = Annual rainfall (inches/yr) (30.6 inches/year for the TCMA)

P_j = Fraction of annual rainfall events that produce runoff (usually 0.9)

R_v = runoff coefficient

R = Average annual runoff (inches)

Average annual runoff volume

$$Q_v = A \times \frac{R}{12}$$

Where: R = Annual runoff (inches/yr)

A = total tributary watershed area (acres)

Q_v = average annual runoff volume (ac-ft/yr)

Allowable Annual Runoff Load (L, lbs/year)

$$L = Q_v \times C \times 2.72$$

Where: Q_v = average annual runoff volume (ac-ft/yr)

C = chronic water quality standard (230 mg/L)

2.72 = conversion factor

Modeling approach - Streams

A slightly modified approach was taken for the streams. The streams tend to exhibit the highest chloride concentrations during the spring snowmelt, which is then flushed through the system. The approach was modified to account for frozen ground conditions and seasonal runoff volume. The runoff coefficient was adjusted to 0.98 over the entire tributary watershed area to account for frozen ground conditions. The seasonal runoff volume is considered to be the total precipitation equivalent for the period from November 1 through March 31 (season is 151 days per year). This period is typically when salt is being applied and is expected to accumulate and run off during the spring snowmelt (as well as occasional winter melts). A seasonal precipitation equivalent for the period of November 1 through

March 31 was determined to be 6.29 inches based on the UMN climate data for the period of record from 1981-2010.

This approach was used to determine the loading capacity for streams. The calculation is shown below.

Runoff coefficient

R_v = 0.98 (frozen ground conditions)

Average seasonal runoff

$$R = P \times R_v$$

Where: P = Seasonal precipitation water equivalent (6.29 inches/season for the TCMA)

R_v = 0.98 (frozen ground conditions)

R = Average seasonal runoff (inches)

Average seasonal runoff volume

$$Q_v = A \times \frac{R}{12}$$

Where: R = Seasonal runoff (inches/season)

A = total tributary watershed area (acres)

Q_v = average seasonal runoff volume (ac-ft/season)

Allowable Seasonal Runoff Load (L, lbs/yr)

$$L = Q_v \times C \times 2.72$$

Where: Q_v = average seasonal runoff volume (ac-ft/season)

C = chronic water quality standard (230 mg/L)

2.72 = conversion factor

4.2 Wasteload Allocation Methodology

MS4 Wasteload Allocation - Runoff

A categorical WLA has been established for the permitted MS4s within each impaired watershed. The runoff loading capacity L, after deducting the natural background and 10% MOS, was split between the permitted and non-permitted parts of the watershed in simple proportion to their runoff volumes.

Wasteload Allocation – Wastewater Sources

Wastewater source discharges were included in the WLA where applicable. The allowable load for treatment facilities within an impaired watershed was set to the expected discharge or design flow of the facility multiplied by 230 mg/L of chloride and a units conversion factor as follows:

$WLA = 0.012 \times Q \times C$

Where: *WLA = Wasteload Allocation (lbs/day)*

Q = mean discharge (gpm)

C = chronic water quality standard (230 mg/L)

0.012 = conversion factor

An alum (aluminum sulfate) treatment plant for stormwater can be considered a wastewater source discharge. However, alum treatment does not contribute chloride to the system. The alum treatment facility is a pass-through for stormwater that already contains chloride. Since the chloride source is the MS4, the WLA has already been assigned to the MS4 and the alum treatment facility does not require an individual chloride WLA. Use of aluminum chloride or ferric chloride for treatment of lake sediments or stormwater should be avoided in waters and watersheds with chloride impairments.

Other

The WLAs for regulated construction stormwater (MNR10001) were not developed since chloride is not a typical pollutant from construction sites.

The WLAs for regulated industrial stormwater were also not developed. Industrial stormwater must receive a WLA only if the pollutant is part of benchmark monitoring for an industrial site in the watershed of an impaired waterbody (as detailed in the MPCA's June 8, 2001, memo). There are no chloride benchmarks associated with the Industrial Stormwater Permit (MNR050000).

Permitted entities located in more than one chloride impaired nested watershed; therefore, receiving multiple WLAs for chloride will be required to meet the most stringent downstream WLA. This approach assumes that by achieving the most stringent WLA all the others will also be met.

4.3 Load Allocation Methodology

Natural background load allocation

Natural background loads of chloride were calculated by multiplying the watershed runoff by 18.7 mg/L, the natural background concentration of chloride in TCMA streams estimated by Stefan et al. (2008).

Non-permitted runoff load allocation

The allowable runoff load from anthropogenic sources was calculated by subtracting the natural background load and the MOS from the allowable runoff load. The allowable load in runoff from anthropogenic sources was then divided between MS4 and non-permitted runoff based on the amount of runoff coming from each associated area within the impaired watershed.

An aggregate LA has been established for the non-permitted watershed runoff sources within each impaired watershed. This consists of townships, cities, counties, and MnDOT outside of the urban boundary and not covered under an MS4 permit. This aggregate LA includes winter maintenance activities in these areas as well as other potential sources including runoff from agricultural lands where fertilizer containing chloride may be applied, and the impact of septic systems on shallow groundwater and recharge.

This LA was calculated by the 0-dimensional modeling equation for the portions of the watershed that are outside the permitted MS4 areas. MOS and LA (natural background) were then subtracted out to get the LA (categorical non-permitted entities).

4.4 Margin of Safety

The MOS is the component of the TMDL allocation that accounts for uncertainty within the calculation methods, sample data, or the allocations which will result in attainment of water quality standards. For the purposes of developing the TMDLs for each lake, wetland and stream, an explicit 10% MOS was selected. This MOS was based on best professional judgment considering the potential variability of the monitored parameters from spatial, temporal, and seasonal changes seen within each lake and stream. Also, an explicit 10% is a reasonable estimate consistent with many other TMDLs prepared by the MPCA. It is reflective of the uncertainty in the data and the modeling. Almost all completed TMDLs for lakes in Minnesota make use of a 0-dimensional model and an explicit 10% MOS is typical. Implementation of the TMDL relies on an adaptive management approach that will revisit whether on-going efforts and the TMDL targets are sufficient to restore impaired waters.

4.5 Seasonal Variation

The TMDLs developed for lakes, wetlands and streams consider chloride sources from both seasonal sources, such as spring snowmelt and runoff, as well as continuous year-round sources of chloride such as the WWTPs. Historical loadings from salt application to impervious areas present in shallow groundwater may contribute chloride to surface waters throughout the year. See section 2.3 of the TCMA Chloride Management Plan for more information about the impacts of chloride to groundwater. The TMDL for lakes assumes lake water quality responds to loadings on an annual or longer term basis. Therefore, the TMDLs for lakes have been developed to achieve an annual average daily load. Some impaired lakes indicate a seasonal trend, with higher chloride concentrations in winter and early spring. The MOS helps to protect for these seasonal variations. Continued monitoring and adaptive management will also be needed to ensure the TMDL is protective of the waterbody.

Chloride loadings to streams vary seasonally. Stream water quality responds to loadings on a seasonal basis and the highest chloride concentrations tend to occur during the spring snowmelt. Therefore, the TMDL has been developed to achieve compliance for the winter and spring snowmelt period.

4.6 TMDL Summary

A summary of the TMDLs is presented in Table 6 for lakes and wetlands and Table 7 for streams. The TMDL for each waterbody including the individual MS4 and other wastewater source discharges within the WLA are presented in Appendix A-4.

Table 6. Summary of TMDL and Components for Impaired Lakes and Wetlands in the TCMA

Lake/Wetland	AUID	Watershed Area (ac)	TMDL and Components (all values in lbs/day of chloride)					
			Loading Capacity (TMDL)	WLA		LA		Margin of Safety
				MS4 Categorical	Wastewater Sources[1]	Non-Permitted Aggregate	Natural Background	
Battle Creek Lake	82-0091-00	4,326	5,900	4,838	0	0	472	590
Brownie Lake	27-0038-00	452	935	767	0	0	75	94
Carver Lake	82-0166-00	2,242	2,934	2,406	0	0	235	293
Como Lake	62-0055-00	1,850	2,723	2,233	0	0	218	272
Diamond Lake	27-0022-00	744	1,332	1,092	0	0	107	133
Kasota Ponds North	62-0280-00	10	17	14	0	0	1	2
Kasota Ponds West	62-0281-00	6	16	13	0	0	1	2
Kohlman Lake	62-0006-00	7,533	13,258	8,512	2,878	0	830	1,038
Little Johanna Lake	62-0058-00	1,703	3,353	2,750	0	0	268	335
Loring Pond (South Bay)	27-0655-02	34	27	22	0	0	2	3
Mallard Marsh	62-0259-00	16	27	22	0	0	2	3
Parkers Lake	27-0107-00	1,064	3,921	1,447	2,157	0	141	176
Peavey Lake	27-0138-00	776	624	454	71	0	44	55

Lake/Wetland	AUID	Watershed Area (ac)	TMDL and Components (all values in lbs/day of chloride)					
			Loading Capacity (TMDL)	WLA		LA		Margin of Safety
				MS4 Categorical	Wastewater Sources[1]	Non-Permitted Aggregate	Natural Background	
Pike Lake	62-0069-00	5,735	9,925	8,066	88	0	787	984
Powderhorn Lake	27-0014-00	332	599	491	0	0	48	60
Silver Lake	62-0083-00	655	1,013	831	0	0	81	101
South Long Lake	62-0067-02	114,785	72,193	58,998	54	156	5,771	7,214
Spring Lake	27-0654-00	39	43	35	0	0	3	4
Sweeney Lake	27-0035-01	2,439	3,990	3,272	0	0	319	399
Tanners Lake	82-0115-00	1,732	2,264	1,857	0	0	181	226
Thompson Lake	19-0048-00	178	368	302	0	0	29	37
Valentine Lake	62-0071-00	2,404	3,192	2,617	0	0	255	319
Wirth Lake	27-0037-00	426	3,000	2,460	0	0	240	300
Battle Creek Lake	82-0091-00	4,326	2,153,699	1,766,033	0	0	172,296	215,370
Brownie Lake	27-0038-00	452	341,418	279,963	0	0	27,313	34,142
Carver Lake	82-0166-00	2,242	1,071,123	878,321	0	0	85,690	107,112
Como Lake	62-0055-00	1,850	994,078	815,144	0	0	79,526	99,408
Diamond Lake	27-0022-00	744	486,017	398,534	0	0	38,881	48,602
Kasota Ponds North	62-0280-00	10	6,234	5,112	0	0	499	623
Kasota Ponds West	62-0281-00	6	5,742	4,708	0	0	459	574
Kohlman Lake	62-0006-00	7,533	4,839,183	3,106,733	1,050,484	0	303,096	378,870

Lake/Wetland	AUID	Watershed Area (ac)	TMDL and Components (all values in lbs/day of chloride)					
			Loading Capacity (TMDL)	WLA		LA		Margin of Safety
				MS4 Categorical	Wastewater Sources[1]	Non-Permitted Aggregate	Natural Background	
Little Johanna Lake	62-0058-00	1,703	1,224,242	1,003,879	0	0	97,939	122,424
Loring Pond (South Bay)	27-0655-02	34	9,764	8,007	0	0	781	976
Mallard Marsh	62-0259-00	16	9,851	8,077	0	0	788	985
Parkers Lake	27-0107-00	1,064	1,431,262	528,161	787,163	0	51,528	64,410
Peavey Lake	27-0138-00	776	205,995	165,889	3,692	0	16,184	20,230
Pike Lake	62-0069-00	5,735	3,591,268	2,943,971	1,059	0	287,217	359,021
Powderhorn Lake	27-0014-00	332	218,588	179,242	0	0	17,487	21,859
Silver Lake	62-0083-00	655	370,011	303,409	0	0	29,601	37,001
South Long Lake	62-0067-02	114,785	26,334,624	21,534,261	4,030	56,826	2,106,448	2,633,059
Spring Lake	27-0654-00	39	15,600	12,792	0	0	1,248	1,560
Sweeney Lake	27-0035-01	2,439	1,456,271	1,194,142	0	0	116,502	145,627
Tanners Lake	82-0115-00	1,732	826,520	677,746	0	0	66,122	82,652
Thompson Lake	19-0048-00	178	134,340	110,159	0	0	10,747	13,434
Valentine Lake	62-0071-00	2,404	1,165,072	955,359	0	0	93,206	116,507
Wirth Lake	27-0037-00	426	1,095,000	897,900	0	0	87,600	109,500

[1] WLA=0 in the wastewater sources column means that there is no wastewater discharges in that watershed

Table 7. Summary of TMDL (lbs/day) and Components for Impaired Streams in the TCMA

Stream	AUID	Watershed Area (ac)	TMDL and Components (all values in lbs/day of chloride)					
			Loading Capacity (TMDL)	WLA		LA		Margin of Safety
				MS4 Categorical	Wastewater Sources[1]	Non-Permitted Aggregate	Natural Background	
Bass Creek	07010206-784	5,434	11,566	9,484	0	0	925	1,157
Bassett Creek	07010206-538	25,209	57,092	43,993	3,442	0	4,292	5,365
Battle Creek	07010206-592	7,246	15,422	12,646	0	0	1,234	1,542
Elm Creek	07010206-508	66,382	141,274	115,145	0	700	11,302	14,127
Judicial Ditch 2	07030005-525	1,587	3,378	2,770	0	0	270	338
Minnehaha Creek	07010206-539	109,151	235,279	189,928	3,537	0	18,584	23,230
Raven Stream	07020012-716	42,750	94,558	2,932	3,576	71,673	7,279	9,098
Raven Stream, East Branch	07020012-543	14,751	34,969	2,928	3,576	22,815	2,511	3,139
Rush Creek, South Fork	07010206-732	13,844	29,521	24,150	58	10	2,357	2,946
Sand Creek (South) - includes 07020012-662	07020012-513	175,578	382,821	29,156	9,154	277,251	29,893	37,367
Unnamed creek (Headwaters to Medicine Lk)	07010206-526	6,447	13,722	11,252	0	0	1,098	1,372
Unnamed creek (Unnamed ditch to wetland)	07010206-718	793	1,688	1,384	0	0	135	169
Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna)	07010206-909	1,627	3,462	2,839	0	0	277	346

[1] WLA=0 in the wastewater sources column means that there is no wastewater discharges in that watershed

Table 8. Summary of TMDL (lbs/yr) and Components for Impaired Streams in the TCMA

Stream	AUID	Watershed Area (ac)	TMDL and Components (all values in lbs/yr of chloride)					
			Loading Capacity (TMDL)	WLA		LA		Margin of Safety
				MS4 Categorical	Wastewater Sources[1]	Non-Permitted Aggregate	Natural Background	
Bass Creek	07010206-784	5,434	1,746,399	1,432,047	0	0	139,712	174,640
Bassett Creek	07010206-538	25,209	9,334,219	6,642,961	1,233,048	0	648,094	810,117
Battle Creek	07010206-592	7,246	2,328,721	1,909,551	0	0	186,298	232,872
Elm Creek	07010206-508	66,382	21,332,410	17,386,888	0	105,688	1,706,593	2,133,241
Judicial Ditch 2	07030005-525	1,587	510,115	418,294	0	0	40,809	51,011
Minnehaha Creek	07010206-539	109,151	35,997,083	28,679,140	1,004,128	0	2,806,140	3,507,675
Raven Stream	07020012-716	42,750	15,023,193	442,771	1,284,983	10,822,561	1,099,057	1,373,821
Raven Stream, East Branch	07020012-543	14,751	6,025,349	442,093	1,284,983	3,445,007	379,229	474,037
Rush Creek, South Fork	07010206-732	13,844	4,470,069	3,646,696	21,010	1,532	355,925	444,906
Sand Creek (South) - includes 07020012-662	07020012-513	175,578	59,480,179	4,402,547	3,056,425	41,864,932	4,513,900	5,642,375
Unnamed creek (Headwaters to Medicine Lk)	07010206-526	6,447	2,071,959	1,699,006	0	0	165,757	207,196
Unnamed creek (Unnamed ditch to wetland)	07010206-718	793	254,852	208,979	0	0	20,388	25,485
Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna)	07010206-909	1,627	522,817	428,710	0	0	41,825	52,282

[1] WLA=0 in the wastewater sources column means that there is no wastewater discharges in that watershed

5. Future Growth Consideration/Reserve Capacity

5.1 New or Expanding Permitted MS4 WLA Transfer Process

Future transfer of watershed runoff loads in this TMDL may be necessary if any of the following scenarios occur within the project watershed boundaries:

1. New development occurs within a regulated MS4s. Newly developed areas that are not already included in the WLA must be transferred from the LA to the WLA to account for the growth.
2. One regulated MS4 acquires land from another regulated MS4. Examples include annexation or highway expansions. In these cases, the transfer is the WLA to WLA.
3. One or more non-regulated MS4s become regulated. If this has not been accounted for in the WLA, then a transfer must occur from the LA.
4. Expansion of a US Census Bureau Urban Area encompasses new regulated areas for existing permittees. An example is existing state highways that were outside an urban area at the time the TMDL was completed, but are now inside a newly expanded urban area. This will require either a WLA to WLA transfer or a LA to WLA transfer.
5. A new MS4 or other stormwater-related point source is identified and is covered under a NPDES permit. In this situation, a transfer must occur from the LA.

Load transfers will be based on methods consistent with those used in setting the allocations in this TMDL. In cases where WLA is transferred from or to a regulated MS4, the permittees will be notified of the transfer and have an opportunity to comment.

For more information on the overall process visit the MPCA's TMDL Policy and Guidance webpage.

5.2 New or Expanding Wastewater

During the permit issuance or reissuance process, new and/or expanding wastewater discharges will be evaluated for the potential to cause or contribute to violations of chloride water quality standards. Water Quality Based Effluent Limits (WQBELs) will be developed for facilities whose discharges are found to have a reasonable potential to cause or contribute to excursions above the water quality standards. The WQBELs will be calculated based on low flow conditions, may vary slightly from the TMDL WLAs and will include concentration based effluent limitations.

6. Reasonable Assurance

The MPCA has worked with stakeholders in the TCMA to develop a plan to restore and protect waters impacted by chloride. The TCMA CMP incorporates water quality assessment, source identification, implementation strategies, monitoring recommendations and measurement and tracking of results into a performance-based adaptive approach for the 7-County TCMA. The goal of the CMP is to develop the framework to assist local partners in minimizing chloride use and provide safe and desirable conditions for the public. The CMP will guide and assist agencies, local governments and other TCMA stakeholders in determining how best to restore and protect water resources impacted by elevated chloride levels while balancing the need for public safety, level of service considerations, as well as water softening needs. The CMP is not intended to resolve all issues. Rather, it provides understanding and guidance for management activities over the next 10 years.

Significant progress has already been made by many entities, including MnDOT, a number of cities including Prior Lake, Shoreview, Richfield, and Waconia, as well as the UMN (see section 3.5 of the TCMA Chloride Management Plan for examples). Their efforts have demonstrated that salt use can be reduced without detrimentally impacting the level of service, as well as showing the economic benefits of improved winter maintenance practices. Funding mechanisms are available to entities interested in investing in better equipment and enhanced education efforts. This is includes the Clean Water, Land, and Legacy Fund which has several grant and loan programs that could be used for implementation of BMPs, education and outreach, and WWTP modifications. Additional discussion of implementation strategies is included in Section 8 of this TMDL as well as in the TCMA CMP.

6.1 Tracking Implementation Efforts

Measuring water quality in the TCMA and monitoring chloride loads in the lakes, wetlands, and streams is critical to understanding progress toward the ultimate goal of restored and protected lakes, wetlands, and streams. However, these types of measurements alone will not be sufficient to demonstrate the progress made in implementing individual salt reduction efforts and accomplishments taking place throughout the TCMA to reduce chloride. Tracking of implementation activities is needed to assess the related benefits to water quality, take credit for making progress, and identify areas where additional effort is needed.

The approach to tracking implementation efforts will vary by the source type. The Winter Maintenance Assessment tool (WMAt) will be an option available to any winter maintenance group and will support a consistent approach to tracking and reporting winter maintenance activities.

6.2 Permitted

Permits issued under the NPDES program are required to have effluent limits consistent with the assumptions and requirements of the WLAs in this TMDL. Compliance with the WLAs, as developed and presented in this TMDL, is assumed to ensure meeting the water quality standards for all of the chloride 303(d) listings. Sections 8.1 and 8.2 of this TMDL report present a brief summary of the permit programs that exist to put into place requirements consistent with the WLAs. For the MS4 Permits, conditions will be included to document winter maintenance practices, establish goals for improving winter maintenance practices, and track improvements as part of the MS4 Storm Water Pollution Prevention Plan (SWPPP). While existing loads and the necessary percent reductions have not been estimated for this TMDL, the expectation for the MS4s is to track progress from the year that implementation of salt reducing BMPs began for each individual winter maintenance organization and reporting that progress to the MPCA as part of their annual reporting. The two previously completed chloride TMDLs in the TCMA, Nine Mile, and Shingle Creek estimated reductions of 60%-70% in existing chloride loads and may be used as an example target to work towards. However, the progress made already will vary greatly as well as the local chloride loadings and target reduction/BMP implementation goals should be established at the local level using the best available information. For wastewater sources, permits will initially include monitoring requirements to assess chloride loadings. Upon permit renewal, effluent limits and/or other permit conditions will be included to address chloride loadings that exceed the WLAs in this TMDL. A number of municipalities within impaired watersheds for chloride are not currently MS4s but are expected to have an MS4 permit by or before 2020. The future MS4 Permits are included in the categorical WLA for MS4s.

6.3 Non-Permitted

Non-permitted non-point sources of chloride will be addressed through the combined efforts of the MPCA, watershed districts (WD) and watershed management organizations (WMO), soil and water conservation districts, natural resources conservation service programs, and municipalities. Organizations that conduct winter maintenance activities and education and outreach programs will experience the benefits of improved practices whether or not they are within an MS4.

6.4 Adaptive Management

Implementation of a TCMA CMP, which includes 186 cities and townships and seven counties as well as colleges, universities, private industries, commercial property owners, school districts, private homeowners, and others, can only be accomplished by maintaining flexibility and adaptability within the overall approach. It should be understood that the water quality goals and chloride loads presented in this TMDL are estimates based on the best available science.

Adaptive management is an approach that allows implementation to proceed in the face of potentially large uncertainties. Adaptation allows for the implementation plan to be adjusted in response to information gained from future monitoring data and new or improved understanding of related issues. The adaptive implementation process begins with initial actions that have a relatively high degree of certainty associated with their water quality outcome. Future actions are then based on continued monitoring of the TCMA water resources and an assessment of the response to the actions taken.

The TCMA Chloride TMDL is a prime candidate for an adaptive implementation process for a number of reasons. First, the scale, complexity, and variability of chloride sources within the area make a traditional implementation plan (i.e., one that identifies the specific implementation activities required to attain the TMDL) impractical. Second, there will likely be a time lag between reduction of external loads and the response of the system, and there will be year-to-year variability in the monitoring results. Finally, the TMDLs focused on the problem of high chloride loads and its current sources. However, restoration and protection of the TCMA water resources will require a planning framework that recognizes potential future threats such as changing deicing products, driver expectations, climate change, and population increases. For these reasons, implementation of the TCMA Chloride TMDL will be conducted within an adaptive framework.

The NPDES permitting requirements will be reviewed and revised as part of the adaptive management approach. As described above, the detection of improved water quality conditions will in many cases occur some years after the implementation, which further justifies the need for an adaptive management approach to the permitting requirements and continued stakeholder input.

7. Monitoring Recommendations

Addressing the issue of chloride impacts on the environment in the TCMA is a long-term endeavor and it may take some time before water quality improvements are seen due to historical loadings, groundwater inputs, variable residence times, and other complicating factors. Therefore, continued monitoring of the TCMA lakes, wetlands, and streams for chloride is critical as well as the need to document changes in winter maintenance activities, wastewater source discharges, and water softener usage. Continued water quality monitoring, along with improved understanding of the sources of chloride, will allow adaptive management to take place and inform future steps needed to restore and protect the TCMA waters. The CMP is intended to be revisited within five years and revised based on improved understanding.

The MPCA has worked with the Monitoring Sub-Group to develop monitoring guidelines for lakes, streams, wetlands and storm sewers. Monitoring guidance documents are available on the MPCA Chloride Project website at: Metropolitan Area Chloride Project. The key components of continued monitoring to support the implementation of the CMP include:

- Collect samples during the critical periods for elevated chloride concentrations: January through May for lakes; and December through April for streams. However, always put safety first when assessing conditions for collection of samples through the ice.
- Analysis of chloride should also be included in typical summer season sampling. Analysis for chloride is relatively inexpensive and should be included if the effort is being made to collect samples for analysis of other parameters, such as phosphorus.
- In lakes with potential for stratification, collect a bottom sample and surface sample.
- Maintain consistency in sampling. Chloride concentrations may vary from year-to-year depending on the winter conditions. Assessment of long-term trends to determine if lakes and streams are improving or degrading will have greater confidence with consistent yearly datasets.
- Collect a "matching" conductivity reading with each sample taken for chloride analysis.
- Expand the sampling program to additional lakes, streams and wetlands as resources allow. Many waterbodies in the TCMA have not been sampled sufficiently to make a reliable assessment of potential impairment by chloride.

There are a number of organizations across the TCMA that monitor water quality or partner with others to conduct monitoring. In addition the MPCA, Metropolitan Council and the United States Geological Survey (USGS) also collect data throughout the TCMA. Incorporating the recommendations below into existing local water monitoring programs will provide valuable data to assist with tracking progress and meeting water quality goals. Monitoring should take place at the existing sites for consistency and comparison purposes. However, since monitoring activities are lead at the local level it will be dependent on available resources and local priorities. We encourage local monitoring data be shared with MPCA by routinely submitting data to the MPCA's water quality database, EQuIS. The monitoring that MPCA conducts across the state follows the 10-year monitoring strategy as described in Minnesota's Water Quality Monitoring Strategy report.

7.1 High Risk Monitoring Recommendations

The MPCA has developed specific guidance for monitoring of TCMA waters not currently impaired but showing a "high risk" of impairment. The chronic standard of 230 mg/L for chloride concentration applies as a 4-day time average. In practice, impairment is often judged from monthly sampling results when these show a clear pattern of prolonged concentrations exceeding the standard. Weekly or twice-weekly sampling would provide the basis for a clear determination of impairment or non-impairment. Long-term sampling at such high frequencies, however, is unreasonably expensive in most cases. Therefore, the MPCA suggests the following guidance for additional monitoring of "high risk" waters:

1. Identify dates or periods of past chloride concentrations that were either:
    a. Exceedances (exceeded the chronic chloride standard), and
    b. "high" occurrences, defining "high" as less than but within 10% of the chronic standard (thus >207 mg/L)
2. Select a 4-week period centered on each such date or period, and for each:
    a. Sample for chloride weekly, always on the same day of the week
    b. Sample at the same depth or depths as in past sampling
3. If an electrical conductivity meter is available, take and record a "matching" conductivity reading with each lab sample taken:
    a. "matching" = from the same primary sample that provides the lab subsample, if the primary sample is a sufficiently larger volume than the laboratory bottle used; or otherwise
    b. "matching" = same location and depth as the lab sample
4. Possible expanded effort:
    a. Monitor twice weekly rather than once, always on the same days of the week (e.g., Monday and Thursday) including, as resources permit:
        ii. Chloride sample and conductivity measurement if possible
        iii. Chloride sample only if lacking conductivity meter
        iv. Conductivity measurement only on the increased frequency if laboratory costs limit sampling but a meter is available

To clarify, sampling for chloride at least weekly during the selected 4-week period(s) is a necessary minimum effort for ensuring the value of this additional monitoring; conductivity measurements alone will not suffice at present. This could change in the future if a reliable and accurate relationship between chloride and conductivity is developed for an individual waterbody or for an area including the waterbody.

7.1.1 Impaired Monitoring Recommendations (tracking progress)

In order to assess "high risk" waters and waters without data, the MPCA recommends monitoring waters already identified as impaired for chloride less frequently. It is recommended that efforts focus on collecting samples during critical periods. For instance, if the impairment is a result of winter maintenance activities, chloride sampling should be conducted during January through May for lakes and wetlands, and December through April for streams. If the impairment is caused by effluent with high chloride concentrations from the WWTPs, monitoring during low-flow periods in the streams should be targeted. If long-term monitoring data has already been collected, less frequent monitoring during critical conditions (monthly or twice monthly) is recommended. If monitoring efforts are limited by costs, and a site-specific chloride-conductivity relationship has been established, the MPCA recommends collecting conductivity measurements during the critical period to track progress.

7.1.2 General Monitoring Recommendations for Waters without Data

At a minimum, collect monthly chloride and conductivity data for waters without data during the critical period. If possible, expand the effort to weekly sampling during the critical period, and include chloride in typical summer season sampling efforts. For lakes with a potential for stratification, collect a bottom and a surface chloride sample. If it is determined that these waters meet the "high risk" criteria, the MPCA recommends following the monitoring guidelines for "high risk" waters.

8. Implementation Strategy Summary

Implementation strategies to restore the TCMA waters impaired by chloride are presented in Figure 10 below and discussed further in this section. Additional information is included in Section 3 of the TCMA CMP. While these strategies apply generally across the TCMA, individual entities, such as the WDs or cities, may want to develop individual plans for specific impaired and high risk waters. Prioritizing reduction activities is a local decision and requires evaluation of local conditions and variables. Section 3.1 of the CMP offers some suggestions.

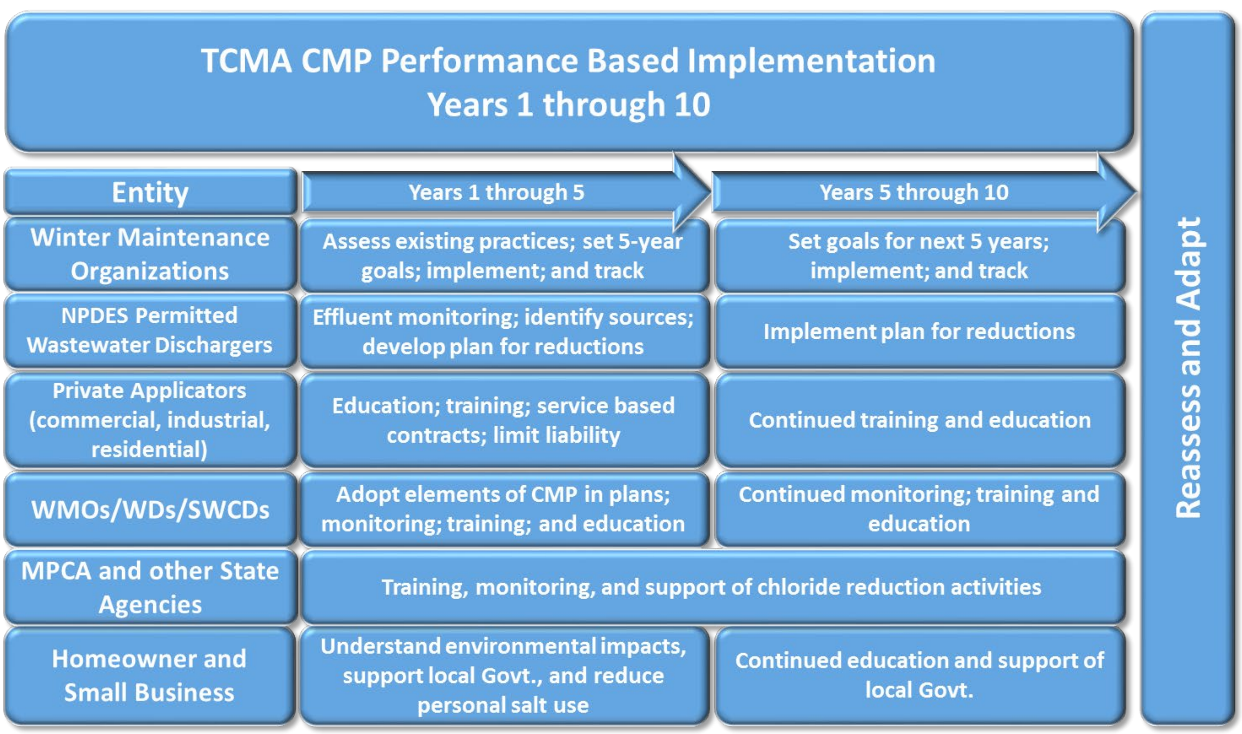

Figure 10. Implementation Strategy to meet the TCMA Chloride TMDLs.

8.1 Performance-Based Approach for Achieving TMDLs

Deicing salt is the most common and the preferred method for meeting the public's winter travel expectations. There is currently no environmentally safe and cost-effective alternative that is effective at melting ice. Therefore, continued use of salt as the predominant deicing agent for public safety in the TCMA can be expected. Setting a specific chloride load reduction target for each individual winter maintenance chloride source is challenging, as is measuring actual chloride loads entering our surface and groundwater from salt and other nonpoint sources in the TCMA. Therefore, priority should be put on improving winter maintenance practices to use only a minimal amount of salt, also referred to as smart salting, across the entire TCMA. With these considerations in mind, the implementation approach for achieving the TMDLs and protecting all waters in the TCMA is to focus on performance of improved winter maintenance practices as well as continuing to monitor trends in local waterbodies. A standard approach to the TMDL implementation is to translate the WLA component of the TMDL directly to a numeric permit limit, which is typical for permitted facilities with monitoring requirements. In the case of urban stormwater regulated through a MS4 Permit, the WLA may be presented in the form of a percent reduction from a baseline condition. The specified percent reduction is then included in the MS4 Permit. With a performance-based approach, the numeric WLA is translated to a performance criterion. This can include the development and implementation of a winter maintenance plan which identifies a desired level of BMP implementation and a schedule for achieving specific implementation activities. Progress made towards those goals are documented and reported, along with annual estimates of salt usage and reductions achieved through the BMPs implemented.

In cases where it is not "feasible" to calculate a numeric effluent limit, federal regulations allow for the use of BMPs as effluent limits (40 CFR § 122.44(k)). Such a performance-based or BMP approach to compliance with the WLAs is being taken by states to address the Chesapeake Bay TMDL for nutrients. The TMDL is being implemented through state Implementation Plans. Some states are taking a performance-based approach to addressing urban stormwater sources, requiring minimum levels of BMP implementation rather than requiring specific levels of pollutant load reductions.

A performance-based approach will be tracked through documentation of existing winter maintenance practices, goals for implementing improved practices including schedules, and reporting on progress made. Entities may choose to use the WMAt, which is a smart salting BMP tracking tool, to assess and document practices and set goals, or another approach of their choice. More information about the WMAt can be found in Appendix B of the TCMA Chloride Management Plan. Entities should track progress and document efforts, including, to the extent possible, estimates of reduced salt usage as a result of improved practices. Entities that have achieved their goals for winter maintenance will have documented their practices in a winter maintenance plan. This plan should be reviewed annually and evaluated against the latest knowledge and technologies available for winter maintenance.

The performance-based approach does not focus on specific numbers to meet, but rather on making progress with BMPs. Progress is measured by degree of implementation and trends in ambient monitoring. In a traditional approach with numeric targets, progress would be measured by accounting for salt applied and comparing to the targets. The performance-based approach is intended to allow for flexibility in implementation and recognize the complexities involved with winter maintenance. Because the performance-based approach doesn't provide a specific numeric target, a limitation of the approach is that it is not definitive on when enough progress has been made. This can only be determined by continued ambient monitoring that demonstrates compliance with water quality standards.

8.2 Permitted Sources

8.2.1 MS4 and Roads

Chloride management is a challenging issue in Minnesota and requires a balance between public safety and the environment. In addition to the balance, chloride management is complex since every winter event is different. The different events can be a result of the type of precipitation, temperature, longevity of the event, timing of the event, etc. In addition to variations in each event, winter seasons can be highly variable from year to year.

Snow and ice maintenance practices vary between road authorities and private applicators. Training, equipment, available resources, and political pressure all factor into the amount of deicer being applied.

There is no single BMP that can cost effectively remove snow and ice and maintain an appropriate level of service for all of the various situations across the TCMA. Chloride management can only be achieved through implementation of an array of different BMPs. The BMPs vary by effectiveness in reducing chloride application and cost of implementing the BMP.

The CMP includes an arsenal of BMPs, which give chloride applicators multiple ways in which to reduce chloride. This provides the BMPs that can be used by high-use/high-experience entities all the way down to low-use/low-experience entities. A wide range of BMPs also allows greater flexibility in the timing and extent of implementation of the BMPs.

Traditional BMP strategies can be implemented by chloride applicators. The primary recommended strategies include, but are not limited to:

1. Shift from granular to more liquid products and higher liquid to solid ratio blends
2. Improved physical snow and ice removal
3. Snow and ice pavement bond prevention
4. Training for maintenance professionals
5. Education for the public and elected officials

This strategy consists of the continued use of chloride containing products in the most efficient and effective manner possible. This approach assumes we maintain the same level of service.

There are several industry shifts that are needed to reduce salt waste. These changes are applicable to all winter maintenance areas in which a high level of service is expected: roads, parking lots, and sidewalks.

<u>Winter Maintenance Assessment tool</u>

A tool called the WMAt has been developed by the MPCA and is available for use by all winter maintenance professionals. The WMAt is a voluntary tool that can be used to understand current practices, identify areas of improvement, and track progress. While optional, everyone that is involved in winter maintenance is highly encouraged to use the WMAt. The tool is intended to streamline and simplify implementation goals and strategies. The tool can also be a great way to compare practices with other entities and learn from each other in order to achieve the greatest chloride reductions while providing a high level of service. Utilization of this planning tool will allow the user to track their progress over time and show the results of their efforts. The tool can serve as both a reporting mechanism to understand the current practices and as a planning tool to understand future practices. The planning side of the tool will help understand the challenges and costs associated with improved practices.

The WMAt provides a more detailed and comprehensive evaluation of all the BMPs available to winter maintenance professionals. More details about the WMAt can be found in Appendix B of the TCMA CMP.

8.2.2 Examples of salt saving BMPs for winter maintenance programs

While the preferred and most effective approach for developing a chloride reduction plan for individual winter maintenance programs is to utilize the WMAt, here are a few BMPs that have been proven to reduce salt use.

1. Calibrate all equipment regularly (both liquid and granular systems)
2. Integrate liquids (avoid applying dry material)
3. Develop a Winter Maintenance Policy/Plan and share it with supervisors, crew and customers
4. Provide state of the art winter maintenance training, education, and professional development for all who work in the industry
5. Store salt indoors and on an impermeable pad
6. Anti-ice before events to reduce bonding of snow to pavement
7. Use ground speed controllers
8. Upgrade to equipment that can deliver low application rates
9. Select products that will work well given the pavement temperatures and conditions
10. Select application rates based on road temperatures and trends, the product used, cycle time, and other factors
11. Start mechanical removal as soon as possible, and continue throughout the storm
12. Use a variety of methods to reduce bounce and scatter of salt
    - Reduce speed
    - Higher liquid to granular ration
    - Lower spinner elevation
    - Chutes or skirts
    - Reduced spinner speed or turn off
    - Target crown of the road or near the center
13. Refine application rate charts and continually test lower rates

These BMPs may not be practical for all winter maintenance programs and should not be considered the best or only options for salt reducing activities, but rather a list of BMPs that many programs have already begun implementing and are seeing reduced salt use as a result. To determine the activities appropriate for each organization please visit the MPCA's Stormwater Manual to utilize the WMAt.

8.2.3 MS4 permit implications, strategies, and reporting

One of the challenges for public road authorities is the variability in road types, conditions, and meeting driver expectations. Each municipality is faced with unique challenges and circumstances that will play a role in determining the specific BMPs implemented. Development of winter maintenance policies/plans that are proactive and aim to minimize salt use is a critical first step for all winter maintenance programs to begin implementing BMPs in an effective and strategic way. Training and regular professional development for all applicators is another key strategy to allow winter maintenance programs to reduce overall chloride use while providing an appropriate level of service.

Municipalities in the TCMA make up the most significant portion of salt applicators and would be expected to take on the majority of the BMP activities for reducing chloride. Those municipalities with an NPDES Permit in a chloride impaired watershed will be required to report progress on the implementation of salt reducing BMPs beginning after issuance of the next Phase II MS4 Permit, which is expected to occur in 2018. The Phase I MS4s, (St. Paul and Minneapolis) will report their progress in 2016.

The WMAt will be a valuable resource to MS4s in terms of prioritizing and implementing BMPs. Use of the WMAt is not a requirement but will allow each MS4 to determine their own priorities that may be based on cost, location, ease of acceptance or other important factors unique to that MS4s particular situation. The WMAt provides specific BMPs related to all areas of winter maintenance to aid in the development in a detailed plan that meets the unique conditions of each individual program and can be prioritized and implemented according to specific needs and constraints.

The WMAt or other methods of tracking can be used to determine the baseline in terms of current practices and BMP's that are being implemented. The baseline of practices will allow the MS4 permittees to establish goals and track progress.

Another valuable resource for public road authorities is their peers. Several public road authorities have improved practices, reduced chloride use, and have realized cost savings by implementing the BMPs. These success stories, when shared between entities can demonstrate specifically how chloride reductions have been successfully achieved. Case studies describing some of these local success stories and specific areas of improvement are discussed in Section 3.5 of the CMP.

The MS4 reporting will consist of a discussion of the BMPs that have already been implemented and the BMPs that are planned to be implemented, including a timeline for implementation. Further information on reporting requirements can be found on the MPCA MS4 program website.

8.2.4 Wastewater (and Water Softening Activities)

Wastewater dischargers determined to have a reasonable potential to exceed 230 mg/L, will work with the MPCA to include appropriate permit conditions, including compliance schedules, chloride management plans, and effluent limits. If a permitted facility receives a chloride limit they will be required to submit a CMP to identify sources of chloride.

Municipal Wastewater

For municipal wastewater facilities, technologies capable of removing chloride from wastewater are either cost-prohibitive, technologically infeasible, or a mix of the two. Reverse Osmosis (RO) and evaporation of the resulting brine is the most viable option for removal of chloride from wastewater in Minnesota at the WWTPs. The MPCA analyzed the cost and implementation concerns of using the RO treatment and evaporation to remove chloride for WWTPs in 2012 (Henningsgaard 2012). Based on the assessment, the RO treatment and evaporation are cost prohibitive and pose significant implementation concerns.

The most feasible option for reducing chloride loading to the WWTPs is upstream source reduction. The two primary sources of chloride to WWTPs are residential water softeners and industrial users. If a facility has a chloride limit or wants to voluntarily reduce chloride WWTPs should work through their Industrial Pretreatment Programs (IPP) to identify significant users who may be contributing chloride. The WWTPs can review existing data from industrial users or can require industrial users to collect chloride data to assist in the assessment. If industrial users are identified as a significant source of chloride, the WWTP can work with the industrial user through the IPP to develop and implement a plan to reduce chloride loads.

During the permit issuance or reissuance process, wastewater discharges will be evaluated for the potential to cause or contribute to violations of chloride water quality standards. Water Quality Based Effluent Limits (WQBELs) will be developed for facilities whose discharges are found to have a reasonable potential to cause or contribute to excursions above the water quality standards. The WQBELs will be calculated based on low flow conditions, may vary slightly from the TMDL WLAs and will include concentration based effluent limitations.

Water Softeners

An assessment of the contribution from residential water softener use will also be important for a WWTP. Where residential water softeners are identified as significant sources of chloride, it is recommended that the WWTP develop and implement a plan to reduce chloride at the source. One option for municipalities includes the potential of providing lime or membrane water softening at the WTP in order to eliminate water softening at individual residences. Centralized lime softening eliminates the use of chloride to soften the water and therefore significantly reduces the chloride loading to the WWTP. This option assumes that all the WWTP users would be connected to city drinking water and would have taken their water softener offline. Water softening at the WTP has the potential to be more cost efficient than individual residential water softening for many users.

Another, but less effective, approach to reducing salt from residential water softeners is to prohibit the installation of timed water softeners for new construction and provide rebates and/or grants to homeowners that replace existing water softeners with high efficiency ion exchange softeners that use salt more efficiently. The following steps will help to reduce the amount of salt being discharged to a WWTP:

- Know the hardness level of local water supply.
- Consider whether a water softener is even needed and avoid the ongoing expenses if it isn't needed. Get a water test for hardness. Typically water hardness greater than 120 mg/L $CaCO_3$ needs to be softened. See the University of Kentucky's Guidance: Hard Water- To Soften or Not to Soften for more information.

- Do not over soften. Program the water softener to obtain an optimal level of hardness.
- Uninstall an old timed softener and replace it with a new demand softener. A new demand softener could be optimized to minimize backwashing and the newer model would have a more efficient ion exchange resin.
- If using a timer-based softener, set to recharge at the lowest effective rate and turn it off when on vacation.
- Install a bypass so landscape irrigation water is not softened.
- Consider alternatives to salt-based water softeners.

For homeowners with water softeners who have an on-site septic system, the above steps should also be taken. Chlorides in on-site septic systems will infiltrate to groundwater and may result in elevated levels of chloride in groundwater which can impact water supplies as well as groundwater recharge of lakes, streams, and wetlands.

Industrial Wastewater

For direct dischargers of industrial wastewater, the individual permittee will need to work with the MPCA to develop and implement a plan to reduce chloride if effluent concentrations have reasonable potential to exceed 230 mg/L. Each industrial discharger will have unique circumstances and will need to consider whether source reduction, treatment, or another approach would be most effective in their specific situation.

During the permit issuance or reissuance process, wastewater discharges will be evaluated for the potential cause or contribution to violations of chloride water quality standards. The WQBELs will be developed for facilities whose discharges are found to have a reasonable potential to cause or contribute to excursions above the water quality standards. The WQBELs will be calculated based on low flow conditions, may vary slightly from the TMDL WLAs and will include concentration based effluent limitations.

8.3 Non-Permitted Sources

Section 3, Prioritizing and Implementing Restoration and Protection of the CMP, has detailed recommendations for implementation strategies for a wide array of audiences. The motivation for voluntary actions to reduce salt use by non-permitted may include cost savings, protection of surface and groundwater, incentives and community expectations. It is anticipated that efforts to reduce salt use will be conducted across the TCMA at various levels regardless of the motivation.

8.3.1 Agriculture

The primary sources of chloride from agricultural lands in the TCMA are from fertilizers and land application of food processing waste and biosolids from municipal sewage treatment. Excessive chloride concentrations on agricultural lands can be harmful to crop growth in addition to contributing to elevated levels of chloride in surface runoff and groundwater infiltration. While fertilizer is not expected to be source of chloride that is contributing to impairments, implementation of nutrient management plans for agricultural lands in the TCMA may also be beneficial in reducing chloride.

8.3.2 Dust Suppressants

Chloride based dust suppressants are often used for dust control on gravel surfaces. Although little information is available on application rates and how often it is used, it is not expected to be a significant source of chloride in the TCMA. Non-chloride dust suppressants are available and may be an option for reducing chloride in watersheds of concern.

8.3.3 Private Applicators (Commercial, Industrial, and Residential Deicing)

A major challenge in the overall reduction of chloride use in the TCMA is in getting private applicators to reduce chloride usage. There are four primary hurdles related to this effort:

1. Liability concerns for applicators and property owners
2. Education and training for applicators, including cost
3. Contracting practices and incentives for applicators
4. Diversity in personnel experience

Two potential approaches to educating/training private applicators include a required training approach and a voluntary training approach, both discussed further below. A required training assumes that an ordinance or other regulatory mechanism is adopted by a governing body that requires training. A voluntary approach assumes that there is no ordinance or regulatory mechanism in place.

Potential Required Training Approaches:

- Development of a state-wide Smart Salting certification program
- Watersheds to require the MPCA Smart Salting certification for anyone performing professional level winter maintenance in the watershed
- Cities within those watersheds create an ordinance requiring Smart Salting certification to work in their cities
- Cities ask commercial property owners in their city to become trained, or they award contracts only to certified applicators
- All government organizations (state/counties/parks/schools/cities) to hire only Smart Salting certified contractors to maintain government properties
- The MPCA, WDs and WMOs, and cities all help advertise the classes

Potential Voluntary Training Approaches:

- The MPCA to continue offering Smart Salting training
    - Increase the number of classes
    - Expand locations of classes
    - Incorporate alternative methods for certification (e.g., Webinars)
    - Increase advertising about the availability and importance of being “certified” winter maintenance professionals
- Watershed organizations, and cities host and advertise classes in their area

In addition to education, a statute that limits liability for private applicators that are certified under the Smart Salting training program would enable private applicators to use less without fear of litigation. An important aspect to a statute like this is requiring certification in order to maintain an appropriate level of service. The State of New Hampshire passed a new law, RSA 489-C, effective November 1, 2013, which limits the liability of business owners who contract for snowplowing and deicing as long as the applicator is certified through the University of New Hampshire – Green SnowPro Program. The entire law can be found at: http://www.gencourt.state.nh.us/rsa/html/NHTOC/NHTOC-L-489-C.htm

Feedback from stakeholders in Minnesota has indicated that many of the private applicators over-apply salt as a result of concerns about litigation. A law similar to New Hampshire's RSA 489-C could change salt application behaviors of private applicators by limiting their liability.

In some cases, compensation for winter maintenance is based on the amount of salt used, which can incentivize over-application of salt. In this case, the state should develop a boiler plate, performance based contract for private entities to use when contracting for winter maintenance services. Performance based contracting methods and the boiler plate contract should be part of the education, training, and certification programs for private applicators.

8.3.4 Homeowners and Small Business Owners

A clear message on why reducing chloride is important for the environment, important for saving money, and how to effectively apply chloride will be the key to changing salt application behaviors by homeowners and small businesses. This messaging should be carried out by various state and local governmental entities in order to reach a broad range of people in the TCMA.

Nine Mile Creek Watershed District approached this by providing a measuring cup type salt scooper to homeowners and small businesses in order to raise awareness of the amount of salt they are using.

For homeowners with water softeners who have an on-site septic system, the steps described above in Section 8.2.4 should also be taken. Chlorides in on-site septic systems will infiltrate to groundwater and may result in elevated levels of chloride in groundwater which can impact water supplies as well as groundwater recharge of lakes, streams and wetlands.

See section 3.2 and 3.3 of the TCMA CMP for more information on implementation strategies.

8.4 Cost

The assessment of costs and economic benefits associated with chloride uses and its impacts are complex. However, one thing is certain; removing chloride from impaired lakes and streams is impractical and cost-prohibitive. Therefore, prevention or source control is the logical approach. The various economic impacts and benefits are shown in Figure 11 and discussed briefly below.

Implementation of improved winter maintenance activities will come with an initial investment cost to address training, new equipment, and public outreach. However, as a result of reduced salt usage, a cost savings is expected based on information provided by several local winter maintenance organizations. A net cost-savings has been shown by many organizations who have tracked cost before and after the implementation of the winter maintenance BMPs. Table 9 provides examples of tracked cost savings associated with the implementation of various salt reducing BMPs by local winter maintenance organizations. Detailed descriptions of these cost savings examples can be found in section 3.5 of the

CMP. The cost estimates provided in Table 9 reflect implementation of a variety of BMPs with multiple activities applied simultaneously. The information provided in Table 9 is not intended to be a reflection of cost for any one practice but rather an overall estimate. Each organization will implement practices that are most appropriate for their individual operations and there is not a one-size-fits-all approach when it comes to winter maintenance; therefore, the costs will vary greatly across organizations. The cost of meeting permit requirements such as reporting will likely be offset by the overall cost savings realized through more efficient and effective winter maintenance.

Table 9. Examples of Municipal and Private Cost Savings

Entity	Implementation Period	Main Actions Implemented	Salt Reduction	Cost Savings
University of Minnesota, Twin Cities	Start 2006	Began making salt brine and anti-icing and adopted several other salt reduction BMPs.	48%	New equipment cost $10,000 $55,000 cost savings first year
City of Waconia	Start 2010	Switch from 1:1 sand:salt to straight salt & liquid anti-icing; calibration; equipment changes; use of air and pavement temperatures.	70%	$8,600 yearly cost savings ($1.80 per lane-mile)
City of Prior Lake	2003-2010	Upgrade to precision controllers & sanders; anti-icing & pre-wetting; use of ground temperatures, best available weather data; on-site pre-mix liquid & bulk-ingredient storage, mixing & transfer equipment; staff education.	42%	$2,000 per event estimated cost savings; 20 – 40 mg/L decrease in receiving-water chloride (liquid app-only watershed)
City of Richfield	Start 2010	All-staff Training*; yearly sander calibration; use of low-pavement-temp de-icers; road crown-only application; minor-arterial-road policy adjustments.	> 50%	$30,000: 2010-2011 $70,000: 2011-2012
Rice Creek Watershed District Cities	2012-2013	Staff training; purchased shared anti-icing equipment	32%	$26,400 in one winter
City of Cottage Grove	2011-2012	Staff training	Not available	$40,000 in one winter
City of Shoreview	Start 2006	Stopped using a salt/sand mixture and moved on with straight salt; set up all its large plow trucks with state of the art salt spreading controls, pre-wetting tanks and controls and pavement sensors; use of calcium chloride in the pre-wetting tanks reduced the amount of rock salt as well; all applicators and supervisors annually attend *Training; crews attend an annual snowplow meeting to review procedures and talk about salt use and conservation methods; trucks set up for anti-icing main roads with calcium chloride.	44% since 2006	$24,468 in 2014
City of Eagan	Start 2005	Moved from a 50/50 salt/sand mix to straight salt; eliminated purchase of safety grit; EPOKE winter chemical application technology; use AVL; pre-wet at spinner.	Not available	$70,000 annual savings
Joe's Lawn & Snow, Minneapolis	Start 2013-2014	Owner & staff Training*; purchase of new spreader, temperature sensors; equipment calibration; use of temperature data; on-going experimentation.	50%	$770 estimated cost savings in 2014 Expected to use 20 tons, only use 9 tons

* Training - MPCA Smart Salting Training (All entities described above have attending the MPCA Smart Salting Training.)

Application of salt is a common method of maintaining safe roads, parking lots, and sidewalks. The economic benefit of safe travel, for both vehicles and pedestrians, is hard to measure. Economic benefits also come in the form of reduced work loss time.

The economic impacts from salt use goes beyond the impairment of lakes and streams and includes costs associated with damage to transportation infrastructure, vehicle corrosion, and vegetation damage.

Removal of chloride from the end-of-pipe of municipal wastewater treatment facilities is cost prohibitive. Source reduction is a critical element of discussions related to wastewater treatment of chloride-containing waste streams.

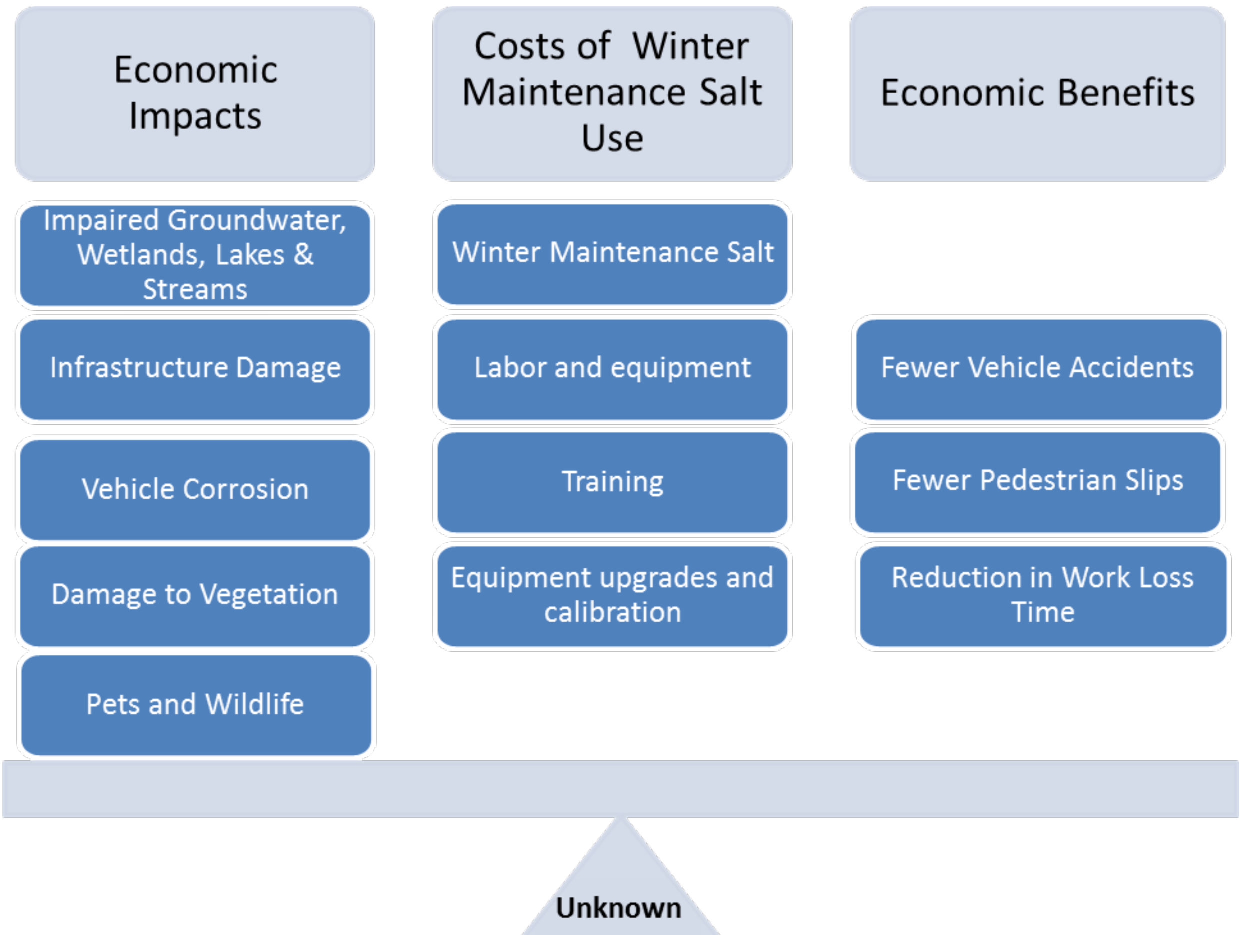

Figure 11. Cost Considerations Related to Winter Maintenance Salt Use.

Reductions in chloride loads from winter maintenance activities will result from improved practices. The improved practices are intended to maintain a consistent level of service in terms of safe roads, parking lots, and sidewalks at a lower level of salt use. While improving practices may require an initial investment, long-term cost-savings have been realized as a result of reduced salt purchases. As part of the TCMA CMP project, an Economic Analysis of Road Salt in the TCMA was completed (Fortin Consulting, 2014). This analysis included examples of salt reductions achieved with the associated cost savings. The specific examples of the unique opportunity for overall cost savings associated with implementing the BMPs that reduce salt use can be found in section 3.5 of the CMP.

8.4.1 Municipal Wastewater (primarily from Water Softening)

The cost for wastewater source dischargers to remove chloride from their waste stream is very high and will likely be cost prohibitive for most facilities. Below are estimates of the cost to treat effluent from a WWTP, which were developed by Henningsgaard, 2012:

An estimate for the total cost is $4-$5.25 million:

- Fine filtration - $1.5 million per million gallons treated
- RO - $1-$2.25 million per million gallons treated
- Evaporation technology prior to landfill – $1.5 million per million gallons treated

Annualized cost for construction (assuming a 20 year term at a market rate of 2.25%) – between $250,568 and $328,871 per year.

Annual Operation and Maintenance costs:

- Fine filtration – $0.01 to $0.15 per 1,000 gallons treatment
- RO - $2,200 per million gallons treatment
- Evaporator fuel - $10,000 to $12,000 per month

Based on specifics from each community, this cost could be considered to have "substantial and widespread economic and social impact" (40 CFR 131.10 (g) (6)) and could be justification for a variance that would not require this type of expensive treatment. The waste stream from the RO treatment at the WWTPs has the potential to produce highly concentrated brine with (environmentally and economically) challenging disposal characteristics.

Due to the high cost of end-of-pipe treatment for chloride and the high cost and difficulty of final disposal of the brine, source reduction is a critical element of discussions related to wastewater treatment of chloride-containing waste streams.

9. Public Participation

A robust stakeholder involvement program process was undertaken to develop partnerships and gain insight into winter maintenance activities and municipal wastewater plants as a source of chloride. This process began in early 2010, and has continued throughout the project allowing the stakeholders to assist in the development of the TCMA CMP and the TMDL and has generated the support of local partners and created a common understanding of the challenges with balancing water quality and public safety. This effort consisted of over 115 participating stakeholders on seven teams over five years; an Inter-Agency team (IAT), a Technical Advisory Committee (TAC), a Monitoring Sub-committee Group (MSG), an Implementation Plan Committee (IPC), an Education and Outreach Committee (EOC), and a Technical Expert Group (TechEx). Meeting information and stakeholder team membership lists are available at: http://www.pca.state.mn.us/programs/roadsalt.html.

The IAT members included water resources experts from the MPCA, MnDOT, Board of Soil and Water Resources (BWSR), Minnesota Department of Health (MDH), USGS, Metropolitan Council Environmental Services (MCES), and the DNR. This team provided high level oversight, support and guidance for the project and became involved in the project during the initial feasibility study in 2009. The Committee met three times from 2010 through 2014.

The TAC members included representatives from the MPCA, MnDOT, St. Paul, Minneapolis, Shoreview, Burnsville, Plymouth, Capitol Region WD, Ramsey-Washington WD, Bassett Creek WMC, Mississippi WMO, Nine Mile Creek WD, Scott County WMO, Minnehaha Creek WD, Rice Creek WD and the American Public Works Association. This team was responsible for providing review, guidance, and support for the technical aspects of the project. Committee meetings were held seven times from 2010 through 2014. In addition to the in-person meetings, regular updates, and gathering of input and feedback on draft documents occurred over email.

The MSG was created to provide detailed technical guidance and support regarding the water quality monitoring aspects of the project. The team not only developed monitoring guidance for chloride but also partnered with MPCA to collect additional chloride data across the TCMA to inform the TCMA CMP and TMDL. This team consisted of local and state water quality experts from the MPCA, DNR, USGS, MCES, Minneapolis Park and Recreation Board, Three Rivers Park District, Ramsey County, Capitol Region WD, Ramsey-Washington WD, Rice Creek WD, Minnehaha Creek WD, and Mississippi WMO. The Committee met four times from 2010 through 2013.

The EOC included local education specialist throughout the TCMA representing WDs, WMOs, counties, Freshwater Society, UMN Extension, East Metro Water Resource Education Program, and the MnDOT. This team was created to provide insight, direction, and to share information and resources to develop the strategies and needs of educating and engaging the public and stakeholders. The team met four times from 2011 through 2014.

A TechEx was formed to assist in the development of the WMAt. The team included hands on leaders in the winter maintenance industry from the MnDOT, cities, counties, and private companies. This team was instrumental in developing the vision and technical details of the WMAt. This group met in-person a few times but provided their review, feedback and expertise through email and review of materials.

The IPC consisted of representatives from all other teams and other interested stakeholders. This team's primary responsibility was to provide oversight and guidance on the development of the TCMA CMP. This group also received updates on the development of the TMDL and other project information. Meetings were held three times from 2012 through 2014.

In addition to the involvement of the stakeholders on the seven project teams many other meetings, events, and conferences were attended over the five-year span of the project to share progress and results. This included;

- annual presentations at the Freshwater Society's Road Salt Symposium since 2010
- presentations at the Minnesota Water Resources conference in 2010 and 2014
- participation in the EPA's Stormwater Pollution Prevention Webinar in 2013
- presenting at the Minnesota Street Superintendent's Association meeting in 2014
- participation in the Mississippi River Forum in 2015
- attendance at numerous local meetings and events to discuss project

In addition to attending the meetings and events mentioned two special outreach meetings were held specifically for the TCMA Chloride project. The first one was the Sand Creek Community Meeting, which was held in Jordan, Minnesota on July 30, 2014, to discuss the draft TMDL results. City, township, and county representatives, along with wastewater-treatment operators within the Sand and Raven Creek watersheds were invited to the meeting. Fourteen stakeholders attended the meeting. The second meeting was the Chloride Extravaganza held in St. Paul, Minnesota, on April 28, 2015. Over 250 permitted and other key stakeholders in the TCMA were invited to hear presentations from the various MPCA staff regarding the water quality conditions of chloride in the TCMA, results of the draft TMDL, and have discussion regarding implementation of the TMCA CMP and TMDL. About 100 stakeholders participated in the event.

Aside from collaborating, engaging and informing local stakeholders with regards to the TCMA Chloride project additional efforts were made to increase the public's awareness about the environmental impacts of chloride. The primary and most effective efforts included the development of a new MPCA webpage with information and tips for the public to reduce salt use and protect water quality. A short YouTube video was created discussing the environmental concerns with deicing salt as well as the effort underway to develop a plan for a collaborative and effective chloride reduction strategy. A large interactive display was designed, built and is now shared with the public at the Minnesota State Fair every year since 2012, and has also been made available to local partners for local educational events. And finally in 2010, the MPCA began generating press releases at the start of every winter that discusses the impacts of deicing salt on water resources and highlights new information, reports or data available.

The official TMDL public comment period was held from August 3, 2015 through September 2, 2015. 10 letters were received during the public comment period.

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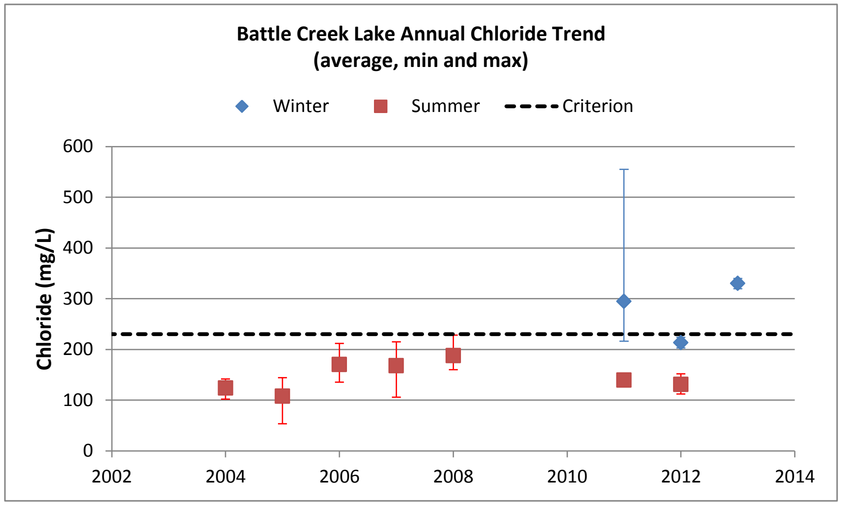
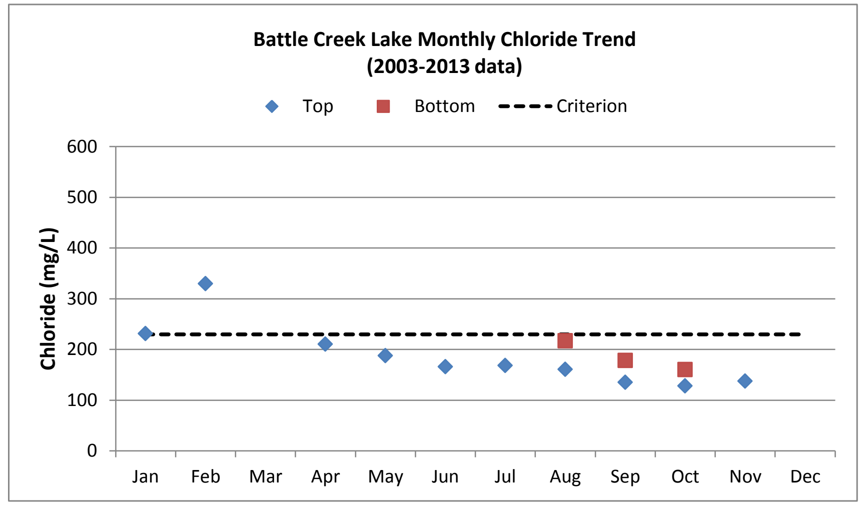
Appendix A-1 – Water Quality Dashboards and Watershed Areas

Battle Creek Lake

WBID:	82-0091-00
Watershed:	Ramsey Washington Metro Watershed District
Watershed Area (ac):	4,326
Impervious:	33%
TMDL (pounds of chloride/year):	2,153,698

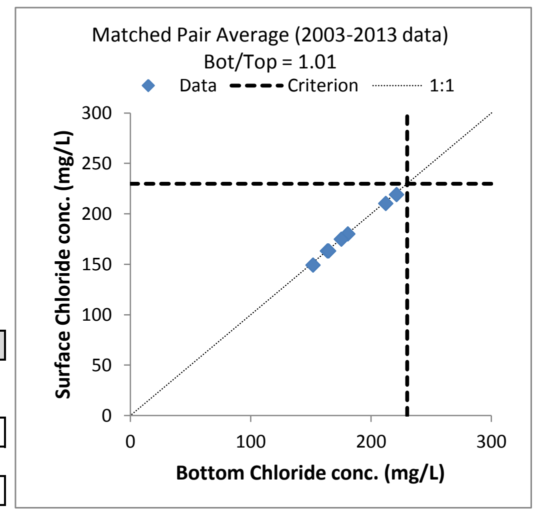
Number of Individual Days with Samples	81
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	4
Percent of Sample Days Exceeding Criterion	5%
Average of Exceeding Samples (mg/L)	344

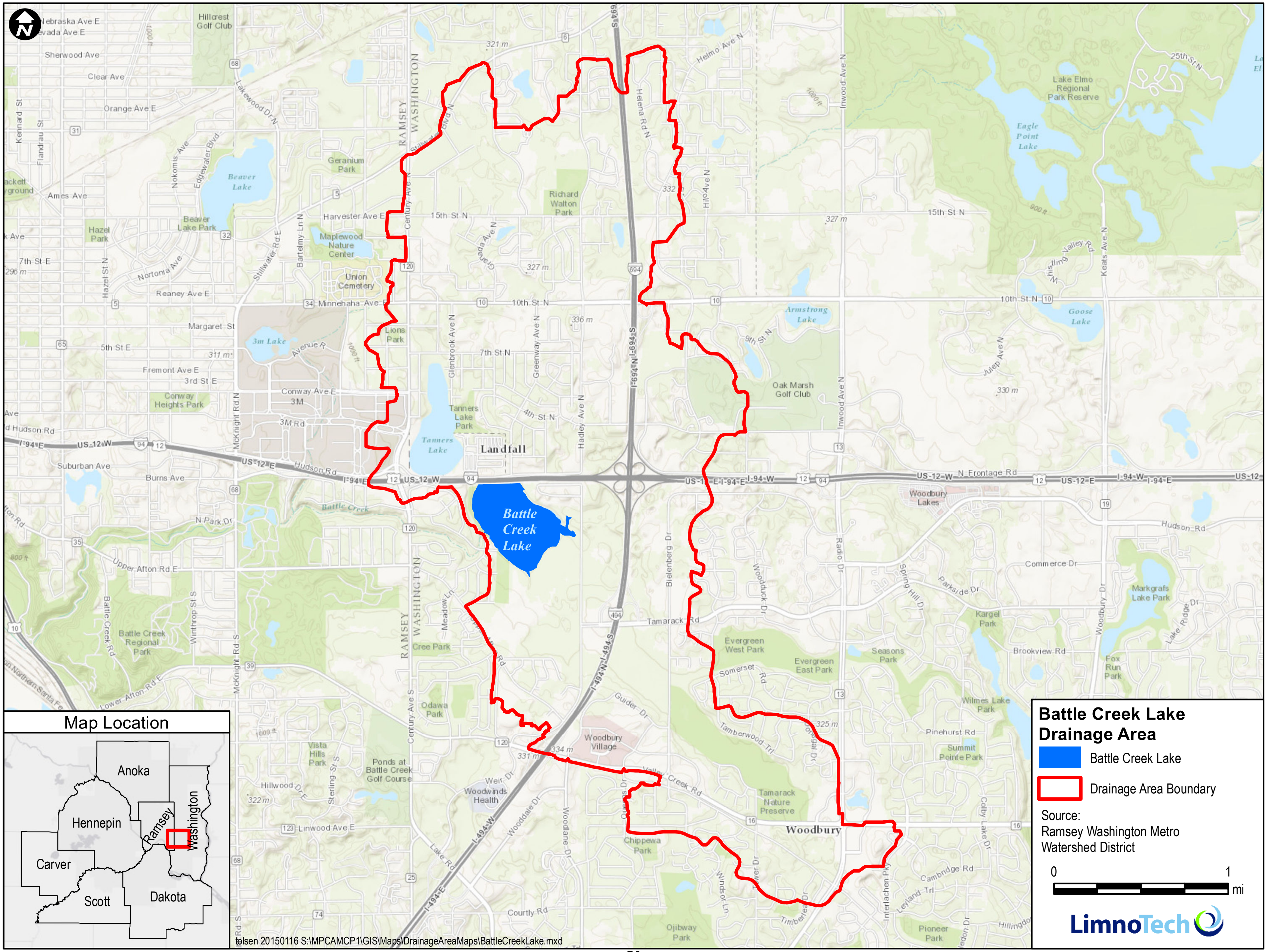




Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min									216	203	320
Max									555	224	340
Average									295	213	330
Season:	**Summer**	**(July-October)**									
Min		102	54	135	106	160			139	112	
Max		142	144	212	215	229			140	152	
Average		124	108	170	168	188			140	131	

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	231	329		211	188	166	168	161	135	128	138	
Elevation:	**Bottom**											
Average								217	178	160		

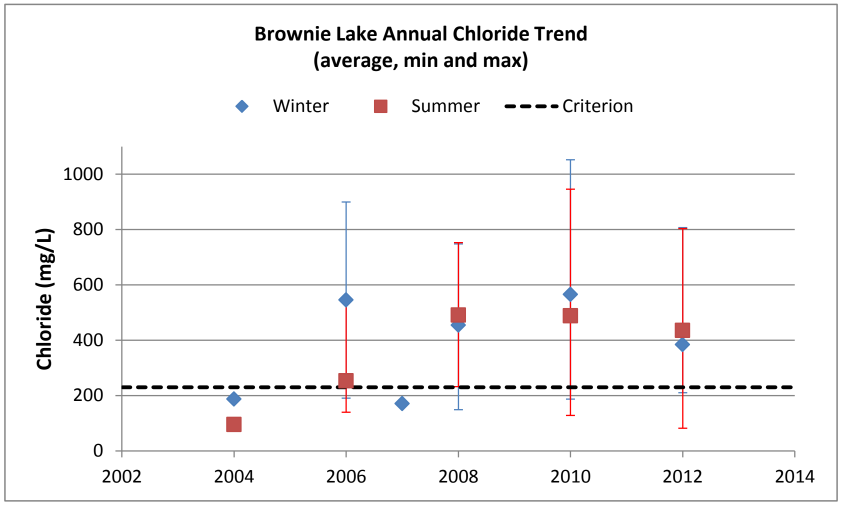


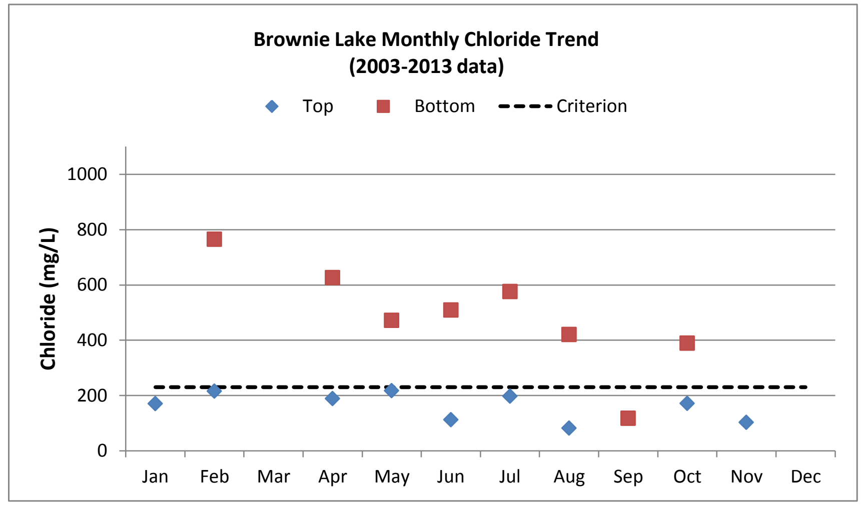

Battle Creek Lake Drainage Area
Battle Creek Lake
Drainage Area Boundary
Source:
Ramsey Washington Metro Watershed District
0
1
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Battle Creek Lake
Tanners Lake
Landfall
Woodbury
Beaver Lake
3m Lake
Eagle Point Lake
Armstrong Lake
Goose Lake
Lake Elmo Regional Park Reserve
Oak Marsh Golf Club
Battle Creek Regional Park
Woodbury Village
Tamarack Nature Preserve
I-94 E
US-12 W
I-694 N
I-494 N
tolsen 20150116 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\BattleCreekLake.mxd

Brownie Lake

WBID:	27-0038-00
Watershed:	Cities of Minneapolis, Golden Valley,& St. Louis Park
Watershed Area (ac):	452
Impervious:	53%
TMDL (pounds of chloride/year):	341,418

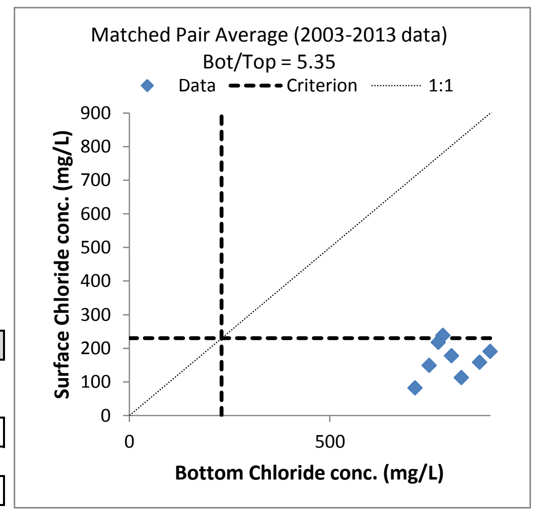
Number of Individual Days with Samples	27
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	21
Percent of Sample Days Exceeding Criterion	78%
Average of Exceeding Samples (mg/L)	780

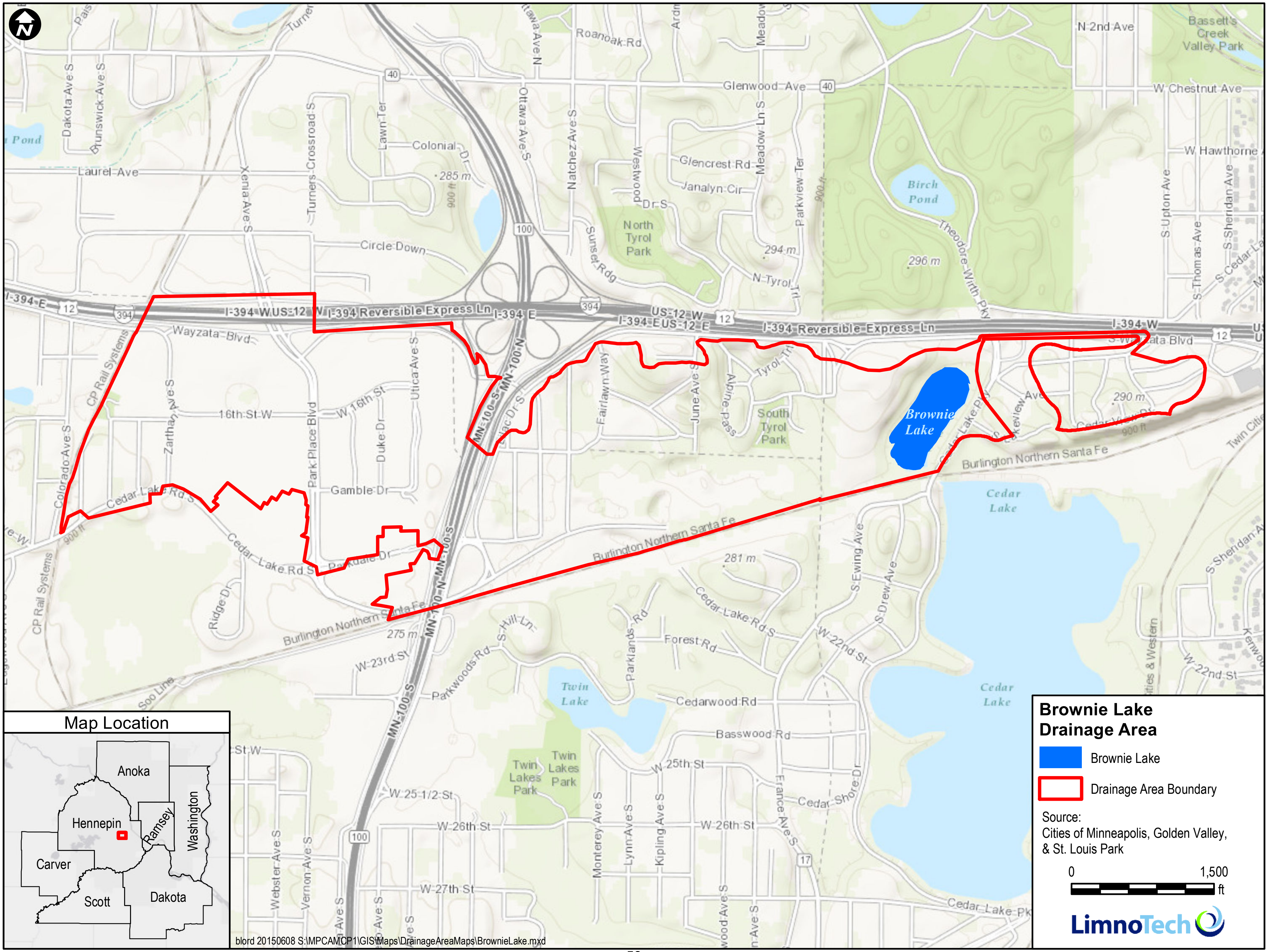




Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min		187		190	170	149		187		210	
Max		187		900	170	748		1052		807	
Average		187		545	170	454		565		384	
Season:	**Summer**	**(July-October)**									
Min		95		140		232		128		82	
Max		95		540		753		946		804	
Average		95		253		490		488		435	

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	170	216		189	217	112	198	82		172	103	
Elevation:	**Bottom**											
Average		765		626	472	509	575	421	118	389		




Brownie Lake
Drainage Area
Brownie Lake
Drainage Area Boundary
Source:
Cities of Minneapolis, Golden Valley, & St. Louis Park
0
1,500
ft
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Brownie Lake
Cedar Lake
Birch Pond
Twin Lake
North Tyrol Park
South Tyrol Park
Twin Lakes Park
Bassett's Creek Valley Park
I-394 Reversible Express Ln
Burlington Northern Santa Fe
Cedar Lake Rd S
Theodore Wirth Pkwy
Glenwood Ave
MN-100 S
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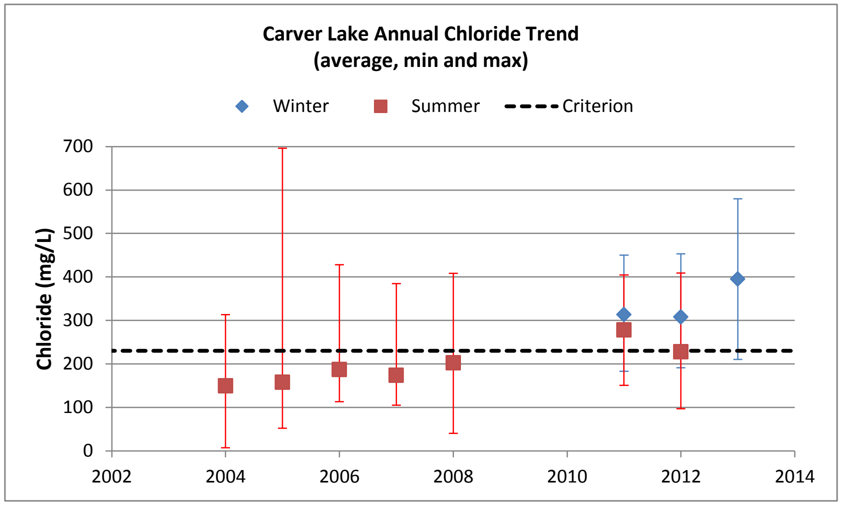
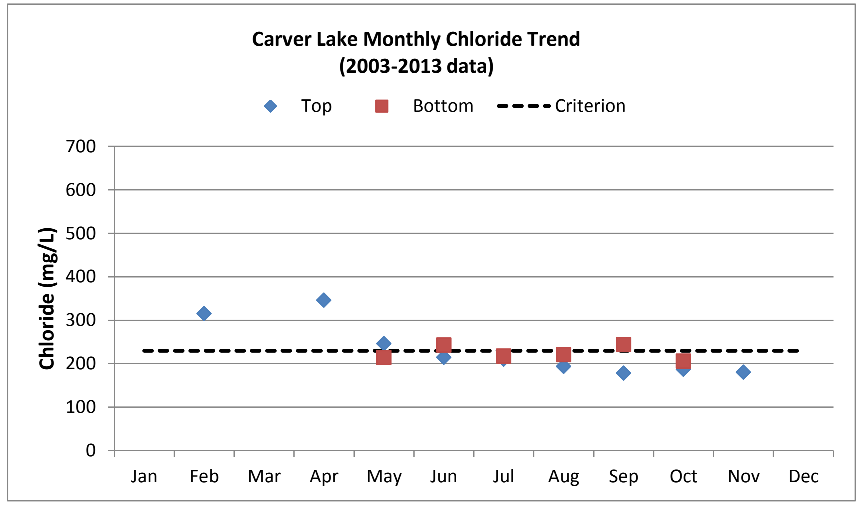
Carver Lake

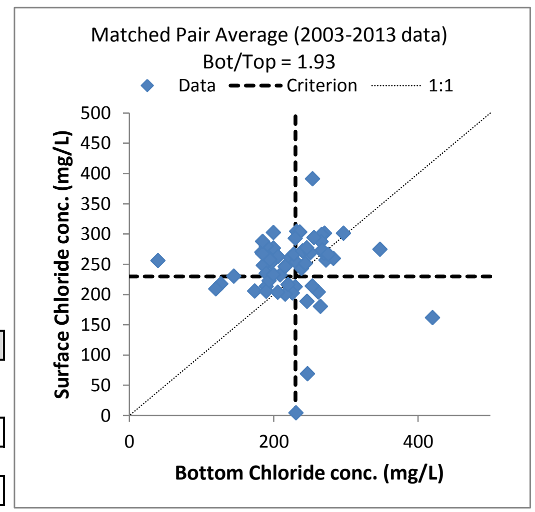
WBID:	82-0166-00
Watershed:	Ramsey Washington Metro Watershed District
Watershed Area (ac):	2,242
Impervious:	31%
TMDL (pounds of chloride/year):	1,071,124

Number of Individual Days with Samples	138
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	79
Percent of Sample Days Exceeding Criterion	57%
Average of Exceeding Samples (mg/L)	373

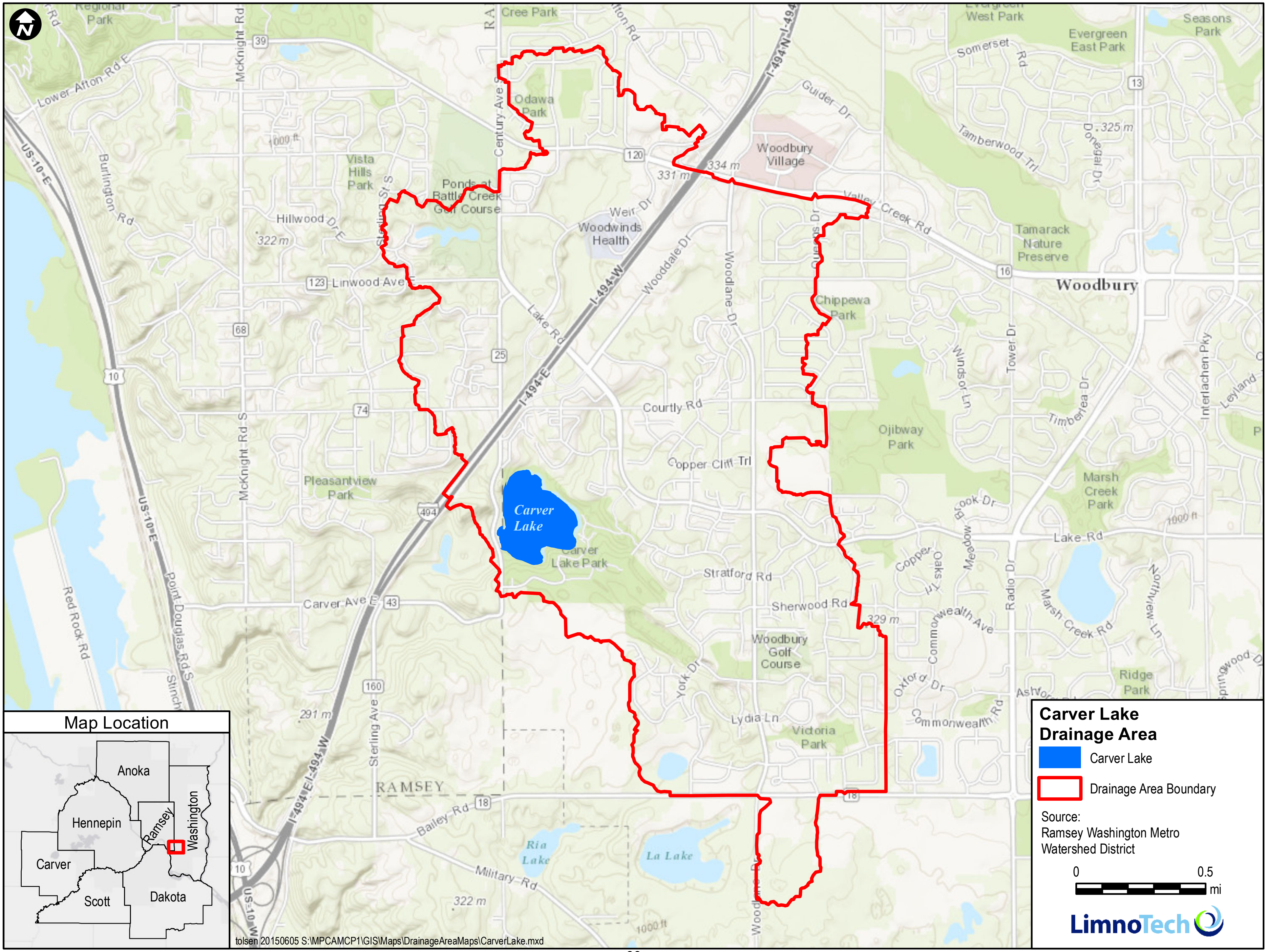




Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min									183	191	210
Max									450	453	580
Average									313	308	395
Season:	**Summer**	**(July-October)**									
Min		7	52	113	105	40			151	97	
Max		313	696	428	385	408			405	409	
Average		149	158	187	174	202			278	228	



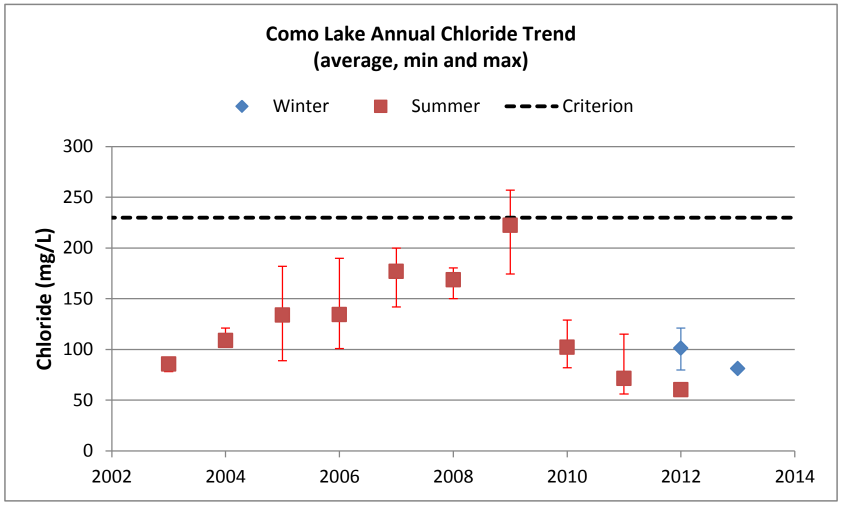
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average		315		346	246	214	210	194	178	187	180	
Elevation:	**Bottom**											
Average					214	242	217	220	244	205		

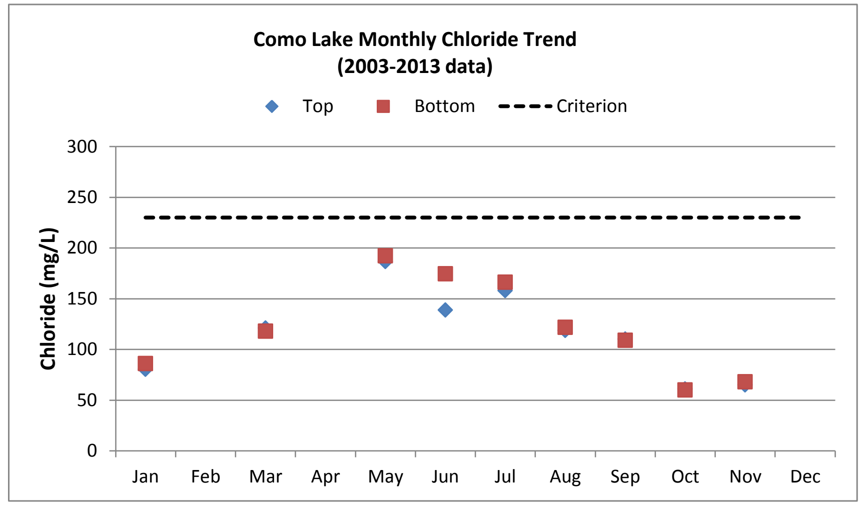

Carver Lake
Drainage Area
Carver Lake
Drainage Area Boundary
Source:
Ramsey Washington Metro
Watershed District
0
0.5
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Carver Lake
Carver Lake Park
Woodbury
Woodbury Village
Woodwinds Health
Odawa Park
Vista Hills Park
Ponds at Battle Creek Golf Course
Pleasantview Park
Chippewa Park
Ojibway Park
Tamarack Nature Preserve
Marsh Creek Park
Woodbury Golf Course
Victoria Park
Ridge Park
Evergreen East Park
Seasons Park
Cree Park
RAMSEY
Ria Lake
La Lake
I-494 E
I-494 W
US-10 E
Century Ave S
McKnight Rd S
Sterling Ave
Linwood Ave
Hillwood Dr E
Lower Afton Rd E
Lake Rd
Courtly Rd
Copper Cliff Trl
Stratford Rd
Sherwood Rd
Lydia Ln
Carver Ave E
Bailey Rd
Military Rd
Valley Creek Rd
Woodlane Dr
Woodale Dr
Weir Dr
Guider Dr
Tamberwood Trl
Tower Dr
Radio Dr
Windsor Ln
Commonwealth Ave
Commonwealth Rd
Oxford Dr
Interlachen Pky
Marsh Creek Rd
Northview Ln
Timberlea Dr
Point Douglas Rd S
Red Rock Rd
Burlington Rd
York Dr
tolsen 20150605 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\CarverLake.mxd

Como Lake

WBID: 62-0055-00
Watershed: Capital Region Watershed District
Watershed Area (ac): 1,850
Impervious: 36%
TMDL (pounds of chloride/year): 994,078

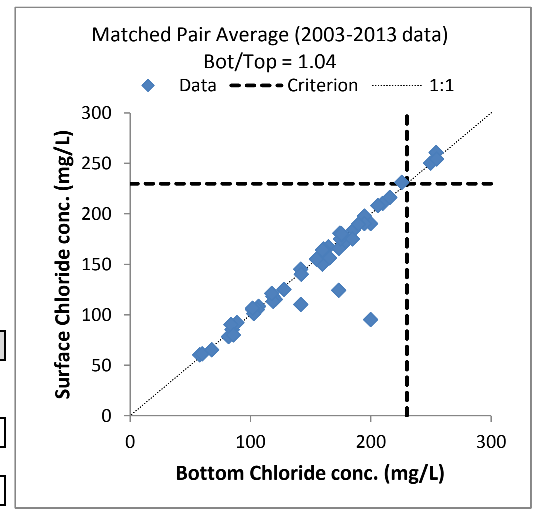
Number of Individual Days with Samples	84
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	8
Percent of Sample Days Exceeding Criterion	10%
Average of Exceeding Samples (mg/L)	250

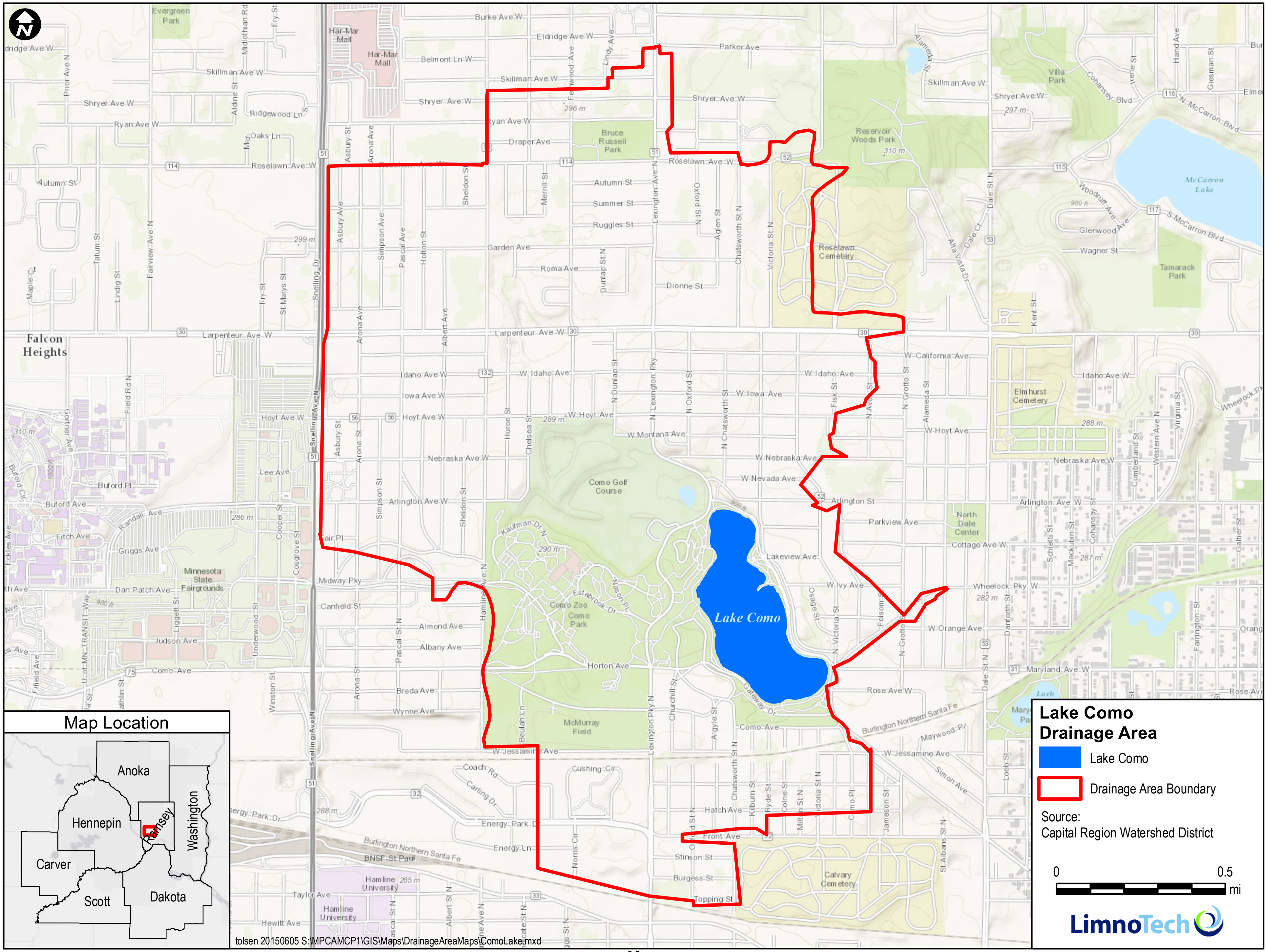




Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min										80	80
Max										121	82
Average										101	81
Season:	**Summer**	**(July-October)**									
Min	78	102	89	101	142	150	175	82	56	56	
Max	92	121	182	190	200	181	257	129	115	63	
Average	86	109	134	134	177	169	222	102	71	60	

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	80		121		187	139	158	119	110	61	65	
Elevation:	**Bottom**											
Average	86		118		192	174	166	122	109	60	68	

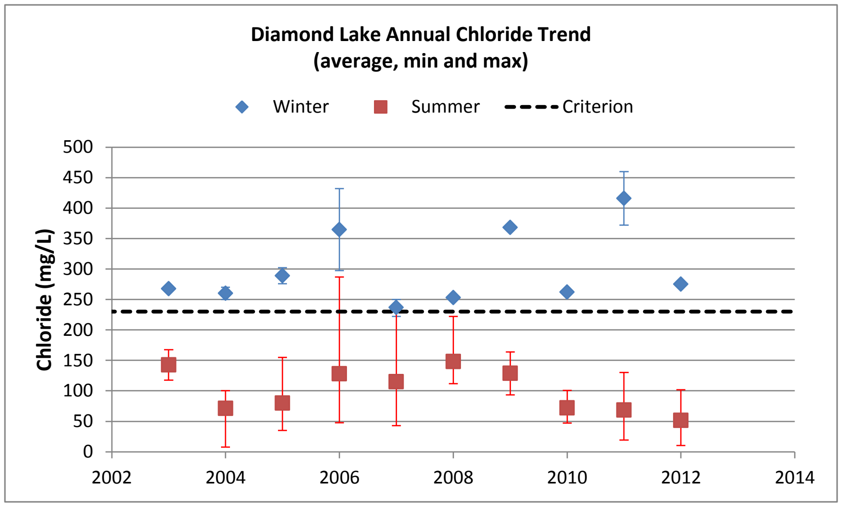


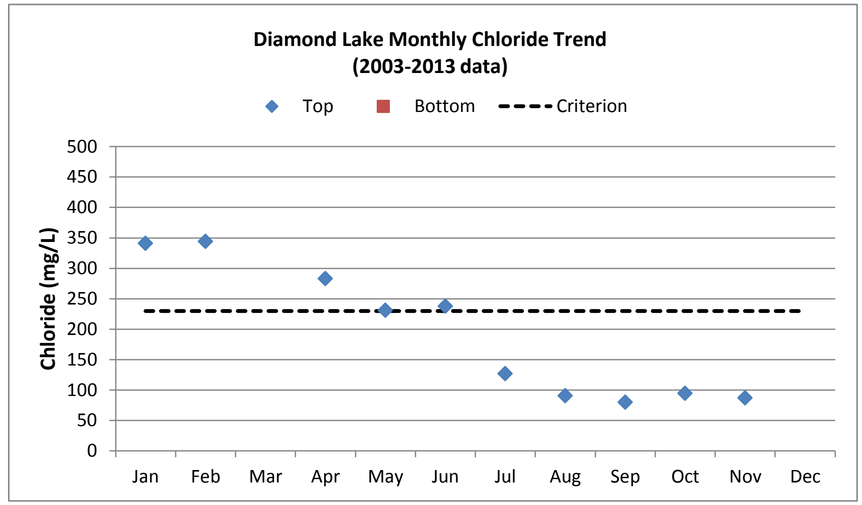

Lake Como
Drainage Area
Lake Como
Drainage Area Boundary
Source:
Capital Region Watershed District
0
0.5
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Lake Como
Como Golf Course
Como Zoo
Como Park
McMurray Field
Roselawn Cemetery
Reservoir Woods Park
Bruce Russell Park
Elmhurst Cemetery
Calvary Cemetery
North Dale Center
Minnesota State Fairgrounds
Falcon Heights
McCarron Lake
Hamline University
Har-Mar Mall
tolsen 20150605 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\ComoLake.mxd

Diamond Lake

WBID:	27-0022-00
Watershed:	Minnehaha Creek Watershed District
Watershed Area (ac):	744
Impervious:	45%
TMDL (pounds of chloride/year):	486,017

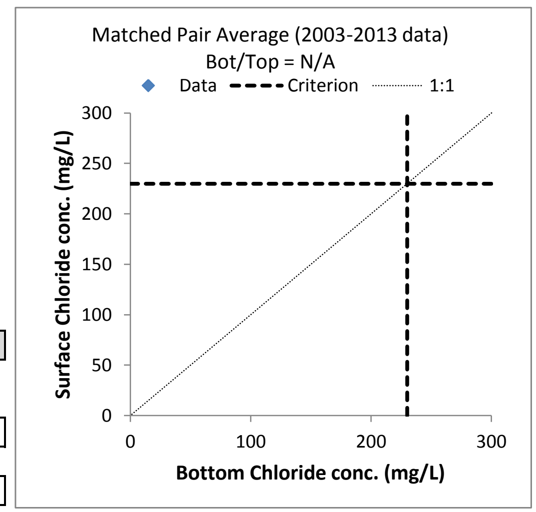
Number of Individual Days with Samples	117
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	32
Percent of Sample Days Exceeding Criterion	27%
Average of Exceeding Samples (mg/L)	340

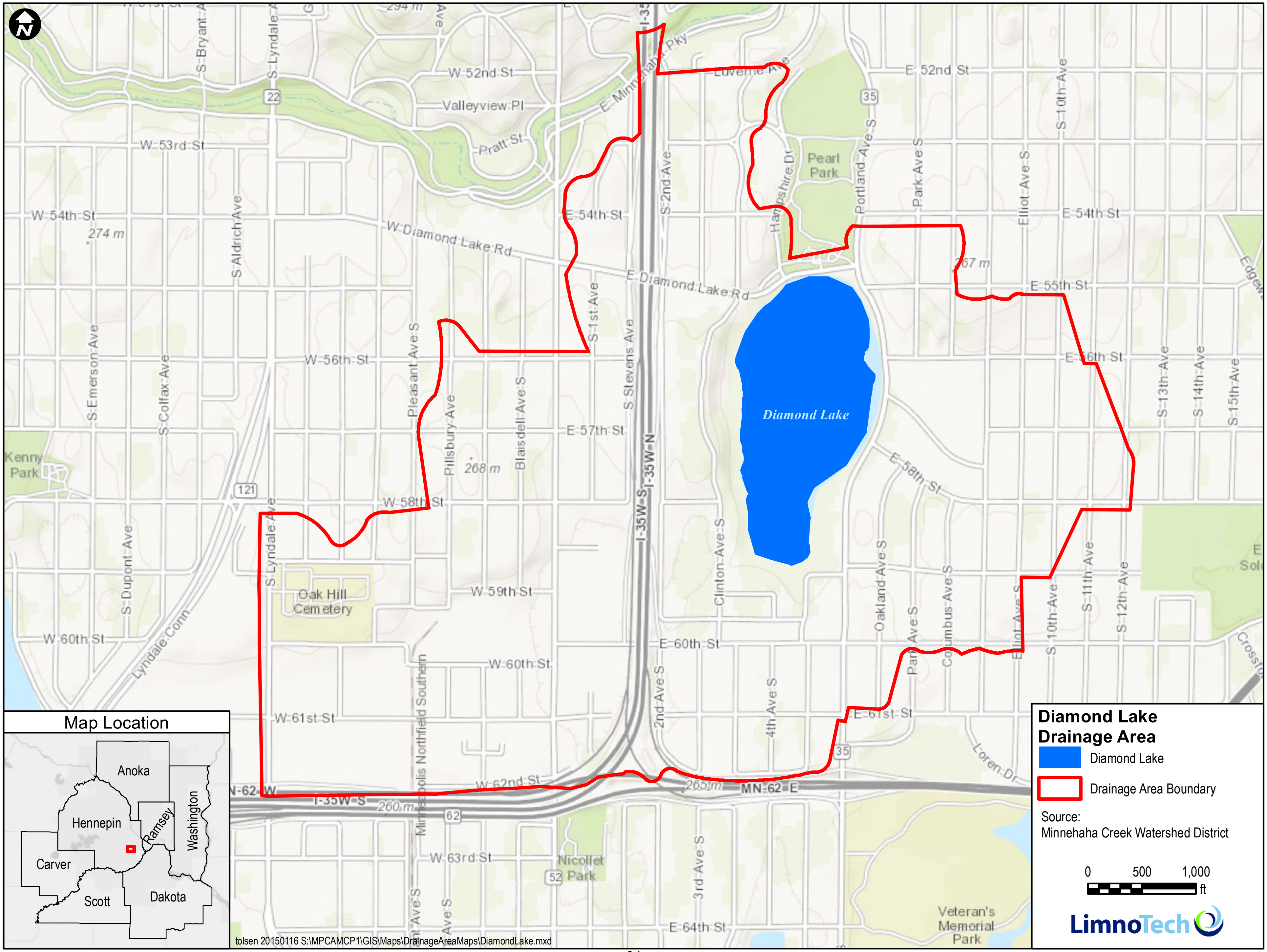




Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min	268	250	276	298	222	250	368	262	372	275	
Max	268	270	302	432	250	256	368	262	460	275	
Average	268	260	289	365	237	253	368	262	416	275	
Season:	**Summer**	**(July-October)**									
Min	118	8	35	48	43	112	93	47	19	11	
Max	168	100	155	287	241	222	164	101	130	102	
Average	143	71	80	128	115	148	129	72	68	51	

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	341	344		283	231	238	127	90	80	95	87	
Elevation:	**Bottom**											
Average												





Diamond Lake
Drainage Area
Diamond Lake
Drainage Area Boundary
Source:
Minnehaha Creek Watershed District
0
500
1,000
ft
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Diamond Lake
Pearl Park
Oak Hill Cemetery
Kenny Park
Nicollet Park
Veteran's Memorial Park
W 52nd St
Valleyview Pl
Pratt St
W 53rd St
W 54th St
W Diamond Lake Rd
E Diamond Lake Rd
E 54th St
E 55th St
W 56th St
E 56th St
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W 58th St
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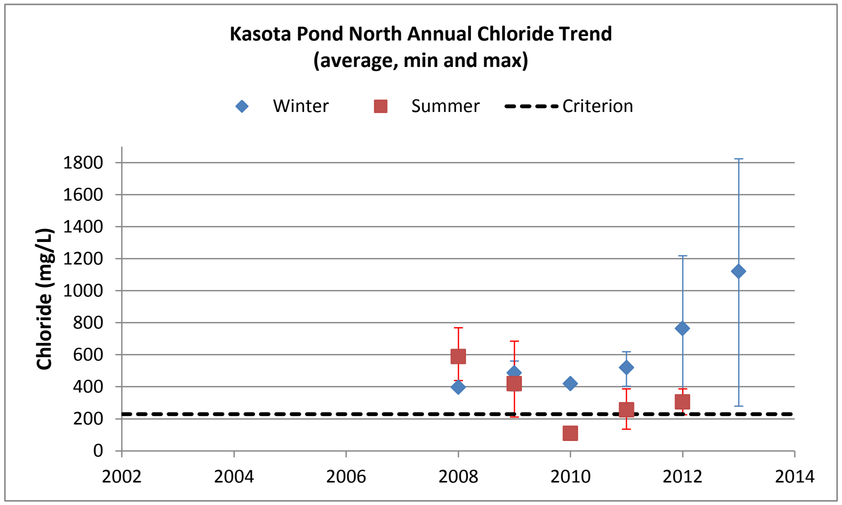
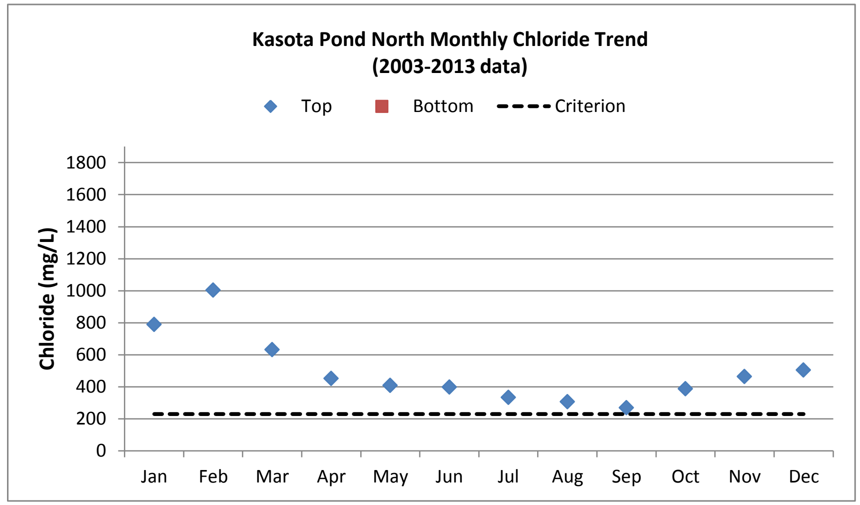
W 60th St
E 60th St
W 61st St
E 61st St
W 62nd St
W 63rd St
E 64th St
E 52nd St
E Minnehaha Pky
Luverne Ave
I-35W-S
I-35W-N
MN-62-E
Lyndale Conn
Loren Dr
S Bryant Ave
S Lyndale Ave
S Aldrich Ave
S Emerson Ave
S Colfax Ave
S Dupont Ave
Pleasant Ave S
Pillsbury Ave
Blaisdell Ave S
S 1st Ave
S Stevens Ave
S 2nd Ave
2nd Ave S
3rd Ave S
4th Ave S
Clinton Ave S
Hampshire Dr
Portland Ave S
Park Ave S
Elliot Ave S
Oakland Ave S
Columbus Ave S
S 10th Ave
S 11th Ave
S 12th Ave
S 13th Ave
S 14th Ave
S 15th Ave
Minneapolis Northfield Southern
274 m
268 m
267 m
265 m
260 m
tolsen 20150116 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\DiamondLake.mxd

Kasota Pond North

WBID:	62-0280-00
Watershed:	LTI derived from St. Paul contours
Watershed Area (ac):	10
Impervious:	45%
TMDL (pounds of chloride/year):	6,234

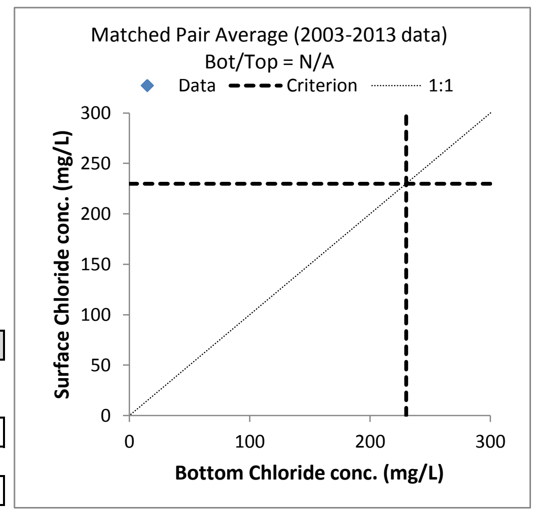
Number of Individual Days with Samples	91
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	70
Percent of Sample Days Exceeding Criterion	77%
Average of Exceeding Samples (mg/L)	533





Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min						394	376	416	402	332	279
Max						398	561	420	619	1218	1823
Average						396	486	418	520	763	1120
Season:	**Summer**	**(July-October)**									
Min						438	212	73	135	226	
Max						768	685	132	386	387	
Average						588	418	108	256	304	

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	789	1004	632	452	408	398	333	307	268	388	464	504
Elevation:	**Bottom**											
Average												

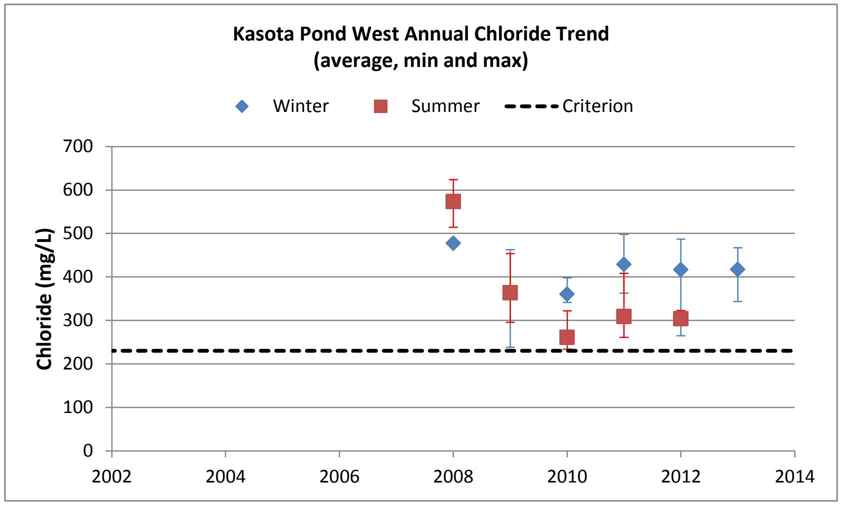


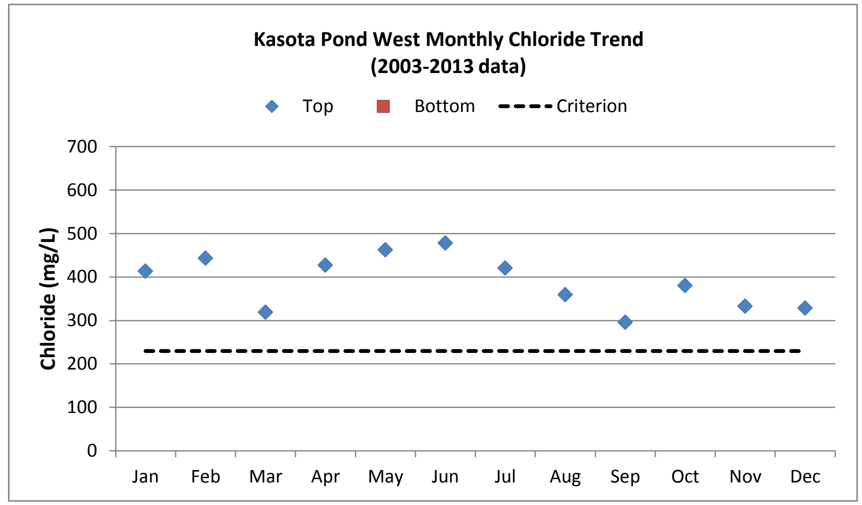

268 m
BOURNE ST
1335
1301
MN-280 N
MN-280 S
280
Minnesota Commercial
2498
CARTER
1257
EUSTIS ST
Kasota
Pond
North
2201
2461
32
ENERGY
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Kasota Pond North
Drainage Area
Kasota Pond North
Drainage Area Boundary
Source:
Drainage areas were developed by
LimnoTech based on contours
provided by the City of St. Paul
0
100
200
Feet
LimnoTech
blord 20150610 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\KasotaPondNorth.mxd

Kasota Pond West

WBID: 62-0281-00
Watershed: LTI derived from City of St. Paul contours
Watershed Area (ac): 6
Impervious: 69%
TMDL (pounds of chloride/year): 5,742

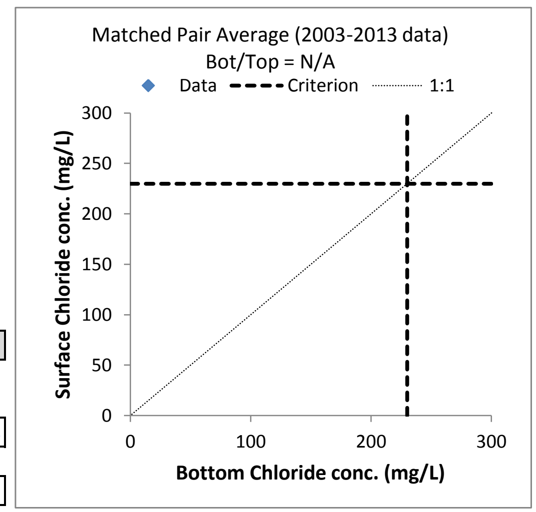
Number of Individual Days with Samples	91
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	91
Percent of Sample Days Exceeding Criterion	100%
Average of Exceeding Samples (mg/L)	393

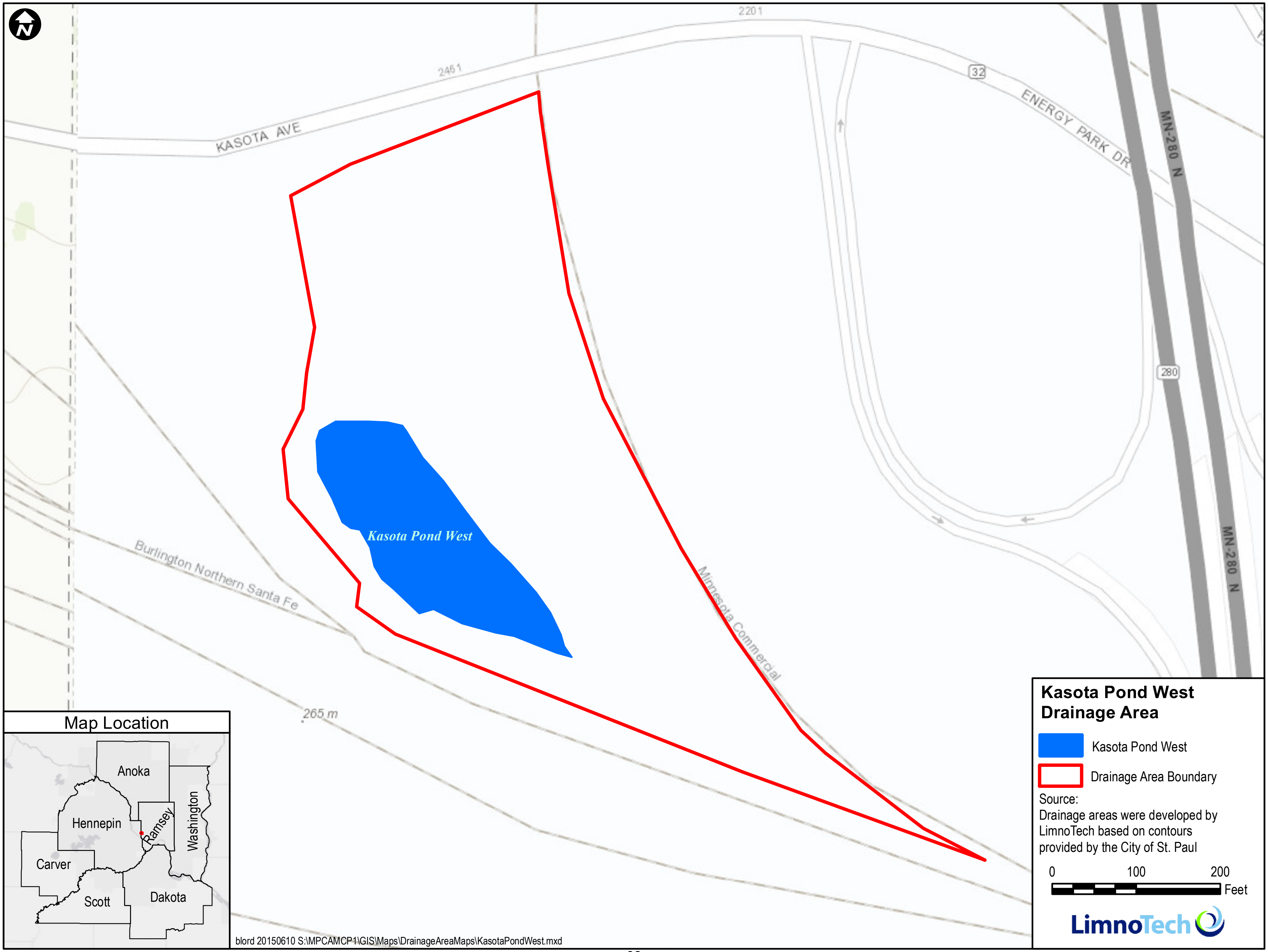




Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min						477	238	341	363	265	343
Max						477	463	398	498	487	467
Average						477	365	360	428	417	417
Season:	**Summer**	**(July-October)**									
Min						514	296	234	261	291	
Max						624	454	322	408	323	
Average						573	364	261	309	304	

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	413	443	319	427	462	478	420	359	296	380	333	328
Elevation:	**Bottom**											
Average												





KASOTA AVE
2461
2201
32
ENERGY PARK DR
MN-280 N
280
MN-280 N
Kasota Pond West
Burlington Northern Santa Fe
Minnesota Commercial
265 m
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Kasota Pond West
Drainage Area
Kasota Pond West
Drainage Area Boundary
Source:
Drainage areas were developed by
LimnoTech based on contours
provided by the City of St. Paul
0
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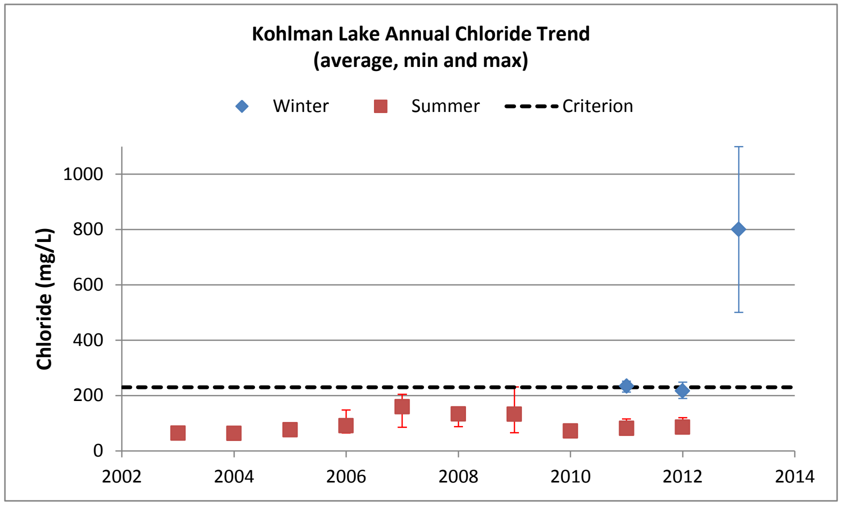
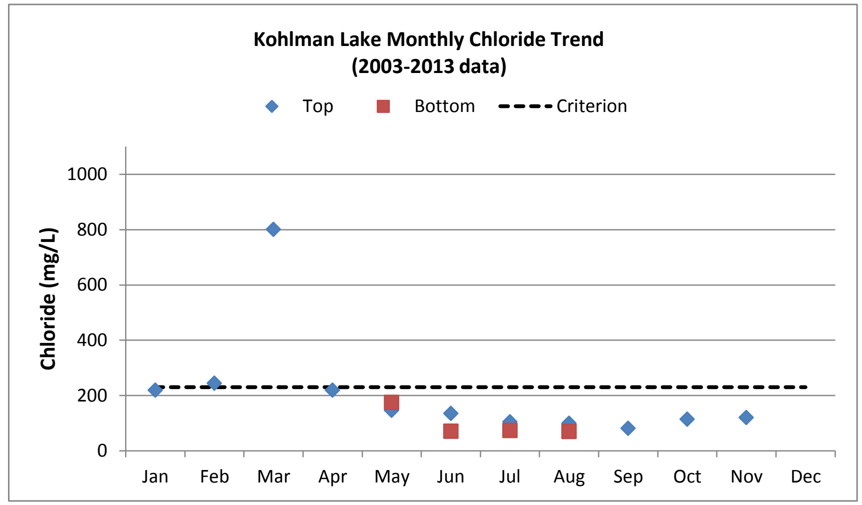
200
Feet
LimnoTech
blord 20150610 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\KasotaPondWest.mxd

Kohlman Lake

WBID:	62-0006-00
Watershed:	Ramsey Washington Metro Watershed District
Watershed Area (ac):	7,533
Impervious:	33%
TMDL (pounds of chloride/year):	3,788,699

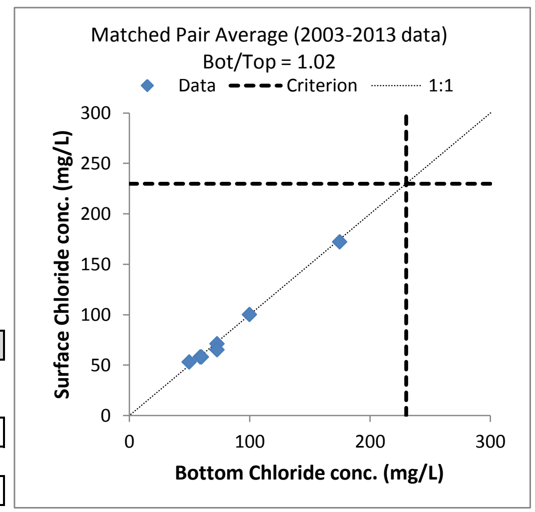
Number of Individual Days with Samples	80
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	6
Percent of Sample Days Exceeding Criterion	8%
Average of Exceeding Samples (mg/L)	387

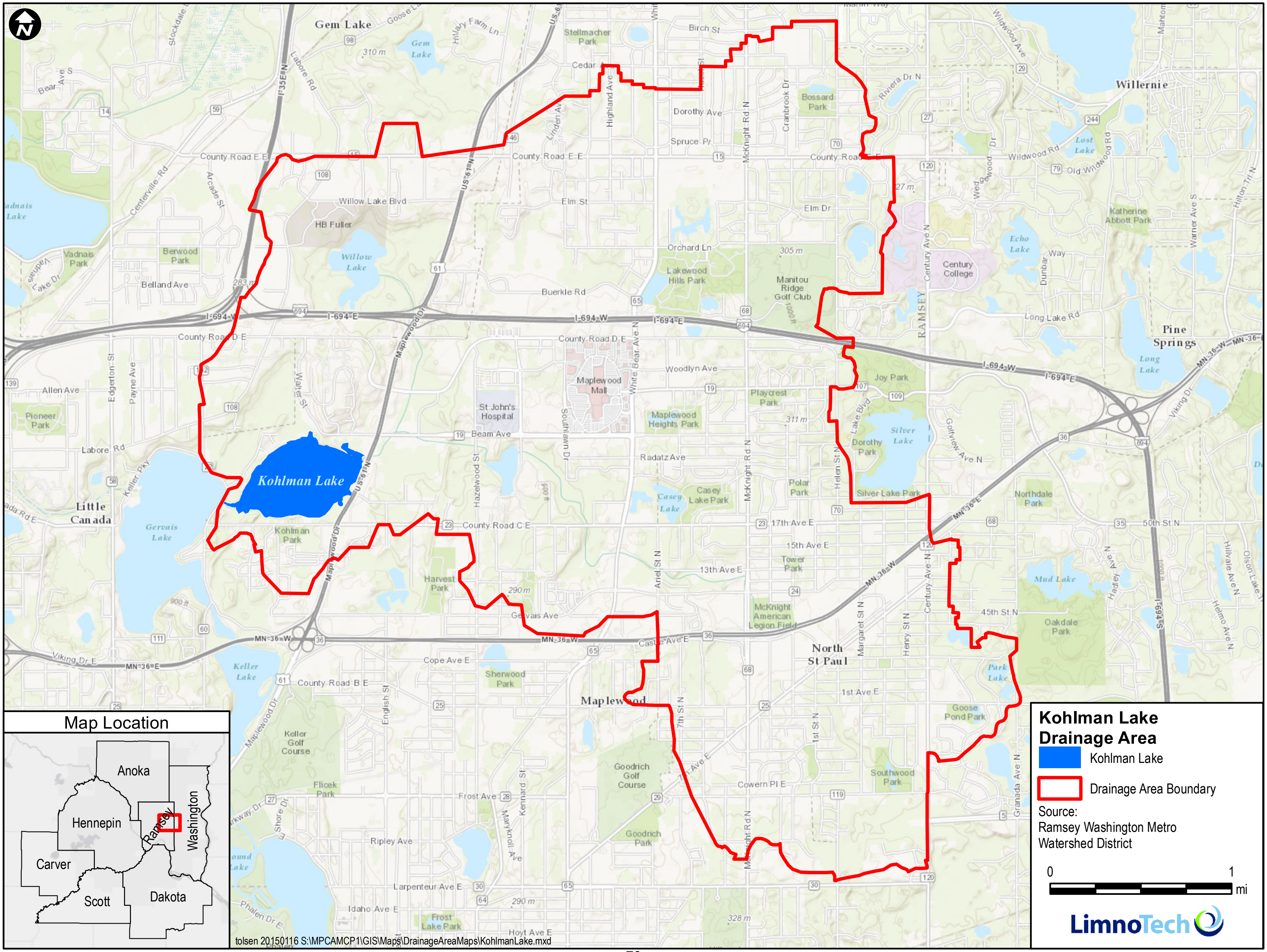




Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min									213	189	500
Max									252	248	1100
Average									234	217	800
Season:	**Summer**	**(July-October)**									
Min	50	54	63	65	85	88	65	62	58	65	
Max	76	73	92	147	204	149	231	80	115	120	
Average	63	63	76	90	159	133	132	72	81	85	

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	219	244	800	219	146	135	104	100	81	114	120	
Elevation:	**Bottom**											
Average					175	71	73	70				





Kohlman Lake
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Kohlman Lake
Drainage Area
Kohlman Lake
Drainage Area Boundary
Source:
Ramsey Washington Metro
Watershed District
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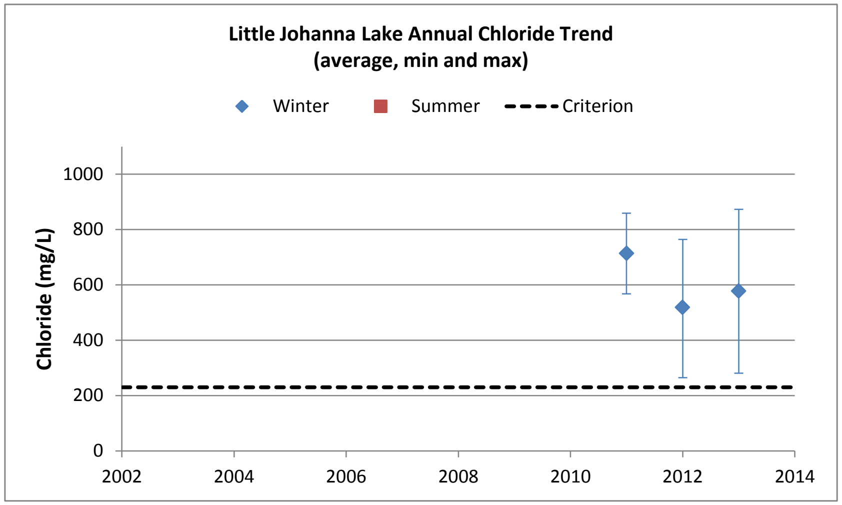
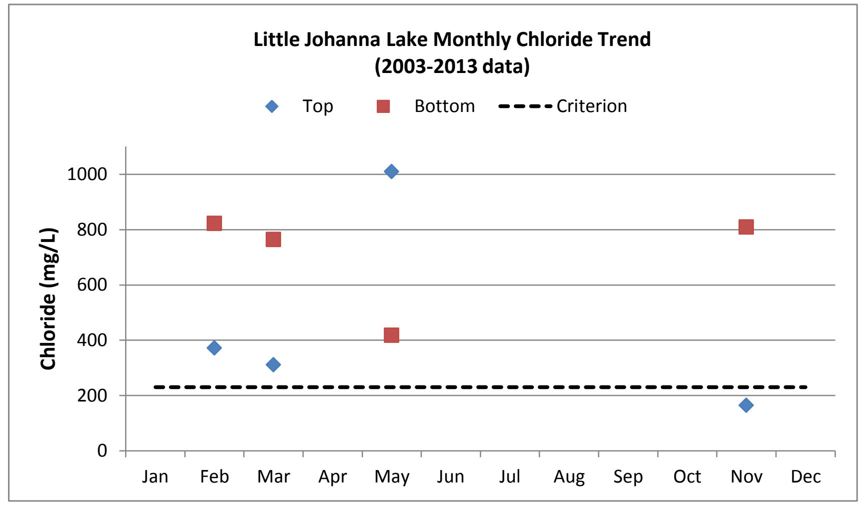
Little Johanna Lake

WBID: 62-0058-00
Watershed: Rice Creek Watershed District
Watershed Area (ac): 1,703
Impervious: 50%
TMDL (pounds of chloride/year): 1,224,243

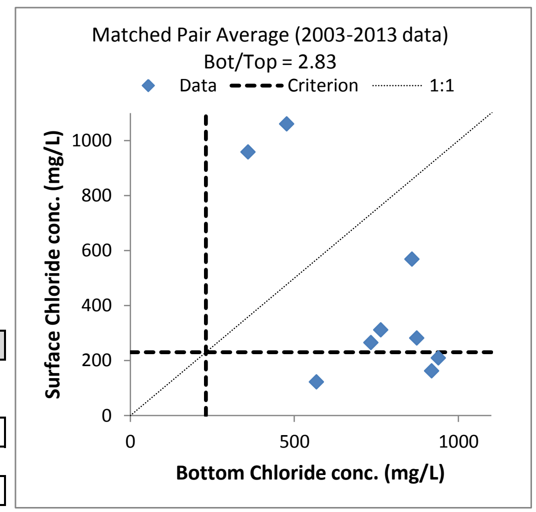
Number of Individual Days with Samples	9
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	9
Percent of Sample Days Exceeding Criterion	100%
Average of Exceeding Samples (mg/L)	853

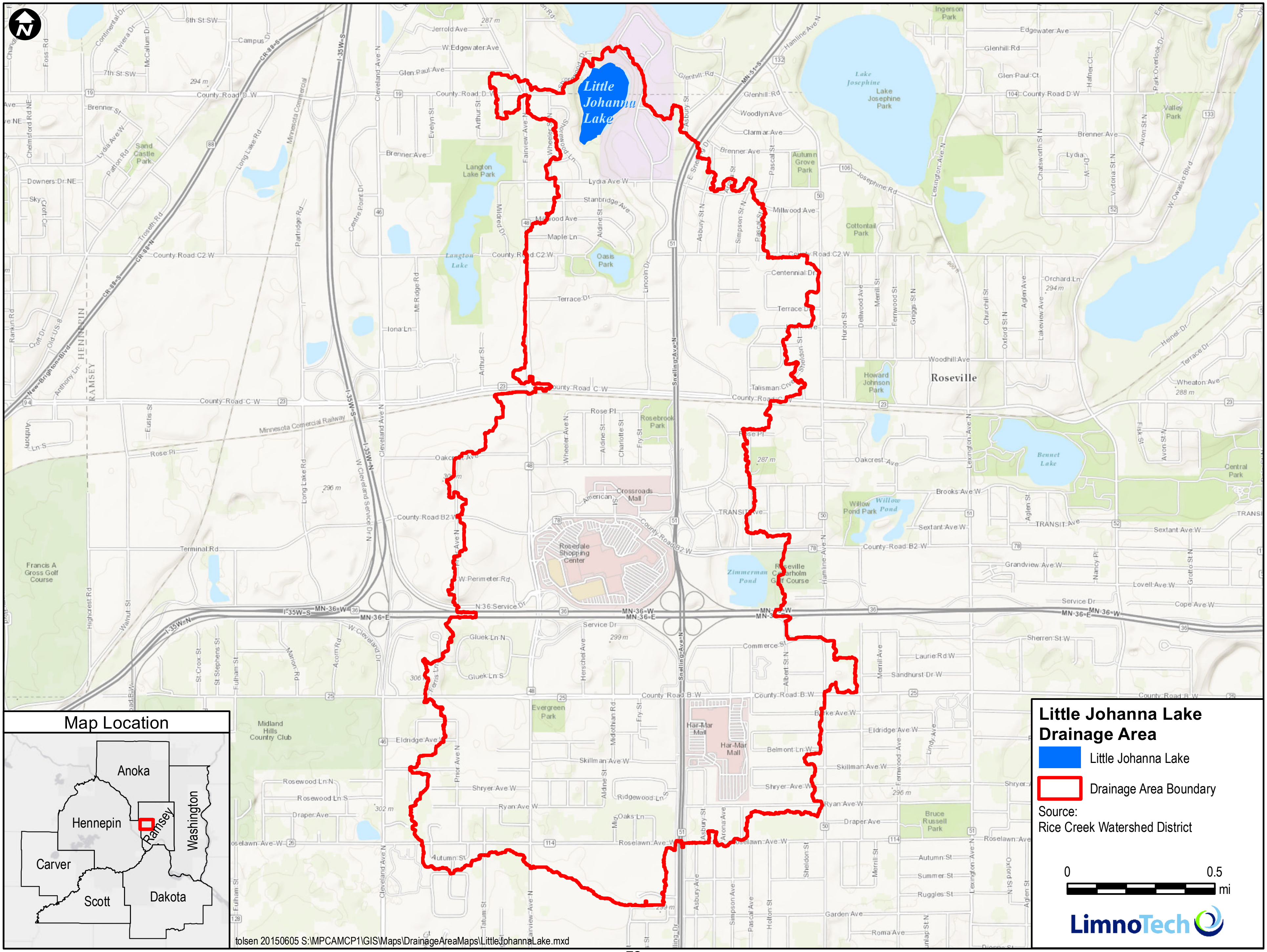




Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min									568	265	281
Max									859	764	873
Average									714	519	577
Season:	**Summer**	**(July-October)**									
Min											
Max											
Average											

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average		371	311		1009						164	
Elevation:	**Bottom**											
Average		822	764		418						809	



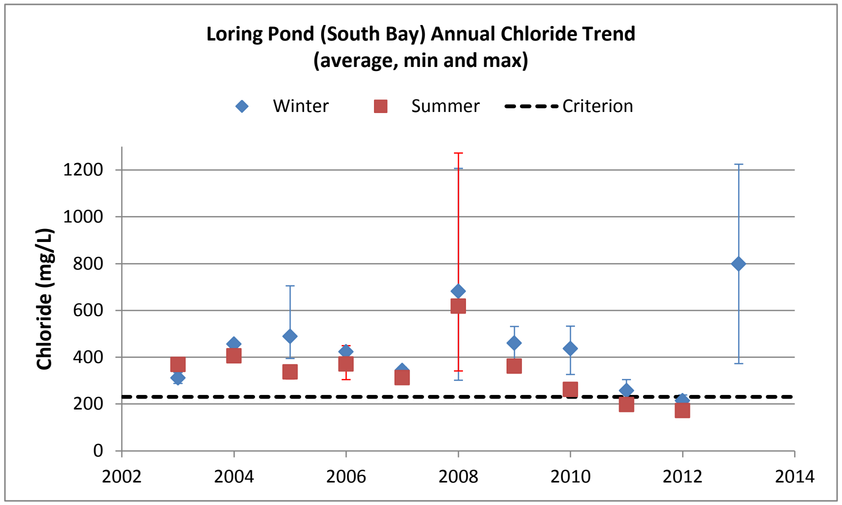


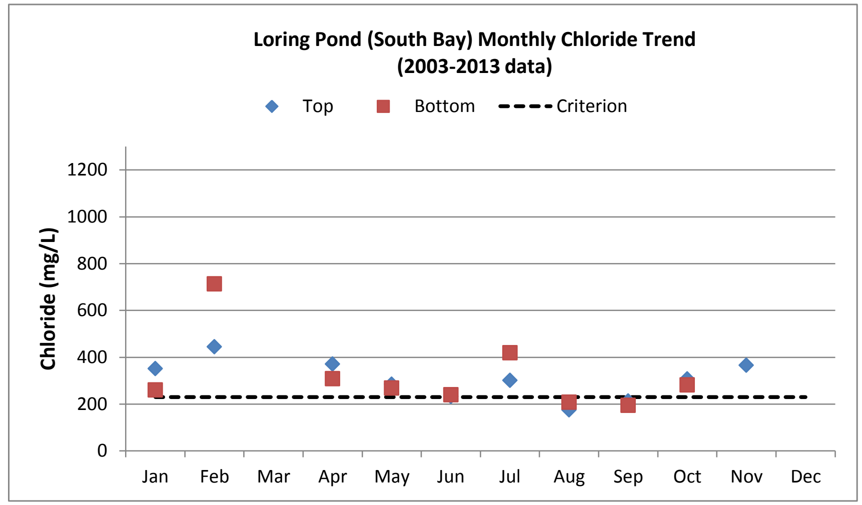
Little Johanna Lake Drainage Area
Little Johanna Lake
Drainage Area Boundary
Source:
Rice Creek Watershed District
0
0.5
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Little Johanna Lake
Lake Josephine
Langton Lake
Bennet Lake
Zimmerman Pond
Willow Pond
Roseville
Rosedale Shopping Center
Har-Mar Mall
Crossroads Mall
Langton Lake Park
Oasis Park
Rosebrook Park
Evergreen Park
Howard Johnson Park
Autumn Grove Park
Cottontail Park
Central Park
Bruce Russell Park
Lake Josephine Park
Willow Pond Park
Roseville Cedarholm Golf Course
Midland Hills Country Club
Francis A Gross Golf Course
Sand Castle Park
Valley Park
Ingerson Park
HENNEPIN
RAMSEY
tolsen 20150605 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\LittleJohannaLake.mxd

Loring Pond (South Bay)

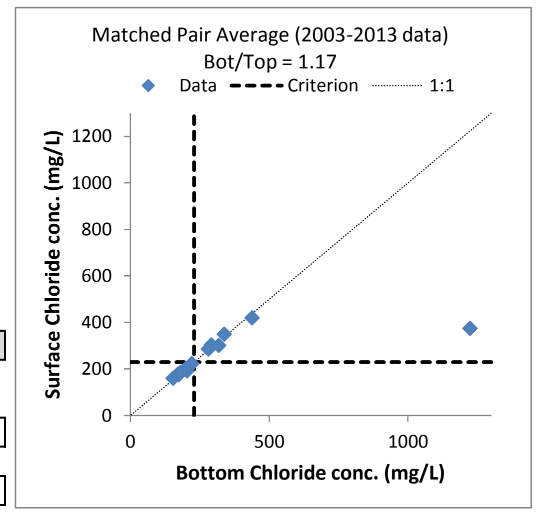
WBID:	27-0655-02
Watershed:	City of Minneapolis
Watershed Area (ac):	34
Impervious:	17%
TMDL (pounds of chloride/year):	9,764

Number of Individual Days with Samples	65
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	43
Percent of Sample Days Exceeding Criterion	66%
Average of Exceeding Samples (mg/L)	429

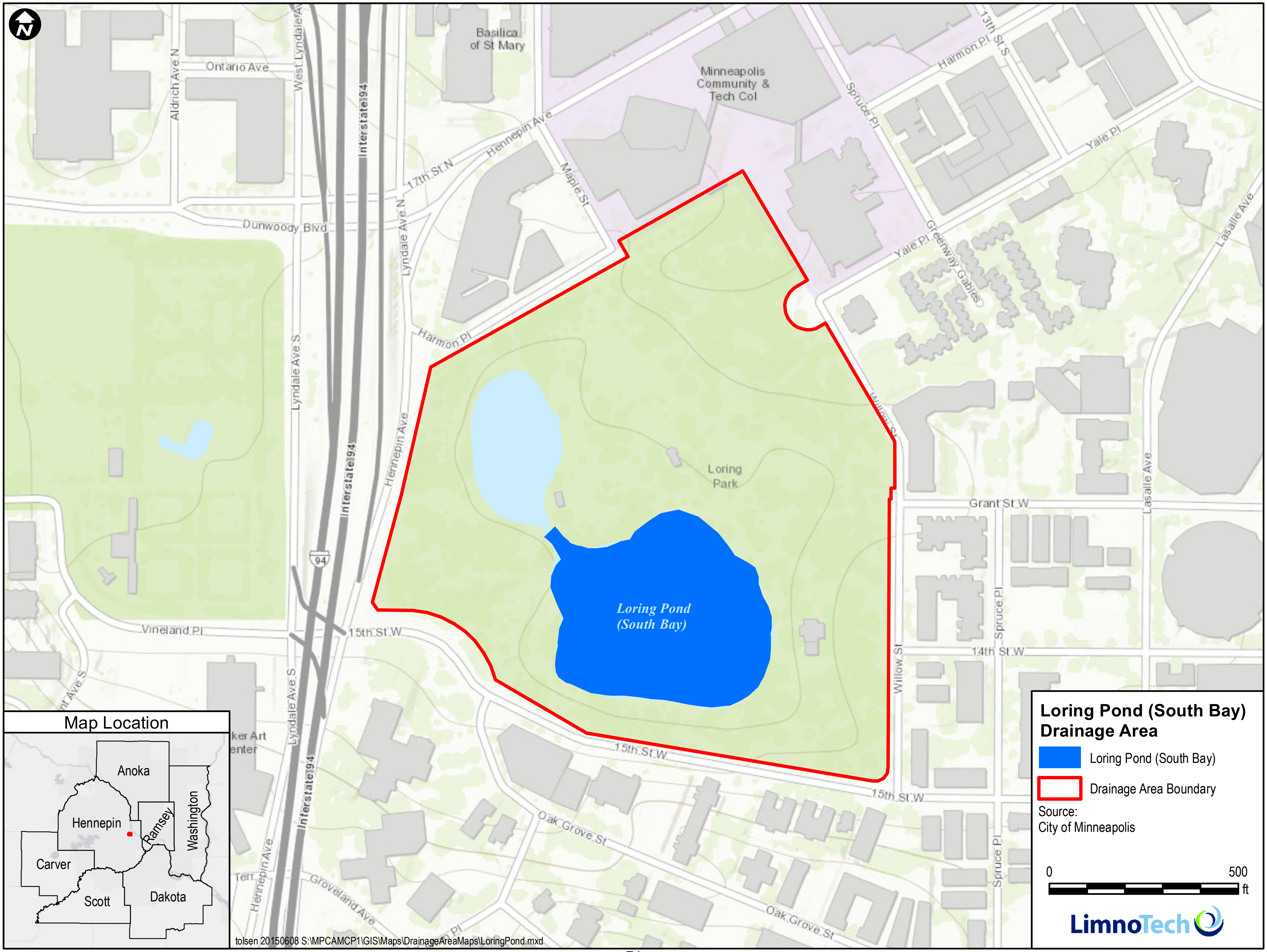




Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min	288	447	395	420	330	302	386	326	215	187	373
Max	335	465	705	425	356	1207	532	533	305	239	1224
Average	311	456	489	423	343	682	460	436	257	213	799
Season:	**Summer**	**(July-October)**									
Min	340	405	307	304	292	341	339	233	171	155	
Max	396	405	366	450	333	1273	380	289	222	188	
Average	368	405	337	371	313	618	362	262	198	171	



Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	351	444		370	284	232	301	175	213	307	365	
Elevation:	**Bottom**											
Average	260	713		308	268	239	419	208	194	281		

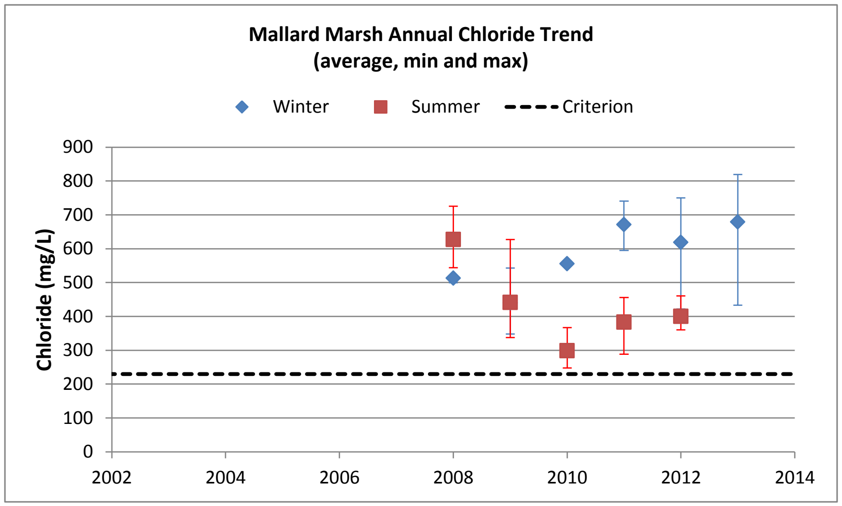


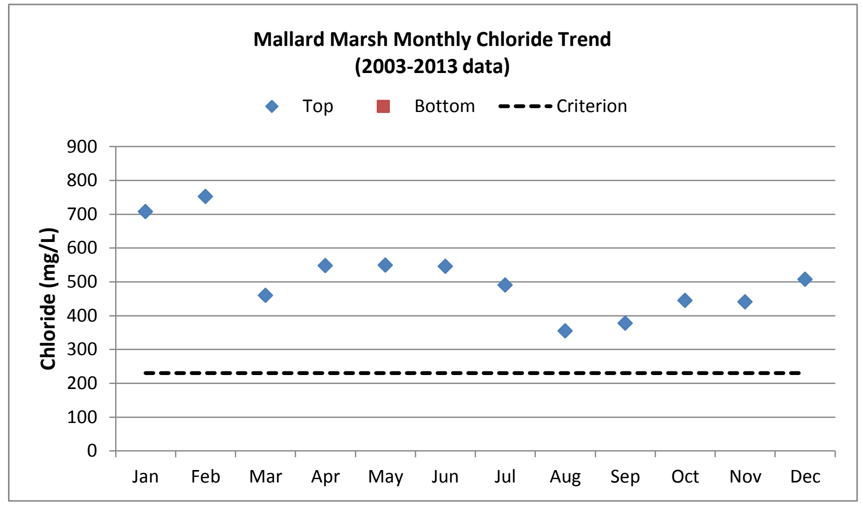
Loring Pond (South Bay)
Drainage Area
Loring Pond (South Bay)
Drainage Area Boundary
Source:
City of Minneapolis
0
500
ft
LimnoTech
Loring Pond
(South Bay)
Loring
Park
Basilica
of St Mary
Minneapolis
Community &
Tech Col
Ontario Ave
Dunwoody Blvd
Vineland Pl
15th St W
14th St W
Grant St W
Harmon Pl
Yale Pl
Hennepin Ave
Lyndale Ave N
Lyndale Ave S
Interstate 94
Maple St
Spruce Pl
Willow St
Lasalle Ave
Oak Grove St
Groveland Ave
Greenway Gables
Aldrich Ave N
West Lyndale Av
17th St N
13th St S
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\LoringPond.mxd

Mallard Marsh

WBID:	62-0259-00	
Watershed:	LTI derived from St. Paul contours	
Watershed Area (ac):	16	
Impervious:	43%	
TMDL (pounds of chloride/year):	9,851	

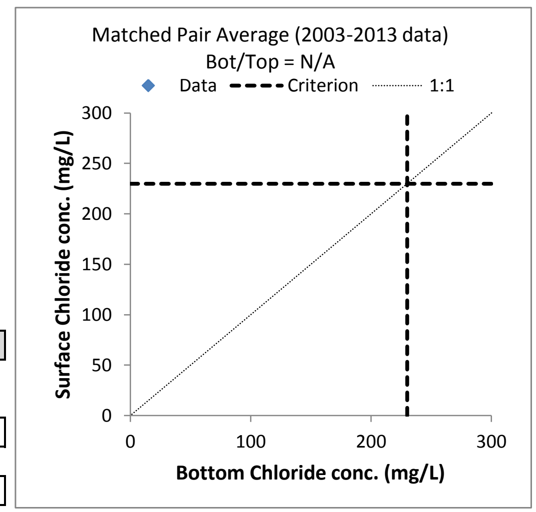
Number of Individual Days with Samples	122
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	122
Percent of Sample Days Exceeding Criterion	100%
Average of Exceeding Samples (mg/L)	494

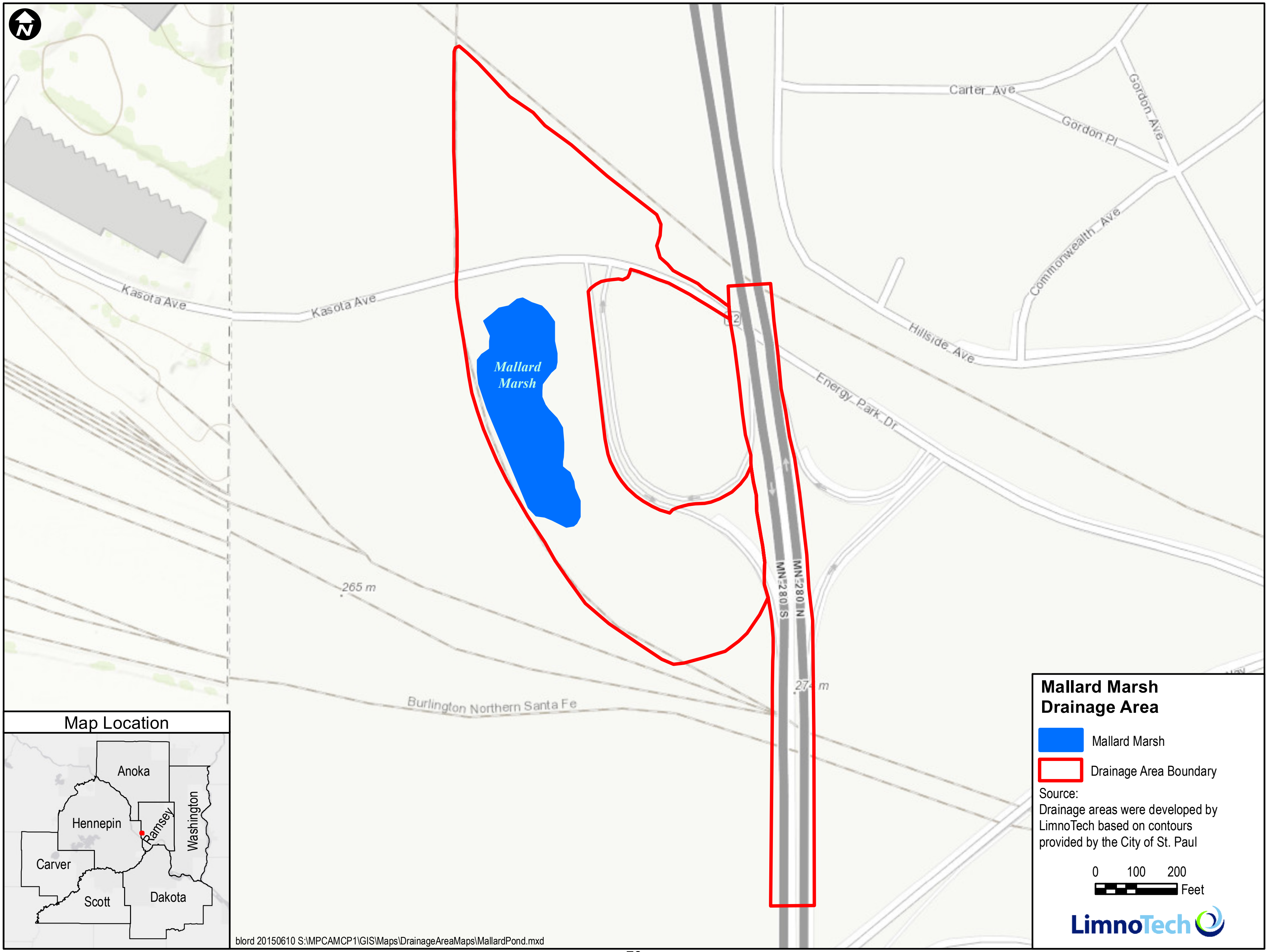




Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min						499	348	555	595	422	433
Max						520	543	556	741	750	819
Average						513	440	556	671	619	679
Season:	**Summer**	**(July-October)**									
Min						544	338	248	288	360	
Max						726	627	367	456	461	
Average						627	441	298	383	400	

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	707	752	460	548	549	546	490	355	378	445	441	507
Elevation:	**Bottom**											
Average												

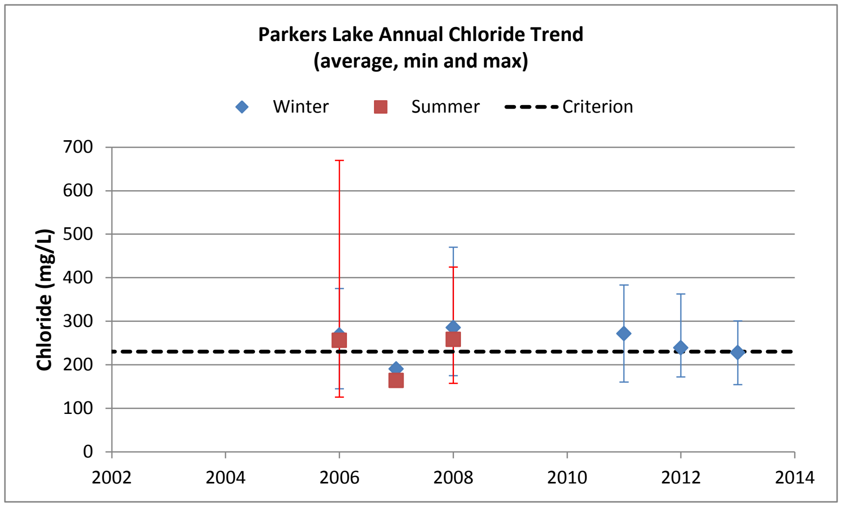


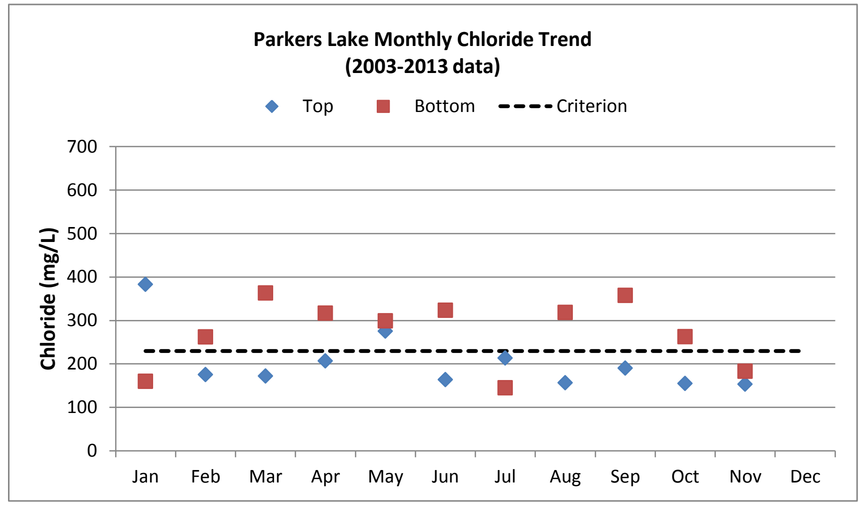

Mallard Marsh
Kasota Ave
Carter Ave
Gordon Pl
Gordon Ave
Commonwealth Ave
Hillside Ave
Energy Park Dr
MN 280 S
MN 280 N
265 m
Burlington Northern Santa Fe
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Mallard Marsh Drainage Area
Mallard Marsh
Drainage Area Boundary
Source:
Drainage areas were developed by LimnoTech based on contours provided by the City of St. Paul
0 100 200
Feet
LimnoTech
blord 20150610 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\MallardPond.mxd

Parkers Lake

WBID: 27-0107-00
Watershed: Bassett Creek Watershed Management Commission 20131017
Watershed Area (ac): 1,064
Impervious: 41%
TMDL (pounds of chloride/year): 644,099

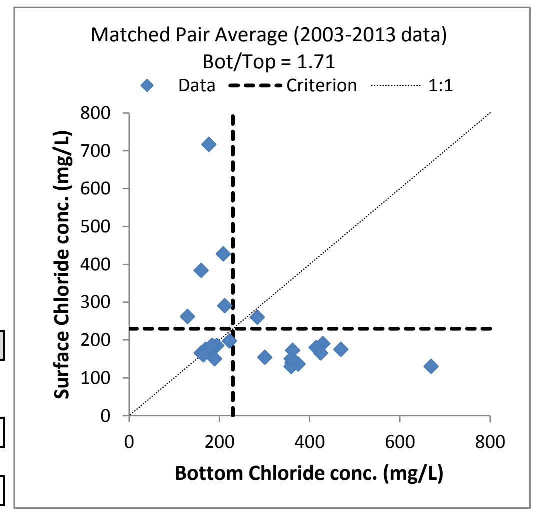
Number of Individual Days with Samples	30
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	19
Percent of Sample Days Exceeding Criterion	63%
Average of Exceeding Samples (mg/L)	418

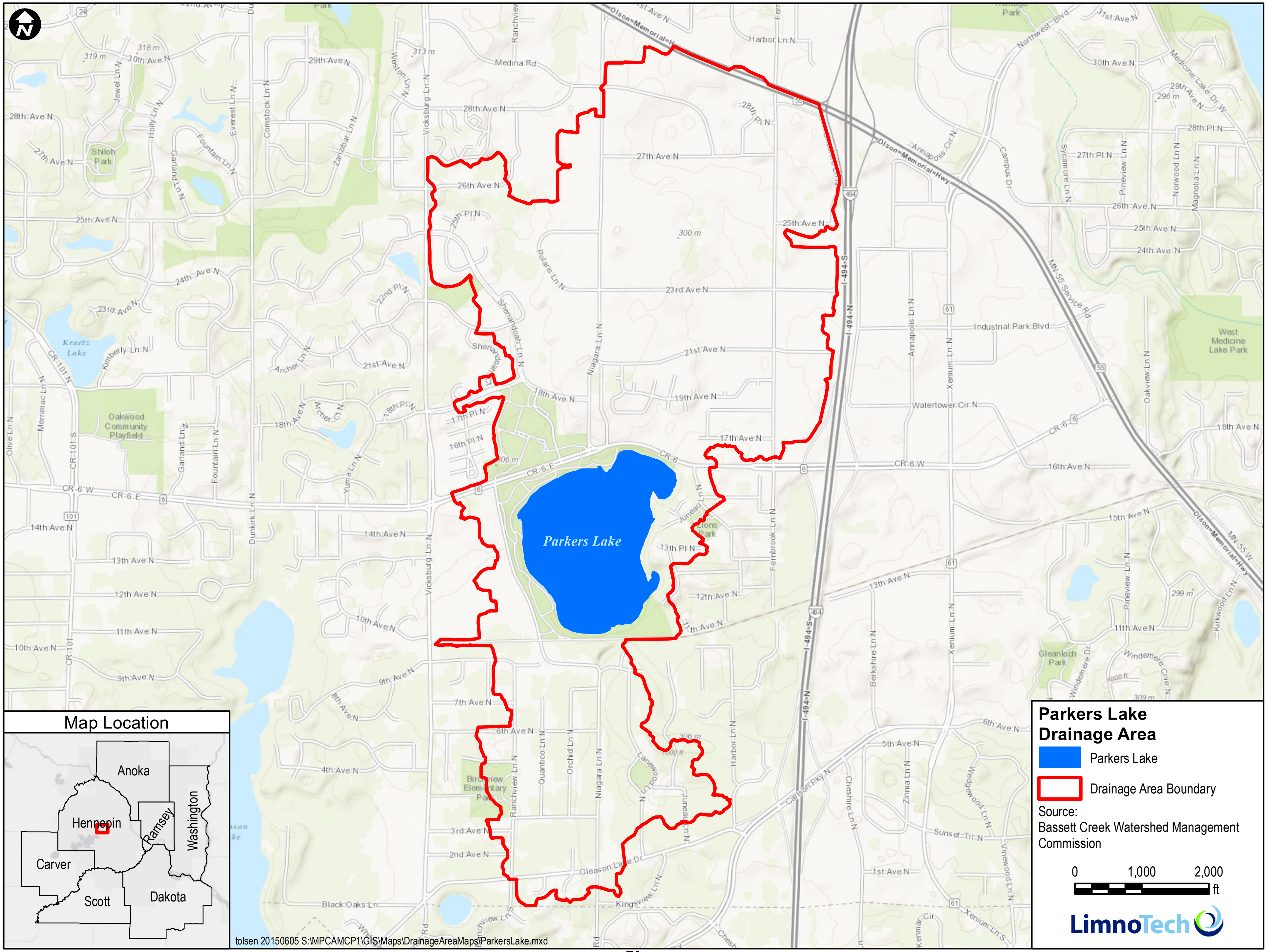




Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min				145	185	175			160	172	154
Max				375	195	470			383	363	301
Average				268	190	285			272	239	228
Season:	**Summer**	**(July-October)**									
Min				126	150	157					
Max				670	190	425					
Average				256	164	258					

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	383	176	172	207	275	164	213	157	190	155	153	
Elevation:	**Bottom**											
Average	160	262	363	317	299	323	145	318	357	262	183	

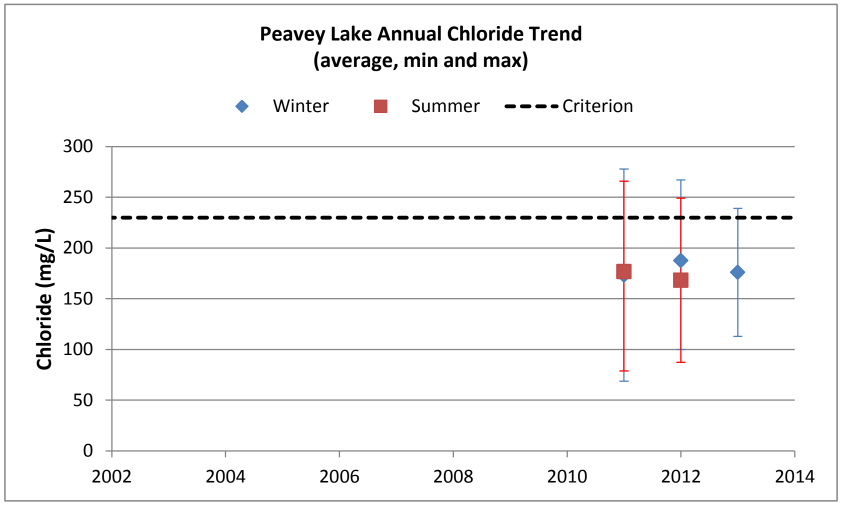


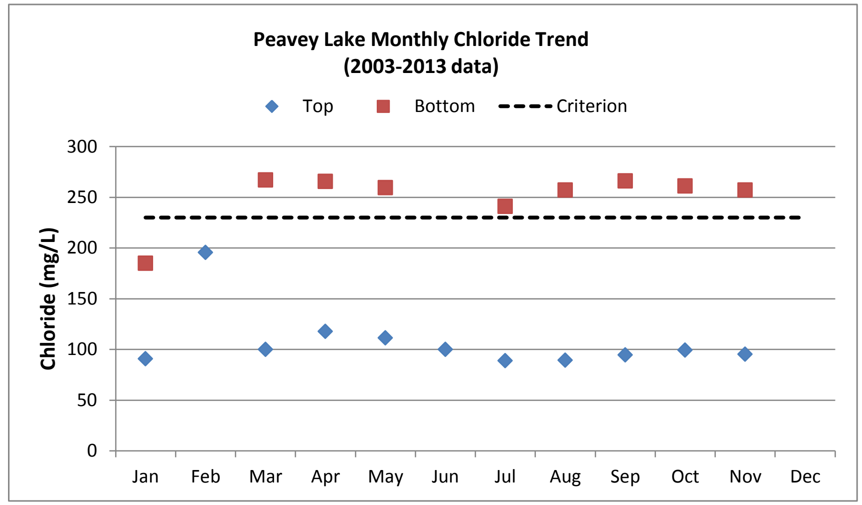

Parkers Lake
Drainage Area
Parkers Lake
Drainage Area Boundary
Source:
Bassett Creek Watershed Management Commission
0
1,000
2,000
ft
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Parkers Lake
tolsen 20150605 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\ParkersLake.mxd

Peavey Lake

WBID: 27-0138-00
Watershed: Minnehaha Creek Watershed District
Watershed Area (ac): 776
Impervious: 15%
TMDL (pounds of chloride/year): 202,304

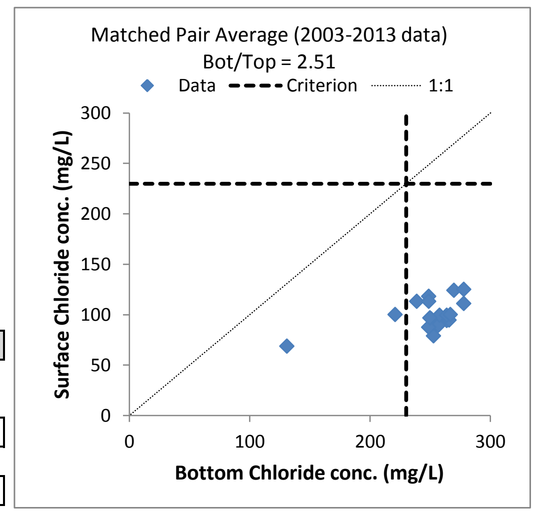
Number of Individual Days with Samples	20
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	17
Percent of Sample Days Exceeding Criterion	85%
Average of Exceeding Samples (mg/L)	259

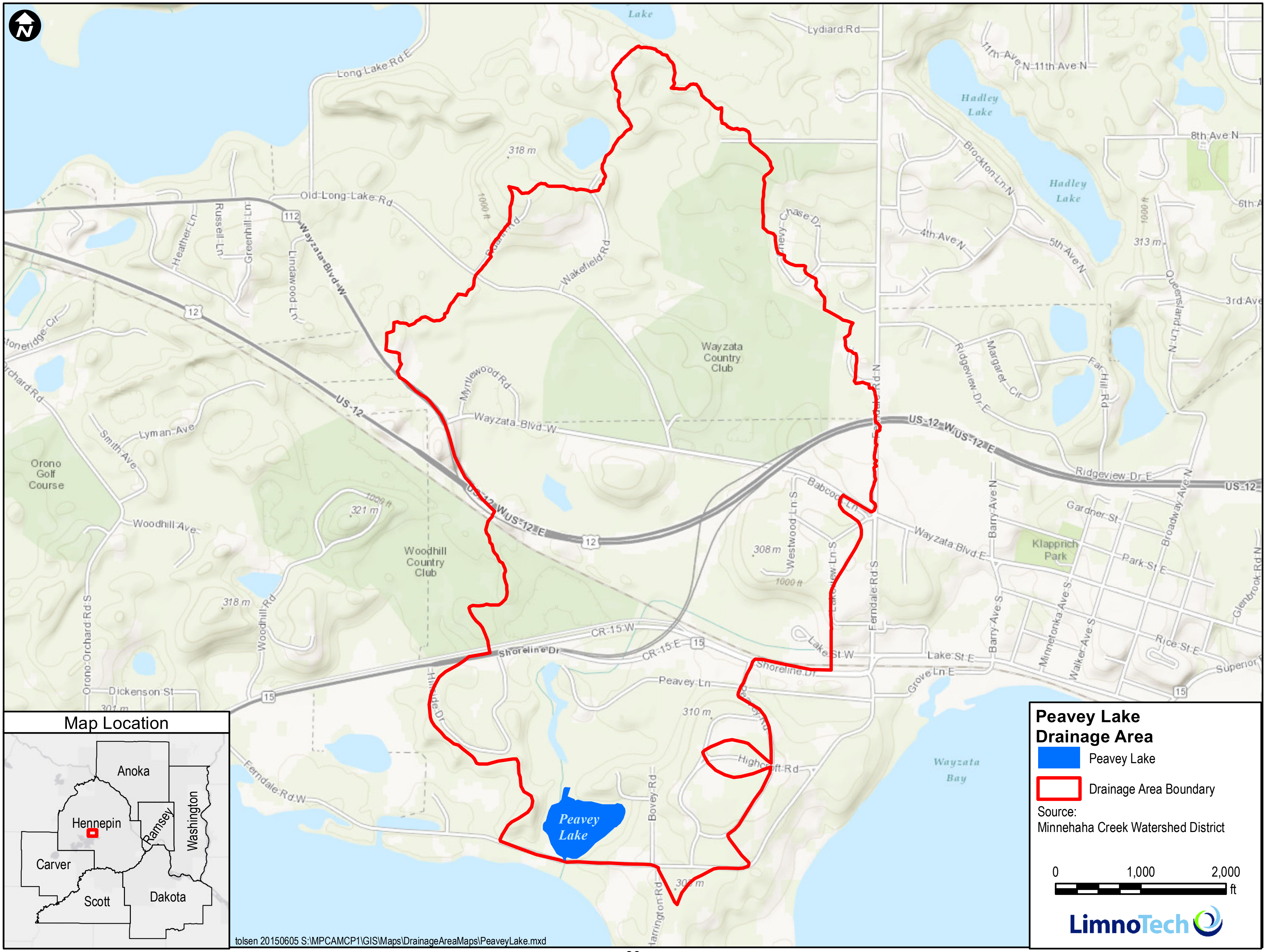




Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min									69	100	113
Max									278	267	239
Average									173	188	176
Season:	**Summer**	**(July-October)**									
Min									79	87	
Max									266	249	
Average									177	168	

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	91	196	100	118	111	100	89	89	94	99	95	
Elevation:	**Bottom**											
Average	185		267	266	259		241	257	266	261	257	

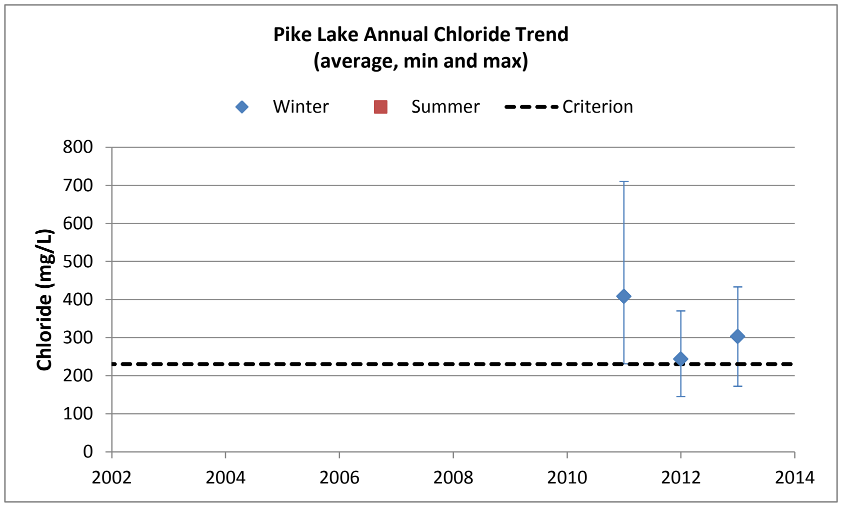


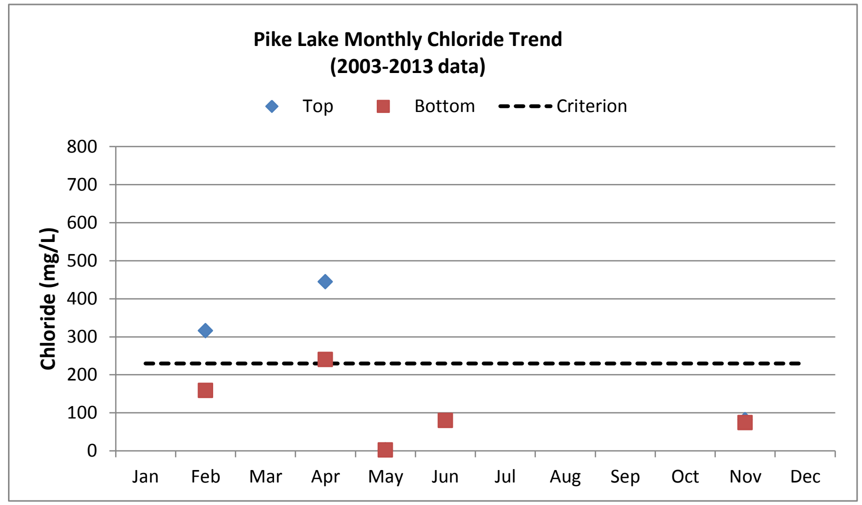

Peavey Lake Drainage Area
Peavey Lake
Drainage Area Boundary
Source:
Minnehaha Creek Watershed District
0
1,000
2,000
ft
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Peavey Lake
Wayzata Country Club
Woodhill Country Club
Orono Golf Course
Klapprich Park
Hadley Lake
Wayzata Bay
Lake
US-12
US-12 W
US-12 E
CR-15 W
CR-15 E
Shoreline Dr
Wayzata Blvd W
Wayzata Blvd E
Lake St W
Lake St E
Peavey Ln
Ferndale Rd W
Ferndale Rd S
Old Long Lake Rd
Long Lake Rd E
Lydiard Rd
Wakefield Rd
Myrtlewood Rd
Highcroft Rd
Bovey Rd
Woodhill Rd
Woodhill Ave
Lyman Ave
Smith Ave
Dickenson St
Orono Orchard Rd S
Babcock Ln
Westwood Ln S
Grove Ln E
Barry Ave N
Barry Ave S
Minnetonka Ave S
Walker Ave S
Broadway Ave N
Gardner St
Park St E
Rice St E
Superior
Glenbrook Rd N
Ridgeview Dr E
Margaret Cir
Far Hill Rd
Queensland Ln N
Brockton Ln N
4th Ave N
5th Ave N
3rd Ave
6th A
8th Ave N
11th Ave N
Chase Dr
Heather Ln
Russell Ln
Greenhill Ln
Lindawood Ln
Wayzata Blvd W
Stoneridge Cir
Orchard Rd
318 m
313 m
321 m
308 m
310 m
1000 ft
tolsen 20150605 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\PeaveyLake.mxd

Pike Lake

WBID: 62-0069-00
Watershed: Rice Creek Watershed District
Watershed Area (ac): 5,735
Impervious: 43%
TMDL (pounds of chloride/year): 3,590,209

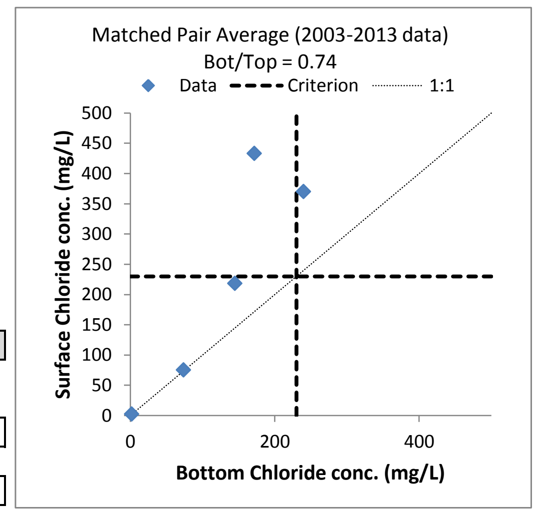
Number of Individual Days with Samples	9
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	4
Percent of Sample Days Exceeding Criterion	44%
Average of Exceeding Samples (mg/L)	469

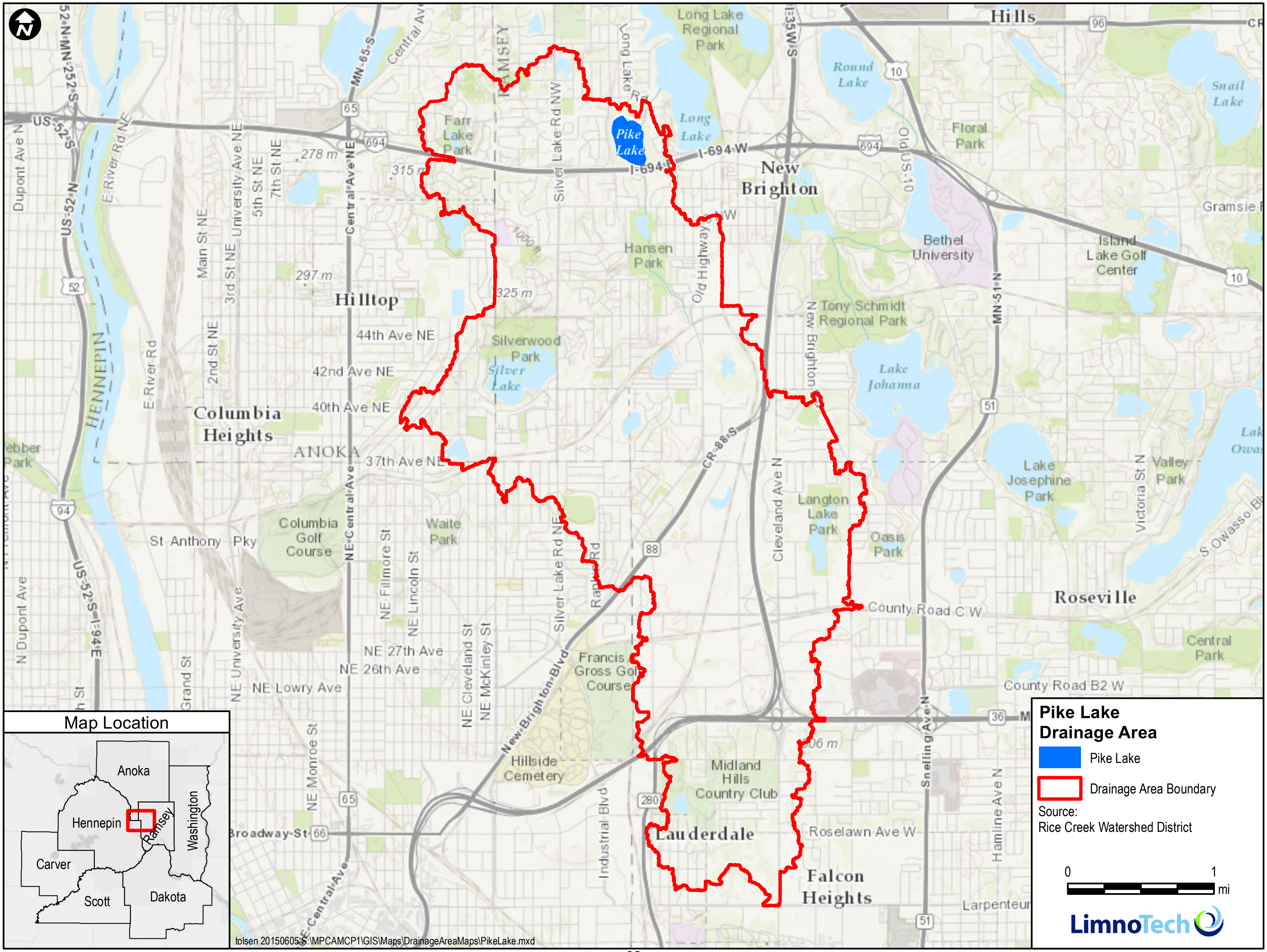




Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min									231	145	172
Max									710	370	433
Average									408	243	303
Season:	**Summer**	**(July-October)**									
Min											
Max											
Average											

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average		316		445	2						81	
Elevation:	**Bottom**											
Average		159		240	2	80					74	

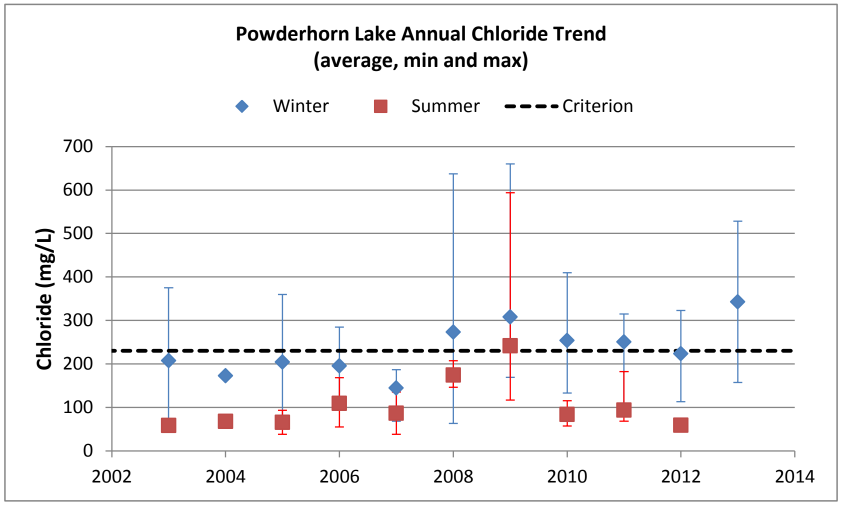


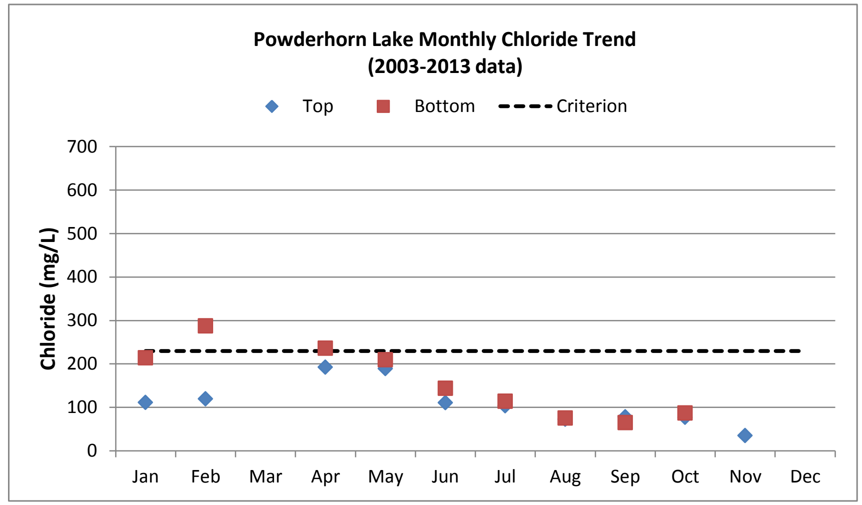

Pike Lake
Drainage Area
Pike Lake
Drainage Area Boundary
Source:
Rice Creek Watershed District
0
1
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Pike Lake
Long Lake
Long Lake Regional Park
Round Lake
Snail Lake
Farr Lake Park
New Brighton
Hills
Floral Park
Bethel University
Island Lake Golf Center
Hansen Park
Hilltop
Tony Schmidt Regional Park
Silverwood Park
Silver Lake
Lake Johanna
Columbia Heights
ANOKA
Lake Josephine Park
Valley Park
Langton Lake Park
Oasis Park
Columbia Golf Course
Waite Park
Roseville
Francis Gross Golf Course
Central Park
Hillside Cemetery
Midland Hills Country Club
Lauderdale
Falcon Heights
HENNEPIN
RAMSEY
I-694 W
County Road C W
County Road B2 W
Roselawn Ave W
St Anthony Pky
NE Lowry Ave
Broadway St
44th Ave NE
42nd Ave NE
40th Ave NE
37th Ave NE
NE 27th Ave
NE 26th Ave
tolsen 20150605 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\PikeLake.mxd

Powderhorn Lake

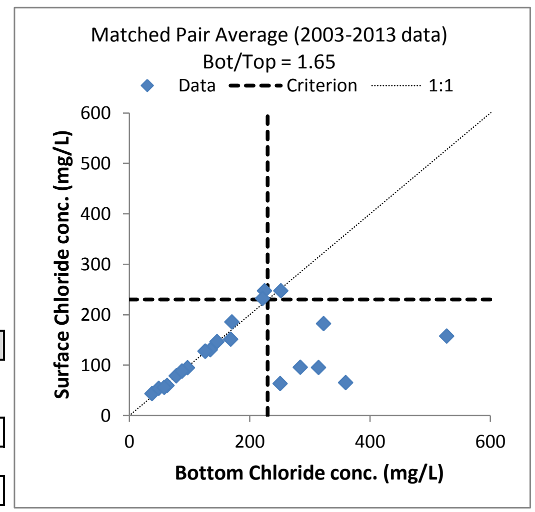
WBID:	27-0014-00
Watershed:	Minnehaha Creek Watershed District
Watershed Area (ac):	332
Impervious:	45%
TMDL (pounds of chloride/year):	218,587

Number of Individual Days with Samples	67
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	18
Percent of Sample Days Exceeding Criterion	27%
Average of Exceeding Samples (mg/L)	366

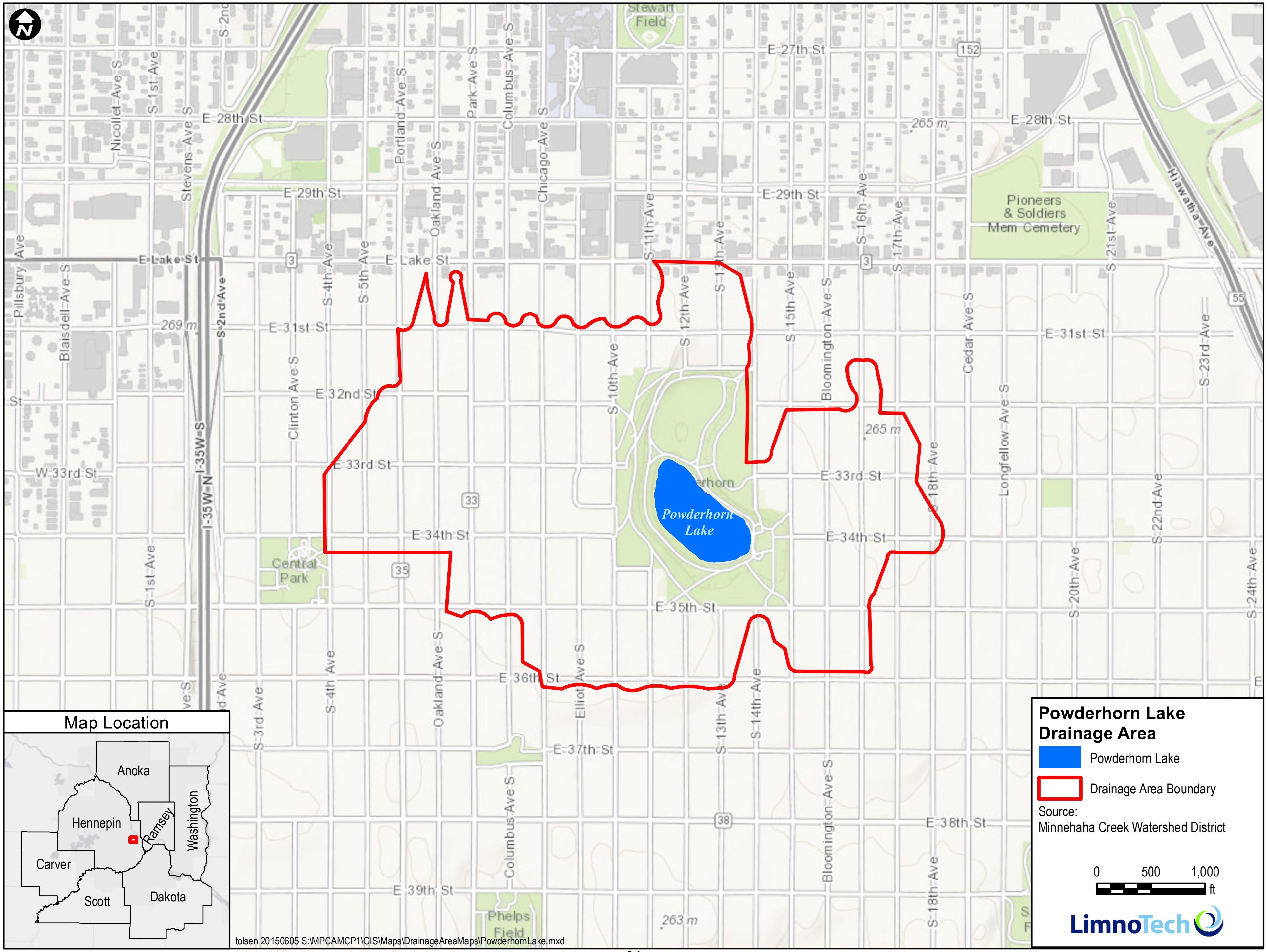




Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min	60	170	65	95	68	63	169	133	95	113	157
Max	375	175	360	285	187	637	660	410	315	323	528
Average	208	173	204	195	144	273	308	254	250	224	343
Season:	**Summer**	**(July-October)**									
Min	54	68	38	55	38	146	117	57	68	45	
Max	63	68	93	168	135	207	594	115	182	75	
Average	58	68	66	109	86	174	241	84	94	59	

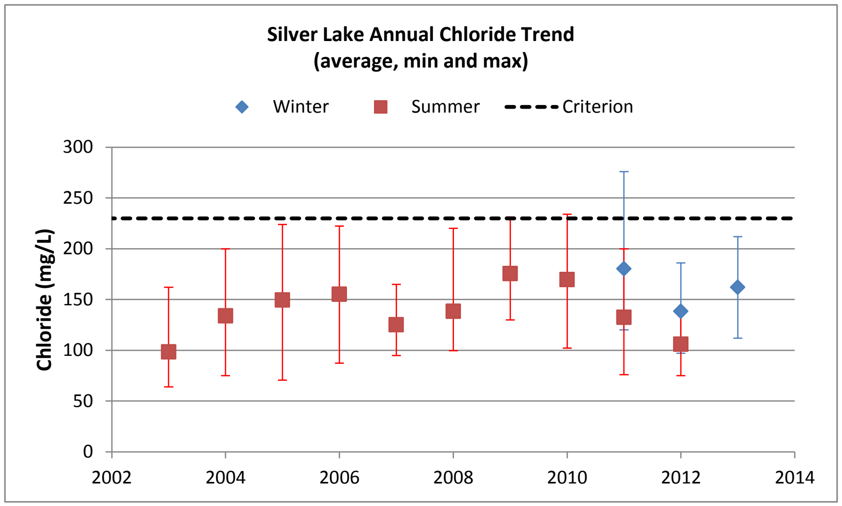


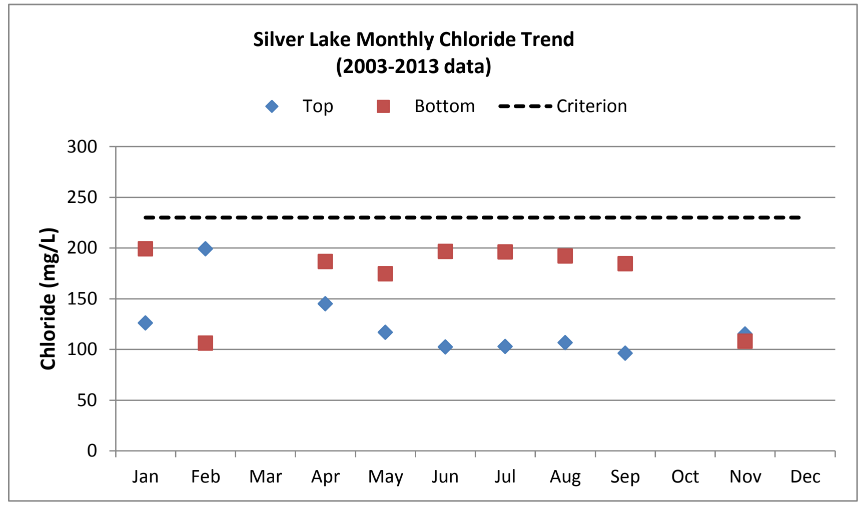
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	111	120		193	189	111	103	73	78	77	35	
Elevation:	**Bottom**											
Average	214	288		236	209	144	114	75	65	87		


Powderhorn Lake Drainage Area
Powderhorn Lake
Drainage Area Boundary
Source:
Minnehaha Creek Watershed District
0 500 1,000
ft
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Powderhorn Lake
Pioneers & Soldiers Mem Cemetery
Central Park
Phelps Field
Stewart Field
E Lake St
E 27th St
E 28th St
E 29th St
E 31st St
E 32nd St
E 33rd St
E 34th St
E 35th St
E 36th St
E 37th St
E 38th St
E 39th St
W 33rd St
I-35W N
I-35W S
Hiawatha Ave
Bloomington Ave S
Cedar Ave S
Chicago Ave S
Columbus Ave S
Portland Ave S
Park Ave S
Oakland Ave S
Clinton Ave S
Elliot Ave S
Longfellow Ave S
Nicollet Ave S
Stevens Ave S
Blaisdell Ave S
Pillsbury Ave
S 1st Ave
S 2nd Ave
S 3rd Ave
S 4th Ave
S 5th Ave
S 10th Ave
S 11th Ave
S 12th Ave
S 13th Ave
S 14th Ave
S 15th Ave
S 16th Ave
S 17th Ave
S 18th Ave
S 20th Ave
S 21st Ave
S 22nd Ave
S 23rd Ave
S 24th Ave
265 m
269 m
263 m
tolsen 20150605 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\PowderhornLake.mxd

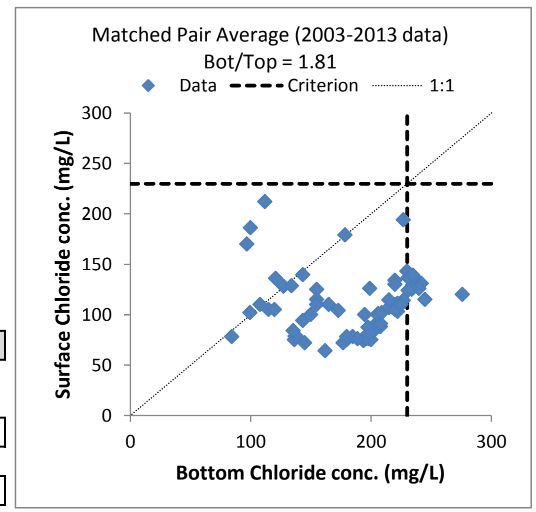
Silver Lake

WBID:	62-0083-00	**Number of Individual Days with Samples**	78
Watershed:	Rice Creek Watershed District	**Number of Days with Samples Exceeding 230 mg/L Chronic Criterion**	11
Watershed Area (ac):	655	**Percent of Sample Days Exceeding Criterion**	14%
Impervious:	38%	**Average of Exceeding Samples (mg/L)**	241
TMDL (pounds of chloride/year):	370,011		

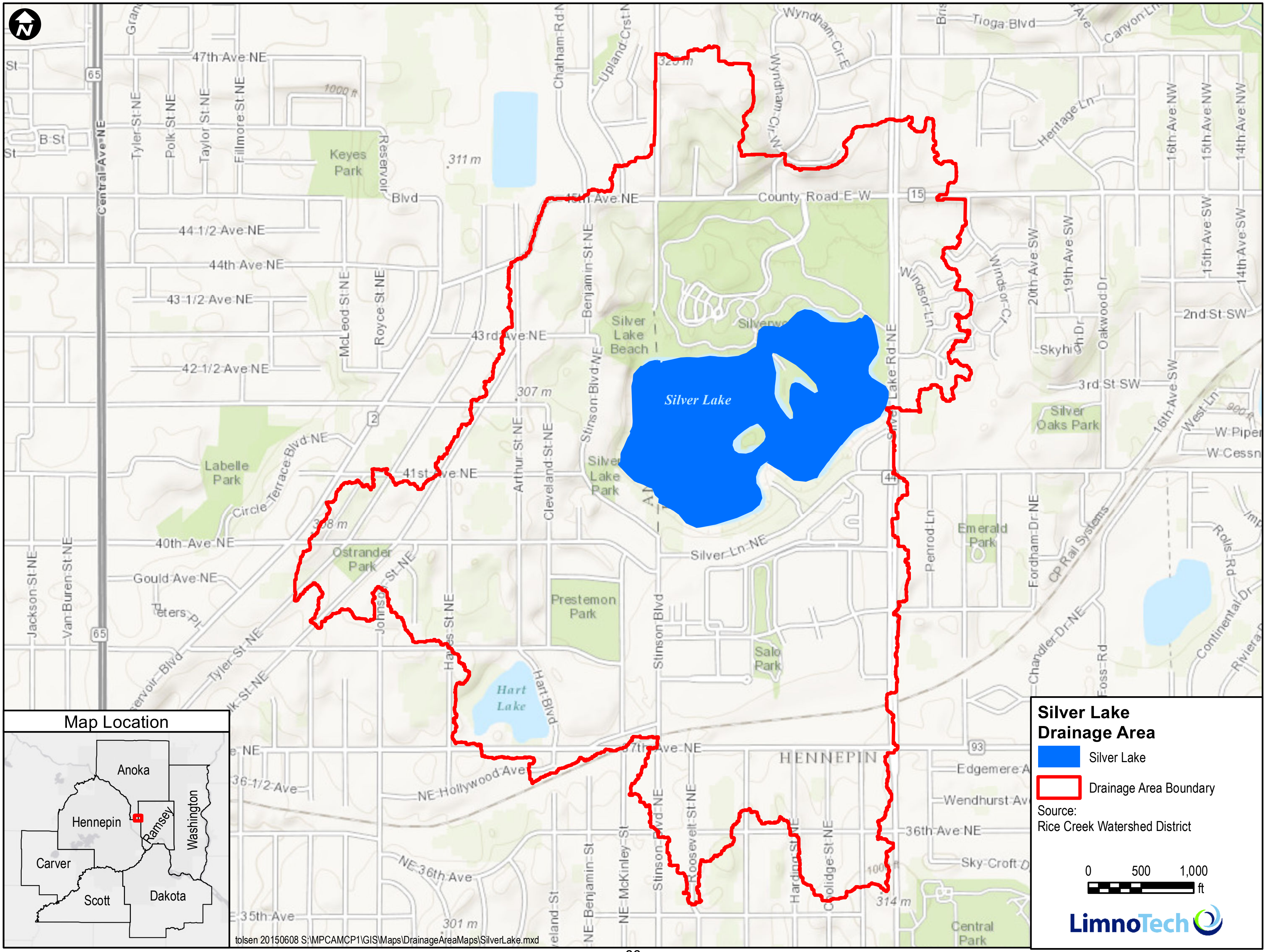




Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min									120	97	112
Max									276	186	212
Average									180	138	162
Season:	**Summer**	**(July-October)**									
Min	64	75	71	87	95	100	130	102	76	75	
Max	162	200	224	222	165	220	231	234	200	138	
Average	98	134	149	155	125	138	175	169	132	106	



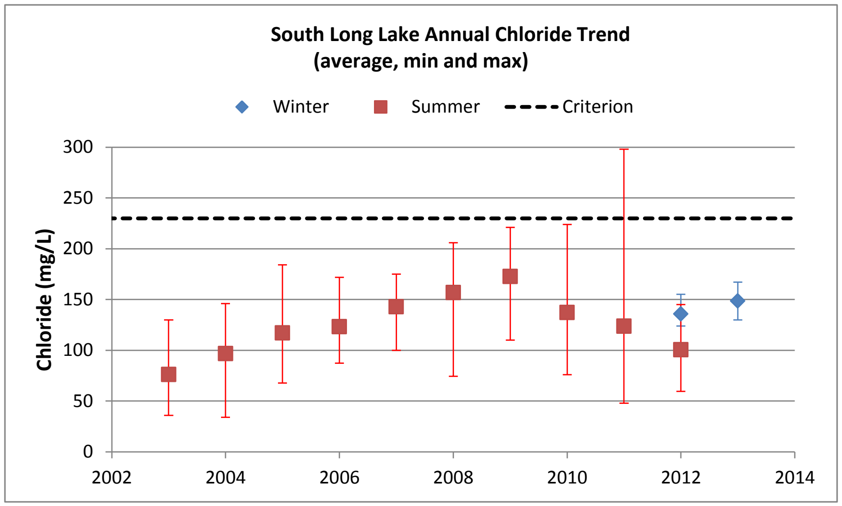
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	126	199		145	117	102	103	107	96		115	
Elevation:	**Bottom**											
Average	199	106		187	174	197	196	192	184		108	

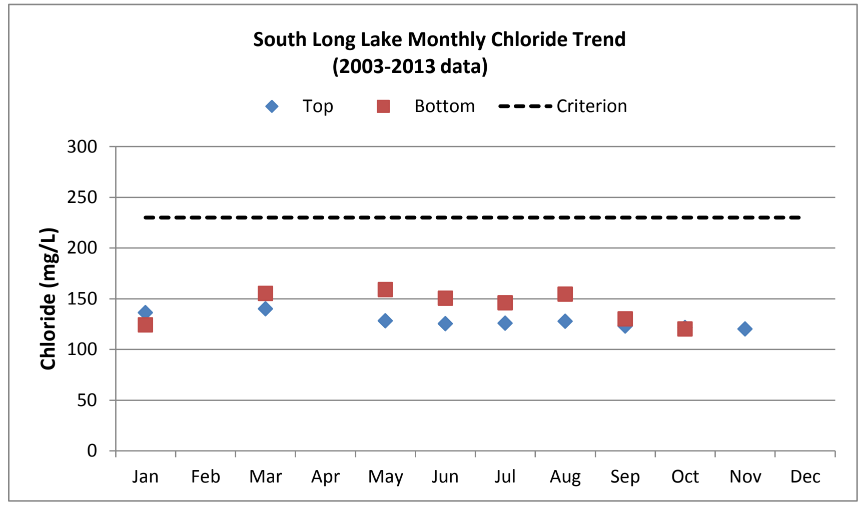

Silver Lake Drainage Area
Silver Lake
Drainage Area Boundary
Source:
Rice Creek Watershed District
0 500 1,000
ft
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Silver Lake
Hart Lake
LimnoTech
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\SilverLake.mxd

Long Lake

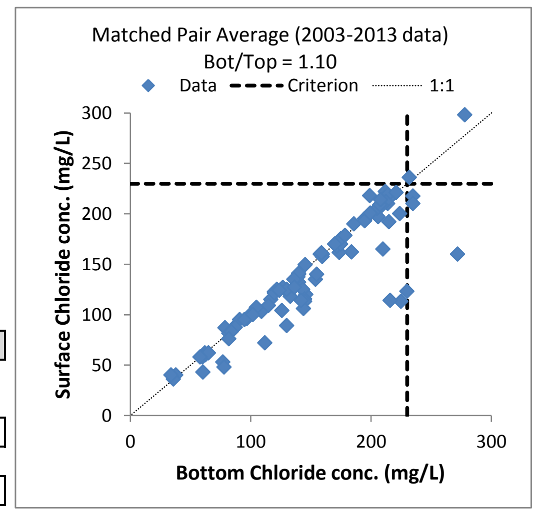
WBID: 62-0067-02
Watershed: Rice Creek Watershed District
Watershed Area (ac): 114,785
Impervious: 12%
TMDL (pounds of chloride/year): 26,330,595

Number of Individual Days with Samples	149
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	5
Percent of Sample Days Exceeding Criterion	3%
Average of Exceeding Samples (mg/L)	256

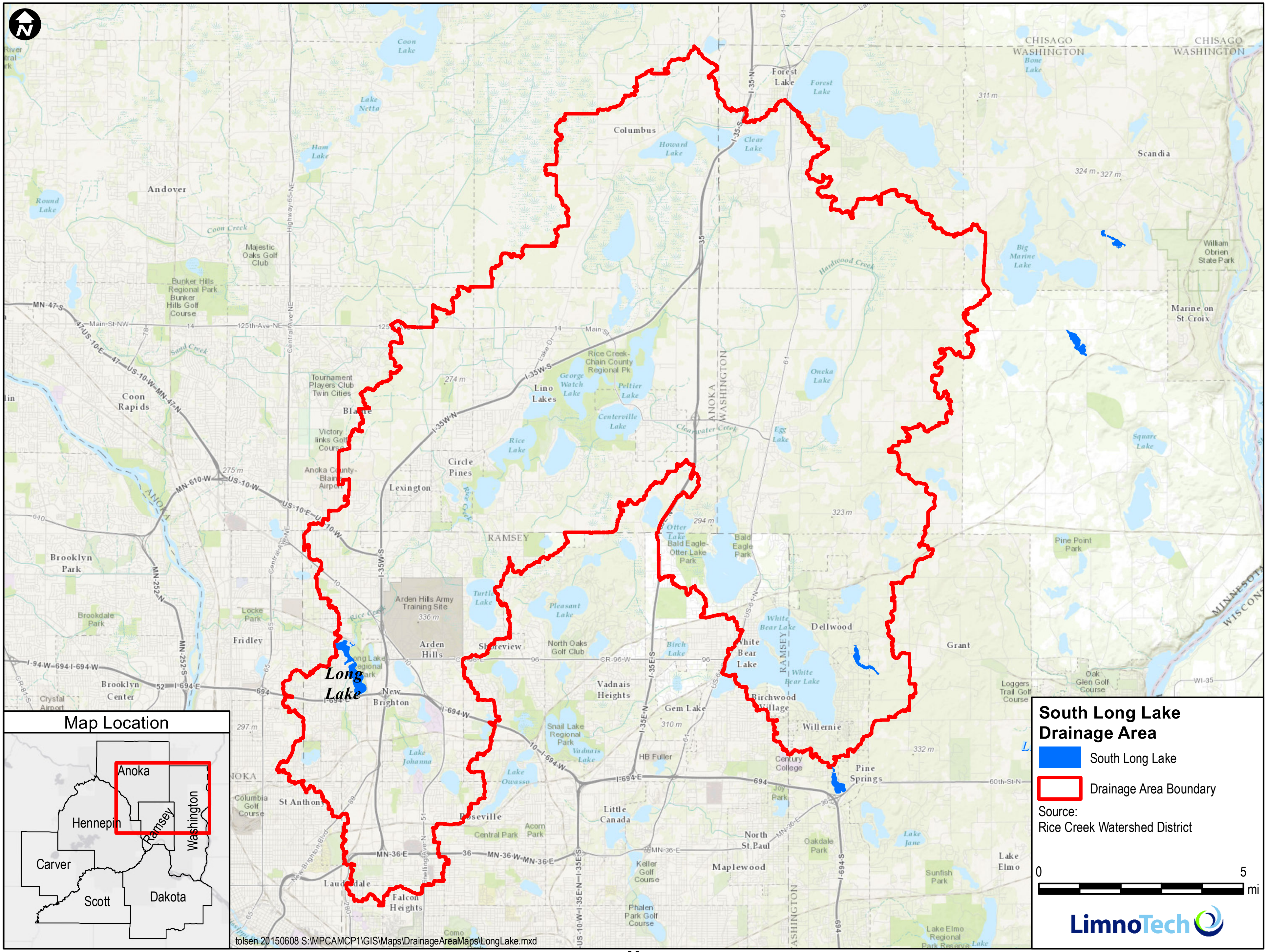




Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min										124	130
Max										155	167
Average										136	149
Season:	**Summer**	**(July-October)**									
Min	36	34	68	87	100	75	110	76	48	60	
Max	130	146	184	172	175	206	221	224	298	145	
Average	76	97	117	123	143	157	173	137	124	100	

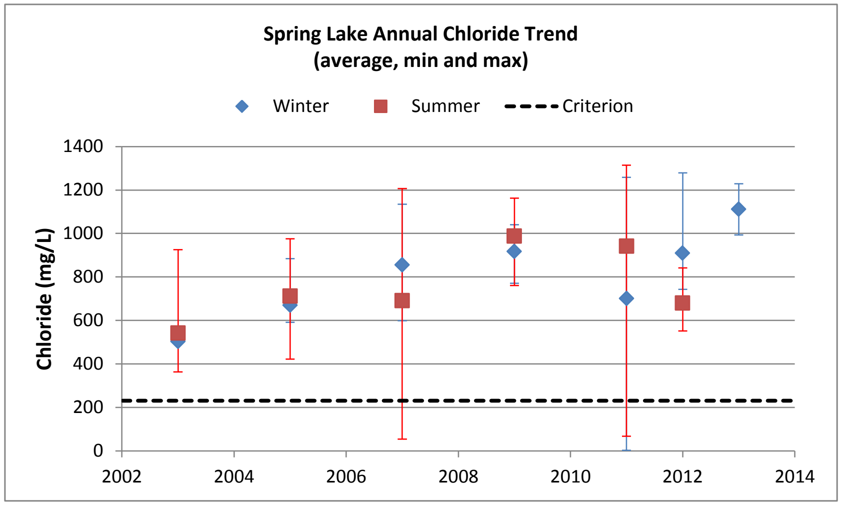


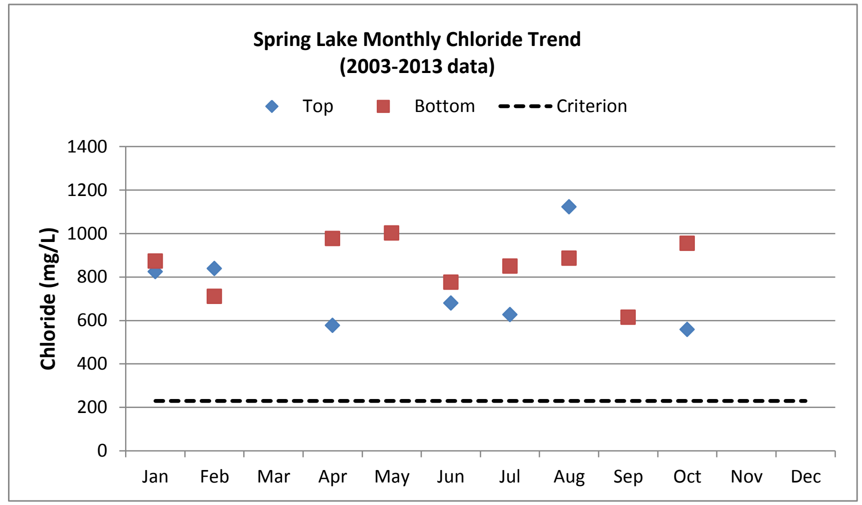
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	136		140		128	125	126	128	123	122	120	
Elevation:	**Bottom**											
Average	124		155		159	150	146	154	130	120		


South Long Lake Drainage Area
South Long Lake
Drainage Area Boundary
Source:
Rice Creek Watershed District
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Long Lake
LimnoTech
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\LongLake.mxd

Spring Lake

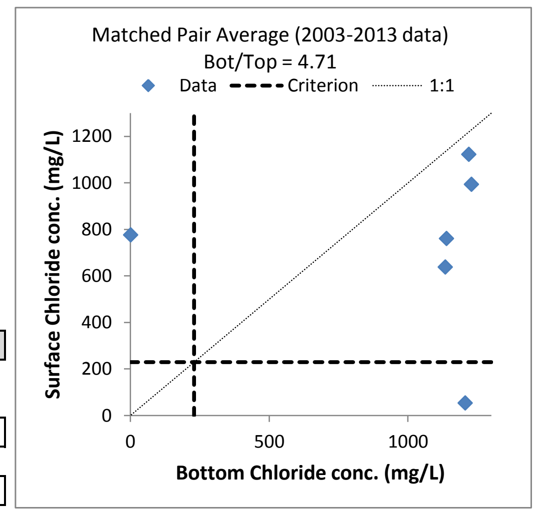
WBID:	27-0654-00		**Number of Individual Days with Samples**	32
Watershed:	City of Minneapolis		**Number of Days with Samples Exceeding 230 mg/L Chronic Criterion**	32
Watershed Area (ac):	39		**Percent of Sample Days Exceeding Criterion**	100%
Impervious:	25%		**Average of Exceeding Samples (mg/L)**	964
TMDL (pounds of chloride/year):	15,600			

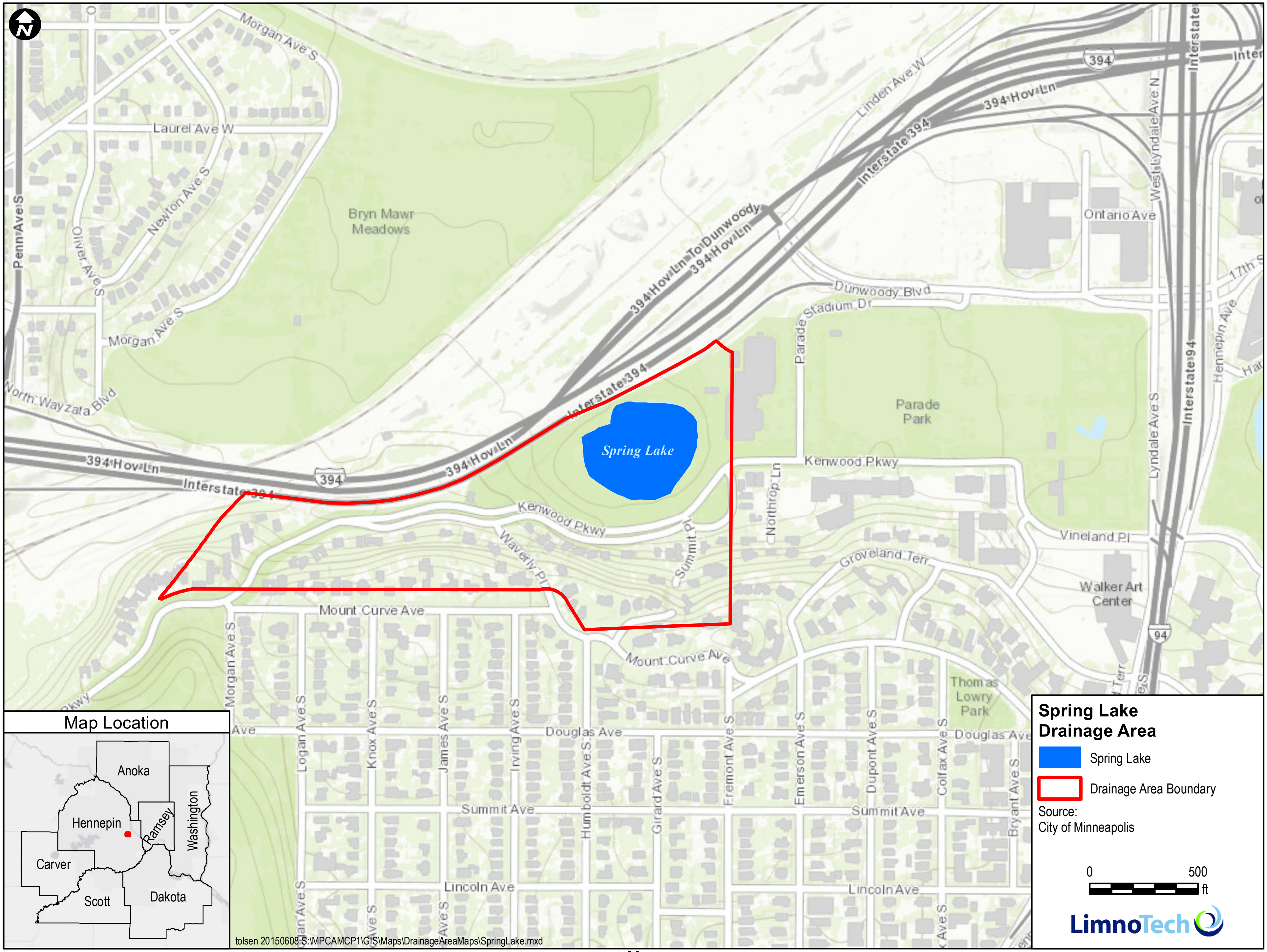




Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min	503		592		599		771		2	743	993
Max	503		885		1135		1040		1259	1279	1229
Average	503		670		855		917		701	910	1111
Season:	**Summer**	**(July-October)**									
Min	363		422		53		760		67	552	
Max	925		976		1207		1163		1314	842	
Average	541		712		691		987		941	679	

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	825	839		577		680	626	1122		558		
Elevation:	**Bottom**											
Average	873	711		977	1002	776	850	886	615	955		

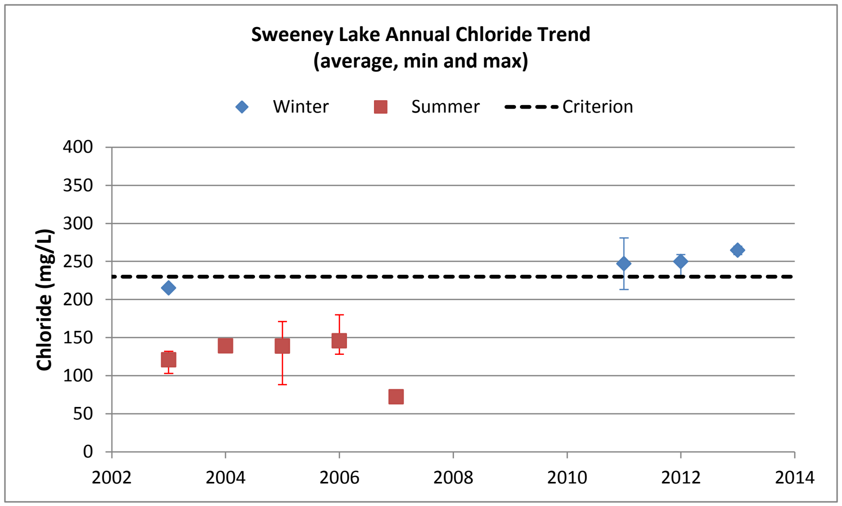


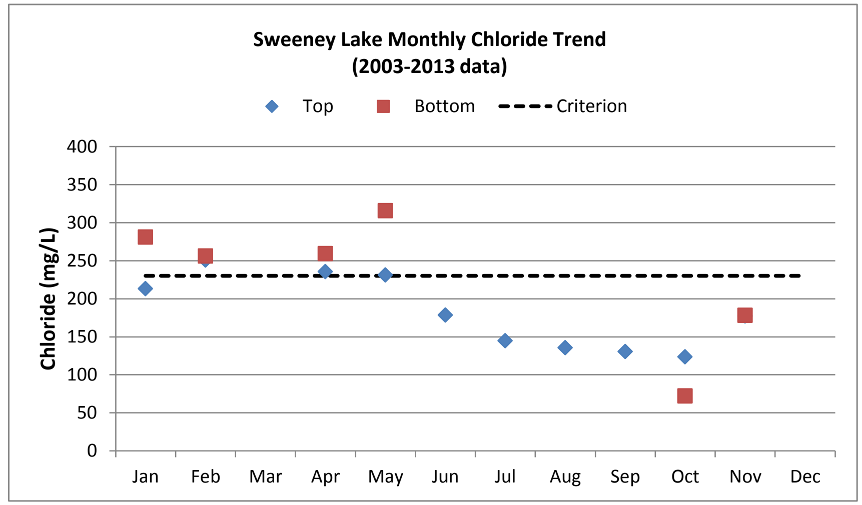

Spring Lake
Drainage Area
Spring Lake
Drainage Area Boundary
Source:
City of Minneapolis
0
500
ft
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Bryn Mawr Meadows
Parade Park
Walker Art Center
Thomas Lowry Park
Spring Lake
Interstate 394
394 Hov Ln
Kenwood Pkwy
Mount Curve Ave
Douglas Ave
Summit Ave
Lincoln Ave
Dunwoody Blvd
Penn Ave S
Morgan Ave S
Laurel Ave W
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\SpringLake.mxd

Sweeney Lake

WBID:	27-0035-01
Watershed:	Bassett Creek Watershed Management Commission 20131017
Watershed Area (ac):	2,439
Impervious:	41%
TMDL (pounds of chloride/year):	1,456,271

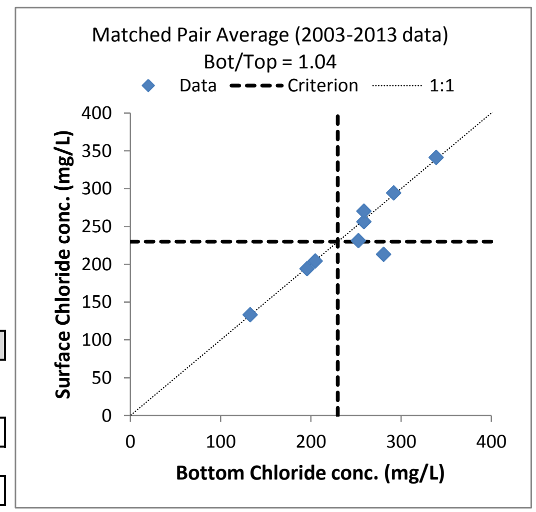
Number of Individual Days with Samples	44
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	6
Percent of Sample Days Exceeding Criterion	14%
Average of Exceeding Samples (mg/L)	283

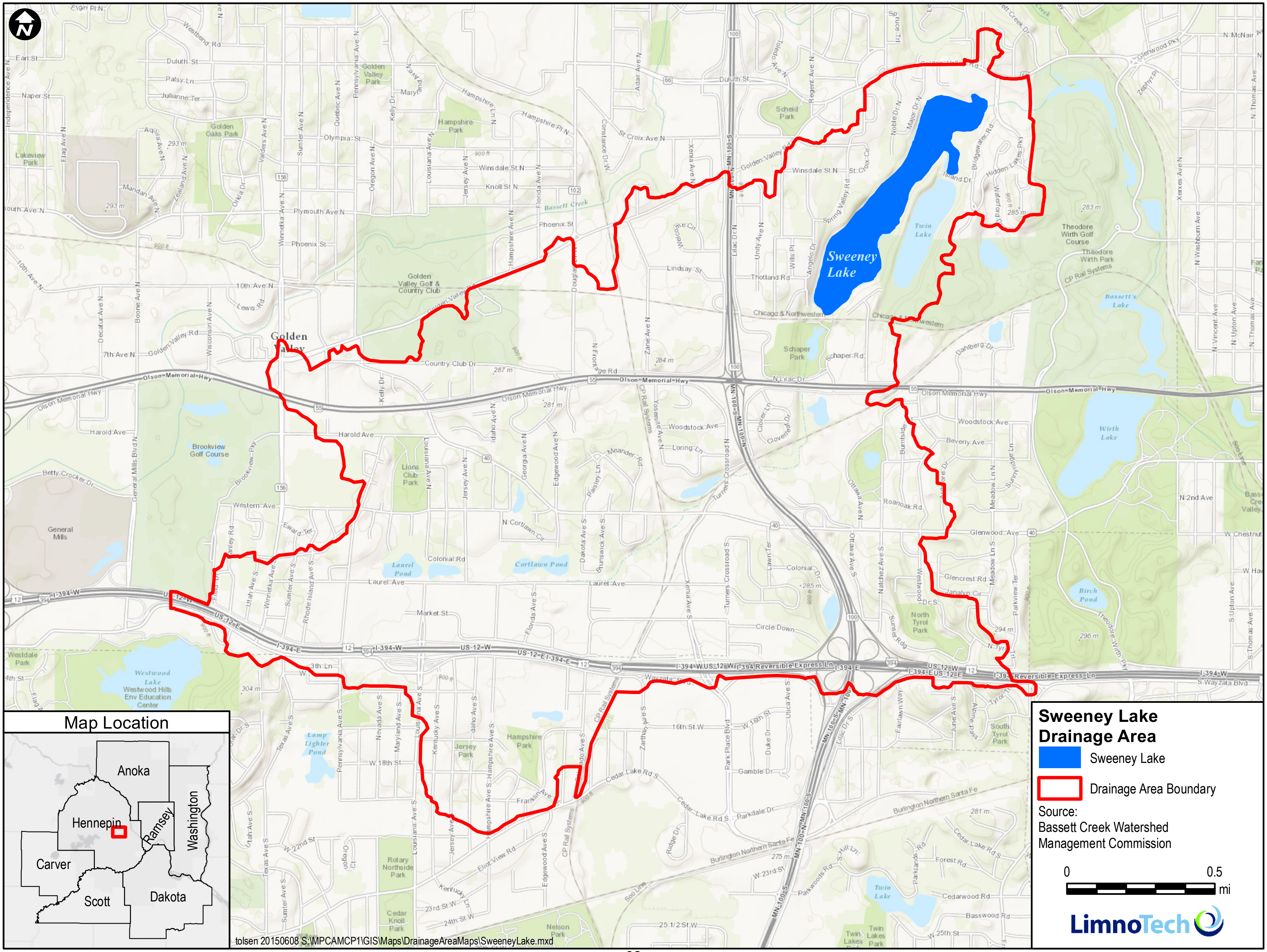




Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min	215								213	231	259
Max	215								281	259	270
Average	215								247	250	265
Season:	**Summer**	**(July-October)**									
Min	103	134	88	128	72						
Max	132	144	171	180	72						
Average	121	139	139	145	72						

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	213	251		236	231	178	145	136	130	124	177	
Elevation:	**Bottom**											
Average	281	256		259	316					72	178	



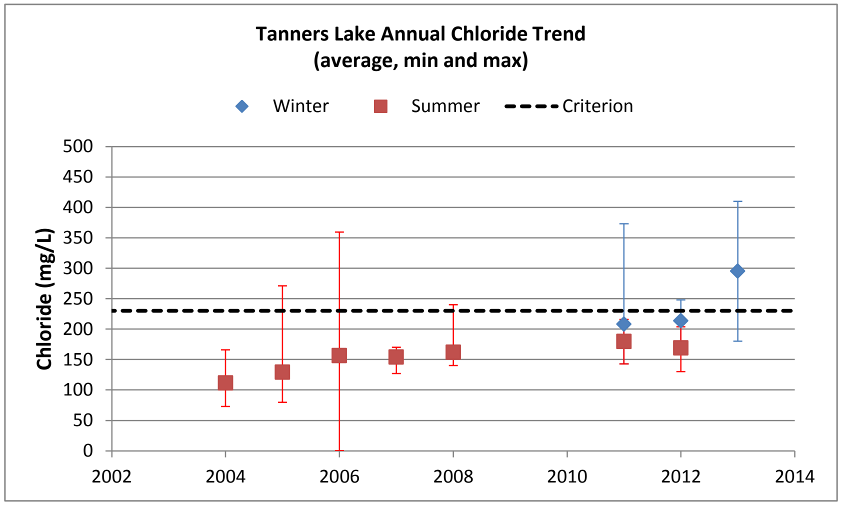


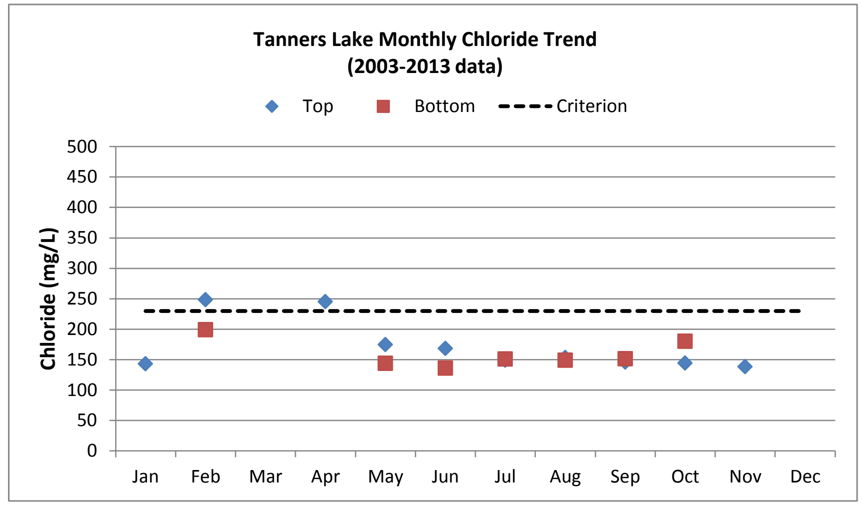
Sweeney Lake Drainage Area
Sweeney Lake
Drainage Area Boundary
Source:
Bassett Creek Watershed Management Commission
0
0.5
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Sweeney Lake
Golden Valley
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\SweeneyLake.mxd

Tanners Lake

WBID:	82-0115-00
Watershed:	Ramsey Washington Metro Watershed District
Watershed Area (ac):	1,732
Impervious:	31%
TMDL (pounds of chloride/year):	826,520

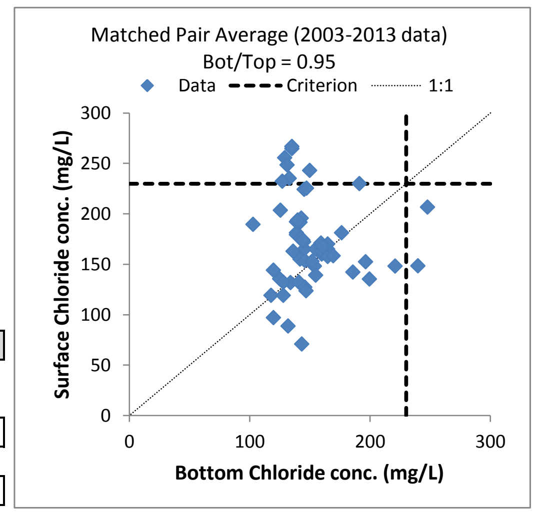
Number of Individual Days with Samples	128
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	29
Percent of Sample Days Exceeding Criterion	23%
Average of Exceeding Samples (mg/L)	308

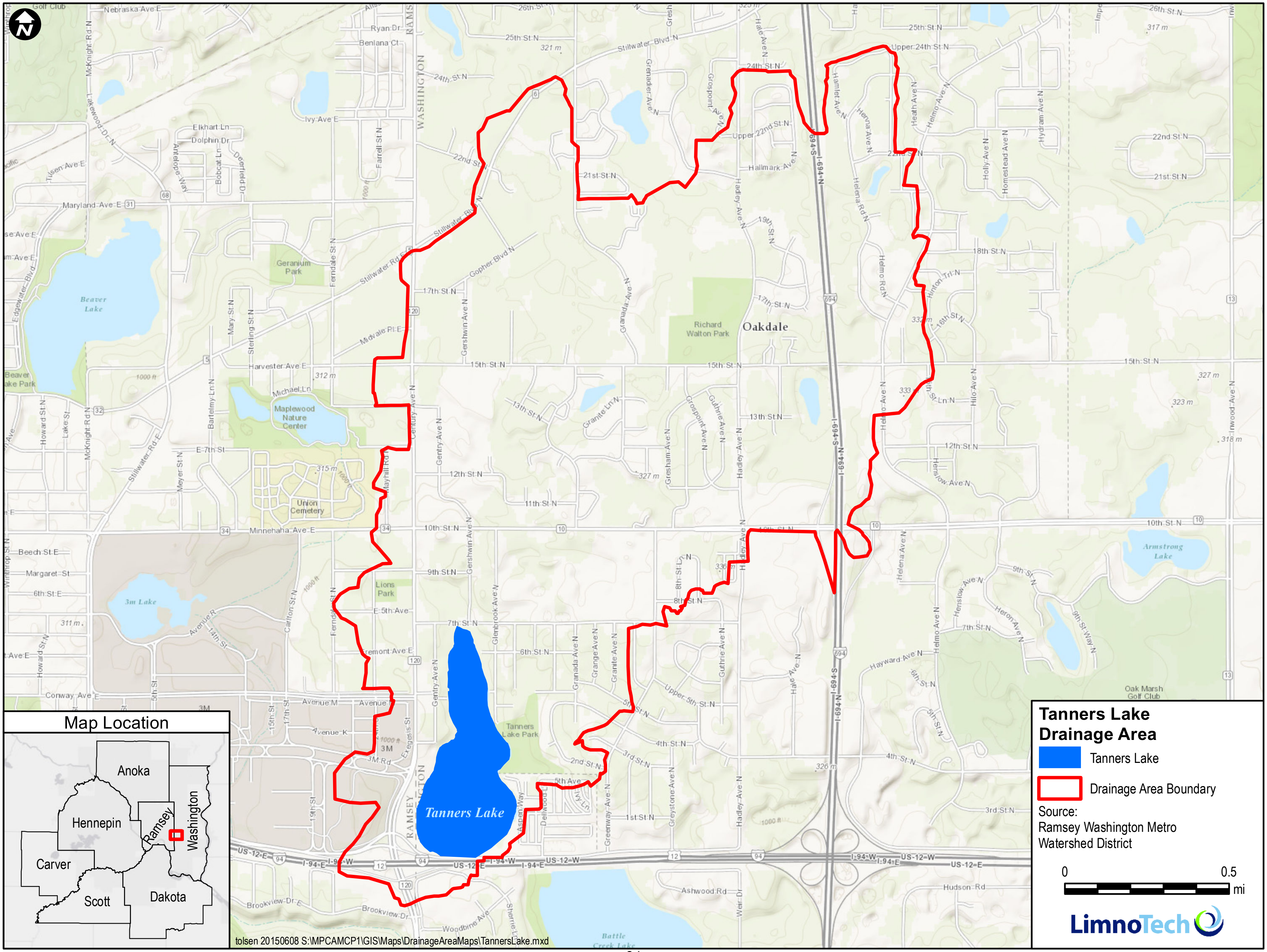




Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min									143	165	180
Max									373	248	410
Average									208	213	295
Season:	**Summer**	**(July-October)**									
Min		73	80	0	127	140			143	130	
Max		166	271	360	170	240			216	204	
Average		111	129	156	154	162			180	169	

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	143	248		245	175	168	149	153	146	144	138	
Elevation:	**Bottom**											
Average		199			144	136	151	149	151	180		



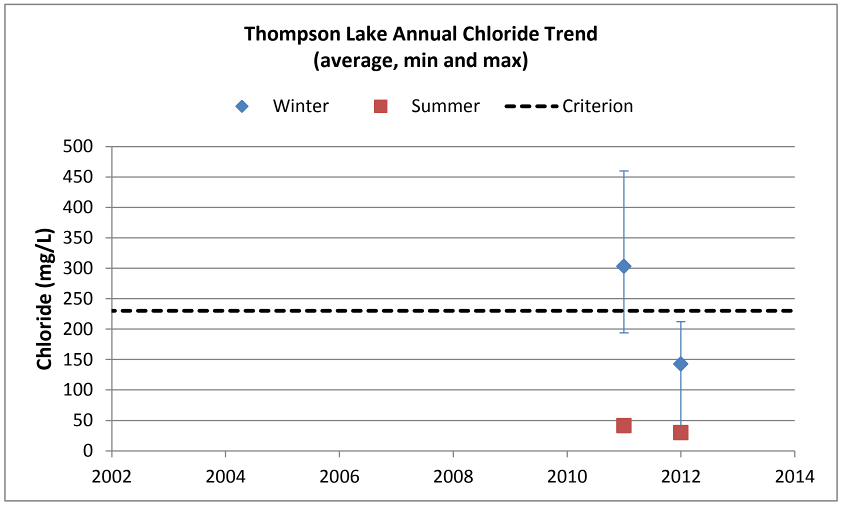


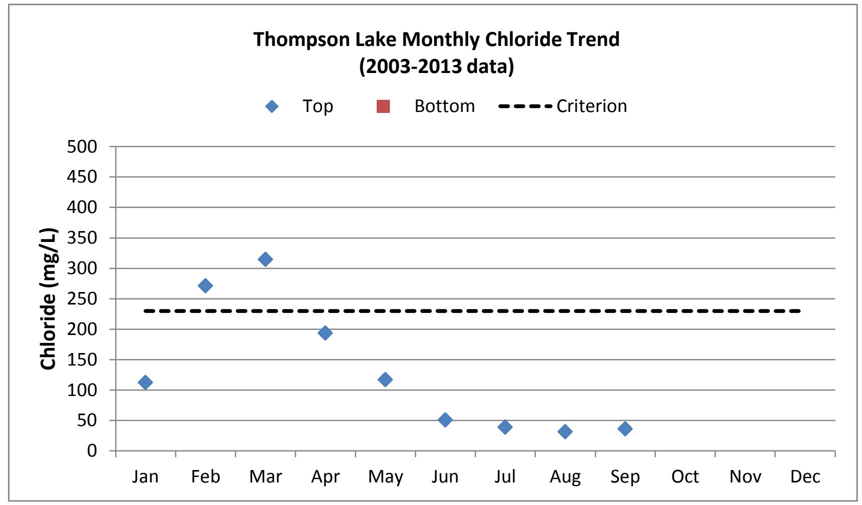
Tanners Lake
Drainage Area
Tanners Lake
Drainage Area Boundary
Source:
Ramsey Washington Metro
Watershed District
0
0.5
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Tanners Lake
Oakdale
Beaver Lake
Armstrong Lake
Battle Creek Lake
3m Lake
Richard Walton Park
Maplewood Nature Center
Union Cemetery
Geranium Park
Lions Park
Tanners Lake Park
Oak Marsh Golf Club
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\TannersLake.mxd

Thompson Lake

WBID: 19-0048-00
Watershed: Dakota County
Watershed Area (ac): 178
Impervious: 53%
TMDL (pounds of chloride/year): 134,340

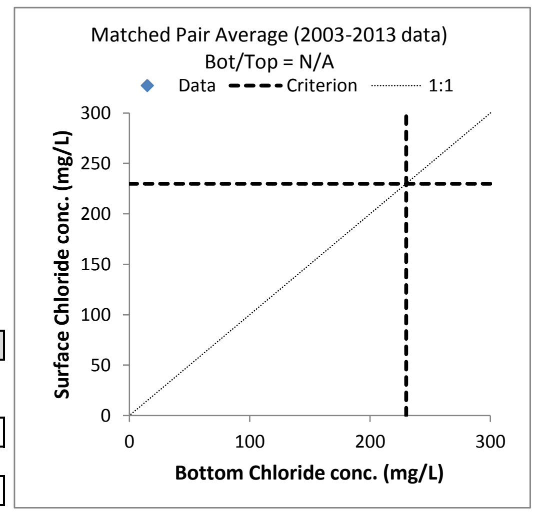
Number of Individual Days with Samples	18
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	2
Percent of Sample Days Exceeding Criterion	11%
Average of Exceeding Samples (mg/L)	395

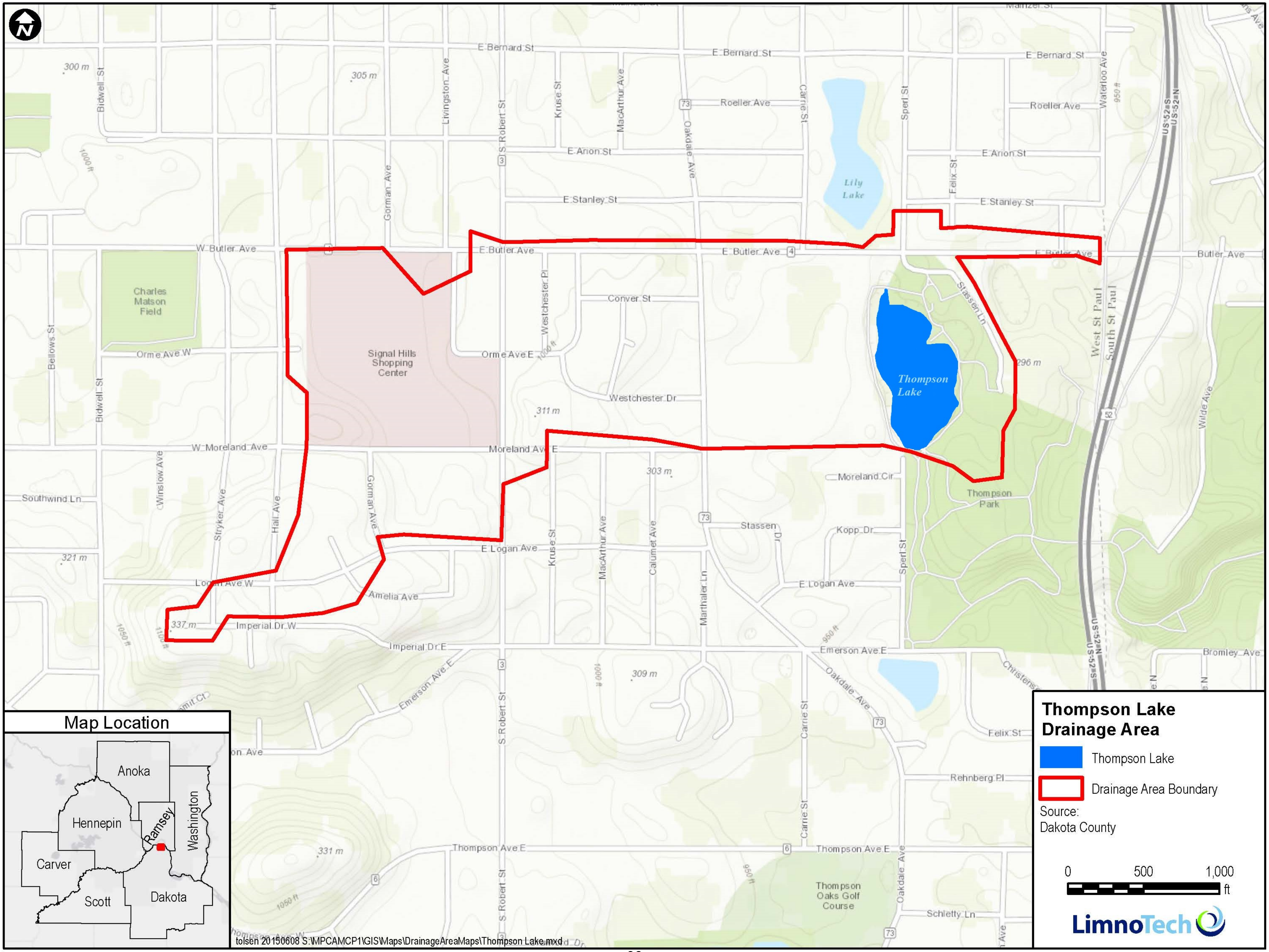




Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min									194	30	
Max									460	212	
Average									303	143	
Season:	**Summer**	**(July-October)**									
Min									33	25	
Max									53	34	
Average									41	30	

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	112	271	315	194	117	51	39	32	36			
Elevation:	**Bottom**											
Average												

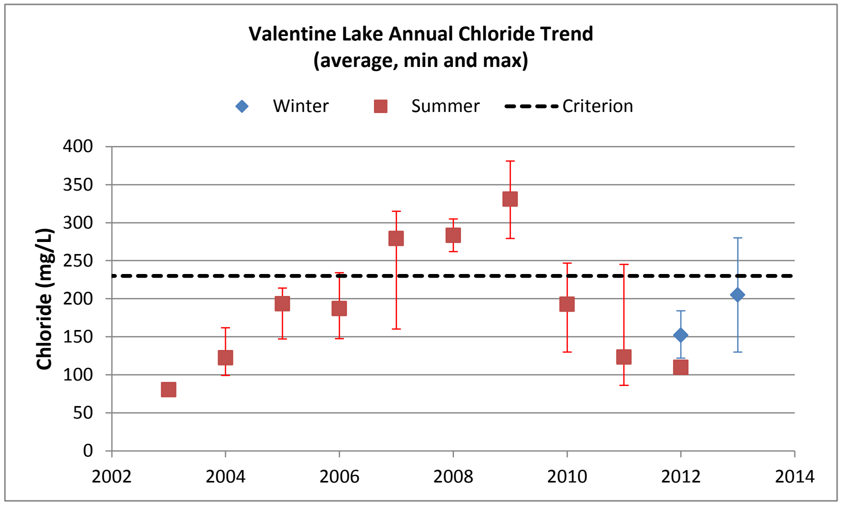


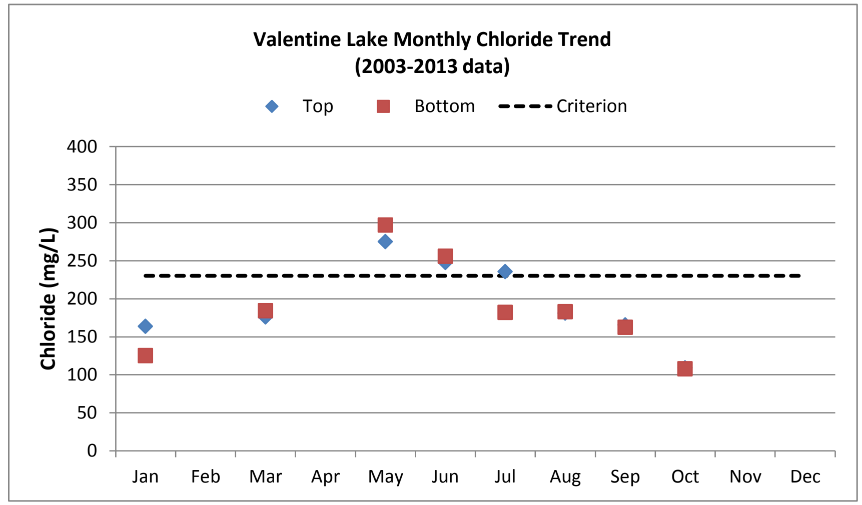

Thompson Lake Drainage Area
Thompson Lake
Drainage Area Boundary
Source:
Dakota County
0 500 1,000
ft
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Thompson Lake
Lily Lake
Signal Hills Shopping Center
Charles Matson Field
Thompson Park
Thompson Oaks Golf Course
E Butler Ave
W Butler Ave
Moreland Ave E
W Moreland Ave
E Logan Ave
E Bernard St
E Arion St
E Stanley St
Roeller Ave
Conver St
Westchester Dr
Stassen Ln
Emerson Ave E
Imperial Dr E
Imperial Dr W
Amelia Ave
S Robert St
Oakdale Ave
Thompson Ave E
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\Thompson Lake.mxd

Valentine Lake

WBID:	62-0071-00
Watershed:	Rice Creek Watershed District
Watershed Area (ac):	2,404
Impervious:	32%
TMDL (pounds of chloride/year):	1,165,072

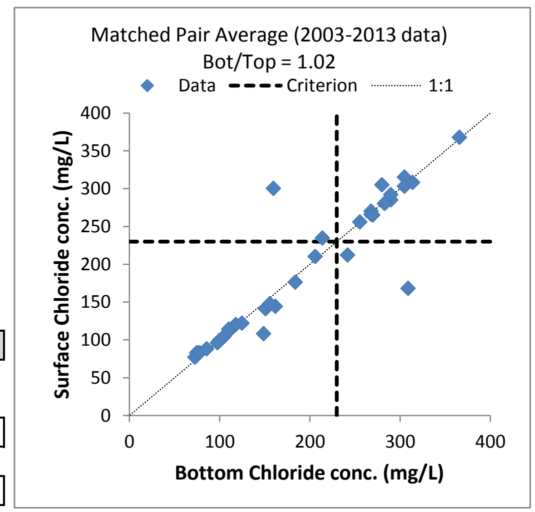
Number of Individual Days with Samples	76
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	38
Percent of Sample Days Exceeding Criterion	50%
Average of Exceeding Samples (mg/L)	301

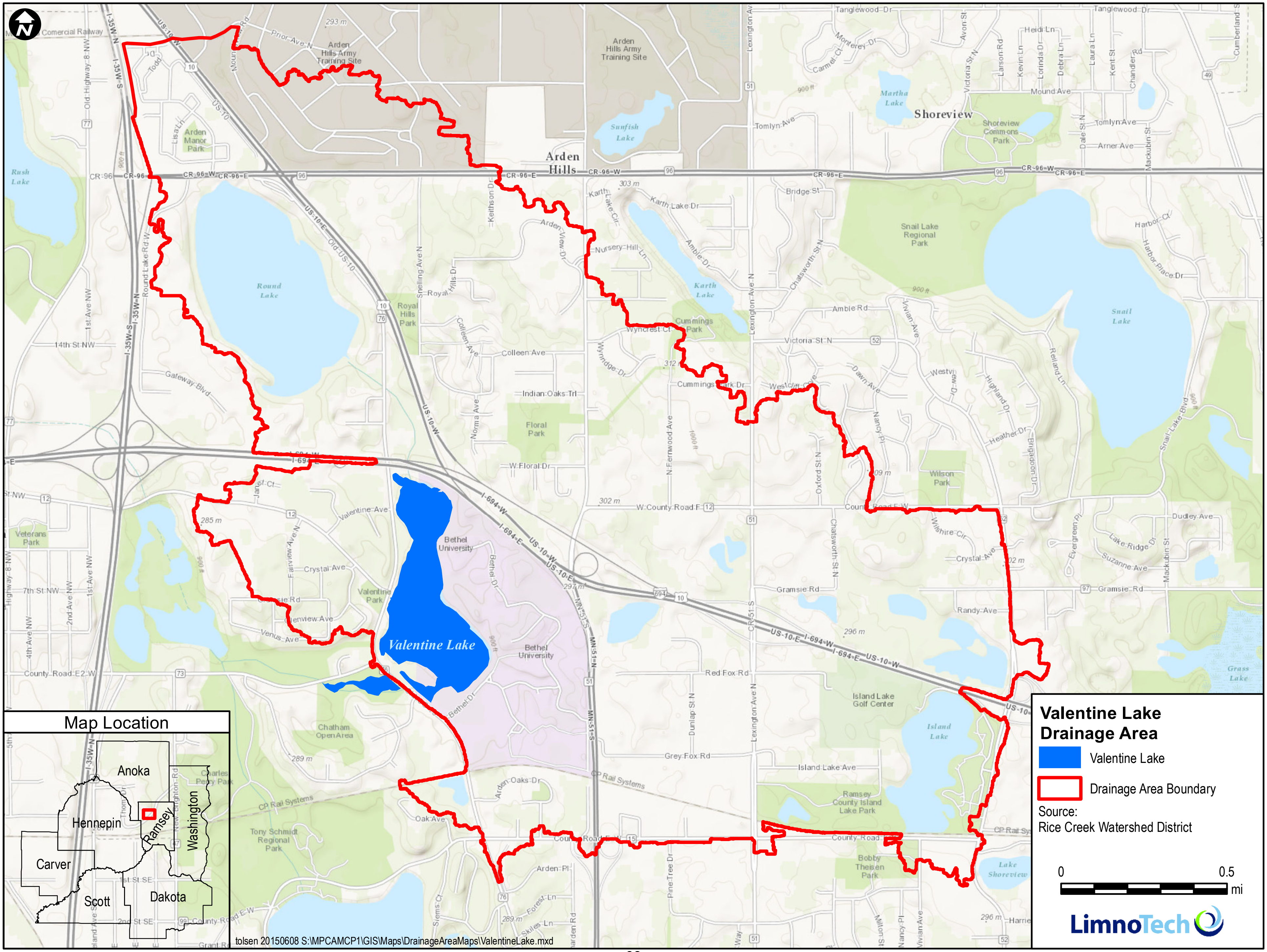




Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min										122	130
Max										184	280
Average										152	205
Season:	**Summer**	**(July-October)**									
Min	73	99	147	148	160	262	279	130	86	104	
Max	88	162	214	234	315	305	381	247	245	114	
Average	80	122	193	187	279	283	331	193	123	109	

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	164		176		275	247	236	181	165	109		
Elevation:	**Bottom**											
Average	125		184		297	256	182	183	162	108		



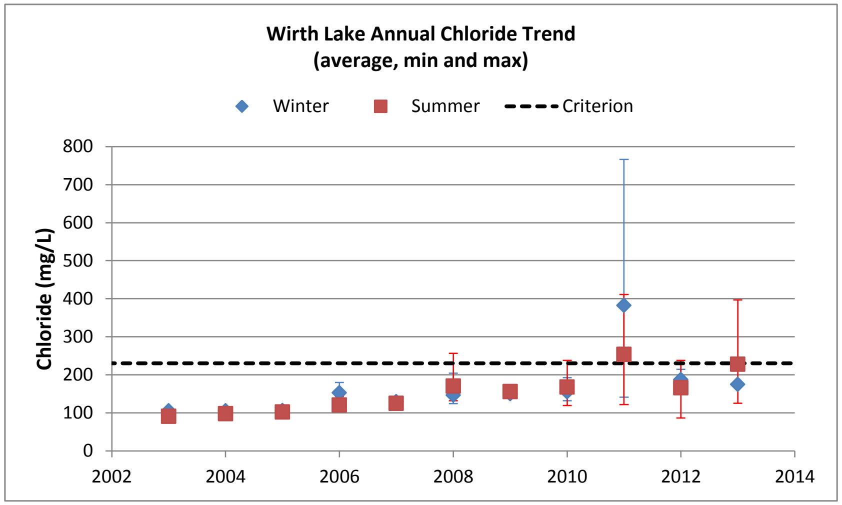


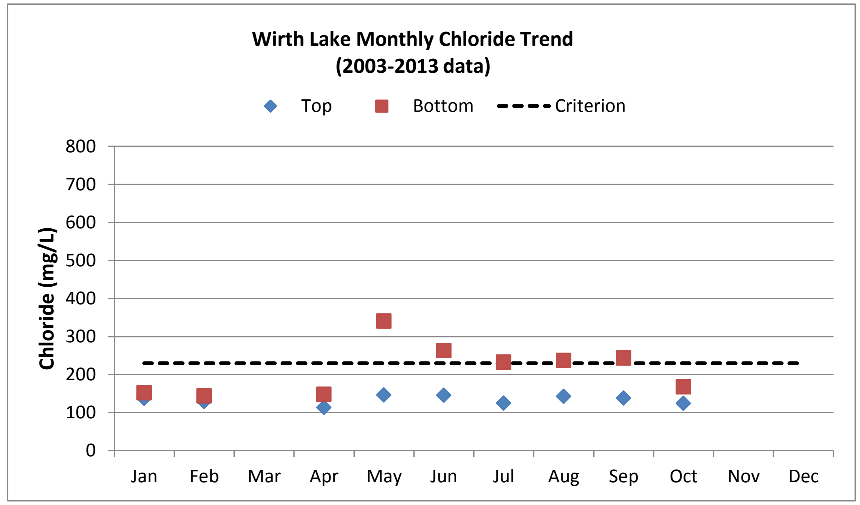
Valentine Lake
Drainage Area
Valentine Lake
Drainage Area Boundary
Source:
Rice Creek Watershed District
0
0.5
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Arden Hills
Shoreview
Round Lake
Snail Lake
Karth Lake
Island Lake
Sunfish Lake
Martha Lake
Rush Lake
Bethel University
Arden Hills Army Training Site
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\ValentineLake.mxd

Wirth Lake

WBID:	27-0037-00
Watershed:	Bassett Creek Watershed Management Commission
Watershed Area (ac):	426
Impervious:	13%
TMDL (pounds of chloride/year):	100,176

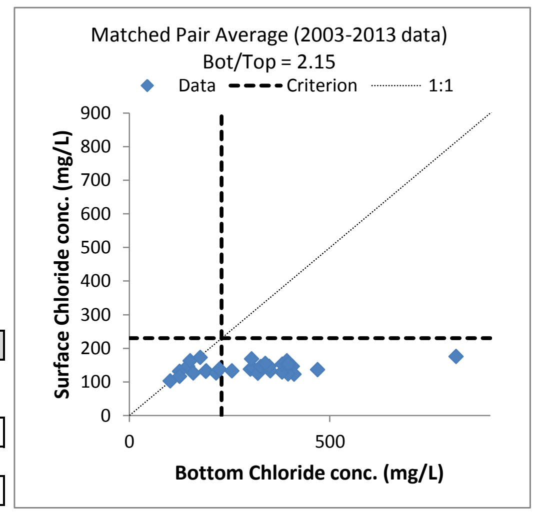
Number of Individual Days with Samples	79
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	26
Percent of Sample Days Exceeding Criterion	33%
Average of Exceeding Samples (mg/L)	391

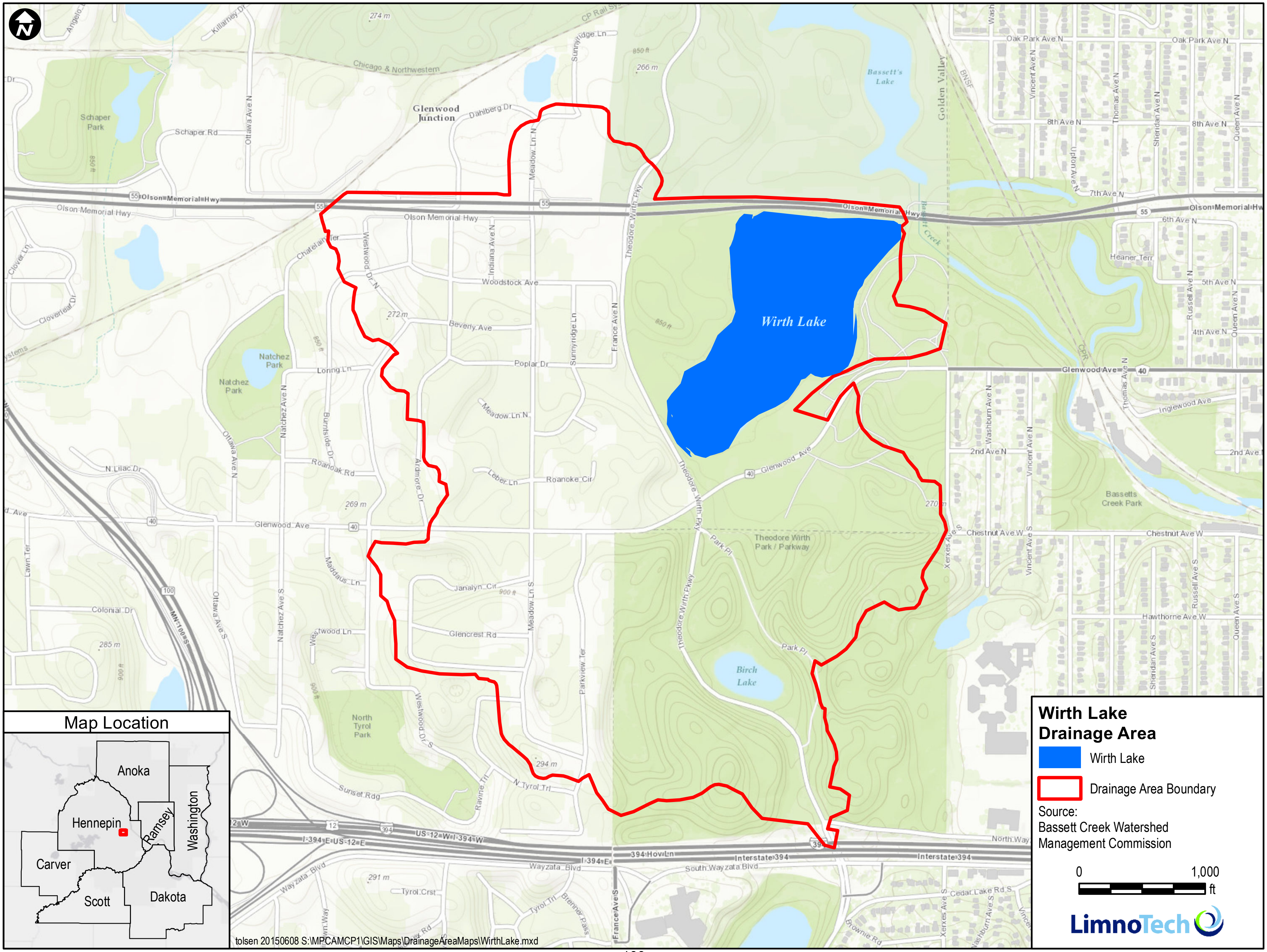




Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-April)**									
Min	103	105	99	125	121	124	146	132	141	157	172
Max	108	105	115	180	137	204	160	192	766	214	177
Average	105	105	106	153	129	146	150	155	382	187	175
Season:	**Summer**	**(July-October)**									
Min	83	95	92	107	116	132	149	119	122	86	125
Max	99	100	112	143	131	256	162	238	411	238	397
Average	91	98	102	120	125	170	156	168	253	166	228

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Elevation:	**Top**											
Average	137	129		113	146	146	124	142	138	124		
Elevation:	**Bottom**											
Average	152	143		148	341	263	232	237	243	168		

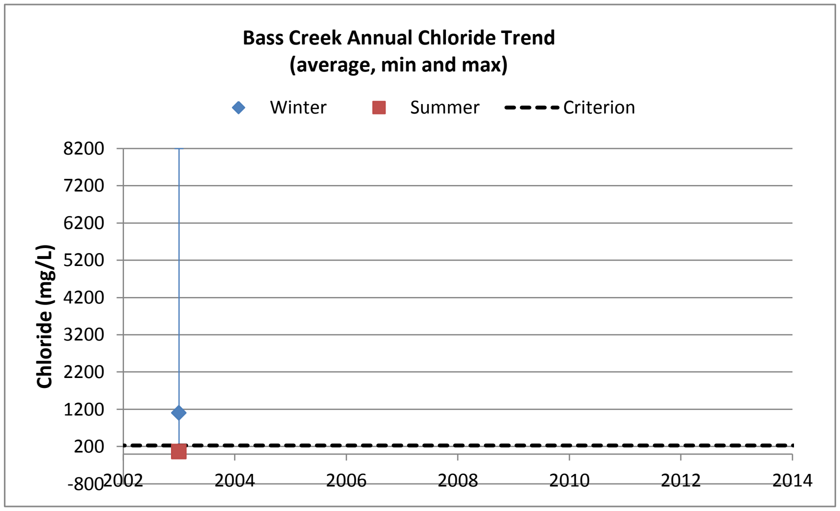


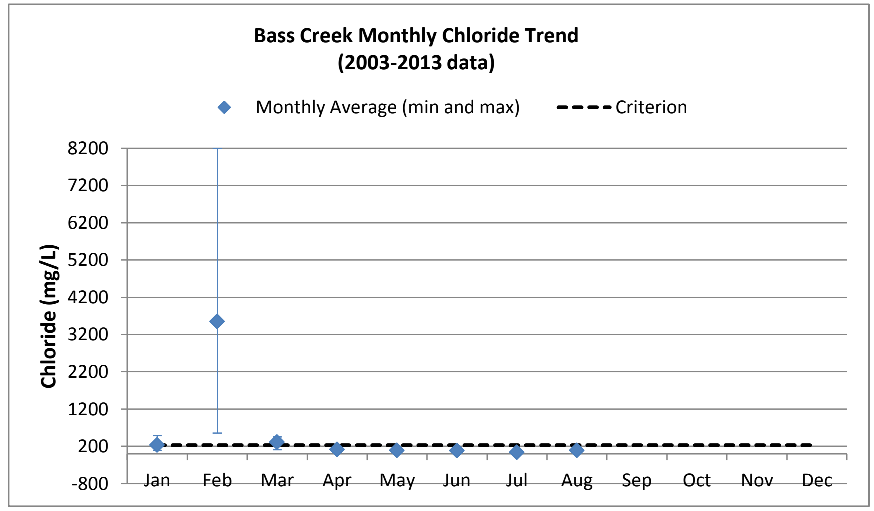

Wirth Lake
Drainage Area
Wirth Lake
Drainage Area Boundary
Source:
Bassett Creek Watershed
Management Commission
0
1,000
ft
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Wirth Lake
Birch Lake
Bassett's Lake
Theodore Wirth Park / Parkway
Glenwood Junction
Schaper Park
Natchez Park
North Tyrol Park
Bassetts Creek Park
Olson Memorial Hwy
Glenwood Ave
Interstate 394
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\WirthLake.mxd

Bass Creek

WBID:	07010206-784
Watershed:	Shingle Creek Watershed District
Watershed Area (ac):	5,434
Impervious:	31%
TMDL (pounds of chloride/year):	1,746,399

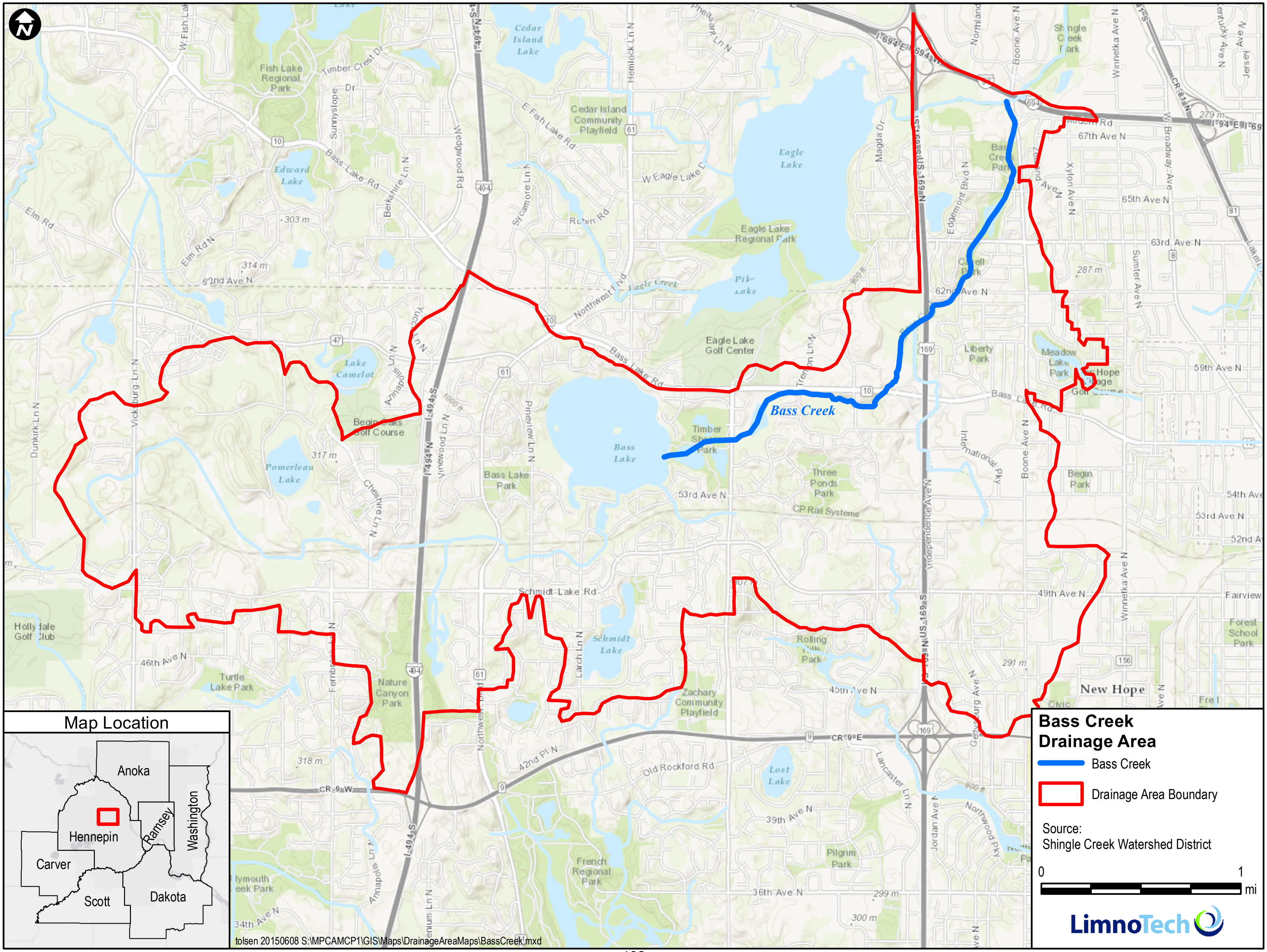
Number of Individual Days with Samples	26
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	8
Percent of Sample Days Exceeding Criterion	31%
Average of Exceeding Samples (mg/L)	1600





Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min	92										
Max	8200										
Average	1104										
Season:	**Summer**	**(July-October)**									
Min	33										
Max	140										
Average	68										

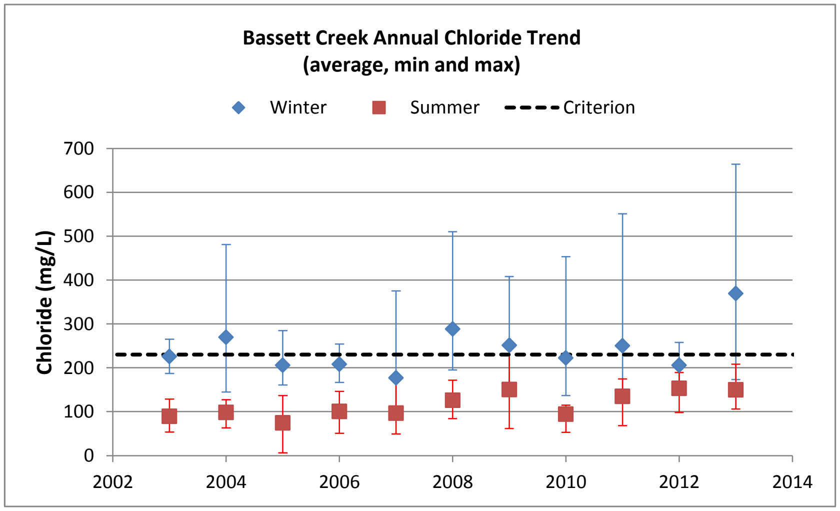
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min	92	560	110	86	82	78	33	42				
Max	490	8200	450	180	98	100	55	140				
Average	234	3553	313	122	90	89	44	91				

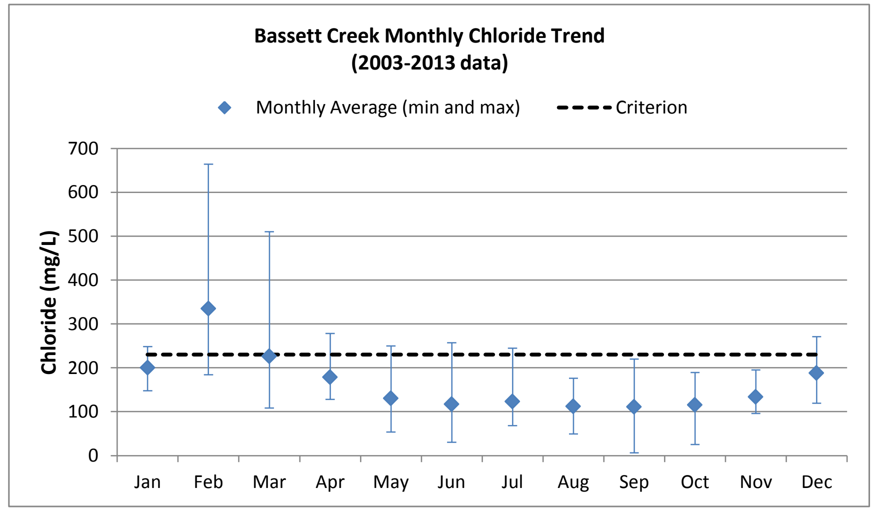

Bass Creek
Drainage Area
Bass Creek
Drainage Area Boundary
Source:
Shingle Creek Watershed District
0
1
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Bass Creek
Bass Lake
Eagle Lake
Pike Lake
Schmidt Lake
Pomerleau Lake
Lake Camelot
Edward Lake
Cedar Island Lake
Lost Lake
New Hope
Bass Lake Rd
Schmidt Lake Rd
Eagle Lake Regional Park
Fish Lake Regional Park
French Regional Park
Three Ponds Park
Rolling Hills Park
Zachary Community Playfield
Nature Canyon Park
Turtle Lake Park
Bass Lake Park
Timber Shores Park
Liberty Park
Begin Park
Pilgrim Park
Hollydale Golf Club
Eagle Lake Golf Center
CP Rail Systems
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\BassCreek.mxd

Bassett Creek

WBID:	07010206-538
Watershed:	Bassett Creek Watershed Management Commission
Watershed Area (ac):	25,209
Impervious:	34%
TMDL (pounds of chloride/year):	9,334,219

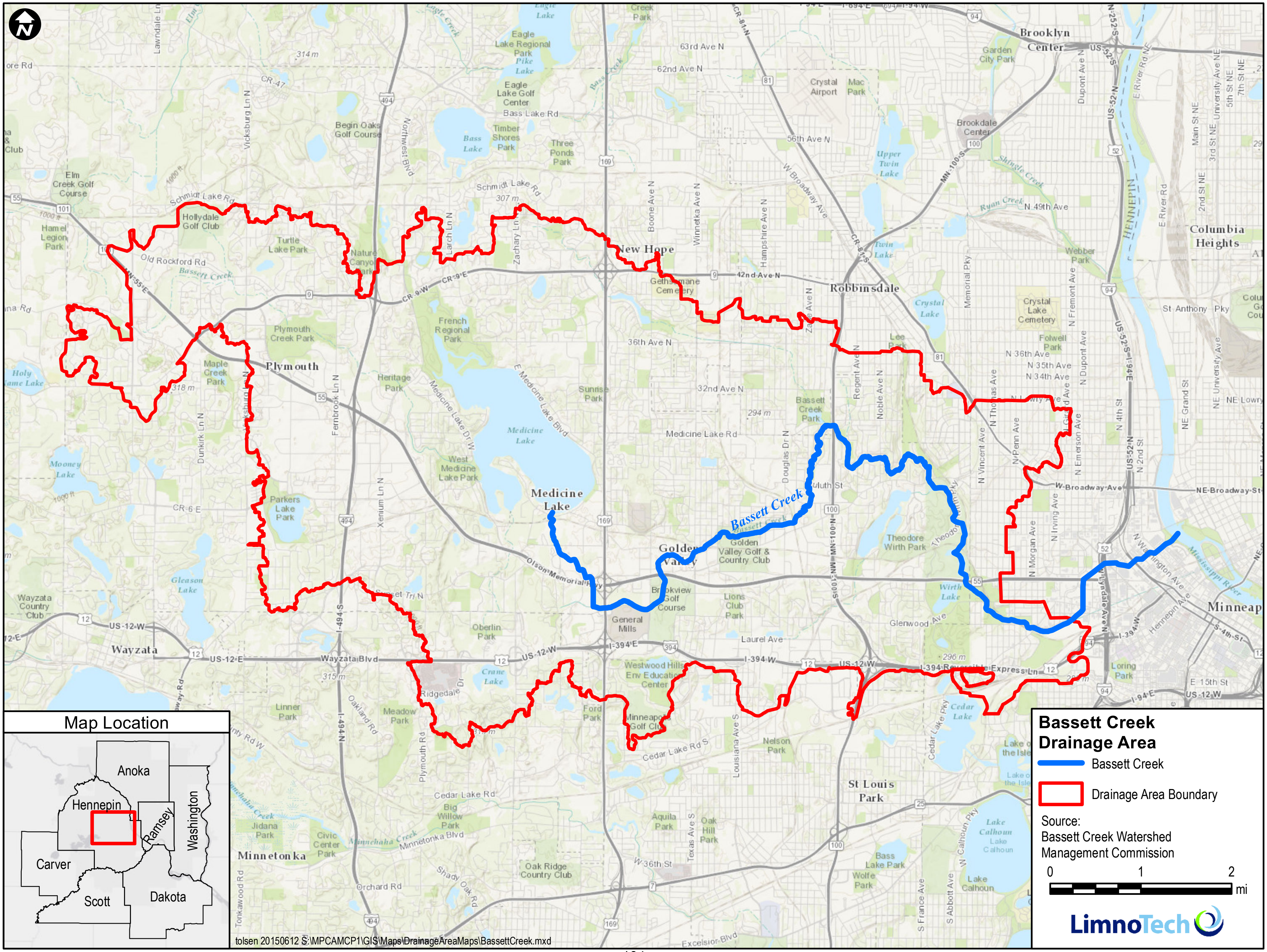
Number of Individual Days with Samples	273
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	35
Percent of Sample Days Exceeding Criterion	13%
Average of Exceeding Samples (mg/L)	321





Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min	187	145	161	167	108	195	157	137	142	148	173
Max	265	481	285	254	375	510	408	453	551	258	664
Average	226	270	206	208	177	288	251	223	251	206	369
Season:	**Summer**	**(July-October)**									
Min	54	63	6	51	49	84	62	53	68	98	107
Max	129	127	137	146	179	172	245	115	175	189	209
Average	90	99	74	101	97	126	150	95	135	154	150

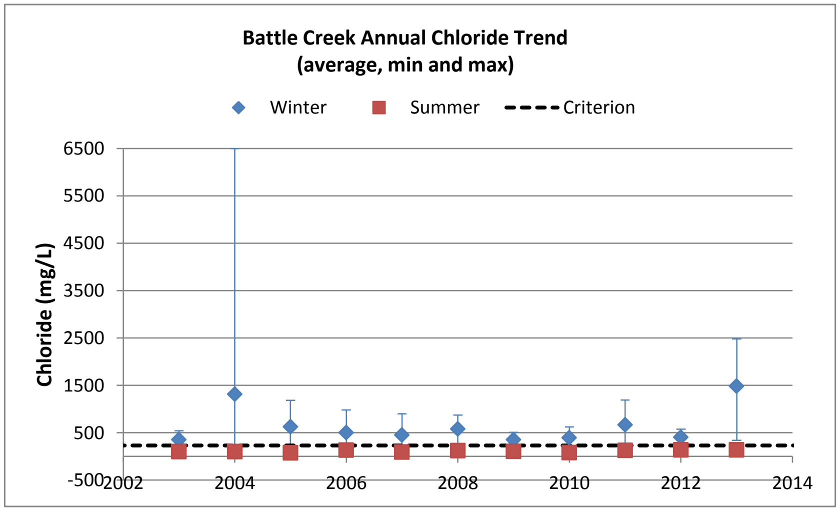
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min	148	184	108	128	54	30	68	49	6	25	96	119
Max	248	664	510	278	250	257	245	176	220	189	195	271
Average	201	335	227	179	130	117	123	112	111	116	134	188

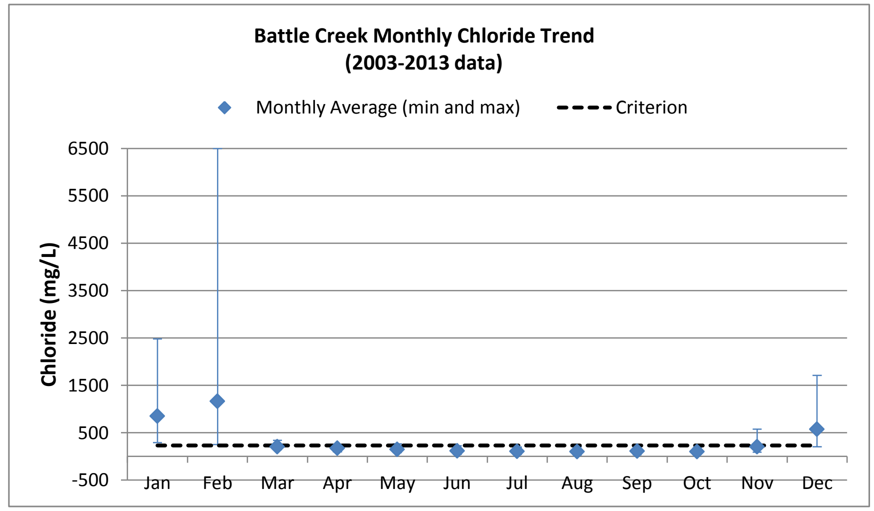

Bassett Creek Drainage Area
Bassett Creek
Drainage Area Boundary
Source:
Bassett Creek Watershed Management Commission
0 1 2 mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
tolsen 20150612 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\BassettCreek.mxd

Battle Creek

WBID:	07010206-592
Watershed:	Ramsey Washington Metro Watershed District
Watershed Area (ac):	7,246
Impervious:	33%
TMDL (pounds of chloride/year):	2,328,720

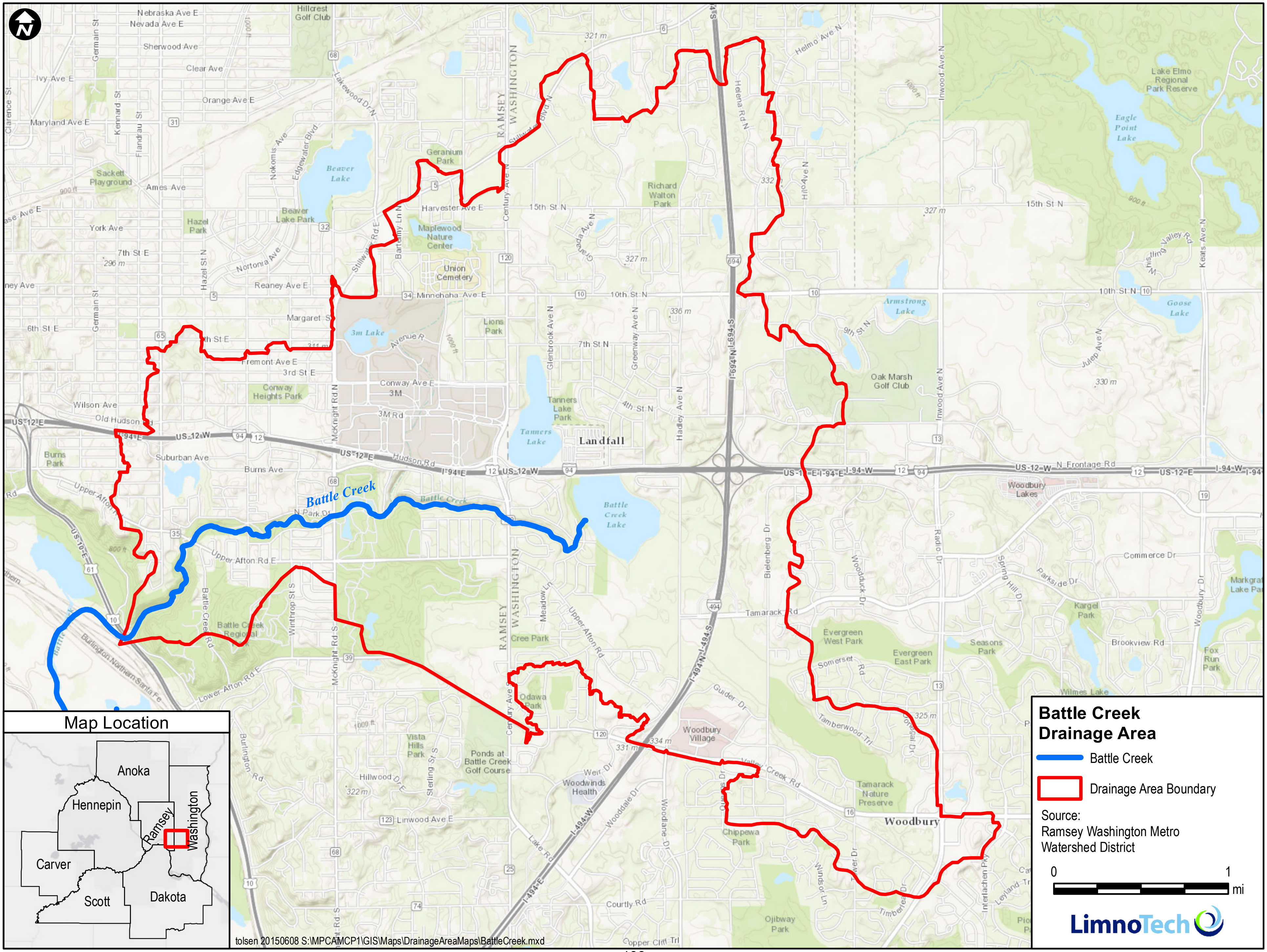
Number of Individual Days with Samples	366
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	39
Percent of Sample Days Exceeding Criterion	11%
Average of Exceeding Samples (mg/L)	805





Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min	167	142	178	233	160	216	167	163	174	194	338
Max	542	6500	1184	980	902	876	510	621	1192	577	2479
Average	355	1317	628	506	452	580	357	395	667	404	1486
Season:	**Summer**	**(July-October)**									
Min	65	38	30	77	43	36	58	46	36	78	59
Max	125	151	136	189	162	165	162	106	201	213	208
Average	104	103	77	133	95	124	108	83	129	140	138

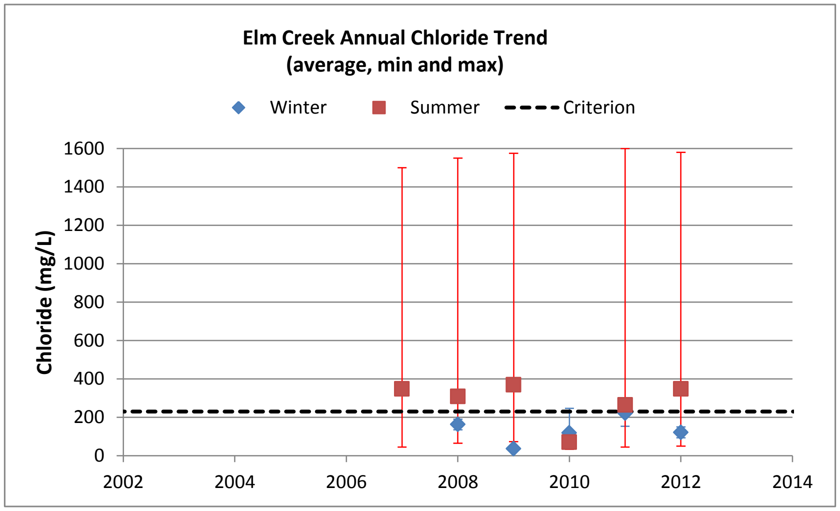
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min	294	250	142	94	82	46	43	30	36	51	89	207
Max	2479	6500	338	218	264	223	196	208	213	181	574	1709
Average	855	1164	205	178	149	121	111	103	113	106	205	574

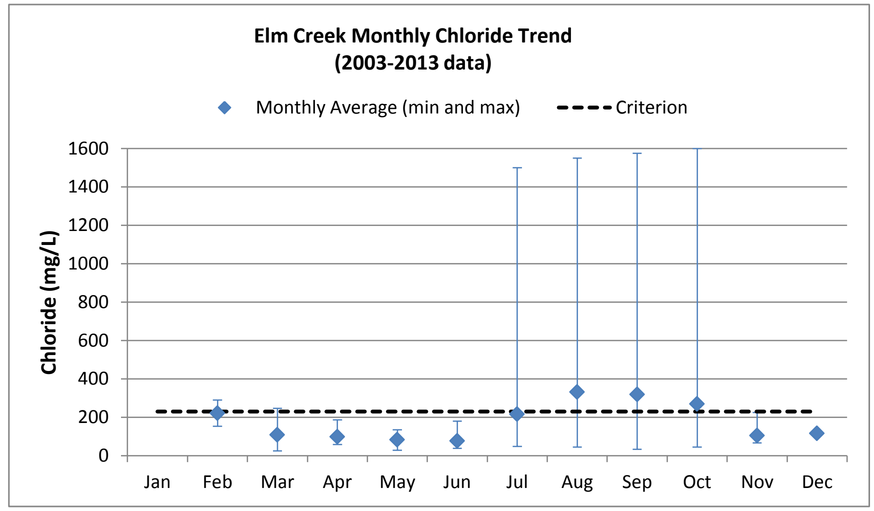

Battle Creek
Drainage Area
Battle Creek
Drainage Area Boundary
Source:
Ramsey Washington Metro
Watershed District
0
1
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Battle Creek
Battle Creek Lake
Beaver Lake
Tanners Lake
Armstrong Lake
Eagle Point Lake
Goose Lake
Landfall
Woodbury
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\BattleCreek.mxd

Elm Creek

WBID:	07010206-508
Watershed:	Three Rivers Park District
Watershed Area (ac):	66,382
Impervious:	10%
TMDL (pounds of chloride/year):	21,332,409

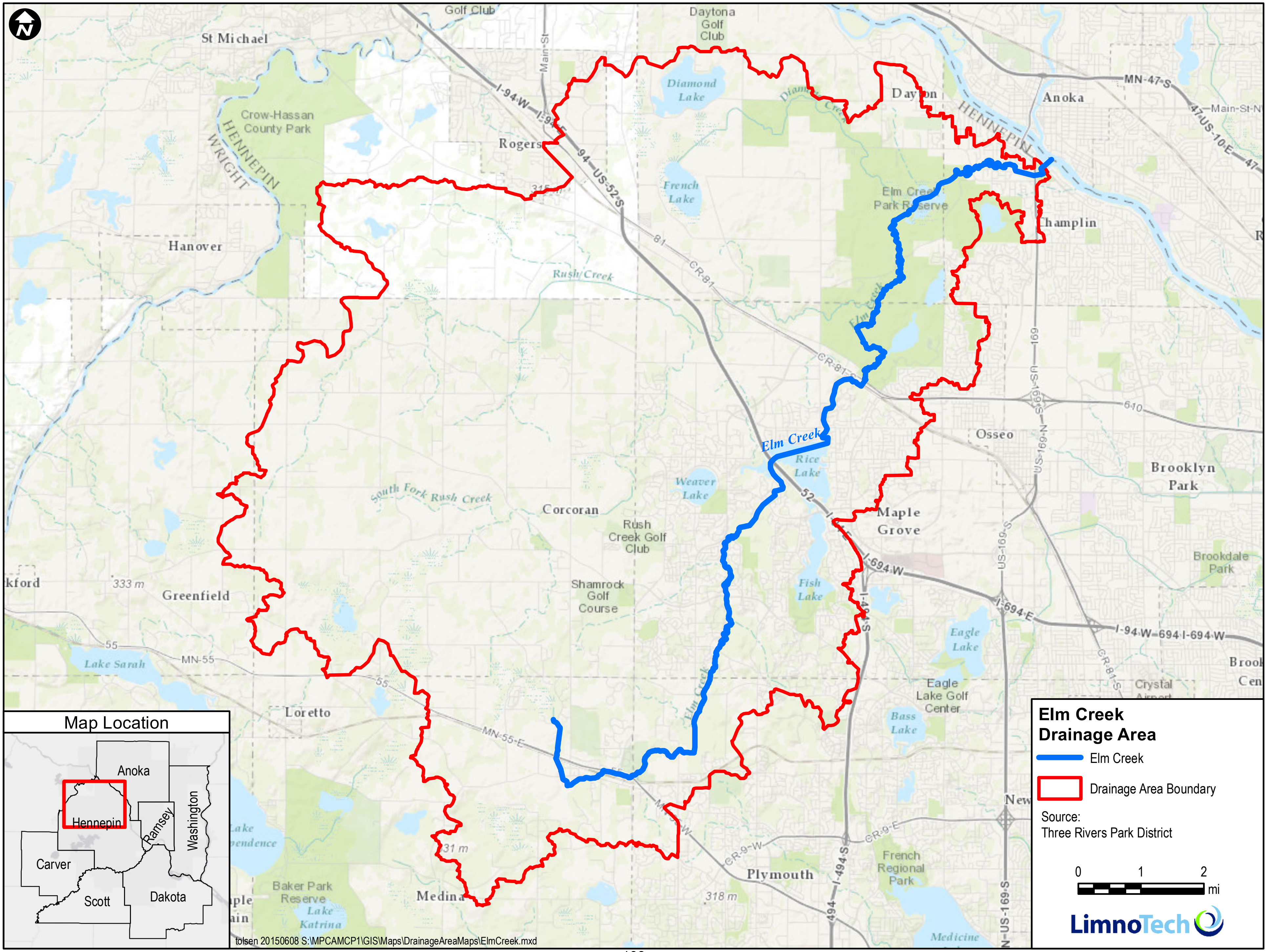
Number of Individual Days with Samples	209
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	20
Percent of Sample Days Exceeding Criterion	10%
Average of Exceeding Samples (mg/L)	1105





Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min						135	24	62	152	92	
Max						190	42	246	290	150	
Average						163	36	118	221	121	
Season:	**Summer**	**(July-October)**									
Min					44	64	72	32	44	50	
Max					1500	1550	1575	106	1600	1580	
Average					348	309	369	71	264	347	

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min		152	24	58	27	38	48	44	32	44	66	116
Max		290	246	186	134	180	1500	1550	1575	1600	225	116
Average		221	109	98	83	77	217	331	318	269	105	116


Elm Creek
Drainage Area
Elm Creek
Drainage Area Boundary
Source:
Three Rivers Park District
0
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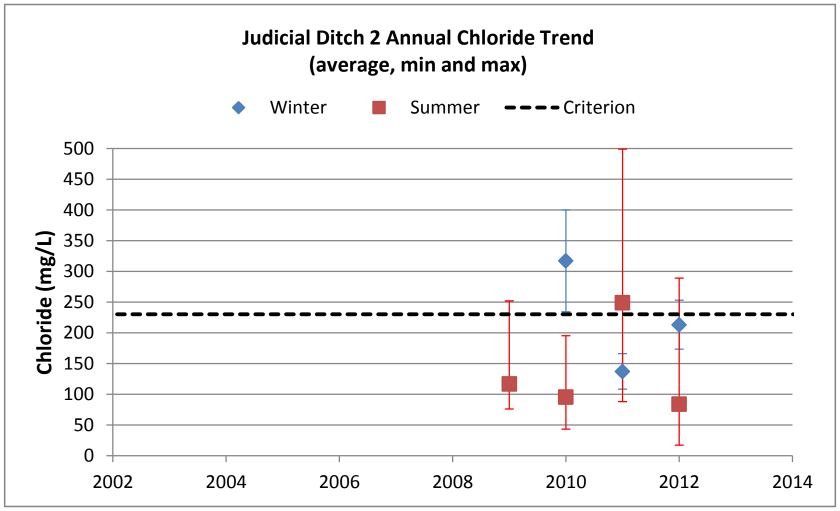
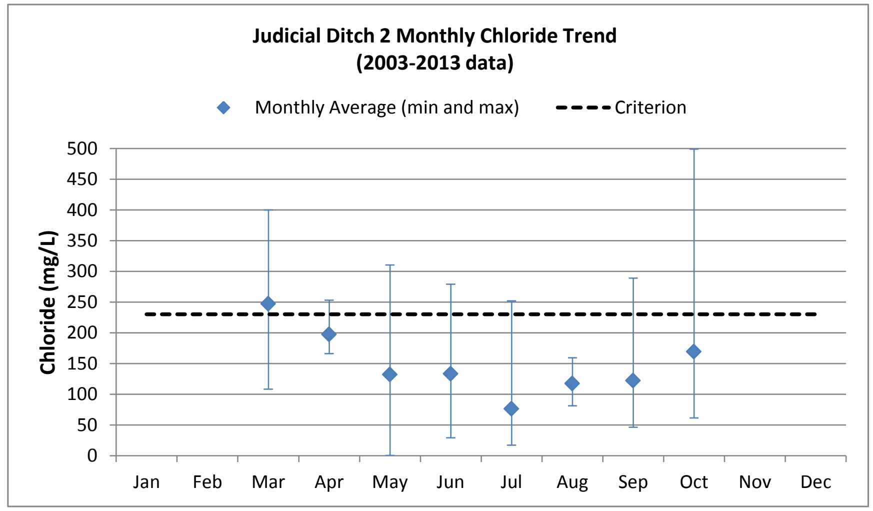
2
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
St Michael
Rogers
Hanover
Dayton
Anoka
Champlin
Osseo
Brooklyn
Park
Maple
Grove
Corcoran
Greenfield
Loretto
Medina
Plymouth
Crow-Hassan
County Park
Elm Creek
Park Reserve
Rush Creek
Golf Club
Shamrock
Golf
Course
Daytona
Golf
Club
Diamond
Lake
French
Lake
Weaver
Lake
Rice
Lake
Fish
Lake
Eagle
Lake
Eagle
Lake Golf
Center
Bass
Lake
Lake Sarah
Baker Park
Reserve
French
Regional
Park
Rush Creek
South Fork Rush Creek
Elm Creek
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\ElmCreek.mxd

Judicial Ditch 2

WBID:	07030005-525
Watershed:	Comfort Lake Forest Lake Watershed District
Watershed Area (ac):	1,587
Impervious:	21%
TMDL (pounds of chloride/year):	510,115

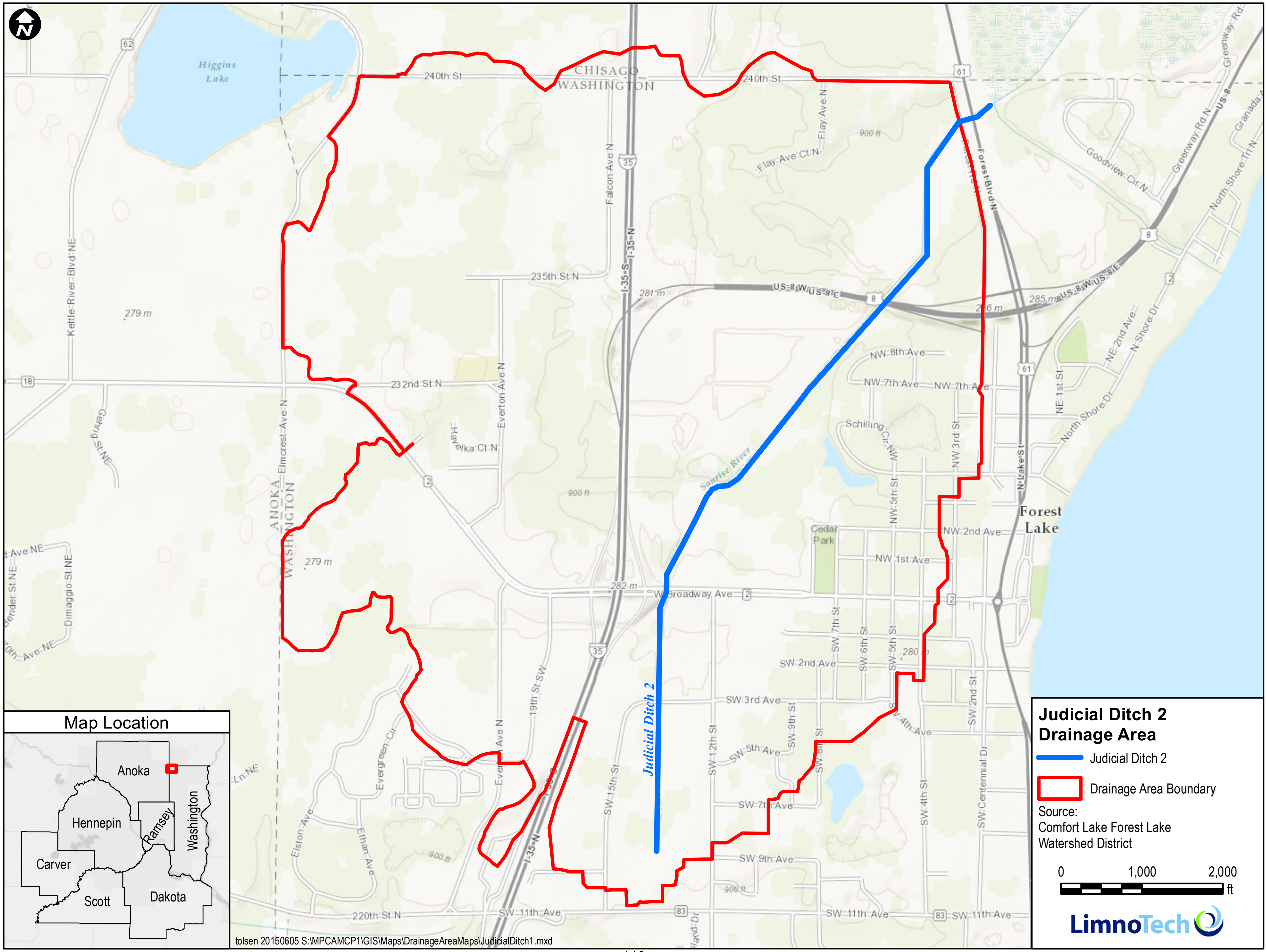
Number of Individual Days with Samples	45
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	9
Percent of Sample Days Exceeding Criterion	20%
Average of Exceeding Samples (mg/L)	311





Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min								234	108	173	
Max								400	166	253	
Average								317	137	213	
Season:	**Summer**	**(July-October)**									
Min							76	43	88	17	
Max							252	195	499	289	
Average							117	95	249	84	

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min			108	166	0	29	17	81	46	61		
Max			400	253	310	279	252	159	289	499		
Average			247	197	132	133	76	118	122	169		

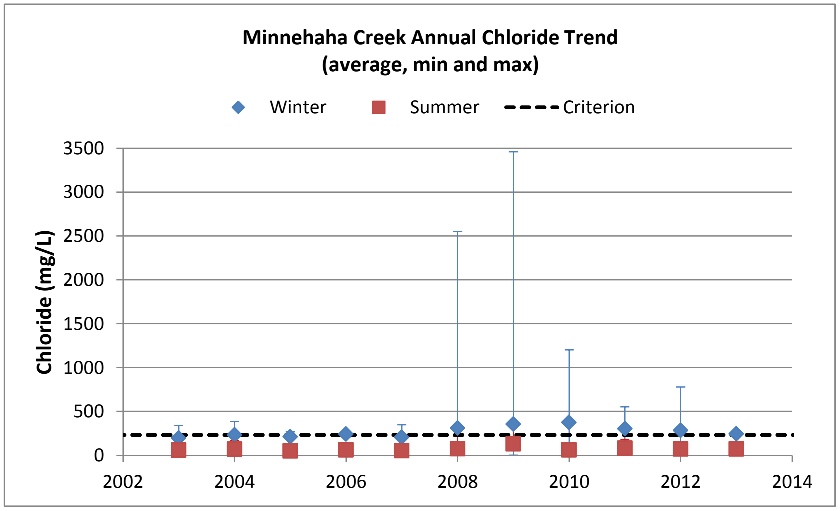


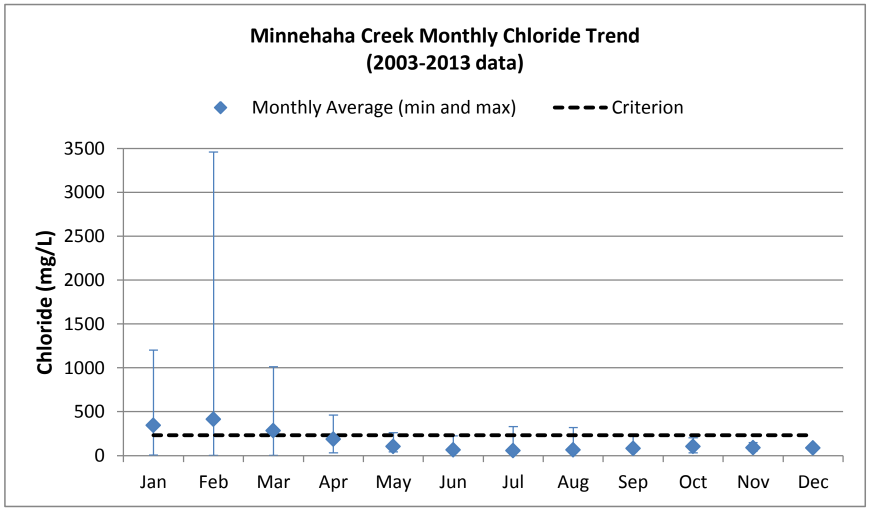
Judicial Ditch 2
Drainage Area
Judicial Ditch 2
Drainage Area Boundary
Source:
Comfort Lake Forest Lake
Watershed District
0 1,000 2,000
ft
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Higgins Lake
CHISAGO
WASHINGTON
ANOKA
WASHINGTON
Forest Lake
240th St
235th St N
232nd St N
220th St N
W Broadway Ave
SW 11th Ave
Sunrise River
Judicial Ditch 2
Cedar Park
tolsen 20150605 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\JudicialDitch1.mxd

Minnehaha Creek

WBID:	07010206-539
Watershed:	Minnehaha Creek Watershed District
Watershed Area (ac):	109,151
Impervious:	14%
TMDL (pounds of chloride/year):	35,076,753

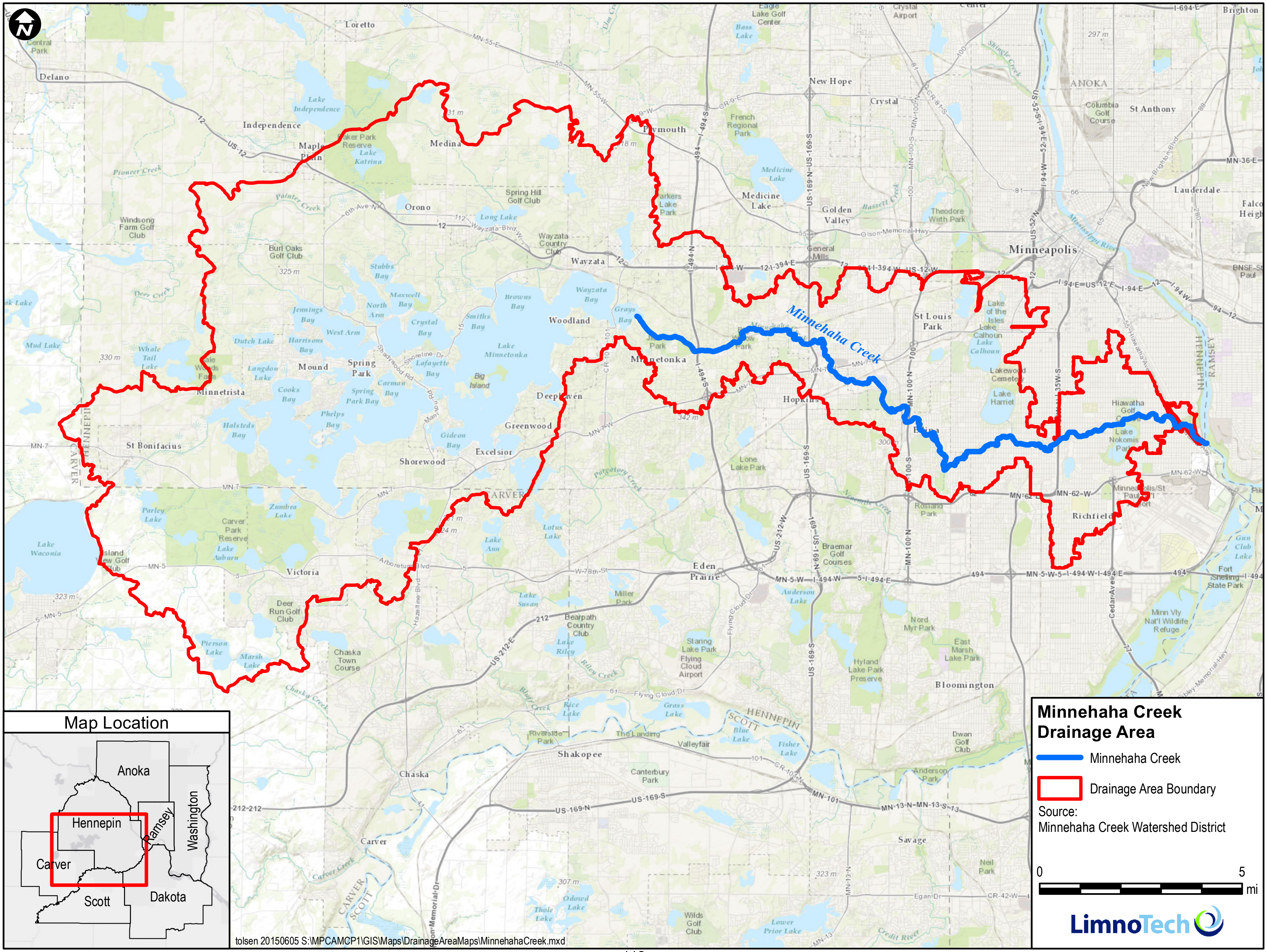
Number of Individual Days with Samples	1281
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	242
Percent of Sample Days Exceeding Criterion	19%
Average of Exceeding Samples (mg/L)	415





Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min	88	123	120	210	128	5	1	141	60	147	237
Max	340	385	269	264	350	2549	3457	1202	553	777	258
Average	198	233	212	243	208	313	358	376	303	285	247
Season:	**Summer**	**(July-October)**									
Min	36	44	31	44	40	38	58	43	46	55	64
Max	123	166	60	77	83	216	329	89	178	94	85
Average	59	72	52	63	56	76	132	64	83	74	73

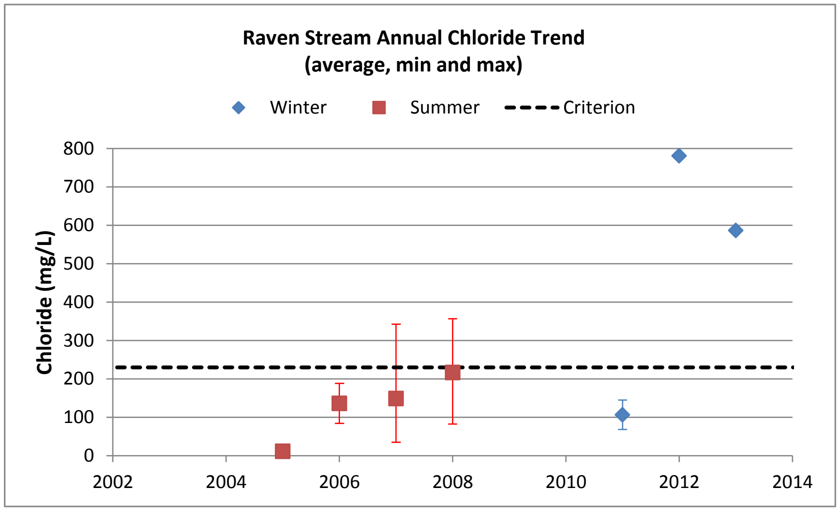
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min	5	1	1	30	41	32	42	36	44	31	51	68
Max	1202	3457	1013	461	262	223	329	320	228	201	148	104
Average	345	415	285	187	104	65	58	67	83	103	89	88

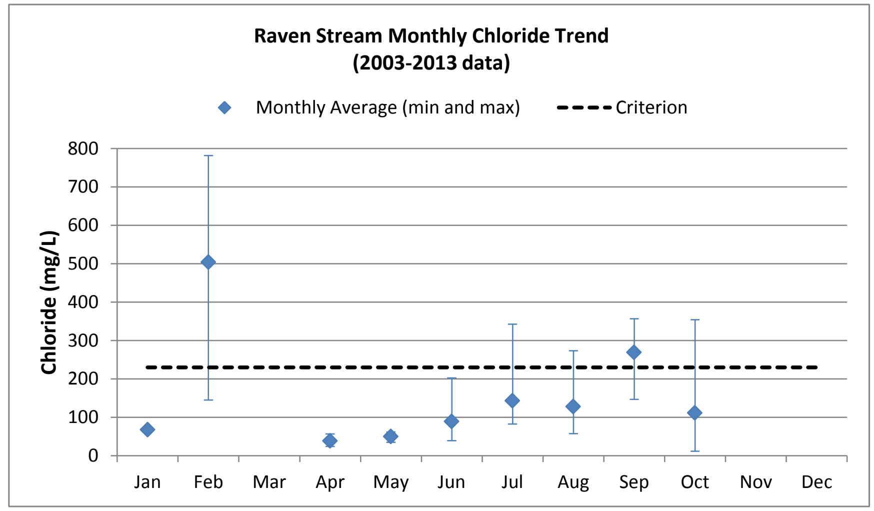

Minnehaha Creek
Drainage Area
Minnehaha Creek
Drainage Area Boundary
Source:
Minnehaha Creek Watershed District
0
5
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Minnehaha Creek
Minneapolis
Wayzata
Minnetonka
Hopkins
Edina
St Louis Park
Richfield
Plymouth
Medina
Independence
Maple Plain
Orono
Minnetrista
Mound
Spring Park
Shorewood
Excelsior
Greenwood
Deephaven
Woodland
St Bonifacius
Victoria
Chaska
Eden Prairie
Bloomington
Shakopee
Savage
Golden Valley
Medicine Lake
New Hope
Crystal
St Anthony
Lauderdale
Delano
Loretto
Lake Minnetonka
Lake Calhoun
Lake Harriet
Lake Nokomis
Lake of the Isles
Lake Waconia
tolsen 20150605 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\MinnehahaCreek.mxd

Raven Stream

WBID: 07020012-716
Watershed: Scott County Natural Resources
Watershed Area (ac): 42,750
Impervious: 2%
TMDL (pounds of chloride/year): 13,738,210

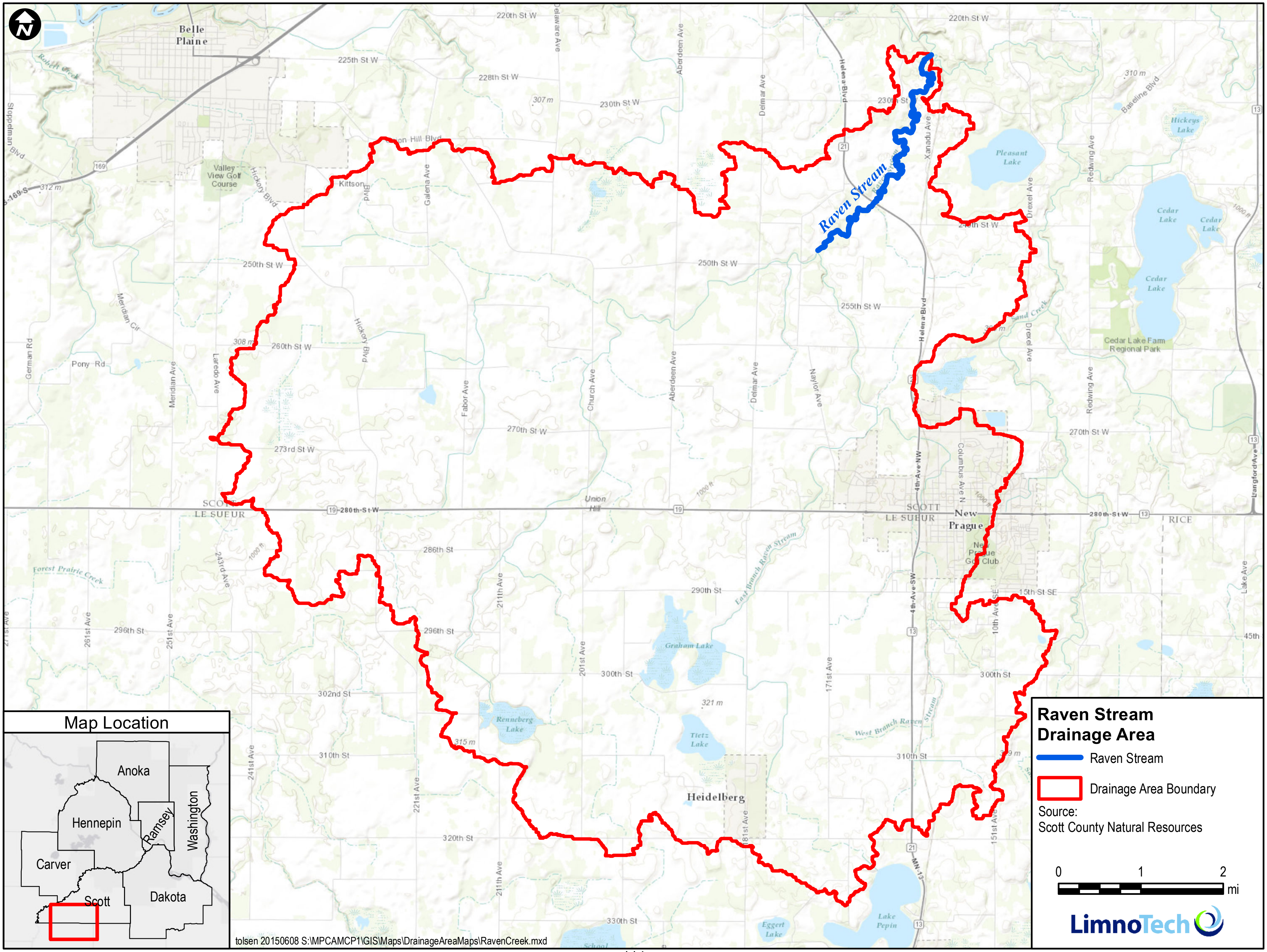
Number of Individual Days with Samples	48
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	11
Percent of Sample Days Exceeding Criterion	23%
Average of Exceeding Samples (mg/L)	375





Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min									68	781	586
Max									145	781	586
Average									106	781	586
Season:	**Summer**	**(July-October)**									
Min			11	84	35	82					
Max			11	188	342	357					
Average			11	136	148	216					

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min	68	145		24	35	39	82	57	146	11		
Max	68	781		56	61	202	342	273	357	354		
Average	68	504		38	50	89	143	128	269	111		

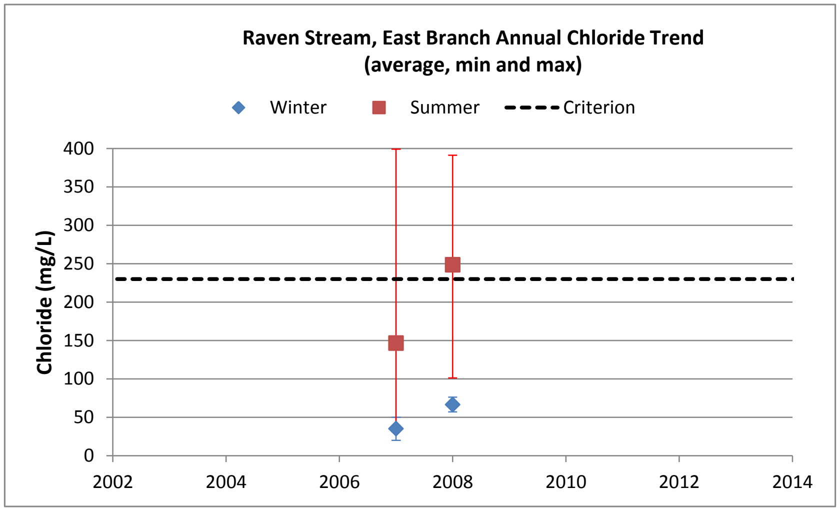


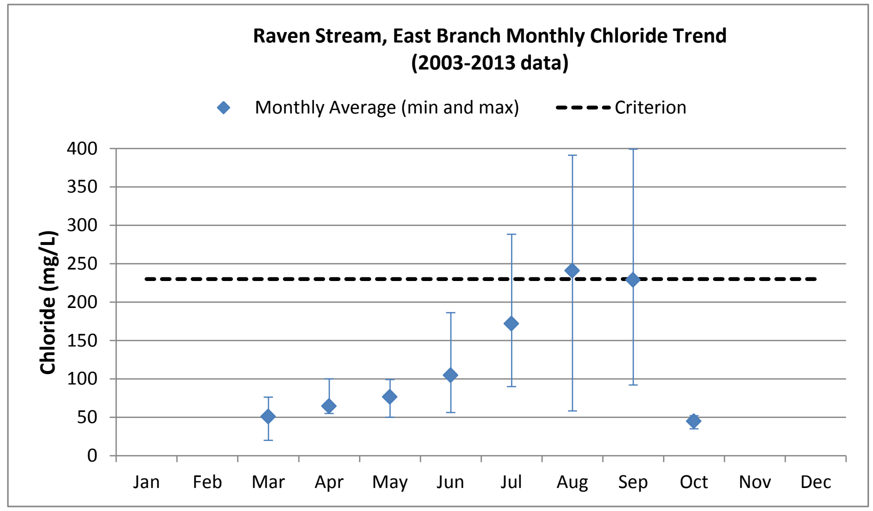
Raven Stream Drainage Area
Raven Stream
Drainage Area Boundary
Source:
Scott County Natural Resources
0 1 2 mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Raven Stream
Belle Plaine
New Prague
Heidelberg
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\RavenCreek.mxd

Raven Stream, East Branch

WBID:	07020012-543
Watershed:	Scott County Natural Resources
Watershed Area (ac):	14,751
Impervious:	4%
TMDL (pounds of chloride/year):	4,740,367

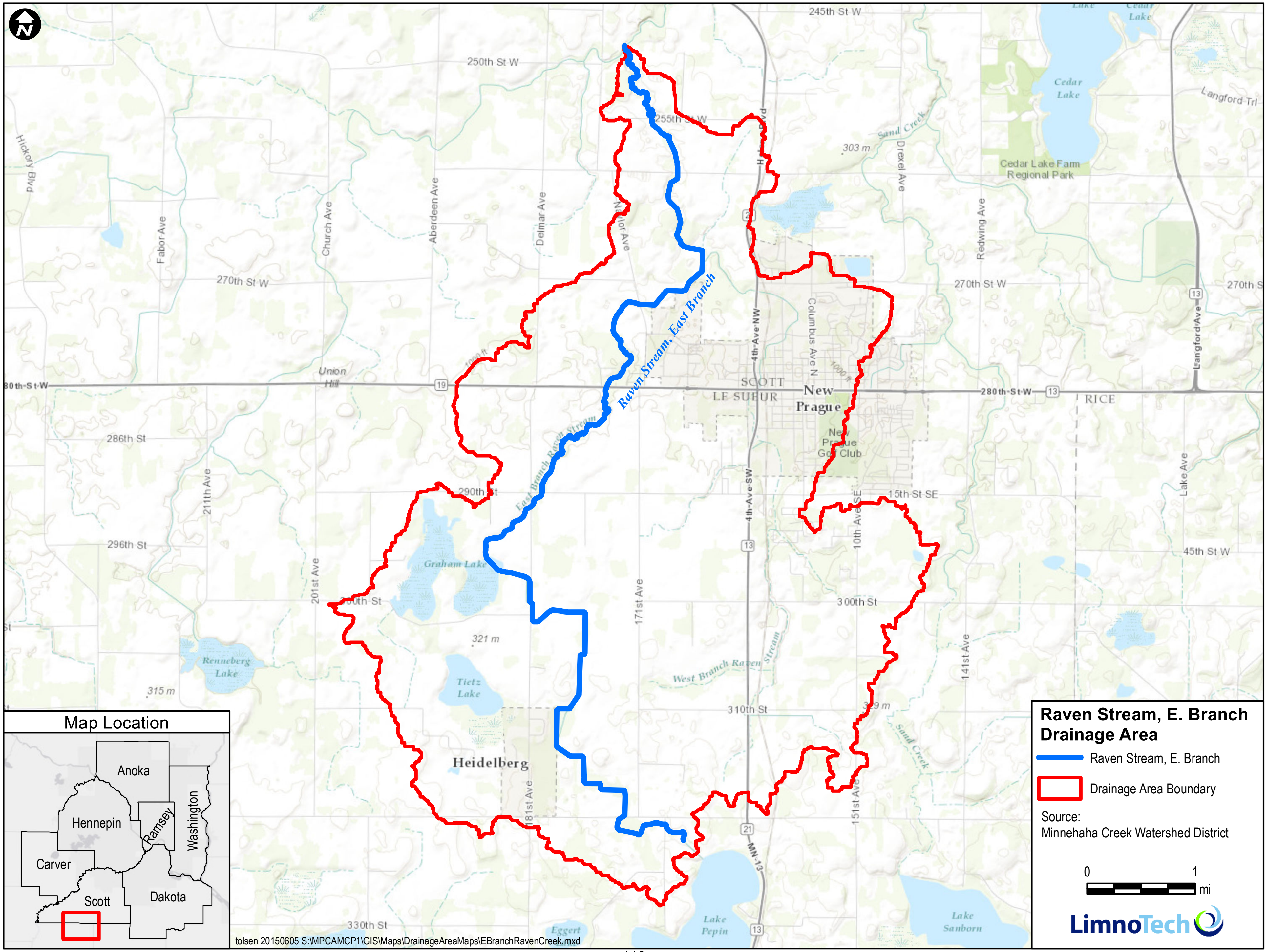
Number of Individual Days with Samples	39
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	7
Percent of Sample Days Exceeding Criterion	18%
Average of Exceeding Samples (mg/L)	329





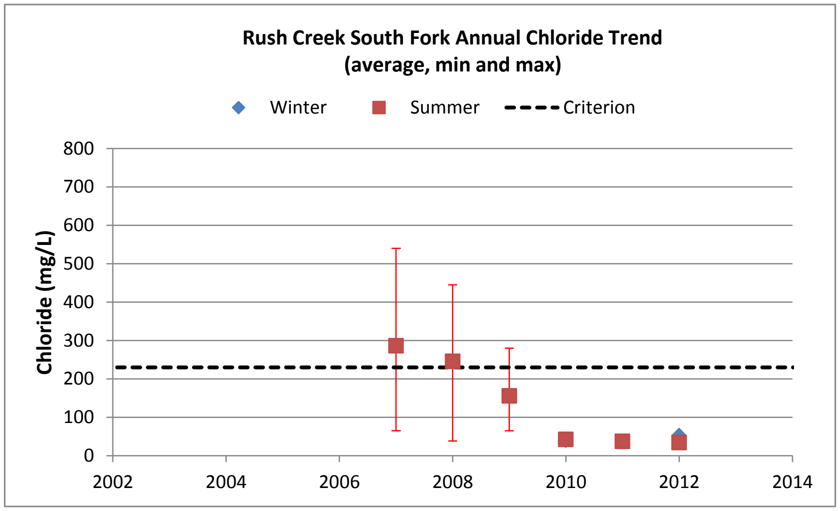
Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min					20	57					
Max					50	76					
Average					35	67					
Season:	**Summer**	**(July-October)**									
Min					35	101					
Max					399	391					
Average					147	248					

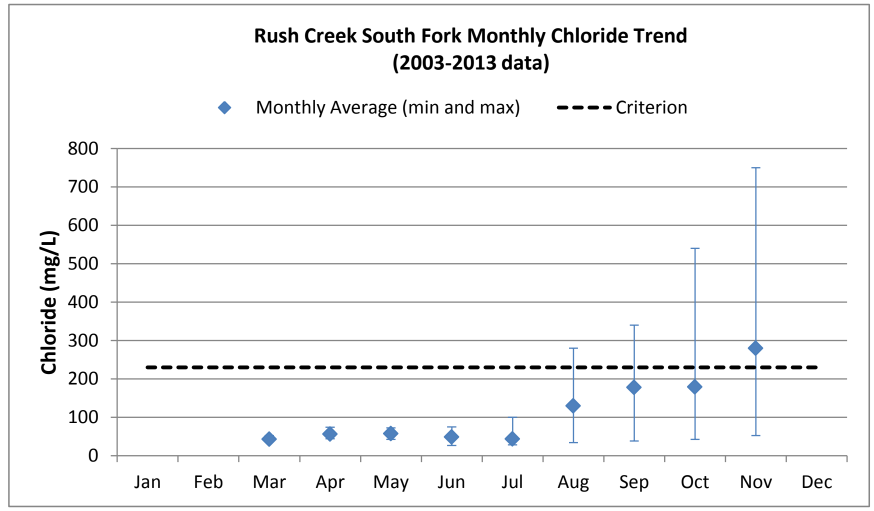
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min			20	55	50	56	90	58	92	35		
Max			76	100	99	186	288	391	399	52		
Average			51	65	77	105	172	241	229	45		


Raven Stream, E. Branch Drainage Area
Raven Stream, E. Branch
Drainage Area Boundary
Source:
Minnehaha Creek Watershed District
0
1
mi
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Raven Stream, East Branch
East Branch Raven Stream
West Branch Raven Stream
New Prague
Heidelberg
Graham Lake
Tietz Lake
Renneberg Lake
Cedar Lake
Cedar Lake Farm Regional Park
Lake Pepin
Lake Sanborn
SCOTT
LE SUEUR
RICE
250th St W
245th St W
255th St W
270th St W
280th St W
286th St
290th St
296th St
300th St
310th St
330th St
15th St SE
45th St W
171st Ave
181st Ave
201st Ave
211th Ave
141st Ave
151st Ave
Aberdeen Ave
Church Ave
Delmar Ave
Fabor Ave
Redwing Ave
Drexel Ave
Langford Ave
Lake Ave
Columbus Ave N
4th Ave NW
4th Ave SW
10th Ave SE
Hickory Blvd
Langford Trl
Sand Creek
Union Hill
321 m
315 m
303 m
tolsen 20150605 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\EBranchRavenCreek.mxd

Rush Creek South Fork

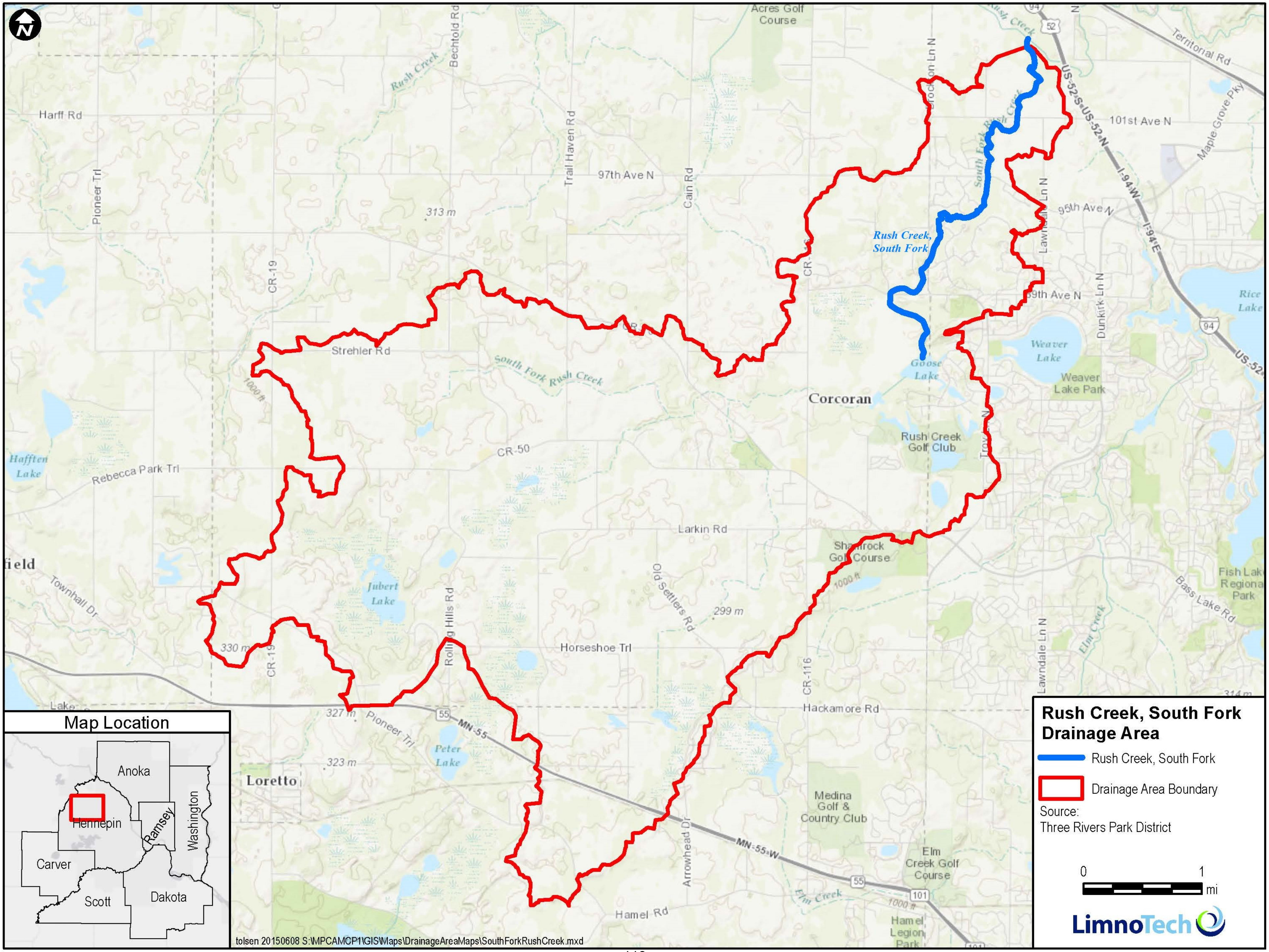
WBID:	07010206-732		**Number of Individual Days with Samples**	87
Watershed:	Three Rivers Park District		**Number of Days with Samples Exceeding 230 mg/L Chronic Criterion**	14
Watershed Area (ac):	13,844		**Percent of Sample Days Exceeding Criterion**	16%
Impervious:	5%		**Average of Exceeding Samples (mg/L)**	377
TMDL (pounds of chloride/year):	4,449,058			





Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min								36		52	
Max								44		52	
Average								40		52	
Season:	**Summer**	**(July-October)**									
Min					65	38	65	34	30	28	
Max					540	445	280	48	46	46	
Average					286	246	155	42	37	34	

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min			36	44	42	26	28	34	38	42	52	
Max			52	74	72	75	100	280	340	540	750	
Average			43	56	57	49	44	130	178	179	280	



Rush Creek, South Fork
Drainage Area
Rush Creek, South Fork
Drainage Area Boundary
Source:
Three Rivers Park District
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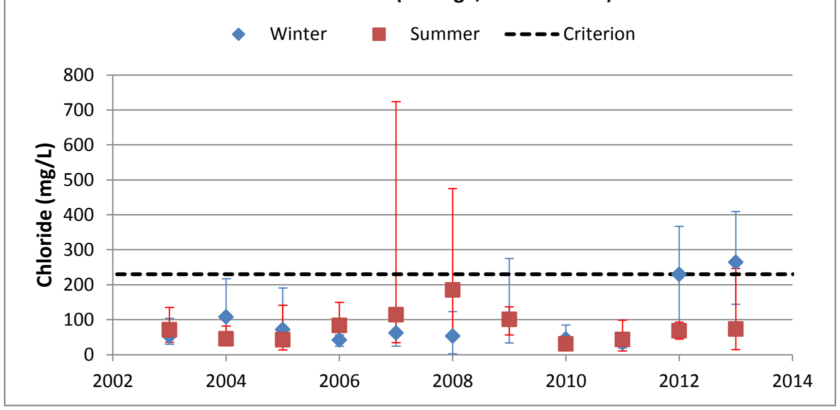
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Rush Creek, South Fork
Corcoran
Loretto
Weaver Lake
Goose Lake
Jubert Lake
Peter Lake
Hafften Lake
Rice Lake
Rush Creek Golf Club
Shamrock Golf Course
Medina Golf & Country Club
Elm Creek Golf Course
Weaver Lake Park
Fish Lake Regional Park
Hamel Legion Park
Acres Golf Course
Strehler Rd
CR-50
Larkin Rd
Horseshoe Trl
Hackamore Rd
Hamel Rd
Old Settlers Rd
Rolling Hills Rd
Rebecca Park Trl
Townhall Dr
Pioneer Trl
Harff Rd
97th Ave N
101st Ave N
Territorial Rd
Maple Grove Pky
Bass Lake Rd
Arrowhead Dr
Lawndale Ln N
Dunkirk Ln N
Trail Haven Rd
Cain Rd
Bechtold Rd
CR-19
CR-116
MN-55
MN-55-W
I-94-W
I-94-E
US-52
Elm Creek
South Fork Rush Creek
Rush Creek
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\SouthForkRushCreek.mxd

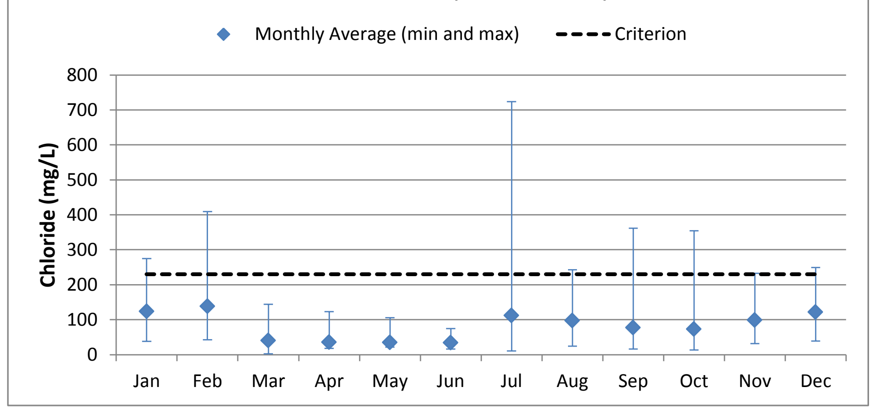
Sand Creek (includes AUIDs: 07020012-513 and 07020012-662)

WBID:	07020012-513
Watershed:	Scott County Natural Resources
Watershed Area (ac):	175,578
Impervious:	2%
TMDL (pounds of chloride/year):	56,423,754

Number of Individual Days with Samples	389
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	19
Percent of Sample Days Exceeding Criterion	5%
Average of Exceeding Samples (mg/L)	320



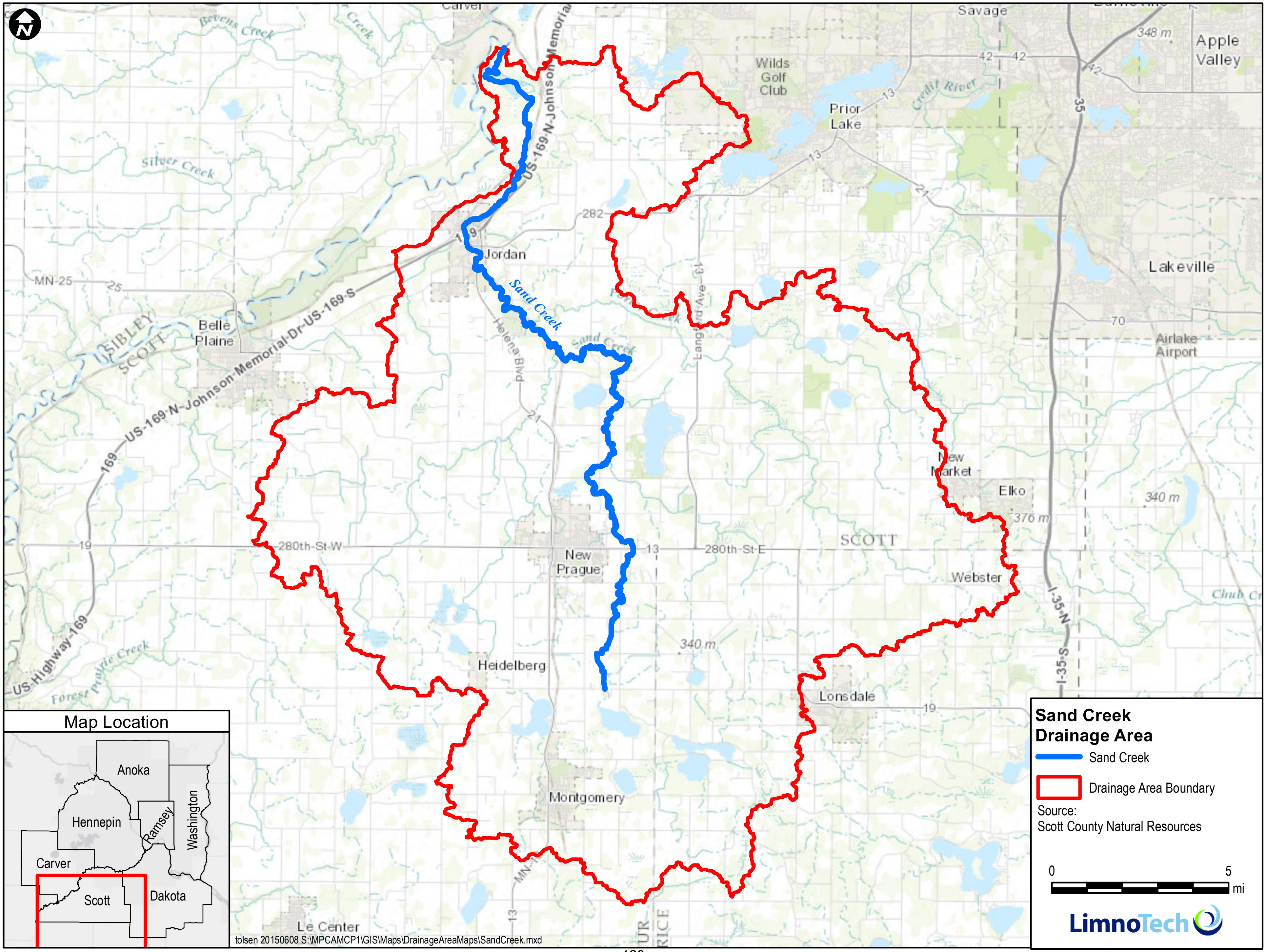
Sand Creek (includes AUIDs: 07020012-513 and 07020012-662) Annual Chloride Trend (average, min and max)



Sand Creek (includes AUIDs: 07020012-513 and 07020012-662) Monthly Chloride Trend (2003-2013 data)

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min	30	40	28	24	24	2	33	23	19	56	144
Max	104	217	191	56	116	123	275	85	56	367	409
Average	54	108	72	42	63	54	104	45	35	230	265
Season:	**Summer**	**(July-October)**									
Min	35	26	13	40	34	59	56	16	11	44	14
Max	135	82	141	150	724	475	137	46	98	93	246
Average	71	45	43	84	114	185	101	31	44	68	73

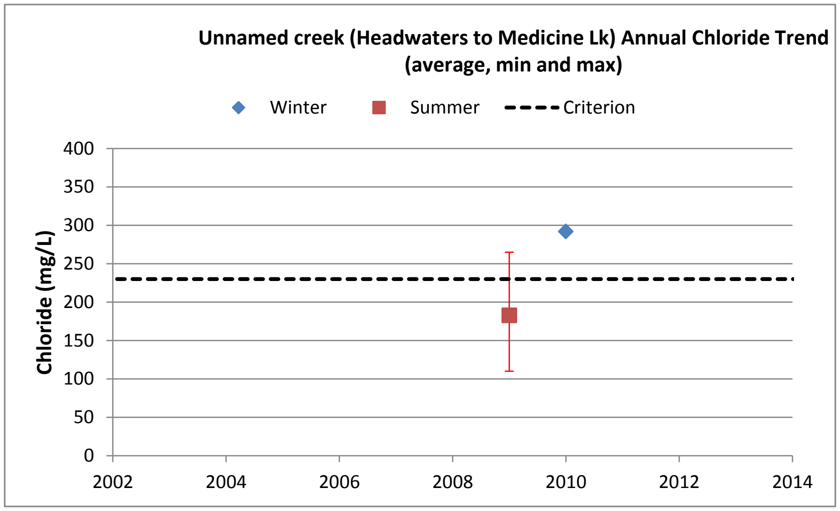
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min	38	43	2	18	22	16	11	24	16	13	32	39
Max	275	409	144	123	106	75	724	243	362	354	233	249
Average	124	139	40	36	35	34	112	98	78	73	99	122

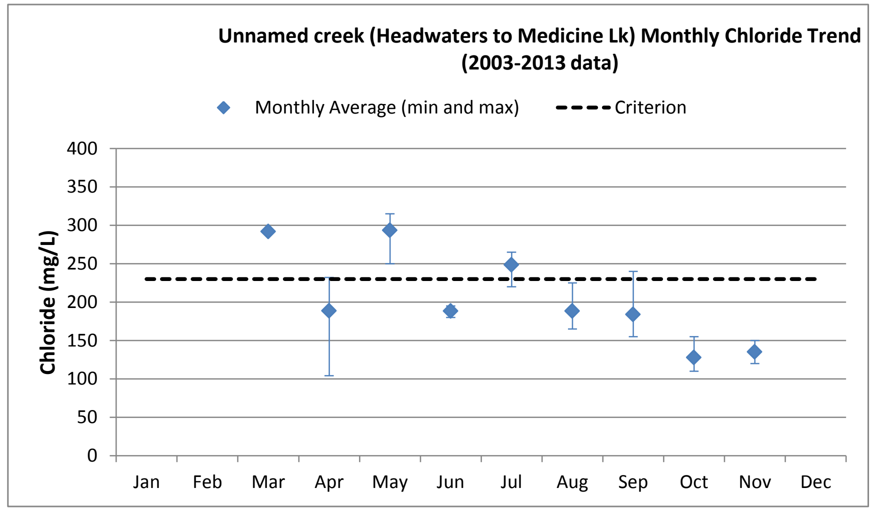

Sand Creek
Drainage Area
Sand Creek
Drainage Area Boundary
Source:
Scott County Natural Resources
0
5
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Jordan
Sand Creek
Belle Plaine
New Prague
Heidelberg
Montgomery
Lonsdale
Webster
New Market
Elko
Lakeville
Apple Valley
Savage
Prior Lake
Wilds Golf Club
Airlake Airport
Le Center
Carver
US-169-N-Johnson-Memorial-Dr-US-169-S
US Highway 169
280th-St-W
280th-St-E
Helena Blvd
Langford Ave
Silver Creek
Bevens Creek
Credit River
Forest Prairie Creek
SIBLEY
SCOTT
MN-25
I-35-N
I-35-S
340 m
348 m
376 m
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\SandCreek.mxd

Unnamed creek (Headwaters to Medicine Lk)

WBID:	07010206-526
Watershed:	Bassett Creek Watershed Management Commission
Watershed Area (ac):	6,447
Impervious:	38%
TMDL (pounds of chloride/year):	2,071,958

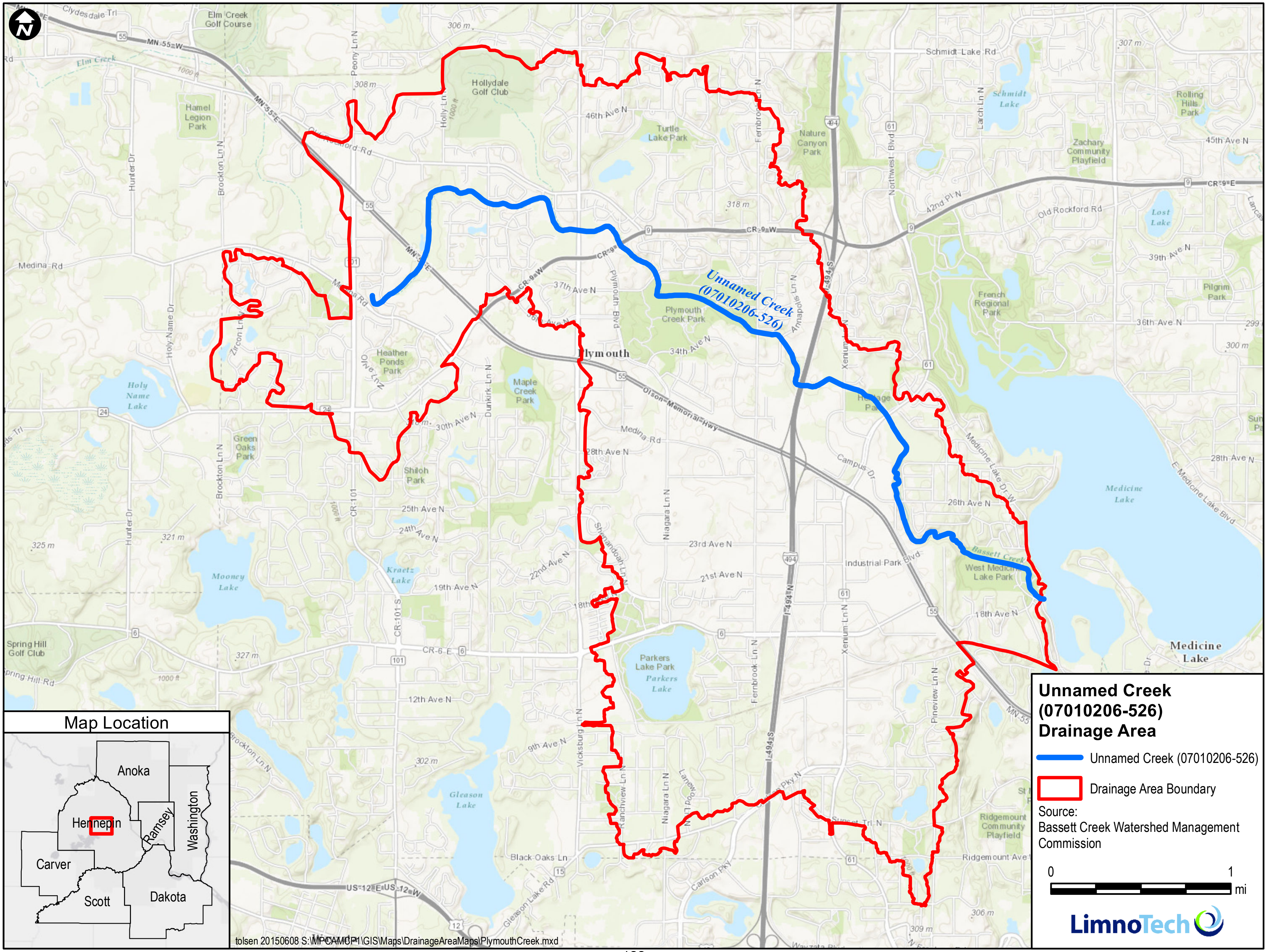
Number of Individual Days with Samples	27
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	8
Percent of Sample Days Exceeding Criterion	30%
Average of Exceeding Samples (mg/L)	271





Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min								292			
Max								292			
Average								292			
Season:	**Summer**	**(July-October)**									
Min							110				
Max							265				
Average							183				

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min			292	104	250	180	220	165	155	110	120	
Max			292	232	315	195	265	225	240	155	150	
Average			292	189	293	188	248	188	184	128	135	

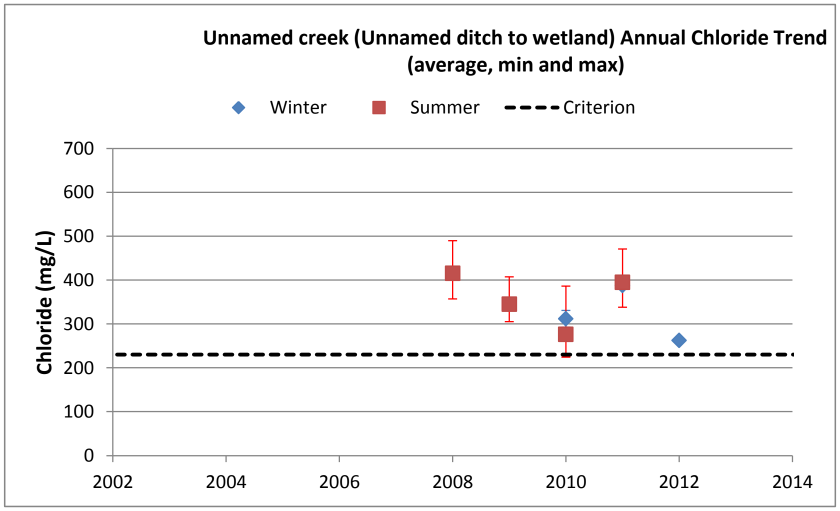


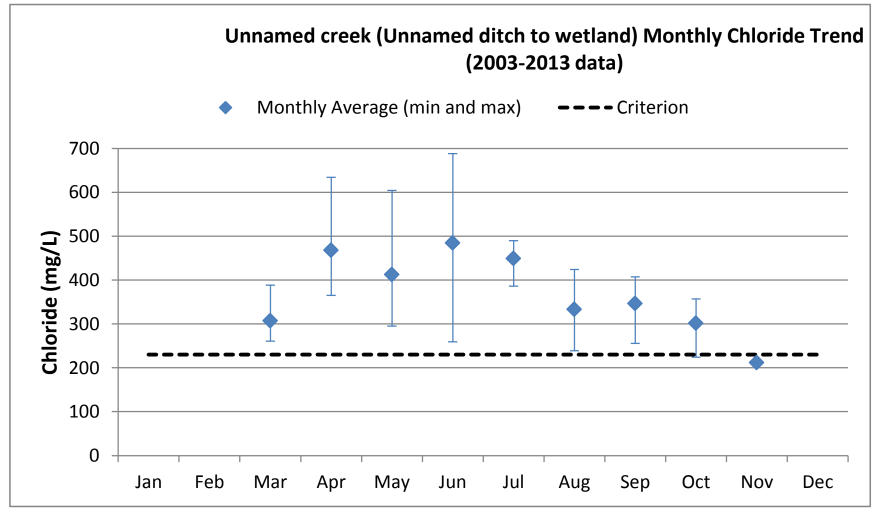
Unnamed Creek (07010206-526) Drainage Area
Unnamed Creek (07010206-526)
Drainage Area Boundary
Source:
Bassett Creek Watershed Management Commission
0
1
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Unnamed Creek (07010206-526)
Plymouth
Medicine Lake
Hollydale Golf Club
Elm Creek Golf Course
Hamel Legion Park
Turtle Lake Park
Nature Canyon Park
Zachary Community Playfield
Rolling Hills Park
Schmidt Lake
Plymouth Creek Park
French Regional Park
Pilgrim Park
Heather Ponds Park
Maple Creek Park
Green Oaks Park
Shiloh Park
Holy Name Lake
Mooney Lake
Kreatz Lake
Parkers Lake Park
Parkers Lake
Gleason Lake
West Medicine Lake Park
Ridgemount Community Playfield
Spring Hill Golf Club
Lost Lake
Bassett Creek
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\PlymouthCreek.mxd

Unnamed creek (Unnamed ditch to wetland)

WBID:	07010206-718
Watershed:	Minnehaha Creek Watershed District
Watershed Area (ac):	793
Impervious:	38%
TMDL (pounds of chloride/year):	254,852

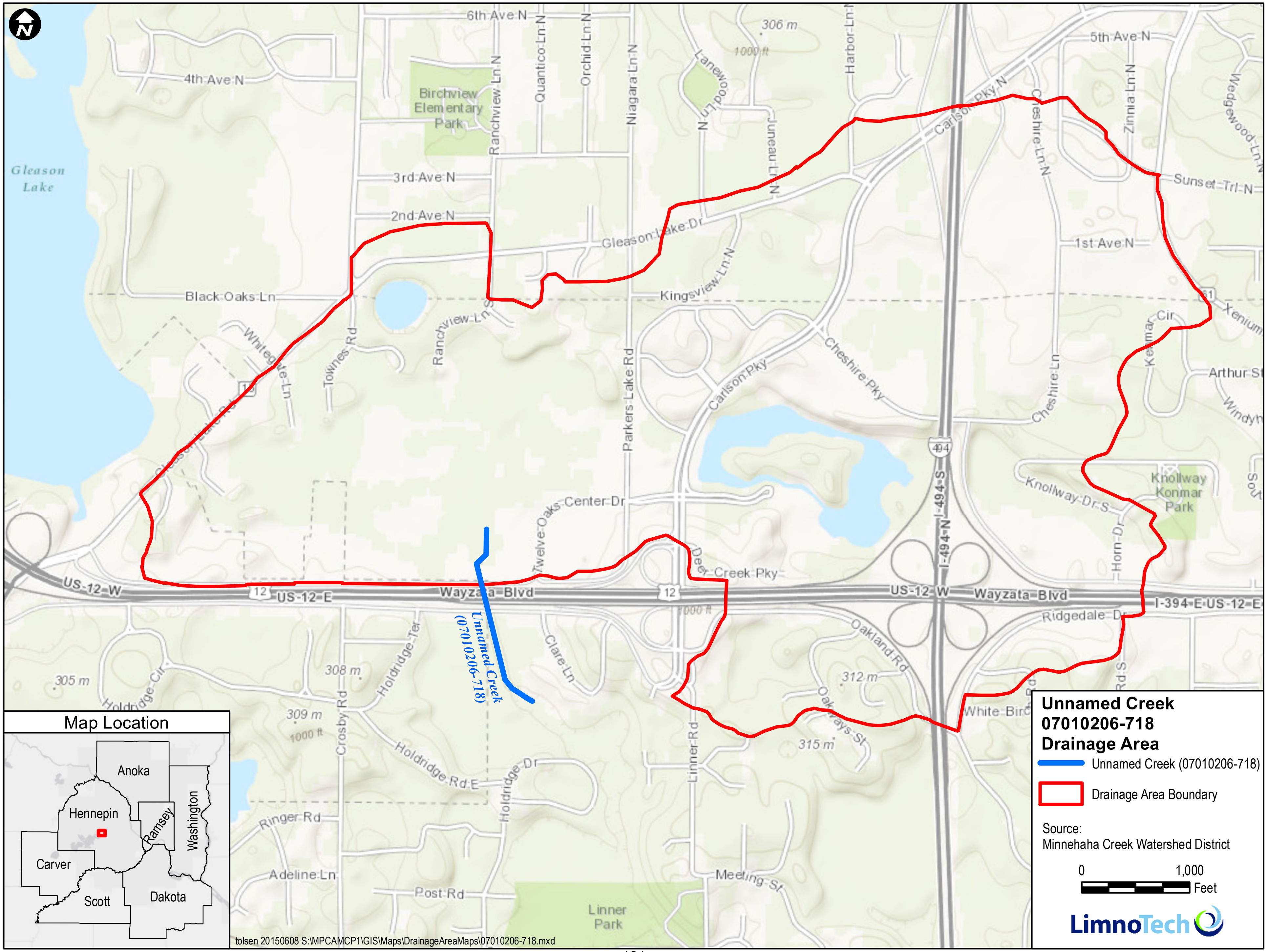
Number of Individual Days with Samples	35
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	33
Percent of Sample Days Exceeding Criterion	94%
Average of Exceeding Samples (mg/L)	399





Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min								293	388	261	
Max								331	388	264	
Average								312	388	263	
Season:	**Summer**	**(July-October)**									
Min						357	305	224	338		
Max						490	407	386	471		
Average						416	345	276	395		

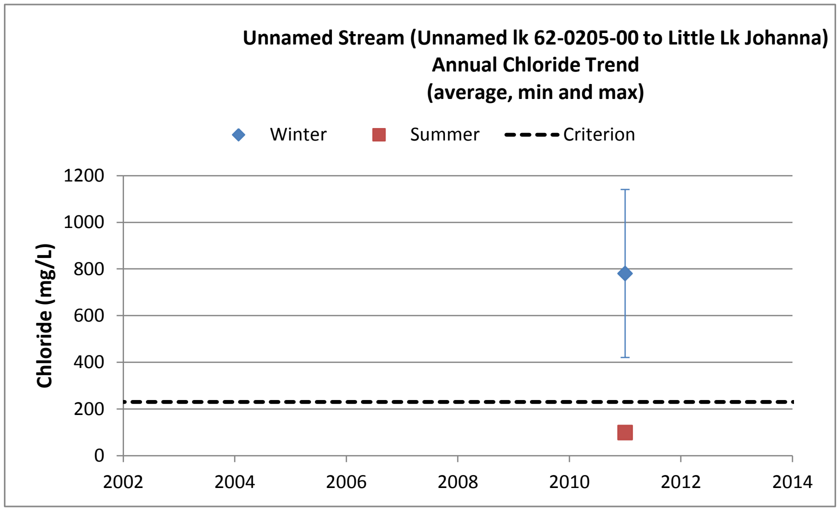
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min			261	365	295	259	386	239	256	224	212	
Max			388	634	604	688	490	424	407	357	212	
Average			307	468	413	485	449	334	347	302	212	

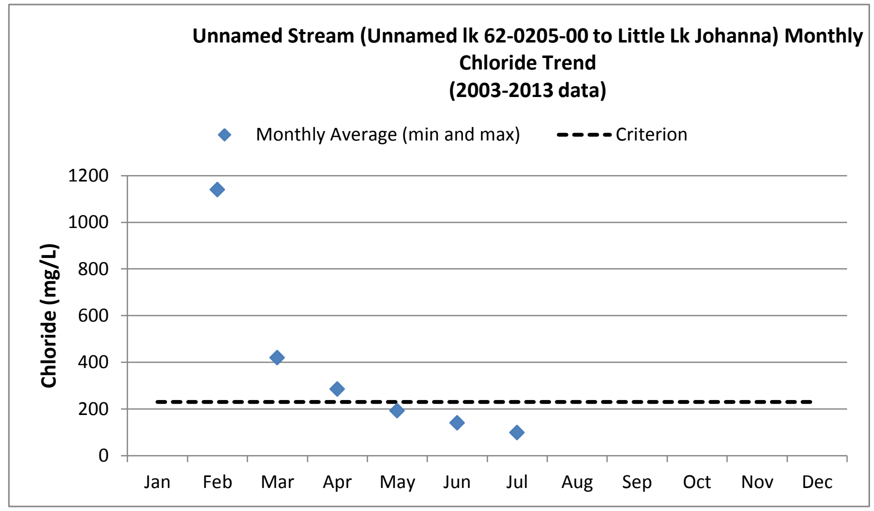

Unnamed Creek
07010206-718
Drainage Area
Unnamed Creek (07010206-718)
Drainage Area Boundary
Source:
Minnehaha Creek Watershed District
0
1,000
Feet
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Gleason Lake
Birchview Elementary Park
Knollway Konmar Park
Linner Park
Unnamed Creek (07010206-718)
6th Ave N
5th Ave N
4th Ave N
3rd Ave N
2nd Ave N
1st Ave N
Black Oaks Ln
Gleason Lake Dr
Kingsview Ln N
Carlson Pky
Cheshire Pky
Parkers Lake Rd
Twelve Oaks Center Dr
Deer Creek Pky
Wayzata Blvd
US-12-W
US-12-E
I-494-N
I-494-S
I-394-E US-12-E
Ridgedale Dr
Oakland Rd
Holdridge Rd E
Ringer Rd
Adeline Ln
Post Rd
Meeting St
Linner Rd
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\07010206-718.mxd

Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna)

WBID:	07010206-909
Watershed:	Rice Creek Watershed District
Watershed Area (ac):	1,627
Impervious:	52%
TMDL (pounds of chloride/year):	522,817

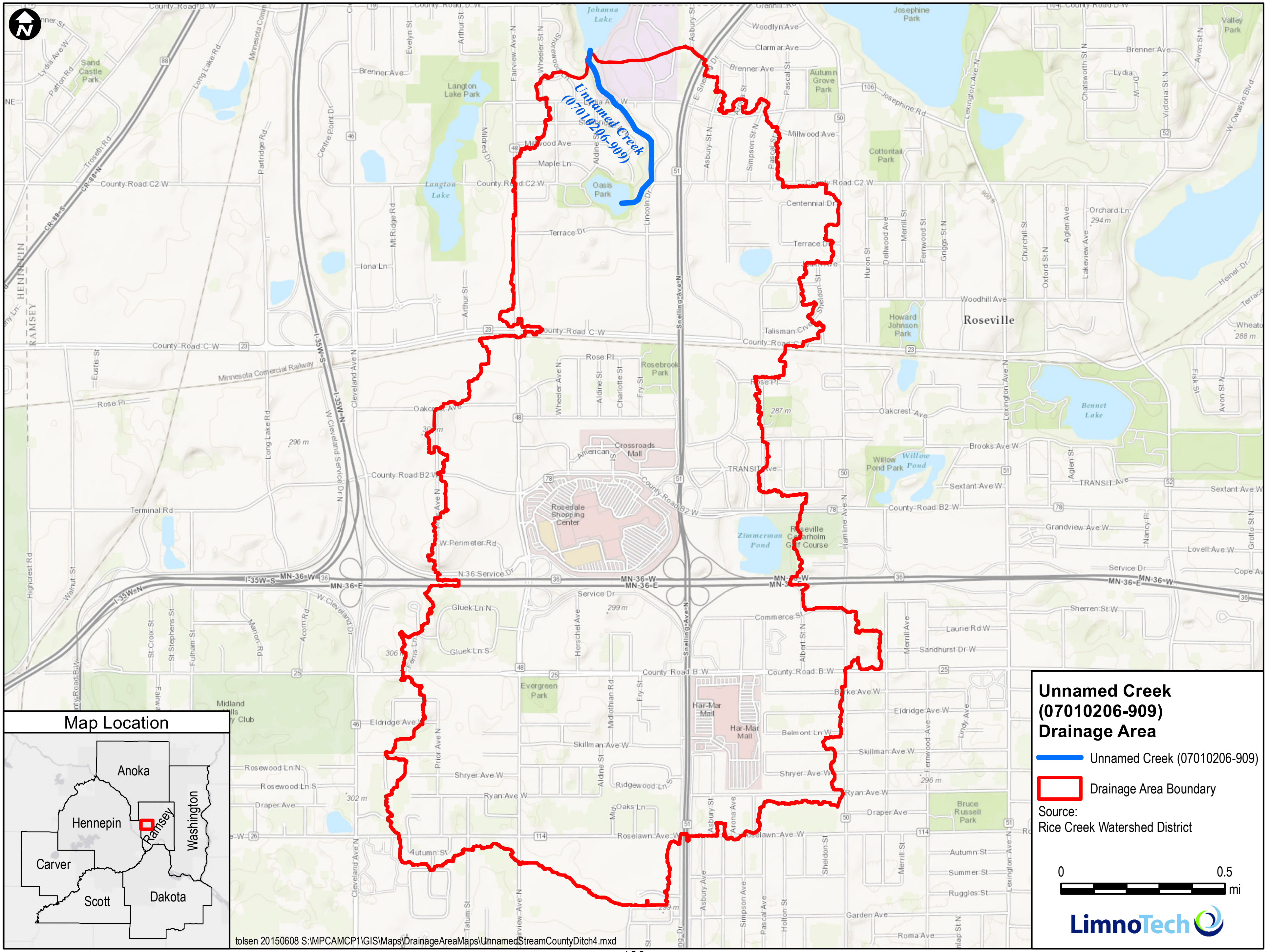
Number of Individual Days with Samples	6
Number of Days with Samples Exceeding 230 mg/L Chronic Criterion	3
Percent of Sample Days Exceeding Criterion	50%
Average of Exceeding Samples (mg/L)	615





Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Chloride concentration (mg/L)											
Season:	**Winter**	**(January-March)**									
Min									420		
Max									1140		
Average									780		
Season:	**Summer**	**(July-October)**									
Min									99		
Max									99		
Average									99		

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chloride concentration based on data available from 2003-2013 (mg/L)												
Min		1140	420	285	192	140	99					
Max		1140	420	285	192	140	99					
Average		1140	420	285	192	140	99					


Unnamed Creek
(07010206-909)
Drainage Area
Unnamed Creek (07010206-909)
Drainage Area Boundary
Source:
Rice Creek Watershed District
0
0.5
mi
LimnoTech
Map Location
Anoka
Hennepin
Ramsey
Washington
Carver
Scott
Dakota
Unnamed Creek
(07010206-909)
Roseville
Rosedale Shopping Center
Crossroads Mall
Har-Mar Mall
Johanna Lake
Josephine Park
Langton Lake
Oasis Park
Bennet Lake
Zimmerman Pond
Willow Pond Park
Howard Johnson Park
Rosebrook Park
Evergreen Park
Bruce Russell Park
Cottontail Park
Autumn Grove Park
Langton Lake Park
tolsen 20150608 S:\MPCAMCP1\GIS\Maps\DrainageAreaMaps\UnnamedStreamCountyDitch4.mxd

Appendix A-2 – Impaired and High Risk Waterbodies by Location

Table A-2.1. Impaired Lakes, Wetlands and Streams by MS4

MS4	Lake/Stream	WBID
Anoka County MS400066	South Long Lake Pike Lake Silver Lake	62-0067-02 62-0069-00 62-0083-00
Arden Hills City MS400002	Little Johanna Lake South Long Lake Pike Lake Valentine Lake	62-0058-00 62-0067-02 62-0069-00 62-0071-00
Belle Plaine- future MS4	Raven Stream Sand Creek - includes 07020012-662	07020012-716 07020012-513 and 07020012-662
Birchwood Village City MS400004	South Long Lake	62-0067-02
Blaine City MS400075	South Long Lake	62-0067-02
Brooklyn Park City MS400007	Bass Creek	07010206-784
Capitol Region WD MS400206	Como Lake	62-0055-00
Carver County MS400070	Minnehaha Creek	07010206-539
Centerville City MS400078	South Long Lake	62-0067-02
Century College MS400171	Kohlman Lake South Long Lake	62-0006-00 62-0067-02
Champlin City MS400008	Elm Creek	07010206-508
Chanhassen City MS400079	Minnehaha Creek	07010206-539
Circle Pines City MS400009	South Long Lake	62-0067-02
Columbia Heights City MS400010	South Long Lake Pike Lake Silver Lake	62-0067-02 62-0069-00 62-0083-00
Corcoran City MS400081	Elm Creek Rush Creek, South Fork	07010206-508 07010206-732
Crystal City MS400012	Bassett Creek	07010206-538
Dakota County MS400132	Thompson Lake	19-0048-00
Dayton City MS400083	Elm Creek	07010206-508
Deephaven City MS400013	Minnehaha Creek	07010206-539
Dellwood City MS400084	South Long Lake	62-0067-02
Edina City MS400016	Minnehaha Creek	07010206-539
Elko New Market City MS400237	Sand Creek - includes 07020012-662	07020012-513 and 07020012-662
Excelsior City MS400017	Minnehaha Creek	07010206-539
Falcon Heights City MS400018	Como Lake Little Johanna Lake South Long Lake Pike Lake Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna)	62-0055-00 62-0058-00 62-0067-02 62-0069-00 07010206-909
Forest Lake City MS400262	Unnamed Creek South Long Lake	07030005-525 62-0067-02

MS4	Lake/Stream	WBID
Fridley City MS400019	South Long Lake Pike Lake	62-0067-02 62-0069-00
Gem Lake City MS400020	Kohlman Lake	62-0006-00
Golden Valley City MS400021	Bassett Creek Brownie Lake Minnehaha Creek Sweeney Lake Wirth Lake	07010206-538 27-0038-00 07010206-539 27-0035-01 27-0037-00
Grant City MS400091	South Long Lake	62-0067-02
Greenwood City MS400022	Minnehaha Creek	07010206-539
Hennepin County MS400138	Bass Creek Bassett Creek Diamond Lake Elm Creek South Long Lake Minnehaha Creek Parkers Lake Peavey Lake Pike Lake Powderhorn Lake Rush Creek, South Fork Silver Lake Sweeney Lake Unnamed creek (Headwaters to Medicine Lk) Unnamed Creek (Unnamed ditch to wetland) Wirth Lake	07010206-784 07010206-538 27-0022-00 07010206-508 62-0067-02 07010206-539 27-0107-00 27-0138-00 62-0069-00 27-0014-00 07010206-732 62-0083-00 27-0035-01 07010206-526 07010206-718 27-0037-00
Hopkins City MS400024	Minnehaha Creek	07010206-539
Hugo City MS400094	South Long Lake	62-0067-02
Independence City MS400095	Minnehaha Creek	07010206-539
Jackson Township MS400140	Sand Creek - includes 07020012-662	07020012-513 and 07020012-662
Jordan- future MS4	Sand Creek - includes 07020012-662	07020012-513 and 07020012-662
Laketown Township MS400142	Minnehaha Creek	07010206-539
Landfall City MS400025	Battle Creek Battle Creek Lake Tanners Lake	07010206-592 82-0091-00 82-0115-00
Lauderdale City MS400026	South Long Lake Pike Lake	62-0067-02 62-0069-00
Lexington City MS400027	South Long Lake	62-0067-02
Lino Lakes City MS400100	South Long Lake	62-0067-02
Little Canada City MS400029	Kohlman Lake	62-0006-00

MS4	Lake/Stream	WBID
Long Lake City MS400101	Minnehaha Creek	07010206-539
Louisville Township MS400144	Sand Creek - includes 07020012-662	07020012-513 and 07020012-662
Mahtomedi City MS400031	South Long Lake	62-0067-02
Maple Grove City MS400102	Bass Creek Elm Creek Rush Creek, South Fork	07010206-784 07010206-508 07010206-732
Maple Plain City MS400103	Minnehaha Creek	07010206-539
Maplewood City MS400032	Battle Creek Battle Creek Lake Carver Lake Kohlman Lake Tanners Lake	07010206-592 82-0091-00 82-0166-00 62-0006-00 82-0115-00
Medicine Lake City MS400104	Bassett Creek	07010206-538
Medina City MS400105	Bassett Creek Elm Creek Minnehaha Creek Rush Creek, South Fork Unnamed creek (Headwaters to Medicine Lk)	07010206-538 07010206-508 07010206-539 07010206-732 07010206-526
Minneapolis Municipal Storm Water MN0061018	Bassett Creek Brownie Lake Diamond Lake Loring Pond (South Bay) Minnehaha Creek Powderhorn Lake Silver Lake Spring Lake Wirth Lake	07010206-538 27-0038-00 27-0022-00 27-0655-02 07010206-539 27-0014-00 62-0083-00 27-0654-00 27-0037-00
Minnehaha Creek WD MS400182	Brownie Lake Diamond Lake Minnehaha Creek Peavey Lake Powderhorn Lake Unnamed Creek (Unnamed ditch to wetland)	27-0038-00 27-0022-00 07010206-539 27-0138-00 27-0014-00 07010206-718
Minnesota Correctional-Lino Lakes MS400177	South Long Lake	62-0067-02
Minnetonka Beach City MS400036	Minnehaha Creek	07010206-539
Minnetonka City MS400035	Bassett Creek Minnehaha Creek Unnamed creek (Headwaters to Medicine Lk) Unnamed Creek (Unnamed ditch to wetland	07010206-538 07010206-539 07010206-526 07010206-718
Minnetrista City MS400106	Minnehaha Creek	07010206-539

MS4	Lake/Stream	WBID
MnDOT Metro District MS400170	Bass Creek Bassett Creek Battle Creek Battle Creek Lake Brownie Lake Carver Lake Como Lake Diamond Lake Elm Creek Kasota Ponds North Kasota Ponds West Kohlman Lake Little Johanna Lake South Long Lake Mallard Marsh Minnehaha Creek Parkers Lake Peavey Lake Pike Lake Spring Lake Sweeney Lake Tanners Lake Thompson Unnamed creek (Headwaters to Medicine Lk) Unnamed Creek (Unnamed ditch to wetland Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna) Valentine Lake Wirth Lake	07010206-784 07010206-538 07010206-592 82-0091-00 27-0038-00 82-0166-00 62-0055-00 27-0022-00 07010206-508 62-0280-00 62-0281-00 62-0006-00 62-0058-00 62-0067-02 62-0259-00 07010206-539 27-0107-00 27-0138-00 62-0069-00 27-0654-00 27-0035-01 82-0115-00 19-0048-00 07010206-526 07010206-718 07010206-909 62-0071-00 27-0037-00
Mounds City MS400108	Minnehaha Creek	07010206-539
Mounds View City MS400037	South Long Lake	62-0067-02
New Brighton City MS400038	Pike Lake Silver Lake South Long Lake	62-0069-00 62-0083-00 62-0067-02
New Hope City MS400039	Bass Creek Bassett Creek	07010206-784 07010206-538
New Prague- future MS4	Raven Stream Raven Stream, East Branch Sand Creek - includes 07020012-662	07020012-716 07020012-543 07020012-513 and 07020012-662
North Oaks City MS400109	South Long Lake	62-0067-02
North St Paul City MS400041	Kohlman Lake	62-0006-00
Oakdale City MS400042	Battle Creek Battle Creek Lake Kohlman Lake	07010206-592 82-0091-00 62-0006-00

MS4	Lake/Stream	WBID
	Tanners Lake	82-0115-00
Orono City MS400111	Minnehaha Creek Peavey Lake	07010206-539 27-0138-00
Plymouth City MS400112	Bass Creek Bassett Creek Elm Creek Minnehaha Creek Parkers Lake Unnamed creek (Headwaters to Medicine Lk) Unnamed Creek (Unnamed ditch to wetland	07010206-784 07010206-538 07010206-508 07010206-539 27-0107-00 07010206-526 07010206-718
Prior Lake City MS400113	Sand Creek - includes 07020012-662	07020012-513 and 07020012-662
Ramsey County Public Works MS400191	Battle Creek Battle Creek Lake Carver Lake Como Lake Kohlman Lake Little Johanna Lake South Long Lake Mallard Marsh Pike Lake Silver Lake Tanners Lake Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna) Valentine Lake	07010206-592 82-0091-00 82-0166-00 62-0055-00 62-0006-00 62-0058-00 62-0067-02 62-0259-00 62-0069-00 62-0083-00 82-0115-00 07010206-909 62-0071-00
Ramsey-Washington Metro WD MS400190	Battle Creek Battle Creek Lake Carver Lake Kohlman Lake Tanners Lake	07010206-592 82-0091-00 82-0166-00 62-0006-00 82-0115-00
Rice Creek WD MS400193	Little Johanna Lake South Long Lake Pike Lake Silver Lake Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna) Valentine Lake	62-0058-00 62-0067-02 62-0069-00 62-0083-00 07010206-909 62-0071-00
Richfield City MS400045	Minnehaha Creek	07010206-539
Robbinsdale City MS400046	Bassett Creek	07010206-538
Rogers- future MS4	Elm Creek	07010206-508
Roseville City MS400047	Como Lake Little Johanna Lake South Long Lake	62-0055-00 62-0058-00 62-0067-02

MS4	Lake/Stream	WBID
	Pike Lake Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna)	62-0069-00 07010206-909
Shakopee City MS400120	Sand Creek - includes 07020012-662	07020012-513 and 07020012-662
Shoreview City MS400121	South Long Lake Valentine Lake	62-0067-02 62-0071-00
Shorewood City MS400122	Minnehaha Creek	07010206-539
Spring Lake Township MS400156	Sand Creek - includes 07020012-662	07020012-513 and 07020012-662
Spring Park City MS400123	Minnehaha Creek	07010206-539
St Anthony Village City MS400051	Pike Lake Silver Lake South Long Lake	62-0069-00 62-0083-00 62-0067-02
St Bonifacius City MS400124	Minnehaha Creek	07010206-539
St Louis Park City MS400053	Bassett Creek Brownie Lake Minnehaha Creek Sweeney Lake	07010206-538 27-0038-00 07010206-539 27-0035-01
St Paul Municipal Storm Water MN0061263	Battle Creek Como Lake Kasota Ponds North Kasota Ponds West Mallard Marsh	07010206-592 62-0055-00 62-0280-00 62-0281-00 62-0259-00
Tanner's Alum WTP MN0067661	Battle Creek Battle Creek Lake Tanners Lake	07010206-592 82-0091-00 82-0115-00
Tonka Bay City MS400056	Minnehaha Creek	07010206-539
UMN-Twin Cities Campus MS400212	Little Johanna Lake South Long Lake Pike Lake Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna)	62-0058-00 62-0067-02 62-0069-00 07010206-909
Vadnais Heights City MS400057	Kohlman Lake	62-0006-00
Victoria City MS400126	Minnehaha Creek	07010206-539
Washington County MS400160	Battle Creek Battle Creek Lake Carver Lake Kohlman Lake South Long Lake Tanners Lake	07010206-592 82-0091-00 82-0166-00 62-0006-00 62-0067-02 82-0115-00
Wayzata City MS400058	Minnehaha Creek Peavey Lake Unnamed Creek (Unnamed ditch to wetland	07010206-539 27-0138-00 07010206-718
West St Paul City MS400059	Thompson Lake	19-0048-00
White Bear Lake City MS400060	Kohlman Lake South Long Lake	62-0006-00 62-0067-02

MS4	Lake/Stream	WBID
White Bear Township MS400163	Kohlman Lake South Long Lake	62-0006-00 62-0067-02
Willernie City MS400061	South Long Lake	62-0067-02
Woodbury City MS400128	Battle Creek Battle Creek Lake Carver Lake Tanners Lake	07010206-592 82-0091-00 82-0166-00 82-0115-00
Woodland City MS400129	Minnehaha Creek	07010206-539

Table A-2.2. Impaired Lakes, Wetlands and Streams by WD & WMO

WD/WMO	Lake/Stream	WBID
Bassett Creek WMC	Bassett Creek	07010206-538
	Parkers Lake	27-0107-00
	Unnamed creek (Headwaters to Medicine Lk)	07010206-526
	Spring Lake	27-0654-00
	Sweeney Lake	27-0035-01
	Wirth Lake	27-0037-00
Capitol Region WD	Como Lake	62-0055-00
Comfort Lake Forest Lake WD	Unnamed Stream	07030005-525
Elm Creek WMC	Elm Creek	07010206-508
	Rush Creek, South Fork	07010206-732
Lower Mississippi River WMO	Thompson Lake	19-0048-00
Minnehaha Creek WD	Brownie Lake	27-0038-00
	Diamond Lake	27-0022-00
	Minnehaha Creek	07010206-539
	Peavey Lake	27-0138-00
	Powderhorn Lake	27-0014-00
	Unnamed Creek (Unnamed ditch to wetland	07010206-718
Mississippi WMO	Kasota Ponds North	62-0280-00
	Kasota Ponds West	62-0281-00
	Loring Pond (South Bay)	27-0655-02
	Mallard Marsh	62-0259-00
Nine Mile Creek WD	Nine Mile Creek	07020012-518
Ramsey Washington Metro WD	Battle Creek	07010206-592
	Battle Creek Lake	82-0091-00
	Carver Lake	82-0166-00
	Kohlman Lake	62-0006-00
	Tanners Lake	82-0115-00
Rice Creek WD	Little Johanna Lake	62-0058-00
	South Long Lake	62-0067-02
	Pike Lake	62-0069-00
	Silver Lake	62-0083-00
	Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna)	07010206-909
	Valentine Lake	62-0071-00
Scott County WMO	Raven Stream	07020012-716
	Raven Stream, East Branch	07020012-543
	Sand Creek - includes 07020012-662	07020012-513 and 07020012-662
Shingle Creek WMO	Bass Creek	07010206-784
	Shingle Creek	07010206-506

Table A-2.3. High Risk Lakes and Streams by WD & WMO

WD/WMO	Lake/Stream	WBID
Bassett Creek WMC	Unnamed Creek	07010206-740
	Unnamed Stream In Plymouth	07010206-738
	Unnamed Stream Receiving Wtr From Medicine Lk	07010206-785
	Medicine Lake	27-0104-00
Browns Creek WD	Unnamed Stream (Trib To Long Lk) (Furgala Creek)	07030005-765
Capitol Region WD	Crosby Lake	62-0047-00
	McCarron Lake	62-0054-00
Carver County WMO	Bevens Creek	07020012-718
Coon Creek WD	County Ditch 17 (Spring Brook)	07010206-557
	Unnamed Creek (Pleasure Ck)	07010206-594
	Unnamed Stream (Sand Ck)	07010206-744
Eagan-Inver Grove Heights WMO	Fish Lake	19-0057-00
Elm Creek WMC	Diamond Creek	07010206-525
	Rush Creek	07010206-528
Middle St. Croix River WMO	Unnamed Stream (Perro Ck)	07030005-612
Minnehaha Creek WD	Calhoun Lake	27-0031-00
	Classen Lake Creek	07010206-703
	Dutch Lake Outlet	07010206-678
	Hiawatha Lake	27-0018-00
	Lake Of The Isles	27-0040-00
	Painter Creek	07010206-700
	Taft Lake	27-0683-00
	Unnamed Creek	07010206-704
Ramsey-Washington Metro WD	Beaver Lake	62-0016-00
	Bennett Lake	62-0048-00
	Fish Creek	07010206-606
	Gervais Lake	62-0007-00
	Keller Lake (Main)	62-0010-02
	Unnamed Lake	62-0278-00
	Wabasso Lake	62-0082-00
	Wakefield Lake	62-0011-00
Rice Creek WD	Centerville Lake	02-0006-00
	Clearwater Creek	07010206-519
	Johanna Lake	62-0078-00
Riley-Purgatory-Bluff Creek WD	Bluff Creek	07020012-710
Scott WMO	Credit River	07020012-517
Shingle Creek WMC	Crystal Lake	27-0034-00
	Ryan Lake	27-0058-00

Appendix A-3 – NPDES Point Source Permits by Waterbody

Table A-3.1. NPDES Source Permits by Lake

Lake	AUID	Wastewater Source	NPDES Permit #
Kohlman Lake	62-0006-00	HB Fuller Co - Willow Lake	MN0051811
Parkers Lake	27-0107-00	AaCron Inc AaCron Inc Medivators	MNG250002 MNG250002 MN0063541
Peavey Lake	27-0138-00	Wayzata WTP - Plant 2	MNG640096
Pike Lake	62-0069-00	New Brighton WTP - Wells 10 & 11 New Brighton WTP - Wells 10 & 11	MNG640068 MNG640068
South Long Lake	62-0067-02	Forest Lake WTP Saint Croix Forge Inc	MNG640118 MN0069051

Table A-3.2. NPDES Source Permits by Stream

Stream	AUID	Wastewater Source	NPDES Permit #
Bassett Creek	07010206-538	Honeywell-Plymouth Operations Honeywell International Inc St Louis Park WTP AaCron Inc AaCron Inc Medivators	MN0063266 MNG255088 MNG640084 MNG250002 MNG250002 MN0063541
Minnehaha Creek	07010206-539	Boomerang Laboratories Inc Kwong Tung Foods Inc MAC - Minneapolis/St Paul Intl Airport Nilfisk-Advance Inc St Louis Park GWP - Reilly Tar Site St Louis Park GWP - Reilly Tar Site St Louis Park WTP St Louis Park WTP St Louis Park WTP Wayzata WTP - Plant 2	MN0066508 MN0062723 MN0002101 MN0066648 MN0045489 MN0045489 MNG640084 MNG640084 MNG640084 MNG640096
Raven Stream, East Branch	07020012-543	New Prague WTP New Prague WWTP	MNG640117 MN0020150
Raven Stream	07020012-716	New Prague WTP New Prague WWTP	MNG640117 MN0020150
Rush Creek, South Fork	07010206-732	Maple Hill Estates	MN0031127
Sand Creek	07020012-513 and 07020012-662	New Prague WTP New Prague WWTP Jordan WWTP Montgomery WWTP Seneca Foods Corp - Montgomery	MNG640117 MN0020150 MN0020869 MN0024210 MN0001279

Appendix A-4 – TMDL Tables

Lake	AUID	Watershed Area (ac)	Loading Capacity (TMDL) (lbs/yr)	Margin of Safety (lbs/yr)	Background LA - (lbs/yr)	Rural areas/non-permitted areas	Rural/non-permitted LA (lbs/yr)	Permitted MS4	NPDES Permit #	MS4 Categorical WLA (lbs/yr)	Wastewater Source	NPDES Permit #	Wastewater WLA (lbs/yr)
Battle Creek Lake	82-0091-00	4,326	2,153,698	215,370	172,296			Ramsey County Public Works MS4	MS400191	1,766,033			
								MNDOT Metro District MS4	MS400170				
								Ramsey-Washington Metro WD MS4	MS400190				
								Maplewood City MS4	MS400032				
								Woodbury City MS4	MS400128				
								Washington County MS4	MS400160				
								Oakdale City MS4	MS400042				
								Landfall City MS4	MS400025				
								Tanner's Alum WTP	MN0067661				
Brownie Lake	27-0038-00	452	341,418	34,142	27,313			Golden Valley City MS4	MS400021	279,963			
								MNDOT Metro District MS4	MS400170				
								Minnehaha Creek WD MS4	MS400182				
								St Louis Park City MS4	MS400053				
								Minneapolis Municipal Storm Water	MN0061018				
Carver Lake	82-0166-00	2,242	1,071,124	107,112	85,690			Woodbury City MS4	MS400128	878,321			
								Ramsey County Public Works MS4	MS400191				
								Maplewood City MS4	MS400032				
								MNDOT Metro District MS4	MS400170				
								Ramsey-Washington Metro WD MS4	MS400190				
								Washington County MS4	MS400160				
Como Lake	62-0055-00	1,850	994,078	99,408	79,526			Ramsey County Public Works MS4	MS400191	815,144			
								Roseville City MS4	MS400047				
								MNDOT Metro District MS4	MS400170				
								St Paul Municipal Storm Water	MN0061263				
								Capitol Region WD MS4	MS400206				
								Falcon Heights City MS4	MS400018				
Diamond Lake	27-0022-00	744	486,017	48,602	38,881			Hennepin County MS4	MS400138	398,534			
								Minneapolis Municipal Storm Water	MN0061018				
								MNDOT Metro District MS4	MS400170				
								Minnehaha Creek WD MS4	MS400182				
Kasota Ponds North	62-0280-00	10	6,234	623	499			St Paul Municipal Storm Water	MN0061263	5,112			
								MNDOT Metro District MS4	MS400170				
Kasota Ponds West	62-0281-00	6	5,742	574	459			St Paul Municipal Storm Water	MN0061263	4,708			
								MNDOT Metro District MS4	MS400170				
Kohlman Lake	62-0006-00	7,533	4,839,183	378,870	303,096			Ramsey County Public Works MS4	MS400191	3,106,733	HB Fuller Co - Willow Lake	MN0051811	1,050,484
								Gem Lake City MS4	MS400020				
								MNDOT Metro District MS4	MS400170				
								Vadnais Heights City MS4	MS400057				
								White Bear Lake City MS4	MS400060				
								Ramsey-Washington Metro WD MS4	MS400190				
								Little Canada City MS4	MS400029				
								Maplewood City MS4	MS400032				
								North St Paul City MS4	MS400041				
								Oakdale City MS4	MS400042				
								White Bear Township MS4	MS400163				
								Washington County MS4	MS400160				
								Century College MS4	MS400171				

Lake	AUID	Watershed Area (ac)	Loading Capacity (TMDL) (lbs/yr)	Margin of Safety (lbs/yr)	Background LA - (lbs/yr)	Rural areas/non-permitted areas	Rural/non-permitted LA (lbs/yr)	Permitted MS4	NPDES Permit #	MS4 Categorical WLA (lbs/yr)	Wastewater Source	NPDES Permit #	Wastewater WLA (lbs/yr)
Little Johanna Lake	62-0058-00	1,703	1,224,243	122,424	97,939			Ramsey County Public Works MS4	MS400191	1,003,879			
								Roseville City MS4	MS400047				
								MNDOT Metro District MS4	MS400170				
								Arden Hills City MS4	MS400002				
								Rice Creek WD MS4	MS400193				
								Falcon Heights City MS4	MS400018				
								U of M-Twin Cities Campus MS4	MS400212				
Loring Pond (South Bay)	27-0655-02	34	9,764	976	781			Minneapolis Municipal Storm Water	MN0061018	8,007			
Mallard Marsh	62-0259-00	16	9,851	985	788			Ramsey County Public Works MS4	MS400191	8,077			
								St Paul Municipal Storm Water	MN0061263				
								MNDOT Metro District MS4	MS400170				
Parkers Lake	27-0107-00	1,064	1,431,262	64,410	51,528			Hennepin County MS4	MS400138	528,161	AaCron Inc	MNG250002	553,255
								Plymouth City MS4	MS400112		AaCron Inc	MNG250002	143,566
								MNDOT Metro District MS4	MS400170		Medivators	MN0063541	90,342
Peavey Lake	27-0138-00	776	205,995	20,230	16,184			Hennepin County MS4	MS400138	165,889	Wayzata WTP - Plant 2	MNG640096	3,692
								Wayzata City MS4	MS400058				
								MNDOT Metro District MS4	MS400170				
								Minnehaha Creek WD MS4	MS400182				
								Orono City MS4	MS400111				
Pike Lake	62-0069-00	5,735	3,591,268	359,021	287,217			Anoka County MS4	MS400066	2,943,971	New Brighton WTP - Wells 10 & 11	MNG640068	530
								Columbia Heights City MS4	MS400010		New Brighton WTP - Wells 10 & 11	MNG640068	530
								MNDOT Metro District MS4	MS400170				
								Fridley City MS4	MS400019				
								Hennepin County MS4	MS400138				
								Roseville City MS4	MS400047				
								St Anthony Village City MS4	MS400051				
								Ramsey County Public Works MS4	MS400191				
								Rice Creek WD MS4	MS400193				
								Arden Hills City MS4	MS400002				
								Falcon Heights City MS4	MS400018				
								Lauderdale City MS4	MS400026				
								New Brighton City MS4	MS400038				
								U of M-Twin Cities Campus MS4	MS400212				
Powderhorn Lake	27-0014-00	332	218,587	21,859	17,487			Hennepin County MS4	MS400138	179,242			
								Minneapolis Municipal Storm Water	MN0061018				
								Minnehaha Creek WD MS4	MS400182				
Silver Lake	62-0083-00	655	370,011	37,001	29,601			Anoka County MS4	MS400066	303,409			
								Columbia Heights City MS4	MS400010				
								Hennepin County MS4	MS400138				
								Minneapolis Municipal Storm Water	MN0061018				
								St Anthony Village City MS4	MS400051				
								Rice Creek WD MS4	MS400193				
								New Brighton City MS4	MS400038				
								Ramsey County Public Works MS4	MS400191				

Lake	AUID	Watershed Area (ac)	Loading Capacity (TMDL) (lbs/yr)	Margin of Safety (lbs/yr)	Background LA - (lbs/yr)	Rural areas/non-permitted areas	Rural/non-permitted LA (lbs/yr)	Permitted MS4	NPDES Permit #	MS4 Categorical WLA (lbs/yr)	Wastewater Source	NPDES Permit #	Wastewater WLA (lbs/yr)
South Long Lake	62-0067-02	114,785	26,334,624	2,633,059	2,106,448	May (Township)	56,826	Lexington City MS4	MS400027	21,534,261	Forest Lake WTP	MNG640118	2,594
						Scandia (City)		Mahtomedi City MS4	MS400031		Saint Croix Forge Inc	MN0069051	1,436
						MNDOT		Mounds View City MS4	MS400037				
								Blaine City MS4	MS400075				
								Centerville City MS4	MS400078				
								Dellwood City MS4	MS400084				
								Grant City MS4	MS400091				
								Hugo City MS4	MS400094				
								Lino Lakes City MS4	MS400100				
								North Oaks City MS4	MS400109				
								Shoreview City MS4	MS400121				
								White Bear Township MS4	MS400163				
								Forest Lake City MS4	MS400262				
								Anoka County MS4	MS400066				
								MNDOT Metro District MS4	MS400170				
								Ramsey County Public Works MS4	MS400191				
								Arden Hills City MS4	MS400002				
								White Bear Lake City MS4	MS400060				
								Columbia Heights City MS4	MS400010				
								Fridley City MS4	MS400019				
								Hennepin County MS4	MS400138				
								Roseville City MS4	MS400047				
								St Anthony Village City MS4	MS400051				
								Circle Pines City MS4	MS400009				
								Rice Creek WD MS4	MS400193				
								Birchwood Village City MS4	MS400004				
								New Brighton City MS4	MS400038				
								Washington County MS4	MS400160				
								Willernie City MS4	MS400061				
								Falcon Heights City MS4	MS400018				
								Lauderdale City MS4	MS400026				
								Minnesota Correctional-Lino Lakes MS4	MS400177				
								Century College MS4	MS400171				
								U of M-Twin Cities Campus MS4	MS400212				
Spring Lake	27-0654-00	39	15,600	1,560	1,248			Minneapolis Municipal Storm Water	MN0061018	12,792			
								MNDOT Metro District MS4	MS400170				
Sweeney Lake	27-0035-01	2,439	1,456,271	145,627	116,502			Hennepin County MS4	MS400138	1,194,142			
								Golden Valley City MS4	MS400021				
								MNDOT Metro District MS4	MS400170				
								St Louis Park City MS4	MS400053				
Tanners Lake	82-0115-00	1,732	826,520	82,652	66,122			Ramsey County Public Works MS4	MS400191	677,746			
								Maplewood City MS4	MS400032				
								MNDOT Metro District MS4	MS400170				
								Ramsey-Washington Metro WD MS4	MS400190				
								Oakdale City MS4	MS400042				
								Woodbury City MS4	MS400128				
								Washington County MS4	MS400160				
								Landfall City MS4	MS400025				
								Tanner's Alum WTP	MN0067661				
Thompson Lake	19-0048-00	178	134,340	13,434	10,747			Dakota County MS4	MS400132	110,159			
								MNDOT Metro District MS4	MS400170				
								West St Paul City MS4	MS400059				
Valentine Lake	62-0071-00	2,404	1,165,072	116,507	93,206			Ramsey County Public Works MS4	MS400191	955,359			
								Shoreview City MS4	MS400121				
								MNDOT Metro District MS4	MS400170				
								Arden Hills City MS4	MS400002				
								Rice Creek WD MS4	MS400193				
Wirth Lake	27-0037-00	426	1,095,000	109,500	87,600			Hennepin County MS4	MS400138	897,900			
								Minneapolis Municipal Storm Water	MN0061018				
								MNDOT Metro District MS4	MS400170				
								Golden Valley City MS4	MS400021				

Lake	AUID	Watershed Area (ac)	Loading Capacity (TMDL) (lbs/day)	Margin of Safety - (lbs/day)	Background LA - (lbs/day)	Rural areas/non-permitted MS4 areas	Rural/non-permitted MS4 LA (lbs/day)	Permitted MS4	NPDES Permit #	MS4 Categorical WLA (lbs/day)	Wastewater Source	NPDES Permit #	Wastewater WLA (lbs/day)
Battle Creek Lake	82-0091-00	4,326	5,901	590	472			Ramsey County Public Works MS4	MS400191	4,838			
								MNDOT Metro District MS4	MS400170				
								Ramsey-Washington Metro WD MS4	MS400190				
								Maplewood City MS4	MS400032				
								Woodbury City MS4	MS400128				
								Washington County MS4	MS400160				
								Oakdale City MS4	MS400042				
								Landfall City MS4	MS400025				
								Tanner's Alum WTP	MN0067661				
Brownie Lake	27-0038-00	452	935	94	75			Golden Valley City MS4	MS400021	767			
								MNDOT Metro District MS4	MS400170				
								Minnehaha Creek WD MS4	MS400182				
								St Louis Park City MS4	MS400053				
								Minneapolis Municipal Storm Water	MN0061018				
Carver Lake	82-0166-00	2,242	2,935	293	235			Woodbury City MS4	MS400128	2,406			
								Ramsey County Public Works MS4	MS400191				
								Maplewood City MS4	MS400032				
								MNDOT Metro District MS4	MS400170				
								Ramsey-Washington Metro WD MS4	MS400190				
								Washington County MS4	MS400160				
Como Lake	62-0055-00	1,850	2,724	272	218			Ramsey County Public Works MS4	MS400191	2,233			
								Roseville City MS4	MS400047				
								MNDOT Metro District MS4	MS400170				
								St Paul Municipal Storm Water	MN0061263				
								Capitol Region WD MS4	MS400206				
								Falcon Heights City MS4	MS400018				
Diamond Lake	27-0022-00	744	1,332	133	107			Hennepin County MS4	MS400138	1,092			
								Minneapolis Municipal Storm Water	MN0061018				
								MNDOT Metro District MS4	MS400170				
								Minnehaha Creek WD MS4	MS400182				
Kasota Ponds North	62-0280-00	10	17	2	1			St Paul Municipal Storm Water	MN0061263	14			
								MNDOT Metro District MS4	MS400170				
Kasota Ponds West	62-0281-00	6	16	2	1			St Paul Municipal Storm Water	MN0061263	13			
								MNDOT Metro District MS4	MS400170				
Kohlman Lake	62-0006-00	7,533	13,258	1,038	830			Ramsey County Public Works MS4	MS400191	8,512	HB Fuller Co - Willow Lake	MN0051811	2,878
								Gem Lake City MS4	MS400020				
								MNDOT Metro District MS4	MS400170				
								Vadnais Heights City MS4	MS400057				
								White Bear Lake City MS4	MS400060				
								Ramsey-Washington Metro WD MS4	MS400190				
								Little Canada City MS4	MS400029				
								Maplewood City MS4	MS400032				
								North St Paul City MS4	MS400041				
								Oakdale City MS4	MS400042				
								White Bear Township MS4	MS400163				
								Washington County MS4	MS400160				
								Century College MS4	MS400171				

Lake	AUID	Watershed Area (ac)	Loading Capacity (TMDL) (lbs/day)	Margin of Safety - (lbs/day)	Background LA - (lbs/day)	Rural areas/non-permitted MS4 areas	Rural/non-permitted MS4 LA (lbs/day)	Permitted MS4	NPDES Permit #	MS4 Categorical WLA (lbs/day)	Wastewater Source	NPDES Permit #	Wastewater WLA (lbs/day)
Little Johanna Lake	62-0058-00	1,703	3,354	335	268			Ramsey County Public Works MS4	MS400191	2,750			
								Roseville City MS4	MS400047				
								MNDOT Metro District MS4	MS400170				
								Arden Hills City MS4	MS400002				
								Rice Creek WD MS4	MS400193				
								Falcon Heights City MS4	MS400018				
								U of M-Twin Cities Campus MS4	MS400212				
Loring Pond (South Bay)	27-0655-02	34	27	3	2			Minneapolis Municipal Storm Water	MN0061018	22			
Mallard Marsh	62-0259-00	16	27	3	2			Ramsey County Public Works MS4	MS400191	22			
								St Paul Municipal Storm Water	MN0061263				
								MNDOT Metro District MS4	MS400170				
Parkers Lake	27-0107-00	1,064	3,921	176	141			Hennepin County MS4	MS400138	1,447	AaCron Inc	MNG250002	1,516
								Plymouth City MS4	MS400112		AaCron Inc	MNG250002	393
								MNDOT Metro District MS4	MS400170		Medivators	MN0063541	248
Peavey Lake	27-0138-00	776	625	55	44			Hennepin County MS4	MS400138	454	Wayzata WTP - Plant 2	MNG640096	71
								Wayzata City MS4	MS400058				
								MNDOT Metro District MS4	MS400170				
								Minnehaha Creek WD MS4	MS400182				
								Orono City MS4	MS400111				
Pike Lake	62-0069-00	5,735	9,924	984	787			Anoka County MS4	MS400066	8,066	New Brighton WTP - Wells 10 & 11	MNG640068	44
								Columbia Heights City MS4	MS400010		New Brighton WTP - Wells 10 & 11	MNG640068	44
								MNDOT Metro District MS4	MS400170				
								Fridley City MS4	MS400019				
								Hennepin County MS4	MS400138				
								Roseville City MS4	MS400047				
								St Anthony Village City MS4	MS400051				
								Ramsey County Public Works MS4	MS400191				
								Rice Creek WD MS4	MS400193				
								Arden Hills City MS4	MS400002				
								Falcon Heights City MS4	MS400018				
								Lauderdale City MS4	MS400026				
								New Brighton City MS4	MS400038				
								U of M-Twin Cities Campus MS4	MS400212				
Powderhorn Lake	27-0014-00	332	599	60	48			Hennepin County MS4	MS400138	491			
								Minneapolis Municipal Storm Water	MN0061018				
								Minnehaha Creek WD MS4	MS400182				
Silver Lake	62-0083-00	655	1,014	101	81			Anoka County MS4	MS400066	831			
								Columbia Heights City MS4	MS400010				
								Hennepin County MS4	MS400138				
								Minneapolis Municipal Storm Water	MN0061018				
								St Anthony Village City MS4	MS400051				
								Rice Creek WD MS4	MS400193				
								New Brighton City MS4	MS400038				
								Ramsey County Public Works MS4	MS400191				

Lake	AUID	Watershed Area (ac)	Loading Capacity (TMDL) (lbs/day)	Margin of Safety - (lbs/day)	Background LA - (lbs/day)	Rural areas/non-permitted MS4 areas	Rural/non-permitted MS4 LA (lbs/day)	Permitted MS4	NPDES Permit #	MS4 Categorical WLA (lbs/day)	Wastewater Source	NPDES Permit #	Wastewater WLA (lbs/day)
South Long Lake	62-0067-02	114,785	72,192	7,214	5,771	May (Township)	156	Lexington City MS4	MS400027	58,998	Forest Lake WTP	MNG640118	50
						Scandia (City)		Mahtomedi City MS4	MS400031		Saint Croix Forge Inc	MN0069051	4
						MNDOT		Mounds View City MS4	MS400037				
								Blaine City MS4	MS400075				
								Centerville City MS4	MS400078				
								Dellwood City MS4	MS400084				
								Grant City MS4	MS400091				
								Hugo City MS4	MS400094				
								Lino Lakes City MS4	MS400100				
								North Oaks City MS4	MS400109				
								Shoreview City MS4	MS400121				
								White Bear Township MS4	MS400163				
								Forest Lake City MS4	MS400262				
								Anoka County MS4	MS400066				
								MNDOT Metro District MS4	MS400170				
								Ramsey County Public Works MS4	MS400191				
								Arden Hills City MS4	MS400002				
								White Bear Lake City MS4	MS400060				
								Columbia Heights City MS4	MS400010				
								Fridley City MS4	MS400019				
								Hennepin County MS4	MS400138				
								Roseville City MS4	MS400047				
								St Anthony Village City MS4	MS400051				
								Circle Pines City MS4	MS400009				
								Rice Creek WD MS4	MS400193				
								Birchwood Village City MS4	MS400004				
								New Brighton City MS4	MS400038				
								Washington County MS4	MS400160				
								Willernie City MS4	MS400061				
								Falcon Heights City MS4	MS400018				
								Lauderdale City MS4	MS400026				
								Minnesota Correctional-Lino Lakes MS4	MS400177				
								Century College MS4	MS400171				
								U of M-Twin Cities Campus MS4	MS400212				
Spring Lake	27-0654-00	39	43	4	3			Minneapolis Municipal Storm Water	MN0061018	35			
								MNDOT Metro District MS4	MS400170				
Sweeney Lake	27-0035-01	2,439	3,990	399	319			Hennepin County MS4	MS400138	3,272			
								Golden Valley City MS4	MS400021				
								MNDOT Metro District MS4	MS400170				
								St Louis Park City MS4	MS400053				
Tanners Lake	82-0115-00	1,732	2,264	226	181			Ramsey County Public Works MS4	MS400191	1,857			
								Maplewood City MS4	MS400032				
								MNDOT Metro District MS4	MS400170				
								Ramsey-Washington Metro WD MS4	MS400190				
								Oakdale City MS4	MS400042				
								Woodbury City MS4	MS400128				
								Washington County MS4	MS400160				
								Landfall City MS4	MS400025				
								Tanner's Alum WTP	MN0067661				
Thompson Lake	19-0048-00	178	368	37	29			Dakota County MS4	MS400132	302			
								MNDOT Metro District MS4	MS400170				
								West St Paul City MS4	MS400059				
Valentine Lake	62-0071-00	2,404	3,192	319	255			Ramsey County Public Works MS4	MS400191	2,617			
								Shoreview City MS4	MS400121				
								MNDOT Metro District MS4	MS400170				
								Arden Hills City MS4	MS400002				
								Rice Creek WD MS4	MS400193				
Wirth Lake	27-0037-00	426	3,000	300	240			Hennepin County MS4	MS400138	2,460			
								Minneapolis Municipal Storm Water	MN0061018				
								MNDOT Metro District MS4	MS400170				
								Golden Valley City MS4	MS400021				

Streams - Chloride TMDL

Stream	AUID	Watershed Area (ac)	Loading Capacity (TMDL) (lbs/yr)	Margin of Safety MOS - (lbs/yr)	Background LA - (lbs/yr)	Rural/non-permitted MS4 areas	Rural/non-permitted MS4 LA (lbs/yr)	Permitted MS4	NPDES Permit #	MS4 Categorical WLA (lbs/yr)	Wastewater Source	NPDES Permit #	Wastewater WLA (lbs/yr)*
Bass Creek	07010206-784	5,434	1,746,399	174,640	139,712			Hennepin County MS4	MS400138	1,432,047			
								Plymouth City MS4	MS400112				
								MNDOT Metro District MS4	MS400170				
								New Hope City MS4	MS400039				
								Brooklyn Park City MS4	MS400007				
								Maple Grove City MS4	MS400102				
Bassett Creek	07010206-538	25,209	9,334,219	810,117	648,094			Medina City MS4	MS400105	6,642,961	Honeywell-Plymouth Operations	MN0063266	49,023
								Plymouth City MS4	MS400112		Honeywell International Inc	MNG255088	392,181
								Hennepin County MS4	MS400138		St Louis Park WTP	MNG640084	4,682
								Minneapolis Municipal Storm Water	MN0061018		AaCron Inc	MNG250002	553,255
								MNDOT Metro District MS4	MS400170		AaCron Inc	MNG250002	143,566
								Crystal City MS4	MS400012		Medivators	MN0063541	90,342
								Golden Valley City MS4	MS400021				
								Minnetonka City MS4	MS400035				
								New Hope City MS4	MS400039				
								Robbinsdale City MS4	MS400046				
								St Louis Park City MS4	MS400053				
								Medicine Lake City MS4	MS400104				
Battle Creek	07010206-592	7,246	2,328,720	232,872	186,298			Ramsey County Public Works MS4	MS400191	1,909,551			
								St Paul Municipal Storm Water	MN0061263				
								MNDOT Metro District MS4	MS400170				
								Ramsey-Washington Metro WD MS4	MS400190				
								Maplewood City MS4	MS400032				
								Woodbury City MS4	MS400128				
								Washington County MS4	MS400160				
								Oakdale City MS4	MS400042				
								Landfall City MS4	MS400025				
								Tanner's Alum WTP	MN0067661				
Elm Creek	07010206-508	66,382	21,332,409	2,133,241	1,706,593	Greenfield (City)	105,688	Champlin City MS4	MS400008	17,386,888			
						MNDOT		Corcoran City MS4	MS400081				
								Dayton City MS4	MS400083				
								Maple Grove City MS4	MS400102				
								Medina City MS4	MS400105				
								Plymouth City MS4	MS400112				
								Hennepin County MS4	MS400138				
								MNDOT Metro District MS4	MS400170				
								Rogers	future				
Unnamed Creek	07030005-525	1,587	510,115	51,011	40,809			Forest Lake City MS4	MS400262	418,294			
Minnehaha Creek	07010206-539	109,151	35,997,084	3,507,675	2,806,140			Hennepin County MS4	MS400138	28,679,140	Boomerang Laboratories Inc	MN0066508	31,515
								Hopkins City MS4	MS400024		Kwong Tung Foods Inc	MN0062723	9,174
								Minnetonka City MS4	MS400035		MAC - Minneapolis/St Paul Intl Airport	MN0002101	83,798
								MNDOT Metro District MS4	MS400170		Nilfisk-Advance Inc	MN0066648	100,846
								Minnehaha Creek WD MS4	MS400182		St Louis Park GWP - Reilly Tar Site	MN0045489	140,765
								Independence City MS4	MS400095		St Louis Park GWP - Reilly Tar Site	MN0045489	605,079
								Maple Plain City MS4	MS400103		St Louis Park WTP	MNG640084	5,852
								Medina City MS4	MS400105		St Louis Park WTP	MNG640084	8,193
								Orono City MS4	MS400111		St Louis Park WTP	MNG640084	15,215
								Long Lake City MS4	MS400101		Wayzata WTP - Plant 2	MNG640096	3,692
								Minnetrista City MS4	MS400106				
								Laketown Township MS4	MS400142				
								Carver County MS4	MS400070				
								Victoria City MS4	MS400126				
								St Louis Park City MS4	MS400053				
								Shorewood City MS4	MS400122				
								St Bonifacius City MS4	MS400124				
								Chanhassen City MS4	MS400079				
								Deephaven City MS4	MS400013				
								Greenwood City MS4	MS400022				
								Tonka Bay City MS4	MS400056				
								Minnetonka Beach City MS4	MS400036				
								Minneapolis Municipal Storm Water	MN0061018				
								Excelsior City MS4	MS400017				
								Edina City MS4	MS400016				
								Golden Valley City MS4	MS400021				
								Woodland City MS4	MS400129				
								Spring Park City MS4	MS400123				
								Richfield City MS4	MS400045				
								Plymouth City MS4	MS400112				
								Mounds City MS4	MS400108				
								Wayzata City MS4	MS400058				

Streams - Chloride TMDL

Stream	AUID	Watershed Area (ac)	Loading Capacity (TMDL) (lbs/yr)	Margin of Safety MOS - (lbs/yr)	Background LA - (lbs/yr)	Rural/non-permitted MS4 areas	Rural/non-permitted MS4 LA (lbs/yr)	Permitted MS4	NPDES Permit #	MS4 Categorical WLA (lbs/yr)	Wastewater Source	NPDES Permit #	Wastewater WLA (lbs/yr)*
Raven Stream	07020012-716	42,750	15,023,192	1,373,821	1,099,057	Derrynane (Township) Heidelberg (City) Lanesburgh (Township) Helena (Township) Belle Plaine (Township) LeSeuer (County) Scott (County) MNDOT	10,822,561	New Prague Belle Plaine	future future	442,771	New Prague WTP New Prague WWTP	MNG640117 MN0020150	3,392 1,281,590
Raven Stream, East Branch	07020012-543	14,751	6,025,349	474,037	379,229	Derrynane (Township) Heidelberg (City) Lanesburgh (Township) Helena (Township) LeSeuer (County) Scott (County) MNDOT	3,445,007	New Prague	future	442,093	New Prague WTP New Prague WWTP	MNG640117 MN0020150	3,392 1,281,590
Rush Creek, South Fork	07010206-732	13,844	4,470,068	444,906	355,925	Greenfield (City) MNDOT	1,532	Corcoran City MS4 Maple Grove City MS4 Medina City MS4 Hennepin County MS4	MS400081 MS400102 MS400105 MS400138	3,646,696	Maple Hill Estates	MN0031127	21,010
Sand Creek (includes AUIDs: 07020012-513 and 07020012-662)	07020012-513	175,578	59,480,179	5,642,375	4,513,900	Cedar Lake (Township) Derrynane (Township) Erin (Township) Heidelberg (City) Lanesburgh (Township) Lonsdale (City) Lexington (Township) Montegomery (Township) Saint Lawrence (Township) Sand Creek (Township) Webster (Township) Wheatland (Township) Helena (Township) Montegomery (City) Belle Plaine (Township) Rice (County) LeSeuer (County) Scott (County) MNDOT	41,864,932	Prior Lake City MS4 Shakopee City MS4 Jackson Township MS4 Louisville Township MS4 Spring Lake Township MS4 Elko New Market City MS4 New Prague Belle Plaine Jordan	MS400113 MS400120 MS400140 MS400144 MS400156 MS400237 future future future	4,402,547	New Prague WTP New Prague WWTP Jordan WWTP Montgomery WWTP Seneca Foods Corp - Montgomery	MNG640117 MN0020150 MN0020869 MN0024210 MN0001279	3,392 1,281,590 902,716 677,912 190,814
Unnamed creek (Headwaters to Medicine Lk)	07010206-526	6,447	2,071,958	207,196	165,757			Medina City MS4 Plymouth City MS4 Hennepin County MS4 Minnetonka City MS4 MNDOT Metro District MS4	MS400105 MS400112 MS400138 MS400035 MS400170	1,699,006			
Unnamed creek (Unnamed ditch to wetland)	07010206-718	793	254,852	25,485	20,388			Hennepin County MS4 Minnetonka City MS4 MNDOT Metro District MS4 Minnehaha Creek WD MS4 Wayzata City MS4 Plymouth City MS4	MS400138 MS400035 MS400170 MS400182 MS400112 MS400058	208,979			
Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna)	07010206-909	1,627	522,817	52,282	41,825			Ramsey County Public Works MS4 Roseville City MS4 MNDOT Metro District MS4 Falcon Heights City MS4 Rice Creek WD MS4 U of M-Twin Cities Campus MS4	MS400191 MS400047 MS400170 MS400018 MS400193 MS400212	428,710			

Streams - Chloride TMDL

Stream	AUID	Watershed Area (ac)	Loading Capacity (TMDL) (lbs/day)	Margin of Safety MOS - (lbs/day)	Background LA - (lbs/day)	Rural/non-permitted MS4 areas	Rural/non-permitted MS4 LA (lbs/day)	Permitted MS4	NPDES Permit #	MS4 Categorical WLA (lbs/day)	Wastewater Source	NPDES Permit #	Wastewater WLA (lbs/day)
Bass Creek	07010206-784	5,434	11,566	1,157	925			Hennepin County MS4	MS400138	9,484			
								Plymouth City MS4	MS400112				
								MNDOT Metro District MS4	MS400170				
								New Hope City MS4	MS400039				
								Brooklyn Park City MS4	MS400007				
								Maple Grove City MS4	MS400102				
Bassett Creek	07010206-538	25,209	57,092	5,365	4,292			Medina City MS4	MS400105	43,993	Honeywell-Plymouth Operations	MN0063266	134
								Plymouth City MS4	MS400112		Honeywell International Inc	MNG255088	1,074
								Hennepin County MS4	MS400138		St Louis Park WTP	MNG640084	77
								Minneapolis Municipal Storm Water	MN0061018		AaCron Inc	MNG250002	1,516
								MNDOT Metro District MS4	MS400170		AaCron Inc	MNG250002	393
								Crystal City MS4	MS400012		Medivators	MN0063541	248
								Golden Valley City MS4	MS400021				
								Minnetonka City MS4	MS400035				
								New Hope City MS4	MS400039				
								Robbinsdale City MS4	MS400046				
								St Louis Park City MS4	MS400053				
								Medicine Lake City MS4	MS400104				
Battle Creek	07010206-592	7,246	15,422	1,542	1,234			Ramsey County Public Works MS4	MS400191	12,646			
								St Paul Municipal Storm Water	MN0061263				
								MNDOT Metro District MS4	MS400170				
								Ramsey-Washington Metro WD MS4	MS400190				
								Maplewood City MS4	MS400032				
								Woodbury City MS4	MS400128				
								Washington County MS4	MS400160				
								Oakdale City MS4	MS400042				
								Landfall City MS4	MS400025				
								Tanner's Alum WTP	MN0067661				
Elm Creek	07010206-508	66,382	141,274	14,127	11,302	Greenfield (City)	700	Champlin City MS4	MS400008	115,145			
						MNDOT		Corcoran City MS4	MS400081				
								Dayton City MS4	MS400083				
								Maple Grove City MS4	MS400102				
								Medina City MS4	MS400105				
								Plymouth City MS4	MS400112				
								Hennepin County MS4	MS400138				
								MNDOT Metro District MS4	MS400170				
								Rogers	future				
Unnamed Creek	07030005-525	1,587	3,378	338	270			Forest Lake City MS4	MS400262	2,770			
Minnehaha Creek	07010206-539	109,151	235,278	23,230	18,584			Hennepin County MS4	MS400138	189,928	Boomerang Laboratories Inc	MN0066508	86
								Hopkins City MS4	MS400024		Kwong Tung Foods Inc	MN0062723	25
								Minnetonka City MS4	MS400035		MAC - Minneapolis/St Paul Intl Airport	MN0002101	555
								MNDOT Metro District MS4	MS400170		Nilfisk-Advance Inc	MN0066648	276
								Minnehaha Creek WD MS4	MS400182		St Louis Park GWP - Reilly Tar Site	MN0045489	386
								Independence City MS4	MS400095		St Louis Park GWP - Reilly Tar Site	MN0045489	1,658
								Maple Plain City MS4	MS400103		St Louis Park WTP	MNG640084	96
								Medina City MS4	MS400105		St Louis Park WTP	MNG640084	134
								Orono City MS4	MS400111		St Louis Park WTP	MNG640084	249
								Long Lake City MS4	MS400101		Wayzata WTP - Plant 2	MNG640096	71
								Minnetrista City MS4	MS400106				
								Laketown Township MS4	MS400142				
								Carver County MS4	MS400070				
								Victoria City MS4	MS400126				
								St Louis Park City MS4	MS400053				
								Shorewood City MS4	MS400122				
								St Bonifacius City MS4	MS400124				
								Chanhassen City MS4	MS400079				
								Deephaven City MS4	MS400013				
								Greenwood City MS4	MS400022				
								Tonka Bay City MS4	MS400056				
								Minnetonka Beach City MS4	MS400036				
								Minneapolis Municipal Storm Water	MN0061018				
								Excelsior City MS4	MS400017				
								Edina City MS4	MS400016				
								Golden Valley City MS4	MS400021				
								Woodland City MS4	MS400129				
								Spring Park City MS4	MS400123				
								Richfield City MS4	MS400045				
								Plymouth City MS4	MS400112				
								Mounds City MS4	MS400108				
								Wayzata City MS4	MS400058				

Streams - Chloride TMDL

Stream	AUID	Watershed Area (ac)	Loading Capacity (TMDL) (lbs/day)	Margin of Safety MOS - (lbs/day)	Background LA - (lbs/day)	Rural/non-permitted MS4 areas	Rural/non-permitted MS4 LA (lbs/day)	Permitted MS4	NPDES Permit #	MS4 Categorical WLA (lbs/day)	Wastewater Source	NPDES Permit #	Wastewater WLA (lbs/day)
Raven Stream	07020012-716	42,750	94,558	9,098	7,279	Derrynane (Township) Heidelberg (City) Lanesburgh (Township) Helena (Township) Belle Plaine (Township) LeSeuer (County) Scott (County) MNDOT	71,673	New Prague Belle Plaine	future future	2,932	New Prague WTP New Prague WWTP	MNG640117 MN0020150	65 3,511
Raven Stream, East Branch	07020012-543	14,751	34,970	3,139	2,511	Derrynane (Township) Heidelberg (City) Lanesburgh (Township) Helena (Township) LeSeuer (County) Scott (County) MNDOT	22,815	New Prague	future	2,928	New Prague WTP New Prague WWTP	MNG640117 MN0020150	65 3,511
Rush Creek, South Fork	07010206-732	13,844	29,522	2,946	2,357	Greenfield (City) MNDOT	10	Corcoran City MS4 Maple Grove City MS4 Medina City MS4 Hennepin County MS4	MS400081 MS400102 MS400105 MS400138	24,150	Maple Hill Estates	MN0031127	58
Sand Creek (includes AUIDs: 07020012-513 and 07020012-662)	07020012-513	175,578	382,821	37,367	29,893	Cedar Lake (Township) Derrynane (Township) Erin (Township) Heidelberg (City) Lanesburgh (Township) Lonsdale (City) Lexington (Township) Montegomery (Township) Saint Lawrence (Township) Sand Creek (Township) Webster (Township) Wheatland (Township) Helena (Township) Montegomery (City) Belle Plaine (Township) Rice (County) LeSeuer (County) Scott (County) MNDOT	277,251	Prior Lake City MS4 Shakopee City MS4 Jackson Township MS4 Louisville Township MS4 Spring Lake Township MS4 Elko New Market City MS4 New Prague Belle Plaine Jordan	MS400113 MS400120 MS400140 MS400144 MS400156 MS400237 future future future	29,156	New Prague WTP New Prague WWTP Jordan WWTP Montgomery WWTP Seneca Foods Corp - Montgomery	MNG640117 MN0020150 MN0020869 MN0024210 MN0001279	65 3,511 2,473 1,857 1,247
Unnamed creek (Headwaters to Medicine Lk)	07010206-526	6,447	13,722	1,372	1,098			Medina City MS4 Plymouth City MS4 Hennepin County MS4 Minnetonka City MS4 MNDOT Metro District MS4	MS400105 MS400112 MS400138 MS400035 MS400170	11,252			
Unnamed creek (Unnamed ditch to wetland)	07010206-718	793	1,688	169	135			Hennepin County MS4 Minnetonka City MS4 MNDOT Metro District MS4 Minnehaha Creek WD MS4 Wayzata City MS4 Plymouth City MS4	MS400138 MS400035 MS400170 MS400182 MS400112 MS400058	1,384			
Unnamed Stream (Unnamed lk 62-0205-00 to Little Lk Johanna)	07010206-909	1,627	3,462	346	277			Ramsey County Public Works MS4 Roseville City MS4 MNDOT Metro District MS4 Falcon Heights City MS4 Rice Creek WD MS4 U of M-Twin Cities Campus MS4	MS400191 MS400047 MS400170 MS400018 MS400193 MS400212	2,839			