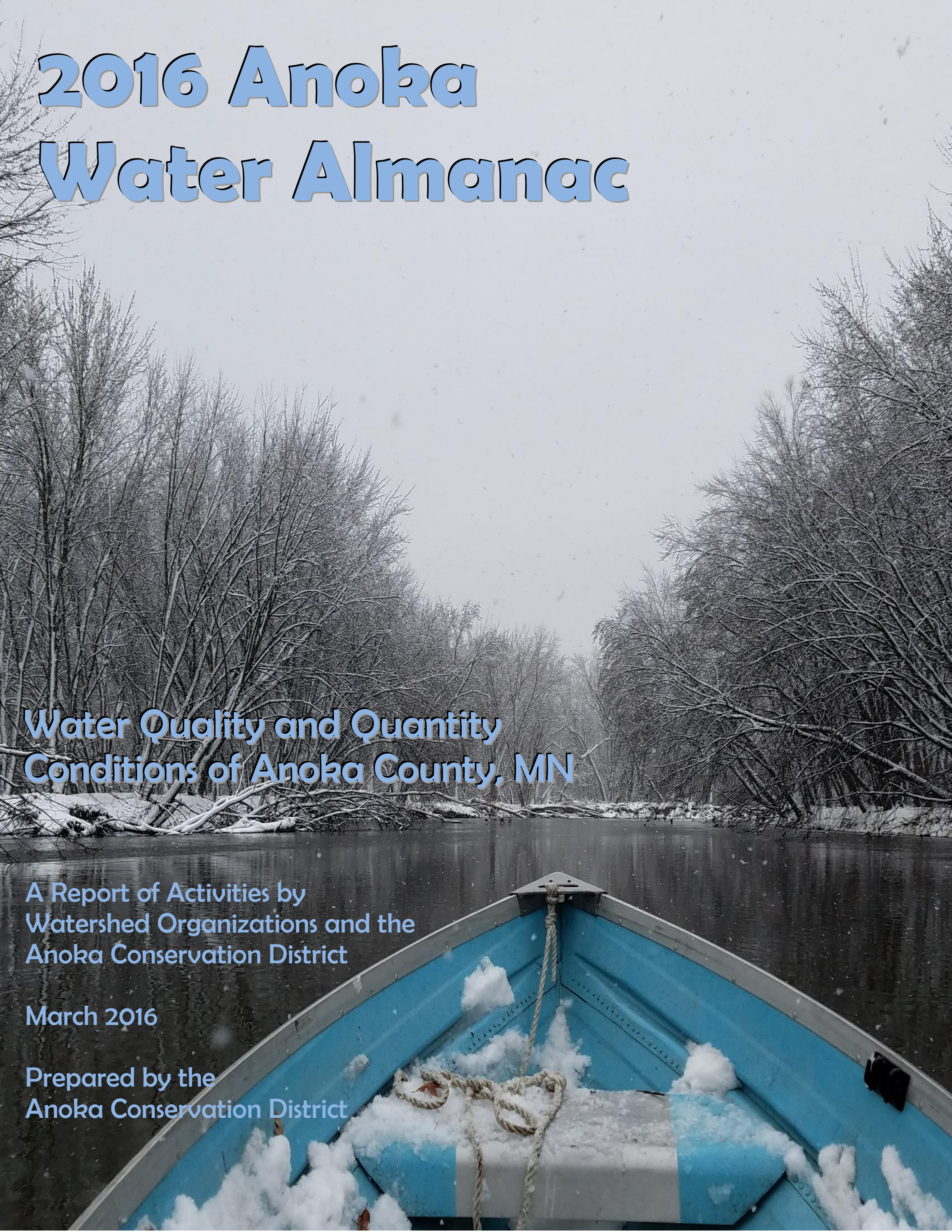

2016 Anoka Water Almanac

Water Quality and Quantity Conditions of Anoka County, MN

A Report of Activities by Watershed Organizations and the Anoka Conservation District

March 2016

Prepared by the Anoka Conservation District

2016 ANOKA WATER ALMANAC

Water Quality & Quantity Conditions of Anoka County, Minnesota

A Report of Activities by Watershed Organizations and the Anoka Conservation District

March 2016

Prepared by
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Digital copies of data in this report are available at www.AnokaSWCD.org

EXECUTIVE SUMMARY
AND ORGANIZATION OF THIS REPORT

This report summarizes water resources management and monitoring work done as a cooperative effort between the Anoka Conservation District (ACD) and a watershed district or watershed management organization. It includes information about lakes, streams, wetlands, precipitation, groundwater, and water quality improvement projects. The results of this work are presented on a watershed basis—this document serves as an annual report to each of the watershed organizations that have helped fund the work. Readers who are interested in a certain lake, stream or river should first determine which watershed it is located in, and then refer to the chapter corresponding to that watershed. The maps and county-wide summaries in Chapter 1 will help the reader determine if the information they are seeking is available and, if so, in which chapter to find it. In addition to county-wide summaries, Chapter 1 also provides methodologies used, explanations of terminology, and instruction on interpreting data.

The water resource management and monitoring work reported here include:

- Monitoring
    - precipitation,
    - lake levels,
    - lake water quality,
    - stream hydrology,
    - stream water quality,
    - stream benthic macroinvertebrates,
    - shallow groundwater levels in wetlands, and
    - deep groundwater in observation wells.
- Water quality improvement projects
    - projects designed, installed, or planned are briefly discussed in this report,
    - cost share grants for erosion correction, lakeshore restorations, and rain gardens, and
    - promotion of available grants for water quality improvement projects.
- Studies and analyses
    - stormwater retrofitting assessments,
    - upstream to downstream water quality analyses,
    - water quality trend analyses,
    - precipitation storm analyses and long term antecedent moisture analyses, and
    - reference wetland multi-year summary analyses.
- Public education efforts
    - newsletters and mailings,
    - signage,
    - workshops,
    - web videos, and
    - websites.
- Other work done for watershed management organizations
    - reviews of local water plans,
    - grant searches and applications,
    - annual reports to the State, and
    - other administrative tasks

While this report is perhaps the most comprehensive source of monitoring data on lakes, stream, rivers, groundwater and wetlands in Anoka County, it is not the only source; nor is this report a summary of all work completed throughout Anoka County in 2016. Rather, it is a summary of work carried out by the Anoka

Conservation District, in conjunction with watershed organizations, within the county. Furthermore, only work conducted during 2016 is presented in this almanac (although trend and similar analysis also include previous years' data). For results of work completed in past years, readers should refer to previous Water Almanacs. All data collected in 2016 and prior is available in digital format from the Anoka Conservation District. All applicable data is also submitted to state databases for wider availability; these include the MPCA's EQuIS water quality database, the DNR's lakefinder tool for lake levels and groundwater level database, and the State Climatology Office online precipitation database.

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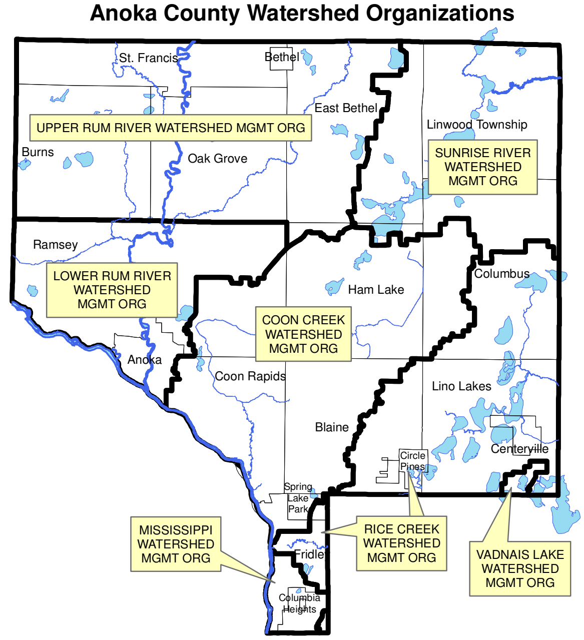
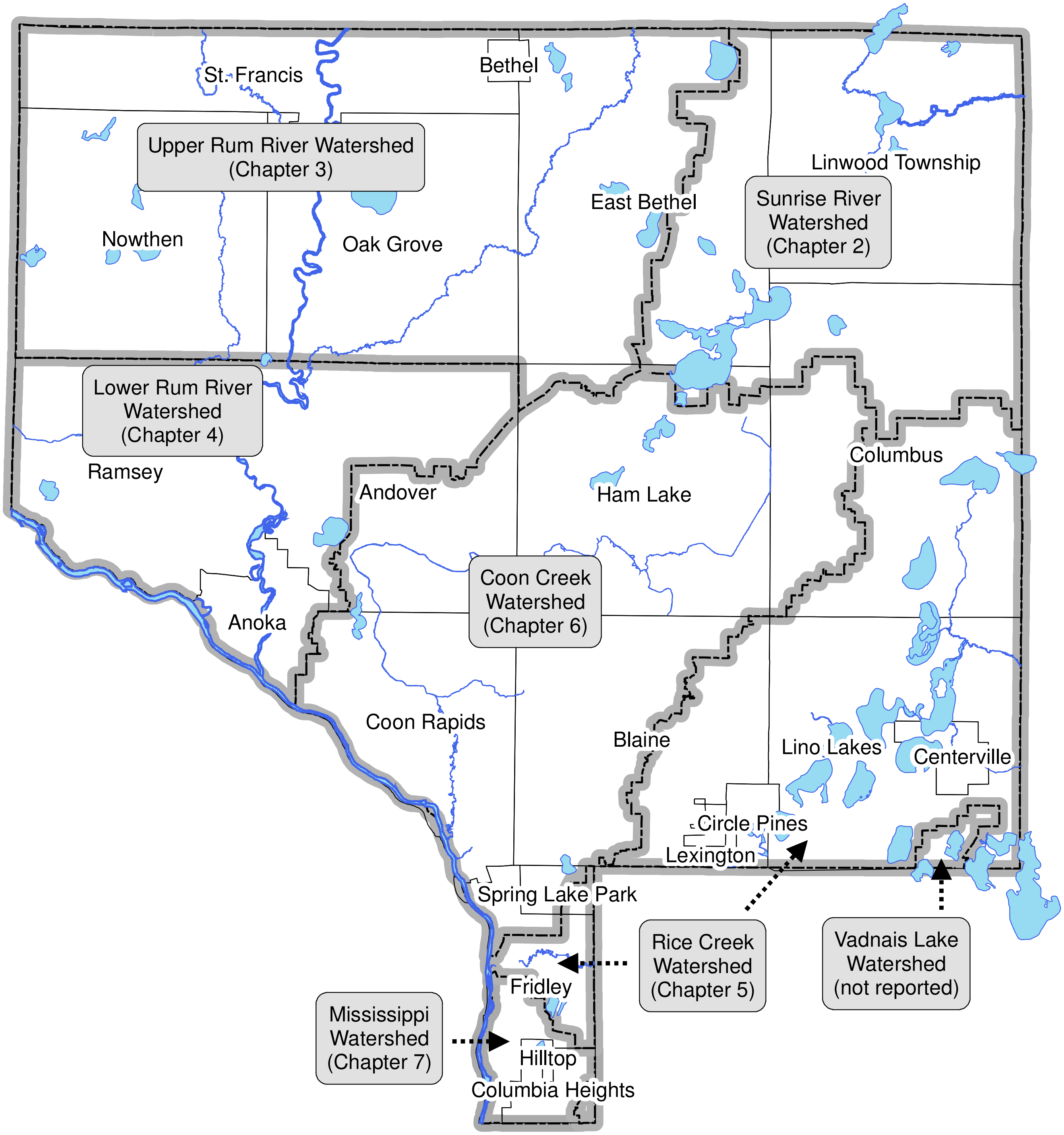
Anoka County Watershed Organizations



Chapter 1 – Primer



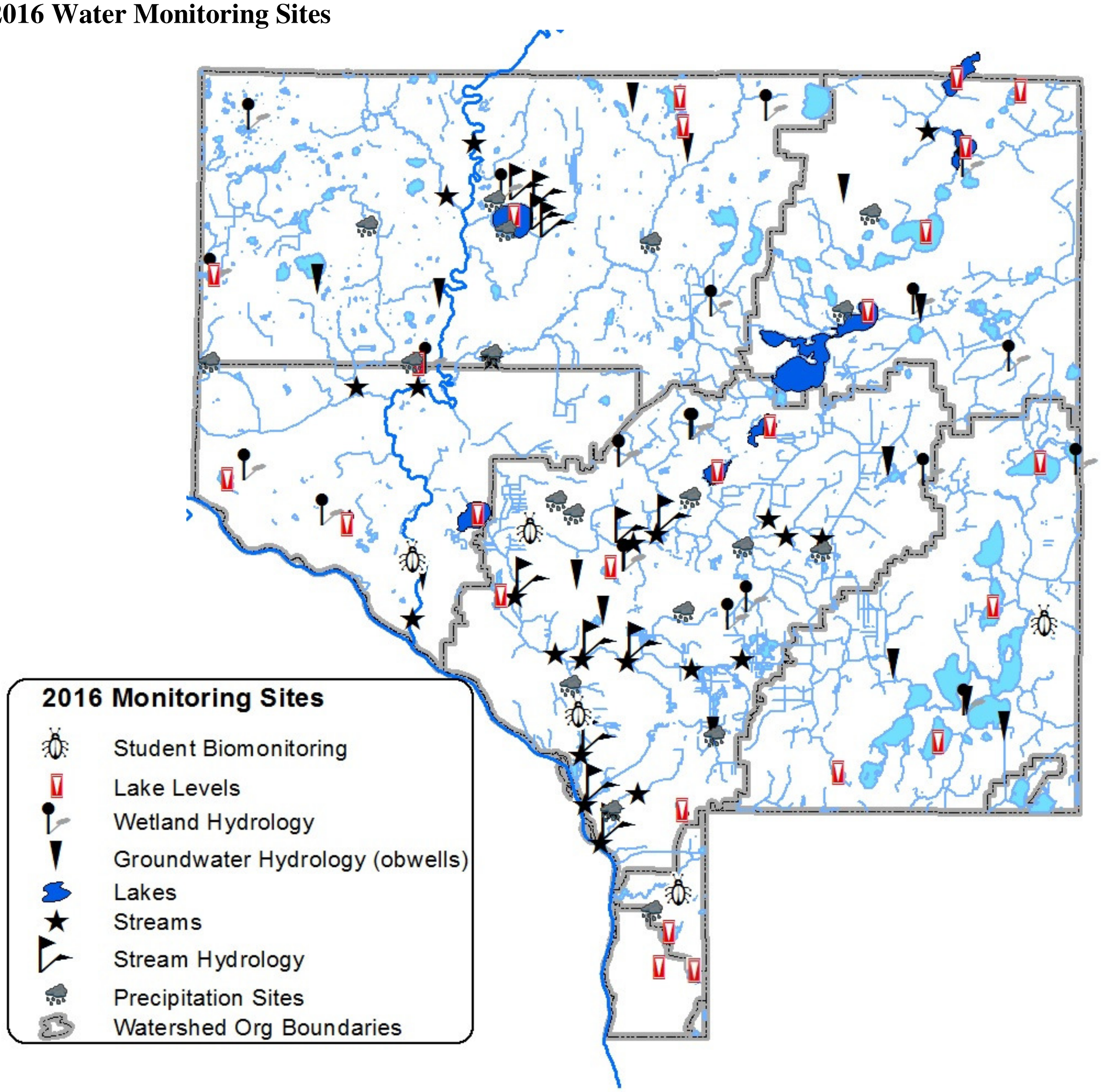
Contact Info: Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 1:
WATER RESOURCE MONITORING PRIMER

This report is an annual report to watershed organizations that helped fund water monitoring and management in cooperative efforts with the Anoka Conservation District. It also includes other water-related work carried out by the ACD without partners. This chapter provides an overview of the monitoring activities reported in later chapters, the methodologies used, and information that will help the reader interpret information found in later chapters. This report includes a variety of work aimed at managing water resources, including lakes, streams, rivers, wetlands, groundwater, and precipitation (see map below).

County-wide precipitation and groundwater hydrology data is presented in Chapter 1.

2016 Water Monitoring Sites



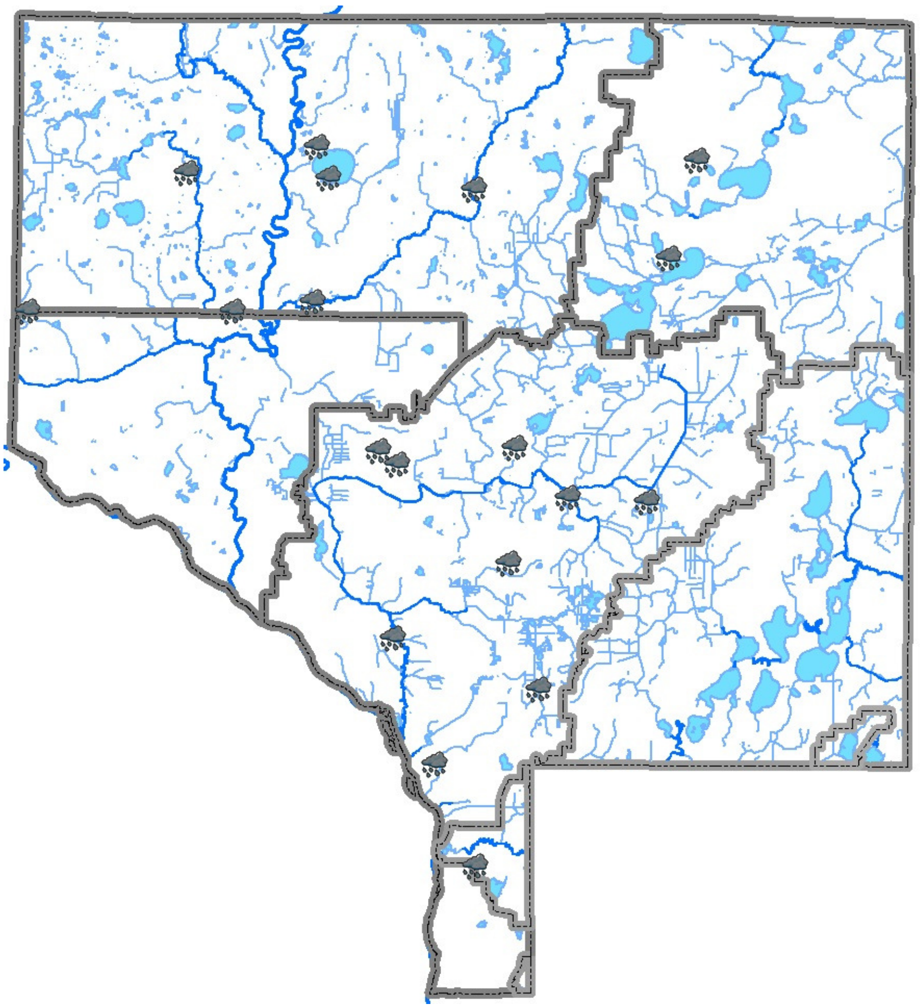
Precipitation

Precipitation data is useful for understanding the hydrology of water bodies, predicting flooding and groundwater limitations, and is needed to guide the use of special regulations that protect property and the environment in times of high or low water. Rainfall can vary substantially, even within one city.

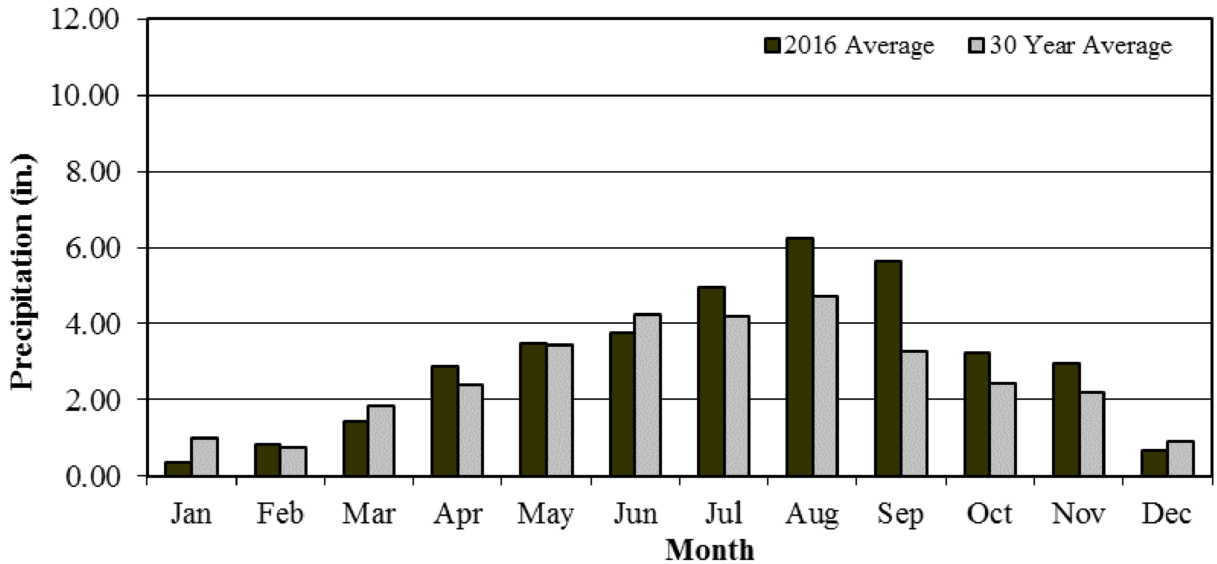
The ACD coordinates a network of 19 rain gauges countywide. Eleven are monitored by volunteers seven are monitored using datalogging stations operated by the ACD for the Coon Creek Watershed District, and one is monitored using a datalogging station independantly operated by the ACD. The volunteer-operated stations are cylinder-style rain gauges located at the volunteer's home. Total rainfall is read daily. The datalogging rain gauges electronically record the time and date of each 0.01 inch of rain that falls. These gauges are downloaded approximately every four weeks. All data collected by volunteers is submitted to the Minnesota State Office of Climatology where it is available to the public through http://climate.umn.edu.

A summary of county-wide data is provided on the following page.

2016 Precipitation Monitoring Sites



2016 Anoka County Average Monthly Precipitation (average of all sites)



2016 Anoka County Monthly Precipitation at each Monitoring Site

Location or Volunteer	City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total	Growing Season (May-Sept)
							Month								
Tipping bucket, datalogging rain gauges (Time and date of each 0.01" is recorded)															
Andover City Hall	Andover			0.38	2.54	0.89*	0.18*	1.87	6.29	4.82	3.76	2.90	0.17	22.73	12.98
Blaine Public Works	Blaine			0.61	3.39	3.47	5.19	5.15	1.69	7.43	3.29	3.59	0.13	33.94	22.93
Coon Rapids City Hall	Coon Rapids			1.9	3.21	3.36	5.04	4.45	7.54	6.86	3.1	3.35	0.21	39.02	27.25
Anoka Cons. District office	Ham Lake			0.07	2.48	3.08	4.13	5.63	6.54	5.08	3.48	2.33	0.12	32.94	24.46
Waconia Street	Ham Lake							4.51	6.63	4.89	3.21	3.27	0.16	22.67	16.03
Northern Nat. Gas substation	Ham Lake						3.97	4.32	3.02	0.86	3.08	2.74	0.14	18.13	12.17
Springbrook Nature Center	Fridley			1.08	3.54	3.42	4.53	4.72	8.38	9.92	0.96*	2.87	0.21	38.67	30.97
Lake George Park	Oak Grove				2.01	3.17	3.44	5.13	4.18	5.39	2.87	1.99		28.18	21.31
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.29	0.68	1.89	2.70	3.87	3.78	6.63	5.97	4.74	3.75	3.24	1.77	39.31	24.99
J. Rufsvold	Burns				3.05	3.81	2.75	1.45	6.25	5.56	2.55			25.42	19.82
J. Arzdorf	Blaine			2.18	3.11	3.02	4.53	5.39	7.71	5.80	3.37			35.11	26.45
P. Arzdorf	East Bethel				2.21	2.84	3.74	6.05	5.53	6.08	3.77			30.22	24.24
A. Mercil	East Bethel	0.40	0.89	1.87	2.07	3.21	4.02	5.57	5.61	3.21	3.50	2.96	1.54	34.85	21.62
K. Ackerman	Fridley	0.31	0.92	1.96	3.73	2.69	2.93	5.02	9.75	8.45	3.08	3.50	1.98	44.32	28.84
B. Myers	Linwood				1.41	3.74	3.29	4.67	5.34	5.15	2.92			26.52	22.19
B. Barkhoff	Nowthen									6.54	2.90				
A. Dalske	Oak Grove				4.58		1.55							6.13	1.55
ACD Office	Ham Lake			2.29	2.96	3.53	4.73	7.13	8.85	5.81	3.66	2.94		41.90	30.05
Y. Lyrenmann	Ramsey				2.84	5.56	2.76	6.77	6.83	4.88	2.87		0.75	33.26	26.80
2016 Average	County-wide	0.33	0.83	1.42	2.86	3.48	3.77	4.97	6.24	5.64	3.24	2.97	0.65	36.43	24.10
30 Year Average	Cedar	0.99	0.76	1.84	2.40	3.43	4.22	4.21	4.70	3.29	2.44	2.18	0.90	31.36	19.85

Precipitation as snow is given in melted equivalents.

*Incomplete monthly data not included in averages

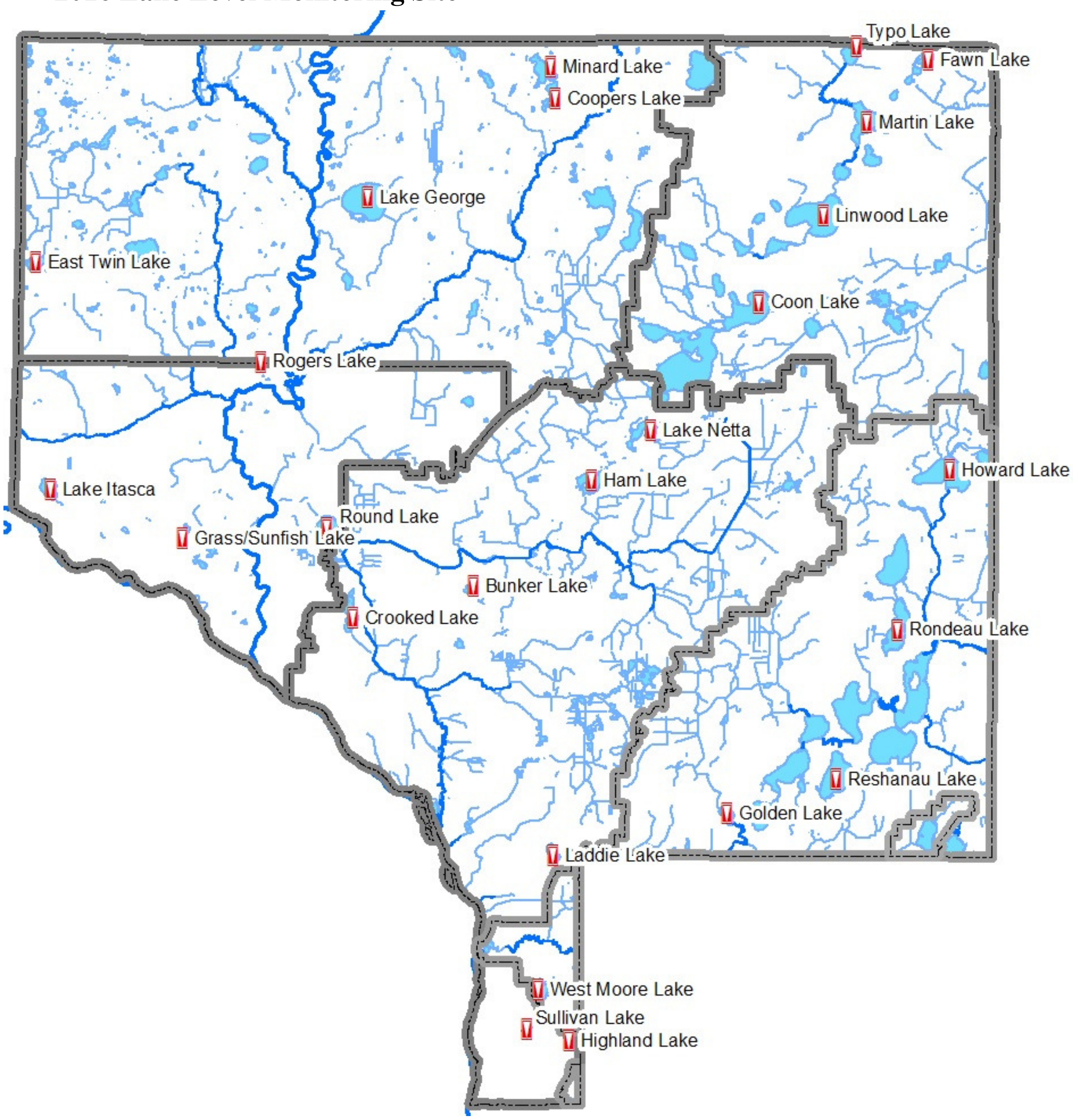
Lake Levels

Long-term lake level records are useful for regulatory decision-making, building/development decisions, lake hydrology manipulation decisions, and investigation of possible non-natural impacts on lake levels. ACD coordinates volunteers who monitor water levels on 24 lakes, with one additional lake monitored by continuous datalogging equipment.

An enamel gauge is installed in each lake and surveyed so that readings coincide with sea level elevations. Each gauge is read weekly. The ACD reports all lake level data to the MN DNR, where it is posted on their website (www.dnr.mn.us.state\lakefind\index.html), along with other information about each lake.

Results of lake level monitoring are separated by watershed in the following chapters.

2016 Lake Level Monitoring Site



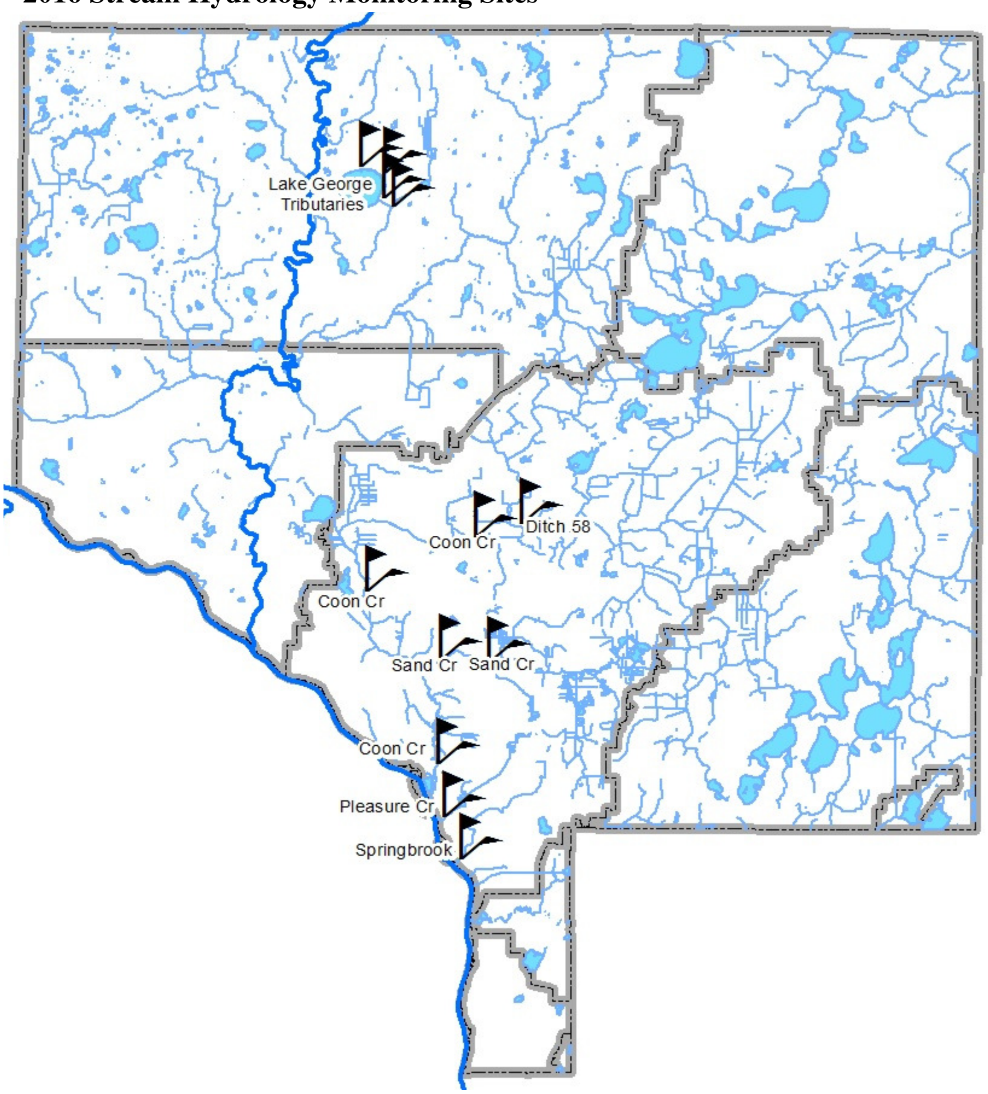
Stream Hydrology

Hydrology is the study of water quantity and movements. Records of the quantity of water flowing in a stream helps engineers and natural resource managers better understand the effects of rain events, land development and storm water management. This information is also often paired with water quality monitoring and used to calculate pollutant loadings, which is then used in computer models and water pollution regulatory determinations.

The ACD monitored hydrology at 12 stream sites in 2016. At each site is an electronic gauge that records water levels every two hours. These gauges are surveyed and calibrated so that stream water level is measured in feet above sea level. Rating curves—a known mathematical relationship between water level and flow such that one can be calculated from the other—have been developed for some sites. The information gained from the stream hydrology monitoring sites is used by the ACD, watershed management organizations, watershed districts, townships, cities, and others.

Results of stream hydrology monitoring are separated by watershed in the following chapters.

2016 Stream Hydrology Monitoring Sites



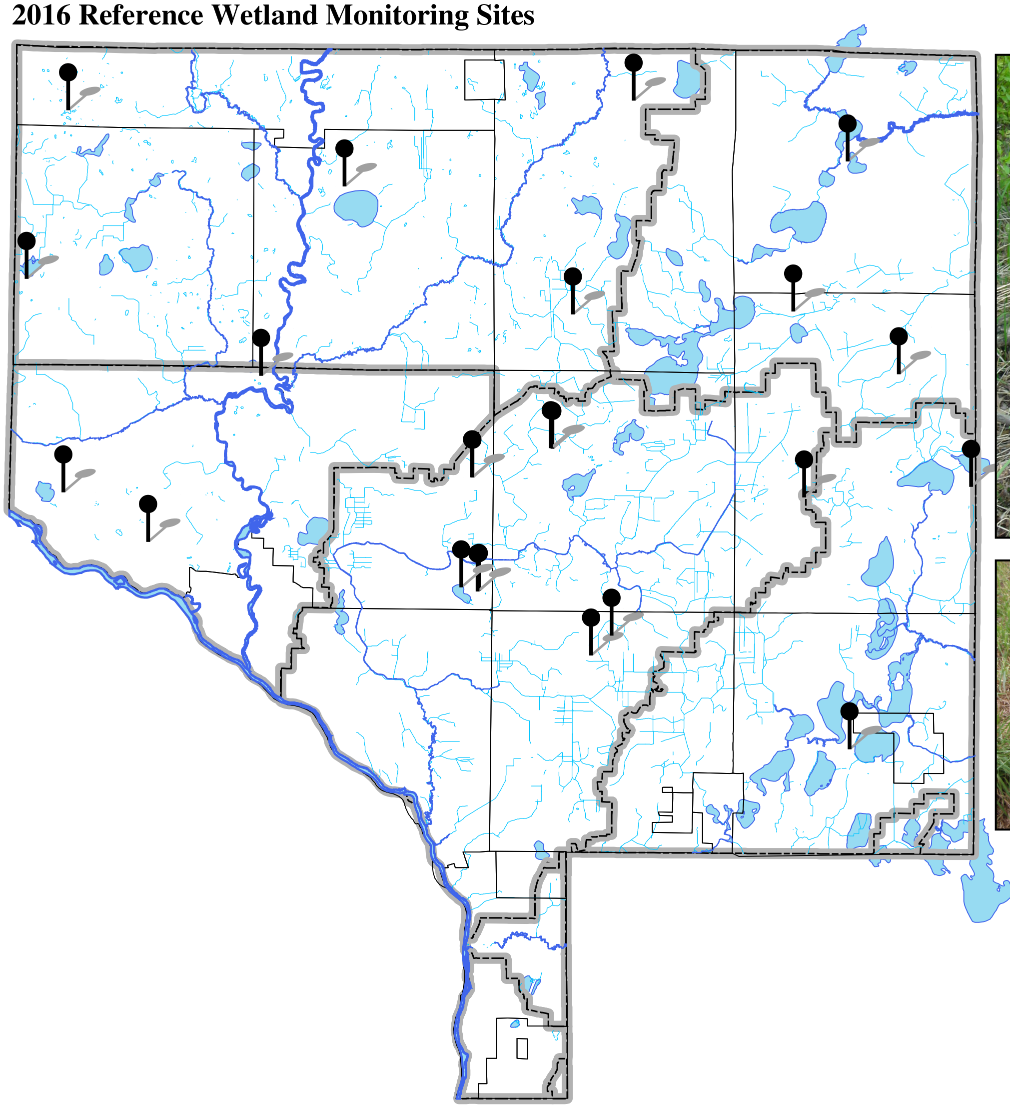
Wetland Hydrology

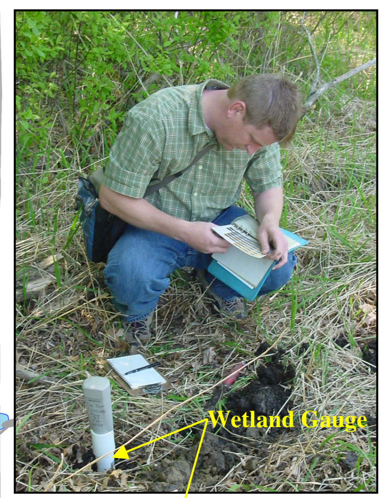
Wetland regulations are often focused upon determining whether an area is, or is not, a wetland. This is difficult at times because most wetlands are not continually wet. In order to facilitate fair, accurate wetland determinations the ACD monitors 19 wetlands throughout the county that serve as a reference of conditions county-wide. These are called reference wetlands. Electronic monitoring wells are used to measure subsurface water levels at the wetland edge every four hours. This hydrologic information, along with examination of the vegetation and soils, aids in accurate wetland determinations and delineations. These reference wetlands represent several wetland types and most have been monitored for 10+ years.

Reference wetland data provides insights into shallow groundwater hydrology trends. This can be useful for a variety of purposes from flood predictions to indices of drought severity. There are concerns locally that shallow aquifers are being drawn down.

Results of wetland hydrology monitoring are separated by watershed in the following chapters. The Coon Creek Watershed chapter includes a multi-year and most recent year analysis of all the wetlands.

2016 Reference Wetland Monitoring Sites



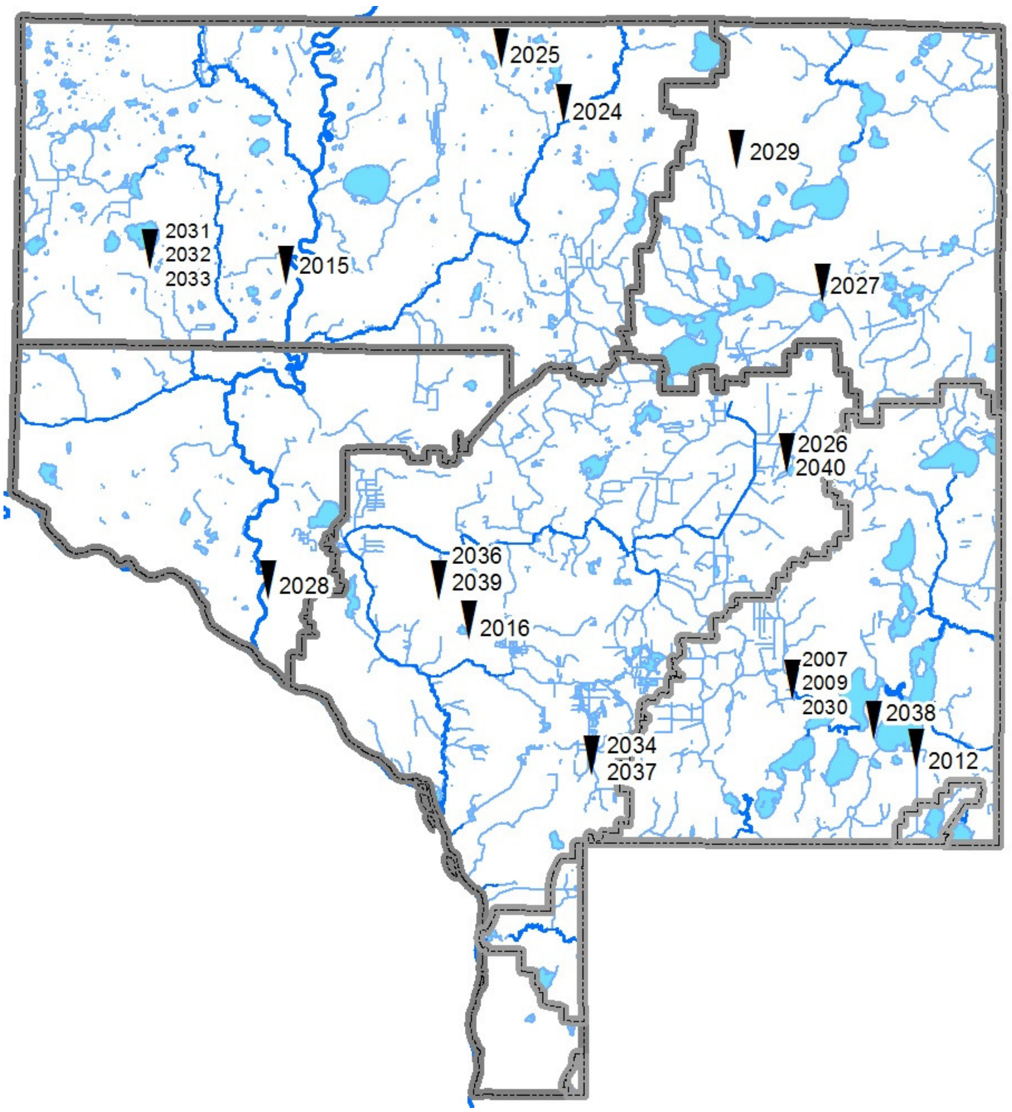


Groundwater Hydrology

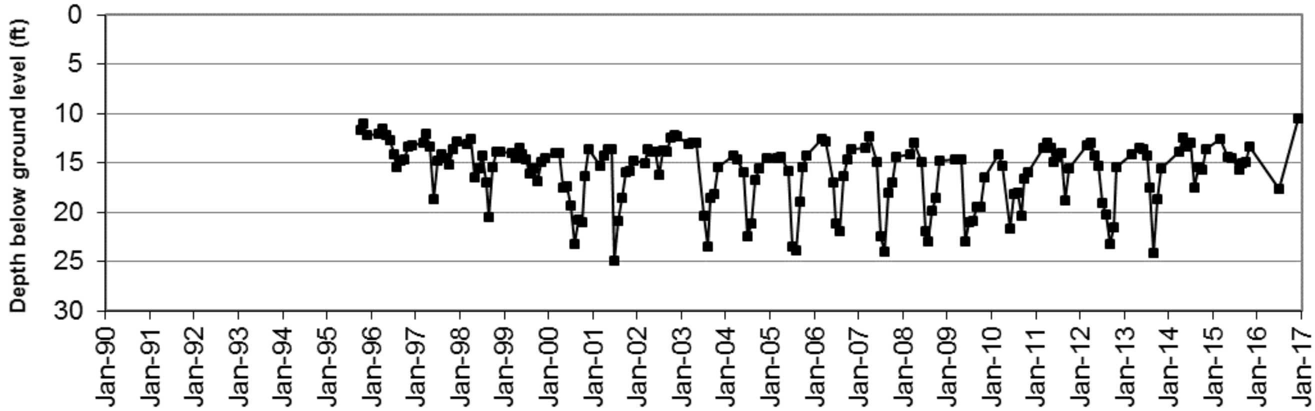
The Minnesota Department of Natural Resources (MN DNR) and the ACD are interested in understanding Minnesota's groundwater quantity and flow. The MN DNR maintains a network of groundwater observation wells across the state. The ACD is contracted to take water level readings at 21 wells in Anoka County from March to December. At some sites, the MN DNR also has automated devices taking water level readings at more frequent intervals. The MN DNR incorporates these data into a statewide database that aids in groundwater mapping. The data are reported by the MN DNR and available to the public on their web site http://www.dnr.state.mn.us/waters/groundwater_section/obwell. These deep groundwater wells are not as sensitive to precipitation as other hydrologic systems such as wetlands and streams, but rather respond to longer term trends.

The charts on the following pages show all recorded groundwater levels through 2016 for each well. These results are not presented elsewhere in this report. Raw data can be downloaded from the MN DNR website, as well as continuous data from wells with data loggers installed. Wells #2031-2040 were monitored by the ACD for the first time in 2016.

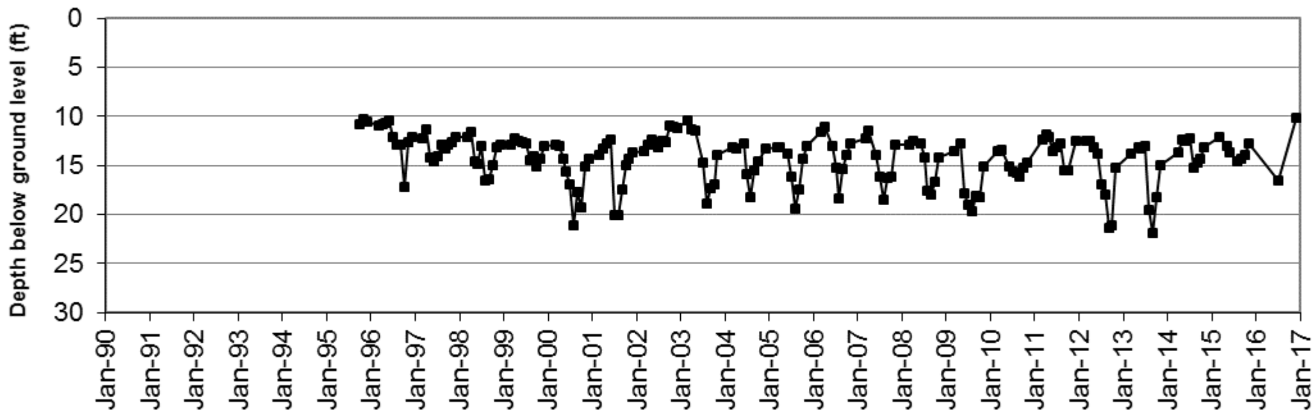
2016 Groundwater Observation Well Sites and Well ID Numbers



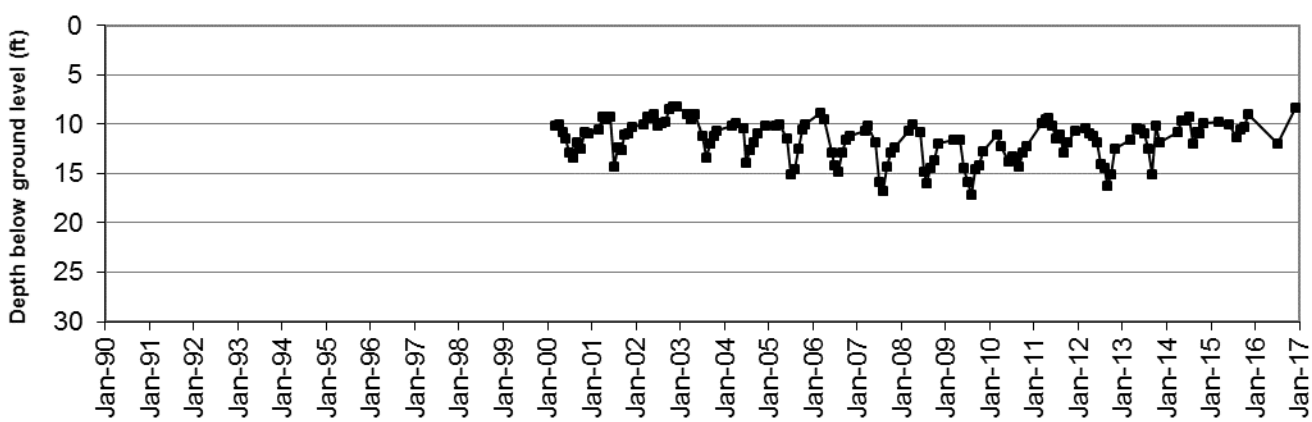
Observation Well #2007 (270 ft deep)—Lino Lakes



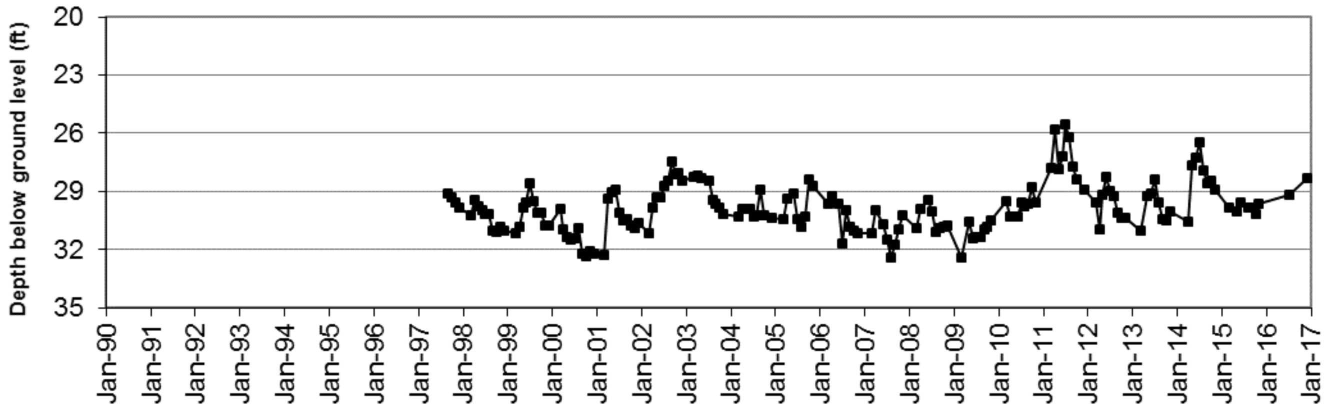
Observation Well #2009 (125 ft deep)—Lino lakes



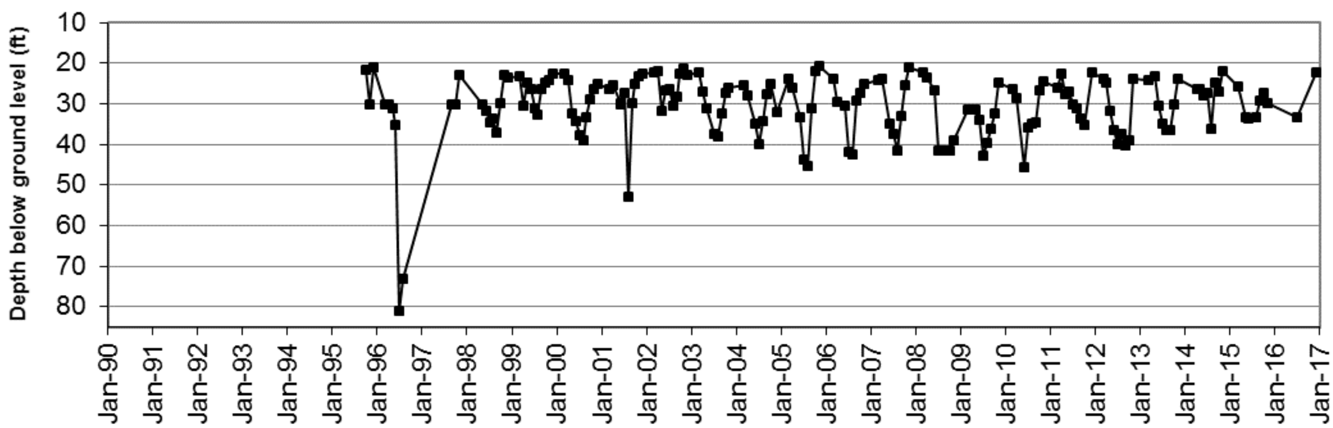
Observation Well #2012 (277 ft deep) – Centerville



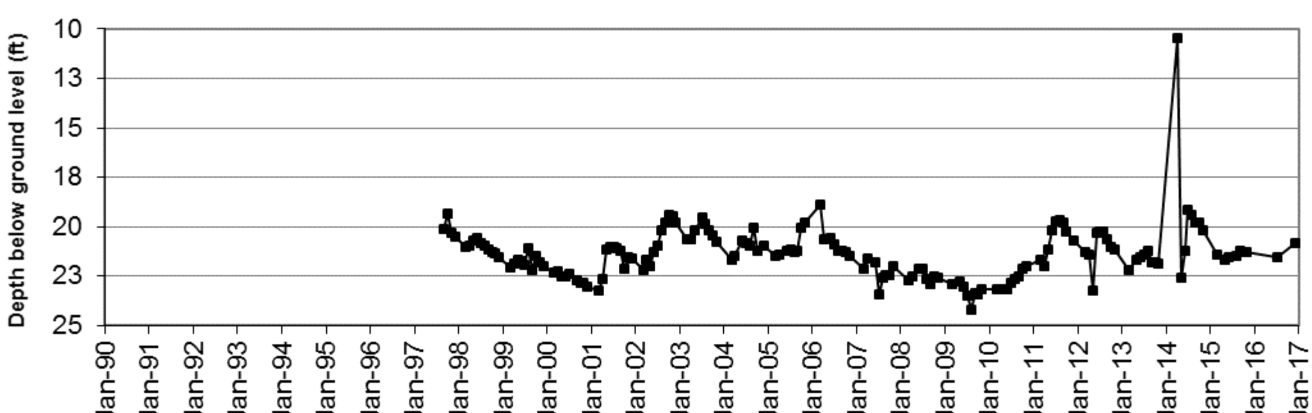
Observation Well #2015 (280 ft deep)—Ramsey



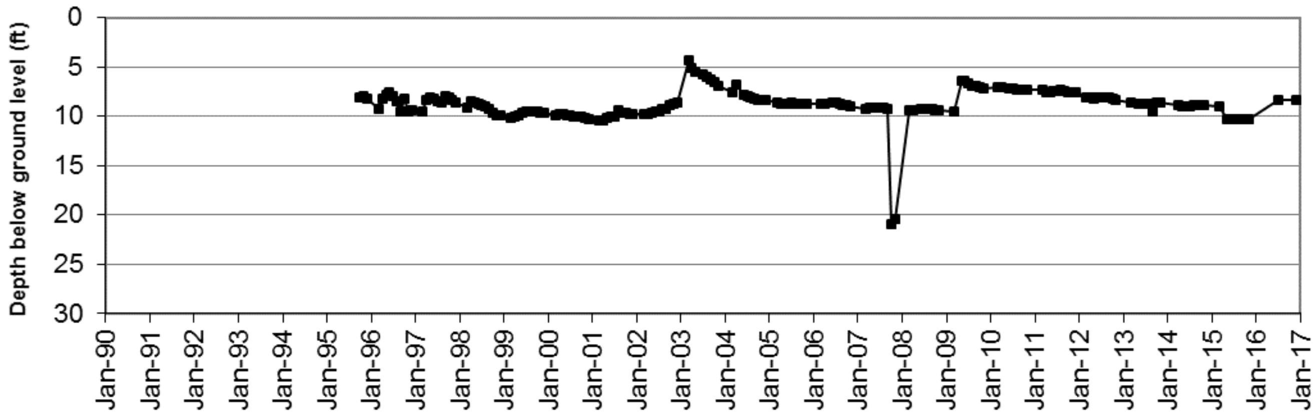
Observation Well #2016 (193 ft deep)—Coon Rapids



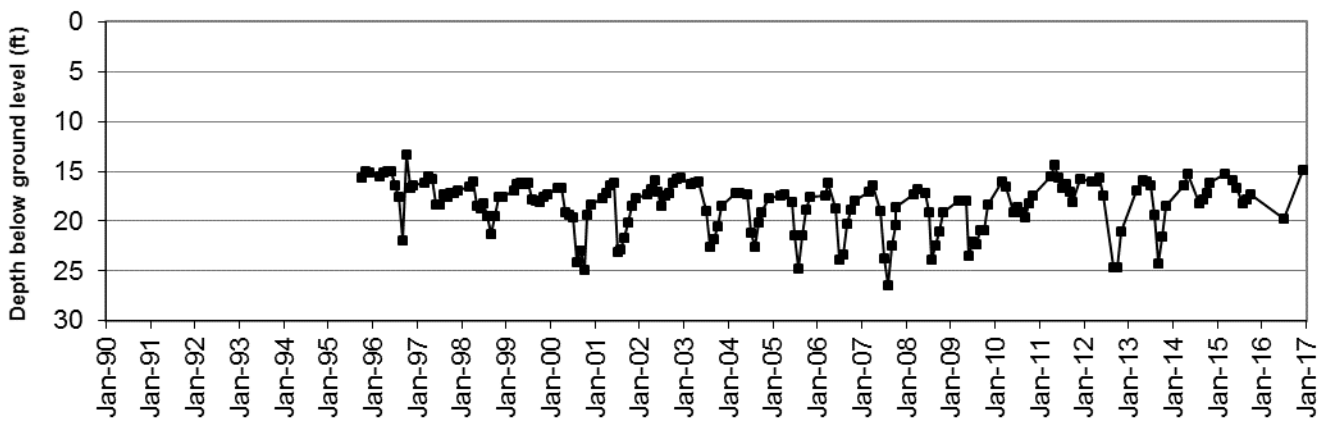
Observation Well #2024 (141 ft deep)—East Bethel



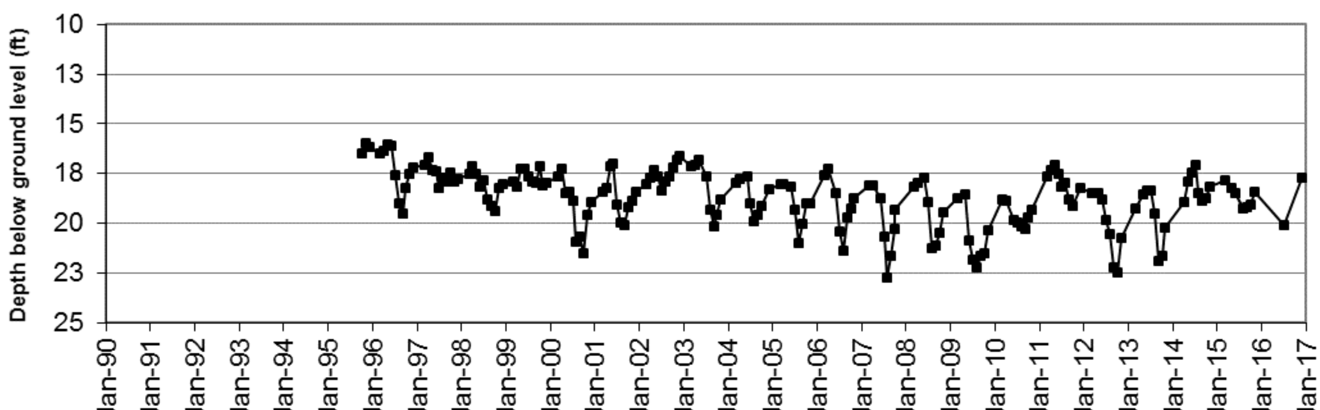
Observation Well #2025 (21 ft deep)—Bethel



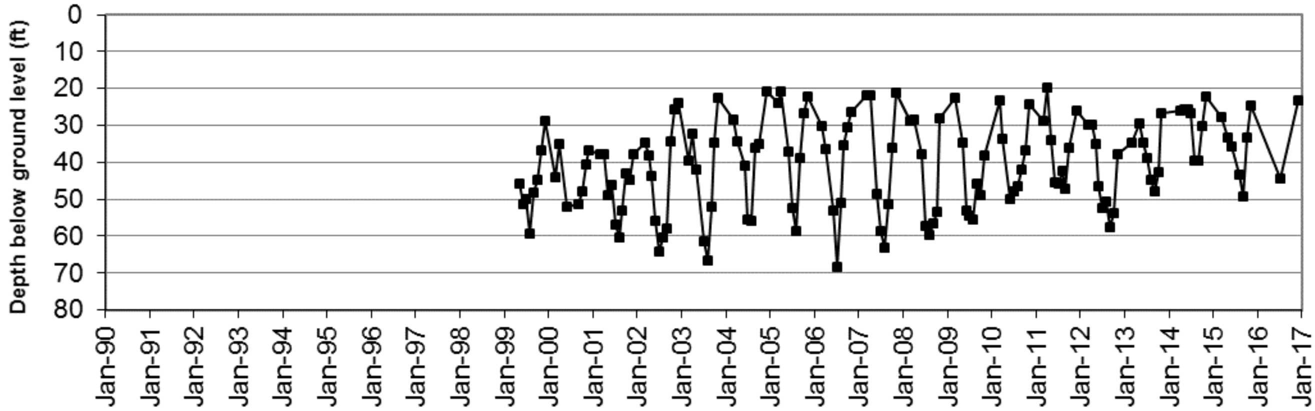
Observation Well #2026 (150 ft deep)— Carlos Avery #4



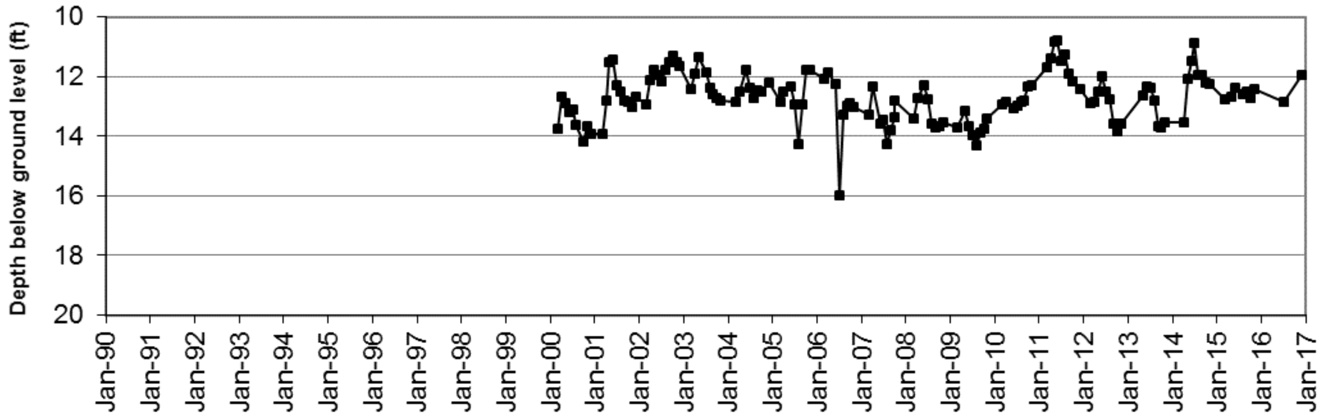
Observation Well #2027 (333 ft deep)— Columbus Twp.



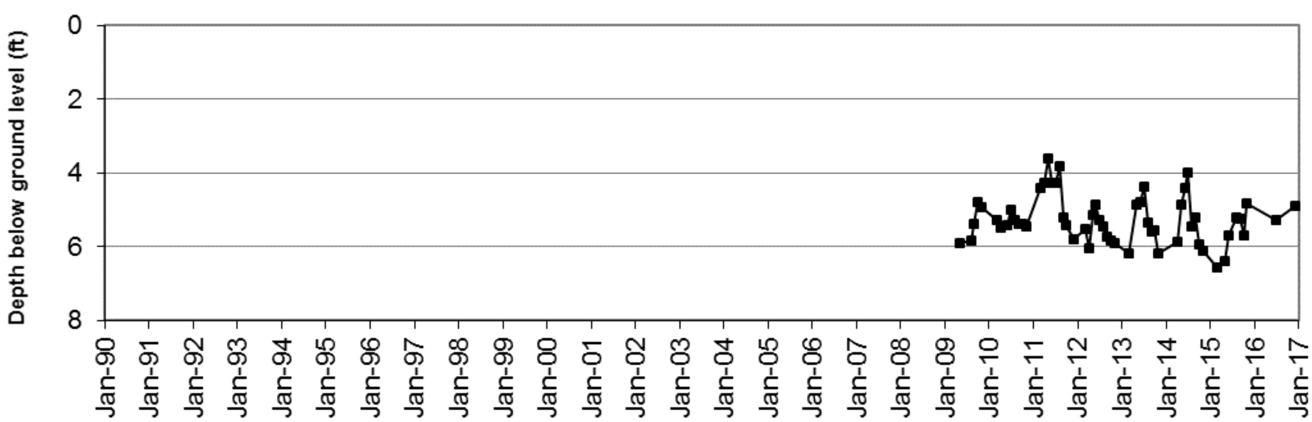
Observation Well #2028 (510 ft deep)—Anoka



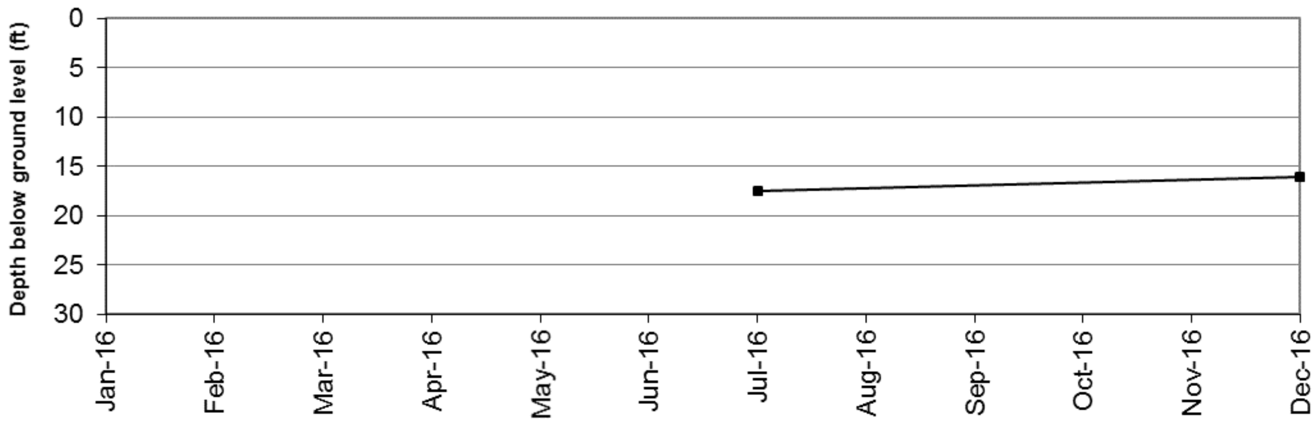
Observation Well #2029 (221 ft deep)—Linwood Twp.



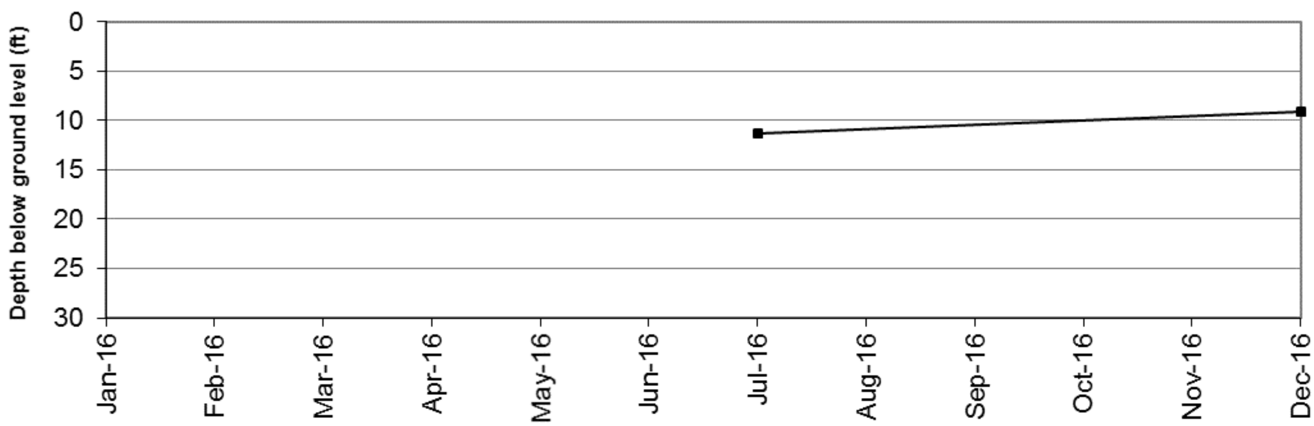
Observation Well #2030 (15 ft deep)—Lino Lakes



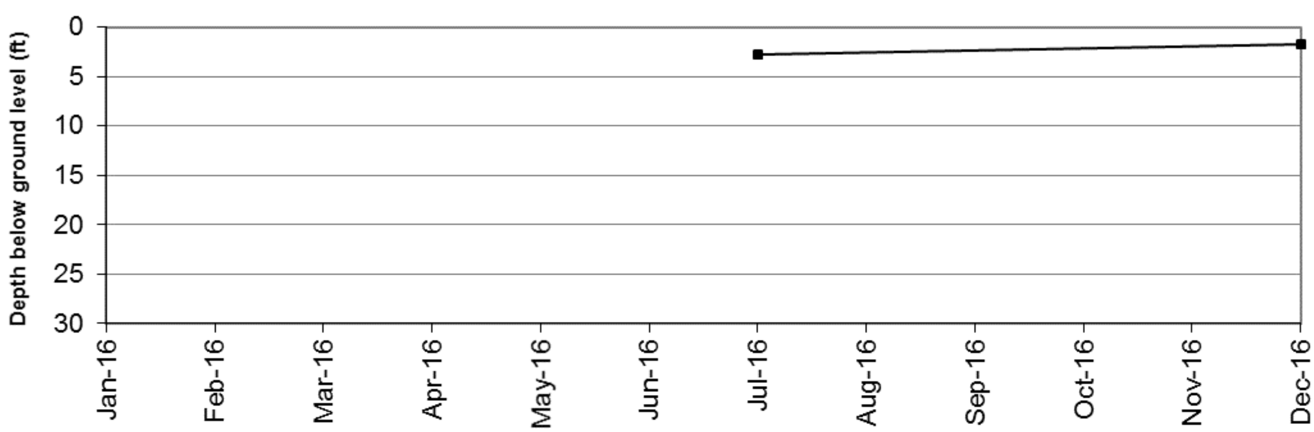
Observation Well #2031 (410 ft deep)—Nowthen



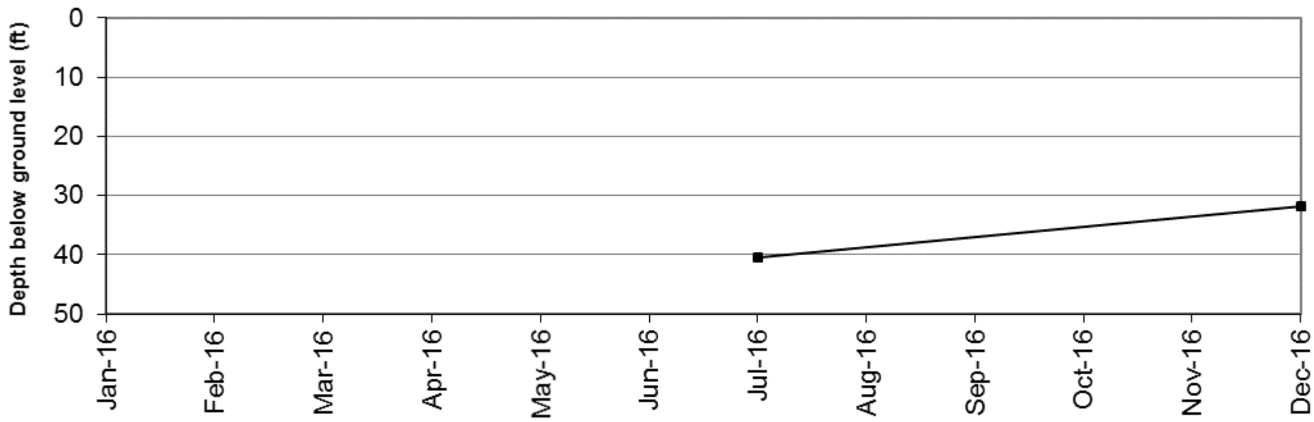
Observation Well #2032 (195 ft deep)—Nowthen



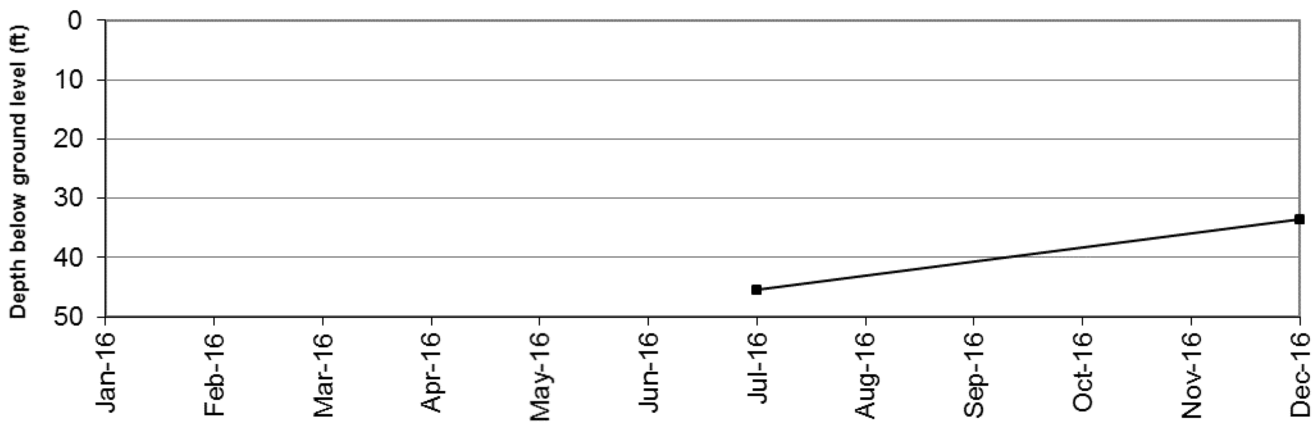
Observation Well #2033 (20.8 ft deep)—Nowthen



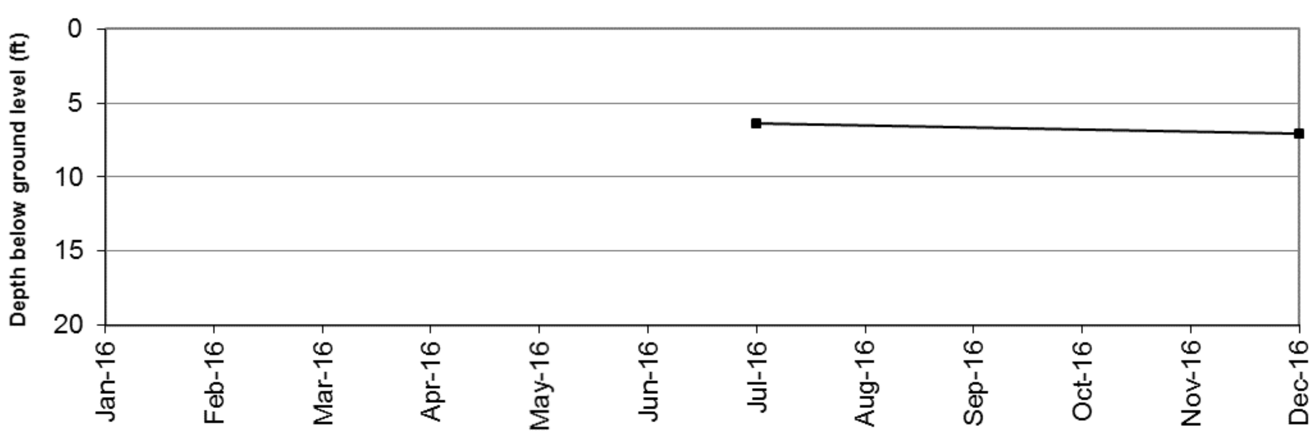
Observation Well #2034 (222 ft deep)—Blaine



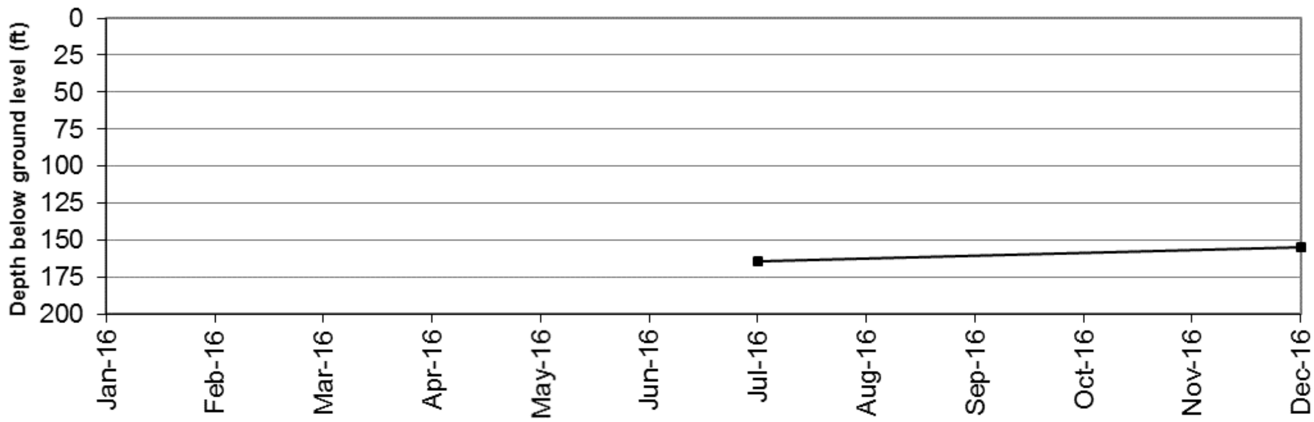
Observation Well #2036 (494 ft deep)—Andover



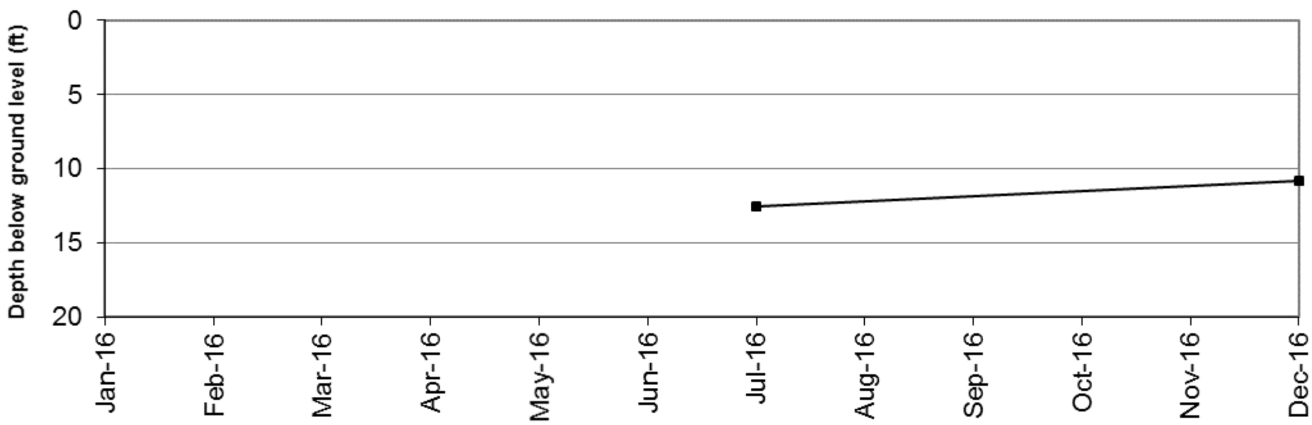
Observation Well #2037 (17.7 ft deep)—Blaine



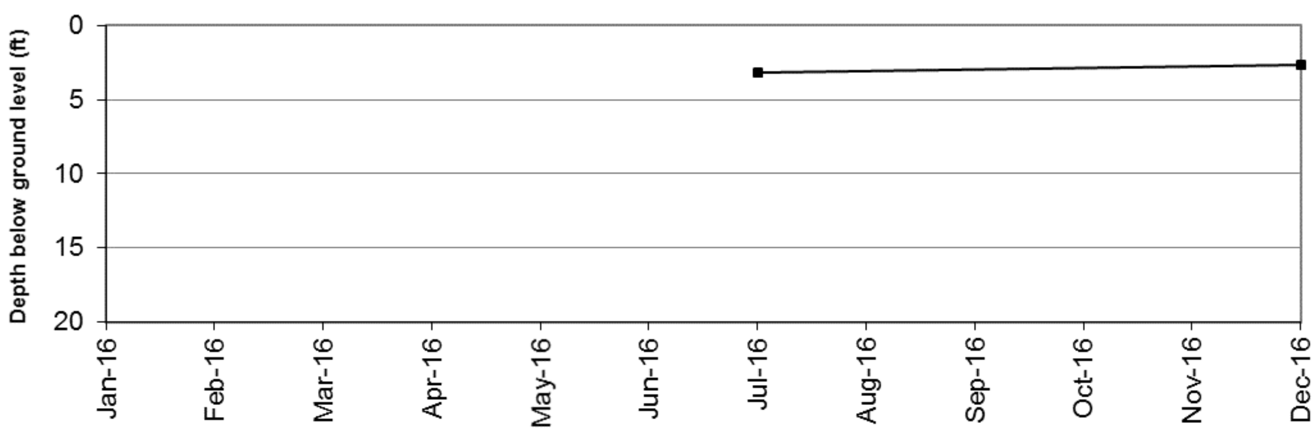
Observation Well #2038 (810 ft deep)—Lino Lakes



Observation Well #2039 (27.5 ft deep)—Andover



Observation Well #2040 (13 ft deep)—Carlos Avery #4

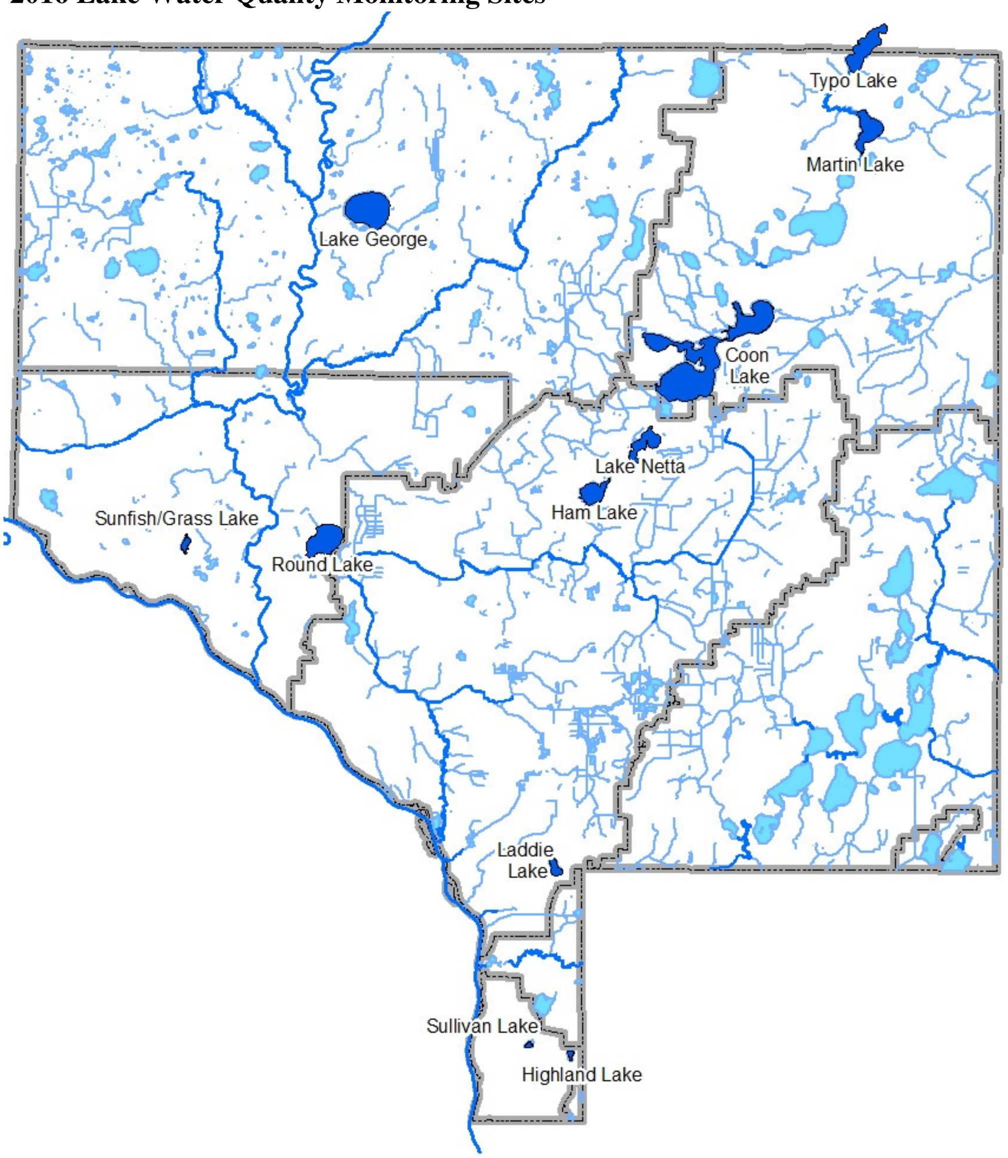


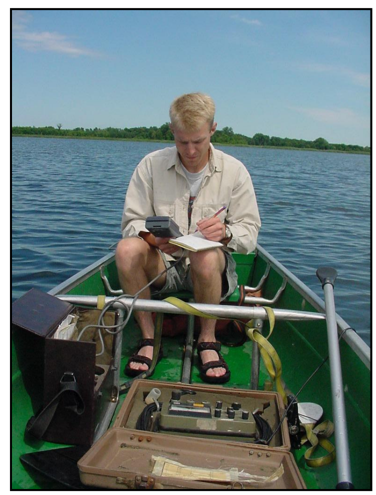
Lake Water Quality

The purpose of lake water quality monitoring is to detect and diagnose water quality problems that may affect suitability for recreation or that may adversely affect people or wildlife. The monitoring regime is designed to ensure major recreational lakes are monitored every 2-3 years. Some lakes are monitored more frequently if problems are suspected or projects are occurring that could affect lake water quality. Lakes with stable conditions, no suspected new problems, and robust datasets are monitored less often. Monitoring efforts of the Minnesota Pollution Control Agency or Metropolitan Council are not duplicated, and are not presented in this report.

In addition to this report, there are several sources of lake water quality data. For lakes monitored by the ACD, Met Council or MPCA prior to the current year, see the letter grade table on page 23. Detailed analyses for the lakes shown in that table are in that year's Water Almanac Report. All data collected by the ACD and most other agencies can be retrieved through the MPCA's website Electronic Data Access tool, which draws data from their EQuIS database.

2016 Lake Water Quality Monitoring Sites





LAKE WATER QUALITY MONITORING METHODS

The following parameters are tested at each lake:

- Dissolved Oxygen (DO);
- Turbidity;
- Conductivity;
- Temperature;
- Salinity;
- Total Phosphorus (TP);
- Transparency (Secchi Disk);
- Chlorophyll-a (Cl-a);
- pH.

Lakes are sampled every two weeks from May to September. Monitoring is conducted by boat at the deepest area of the lake. These sites are located using a portable depth finder or GPS. Conductivity, pH, turbidity, salinity, dissolved oxygen (DO), and temperature are measured using the Hydolab Quanta multi-probe at a depth of one meter. Water samples are collected with a Kemmerer sampler from a depth of one meter, to be analyzed by an independent laboratory (MVTL Labs) for chlorophyll-a, chlorides, and total phosphorus. Sample bottles are provided by the laboratory. Total phosphorus sample bottles contain preservative sulfuric acid (H_2SO_4), while bottles for Chlorides and Chlorophyll-a analyses do not require preservative. Chlorophyll-a bottles are wrapped in aluminum foil to exclude light. Water samples are kept on ice and delivered to the laboratory within 24 hours of collection.

Transparency is measured using a Secchi disk. The disk is lowered over the shaded side of the boat until it disappears and is then pulled up to the point where it reappears again. The midpoint between these two depths is the Secchi disk measurement.

To evaluate the lake, results are compared to other lakes in the region and past readings at the lake. Comparisons to other lakes are based on the Metropolitan Council's lake quality grading system and the Carlson's Trophic State Index for the North Central Hardwood Forest ecoregion. Historical data for each lake can be obtained from the U.S. EPA's national water quality database, EQuIS, via the Minnesota Pollution Control Agency.

Lake Water Quality Questions and Answers

This section is intended to answer basic questions about the Anoka Conservation District's methodology for monitoring lake water quality and interpreting the data.

Q- Which parameters did you test and what do they mean?

A- The table on the following page outlines technical information about the parameters measured, which include:

pH- This test measures if the lake water is basic or acidic. A pH reading of greater than 7 signifies that the lake is basic and a reading of less than 7 means the lake is acidic. Many fish and other aquatic organisms need a pH in the range of 6.5 to 9.0 in order to remain viable. Eutrophic lakes are often basic (pH = >7). The pH of a lake will fluctuate daily and seasonally due to algal photosynthesis, runoff, and other factors.

Conductivity- This is a measure of the degree to which the water can conduct electricity. It is caused by dissolved minerals in the lake. Although every lake has a certain amount of dissolved matter, high conductivity readings may indicate additional inputs from sources such as storm water, agricultural runoff, or from failing septic systems.

Turbidity- This is a measure of the diffraction of light from solid material suspended in the water column, due to "muddiness" or algae.

Dissolved Oxygen (DO) - Sources of dissolved oxygen include the atmosphere, aeration from stream inflow, and photosynthesis by algae and submerged plants in the lake. Dissolved oxygen is consumed by organisms in the lake and by decomposition processes.

Dissolved oxygen is essential to the metabolism of all aquatic organisms, and low dissolved oxygen is often the reason for fish kills. Extremely low DO concentrations at the lake bottom can also trigger a chemical reaction that causes phosphorus to be released from the sediment into the water column.

Salinity- This parameter measures the amount of dissolved salts in the water. Dissolved salts in a lake are not naturally occurring in Anoka County. High salinity measurements may be the result of inputs from other sources such as failing septic systems, spring runoff from roads, and farm field runoff.

Temperature- Fish species are sensitive to water temperature. Lake trout and salmon prefer temperatures between 46-56°F, while bass and pan fish will withstand temperatures of 76°F or greater. Temperature also affects the amount of dissolved oxygen that the water can hold in solution. At warmer temperatures, oxygen is readily released to the atmosphere and dissolved oxygen concentrations fall.

Secchi Transparency- Transparency is directly related to the amount of algae and suspended solids in the water column. A Secchi disk is a white and black disk attached to the end of a rope that is marked at 0.1-foot intervals. The disk is lowered over the shaded side of the boat until it disappears and is then pulled up to the point where it reappears again. The midpoint between these two points is the Secchi transparency. Shallow measurements indicate abundant algae and/or suspended solids.

Total Phosphorus (TP) - Phosphorus is an essential nutrient. Algal growth is commonly limited by phosphorous. High phosphorous in a lake can result in abundant algal growth. This, in turn, affects a variety of chemical and ecological factors including the lake's recreational suitability, fisheries, plants, and dissolved oxygen. A single pound of phosphorus can result in 500 pounds of algal growth. Minnesota Pollution Control Agency standards designate a lake in our ecoregion as "impaired" if average summertime phosphorus is >40 µg/L (or >60 µg/L for shallow lakes).

Sources of phosphorus include runoff from agricultural land, runoff carrying fertilizer from lakeshore properties, failing septic systems, pet waste, and stormwater runoff. The lake itself can also be a source of phosphorus. High levels of phosphorus contained in the bottom sediments of lakes can be released when the sediment is disturbed through recreation or animal activity, or when dissolved oxygen levels are low.

Chlorophyll-a (Cl-a) - Chlorophyll-a is the inorganic portion of all green plants that absorbs the light needed for photosynthesis. Chlorophyll-a measurements are used to indicate the concentration of algae in the water column. It does not provide an indication of large plant (macrophytes) or filamentous algae abundance.

Lake Water Quality Monitoring Parameters

Parameter	Units	Reporting Limit	Accuracy	Average Summer Range for North Central Hardwood Forest
pH	pH units	0.01	± .05	8.6 - 8.8
Conductivity	**mS/cm**	0.01	± 1%	0.3 - 0.4
Turbidity	FNRU	0.1	± 3%	1-2
D.O.	mg/L	0.01	± 0.1	N/A
Temperature	°C	0.1	± 0.17 °	N/A
Salinity	%	0.01	± 0.1%	N/A
T.P.	µg/L	1	NA	23 – 50
Cl-a	µg/L	1	NA	5 – 27
Secchi Depth	ft m	NA	NA	4.9 - 10.5 1.49 – 3.2

Q- Lakes are often compared to the "ecoregion." What does this mean?

A- We compare our lakes to other lakes in the same ecoregion. The U.S. Environmental Protection Agency mapped regions of the U.S based on soils, landform, potential natural vegetation, and land use. These regions are referred to as ecoregions. Minnesota has seven ecoregions. Anoka County is in the North Central Hardwood Forest ecoregion. Reference lakes, deemed to be representative and minimally impacted by man (e.g., no point source wastewater discharges, no large urban areas in the watershed, etc.), were sampled in each ecoregion to establish a standard range for water quality that should be expected in each ecoregion.
The average summer range of water quality values in the table on the previous page are the inter-quartile range (25^{th} to 75^{th} percentile) of the reference lakes for the North Central Hardwood Forest ecoregion. This provides a range of values that represent the central tendency of the reference lakes' water quality.

Q- What do the lake physical condition and recreational suitability numbers mean?

A- The Minnesota Pollution Control Agency has established a subjective ranking system that ACD staff use during each lake visit (see table, this page). Ranks are based purely upon the observer's perceptions. These physical and recreational rankings are designed to give a narrative description of algae levels (physical condition) and recreational suitability of each lake. While the physical condition is straight-forward, the recreational suitability may be complicated by the impacts of both water quality and dense aquatic vegetation (the influence of these two factors is not separated in the ranking).

Lake Physical and Recreational Conditions Ranking System

	Rank	Interpretation
Physical Condition	1	crystal clear
	2	some algae
	3	definite algae
	4	high algae
	5	severe bloom
Recreational Suitability	1	beautiful
	2	minimal problems, excellent swimming and boating
	3	slightly swimming impaired
	4	no swimming / boating ok
	5	no swimming or boating

Q- What is the lake quality letter grading system?

A- The Metropolitan Council developed the lake water quality report card in 1989 (see table below). Each lake receives a letter grade, that is based on average summertime (May-Sept) chlorophyll-a, total phosphorus and Secchi depth. In the same way that a teacher would grade students on a "curve," the lake grading system compares each lake only to other lakes in the region. Thus, a lake that gets an "A" in the Twin Cities Metro might only get a "C" in northern Minnesota. The goal of this grading system is to provide a single, easily understandable description of lake water quality.

Lake Grading System Criteria

Grade	Percentile	TP (µg/L)	Cl-a (µg/L)	Secchi Disk (m)
A	**< 10**	**<23**	**<10**	**>3.0**
B	**10 - 30**	**23 – 32**	**10 - 20**	**2.2 - 3.0**
C	**30 – 70**	**32 – 68**	**20 – 48**	**1.2 – 2.2**
D	**70 – 90**	**68 – 152**	**48 – 77**	**0.7 – 1.2**
F	**> 90**	**> 152**	**> 77**	**< 0.7**

Q- What is Carlson's Trophic State Index?

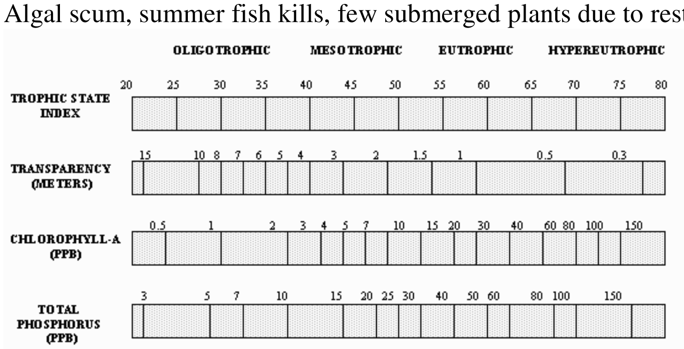
A- Carlson's Trophic State Index (see figure below) assigns a number used to describe a lake's stage of eutrophication (nutrient level, amount of algae). The index ranges from oligotrophic (clear, nutrient poor lakes) to hypereutrophic (green, nutrient overloaded lakes). The index values generally range between 0 and 100 with increasing values indicating more eutrophic conditions. Unlike the lake letter grading system, the Carlson's Trophic State Index does not compare lakes only within the same ecoregion; it is a scale used worldwide.

There are four trophic state index values: one each for phosphorus, chlorophyll-a, and transparency, plus an overall trophic state index value which is a composite of the others. The indices are abbreviated as follows:
TSI- Overall Trophic State Index.
TSIP- Trophic State Index for Phosphorus.
TSIS- Trophic State Index for Secchi transparency.
TSIC- Trophic State Index for the inorganic part of algae, Chlorophyll-a.
At the conclusion of each monitoring season, the summertime (May to September) average for each trophic state index is calculated.

Carlson's Trophic State Index Scale

CARLSON'S TROPHIC STATE INDEX

TSI < 30	Classic Oligotrophy: Clear water, oxygen throughout the year in the hypolimnion, salmonid fisheries in deep lakes.
TSI 30-40	Deeper lakes still exhibit classical oligotrophy, but some shallower lakes will become anoxic in the hypolimnion during the summer.
TSI 40-50	Water moderately clear, but increasing probability of anoxia in hypolimnion during the summer.
TSI 50-60	Lower boundary of classical eutrophy: Decreased transparency, anoxic hypolimnion during the summer, submerged plant growth problems evident, warm-water fisheries only.
TSI 60-70	Dominance of blue-green algae, algal scum probable, extensive submerged plant problems.
TSI 70-80	Heavy algal blooms possible throughout the summer, dense submerged plant beds, but extent limited by light penetration. Often classified as hypereutrophic.
TSI >80	Algal scum, summer fish kills, few submerged plants due to restricted light penetration.



Q- What does the "trophic state" of a lake mean?

A- Lakes fall into four categories, or trophic states, based on lake productivity and clarity.

1. Oligotrophic- In these lakes, nutrients (total phosphorus and nitrogen) are low. Oligotrophic lakes are the deepest and clearest of all lakes, but the least productive (i.e. lowest biomass of plants and fish due to lack of nutrients).

2. Mesotrophic- In these lakes, plant nutrients are available in limited quantities allowing for some, but not excessive plant growth. These lakes are still considered relatively clear. Northern Minnesota walleye and lake trout lakes are usually mesotrophic.

3. Eutrophic- In these lakes, the water is nutrient-rich. Productivity is high for both plants and fish. Abundant plant life, especially algae, results in poorer water clarity and can reduce the dissolved oxygen content when it decays. Algae blooms in the "dog days of summer" are commonplace. Bass and panfish are usually large components of the fish community, but rough fish can become problematic.

4. Hypereutrophic- In these lakes, nutrients are extremely abundant. Algae are grossly abundant, starving all other plants of light. The poor conditions often favor rough fish over game fish. These lakes have the poorest recreational potential.

Q- At what concentrations do total phosphorus and chlorophyll-a become a problem in lake water?

A- Lakes in the North Central Hardwood Forests have a certain criteria set for both total phosphorus and chlorophyll-a. For total phosphorus, the concentration for primary contact, recreation and aesthetics set at < 40 µg/L (<60 µg/L in shallow lakes). For chlorophyll-a, the average concentrations range from 5 to 22 µg/L, with maximums ranging from 7 to 37 µg/L. Once these set limits have been reached or exceeded, excessive algae growth will be observed.

Q- How do lakes change throughout the year and how does this affect water quality?

A- Water temperature is very important to the function of lakes. Lakes undergo seasonal changes that can influence water quality conditions. Because many Anoka County lakes are shallow (< 20 ft), some of the seasonal changes that are typical for deep lakes do not occur. The following discussion does not apply to these shallow lakes.

In the summer after the lake has warmed, deep lakes typically will be divided into three layers (stratified) based on the water's temperature and density; the well-mixed upper layer (epilimnion); the middle transition layer (metalimnion); and the cool, deep bottom layer (hypolimnion). The hypolimnion is usually depleted of oxygen because of decomposition of organic matter, the lack of photosynthesis, and because there is no contact with the surface where gas exchange with air can occur. Nutrients attached to sediment or decomposing organic material also fall into the hypolimnion where they are temporarily or permanently lost from the system. This is one reason deep lakes are usually not as nutrient rich and do not experience algae problems like shallow lakes.

In the autumn, the water near the surface eventually cools to the same temperature as the water at the bottom of the lake. When the water is of uniform temperature from top to bottom, it is easily mixed by the wind. This mixes nutrients that were formerly trapped at the bottom and may cause an autumn algal bloom. If the algal bloom is too severe, it could be detrimental to the lake during the winter when it is covered with ice. These algae will decay consuming dissolved oxygen, already decreased due to ice over, which may lead to a winter fish kill. This situation is typically observed in shallow eutrophic and/or hypereutrophic lakes.

In winter an inverse thermal stratification sets up. Ice is less dense than water and therefore floats. The coldest water is nearest the surface. Water has a maximum density at 4^{o} C, and that water is found at the bottom. The reversal of the temperature layers in spring and fall is called "turning over."

In spring, the lake "turns over" with the warmer water rising to the top and the colder sinking to the bottom. When this occurs, nutrients needed for plant growth (total phosphorus and nitrogen) are distributed throughout the lake from the bottom. As solar radiation slowly warms the deeper lakes during the spring and summer, the lake starts to stratify into the three layers again, this time with the warmest water on top.

Q- How do we determine if there is a trend of improving or worsening lake water quality?

A- Because of inherent natural variation, lake water quality is not the same each year. Sorting out this natural variation from true trends is best accomplished with statistical tests that analyze the data objectively. When at least 5 years of monitoring data are present, ACD staff test for lake trends using a Multivariate Analysis of Variance (MANOVA). MANOVA tests the vector response of correlated response variables (Secchi depth, total phosphorus, and chlorophyll-a) while maintaining the probability of making a type I error (rejecting a true null hypothesis) at $\alpha = 0.05$. In other words, we are simultaneously testing the three most important measurements of lake water quality. Testing each response variable separately would increase the chance of making a type I error.

Historical Water Quality Grades for Anoka County Lakes (includes monitoring by ACD and Met Council's CAMP program, post-1980 only.)

YEAR →	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cenaiko																		B	A	A	A	B	A	A	A	A	A	A	B	B	B	B	B				
Centerville		C		C					D												C	C		C	C	A											
Coon	C				C					C					C			C	B	A	B	C			C		C		C								
Coon (East Bay)					C					C	C	C		C	C	C		B	B	A	B	C	B		C	C	C	B	A	B	B	B	B	B+	A		B
Coon (West Bay)																															A		A		B		A-
Crooked				C		C				C					B	C	B	B	B		B		B	B		B	B-		B	B		B	A-		A	B	
East Twin	A	B		C						B						B		A	B	A	A		A			A			A			A		A			
Fawn									B									A	B	A	A	A			A		A		A		A		A			A	
George	A	A	A		A					A								A	B	A	A		A			B			B			B		B	B	A	A
George Watch		F	D	D		D		D	D	F	D	F					F	D	F	D	D	F	D	D	F	D	F	F	D	D	D	D	F				
Golden						D	C	D	F	F	F	F		D			C	D	C	C	C	D	D	D	D	C	C	C	C	C	C						
Ham					C									A	B		A	A	B		C	C			B	B		B	A		B	B		A	A		B
Highland																				D	D	D	F	F	F	F	F	F									F
Howard										F	F	F							F	D	D																
Island				C																				B	B	C	C	B	B	C	C	C	C				
Itasca																			A	B	B																
Laddie	D													B	B	B			B	B	B	B	B	B	B	B			B			B					A
Linwood	B	C		C						C					C			C	C	C	C	C		C		C		C	C	C			C			C	
Lochness																												A	B		B	C	C				
Martin				D														D	D	C	D	D		D		D		D	D	D			D		C	C	C
Minard																																		A	A		
E. Moore	C	C	C	C	C	B	C	C							C				C	B	B	C	C	C		C											
W. Moore	C	C	F	C	B	C	F	C												B	B	C	C	C		C											
Mud														B						B	C																
Netta																		B	C	A		B		A	A		B+	B+		B	A-		A-	A		A	A
Peltier				D										D	F	D	D	D	D	D	D	F	F	D	D	D	F	D									
Pickerel																B		A	A	B	C										A	C		B	A		
Reshanau																											D	D	D	D	D	D	D				
Rogers																			C		C			B			D		B	B							
Round																			B	A	B			A		B		C		C	C		A		A		A
Sullivan (Sandy)														D	D	D		D	D	D	D	D	F	D	D	D								D			D
Sunfish/Grass																																	B	B			B
Typo														F	F	F		F	F	F	F	F		F		F		F		F			F		D	F	F

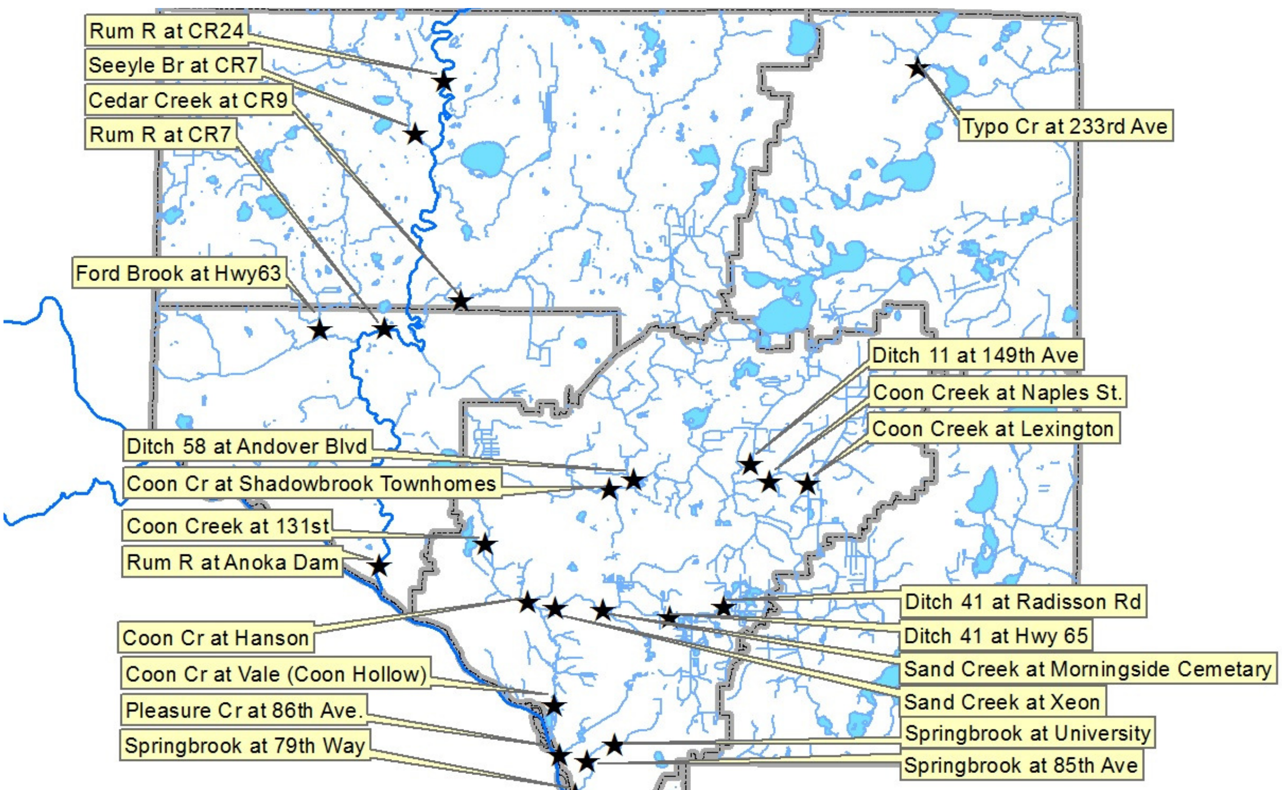
Stream Water Quality – Chemical Monitoring

Stream water quality monitoring is conducted to detect and diagnose water quality problems impacting the ecological integrity of waterways, recreation, or human health. Because many streams flow into lakes, stream water quality is often studied as part of lake improvement studies.

Chemical stream water quality monitoring in 2016 was conducted at Cedar Creek, Seeyle Brook, four Sand Creek sites, eight Coon Creek sites, three Springbrook sites, three Rum River sites, Ford Brook and Pleasure Creek. Additionally, the ACD continued a cooperative effort with the Metropolitan Council for monitoring of the Rum River at the Anoka Dam as part of the Metropolitan Council's Watershed Outlet Monitoring Program (WOMP). Those data are housed with the Metropolitan Council, and methodologies are available upon request from either organization.

The methodologies for chemical stream water quality monitoring and information on data interpretation can be found on the following pages. Monitoring results are presented in the following chapters.

2016 Chemical Stream Water Quality Monitoring Sites



STREAM WATER QUALITY MONITORING METHODS

Stream water is monitored four times during base flow conditions and four times immediately following storm events between the months of April and September (some special studies have different sampling regimes). Grab samples are a single sample of water collected to represent water quality for a given moment or stream condition. A composite sample, conversely, consists of collecting several small samples over a period of time and mixing them. Grab samples are used for all stream water quality monitoring performed by the ACD. Each stream grab sample was tested for the following parameters:

- pH;
- Dissolved Oxygen (DO);
- Turbidity;
- Conductivity;
- Temperature;
- Salinity;
- Total Phosphorus (TP);
- Total Suspended Solids;
- Secchi Tube Transparency
- others for some special investigations.

Conductivity, pH, turbidity, salinity, dissolved oxygen (DO), and temperature are measured in the field using a Hydrolab Quanta multi-probe. E. coli samples are analyzed by the independent laboratory Instrumental Research Inc. (IRI). Total phosphorus, chlorides, total suspended solids, sulfate, hardness, and any other parameters are analyzed by the independent laboratory Minnesota Valley Testing labs (MVTL). Sample bottles are provided by the laboratory, complete with necessary preservatives. Water samples are kept on ice and delivered to the laboratory within 24 hours of collection, with the exception of E. coli samples, which are delivered to the laboratory no later than 7 hours after being collected. Stream water level is noted when the sample is collected.

Stream Water Quality Monitoring Questions and Answers

This section is intended to answer basic questions about the Anoka Conservation District's methodology for monitoring stream water quality and interpreting the data.

Q- What do the parameters that you test mean?

A- pH- This test measures if the water is basic or acidic. A pH reading of greater than 7 signifies that the stream is basic and a reading of less than 7 means the stream is acidic. Many fish and other aquatic organisms need a pH in the range of 6.5 to 9.0.

Conductivity- This is a measure of the degree to which the water can conduct electricity. It is caused by dissolved minerals in the lake. Although every lake has a certain amount of dissolved matter, high conductivity readings may indicate additional inputs from sources such as storm water, agricultural runoff, or from failing septic systems.

Turbidity- This is a measure of the diffraction of light from solid material suspended in the water column, due to "muddiness" or algae.

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Dissolved oxygen is essential to the metabolism of all aquatic organisms, and low dissolved oxygen is often the reason for fish kills. Extremely low DO concentrations at the lake bottom can also trigger a chemical reaction that causes phosphorus to be released from the sediment into the water column.

Salinity- This parameter measures the amount of dissolved salts in the water. Dissolved salts in a lake are not naturally occurring in Anoka County. High salinity measurements may be the result of inputs from other sources such as failing septic systems, spring runoff from roads, and farm field runoff.

Temperature- Fish species are sensitive to water temperature. Lake trout and salmon prefer temperatures between 46-56°F, while bass and pan fish will withstand temperatures of 76°F or greater.

Temperature also affects the amount of dissolved oxygen that the water can hold in solution. At warmer temperatures, oxygen is readily released to the atmosphere and dissolved oxygen concentrations fall.

Secchi Transparency- Transparency is directly related to the amount of algae and suspended solids in the water column. A Secchi disk is a white and black disk attached to the end of a rope that is marked at 0.1-foot intervals. The disk is lowered over the shaded side of the boat until it disappears and is then pulled up to the point where it reappears again. The midpoint between these two points is the Secchi transparency. Shallow measurements indicate abundant algae and/or suspended solids.

Total Phosphorus (TP) - Phosphorus is an essential nutrient. Algal growth is commonly limited by phosphorous. High phosphorous in a lake can result in abundant algal growth. This, in turn, affects a variety of chemical and ecological factors including the lake's recreational suitability, fisheries, plants, and dissolved oxygen. A single pound of phosphorus can result in 500 pounds of algal growth. Minnesota Pollution Control Agency standards designate a lake in our ecoregion as "impaired" if average summertime phosphorus is >40 µg/L (or >60 µg/L for shallow lakes).

Sources of phosphorus include runoff from agricultural land, runoff carrying fertilizer from lakeshore properties, failing septic systems, pet waste, and stormwater runoff. The lake itself can also be a source of phosphorus. High levels of phosphorus contained in the bottom sediments of lakes can be released when the sediment is disturbed through recreation or animal activity, or when dissolved oxygen levels are low.

Chlorides– This is a measure of dissolved chloride materials. The most common source is road salt (sodium chloride), but other sources include various chemical pollutants and sewage effluent.

Sulfates and hardness – These parameters were tested because of research findings that chloride toxicity varies with sulfates and hardness. In some states, like Iowa, the chloride water quality standard is linked to hardness and sulfates. Minnesota is likely to change their water quality standards in this way in the near future.

Analytical Limits for Stream Water Quality Parameters

Parameter	Unit of Measurement	Method Detection Limit	Reporting Limit	Analysis or Instrument Used
pH	pH units	0.01	0.01	Hydrolab Quanta
Conductivity	**mS/cm**	0.001	0.001	Hydrolab Quanta
Turbidity	NTU	0.1	0.1	Hydrolab Quanta
Dissolved Oxygen	mg/L	0.01	0.01	Hydrolab Quanta
Temperature	°C	0.1	0.1	Hydrolab Quanta
Salinity	%	0.01	0.01	Hydrolab Quanta
Total Phosphorus	µg/L	0.3	1.0	EPA 365.4
Total Suspended Solids	mg/L	5.0	5.0	EPA 160.2
Chloride	mg/L	0.005	0.01	EPA 325.1
Sulfate	mg/L	1.0	4.0	ASTM D516-02
Hardness	mg/L		na	2340.B
E. *coli*	MPN/100 mL	1.0	1.0	SM9223 B-97

Q- How do you rate the quality of a stream's water?

A- We make up to three comparisons. First, with published water quality values for the ecoregion. Ecoregions are areas with similar soils, landform, potential natural vegetation, and land use. All of Anoka County is within the North Central Hardwood Forest (NCHF) Ecoregion. Mean values for our ecoregion, and for minimally impacted streams in our ecoregion are in the table below.

Secondly, we compare each stream to 34 other streams the Anoka Conservation District has monitored throughout the county. The county includes urban, suburban, and rural areas so this comparison incorporates water quality expectations in all these land uses.

Third, we compare levels of a pollutant observed to state water quality standards. These standards exist for some, but not all, pollutants.

Q- What Quality Assurance/Quality Control procedures are in place?

A- QA/QC is accomplished in the following ways:

Minnesota Valley Testing Laboratories (MVTL) conducted the laboratory analysis. MVTL has a comprehensive QA/QC program, which is available by contacting them directly. The ACD followed field protocols supplied by MVTL including keeping samples on ice, avoiding sample contamination, delivering samples to the lab within 24 hours of sampling, and providing duplicates and blanks. Sample bottles are provided by MVTL and include the necessary preservatives.

The hand held Hydrolab Quanta multi-probe used to conduct in-stream monitoring is calibrated at least daily.

Typical Stream Water Quality Values for the North Central Hardwood Forest (NCHF) Ecoregion and for Anoka County

Parameter	Units	NCHF Ecoregion Mean[1]	NCHF Ecoregion Minimally Impacted Stream[1]	Median of Anoka County Streams
pH	pH units		8.1	7.62
Conductivity	mS/cm	.389	.298	0.362
Turbidity	FNRU		7.1	8.5
Dissolved Oxygen	mg/L	-	-	6.97
Temperature	°F		71.6	
Salinity	%		0	0.01
Total Phosphorus	µg/L	220	130	135
Total Suspended Solids	mg/L		13.7	12
Chloride	mg/L		8	17
Sulfate	Mg/L			18.7
Hardness	mg/L CaCO3			180.5

[1]MPCA 1993 Selected Water Quality Characteristics of Minimally Impacted Streams for Minnesota's Seven Ecoregions: Addendum to Descriptive Characteristics of the Seven Ecoregions of Minnesota. McCollor & Heiskary.

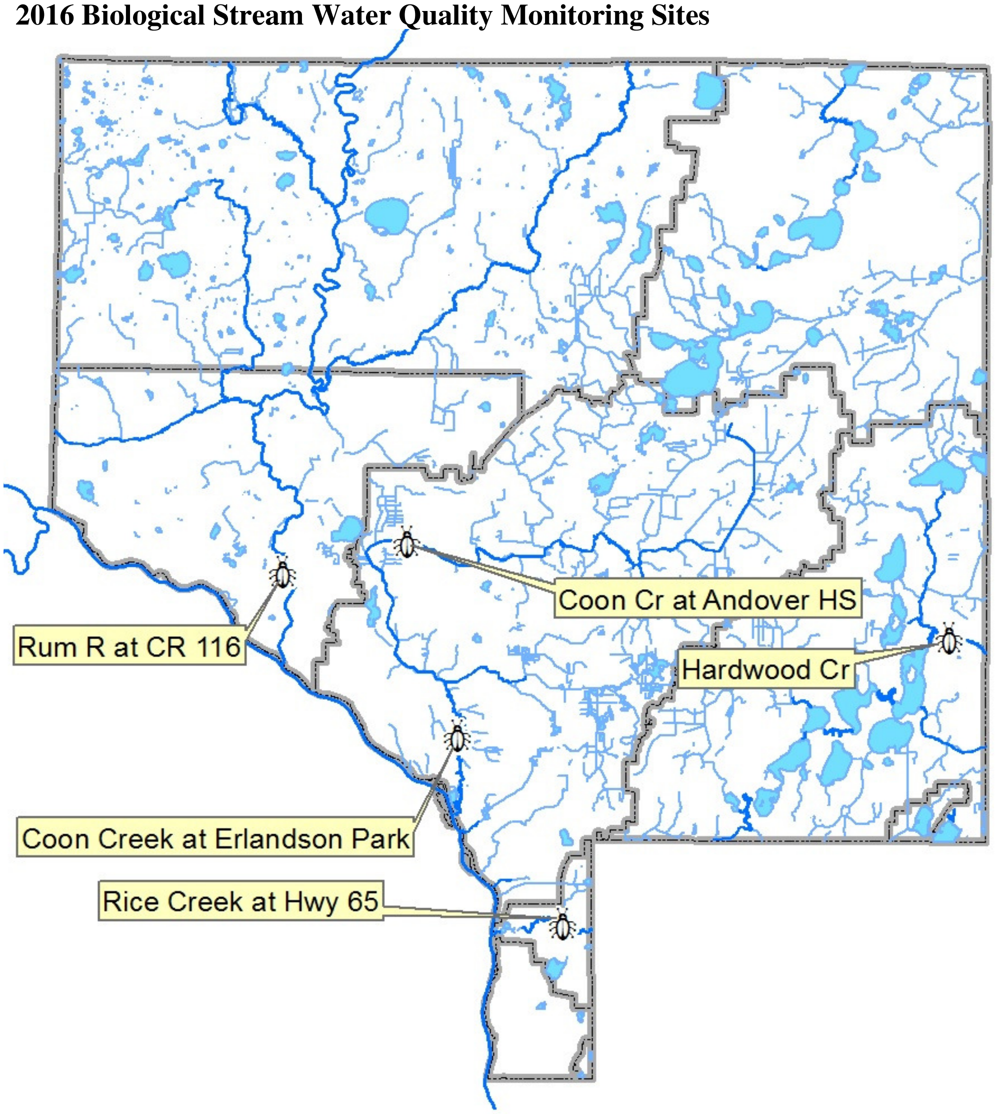
Stream Water Quality – Biological Monitoring

The stream biological monitoring program, often called biomonitoring, is both a stream health assessment and educational program. This biomonitoring program uses benthic (bottom dwelling) macroinvertebrates to determine stream health. Macroinvertebrates are animals without a backbone and large enough to see without a microscope, such as aquatic insects, snails, leeches, clams, and crayfish. Certain macroinvertebrates, such as stoneflies, require high quality streams, while others thrive in poor quality streams. Because of their extended exposure to stream conditions and sensitivity to habitat and water quality, benthic macroinvertebrates serve as good indicators of stream health.

ACD adds an educational component to the program by involving students in the biomonitoring at many of the sites. High school science classes are the primary volunteers. In 2016 there was one 4-H group as well as approximately 316 students from four high schools who monitored five sites. Since 2000, over 5,000 students have participated. The experience affords students an opportunity to learn scientific methodologies and become involved in local natural resource management.

Results of this monitoring are separated by watershed in the following chapters.

2016 Biological Stream Water Quality Monitoring Sites



Biomonitoring Methods

ACD biomonitoring is based on the US Environmental Protection Agency (EPA) multi-habitat protocol for low-gradient streams (www.epa.gov/owow/monitoring/volunteer/stream/). Using this methodology, individuals doing the sampling determine how much of the stream is occupied by four types of micro-habitat: vegetated bank margins, snags and logs, aquatic vegetation beds and decaying organic matter, and silt/sand/gravel substrate. Sampling is by "jabs" or sweeps with a D-frame net. Each habitat type is sampled in proportion to the prevalence of the habitat type. At least 20 jabs are taken. For student biomonitoring, all habitat types are sampled but not in proportion. All macroinvertebrates are preserved and returned to the lab (or classroom) for identification to the family level. The identified invertebrates are preserved in labeled vials. From the identifications, biomonitoring indices are calculated to rank stream health. Fieldwork is overseen by Anoka Conservation District (ACD) staff and student identifications are checked by ACD staff before any analysis is done.

Biomonitoring Indices

Indices are mathematical calculations that summarize tallies of identified macroinvertebrates and known values of their pollution tolerance into a single number that serves as a gauge of stream health. The indices listed below are used in the biomonitoring program, but are not the only indices available. No single index is a complete measure of stream health. Multiple indices should be considered in concert.

Taxa Richness and Composition Measures

Number of Families: This is a count of the number of taxa (families) found in the sample. A high richness or variety is good.

EPT: This is a measure of the number of families in each of three generally pollution-sensitive orders: <u>E</u>phemeroptera (mayflies), <u>P</u>lecoptera (stoneflies), and <u>T</u>richoptera (caddisflies). A high number of these families is good.

Tolerance and Intolerance Metrics

Family Biotic Index (FBI): The Family Biotic Index summarizes the various pollution tolerance values of all families in the sample. FBI ranges from 0 to 10, with LOWER values reflecting HIGHER water quality. Each macroinvertebrate family has a unique pollution tolerance value associated with it. The table below provides a guide to interpreting the FBI.

Key to interpreting the Family Biotic Index (FBI)

Family Biotic Index (FBI)	Water Quality Evaluation	Degree of Organic Pollution
0.00 - 3.75	Excellent	Organic pollution unlikely
3.76 - 4.25	Very Good	Possible slight organic pollution
4.26 - 5.00	Good	Some organic pollution probable
5.01 - 5.75	Fair	Fairly substantial pollution likely
5.76 - 6.50	Fairly Poor	Substantial pollution likely
6.51 - 7.25	Poor	Very substantial pollution likely

Population Attributes Metrics

% EPT: This measure compares the number of organisms in the EPT orders (Ephemeroptera - mayflies: Plecoptera - stoneflies: Trichoptera - caddisflies) to the total number of organisms in the sample. A high percent of EPT is good.

% Chironomidae: This measure compares the number of midges to the total number of organisms in the sample. A low percentage of midge larvae is good.

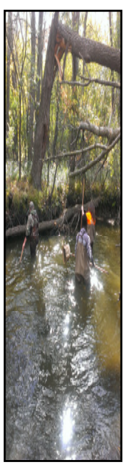
% Dominant Family: This measures the percentage of individuals in the sample that are in the sample's most abundant family. A high percentage is usually bad because it indicates low evenness (one or a few families dominate, and all others are rare).

Sites

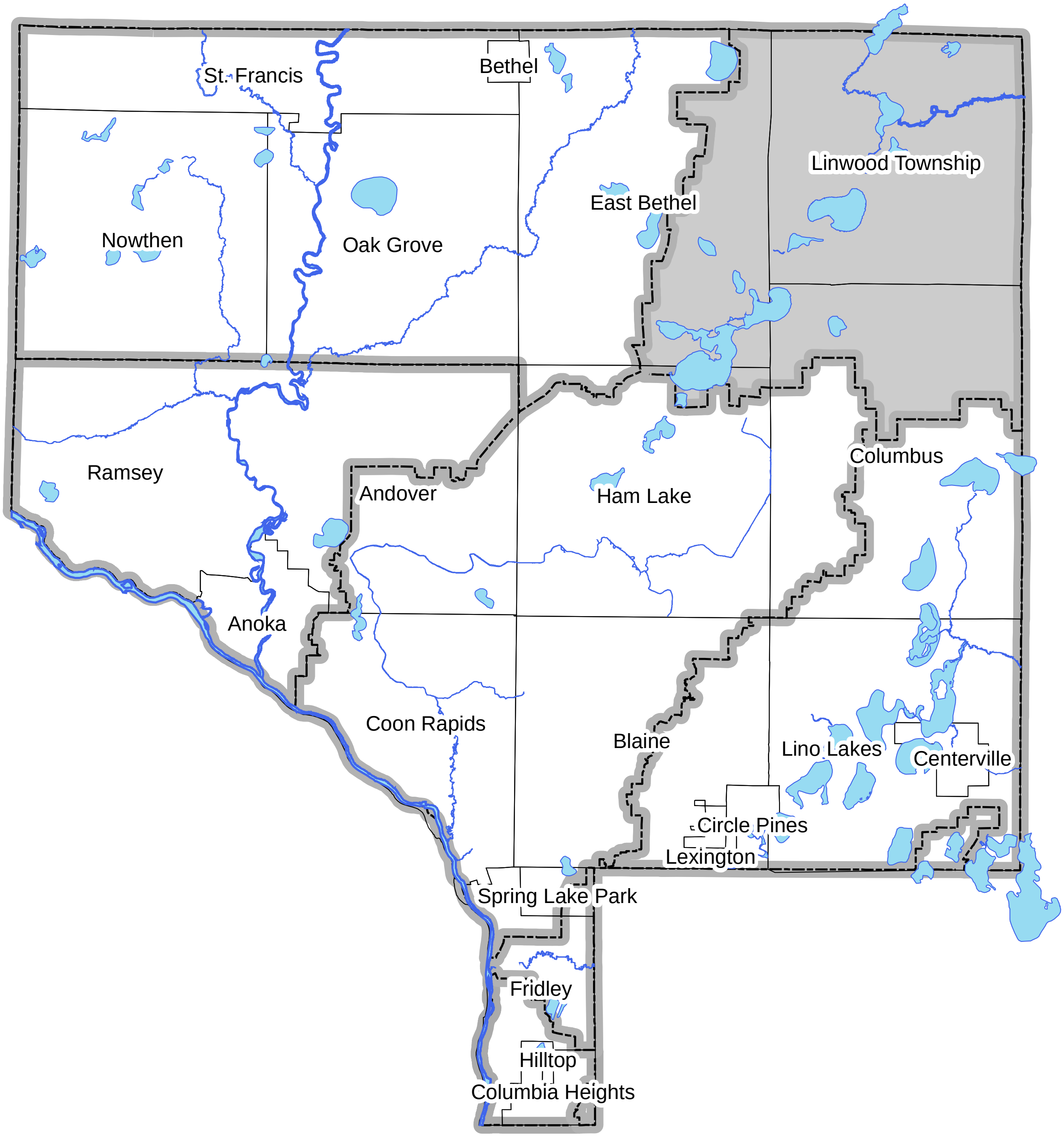
In 2016, high school classes and a 4-H group, with ACD staff supervision, sampled five sites for benthic macroinvertebrates.

2016 Biomonitoring Sites and Corresponding Monitoring Groups

Monitoring Group	Stream
Andover High School	Coon Creek
Anoka High School	Rum River (South)
Forest Lake Area Learning Center	Hardwood Creek
Totino Grace High School	Rice Creek
Anoka County 4-H	Coon Creek



Sunrise River Watershed



Contact Info: Sunrise River Watershed Management Organization
www.srwmo.org
763-434-9569

Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

Chapter 2:
Sunrise River Watershed

Task	Partners	Page
Lake Levels	SRWMO, ACD, MN DNR, volunteers	2-32
Lake Water Quality	SRWMO, ACD, ACAP	2-34
Stream Water Quality	SRWMO, ACD, ACAP	2-44
Stream Water Hydrology	SRWMO, ACD, ACAP	2-52
Wetland Hydrology	SRWMO, ACD, ACAP	2-53
Water Quality Grant Fund	SRWMO, ACD	2-57
Coon Lake Area Stormwater Retrofit Assessment	SRWMO, ACD	2-58
Carp Barriers Installation	SRWMO, ACD, Martin Lakers Assoc, DNR, Linwood Twp, et al	2-60
Annual Education Publication	SRWMO, ACD	2-61
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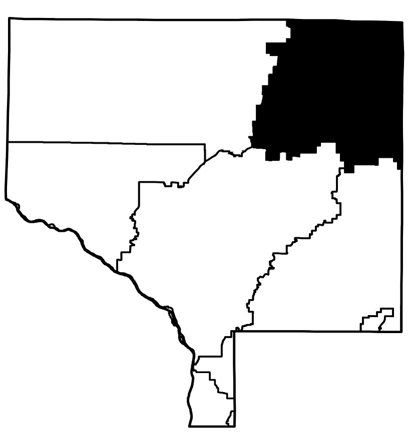
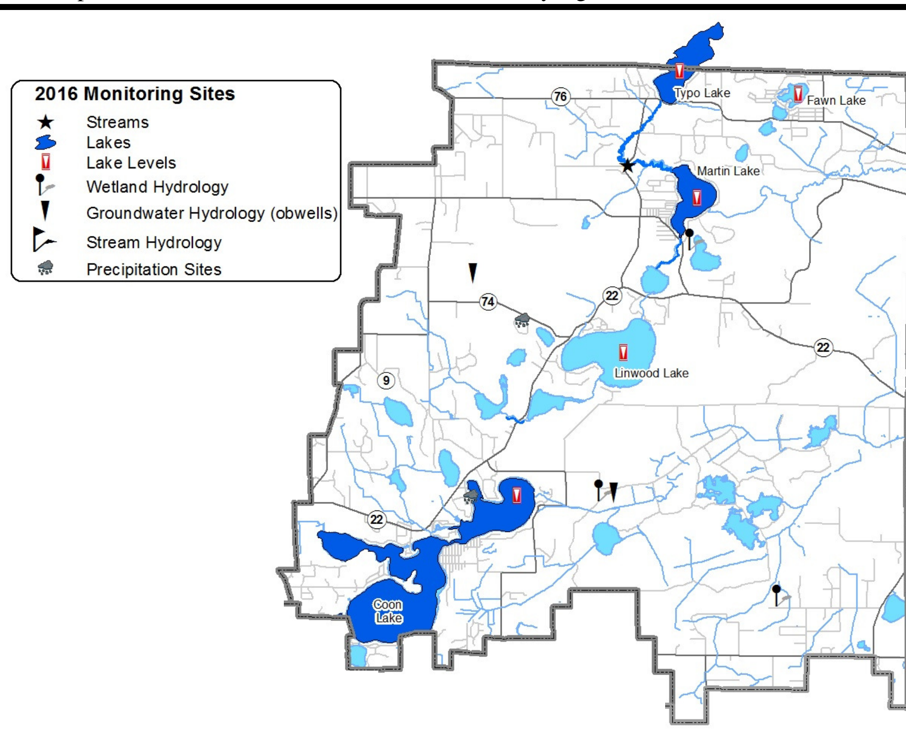
Groundwater Hydrology (obwells)	ACD, MNDNR	See Chapter 1
Precipitation	ACD, volunteers	See Chapter 1

ACD = Anoka Conservation District, SRWMO = Sunrise River Watershed Management Organization, MNDNR = Minnesota Dept. of Natural Resources, ACAP = Anoka County Ag Preserves





Lake Levels

Description: Weekly water level monitoring in lakes. The past five and twenty-five years of data are illustrated below, and all historical data are available on the Minnesota DNR website using the "LakeFinder" feature (www.dnr.mn.us.state\lakefind\index.html).

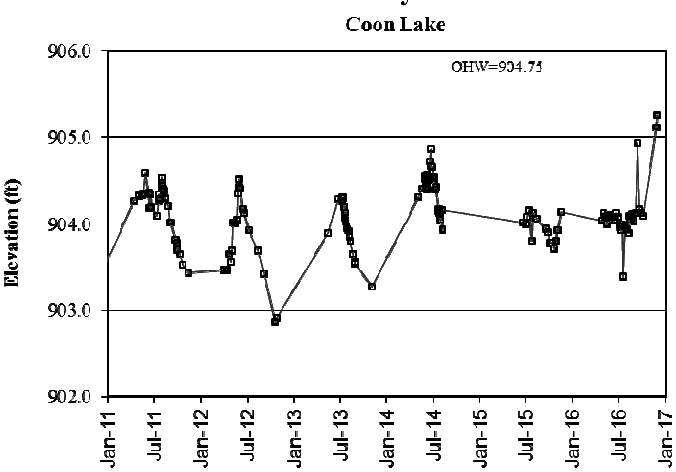
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

Locations: Coon, Fawn, Linwood, Martin, and Typo Lakes

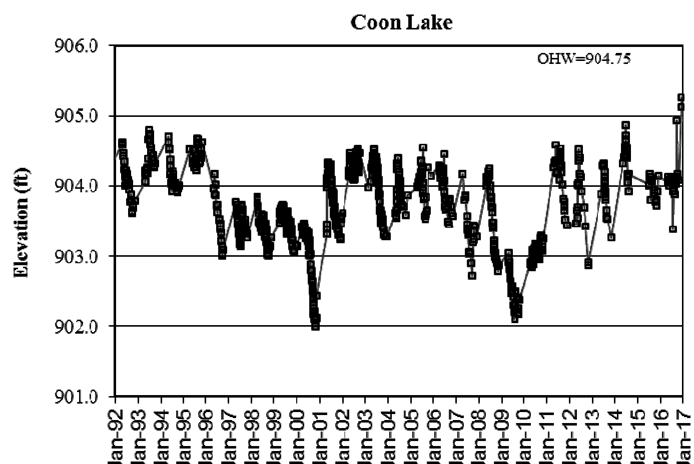
Results: Lake levels were measured by volunteers throughout the 2016 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes followed the expected pattern of increasing water levels in spring and early summer and then fell later in the summer due to less rainfall. High rainfall amounts late into fall caused a spike in lake levels at the end of the year. Coon and Fawn Lakes had their highest water levels in more than 25 years. Average lake levels were similar or slightly higher than 2015.

All lake level data can be downloaded from the MN DNR website's Lakefinder feature. Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is listed for each lake on the corresponding graphs below.

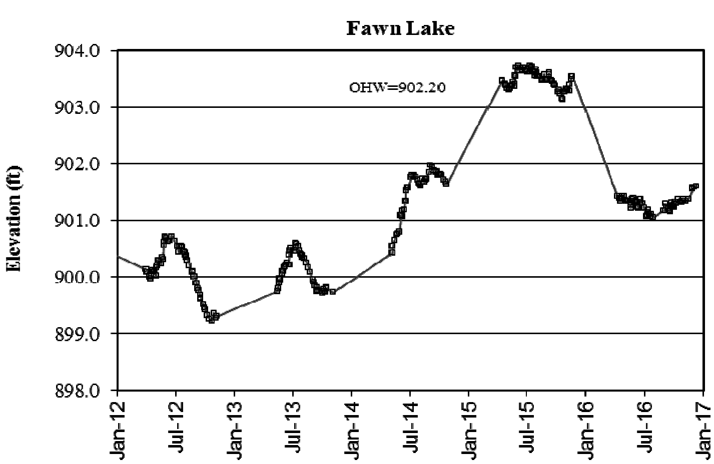
Coon Lake Levels – last 5 years



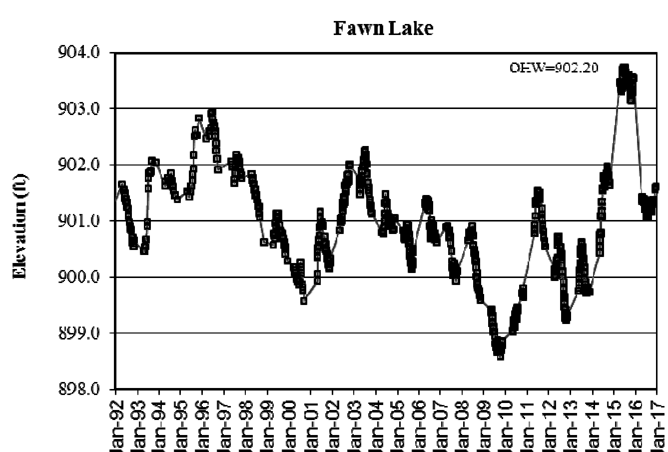
Coon Lake Levels – last 25 years



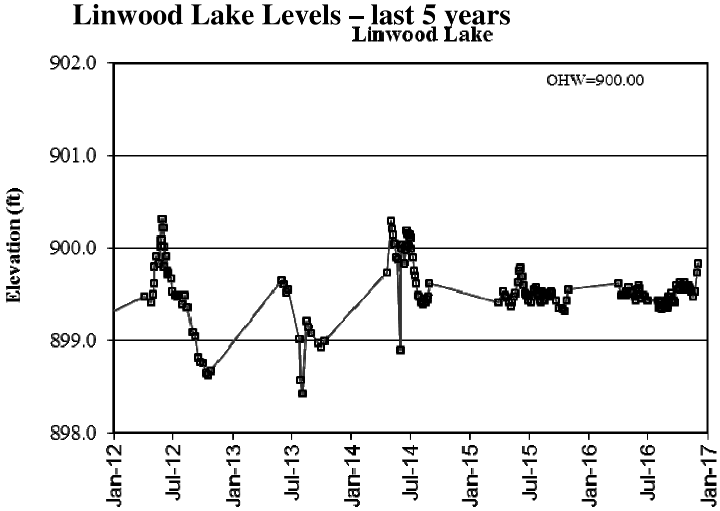
Fawn Lake Levels – last 5 years



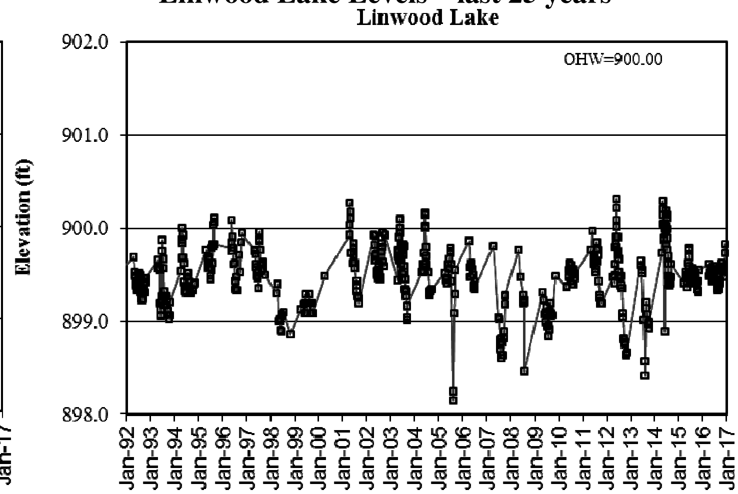
Fawn Lake Levels – last 25 years



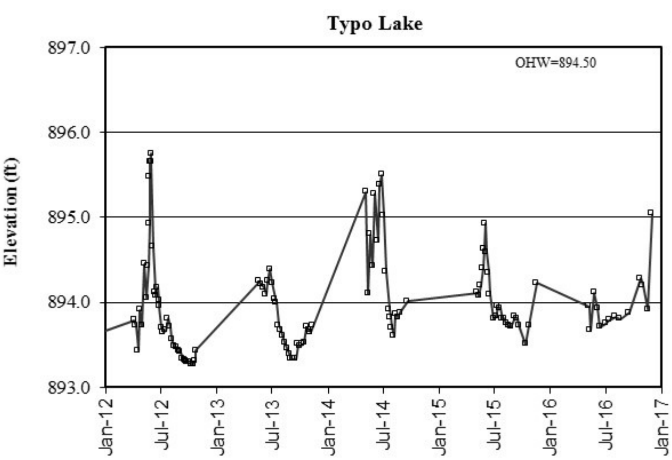
Linwood Lake Levels – last 5 years



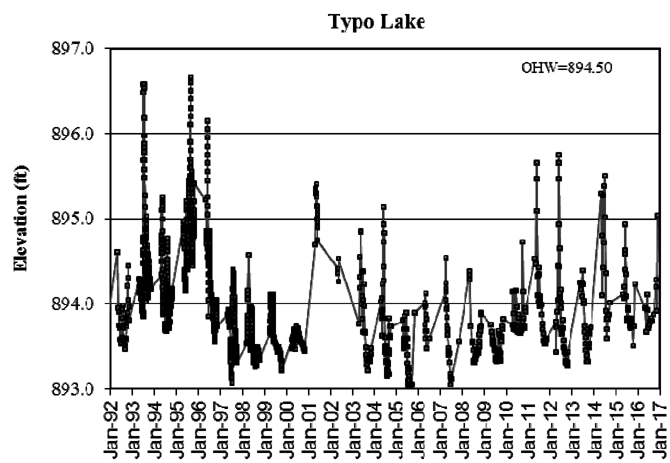
Linwood Lake Levels – last 25 years



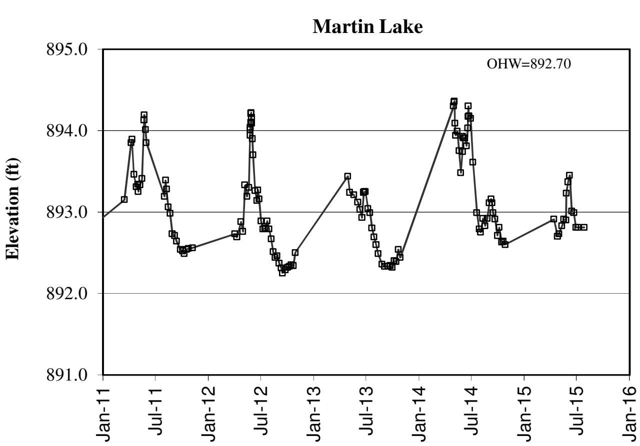
Typo Lake Levels – last 5 years



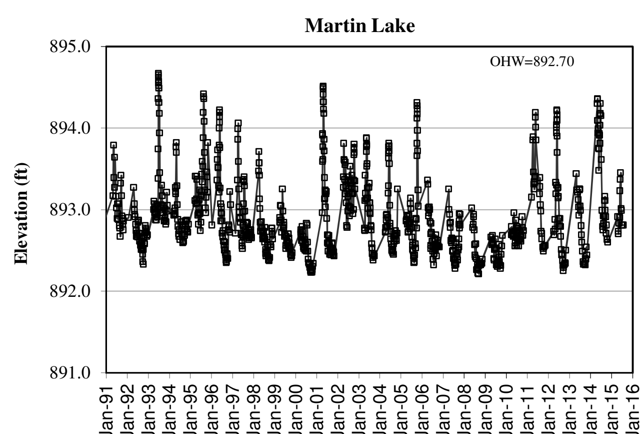
Typo Lake Levels – last 25 years



*Martin Lake Levels – last 5 years



*Martin Lake Levels – last 25 years



***No lake level data was received for Martin Lake in 2016**

Lake Water Quality

Description: May through September, every-other-week, monitoring is conducted for the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

Purpose: To detect water quality trends and diagnose the cause of changes.

Locations: Coon Lake East Bay

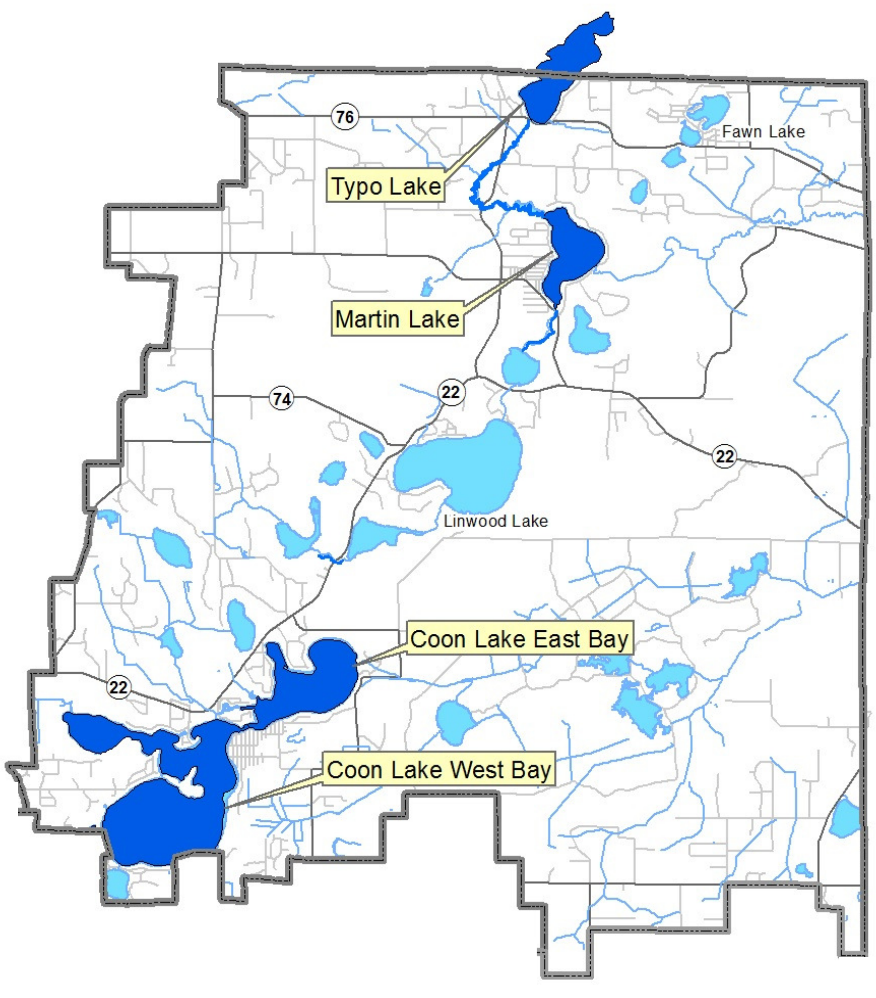
Coon Lake West Bay

Typo Lake

Martin Lake

Results: Detailed data for each lake are provided on the following pages, including summaries of historical conditions and trend analysis. Previous years' data are available from the ACD. Refer to Chapter 1 for additional information on lake dynamics and interpreting the data.

Sunrise Watershed Lake Water Quality Monitoring Sites



Coon Lake- East and West Bays

City of East Bethel, City of Ham Lake & City of Columbus, Lake ID # 02-0042

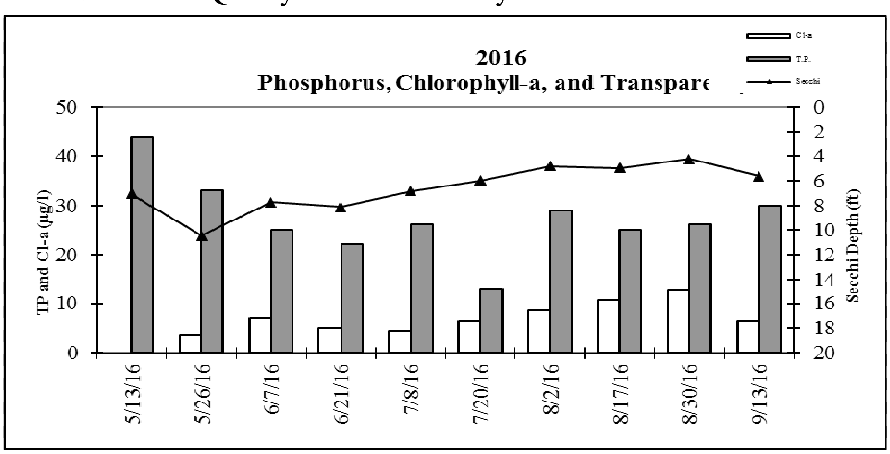
Background

Coon Lake is located in east central Anoka County and is the county's largest lake. Coon Lake has a surface area of 1,498 acres and a maximum depth of 27 feet (9 m). Public access is available at three locations with boat ramps, including one park with a swimming beach. The lake is used extensively by recreational boaters and fishers. Most of the lake is surrounded by private residences. The watershed of 6,616 acres is rural residential. This report includes information for the East Bay (aka northeast or north bay) and West Bay (aka southwest or south bay) of Coon Lake in 2016. The 2010-16 data is from the Anoka Conservation District (ACD) monitoring at the MN Pollution Control Agency (MPCA) monitoring site #203 for the East Bay and #206 for the West Bay. Over the years, other sites have been monitored and are included in this report's trend analysis when appropriate. When making comparisons between the two bays, please consider that both bays were monitored simultaneously only biennially from 2010 to 2016. Data from other years do not lend themselves well to direct comparisons because monitoring regimes were likely different.

2016 Results- East Bay

In 2016 the East Bay of Coon Lake was monitored every 2 weeks. Water quality was slightly better than average for this region of the state (NCHF Ecoregion), receiving a B grade, down from the A grade achieved in 2014. Average values of important water quality parameters included 27.3 µg/L for total phosphorus, 7.2 µg/L of chlorophyll-a, and an average Secchi transparency of 6.6 feet. Both chlorophyll-a and phosphorous levels were higher than levels measured in 2014, but were still much lower than levels measured before 2010. Both parameters, however, broke a trend of reduction in each of the previous 5 years sampled. Secchi transparency results were poorer than the averages of each of the previous three years sampled at 6.6 feet, but still averaged 6 inches better than historical results. The subjective observations of the lake's physical characteristics and recreational suitability by the ACD staff indicated that lake conditions remained excellent for swimming and boating.

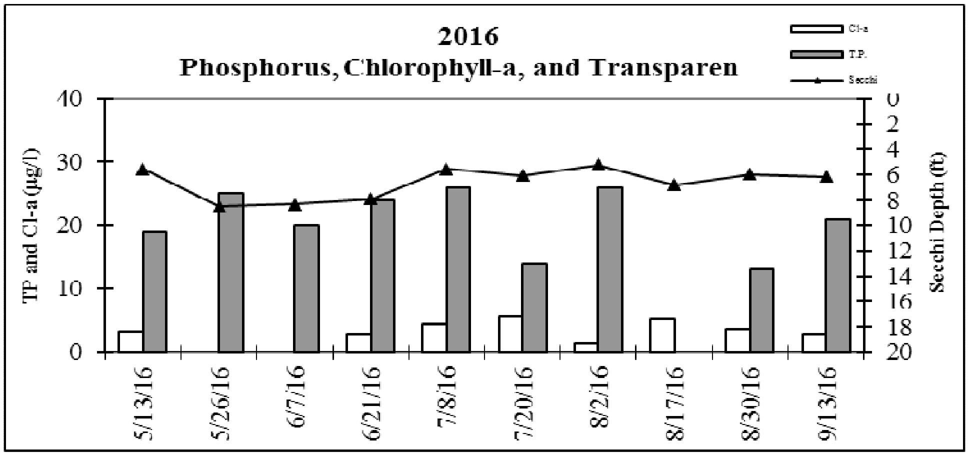
2016 Water Quality Results- East Bay



2016 Results- West Bay

In 2016 the West Bay had better than average water quality for this region of the state (NCHF Ecoregion), receiving an A- letter grade. Average values of water quality parameters included 21.0 µg/L for total phosphorus, 3.6 µg/L of chlorophyll-a, and Secchi transparency of 6.6 feet. Average total phosphorus levels were the lowest of all monitored years, and only 2014 chlorophyll-a levels were lower than those measured in 2016. Secchi transparency had its second best average of the last twelve years; only beat out by the 2014 average of 6.9 feet.

2016 Water Quality Results- West Bay



Comparison of the Bays

The East and West Bays of Coon Lake often have noticeably different water quality. In 2010, on every date sampled, water quality was better in the West Bay than in the East. In both 2012 and 2014, water quality in the two bays was more similar. In 2016, the West Bay regained its position of higher water quality. The West Bay had lower total phosphorus readings on each sample date but two, with an average 6.1 µg/L lower than that of the East Bay. Chlorophyll-a readings were consistently lower in the West bay after the first sample date of 5/13/2016, with levels averaging exactly half those of the East Bay. Secchi transparency was consistently deeper in the East Bay during the first half of the season, but consistently lower in the second half, with overall averages being virtually identical (6.60 feet in the East Bay and 6.62 feet in the West Bay).

Trend Analysis

To analyze Coon Lake trends we obtained historical monitoring data from the MPCA. Over the years water quality has been monitored at 17 different sites on the lake. For the trend analysis, we pooled data from five East Bay sites (#102, 203, 208, 209, and 401) and four West Bay sites (#101, 105, 206, and 207). These sites were chosen because they were all in the bay of interest, close to each other, and distant from the shoreline. The trend analysis is based on average annual water quality data for each year with data. We used data only from years with data from every month from May to September, allowing for one month of missing data. Only data from May to September were used. For years 1998 and after, only data from the ACD was used for greater comparability.

<u>East Bay Trend Analysis</u>

In the East Bay twenty two years of water quality data have been collected since 1978. During the most recent fourteen years that were monitored (since 1996), the data collected included total phosphorus, chlorophyll-a, and Secchi transparency. For most of the other eight years (pre-1997) only Secchi transparency data is available. This provides an adequate dataset for a trend analysis, however given that most of the data is from the last couple of decades, the analysis is not strong at detecting changes that occurred prior to 1990. When we examined those years with total phosphorus, chlorophyll-a, and Secchi transparency, excluding the years with only Secchi transparency data, an improving water quality trend did exist. The analysis was a repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth ($F_{2,15}$=5.43, p=0.02). This is our preferred approach because it examines all three parameters simultaneously. We also examined variables TP, Cl-a, and Secchi depth across all years of existing data using a one-way ANOVA. Including all years, a significant trend of improving TP ($F_{1,16}$=7.84, p=0.01) , Cl-a ($F_{1,16}$=9.69, p=<0.01), and transparency ($F_{1,21}$=20.10, p=<0.001) is found. In summary, it appears that water quality improvements have been occurring. It is noteworthy that this improvement seems to have primarily occurred since 2010 (see graph below). The reason for change is unknown, but we speculate that infestation by Eurasian watermilfoil (EWM), treatment of EWM and curly leaf pondweed beginning in 2009 and constructed water quality improvement projects may be contributing.

West Bay Trend Analysis

Twelve years of data are available for the West Bay with only four of those years including phosphorus and chlorophyll-a data, so a powerful trend analysis is not possible. The dataset for Secchi transparency is longer, but data from 2010 and 2012 must be excluded because a full suite of Secchi measurements is not available due to clarity exceeding the lake depth occasionally. Therefore, a statistical analysis would not be highly meaningful. Instead, we will use a non-analytical look at the data. In 2016, the average Secchi transparency was 6.62 feet. For eight monitored years from 1998-2009, seven of those years had average Secchi transparency of <6 feet. It is notable that in the two most recent years sampled (2014 and 2016), the average Secchi transparency was greater than in all but one of previous years (2002). This suggests that Secchi transparency may be mildly improving, and is at least not declining.

Discussion

While Coon Lake is not listed as "impaired" by the MN Pollution Control Agency, the East Bay has been close to, or exceeded, the state water quality standard of 40 µg/L of total phosphorus in the past. Total phosphorus averaged 42 µg/L in 2006, 37 µg/L in 2008, and 39 µg/L in 2010. However, 2011 was the beginning of a four-year consecutive decline in phosphorous levels, a trend unfortunately not continued in 2016. Phosphorous levels dropped to 27 µg/L in 2011, to 26 µg/L in 2012, to 23.2 µg/L (second lowest on record) in 2013, and in 2014 hit an all-time low of 18.8 µg/L, only to rebound to 27.3 µg/L in 2016. While this result appears to break a trend in the right direction, it is still much lower than levels measured between 2001 and 2010. One year of data cannot signify either the start or the end of such a trend.

Given the highly developed nature of the lakeshore, the practices of lakeshore homeowners are a reasonable place to begin water quality improvement efforts. Residents should increase the use of shoreline practices that improve water quality and lake health, such as native vegetation buffers and rain gardens. Clearing of native vegetation to create a "cleaner" lakefront should be avoided because this vegetation is important to lake health and water quality. Septic system maintenance and replacement where necessary, should be a priority on an individual home basis and on a community level. This might be most beneficial in the Hiawatha Beach, Interlachen, and Coon Lake Beach neighborhoods, where the greatest frequency of septic system failures is suspected.

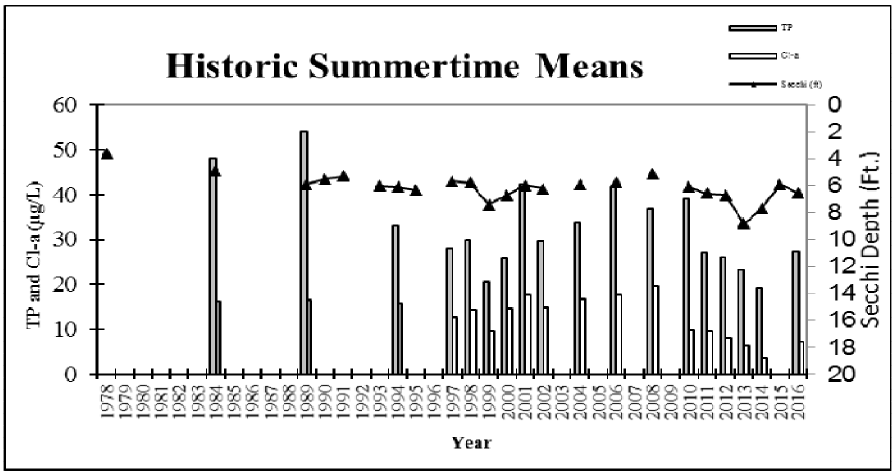
A final challenge for Coon Lake are the aquatic invasive species Eurasian water milfoil (EWM) and Curly Leaf Pondweed (CLP). EWM was discovered in the lake in 2003 and spread rapidly. In 2008 a Coon Lake Improvement District (CLID) was formed, with EWM management as a core of its function. EWM is actively monitored and treated with herbicide in accordance with DNR rules and a lake vegetation management plan. CLP has been present in Coon Lake longer than EWM and CLID began treatment of it in 2009. In 2010 the East Bay was accepted into a five-year pilot program for treatment of CLP. There is not yet enough data to say definitively, but it is possible that the early season treatment could be a contributing factor in the recent decline in phosphorous levels. CLP takes up phosphorous from the soil through its root system and dies off early summer causing a spike in phosphorous. Early treatment may be shortening the time the CLP has to uptake phosphorous from the soil as well as reducing overall regrowth due to treatments occurring prior to CLP sprouting turions (a shoot vital to reproduction).

2016 Coon Lake East Bay Water Quality Data

Coon Lake East Bay 2016 Water Quality Data			5/13/2016	5/26/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/2/2016	8/17/2016	8/30/2016	9/13/2016			
			14:45	12:45	15:30	13:40	13:10	13:15	11:00	12:45	13:10	12:30			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.23	9.15	8.61	8.42	8.17	8.73	8.60	9.09	8.46	8.11	8.56	8.11	9.15
Conductivity	mS/cm	0.01	0.242	0.260	0.267	0.235	0.246	0.253	0.238	0.250	0.234	0.220	0.245	0.220	0.267
Turbidity	NTU	1	12.60	3.50	3.40	2.60	11.90		6.10	4.60	10.20	13.20	8	3	13
D.O.	mg/L	0.01	9.53	10.64	11.47	8.87	8.51	9.61	9.45	9.56	8.69	8.30	9.46	8.30	11.47
D.O.	%	1	96%	124%	116%	109%	109%	121%	120%	123%	107%	95%	112%	95%	124%
Temp.	°C	0.1	14.5	21.4	20.6	24.5	25.3	26.9	26.6	26.5	24.4	21.7	23.2	14.5	26.9
Temp.	°F	0.1	58.1	70.5	69.1	76.0	77.6	80.4	79.8	79.7	76.0	71.1	73.8	58.1	80.4
Salinity	%	0.01	0.11	0.13	0.13	0.11	0.12	0.12	0.11	0.12	0.11	0.11	0.12	0.11	0.13
Cl-a	ug/L	0.5	<1	3.6	7.1	5.0	4.3	6.4	8.5	10.7	12.8	6.4	7.20	3.6	12.8
T.P.	mg/L	0.010	0.044	0.033	0.025	0.022	0.026	0.013	0.029	0.025	0.026	0.030	0.027	0.013	0.044
T.P.	ug/L	10	44	33	25	22	26	13	29	25	26	30	27.3	13	44
Secchi	ft	0.1	7.1	10.5	7.8	8.1	6.8	6.0	4.8	5.0	4.3	5.7	6.60	4.3	10.5
Secchi	m	0.1	2.2	3.2	2.4	2.5	2.1	1.8	1.5	1.5	1.3	1.7	2.01	1.3	3.2
Physical			2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.8	1.0	2.0
Recreational			2	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.7	1.0	2.0

*reporting limit

Coon Lake East Bay Water Quality Results



Coon Lake East Bay Historic Summertime Mean Values

Agency	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1978	1984	1989	1990	1991	1993	1994	1995	1997	1998	1999	2000	2001	2002	2004	2006	2008	2010	2011	2012	2013	2014	2016
TP		48.0	54.0				33.0		28.0	29.8	20.6	25.8	42.3	29.6	33.7	41.7	36.8	39.0	27.0	26.0	23.2	19.0	27
Cl-a		16.2	16.4				15.8		12.6	14.4	9.4	14.6	17.6	14.8	16.6	17.6	19.5	9.8	9.6	8.2	6.5	3.6	7.2
Secchi (m)	1.11	1.50	1.80	1.68	1.62	1.83	1.86	1.93	1.72	1.76	2.26	2.04	1.82	1.90	1.81	1.80	1.55	1.90	2.00	2.10	2.68	2.35	2.0
Secchi (ft)	3.6	4.9	5.9	5.5	5.3	6.0	6.1	6.3	5.6	5.8	7.4	6.7	6.0	6.2	5.9	5.8	5.1	6.1	6.6	6.7	8.8	7.7	6.6

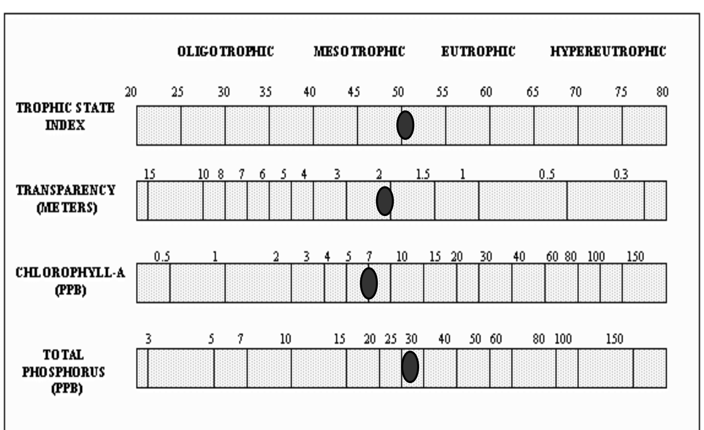
Carlsons trophic state indices

TSIP		60	62				55		52	53	48	51	58	53	55	58	56	57	52	51	49	47	52
TSIC		58	58				58		55	57	53	57	59	57	58	59	60	53	53	51	49	43	50
TSIS	58	54	52	53	53	51	51	51	52	52	48	50	51	51	51	52	54	51	50	49	46	48	50
TSI		57	57				54		53	54	50	53	56	54	55	56	57	54	51	51	48	46	51

Coon Lake Water Quality Report Card

Year	1978	1984	1989	1990	1991	1993	1994	1995	1997	1998	1999	2000	2001	2002	2004	2006	2008	2010	2011	2012	2013	2014	2016
TP		C	C				C		B	B	A	B	C	B	C	C	C	C	B	B	B+	A	B
Cl-a		B	B				B		B	B	A	B	B	B	B	B	B	A	A	A	A	A	A
Secchi	D	C	C	C	C	C	C	C	C	C	B	C	C	C	C	C	C	C	C	C+	B	B	C
Overall	**D**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**B**	**B**	**A**	**B**	**C**	**B**	**C**	**C**	**C**	**B-**	**B**	**B**	**B+**	**A**	**B**

Carlson's Trophic State Index



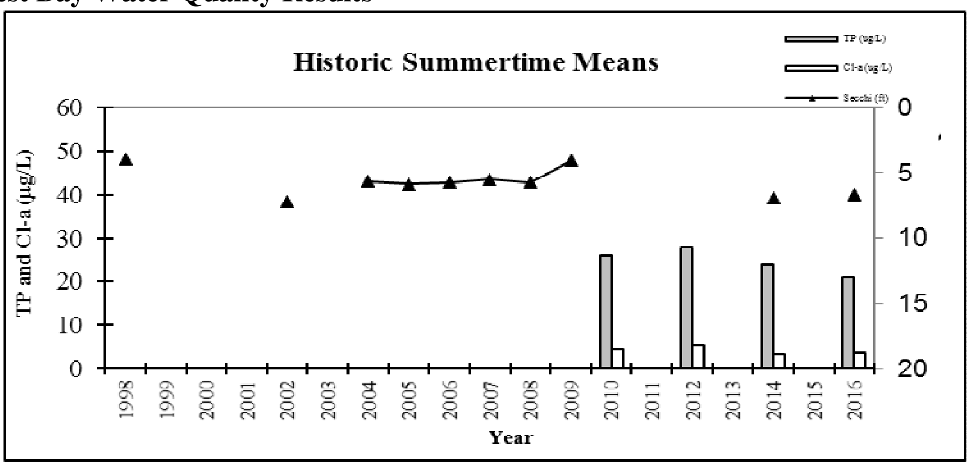
2016 Coon Lake West Bay Water Quality Data

Coon Lake West Bay
2016 Water Quality Data

	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
		Date:	5/13/2016	5/26/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/2/2016	8/17/2016	8/30/2016	9/13/2016			
		Time:	15:10	14:30	16:10	14:20	13:45	13:40	10:30	13:25	14:00	13:00			
pH		0.1	8.42	8.91	8.61	8.06	8.65	8.81	9.08	8.95	8.61	8.28	8.64	8.06	9.08
Conductivity	mS/cm	0.01	0.217	0.227	0.225	0.200	0.180	0.206	0.166	0.190	0.175	0.166	0.195	0.166	0.227
Turbidity	FNRU	1	13.00	1.60	2.30	8.36	7.10		7.20	1.10	5.50	10.00	6	1	13
D.O.	mg/l	0.01	10.51	10.58	10.14	8.36	8.65	9.62	10.72	8.32	8.42	8.71	9.40	8.32	10.72
D.O.	%	1	102%	124%	110%	104%	113%	120%	135%	105%	103%	97%	1	1	1
Temp.	°C	0.1	13.8	21.9	20.2	25.0	24.6	27.0	26.4	25.8	24.0	20.7	22.9	13.8	27.0
Temp.	°F	0.1	56.8	71.3	68.3	77.0	76.3	80.7	79.4	78.4	75.2	69.2	73.3	56.8	80.7
Salinity	%	0.01	0.10	0.11	0.11	0.10	0.09	0.10	0.08	0.09	0.09	0.08	0.10	0.08	0.11
Cl-a	ug/L	0.5	3.2	<1	<1	2.8	4.3	5.7	1.4	5.3	3.6	2.8	3.6	1.4	5.7
T.P.	mg/l	0.010	0.019	0.025	0.020	0.024	0.026	0.014	0.026	<0.02	0.013	0.021	0.021	0.013	0.026
T.P.	ug/l	10	19	25	20	24	26	14	26	<20	13	21	20.9	13	26
Secchi	ft		5.6	8.5	8.3	7.9	5.6	6.1	5.3	6.8	6.0	6.2	6.62	5.3	8.5
Secchi	m		1.7	2.6	2.5	2.4	1.7	1.9	1.6	2.1	1.8	1.9	2.02	1.6	2.6
Field Observations															
Physical			2	2	2	2	2	2	2	2	1	1	1.8	1.0	2.0
Recreational			2	2	2	2	2	2	2	1	1	1	1.7	1.0	2.0

*reporting limit

Coon Lake West Bay Water Quality Results



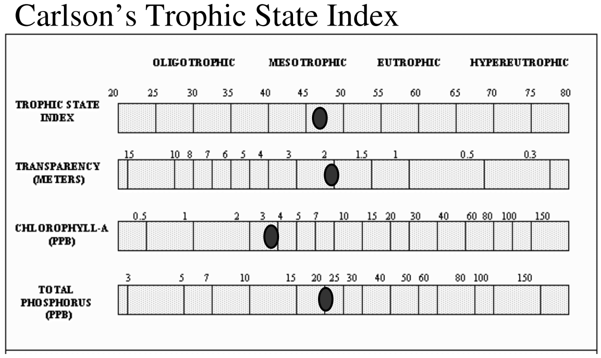
Coon Lake West Bay Historical Summertime Mean Values

Agency	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1998	2002	2004	2005	2006	2007	2008	2009	2010	2012	2014	2016
TP									26.0	28.0	24.0	21.0
Cl-a									4.4	5.4	3.3	3.6
Secchi (m)	1.21	2.19	1.71	1.79	1.74	1.68	1.74	1.24			2.1	2.0
Secchi (ft)	3.97	7.18	5.61	5.87	5.71	5.51	5.71	4.07			6.9	6.6
Carlson's Trophic State Index												
TSIP									51	52	50	48
TSIC									45	47	42	43
TSIS	57	49	52	52	52	53	52	57			49	50
TSI									48	50	47	47

Coon Lake West Bay Water Quality Report Card

Year	1998	1999	2001	2003	2004	2006	2007	2009	2010	2012	2014	2016
TP (µg/L)									B	B	B	A
Cl-a (µg/L)									A	A	A	A
Secchi (m)	C	C	C	C	C	C	C	C			C	C
Overall									A-	A-	B	A-

Carlson's Trophic State Index



Typo Lake

Linwood Township, Lake ID # 30-0009

Background

Typo Lake is located in portions of northeast Anoka County and southeast Isanti County. It has a surface area of 290 acres and maximum depth of 6 feet (1.82 m), though most of the lake is about 3 feet deep. The lake has a mucky, loose, and unconsolidated bottom in some areas, while other areas have a sandy bottom. The public access is located at the south end of the lake along Fawn Lake Drive. The lake is used very little for fishing or recreational boating because of the shallow depth and extremely poor water quality. The lake's shoreline is mostly undeveloped, with only 21 homes within 300 feet of the lakeshore. The lake's watershed of 11,520 acres is 3% residential, 33% agricultural, 28% wetlands, with the remainder being forested or grassland. Typo Lake is on the Minnesota Pollution Control Agency's (MPCA) list of impaired waters for excess nutrients.

2016 Results

In 2016 Typo Lake had extremely poor water quality compared to other lakes in this region (NCHF Ecoregion), receiving an overall F letter grade. This overall grade is consistent to all previous years monitored except for the D- achieved in 2014. Average total phosphorus, however, was the lowest measured in Typo Lake since 1997 at 172.0 µg/L. This is approximately half of the average total phosphorus measured in 2007 (340 µg/L) and 2009 (353 µg/L). Chlorophyll-a levels in 2016 (83.4 µg/L) rebounded from their second lowest average in 2015 (57.5 µg/L). However, this total is still well below the historical average of 111.3 µg/L. In both 2007 and 2009 a Secchi disk could be seen only 5-6 inches below the surface, on average. There was a slight improvement in 2012 to 9-10 inches and a larger improvement in 2014 to 21-22 inches. In 2016, average Secchi transparency declined back to under a foot (about 11inches) after its first consecutive years averaging over one foot in 2014 and 2015.

Trend Analysis

Sixteen years of water quality monitoring have been conducted by the Minnesota Pollution Control Agency (1993, '94, and '95) and the Anoka Conservation District (1997-2001, '03, '05, '07, '09, '12, '14, '15, '16). Water quality has significantly declined from 1993 to 2016 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,13}$=4.22, p=0.04). When we tested these response variables individually with one-way ANOVAs TP, Cl-a, and Secchi depth show no significant change across this time period. A superficial look at graphs of these parameters suggests that total phosphorus is generally increasing. The trend toward higher phosphorus continues even though 2016 had the lowest average in Typo since 1997. Cl-a appears to be declining and Secchi depth appears to be increasing.

Discussion

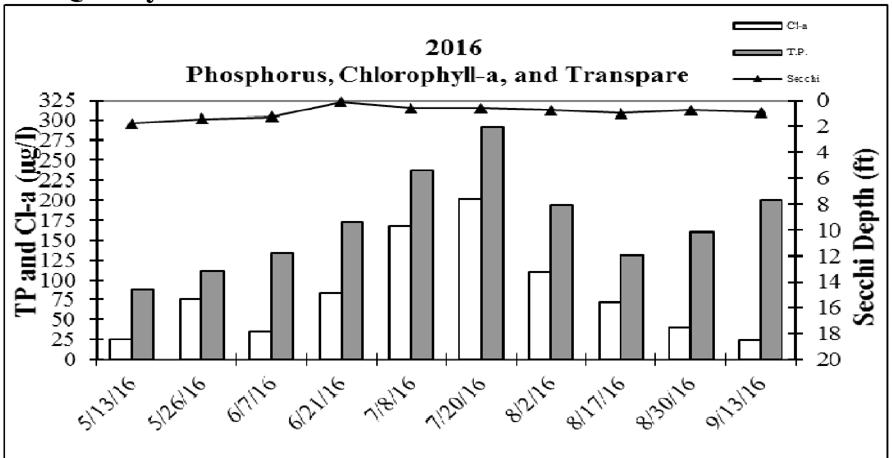
Typo Lake, along with Martin Lake downstream, were the subject of a TMDL study by the Anoka Conservation District, which was approved by the State and EPA in 2012. This study documented the source of nutrients to the lake, the degree to which each is impacting the lake, and put forward lake rehabilitation strategies. Some factors impacting water quality on Typo Lake include the presence of rough fish, high phosphorus inputs from a ditched wetland west of the lake, and lake sediments. Several rain gardens have been installed, carp barriers were completed in 2016 with carp removals planned for 2017-19 and a feasibility study of ditched wetland projects upstream of Typo Lake is underway.

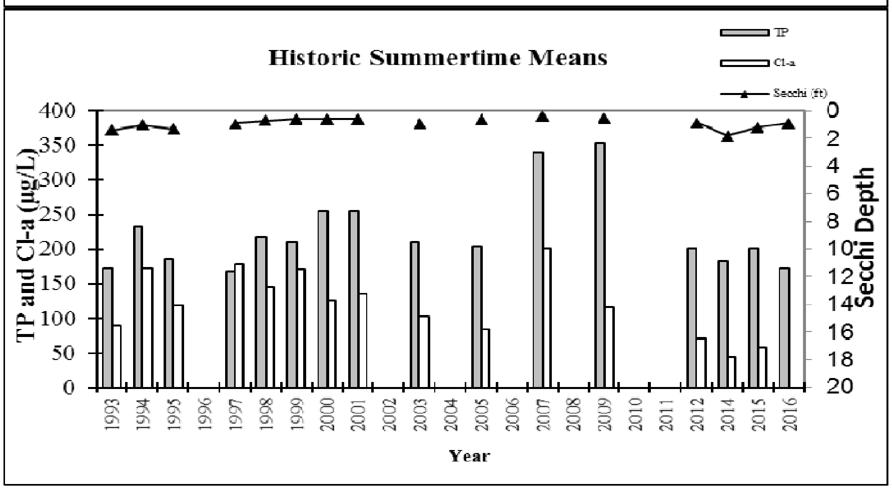
2016 Typo Lake Water Quality Data

Typo Lake		Date	5/13/2016	5/26/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/2/2016	8/17/2016	8/30/2016	9/13/2016			
2016 Water Quality Data		Time	13:15	12:00	14:20	12:25	12:00	11:50	12:55	11:45	12:20	11:30			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	9.25	8.59	9.27	9.17	9.06	9.69	9.62	9.48	9.23	8.74	9.21	8.59	9.69
Conductivity	mS/cm	0.01	0.317	0.283	0.309	0.252	0.221	0.216	0.220	0.242	0.232	0.228	0.252	0.216	0.317
Turbidity	FNRU	1	42.20	60.70	71.40	87.80	218.00		120.00	105.00	104.00	106.00	102	42	218
D.O.	mg/l	0.01	12.11	8.64	12.57	11.07		10.36	13.05	7.57	10.27	9.34	10.55	7.57	13.05
D.O.	%	1	109%	100%	144%	148%	117%	140%	169%	92%	126%	102%	125%	92%	169%
Temp.	°C	0.1	13.3	21.4	21.1	24.7	24.9	27.8	27.1	23.6	24.3	19.7	22.79	13.30	27.79
Temp.	°F	0.1	55.9	70.5	70.0	76.5	76.8	82.0	80.8	74.6	75.7	67.4	73.0	55.9	82.0
Salinity	%	0.01	0.15	0.14	0.15	0.12	0.11	0.11	0.11	0.12	0.11	0.11	0.1	0.1	0.2
Cl-a	ug/l	0.5	25.6	75.8	35.6	83.3	167.0	201.0	110.0	71.2	39.9	24.2	83.4	24.2	201.0
T.P.	mg/l	0.010	0.088	0.111	0.134	0.172	0.238	0.292	0.194	0.131	0.160	0.200	0.172	0.088	0.292
T.P.	ug/l	10	88	111	134	172	238	292	194	131	160	200	172	88	292
Secchi	ft	0.1	1.8	1.4	1.3	0.1	0.6	0.6	0.8	1.0	0.8	0.9	0.9	0.1	1.8
Secchi	m	0.1	0.5	0.4	0.4	0.0	0.2	0.2	0.2	0.3	0.2	0.3	0.3	0.0	0.5
Field Observations															
Physical			3.0	5.0	4.0	5.0	5.00	5.00	5.0	4.0	3.0	3.0	4.2	3.0	5.0
Recreational			3.0	5.0	4.0	5.0	5.00	5.00	5.0	4.0	3.0	3.0	4.2	3.0	5.0

*reporting limit

Typo Lake Water Quality Results





Typo Lake Historic Summertime Mean Values

Agency	CLMP	CLMP	MPCA	MPCA	MPCA	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1974	1975	1993	1994	1995	1997	1998	1999	2000	2001	2003	2005	2007	2009	2012	2014	2015	2016
TP			172.0	233.0	185.6	168.0	225.7	202.1	254.9	256.0	209.8	204	340.5	353.0	201.0	182.0	201.4	172.0
Cl-a			88.1	172.8	119.6	177.8	134.7	67.5	125.3	136.0	102.5	84.7	200.9	116.2	70.7	42.8	57.5	83.4
Secchi (m)	0.23	0.27	0.43	0.29	0.38	0.27	0.21	0.25	0.18	0.19	0.3	0.2	0.1	0.1	0.2	0.6	0.4	0.3
Secchi (ft)	0.2	0.3	1.4	1.0	1.3	0.9	0.7	0.8	0.6	0.6	0.9	0.6	0.4	0.5	0.8	1.8	1.2	0.9

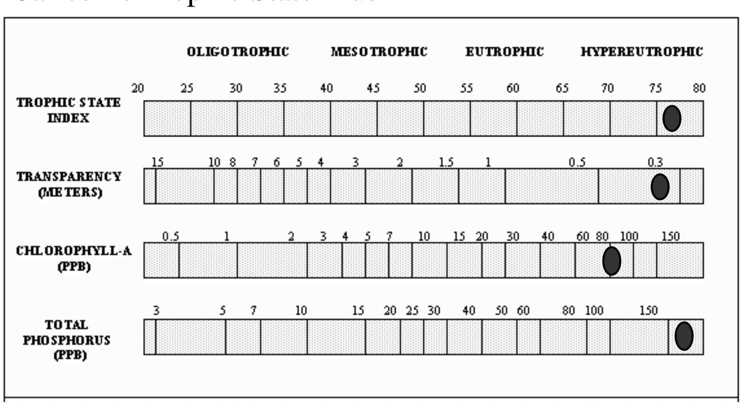
Carlson's Trophic State Indices

TSIP			78	83	79	78	82	81	83	82	81	81	88	89	81	79	81	78
TSIC			75	81	78	82	79	72	74	77	76	74	83	77	72	68	70	74
TSIS	81	79	72	78	74	79	82	80	86	85	77	83	93	93	83	67	73	77
TSI			75	81	77	79	81	78	81	81	78	79	88	86	79	71	75	77

Typo Lake Water Quality Report Card

Year	1974	1975	1993	1994	1995	1997	1998	1999	2000	2001	2003	2005	2007	2009	2012	2014	2015	2016
TP			F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Cl-a			F	F	F	F	F	D	F	F	F	F	F	F	D	C	D	F
Secchi	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Overall			**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**F**	**D-**	**F**	**F**

Carlson's Trophic State Index



Martin Lake
Linwood Township, Lake ID # 02-0034

Background

Martin Lake is located in northeast Anoka County. It has a surface area of 223 acres and maximum depth of 20 ft. The public access is located on the southern end of the lake. The lake is used moderately by recreational boaters and fishers, and would likely be used more if water quality improved. Martin Lake is almost entirely surrounded by private residences. The 5402 acre watershed is 18% developed; the remainder is vacant, agricultural or wetlands. The non-native, invasive plant curly-leaf pondweed occurs in Martin Lake, but not at nuisance levels. Martin is on the Minnesota Pollution Control Agency's (MPCA) list of impaired waters for excess nutrients.

2016 Results

In 2016 Martin Lake had poor water quality compared other lakes in the North Central Hardwood Forest Ecoregion (NCHF), receiving a C letter grade. This eutrophic lake has chronically high total phosphorus and chlorophyll-a. In 2016 total phosphorus averaged 69.1 µg/L, well below the lake's historical average of 92.1 µg/L and only slightly above the impairment threshold of 60 µg/L. In fact, this is the lowest average total phosphorus on record for Martin Lake, just edging out an average of 69.2 µg/L in 1999. Chlorophyll-a was higher than the previous three years, however, at 17.8 µg/L. Average Secchi transparency was only 3.1 feet in 2016, right on par with its historical average. The ACD staff's subjective perceptions of the lake were that "high" algae made the lake less than desirable for swimming from July through September.

Trend Analysis

Fifteen years of water quality data have been collected by the Minnesota Pollution Control Agency (1983), Metropolitan Council (1998, 2008), and the ACD (1997, 1999-2001, 2003, 2005, 2007, 2009, 2012-2016). Citizens monitored Secchi transparency 17 other years. Anecdotal notes from DNR fisheries data indicate poor water quality dating back to at least 1954. Although still pretty poor, water quality in Martin Lake has actually shown an improvement from 1983 to 2016 that is statistically significant (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,12}$=7.06, p=<0.01). Further examination of the data (one-way ANOVAs on the individual response variables) shows that while TP and Secchi depth appear to be trending in the wrong direction, though not statistically significant, Cl-a has now shown a statistical decrease with $F_{1,13}$=7.42, p=<0.02.

Discussion

Martin Lake, along with Typo Lake upstream, were the subject of a TMDL study by the Anoka Conservation District that was approved by the State and EPA in 2012. This study documented the source of nutrients to the lake, the degree to which each is impacting the lake, and put forward lake rehabilitation strategies. Water from Typo Lake and internal loading (carp, septic systems, sediments, etc) are two of the largest negative impacts on Martin Lake water quality. Several rain gardens have been installed, carp barriers were completed in 2016 with carp removals planned for 2017-19 and a feasibility study of ditched wetland projects upstream of Typo Lake is underway. While the lowest average total phosphorus on record measured in one season does not necessarily represent a trend of improving water quality in Martin Lake, it is certainly not a bad sign. Hopefully these results can be replicated and improved on in the future.

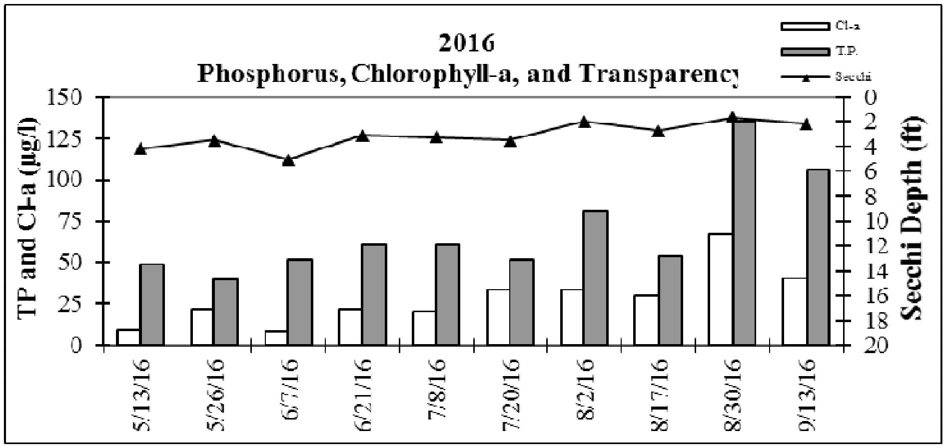
2016 Martin Lake Water Quality Data

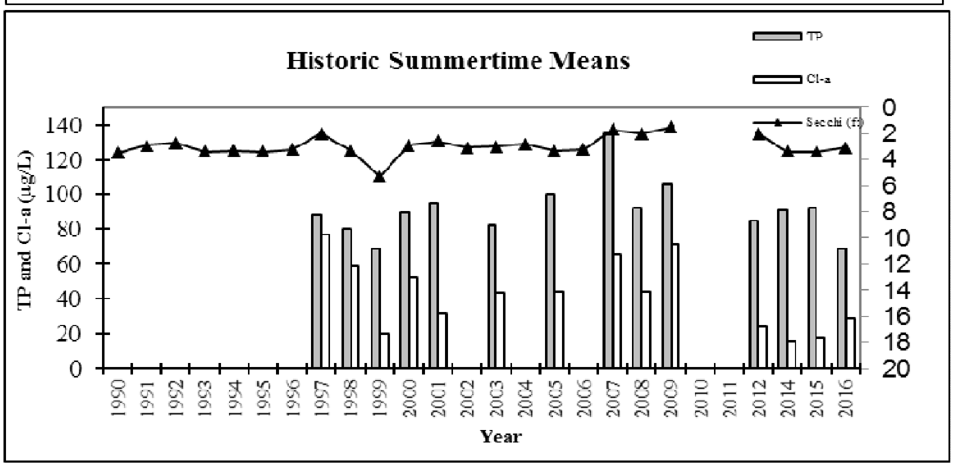
Martin Lake
2016 Water Quality Data

		Date:	5/13/2016	5/26/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/2/2016	8/17/2016	8/30/2016	9/13/2016			
		Time:	13:50	12:45	14:50	13:00	12:30	12:30	12:00	12:05	12:45	12:00			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.64	9.15	7.76	8.46	8.37	9.22	8.87	9.03	8.63	8.46	8.66	7.76	9.22
Conductivity	mS/cm	0.01	0.326	0.332	0.362	0.320	0.342	0.325	0.310	0.339	0.315	0.292	0.326	0.292	0.362
Turbidity	FNRU	1	21.50	14.30	9.10	16.40	36.90		28.30	21.80	53.80	49.70	27.98	9.10	53.80
D.O.	mg/l	0.01	8.88	13.05	6.80	9.83	8.25	13.64	11.06	10.72	11.34	9.13	10.27	6.80	13.64
D.O.	%	1	90%	151%	76%	120%	105%	172%	141%	136%	139%	104%	123%	76%	172%
Temp.	°C	0.1	14.8	21.4	20.1	24.4	25.1	26.2	26.3	25.9	24.1	21.3	22.9	14.8	26.3
Temp.	°F	0.1	58.6	70.5	68.2	76.0	77.1	79.1	79.3	78.6	75.3	70.4	73.3	58.6	79.3
Salinity	%	0.01	0.15	0.16	0.18	0.15	0.16	0.16	0.15	0.16	0.15	0.14	0.16	0.14	0.18
Cl-a	ug/L	0.5	9.3	22.1	8.5	22.1	20.6	33.5	33.5	29.9	67.3	40.6	28.7	8.5	67.3
T.P.	mg/l	0.010	0.049	0.040	0.052	0.061	0.061	0.052	0.081	0.054	0.135	0.106	0.069	0.040	0.135
T.P.	ug/l	10	49	40	52	61	61	52	81	54	135	106	69.1	40	135
Secchi	ft		4.2	3.5	5.1	3.1	3.3	3.5	2.0	2.8	1.7	2.2	3.1	1.7	5.1
Secchi	m		1.3	1.1	1.5	0.9	1.0	1.1	0.6	0.8	0.5	0.7	1.0	0.5	1.5
Field Observations/Appearance															
Physical			3.0	4.0	3.0	4.0	4.0	4.0	3.0	4.0	2.0	2.0	3.3	2.0	4.0
Recreational			3.0	4.0	3.0	4.0	4.0	4.0	3.0	3.0	1.0	2.0	3.1	1.0	4.0

*reporting limit

Martin Lake Water Quality Results





Martin Lake Summertime Annual Mean

Agency	CLMP	ACD	MC	ACD	ACD	ACD	CLMP	ACD	CLMP	ACD	ACD	ACD	CAMP	CAMP	ACD	ACD	ACD	ACD
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2012	2014	2015	2016
TP		88.0	80.0	61.7	89.4	95.4		81.9		100.0		135.0	92.0	106.0	85.0	91.0	92.6	69.1
Cl-a		77.0	58.8	18.0	52.5	31.4		43.3		44.3		65.8	44.1	71.4	24.1	15.5	17.4	28.7
Secchi (m)	1.0	0.6	1.0	1.8	0.9	0.8	0.9	0.9	0.9	1.0	1.0	0.5	0.6	0.4	0.6	1.0	1.0	1.0
Secchi (ft)	3.2	2.0	3.3	5.3	2.9	2.6	3.1	3.0	2.8	3.3	3.2	1.7	2.0	1.5	2.0	3.4	3.4	3.1

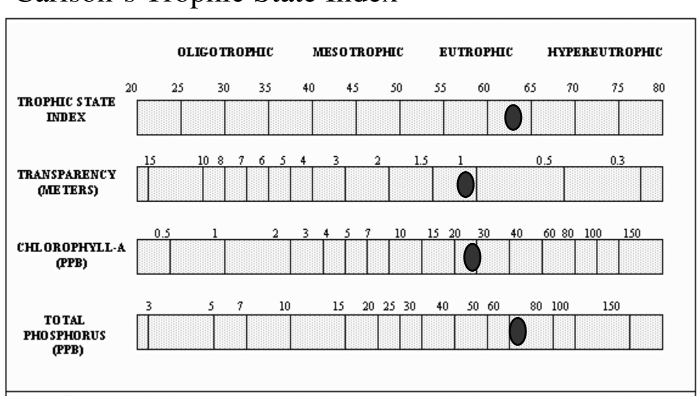
Carlson's Tropic State Indices

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2012	2014	2015	2016
TSIP		69	67	64	68	69		68		71		75	69	71	68	69	69	65
TSIC		73	71	59	67	63		68		68		72	68	73	62	58	59	64
TSIS	60	67	60	52	63	65	65	62	62	60	60	70	67	73	67	60	60	60
TSI		70	66	58	66	66		66		66		72	68	72	66	62	63	63

Martin Lake Water Quality Report Card

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2012	2014	2015	2016
TP		D	D	C	D	D		D		D		D	D	D	D	D	D	C
Cl-a		D	D	B	C	C		C		C		D	C	D	C	B	B	C
Secchi	D	F	D	C	D	D	D	D	D	D	D	F	F	F	F	D	D	D
Overall		**D**	**D**	**C**	**D**	**D**		**D**		**D**		**D**	**D**	**D**	**D**	**C**	**C**	**C**

Carlson's Trophic State Index



Stream Water Quality

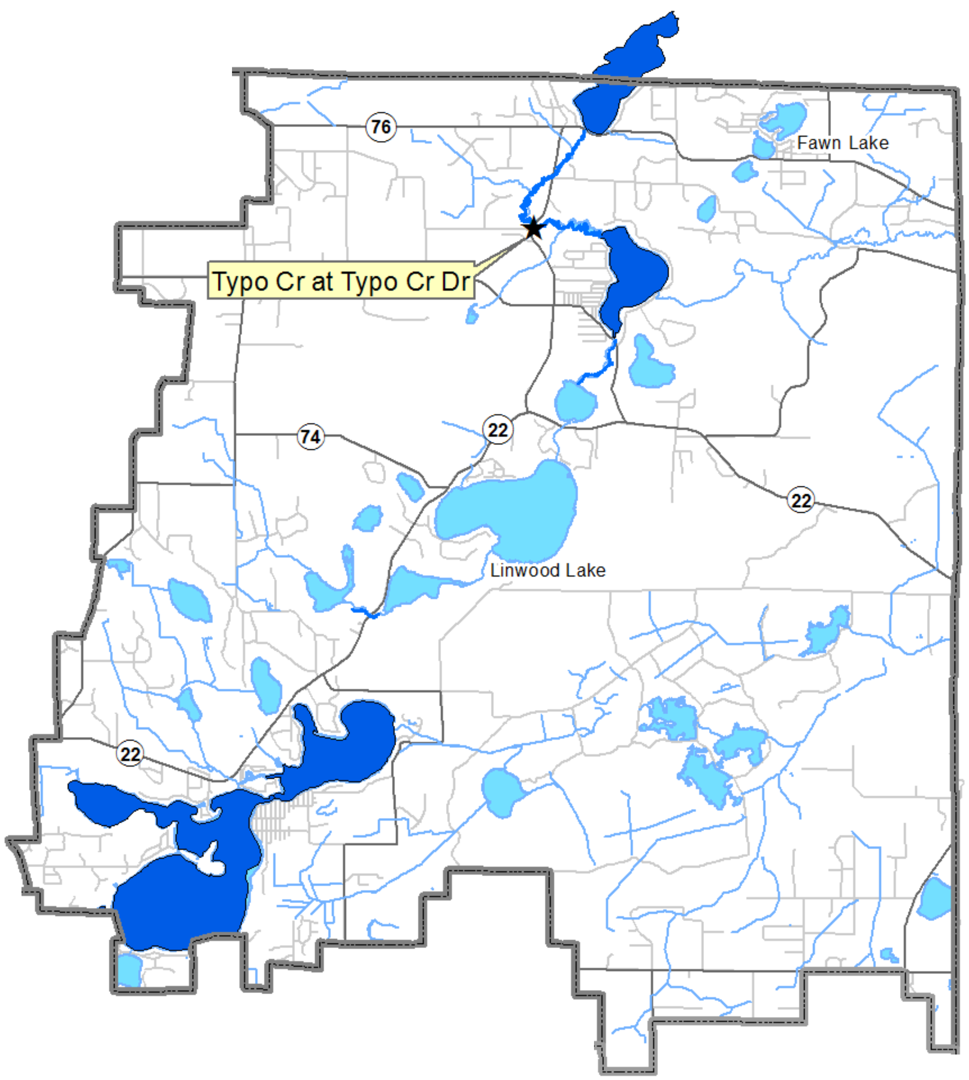
Description: Stream water quality is monitored with grab samples on eight occasions throughout the open water season, including four times immediately following a storm (1" of rain within a 24hr period) and four times during baseflow conditions. The selected site was chosen to monitor the impacts of the carp barriers installed in the watershed over time. Parameters monitored include water level, pH, conductivity, turbidity, transparency, dissolved oxygen, total phosphorus and total suspended solids. This data can be paired with stream hydrology monitoring to do pollutant-loading calculations.

Purpose: To detect water quality trends and problems, and diagnose the source of problems.

Location: Typo Creek at Typo Creek Drive near 233rd Ave. NE

Results: Results are presented on the following pages.

Sunrise Watershed Stream Water Quality Monitoring Sites



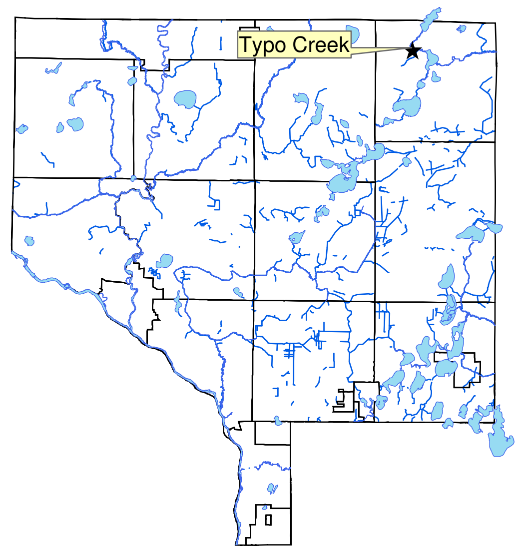
TYPO CREEK AT TYPO CREEK DR.

Near Typo Creek Dr. and 233rd Ave. NE, Linwood Township

STORET SiteID = S003-188

Years Monitored

1998, 2000, 2001, 2003, 2016



Background

The northern inlet to Martin Lake, also called Typo Creek, flows from the outlet of Typo Lake about 1.9 miles south to Martin Lake. It is the primary inlet to Martin Lake. This stream was monitored in 2001 and 2003 as part of a TMDL impaired waters study for the two lakes it links. The watershed is primarily undeveloped. This stream carries a relatively large volume of water, with flows ranging from 4-6 cfs during baseflow and 10-17 cfs during stormflow.

Methods

The creek was monitored by grab samples. Eight water quality sampling events were conducted in 2016; four during baseflow and four following storms. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, dissolved oxygen, and salinity. Parameters tested by water samples sent to a state-certified lab included total phosphorus, and total suspended solids.

Summary

Summarized water quality monitoring findings and management implications include:

- Dissolved pollutants, as measured by conductivity and chlorides, are at low and healthy levels.

  Management discussion: Road deicing salts are a concern region-wide. They are measurable in area streams year-round, including Typo Creek. While they may be acceptably low here currently, excessive use should be avoided.

- Phosphorus loading and eutrophication remains the biggest concern for Typo Creek.

  Management discussion: Management in response to the TMDL report, including projects like the installation of carp barriers, will reduce phosphorus levels in the creek as well as the upstream and downstream lakes, but additional work and time may be needed to reach goals.

- Suspended solids and turbidity remain a large problem in Typo Creek. This problem is directly related to the issues causing excessive nutrient loading.

  Management discussion: Efforts involved with the reduction of nutrient loading and management of carp populations will have a direct effect on the suspended solids and turbidity issues in Typo Creek.

- pH was within the range considered normal and healthy for streams in this area during 2016, but this has not been the case in most years and the creek is listed by the State as impaired for high pH. High algal production in Typo Lake upstream causes the high pH. Management to address eutrophication will address the pH problem.

- Dissolved oxygen (DO) was quite low in 2016 compared to the years this site was monitored shortly after the turn of the millennium. This issue is likely also tied to the nutrient loading of this system.

  Management discussion: Low dissolved oxygen is likely having a profound impact on aquatic life. This issue is primarily driven by the nutrient loading at the root of this system's problems and will likely see improvements which coincide with the nutrient reduction strategies identified and underway.

Results and Discussion

Nutrient loading is the root cause of intense eutrophication and turbidity in Typo Creek. This, along with populations of invasive carp species, is having a profound negative impact on the flora and fauna of this system. A TMDL study has been completed for this stream, and corrective projects are being implemented. It is likely that the severity of the issues facing this creek, and the rest of its watershed, will require a large amount of time, involvement and project development to reach goals.

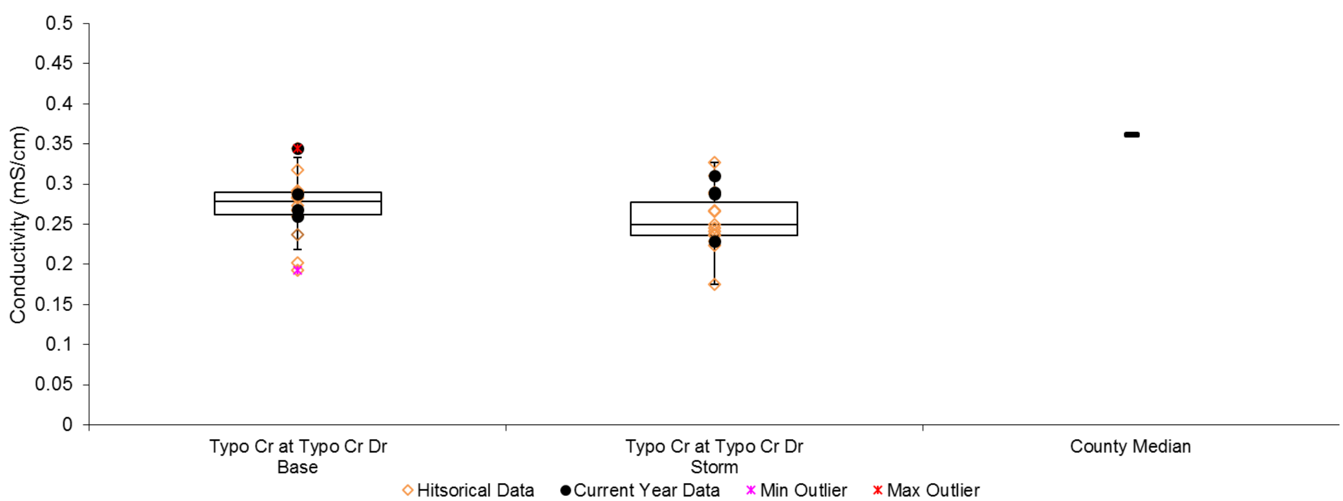
Conductivity and chlorides

Conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial chemicals, among many others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we used. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides are the measure of chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community.

Conductivity was acceptably low in Typo Creek, averaging 0.285 mS/com over the sampling season. This is notably lower than the median for 34 Anoka County streams of 0.362 mS/cm. Conductivity was slightly lower during storms, suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow conductivity has been observed in many other area streams with the largest cause believed to be road salts that have infiltrated into the shallow aquifer.

Chlorides were not tested in 2016, and were last sampled at this site in 2003. Chloride results in 2003 ranged between 8 mg/L and 12 mg/L, far below the Minnesota Pollution Control Agency's (MPCA) chronic standard for aquatic life of 230 mg/L. The primary reason for low chloride levels in this river is low road densities in the watershed, and therefore less use of road deicing salts.

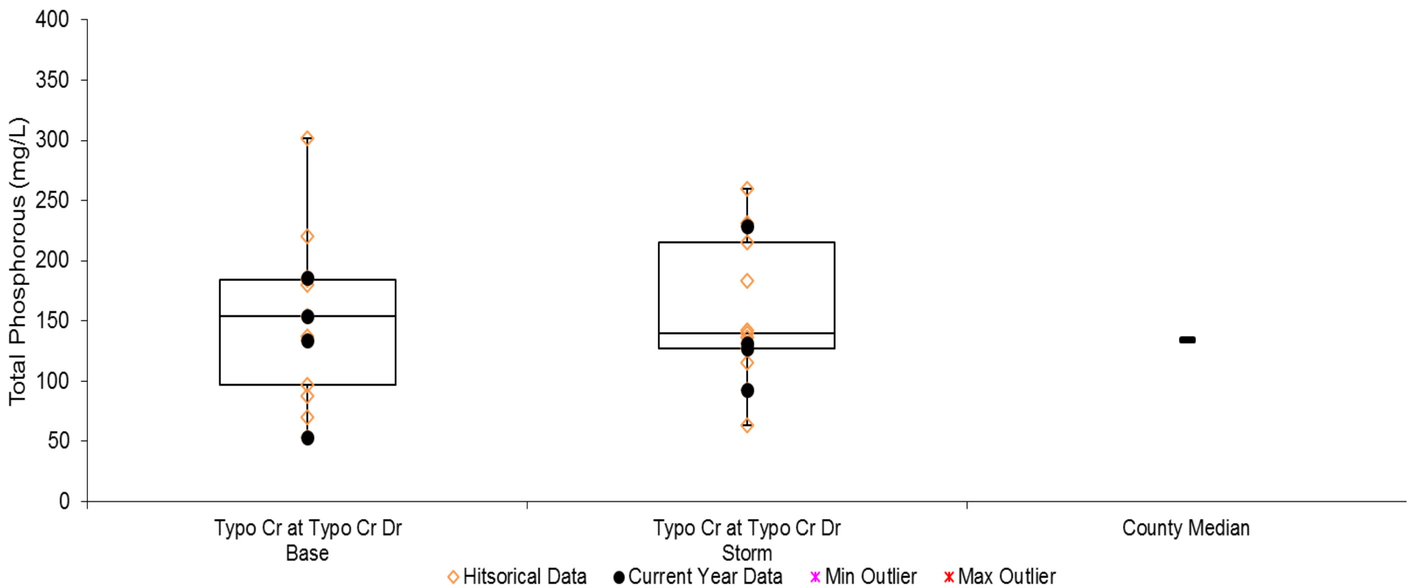
Conductivity during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Total Phosphorus

Total phosphorus (TP), a nutrient, is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. The average total phosphorus concentration of Typo Creek in 2016 was 138 ug/L, well in exceedance of the state standard (100 ug/L). These high phosphorus levels are common for the area. In the case of Typo Creek, phosphorus levels are also reflective of conditions of Typo Lake upstream. A TMDL was approved for Typo Creek in 2012 for pH and turbidity before the current stream eutrophication standards applied. Nutrients are the primary cause of high turbidity and pH. Nutrient reduction projects are ongoing.

Total phosphorus during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Turbidity and Total Suspended Solids (TSS)

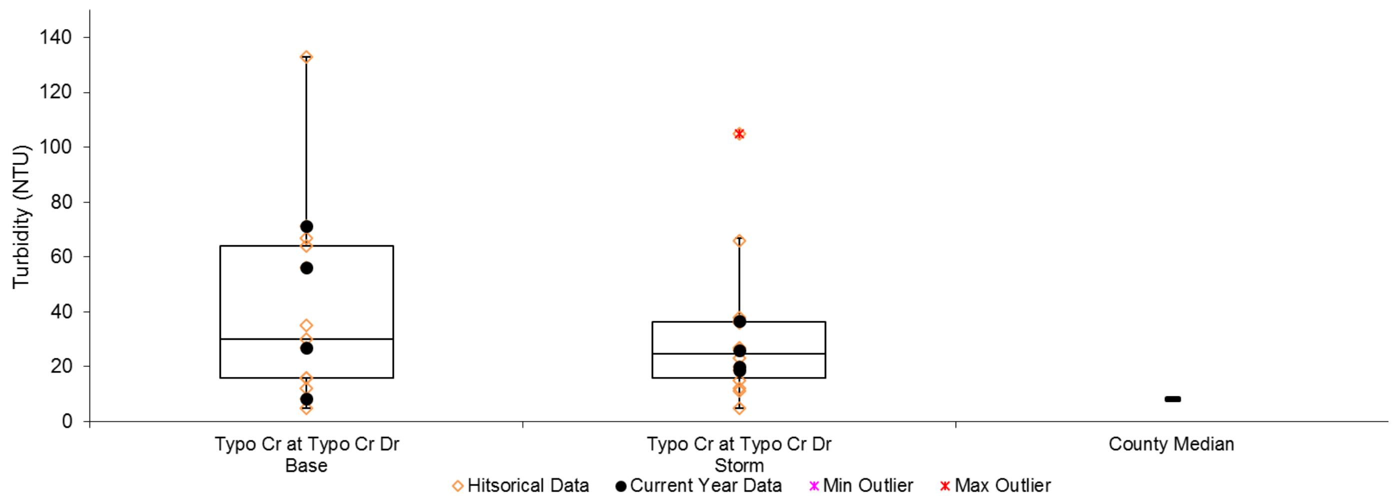
Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by refraction of a light beam passed through a water sample. It is most sensitive to large particles. Total suspended solids is measured by filtering solids from a water sample and weighing the filtered material. The amount of suspended material is important because it affects transparency and aquatic life, and because many other pollutants are attached to particles. Many stormwater treatment practices such as street sweeping, sumps, and stormwater settling ponds target sediment and attached pollutants.

It is important to note the suspended solids can come from sources both internal and external of the river. Sources on land include soil erosion, road sanding, and many others. Internally, riverbank erosion and movement of the river bottom also contributes to suspended solids. Algal production and sediment disturbance I upstream lakes also contribut.

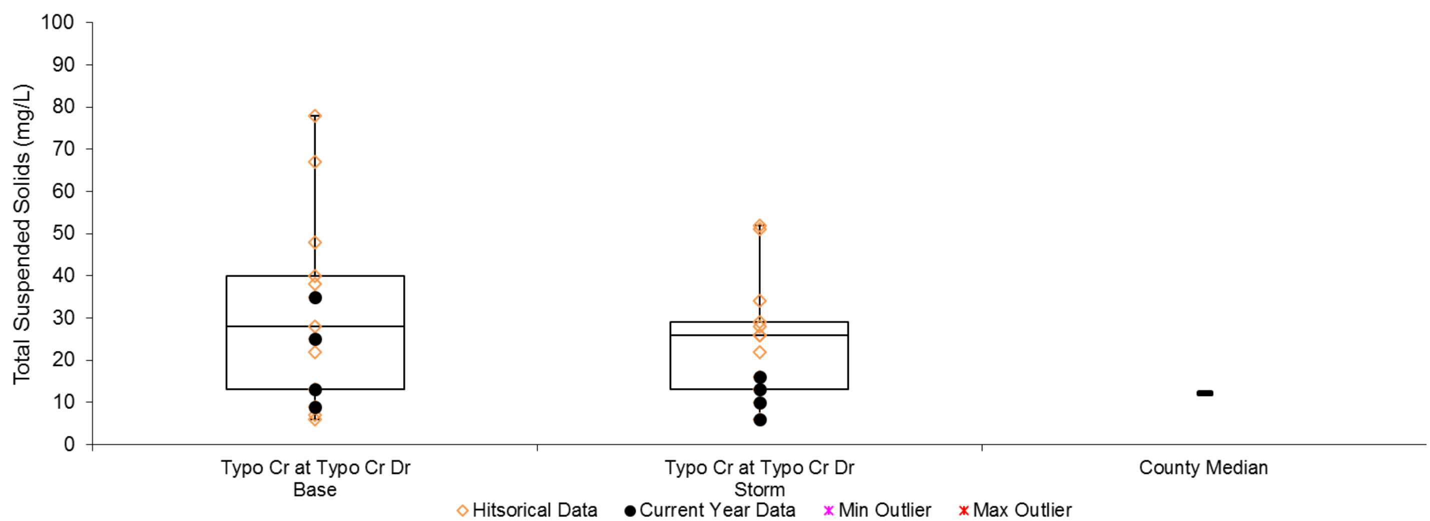
Typo Creek has been on the MPCA Impaired Waters List for turbidity since 2006. The threshold is 25 NTU turbidity. If a river exceeds this value on three occasions and at least 10% of all sampling events it is declared impaired for turbidity. Based on all years of ACD sampling, Typo Creek has exceeded 25 NTU turbidity on 15 of 27 sampling occasions, or 56% of the time. In 2016 five of eight samples had turbidity in excess of 25 NTU, with 71.2 NTU being the highest level recorded for the year.

The high turbidity levels in Typo Creek are likely due to many factors within the watershed. Rough fish are present in the creek, as well as each of the lakes it connects. Typo Lake upstream is hypertrophic, and MN DNR fisheries anecdotal notes suggest large algae blooms dating back to the 1960s. Additionally, Typo Creek and Typo Lake each have a very loose, unconsolidated, silty bottom that easily mixes with the water column and readily remains suspended.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Total suspended solids during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

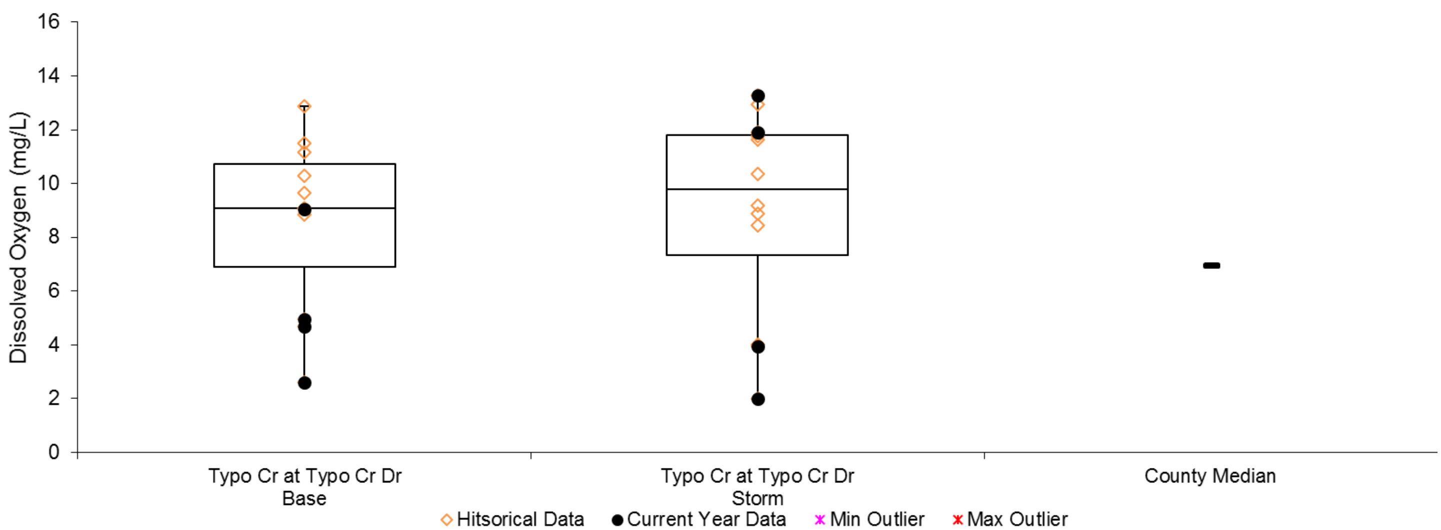


Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution cases oxygen to be consumed when it decomposes. If oxygen levels fall below 5 mg/L aquatic life begins to suffer, therefore, the state water quality standard is a daily minimum of 5 mg/L. A stream is considered impaired if 10% of observations are below this level in the last 10 years. Dissolved oxygen levels are typically lowest in the early morning because of decomposition consuming oxygen at night without offsetting oxygen production by photosynthesis.

In three past years of sampling, Typo Creek only had a DO level below 5 mg/L on one occasion. In 2016, five of eight samples yielded sub-5 mg/L results. These results are especially disconcerting considering low DO was measured during both storm and baseflow conditions during a year that was generally wet but without flooding. These low DO concentrations are likely directly attributable to decomposition, eutrophication and lack of clarity within the stream. These conditions cause high levels of oxygen consumption without allowing sunlight to penetrate the water column and trigger photosynthesis.

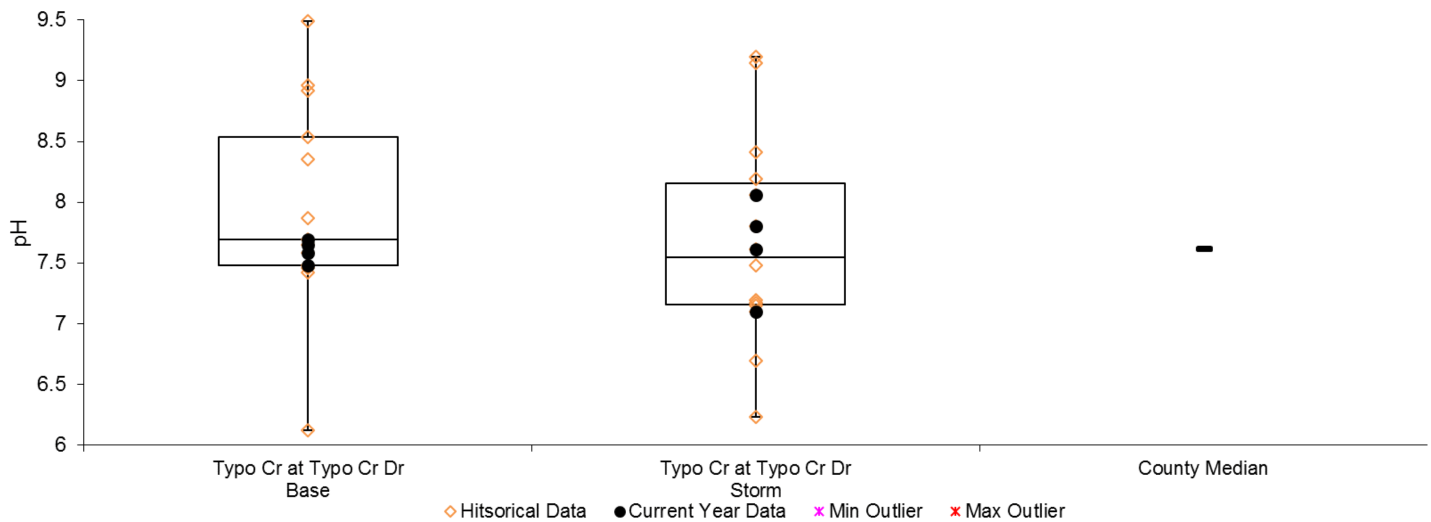
Dissolved oxygen results during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

pH refers to the acidity of the water, and has a large effect on a stream's ability to support aquatic life. The Minnesota Pollution Control Agency's water quality standard is for pH to be between 6.5 and 8.5. Typo Creek has been listed as impaired for pH since 2006 due to great swings both above and below the state standard range in past sampling years. In 2016, however, pH was much more stable, ranging from 7.10 to 8.06.

pH results during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Recommendations

A Total Maximum Daily Load (TMDL) plan was approved in 2012 for Typo Creek for pH and turbidity. By far the biggest issue with Typo Creek is the nutrient loading and eutrophication of the watershed. Projects including the Martin and Typo Lake carp barriers and carp removal (barriers in 2016, removals in 2017-19), projects in ditched wetalnds upstream of Typo Lake (feasibility study underway) and stormwater retrofits (rain gardens installed) aim to address these issues. Conditions in Typo Creek are not likely to improve until the water quality of Typo Lake upstream improves.

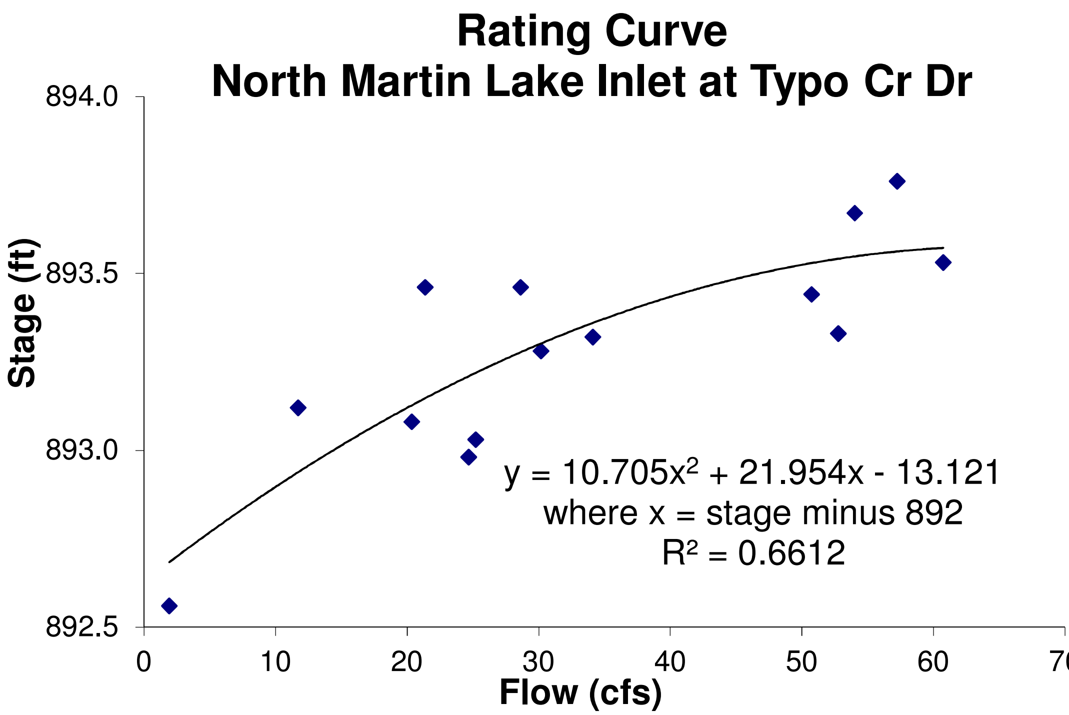
Stream Rating Curves

Description: Rating curves are the mathematical relationship between water level and flow volume. They are developed by manually measuring flow at a variety of water levels. These water level and flow measurements are plotted against each other and the equation of the line best fitting these points is calculated. That equation allows flow to be calculated from continuous water level monitoring in streams.

Purpose: To allow flow to be calculated from water level, which is much easier to monitor.

Locations: North Inlet of Martin Lake (Typo Cr) at Typo Creek Drive

Results: Rating curves were developed for the site listed above in previous years. In 2012 ACD staff discovered an error in the equations and corrected them. They also corrected all past hydrology records that used the equations. Below are the corrected rating curves.



Wetland Hydrology

Description: Continuous groundwater level monitoring at a wetland boundary. Countywide, the ACD maintains a network of 23 wetland hydrology monitoring stations.

Purpose: To provide understanding of wetland hydrology, including the impacts of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

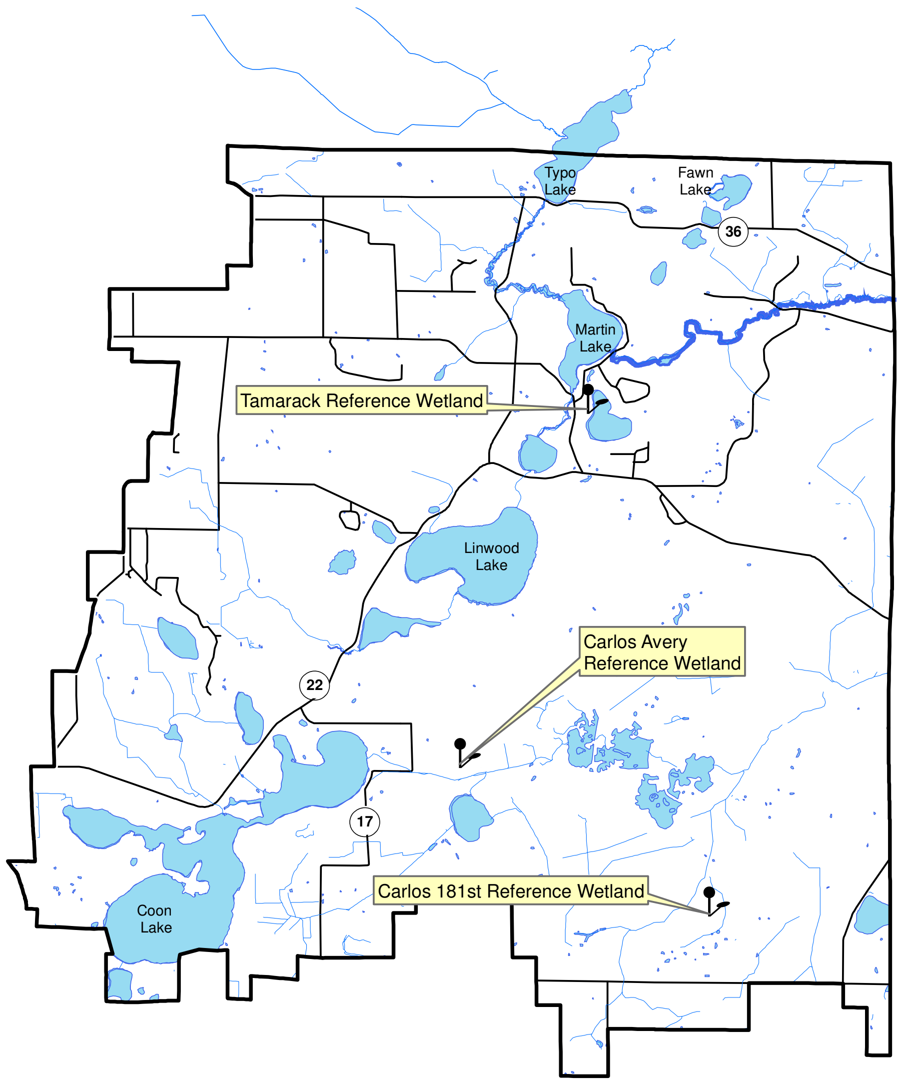
Locations: Carlos Avery Reference Wetland, Carlos Avery Wildlife Management Area, City of Columbus

Carlos 181st Reference Wetland, Carlos Avery Wildlife Management Area, City of Columbus

Tamarack Reference Wetland, Linwood Township

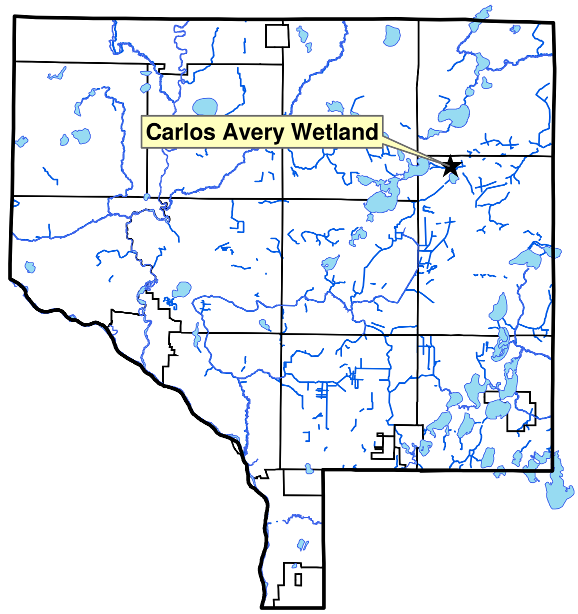
Results: See the following pages.

Sunrise Watershed Wetland Hydrology Monitoring Sites



CARLOS AVERY REFERENCE WETLAND

Carlos Avery Wildlife Management Area, City of Columbus



Site Information

Monitored Since: 1997

Wetland Type: 3

Wetland Size: >300 acres

Isolated Basin? No

Connected to a Ditch? Yes

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa	0-4	N2/0	Organic	-
Bg	4-25	10yr 5/2	Sandy Loam	25% 10yr 5/6 with organic streaking

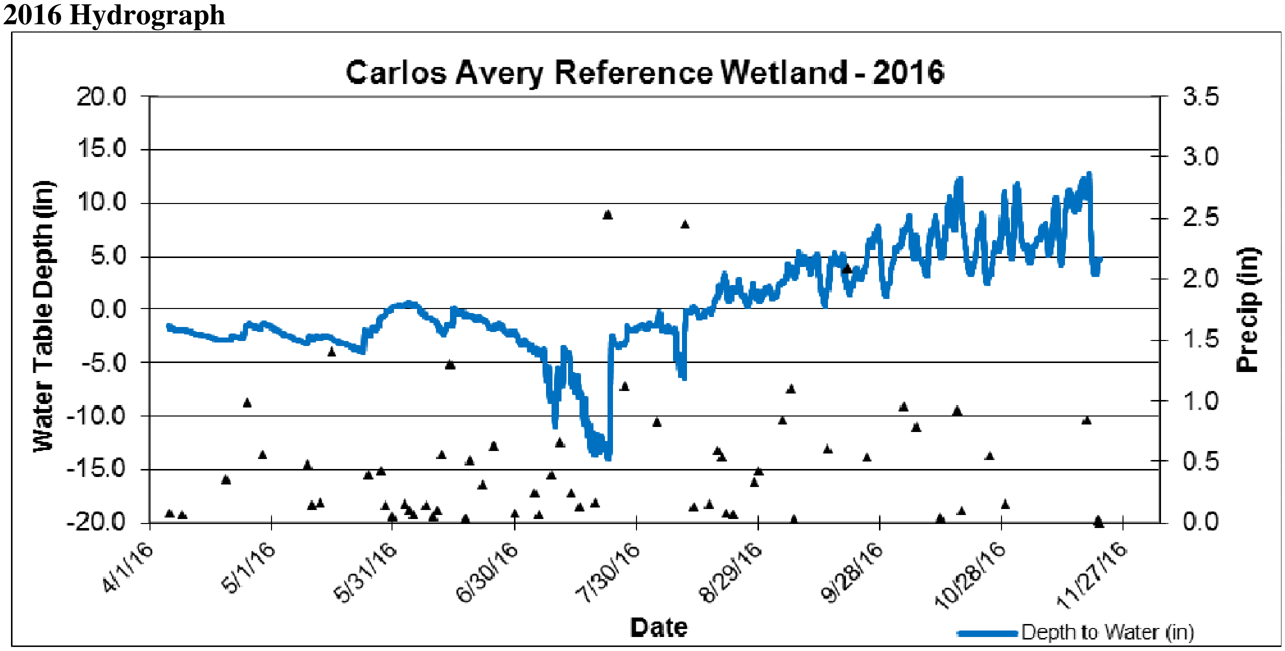
Surrounding Soils: Lino loamy fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	80
Carex Spp	Sedge undiff.	40
Quercus macrocarpa	Bur Oak	40
Sagitaria latifolia	Broad-leaf Arrowhead	20
Cornus stolonifera	Red-osier Dogwood	20

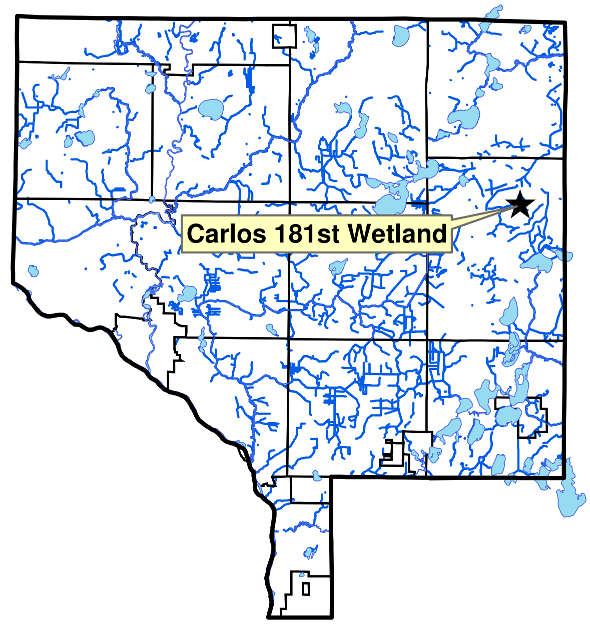
Other Notes: This is a broad, expansive wetland within a state-owned wildlife management area. Cattails dominate within the wetland.

2016 Hydrograph



CARLOS 181ST REFERENCE WETLAND

Carlos Avery Wildlife Management Area, City of Columbus



Site Information

Monitored Since: 2006

Wetland Type: 2-3

Wetland Size: 3.9 acres (approx)

Isolated Basin? Yes

Connected to a Ditch? Roadside swale only

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa	0-3	N2/0	Sapric	-
A	3-10	N2/0	Mucky Fine Sandy Loam	-
Bg1	10-14	10yr 3/1	Fine Sandy Loam	-
Bg2	14-27	5Y 4/3	Fine Sandy Loam	-
Bg3	27-40	5y 4/2	Fine Sandy Loam	-

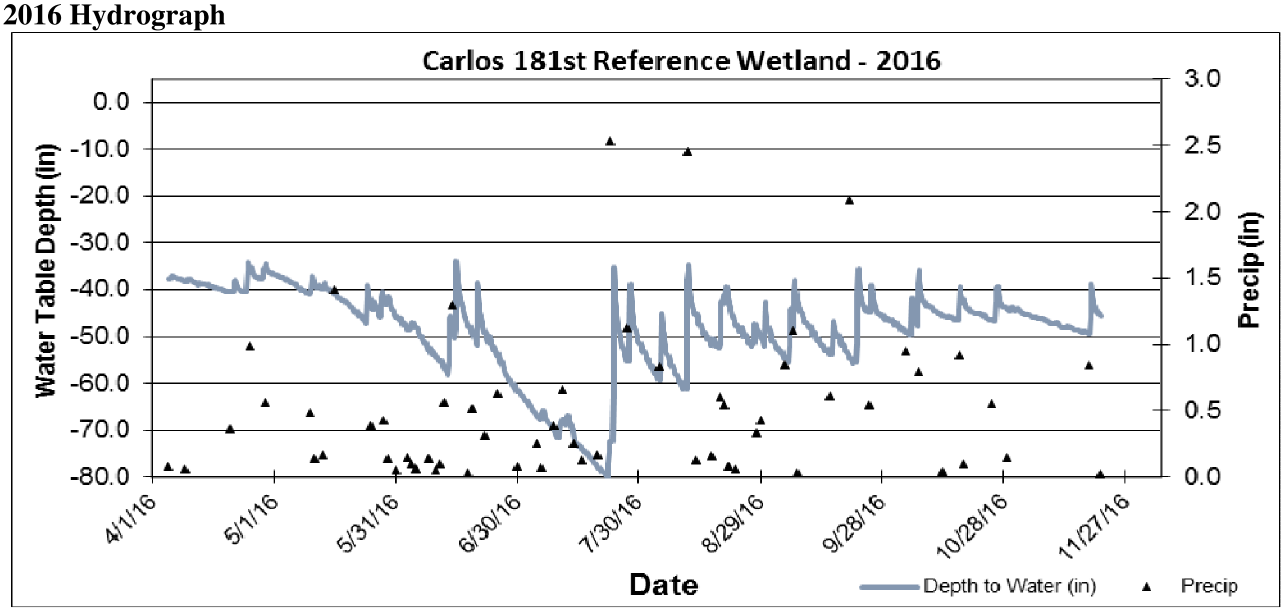
Surrounding Soils: Soderville fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Rhamnus frangula (S)	Glossy Buckthorn	40
Ulmus american (S)	American Elm	15
Populus tremulodies (T)	Quaking Aspen	10
Acer saccharum (T)	Silver Maple	10

Other Notes: The site is owned and managed by MN DNR. Access is from 181st Avenue.

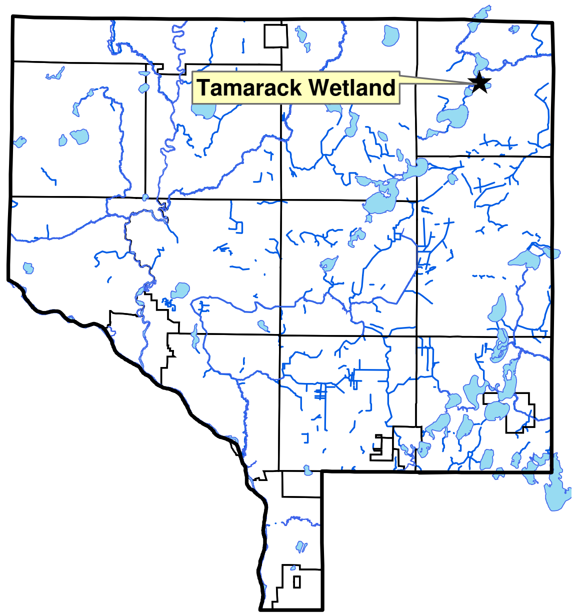
2016 Hydrograph



Wetland Hydrology Monitoring

TAMARACK REFERENCE WETLAND

Martin-Island-Linwood Regional Park, Linwood Township



Site Information

Monitored Since: 1999

Wetland Type: 6

Wetland Size: 1.9 acres (approx)

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-6	N2/0	Mucky Sandy Loam	-
A2	6-21	10yr 2/1	Sandy Loam	-
AB	21-29	10yr3/2	Sandy Loam	-
Bg	29-40	2.5y5/3	Medium Sand	-

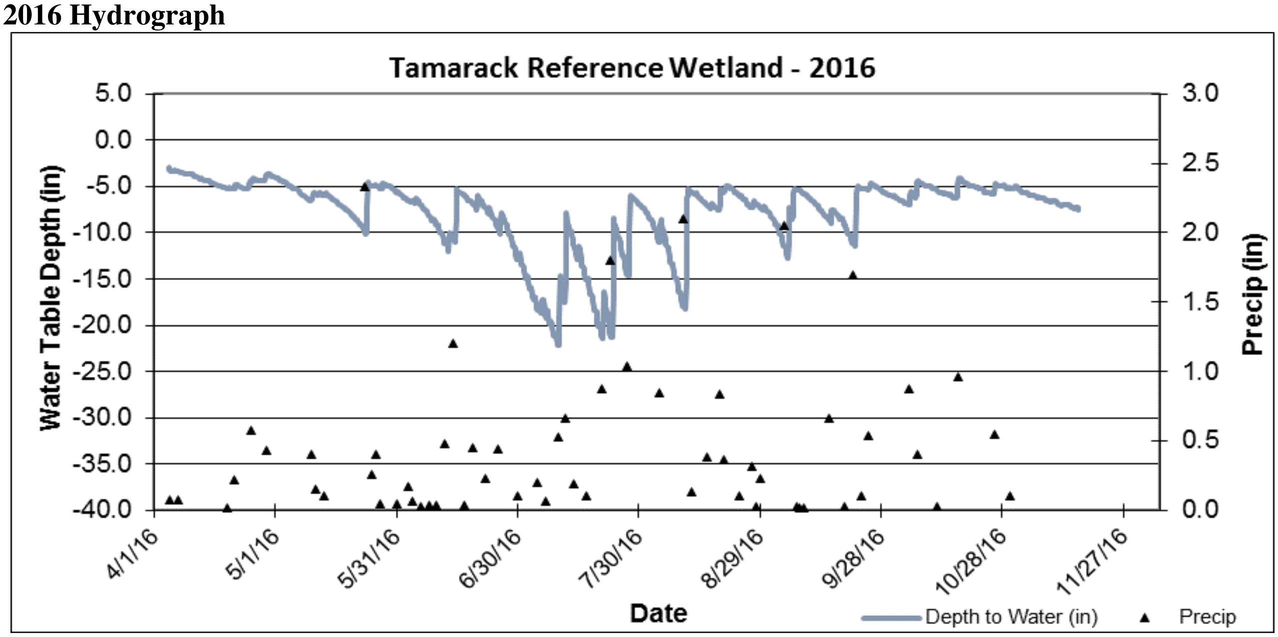
Surrounding Soils: Sartell fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Rhamnus frangula	Common Buckthorn	70
Betula alleghaniensis	Yellow Birch	40
Impatiens capensis	Jewelweed	40
Phalaris arundinacea	Reed Canary Grass	40

Other Notes: The site is owned and managed by Anoka County Parks.

2016 Hydrograph



Water Quality Grant Fund

Description: The Sunrise River Watershed Management Organization (SRWMO) offers cost share grants to encourage projects that will benefit lake and stream water quality. These projects include lakeshore restorations, rain gardens, erosion correction, and others. These grants, administered by the ACD, offer 50-70% cost sharing of the materials needed for a project. The landowner is responsible for the remaining materials expenses, all labor, and any aesthetic components of the project. The ACD assists interested landowners with design, materials acquisition, installation, and maintenance.

Purpose: To improve water quality in area lakes, streams, and rivers.

Locations: Throughout the watershed.

Results: Projects reported in the year they are installed. Installation for one rain garden began in 2016.

SRWMO Cost Share Fund Summary

2005 SRWMO Contribution	+	$1,000.00
2006 SRWMO Contribution	+	$1,000.00
2006 Expense - Coon Lake, Rogers Property Project	-	$ 570.57
2007 – no expenses or contributions		$ 0.00
2008 SRWMO Contribution	+	$2,000.00
2008 Expense - Martin Lake, Moos Property Project	-	$1,091.26
2009 SRWMO Contribution	+	$2,000.00
2010 SRWMO Contribution	+	$1,840.00
2011 SRWMO Contribution	+	$2,000.00
2012 SRWMO Contribution	+	$2,000.00
2012 Expense – Linwood Lake, Gustafson Property Project	-	$ 29.43
2012 Expense – Transfer to Martin-Typo Lakes Carp Barriers	-	$4,300.00
2013 – no expenses or contributions		$ 0.00
2014 SRWMO Contribution	+	$2,000.00
2015 SRWMO Contribution		$ 0.00
2016 SRWMO Contribution		$ 0.00
2016 Expense – Voss Rain Garden	-	$1,229.31
2017 Expense – Anticipated Voss Finish Up	-	$2,658.69*
Fund Balance		**$3,960.74**

*Actual amount anticipated amount to be spent = $451.00

Coon Lake Area Stormwater Retrofits

Description: Two more water quality improvement projects were completed in 2016, both lakeshore restorations**.** These projects, along with the four projects completed in 2015, were identified in a 2014 stormwater retrofit analysis study. The projects were funded by a State Clean Water Legacy Grant and local partners. An additional rain garden project was started in 2016 and is to be finished in early 2017.

Purpose: To improve Coon Lake water quality.

Results: Installed two lakeshore restorations and started work on installing a rain garden.

Four water quality improvement projects were installed in 2015 including two rain gardens, a new stabilized conveyance of stormwater flowing down Lincoln Drive and a lakeshore restoration.

Coon Lake Beach Community Center rain garden

19511 East Tri Oak Circle NE lakeshore restoration

19303 East Front Blvd rain garden

Lincoln Avenue stormwater stabilization.

Two water quality improvement projects were completed in 2016, both lakeshore restorations, with a third project, a rain garden, planned to be finished in early 2017.

3340 183rd Ave. NE lakeshore restoration

18453 Lakeview Pt. Drive Lakeshore Restoration

19303 E Front Blvd. NE rain garden to be finished in 2017

Carp Barriers Installation

Description: This project aims to improve water quality in Martin and Typo Lakes by controlling carp with strategically placed barriers and increased commercial harvests. Both lakes fail to meet state water quality standards due to excessive phosphorus, which fuels algae blooms. As a result, the lakes are often strongly green or brown and the game fishery is depressed. Carp are a major cause of poor water quality in these lakes, diminishing their value for swimming, boating, and fishing.

Barriers are an effective strategy for carp control because Typo and Martin Lake each provide something important for carp, and moving between the lakes is important to their success. Martin Lake is deeper, and good for overwintering. Typo Lake and Typo Creek are shallow and good for spawning. Stopping migrations between the lakes with barriers will reduce overwintering survival and spawning success. Additionally, barriers will allow successful commercial carp harvests.

Purpose: To improve water quality.

Results: In 2014, the SRWMO installed one carp barrier at the south inlet of Martin Lake. In the early spring of 2016, the installation of three additional barriers was completed at the following locations: Typo Lake outlet, Martin Lake north inlet, and Martin Lake outlet.

Martin Lake south inlet (completed 2014)

Typo Lake outlet (completed early 2016)

Martin Lake outlet (completed early 2016)

Martin Lake north inlet (completed early 2016)

Annual Education Publication

Description: An annual newsletter article about the SRWMO is required by MN Rules 8410.010 subpart 4, and planned in the SRWMO Watershed Management Plan.

Purpose: To improve citizen awareness of the SRWMO, its programs, and accomplishments.

Results: In 2016 the SRWMO contracted with the ACD to write the annual newsletter and provide it to member communities for distribution in their newsletters. Topics for the annual newsletter were discussed by the SRWMO Board. Shoreline restoration grant opportunities was the chosen topic.

SRWMO 2016 Newsletter Article:

Grants Available to Homeowners for Shoreline Restoration

Grants and technical help are being offered by the Sunrise River Watershed Management Organization (SRWMO) to homeowners for projects that benefit water quality. Grants are targeted toward stabilizing eroding shorelines and filtering runoff before it reaches the lake. Other projects that benefit water quality are also considered. The eligible area includes Coon, Linwood, Martin and Typo Lakes, as well as smaller waterbodies in the vicinity.

Most projects include “soft engineering” to stabilize erosive losses and planting of native grasses and wildflowers that filter runoff and provide habitat. Portions of the shoreline are typically left unplanted for a dock, beach and other water access. Each design is unique but all projects provide beauty and a lasting benefit to the lake’s water quality and fish.

No-cost consultations are offered, as well as assistance with a design and cost estimate. The grants pay 50-70% of materials costs. Homeowners are responsible for labor costs.

Interested landowners should contact Jamie Schurbon at the Anoka Conservation District at 763-434-2030 ext. 12 or jamie.schurbon@anokaswcd.org.

Additional information about lakeshore landscaping, including hints for do-it-yourselfers and recommended plant lists, is at www.SRWMO.org.

The SRWMO is a collaboration of Linwood Township and the Cities of East Bethel, Ham Lake and Columbus to manage water resources. It covers all of Linwood and portions of each city in the Sunrise River watershed.

Photo: Restored shoreline at Coon Lake.

SRWMO Website

Description: The Sunrise River Watershed Management Organization (SRWMO) contracts the Anoka Conservation District (ACD) to maintain a website about the SRWMO and the Sunrise River watershed.

Purpose: To increase awareness of the SRWMO and its programs. The website also provides tools and information that helps users better understand water resources issues in the area. The website serves as the SRWMO's alternative to a state-mandated newsletter.

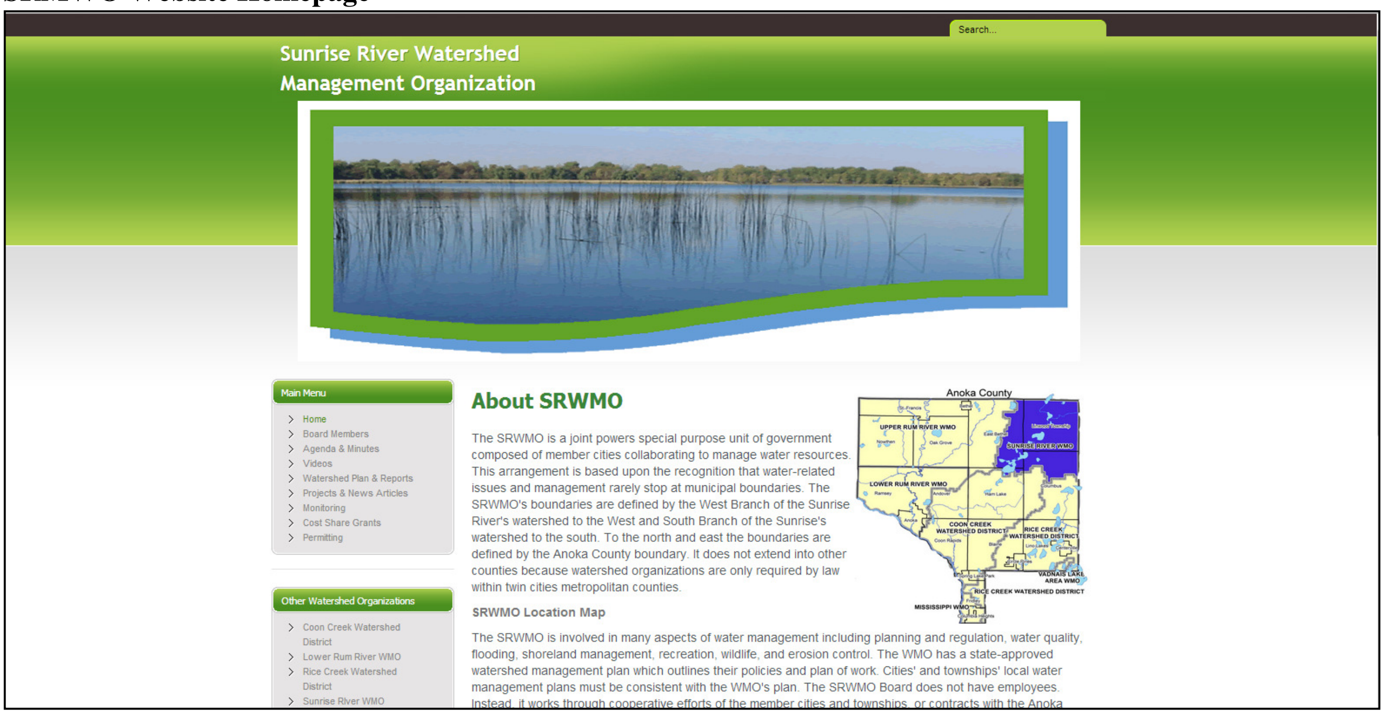
Location: www.SRWMO.org

Results: In 2013, the ACD re-launched the SRWMO website.

Regular website updates occurred throughout 2016. The SRWMO website contains information about both the SRWMO and about natural resources in the area.
Information about the SRWMO includes:

- a directory of board members,
- meeting minutes and agendas,
- the watershed management plan and information about plan updates,
- descriptions of work that the organization is directing,
- highlighted projects.

SRMWO Website Homepage



Grant Searches and Applications

Description: The Anoka Conservation District (ACD) partners with the SRWMO with the preparation of grant applications. Several projects in the SRWMO Watershed Management Plan need outside funding in order to be accomplished.

Purpose: To provide funding for high priority local projects that benefit water resources.

Results: Several grant opportunities were explored in 2016, however no grant applications were prepared. Recent successful grant applications have included the Ditch 20 Feasibility Study ($72,402) and Martin and Typo Lake Carp Barriers ($435,754).

Installation of the Martin and Typo Lake Carp Barriers was completed in 2016, and the grant is in the final stages of being wrapped up.

SRWMO Annual Report to BWSR and State Auditor

Description: The Sunrise River Watershed Management Organization (SRWMO) is required by law to submit an annual report to the Minnesota Board of Water and Soil Resources (BWSR), the state agency with oversight authorities. This report consists of an up-to-date listing of SRWMO Board members, activities related to implementing the SRWMO Watershed Management Plan, the status of municipal water plans, financial summaries, and other work results. The SRWMO bolsters the content of this report beyond the statutory requirements so that it also serves as a comprehensive annual report to SRWMO member communities. The report is due annually 120 days after the end of the SRWMO's fiscal year (April 30th).

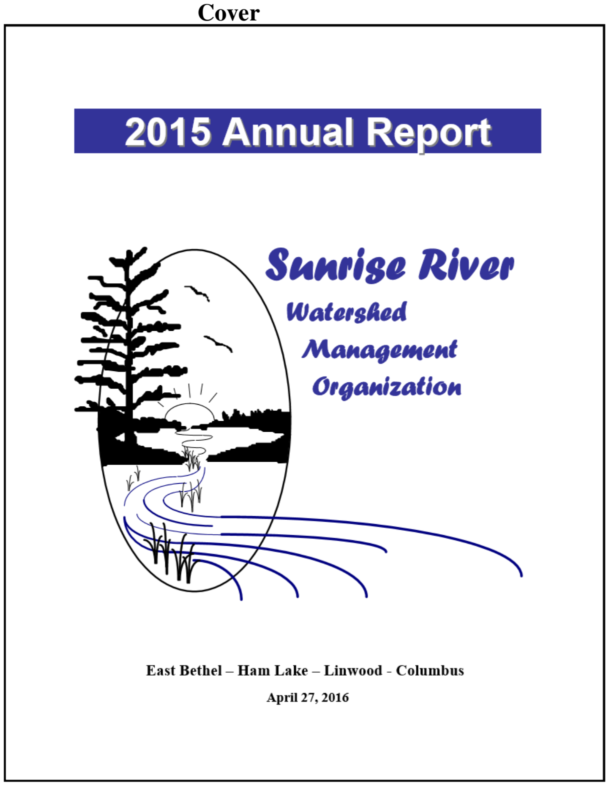
The SRWMO must also submit an annual financial report to the State Auditor. They accept unaudited financial reports for financial districts with annual revenues less than $185,000.

Purpose: To document progress toward implementing the SRWMO Watershed Management Plan and to provide transparency of government operations.

Locations: Watershed-wide

Results: Anoka Conservation District (ACD) assisted the SRWMO with preparation of an annual Sunrise River WMO Annual Report. The ACD drafted the report and a cover letter. After SRWMO Board review the final draft was forwarded to BWSR. A sufficient number of copies of the report were sent to each member community to ensure that each city council person and town board member would receive a copy. The report is available to the public on the SRWMO website.

Cover



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On-call Administrative Services

Description: The Anoka Conservation District Water Resource Specialist provides limited, on-call administrative assistance to the SRWMO. Tasks are limited to those defined in a contractual agreement.

Purpose: To ensure day-to-day operations of the SRWMO are attended to between regular meetings.

Results: In 2016 a total of 39.5 hours of administrative assistance occurred as of December 31.

The following tasks were accomplished:

- Provided BWSR with information needed for the PRAP performance assessment of the WMO. Met with BWSR and the SRWMO to discuss draft findings. Prepared a letter to BWSR outlining corrections needed to the draft report.
- Responded to inquires from the Linwood Lake Association regarding the SRWMO, budgeting, and meetings.
- Fielded questions from the Wolens family about whether they are in the SRWMO or CCWD. Ultimately, the discussion is leading to a boundary amendment, as their property is currently in the wrong watershed organization.
- Prepared a resolution supporting a WMO boundary change. Discussed this item with Mike Bury of the lake association for feedback.
- Prepared a SRWMO display for Linwood Family Fun Day.
- Prepared 2017 budget, met with the SRWMO to edit, and forwarded the budget to the cities for ratification.
- Began preparation of the 2018 budget.
- Prepared a resolution regarding One Watershed One Plan and presented the concept to the SRWMO board.
- Completed a lobbying expenses report required by the State.
- Contacted all the member cities about whether to pursue changes to the joint powers agreement proposed by Ham Lake, received their feedback and reported to the SRWMO Board.
- Filled a City of East Bethel request for a map of the WMO.
- Delivered annual reports to the member cities.
- Forwarded an offer from FEMA and DNR for floodplain mapping services to member cities.
- Occasional inquiries from contractors and developers about any SRWMO permitting requirements.
- Answered Board member questions outside of meetings.
- Assist with meeting packet preparation.

Financial Summary

The ACD accounting is organized by program and not by customer. This allows us to track all of the labor, materials and overhead expenses for a program. We do not, however, know specifically which expenses are attributed to monitoring which sites. To enable reporting of expenses for monitoring conducted in a specific watershed, we divide the total program cost by the number of sites monitored to determine an annual cost per site. We then multiply the cost per site by the number of sites monitored for a customer.

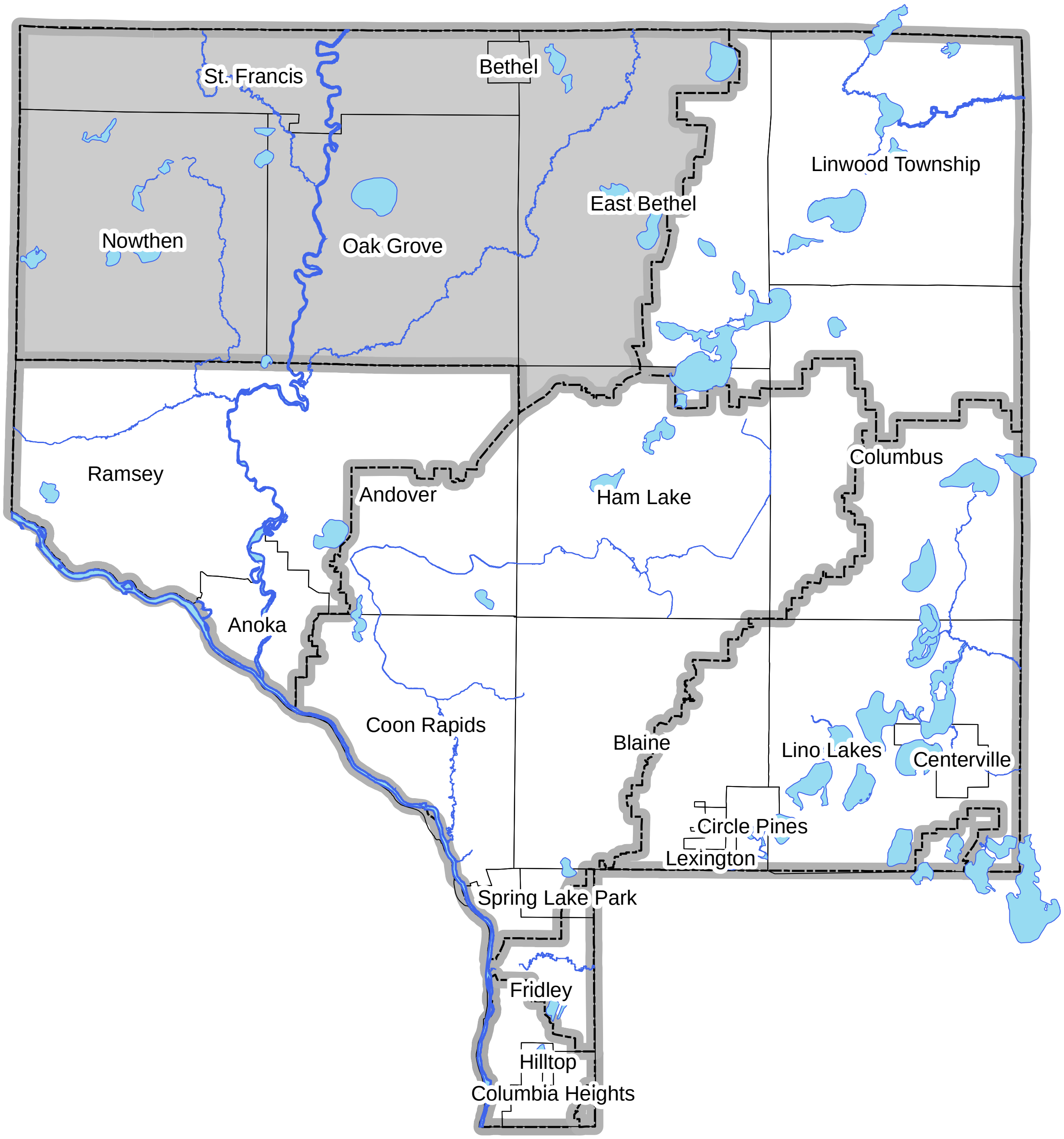
Sunrise River Watershed Financial Summary

Sunrise River Watershed	WMO Asst (no charge)	Volunteer Precip	Reference Wetlands	Ob Well	Lake Level	Lake WQ	Stream Level	Stream WQ	SRWMO Admin/Grant Search	WMO Annual Rpts to State	SRWMO Outreach/Promo	WMO Website Maint	Martin/Typo Carp Barriers	Buckthorn Clean Sweep	Coon Lake Retrofits	Boot Lake Buckthorn	Ditch 20 Feasibilty	Total
Revenues																		
SRWMO	0	0	1725	0	1250	6600	1250	1400	2875	1100	500	505	8000	0	19675	0	2500	47379
State	0	0	0	240	0	0	0	0	0	0	0	0	50607	3847	7093	8669	9034	79490
Anoka Co. General Services	390	0	32	235	751	242	12	0	510	0	0	50	185	6057	1389	8789	110	18751
Anoka Conservation District	0	0	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	69
County Ag Preserves/Projects	0	0	0	0	0	0	0	0	0	0	0	0	0	0	743	0	0	743
Service Fees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2500	2500
Regional/Local	0	0	48	0	0	557	0	0	0	0	0	0	0	0	2000	0	(0)	2605
BWSR Cons Delivery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BWSR Capacity Funds	0	0	1834	0	0	0	0	0	0	0	0	0	12704	0	6211	0	0	20749
BWSR Cost Share TA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metro ETA & AWQCP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6977	0	0	6977
Local Water Planning	0	367	911	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1278
TOTAL	390	367	4619	475	2001	7399	1262	1400	3385	1100	500	555	71496	9904	44088	17458	14144	180542
Expenses-																		
Capital Outlay/Equip	5	5	24	6	23	59	11	7	39	6	5	5	230	113	111	170	165	984
Personnel Salaries/Benefits	339	356	1771	413	1741	4370	810	501	2945	474	409	352	17186	8449	8254	12694	12288	73351
Overhead	25	26	130	30	128	321	60	37	217	35	30	26	1264	621	607	934	904	5395
Employee Training	2	2	10	2	10	25	5	3	17	3	2	2	97	48	46	71	69	413
Vehicle/Mileage	7	8	37	9	37	92	17	11	62	10	9	7	363	179	174	268	260	1551
Rent	12	13	63	15	62	156	29	18	105	17	15	13	614	302	295	454	439	2621
Program Participants	0	0	0	0	0	0	0	0	0	0	0	0	51430	0	31366	0	0	82795
Program Supplies	0	-42	2411	0	0	1777	2	265	0	0	0	191	311	192	3235	2866	20	11229
TOTAL	390	367	4447	475	2001	6801	933	840	3385	545	470	596	71496	9904	44088	17458	14144	178338

Recommendations

- **Pursue carp harvests now that Martin and Typo Lakes carp barriers are complete**. The SRWMO, ACD and Martin Lakers applied for a carp removal grant in January 2017.
- **Collaborate with the Linwood Lake Association.** The association has recently become more active, and has requested partnerships to manage aquatic invasive species and improve water quality.
- **Support the Ditch 20 (Data Creek) water quality improvement projects feasibility study.** The grant-funded project is led by the Anoka Conservation District. The study will be completed by 2018. Thereafter, construction of favored projects is anticipated.
- **Continue installation of stormwater retrofits around Coon and Martin Lakes** where completed studies have identified and ranked projects.
- **Continue efforts to secure grants.** A number of water quality improvement projects are being identified with more to come in 2017. Outside funding will be necessary for installation of most of these. These projects should be highly competitive for those grants.
- **Bolster lakeshore landscaping education efforts.** The SRWMO Watershed Management Plan sets a goal of three lakeshore restorations per year. Few are occurring. Fresh approaches should be welcomed.
- **Increase the use of web videos as an effective education and reporting tool.**
- **Continue the SRWMO cost share grant program** to encourage water quality projects. Consider refining the program to increase participation.
- **Encourage communities to report water quality projects to the SRWMO.** An overarching goal in the SRWMO Plan is to reduce phosphorus by 20% (986 lbs). State oversight agencies will evaluate efforts toward this goal. Both WMO and municipal project benefits should be counted.

Upper Rum River Watershed



Contact Info: Upper Rum River Watershed Management Organization
www.urrwmo.org
763-753-1920

Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 3: UPPER RUM RIVER WATERSHED

Task	Partners	Page
Lake Level Monitoring	URRWMO, ACD, MN DNR, volunteers	3-70
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Lake George Stormwater Retrofit Analysis	Lake George LID, ACD	3-108
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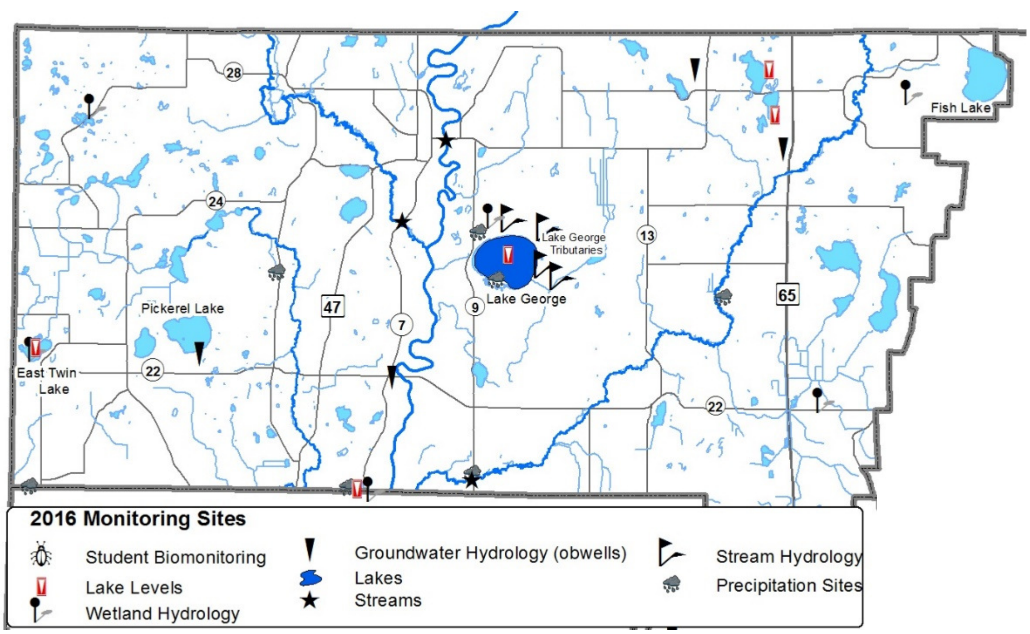
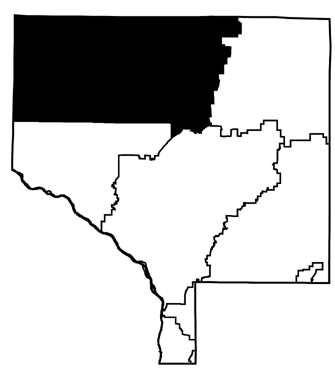
Precipitation	ACD, volunteers	Chapter 1

ACAP = Anoka County Ag Preserves, ACD = Anoka Conservation District, LID= Lake Improvement District
LRRWMO = Lower Rum River Watershed Mgmt. Org, MC = Metropolitan Council
MNDNR = Minnesota Dept. of Natural Resources, URRWMO = Upper Rum River Watershed Mgmt. Org





Lake Levels

Description: Weekly water level monitoring in lakes. The past five years and, when available, past twenty-five years are illustrated below. All historical data are available on the Minnesota DNR website using the "LakeFinder" feature (www.dnr.mn.us.state\lakefind\index.html).

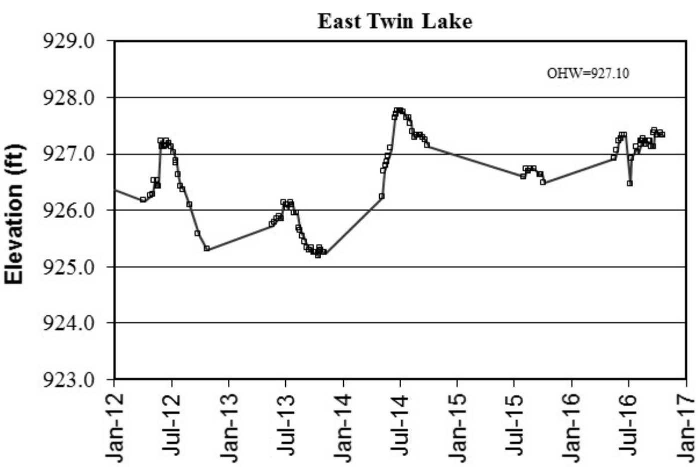
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

Locations: East Twin Lake, Lake George, Rogers Lake, Minard Lake, Coopers Lake

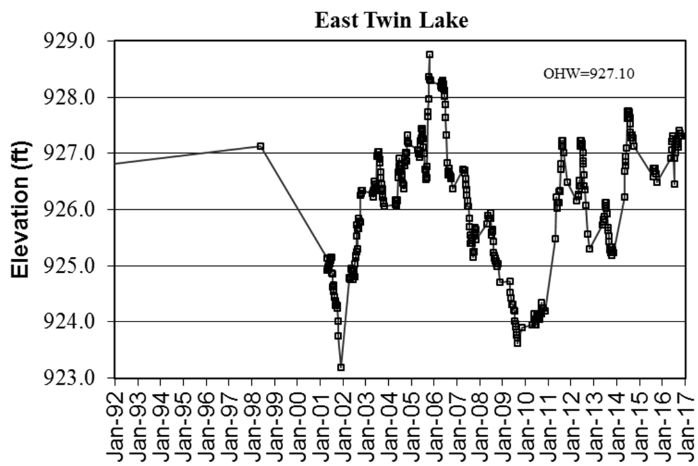
Results: Lake levels were measured by volunteers throughout the 2016 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes had increasing water levels in spring and early summer and dropped steadily by mid-summer. A resurgence of rainfall late into fall caused a spike in lake levels at the end of the year. Overall lake levels were lower than in 2014 when very heavy rainfall totals occurred.

All lake level data can be downloaded from the MN DNR website's Lakefinder feature. Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is listed for each lake on the corresponding graphs below.

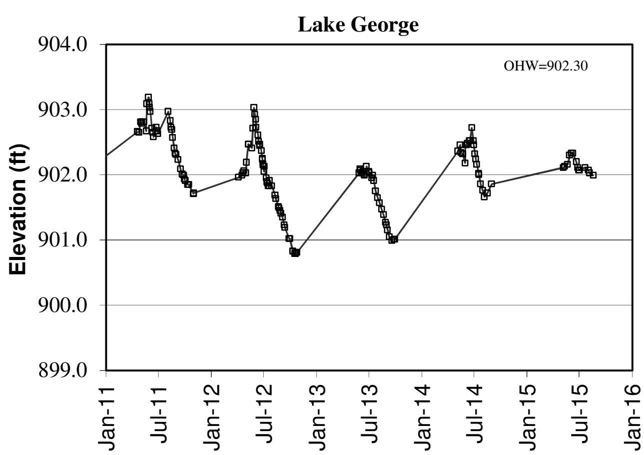
East Twin Lake Levels – last 5 years



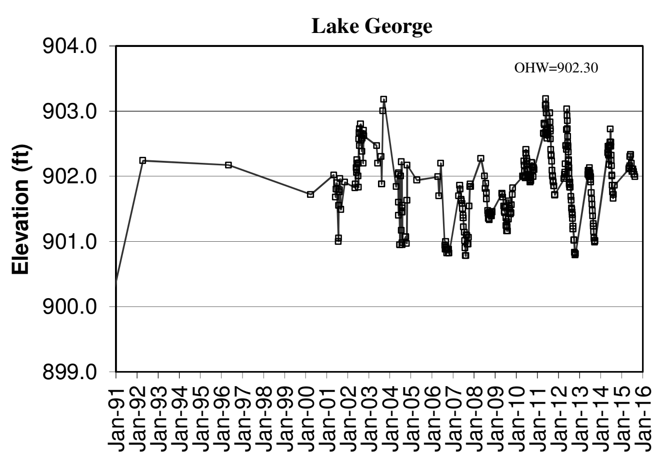
East Twin Lake Levels – last 25 years



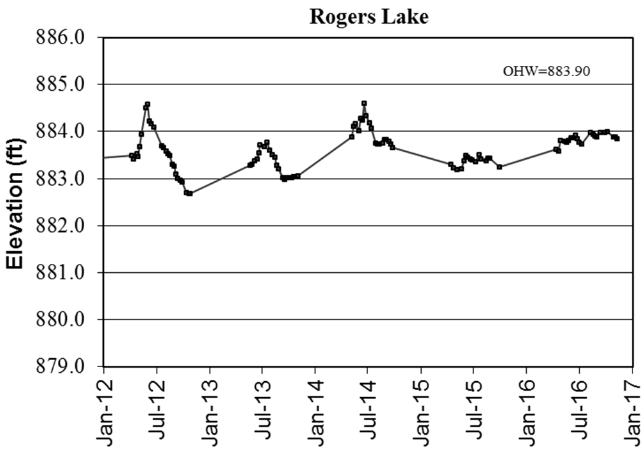
***Lake George Levels – last 5 years**



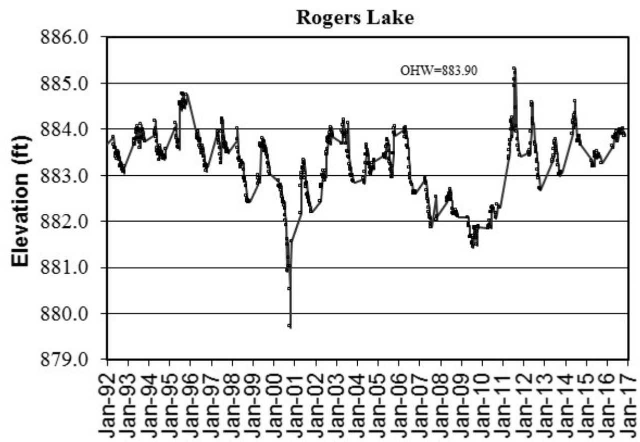
Lake George Levels – last 25 years



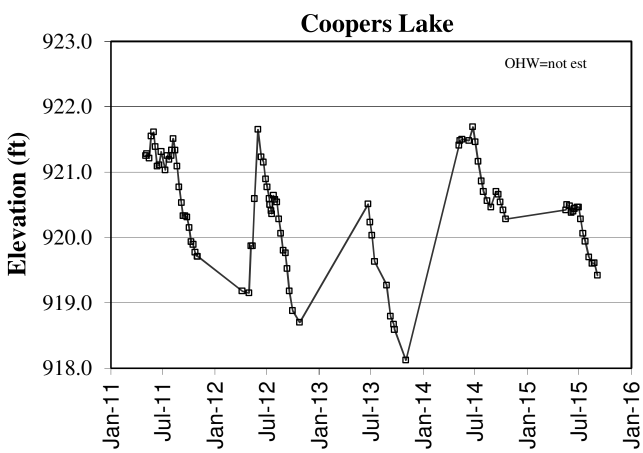
Rogers Lake Levels – last 5 years



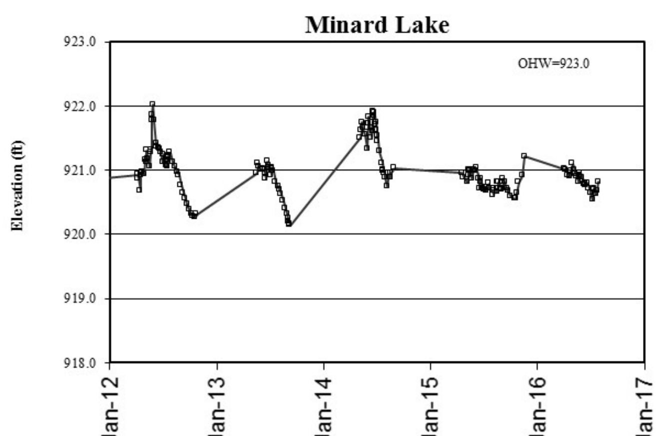
Rogers Lake Levels – last 25 years



***Coopers Lake Levels – last 5 years**



Minard Lake Levels – last 5 years



*2016 lake level readings were not received from Lake George or Coopers Lake volunteers.

Lake Water Quality

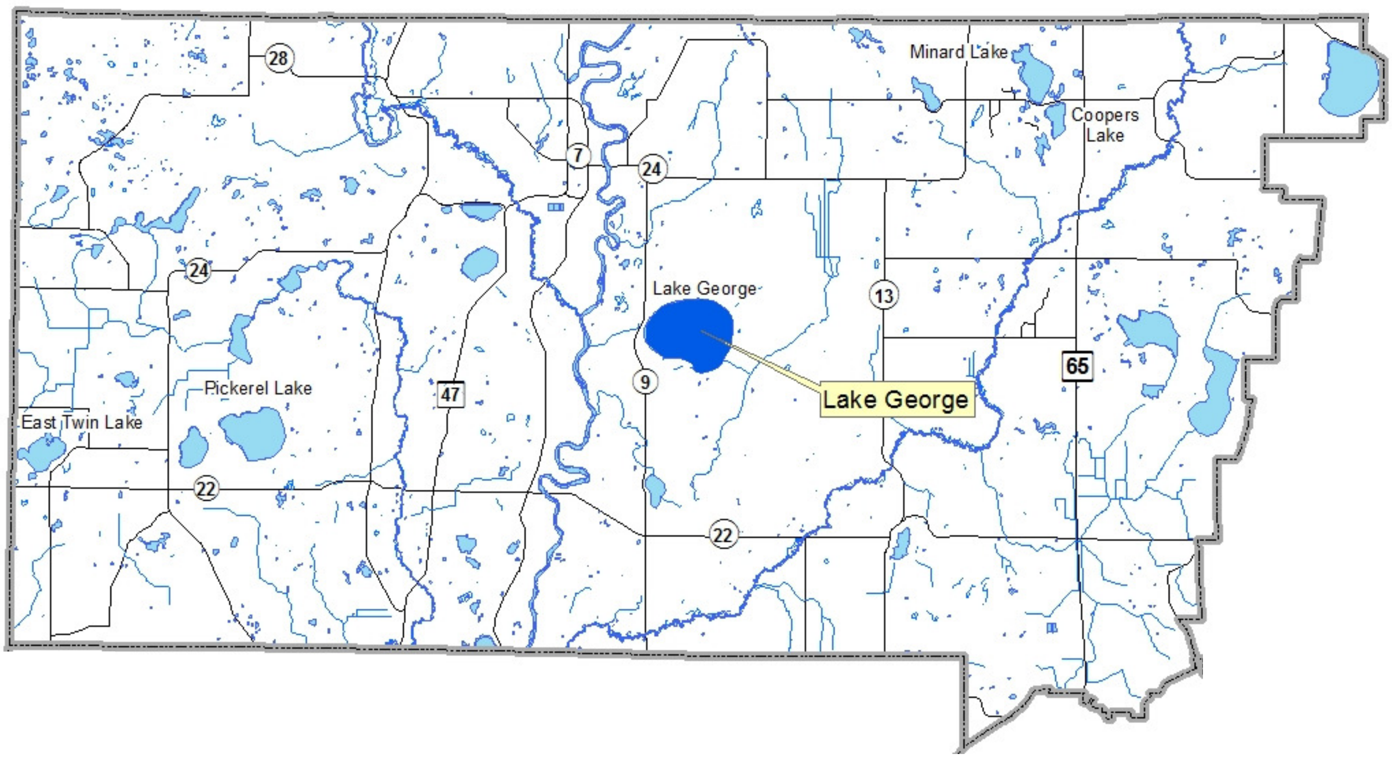
Description: May through September at least once-monthly monitoring of the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

Purpose: To detect water quality trends and diagnose the cause of changes.

Locations: Lake George

Results: Detailed data for each lake are provided on the following pages, including summaries of historical conditions and trend analysis. Previous years' data are available at the MPCA's electronic data access website. Refer to Chapter 1 for additional information on interpreting the data and on lake dynamics.

Upper Rum River Watershed Lake Water Quality Monitoring Sites



Lake George

City of Oak Grove, Lake ID # 02-0091

Background

Lake George is located in north-central Anoka County. The lake has a surface area of 535 acres with a maximum depth of 32 feet (9.75 m). Public access is from Lake George County Park on the lake's north side, where there is both a swimming beach and boat launch. About 70% of the lake is circumscribed by homes; the remainder is county parkland. The watershed is mostly undeveloped or vacant, with some residential areas, particularly on the lakeshore and in the southern half of the watershed. Two invasive exotic aquatic plants are established in this lake, Curly-leaf pondweed and Eurasian Water Milfoil. The Lake George Improvement District treats both with herbicide.

2016 Results

In 2016 Lake George had good water quality for this region of the state (NCHF Ecoregion), receiving an overall A grade. The lake is mesotrophic. Total phosphorus averaged 28.4 ug/L, higher than the previous two years. Secchi transparency was as high as 15 feet in May, but dropped to as low as 3.9 feet in early August. Average Secchi transparency was 7.4 feet, slightly down from 2015. Chlorophyll-a averaged 7.8 mg/L, which is higher than the last three years monitored. Total phosphorous, chlorophyll-a, and transparency were poorest in August. All three parameters conformed to state water quality standards for non-shallow lakes in this region (40 ug/L TP, 14 ug/L Cl-a, and >1.4m Secchi transparency).

Trend Analysis

Nineteen years of water quality data have been collected by the Metropolitan Council (between 1980 and 2009) and the Anoka Conservation District (1997, 1999, 2000, 2002, 2005, 2008, 2011, 2013, 2014, 2015 and 2016). During this period there is a statistically significant trend of declining Secchi transparency (one-way ANOVA $F_{1,17}$= 10.75, p=<0.05). The Rum River Watershed Restoration and Protection Strategy (WRAPS) report, being finalized in 2017, also found "strong evidence" of declining water clarity using a Kendall-Mann statistical analysis. However, an Anoka Conservation District broader analysis of water quality that simultaneously considers TP, Cl-a and Secchi transparency did not find a statistically significant trend (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,16}$= 1.54, p=0.24).

Discussion

Lake George remains one of the clearest of the Anoka County lakes, but its trend toward of declining Secchi transparency is seriously concerning. Lake George is a highly valued lake due to its recreational opportunities and ecological quality. The lake has a large park, many lakeshore homes, and a notably diverse plant community (most metro area lakes have 10-12 different aquatic plant species; Lake George is home to 24).

Additional concern for Lake George is noted in the 2017 Rum River Watershed Fish-Based Lake IBI Stressor Identification Report. That report found Lake George's fish community was not impaired, but was of special concern and vulnerable. Lack of aquatic habitat and near-shore development disturbances were concerns.

In 2016 the ACD began monitoring and data collection for an in depth study funded by the Lake George Improvement District and State Clean Water Fund. The study is aiming to identify causes of water quality degradation and projects that can be installed to fix it. The work will take 1-3 years.

In the meantime, continued efforts should include monitoring, education, and lakeshore best management practices. Residential lakeshore restorations are one high priority and immediately actionable item. Several lakeshore properties have recently undertaken projects to correct erosion and restore native plant communities, but many properties on Lake George aggressively manicure their lakeshore in ways that are detrimental to lake health.

Two exotic invasive plants are present in Lake George, Curly leaf pondweed and Eurasian Water milfoil. The Lake George Improvement District was formed to control these plants, and multiple years of localized treatments have occurred. Concern has been voiced that plant treatments may have a negative impact on water quality. In 2013, water quality monitoring showed a dramatic rise in phosphorus shortly after curly leaf pondweed treatment, and it was suspected that the herbicide treatment may have caused the phosphorus increase. In the three years since, water quality data was collected immediately before and after herbicide treatment to determine if this was the case. No obvious causal relationship between weed treatment and water quality was observed.

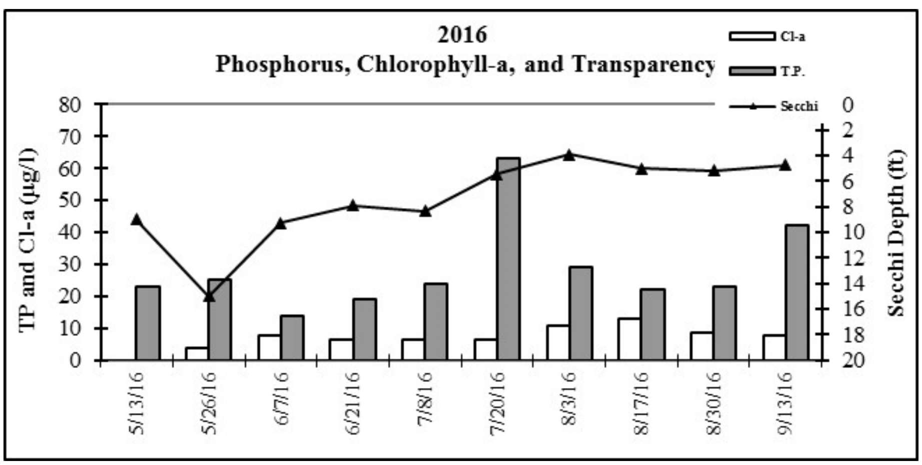
2016 Lake George Water Quality Data

Lake George
2016 Water Quality Data

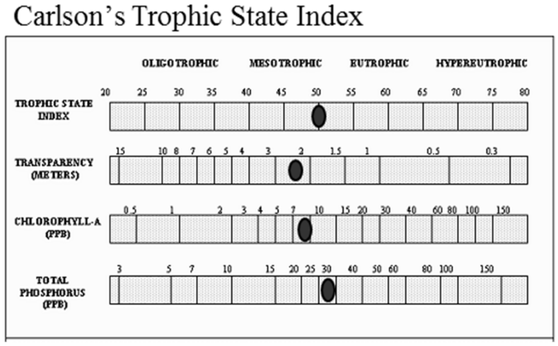
		Date:	5/13/2016	5/26/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/3/2016	8/17/2016	8/30/2016	9/13/2016			
		Time:	12:20	11:00	13:20	11:30	11:05	10:50	12:20	10:20	11:30	10:30			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.38	8.69	8.24	8.07	8.33	8.85	9.25	9.03	8.26	7.94	8.50	7.94	9.25
Conductivity	mS/cm	0.01	0.246	0.262	0.271	0.240	0.251	0.250	0.233	0.255	0.246	0.230	0.248	0.230	0.271
Turbidity	FNRU	1	11.30	0.80	1.60	3.40	17.90		6.30	4.80	14.80	16.50	9	1	18
D.O.	mg/l	0.01	10.04	10.15	9.29	8.33	9.26	9.31	9.25	8.54	8.17	8.22	9.06	8.17	10.15
D.O.	%	1	101%	117%	104%	102%	119%	118%	141%	108%	99%	93%	110%	93%	141%
Temp.	°C	0.1	14.6	21.0	19.8	24.1	25.0	25.9	27.3	25.7	23.6	21.1	22.8	14.6	27.3
Temp.	°F	0.1	58.3	69.7	67.6	75.4	77.0	78.7	81.2	78.3	74.4	70.0	73.1	58.3	81.2
Salinity	%	0.01	0.12	0.12	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.12	0.11	0.13
Cl-a	ug/L	0.5	<1	3.6	7.8	6.4	6.4	6.4	10.7	12.8	8.5	7.8	7.8	3.6	12.8
T.P.	mg/l	0.010	0.023	0.025	0.014	0.019	0.024	0.063	0.029	0.022	0.023	0.042	0.028	0.014	0.063
T.P.	ug/l	10	23	25	14	19	24	63	29	22	23	42	28.4	14	63
Secchi	ft		9.0	15.0	9.3	7.9	8.3	5.4	3.9	5.0	5.2	4.8	7.4	3.9	15.0
Secchi	m		2.7	4.6	2.8	2.4	2.5	1.7	1.2	1.5	1.6	1.4	2.25	1.2	4.6
Field Observations			Moderately	Clear, light l	Clear, light green, algae		Moderately c	Fairly murky	Green	light green, fa	Fairly clear, (	Fairly clear, green tinge			
Physical			2.0	2.0	2.0	2.0	2.0	3.0	2.0	2.0	1.0	1.0	1.9	1.0	3.0
Recreational			2.0	2.0	2.0	2.0	2.0	3.0	2.0	1.0	1.0	1.0	1.8	1.0	3.0

*reporting limit

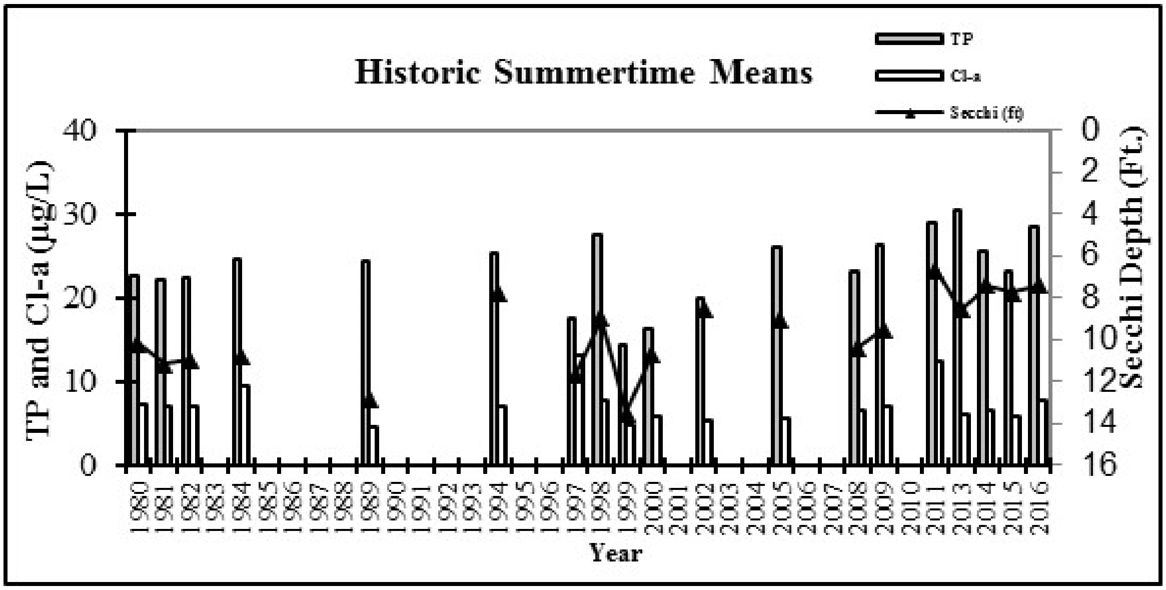
		2016 Median
pH		8.36
Conductivit	mS/cm	0.248
Turbidity	FNRU	4.80
D.O.	mg/l	8.78
D.O.	%	104.00%
Temp.	°C	23.00
Temp.	°F	73.33
Salinity	%	0.11
Cl-a	ug/L	3.60
T.P.	mg/l	0.024
T.P.	ug/l	24.00
Secchi	ft	6.70
Secchi	m	2.03



Carlson's Trophic State Index



Historical Lake George Water Quality Data



Lake George Summertime Annual Means

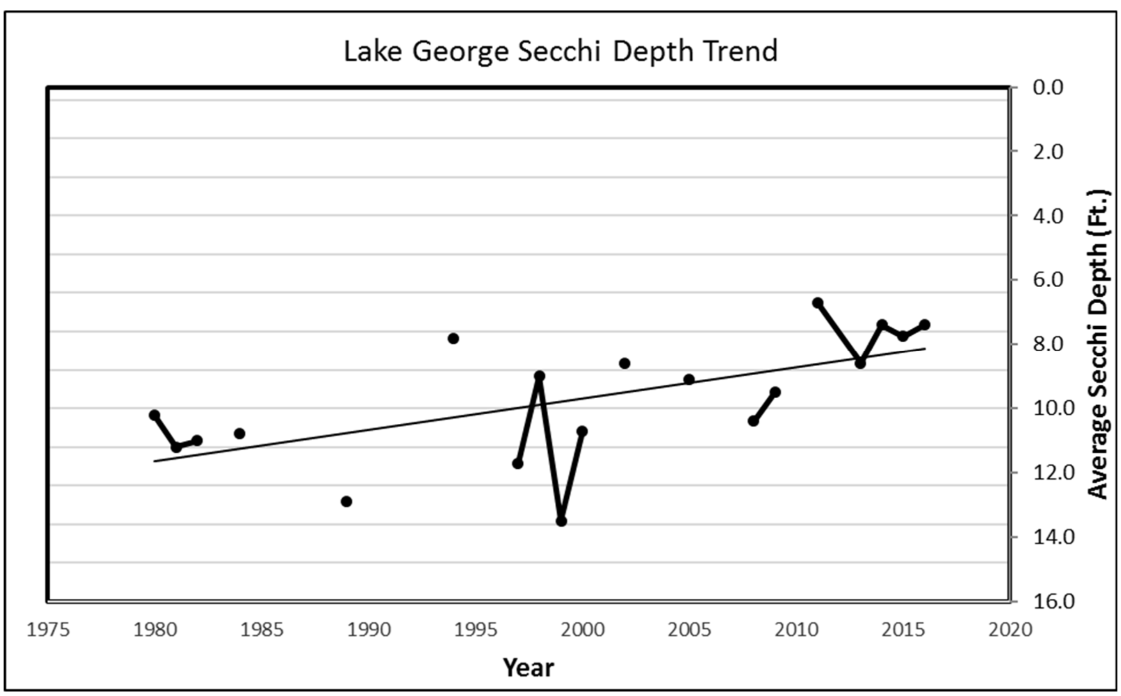
Agency	MC	MC	MC	MC	MC	MC	ACD	MC	ACD	ACD	ACD	ACD	ACD	MC	MC	ACD	ACD	ACD	ACD
Year	1980	1981	1982	1984	1989	1994	1997	1998	1999	2000	2002	2005	2008	2009	2011	2013	2014	2015	2016
TP	22.5	22.0	22.3	24.4	24.3	25.4	17.4	27.5	14.2	16.3	19.9	26.0	23.0	26.2	29.0	30.3	25.5	23.1	28.4
Cl-a	7.3	7.1	7.0	9.5	4.5	6.9	13.2	7.8	4.8	5.8	5.2	5.4	6.4	7.0	12.4	6.1	6.4	5.7	7.8
Secchi (m)	3.1	3.4	3.4	3.3	3.9	2.4	3.6	2.7	4.1	2.8	2.6	2.8	3.2	2.9	1.8	2.6	2.2	2.4	2.3
Secchi (ft)	10.2	11.2	11.0	10.8	12.9	7.8	11.7	9.0	13.5	10.7	8.6	9.1	10.4	9.5	6.7	8.6	7.4	7.7	7.4

Carlson's Trophic State Indices

TSIP	49	49	49	50	50	51	45	52	42	44	47	51	49	51	53	53	51	49	52
TSIC	50	50	50	53	45	50	56	51	46	48	47	47	49	50	55	48	49	47	51
TSIS	44	42	43	43	40	48	42	45	40	45	46	45	43	45	52	46	49	48	48
TSI	48	47	47	49	45	49	48	49	43	46	47	48	47	49	53	49	49	48	50

Lake George Water Quality Report Card

Year	80	81	82	84	89	94	97	98	99	2000	2002	2005	2008	2009	2011	2013	2014	2015	2016
TP	A	A	A	B	B	B	A	B	A	A	A	B	B+	B	B	B	B	A	B
Cl-a	A	A	A	A	A	A	B	A	A	A	A	A	A	A	B	A	A	A	A
Secchi	A	A	A	A	A	B	A	B	A	B	B	B	A	B	C	B	B	B	A
Overall	**A**	**A**	**A**	**A**	**A**	**B**	**A**	**B**	**A**	**A**	**A**	**B**	**A**	**B**	**B**	**B**	**B**	**A**	**A**



Aquatic Invasive Vegetation Mapping

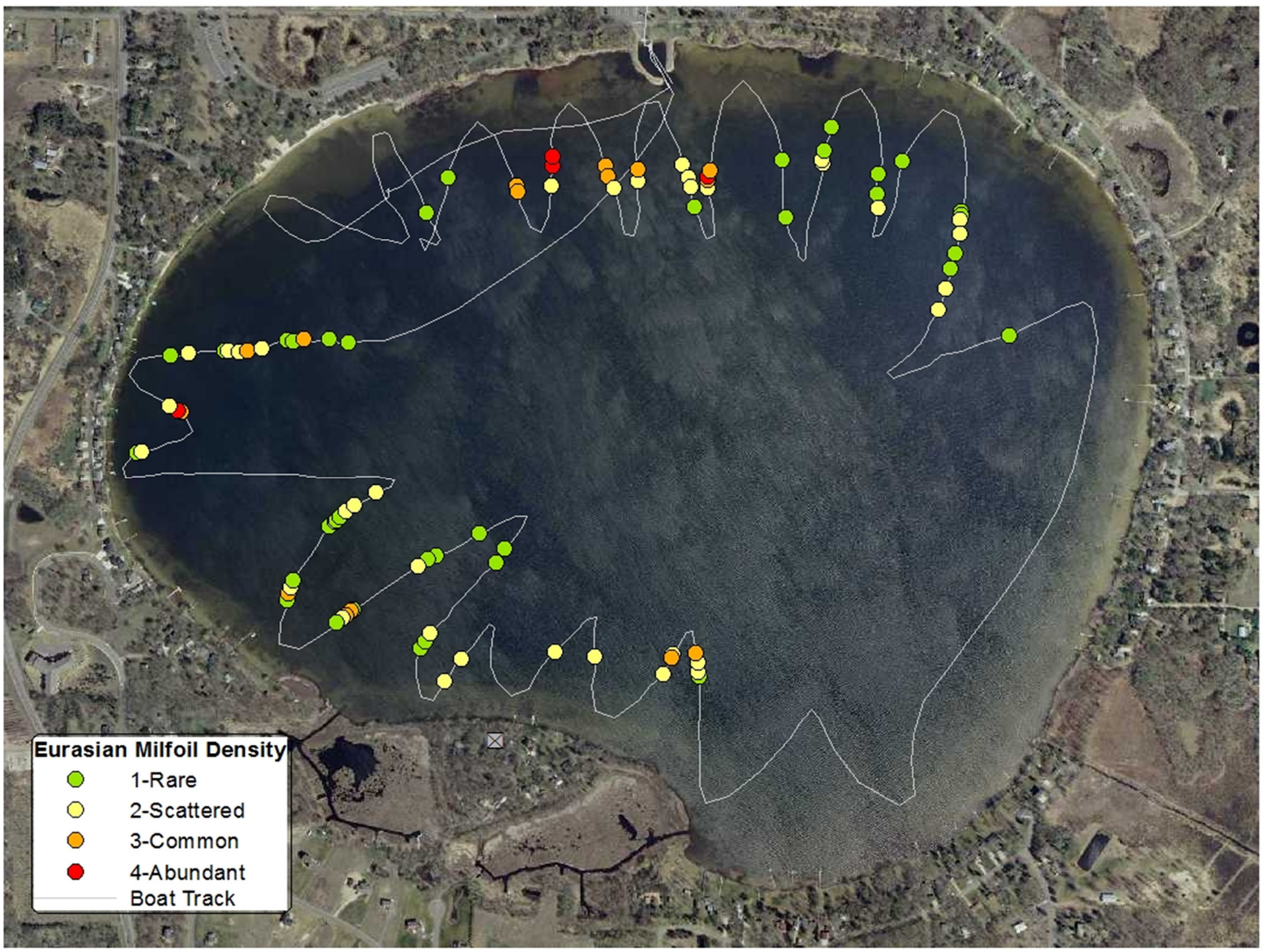
Description: The Anoka Conservation District (ACD) was contracted by the Lake George Lake Improvement District (LID) to conduct an aquatic invasive vegetation delineation.

Purpose: To map out the presence of Curly Leaf Pondweed (CLP) and Eurasian Water Milfoil (EWM) as required for MN DNR herbicide treatment permits. In particular, a goal was to map these invasive species as early as possible in the growing season to allow for herbicide treatment as early as possible. There is concern that plant die-offs associated with later herbicide applications, when plants are larger, may negatively affect water quality.

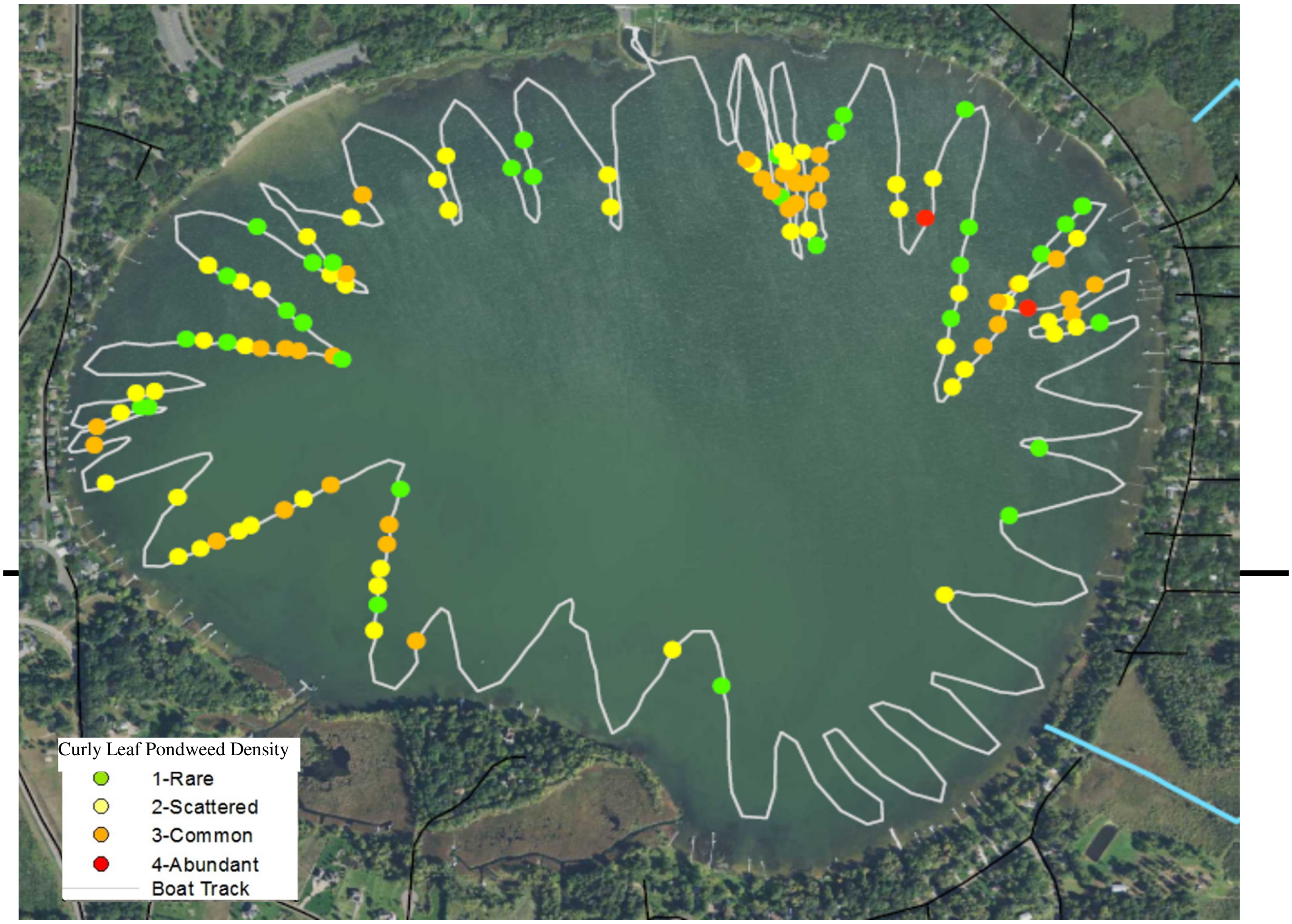
Locations: Lake George

Results: A map is presented below and were delivered to the MN DNR and Lake George Improvement District within 48 hours of the field surveys. These survey points were reviewed by the MNDNR and herbicide treatments occurred in areas with the greatest density of invasive plants.

2016 Lake George Eurasian Water Milfoil (EWM) Survey



2016 Lake George Curly Leaf Pondweed (CLP) survey



Stream Water Quality - Chemical Monitoring

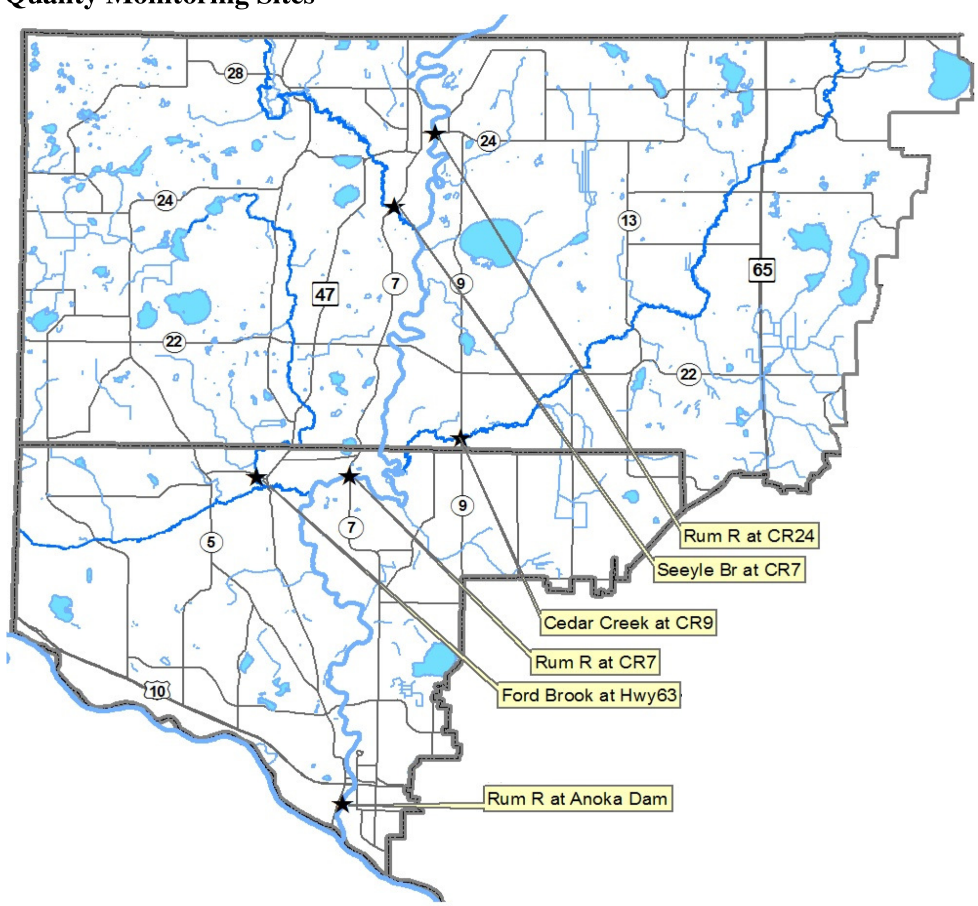
Description: The Rum River and several tributary streams were monitored in 2016. The locations of river monitoring include the approximate top and bottom of the Upper and Lower Rum River Watershed Management Organizations. Tributaries were monitored simultaneously with Rum River monitoring for greatest comparability near their outfalls into the river. Collectively, these data allow for an upstream to downstream water quality comparison within Anoka County, as well as within each watershed organization. It also allows us to examine whether the tributaries degrade Rum River water quality. Monitoring occurred in May through September for each of the following parameters: total suspended solids, total phosphorus, Secchi tube transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

Purpose: To detect water quality trends, diagnose and identify the source of any problems, and provide an initial assessment of water quality to be used in the completion of the Rum River Watershed Restoration and Protection Plan (WRAPP).

Locations:
Rum River at Co Rd 24
Rum River at Co Rd 7
Rum River at the Anoka Dam
Seelye Brook at Co Rd 7
Cedar Creek at Co Rd 9
Ford Brook at Co Rd 63

Results: Results are presented on the following pages.

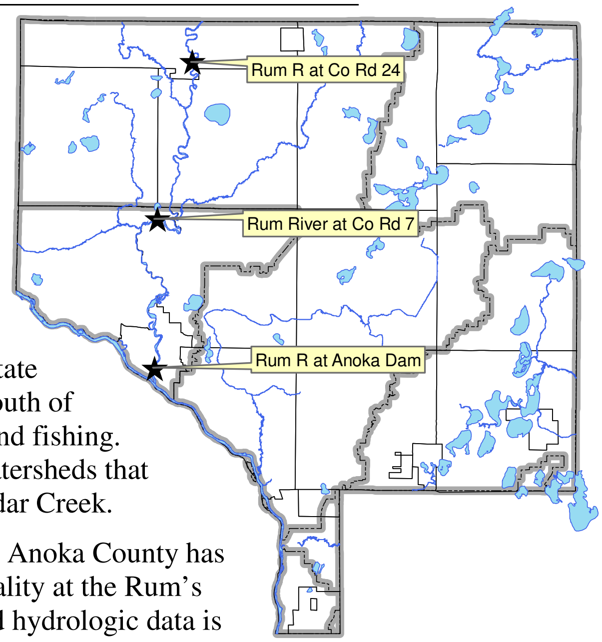
Upper and Lower Rum River Watershed Management Organization
Stream Water Quality Monitoring Sites



RUM RIVER

Rum River at Co. Rd. 24 (Bridge St), St. Francis*	STORET SiteID =	S000-066
Rum River at Co. Rd. 7 (Roanoke St), Ramsey	STORET SiteID =	S004-026
Rum River at Anoka Dam, Anoka	STORET SiteID =	S003-183

*Located in and contracted by the URRWMO, but reported with
all Rum River data for a more complete analysis of the river.



Years Monitored

At Co. Rd. 24 – 2004, 2009, 2010, 2011, 2014, 2015, 2016

At Co. Rd. 7 – 2004, 2009, 2010, 2011, 2014, 2015, 2016

At Anoka Dam – 1996-2011(MC WOMP), 2015, 2016

Background

The Rum River is regarded as one of Anoka County's highest quality and most valuable water resources. It is designated as a state scenic and recreational river throughout Anoka County, except south of the county fairgrounds in Anoka. It is used for boating, tubing, and fishing. Much of western Anoka County drains to the Rum River. Subwatersheds that drain to the Rum include Seelye, Trott, and Ford Brooks, and Cedar Creek.

The extent to which water quality improves or is degraded within Anoka County has been unclear. The Metropolitan Council has monitored water quality at the Rum's outlet to the Mississippi River since 1996. This water quality and hydrologic data is well suited for evaluating the river's water quality just before it joins the Mississippi River. Monitoring elsewhere has occurred only in more recent years. Water quality changes might be expected from upstream to downstream because land use changes dramatically from rural residential in the upstream areas of Anoka County to suburban in the downstream areas.

Methods

In 2004, 2009- 2011 and 2014-2016 monitoring was conducted to determine if Rum River water quality changes in Anoka County, and if so, generally where changes occur. The data is reported together for a more comprehensive analysis of the river from upstream to downstream.

In 2016 the river was monitored during both storm and baseflow conditions by grab samples. At the two downstream locations, eight water quality samples were taken; half during baseflow and half following storms. At the upstream site, only four samples were taken due to lower funding levels. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. In some years, particularly the drought year of 2009, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus and total suspended solids. During every sampling event, the water level (stage) was recorded. The monitoring station at the Anoka Dam includes automated equipment that continuously tracks water levels and calculates flows. Water level and flow data for other sites was obtained from the US Geological Survey, who maintains a hydrological monitoring site at Viking Boulevard.

The purpose of this report is to make an upstream to downstream comparison of Rum River water quality. It includes only parameters tested in 2016. It does not include additional parameters tested at the Anoka Dam or additional monitoring events at that site. For that information, see Metropolitan Council reports at http://www.metrocouncil.org/Environment/RiversLakes. All other raw data can be obtained from the Anoka

Conservation District, and is also available through the Minnesota Pollution Control Agency's EQuIS database, which is available through their website.

Results Summary

This report includes data from 2016. The following is a summary of results.

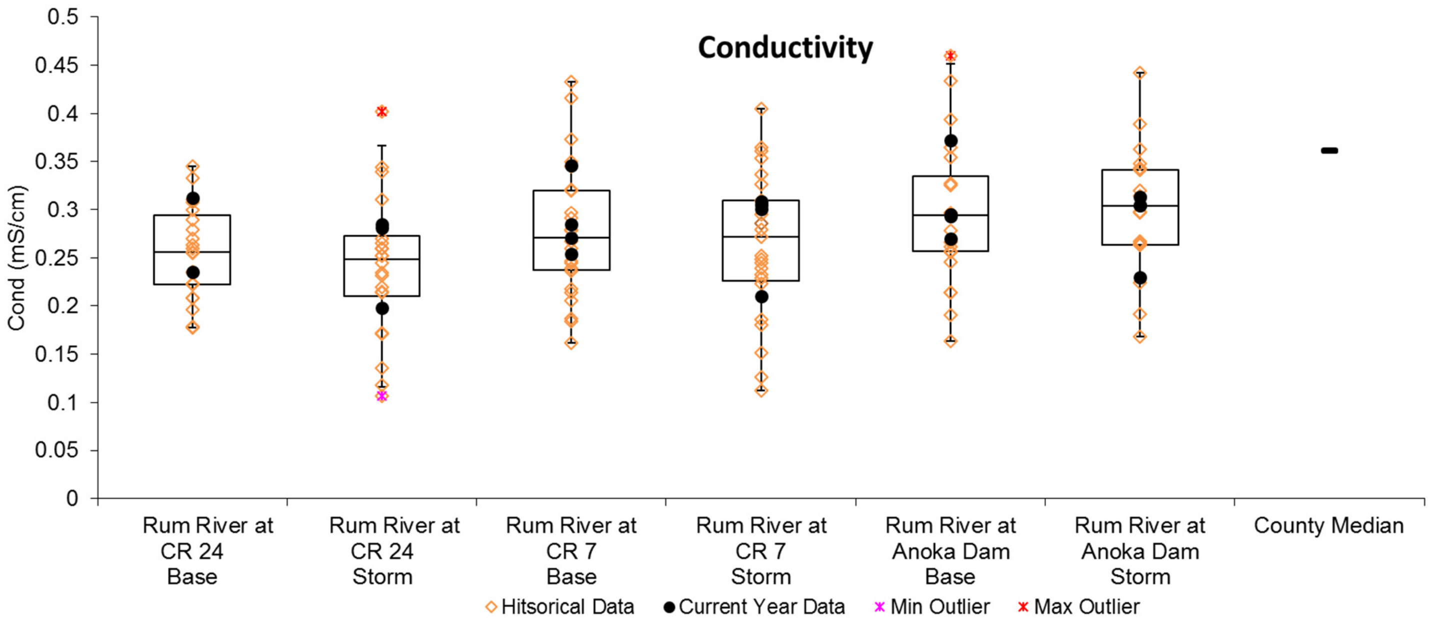
- Dissolved constituents, as measured by conductivity and chlorides. Conductivity results in the Rum River are lower than other Anoka County streams. There is cause for concern however, as conductivity consistently increases moving downstream. Average conductivity for sites tested in 2016 from upstream to downstream was 0.281, 0.293 and 0.300 mS/cm respectively. This increase is likely caused by higher road and development density contributing higher loads of road salts.
- Phosphorous is typically lower than the state water quality standard of 100 ug/L at all sampled sites. Sites exceeded this mark on two single sampling occasions in 2016, once during baseflow, and once after a storm event. Total phosphorus in the Rum River in 2016 averaged 84, 96 and 87 ug/ at sampled sites moving upstream to downstream. Compared to other Anoka County streams, these averages are low. They are however close to the state standard and phosphorus should remain a focus of watershed management.
- Suspended solids and turbidity generally remain at acceptable levels in the Rum River, though turbidity averages were slightly above other Anoka County streams. Average turbidity actually decreased from upstream to downstream in 2016 with averages of 14.8, 10.3 and 8.5 NTU respectively. TSS levels are low in the Rum River compared to other Anoka County streams with 2016 sampling site averages of 7, 9 and 5.5 mg/L upstream to downstream. Turbidity shows a marked increase in the Rum River during storm events, and stormwater runoff mitigation should be a focus of management efforts.
- pH was within the range considered normal and healthy for streams in this area.
- Dissolved oxygen remained well above the state standard of 5 mg/L in 2016.

On the following pages data are presented and discussed for each parameter. Management recommendations will be included at the conclusion of this report. The Rum River is an exceptional waterbody, and its protection and improvement should be a high priority.

Conductivity

Conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include road runoff and industrial chemicals, among many others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we used. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides are the measure of chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community. They can also be of concern because the Rum River is upstream from the Twin Cities drinking water intakes on the Mississippi River.

Conductivity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Conductivity is acceptably low in the Rum River, but increases downstream (see figures above) and is usually higher during baseflow. Median conductivity from upstream to downstream of the sites monitored in 2016 (all conditions) was 0.281 mS/cm, 0.293 and 0.300 mS/cm, respectively. All three sites are lower than the median for 34 Anoka County streams of 0.362 mS/cm. The 2016 maximum observed conductivity in the Rum River was 0.37 mS/cm which is the close to the median for all other Anoka County streams, and levels in general were far lower than in 2015.

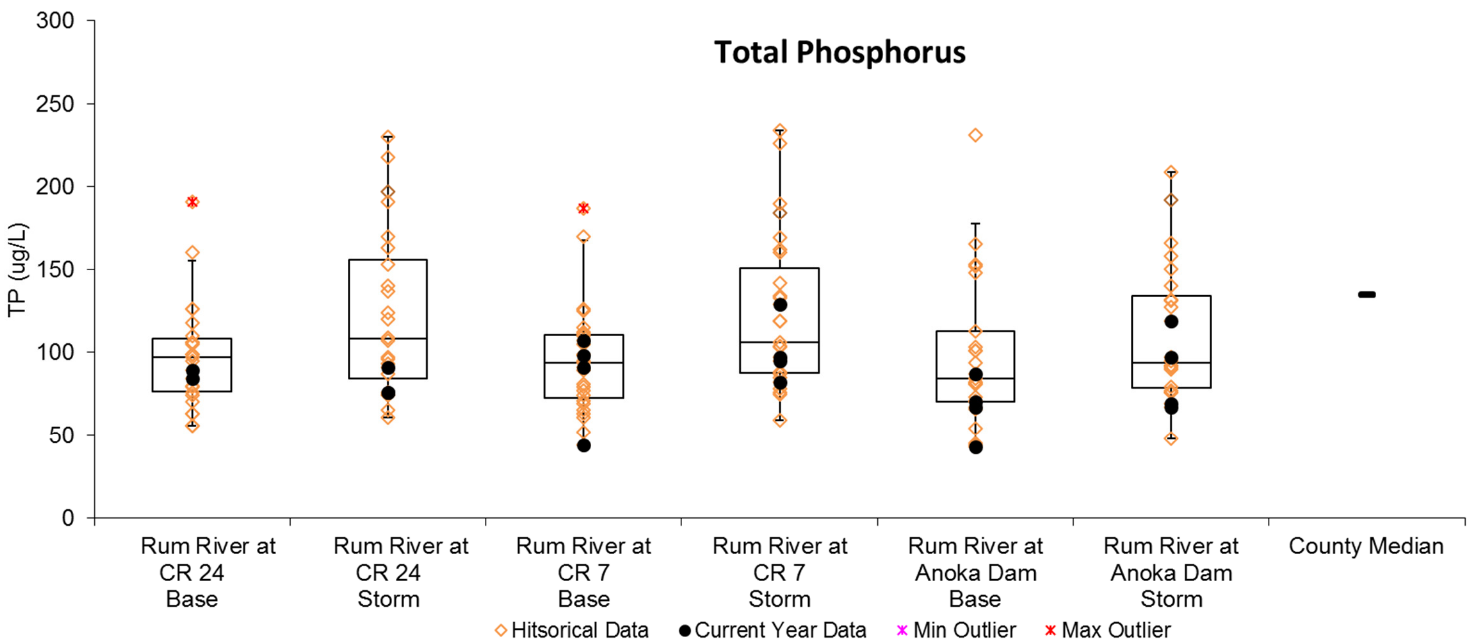
Conductivity was lowest at most sites during storms, suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow conductivity has been observed in most other nearby streams as well. This occurrence has been studied extensively, and the largest cause has been found to be road salts that have infiltrated into the shallow aquifer. Geologic materials also contribute, but to a lesser degree.

Conductivity increased from upstream to downstream. During baseflow, this increase from upstream to downstream reflects greater road densities and deicing salt application. During storms, the higher conductivity downstream is reflective of greater stormwater runoff and pollutants associated with the more densely developed lower watershed.

Total Phosphorus

Total phosphorus in the Rum River is acceptably low and is lower than the median for all other monitored 34 Anoka County streams (see figure below). 2016 readings averaged lower than 2015 results, which had a marked decrease from 2014 results. This nutrient is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. The median phosphorus concentration in 2016 at the three monitored sites (all conditions) was 84, 96 and 87 ug/L. These upstream-to-downstream differences are negligible and there is no trend of increasing phosphorus downstream. All sites in 2016 had phosphorus concentrations lower than the median for Anoka County streams of 135 ug/L. In 2016, the highest observed total phosphorus reading was during one particular storm event, with a concentration of 132 ug/L. In all, phosphorus in the Rum River is below the state standard of 100 ug/L, but should continue to be an area of pollution control effort as the area continues to be developed.

Total phosphorus during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Turbidity and Total Suspended Solids (TSS)

Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by the refraction of a light beam passed through a water sample. It is most sensitive to large particles. Total suspended solids is measured by filtering solids from a water sample and weighing the filtered material. The amount of suspended material is important because it affects transparency and aquatic life, and because many other pollutants are attached to particles. Many stormwater treatment practices such as street sweeping, sumps, and stormwater settling ponds target sediment and attached pollutants. In 2016, suspended solids in the Rum River were acceptably low.

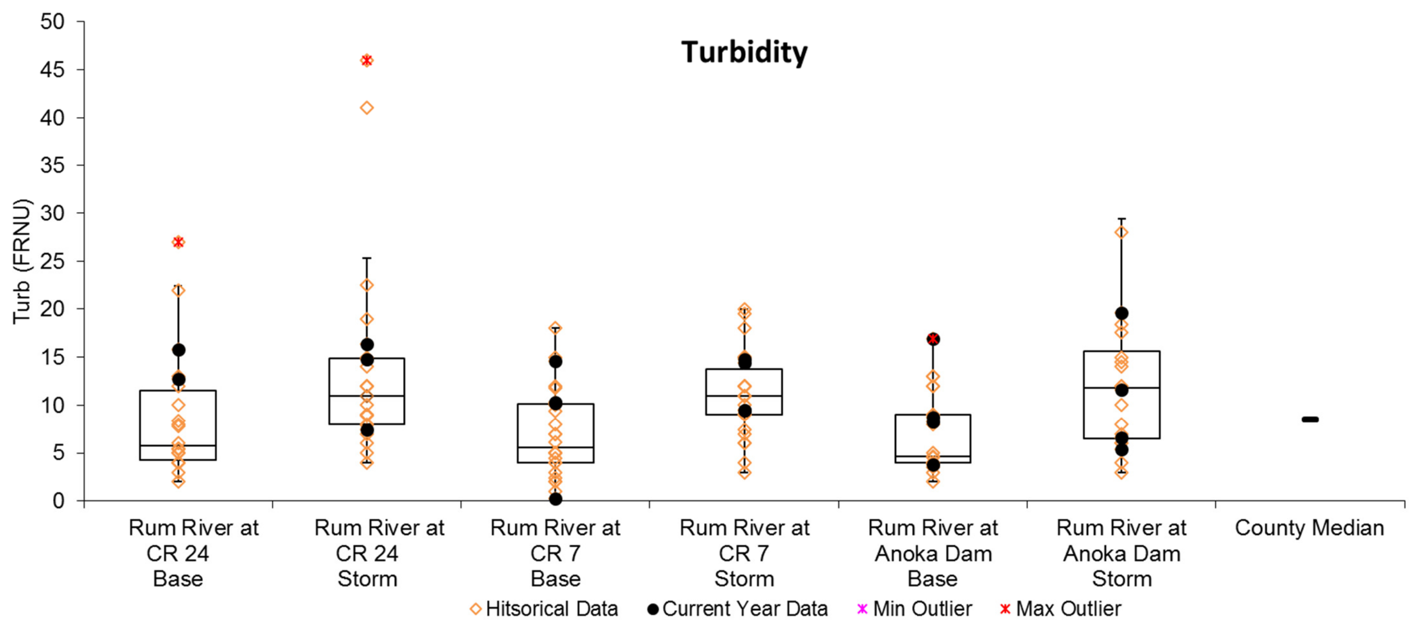
It is important to note the suspended solids can come from sources within and outside of the river channel. Sources on land include soil erosion, road sanding, and others. Riverbank erosion and movement of the river bottom also contributes to suspended solids. A moderate amount of this "bed load" is natural and expected.

In the Rum River, turbidity was low with increases during storms and a slight decrease at downstream monitoring sites (see figure below). The median turbidity, in 2016 (all conditions) was 14.8, 10.3 and 8.5 NTU (upstream to downstream), which is somewhat higher than the median for Anoka County streams of 8.5 NTU. Turbidity was elevated on a few occasions, especially during storms. In 2016 the maximum observed was 19.6 NTU during a mid-season monitoring event.

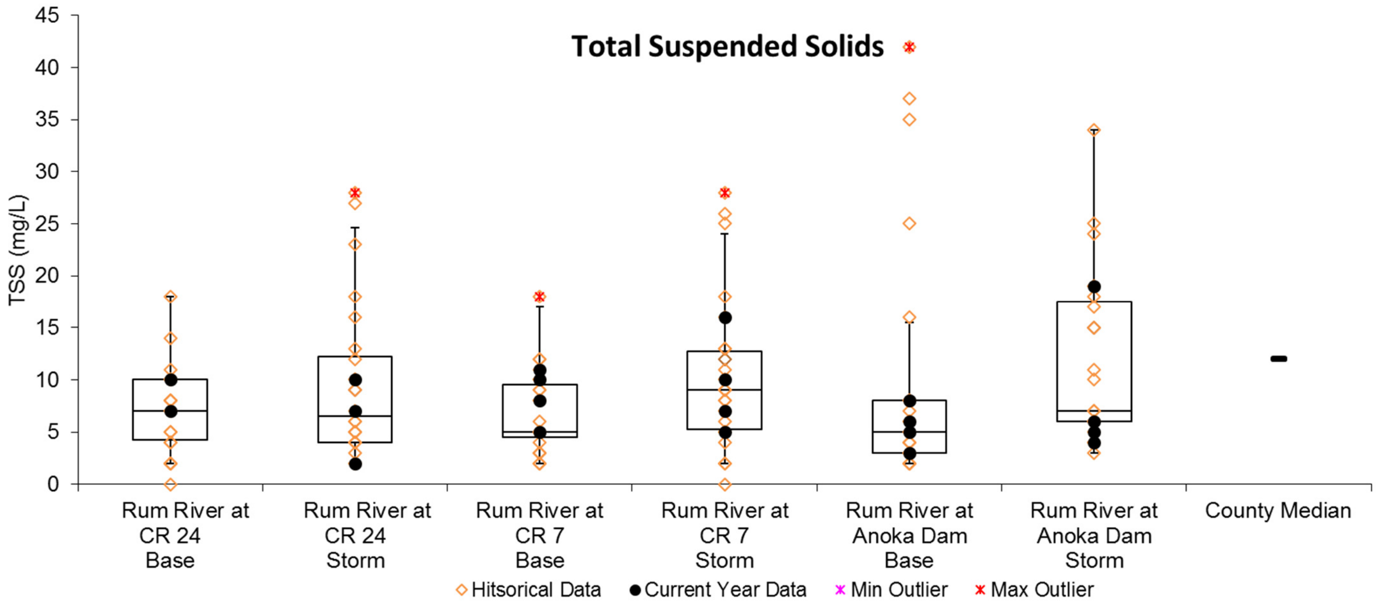
TSS in 2016 was similar to 2015 results. The median TSS, in 2016 (all conditions) was 7, 9 and 5.5 (upstream to downstream). These are all lower than the Anoka County stream median for TSS of 12.

Rigorous stormwater treatment should occur as the Rum River watershed continues to be developed, or the collective pollution caused by many small developments could seriously impact the river. Bringing stormwater treatment up to date in older developments is also important.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



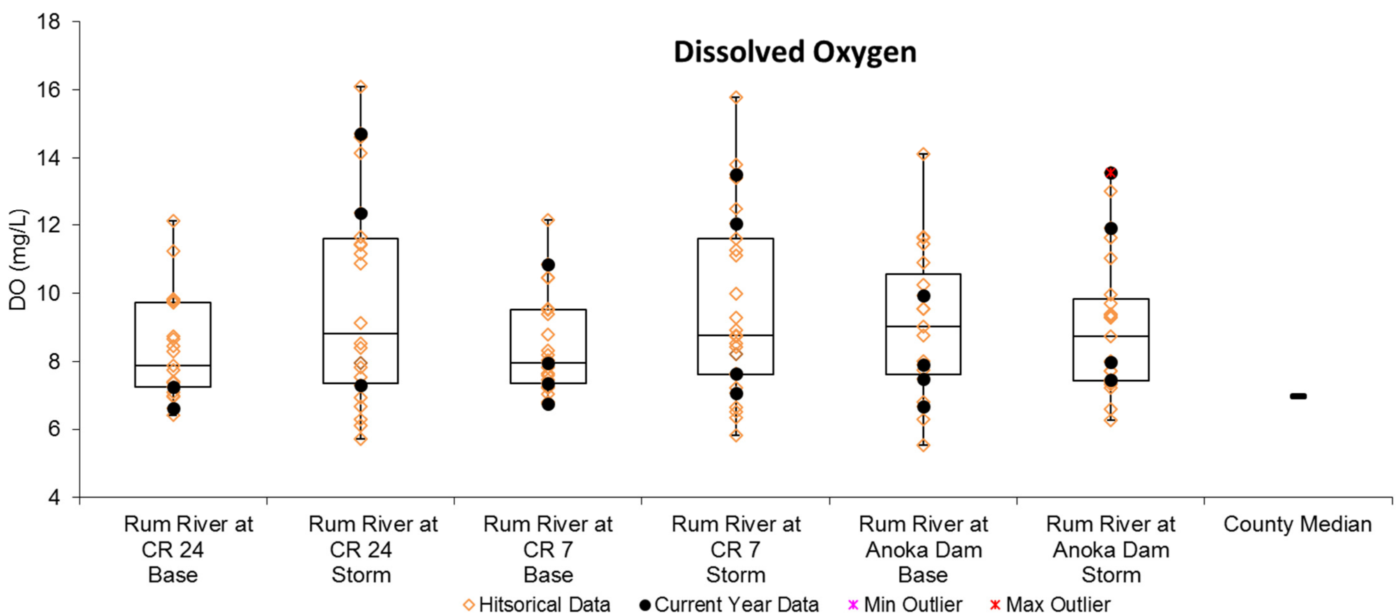
Total suspended solids during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution causes oxygen to be consumed when it decomposes. If oxygen levels fall below the state water quality standard of 5 mg/L, aquatic life begins to suffer. A stream is considered impaired if 10% of observations are below this level in the last 10 years. Dissolved oxygen levels are typically lowest in the early morning because of decomposition consuming oxygen at night without offsetting oxygen production by photosynthesis. In the Rum River, dissolved oxygen was always above 5 mg/L at all monitoring sites, with 6.62 mg/L being the lowest level recorded in 2016.

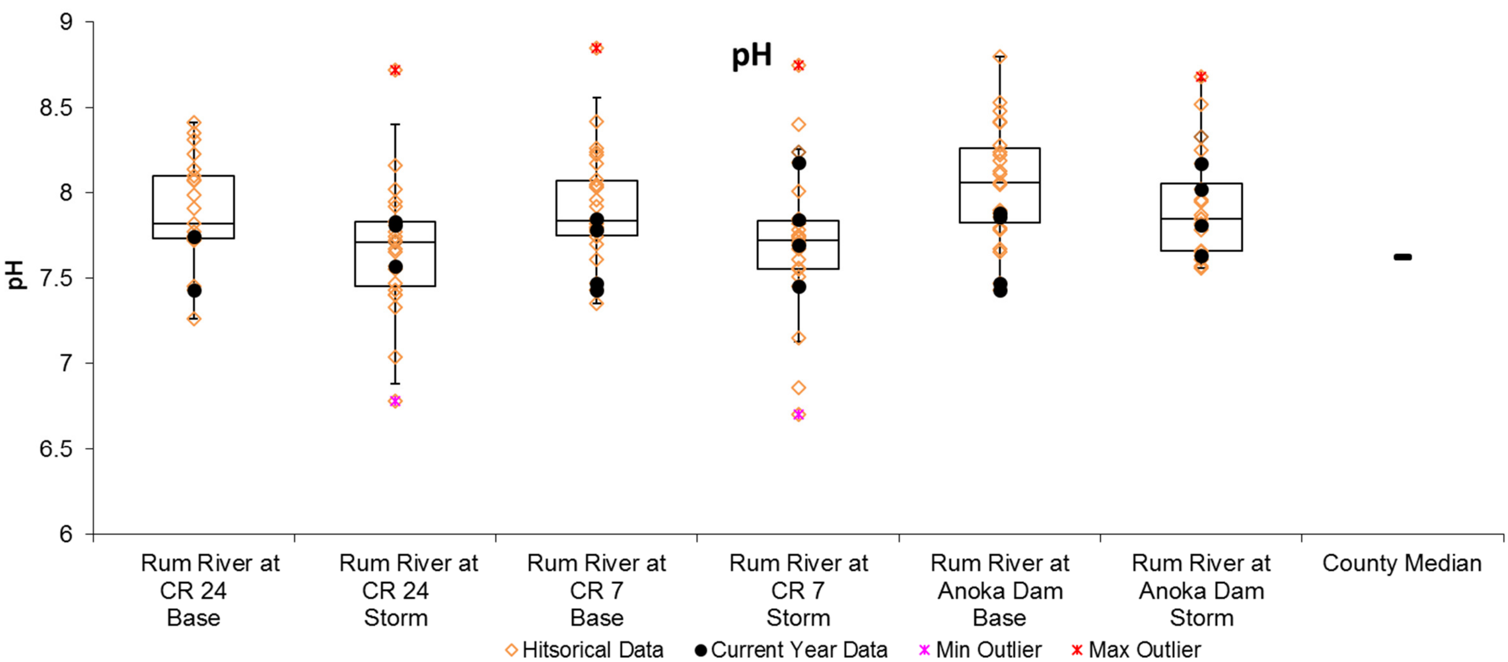
Dissolved oxygen during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

pH refers to the acidity of the water. The Minnesota Pollution Control Agency's water quality standard is for pH to be between 6.5 and 8.5. The Rum River is generally within this range and easily remained so in 2016 (see figure below).

pH during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

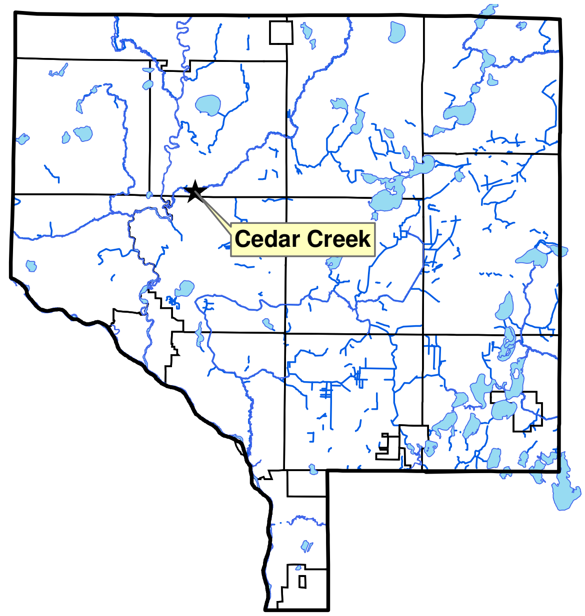


Summary and Recommendations

The Rum River's water quality is good. It does show a slight increase in conductivity downstream. Phosphorus levels are near, but slightly below, state water quality standards. Protection of the Rum River should be a high priority for local officials. Large population increases are expected for the Rum River's watershed within Anoka County, and this continued development has the potential to degrade water quality unless carefully planned and managed with the river in mind. Development pressure is likely to be especially high near the river because of its scenic and natural qualities.

CEDAR CREEK

at Hwy 9, Oak Grove



Background

Cedar Creek originates in south-central Isanti County and flows south. Cedar Creek is a tributary to the Rum River. In north-central Anoka County it flows through some areas of high quality natural communities, including the Cedar Creek Ecosystem Science Reserve. Habitat surrounding the stream in other areas is of moderate quality overall.

Cedar Creek is one of the larger streams in Anoka County. Stream widths of 25 feet and depths greater than 2 feet are common at baseflow. The stream bottom is primarily silt. The watershed is moderately developed with scattered single-family homes, and continues to develop rapidly.

Results Summary

This report includes data from 2016. The following is a summary of results.

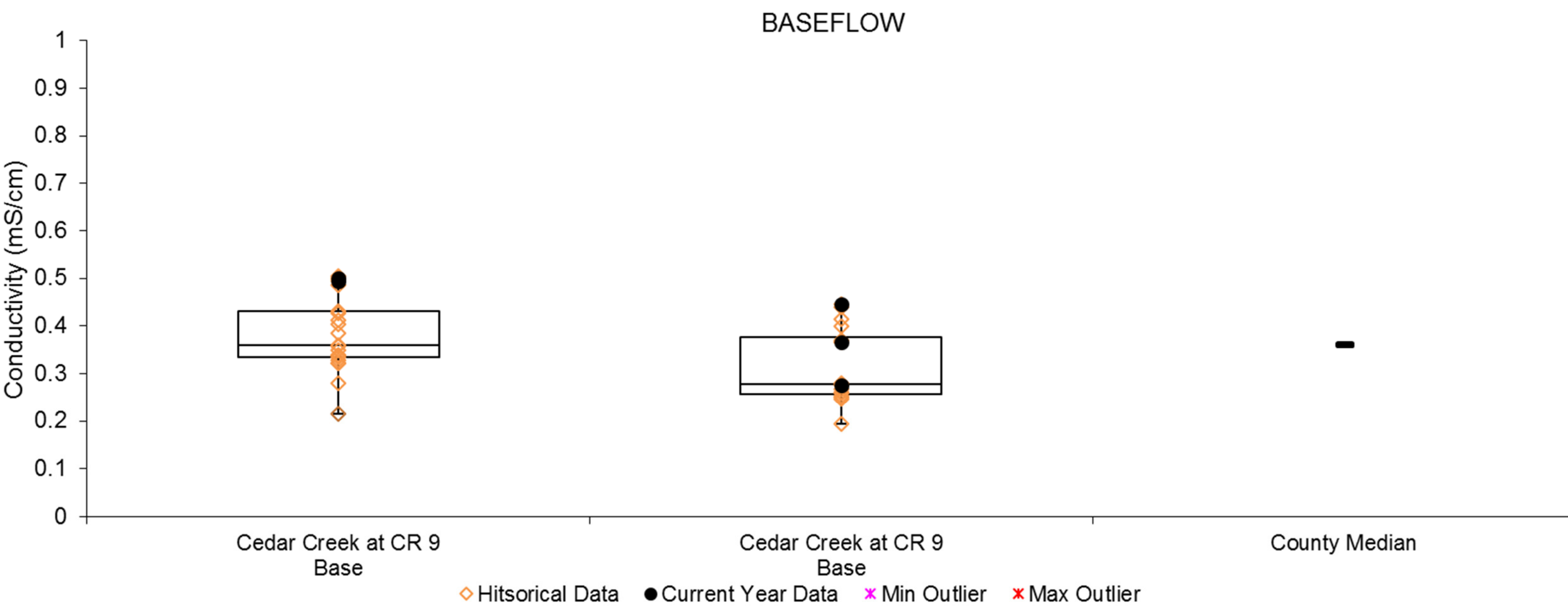
- Dissolved constituents, as measured by conductivity and chlorides, in Cedar Creek were higher than average when compared to similar Anoka County streams. Conductivity averaged 0.422 mS/cm with a maximum of 0.501 mS/cm and a minimum of 0.276 mS/cm). Chlorides were last sampled in 2013 where they averaged 26 mg/l (maximum of 32 mg/l and a minimum of 17 mg/l).
- Phosphorous averaged more than twice the state water quality standard of 100 ug/L. Cedar Creek often exceeds the state standard, even during baseflow periods. Phosphorous results in Cedar Creek averaged 201 ug/l (maximum of 261 ug/l and a minimum of 127 ug/l).
- Suspended solids and turbidity were both fairly high. Total suspended solids averaged 22.6 mg/l (with a maximum of 33.0 mg/l and a minimum of 8 mg/l). Turbidity averaged 20.28 NTU (with a maximum of 38.20 NTU and a minimum of 6.80 NTU).
- pH were within the range considered healthy for streams in this area. pH averaged 7.56 (maximum of 7.98 and a minimum of 6.98).
- Dissolved oxygen was within the range considered healthy for streams in this area. DO averaged 8.87 mg/l (maximum of 11.35 mg/l and a minimum of 7.46 mg/l).

Cedar Creek at CR 9			3/8/2016	3/16/2016	6/1/2016	6/13/2016	8/25/2016				
	Units	R.L.*	Results	Results	Results	Results	Results	Median	Average	Min	Max
pH		0.1	7.76	6.93	7.93	7.57	7.57	7.57	7.56	6.93	7.93
Conductivity	mS/cm	0.01	0.367	0.276	0.501	0.446	0.494	0.45	0.422	0.276	0.501
Turbidity	NTU	1	19.3	18.8	19.3	38	6.8	19.30	20.28	6.80	38.20
D.O.	mg/L	0.01	11.35	10.43	8.25	7.46	7.49	8.25	8.87	7.46	11.35
D.O.	%	1	97.9	85.1	87.6	83.5	83.3	85.10	87.1	83.3	97.9
Temp.	°C	0.1	7.84	4.87	16.56	19.5	19.07	16.56	14.1	4.9	19.5
Salinity	%	0.01	0.17	0.13	0.24	0.21	0.24	0.21	0.20	0.13	0.24
T.P.	ug/L	10	178	251	195	261	127	195.00	201	127	261
TSS	mg/L	2	26		22	33	8	24.00	22.6	8.0	33.0
Secchi-tube	cm		83.00	54.00	67	50	>100	67.00	>90	50	>100

Conductivity

Conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity was the broadest measure of dissolved pollutants used. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides were not sampled in 2016 and thus not displayed below. Historical chloride data can be obtained from the Anoka Conservation District and is also available through the Minnesota Pollution Control Agency's EQuIS database, which is available through their website. These pollutants are of greatest concern because of the effect they can have on the stream's biological community.

Conductivity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

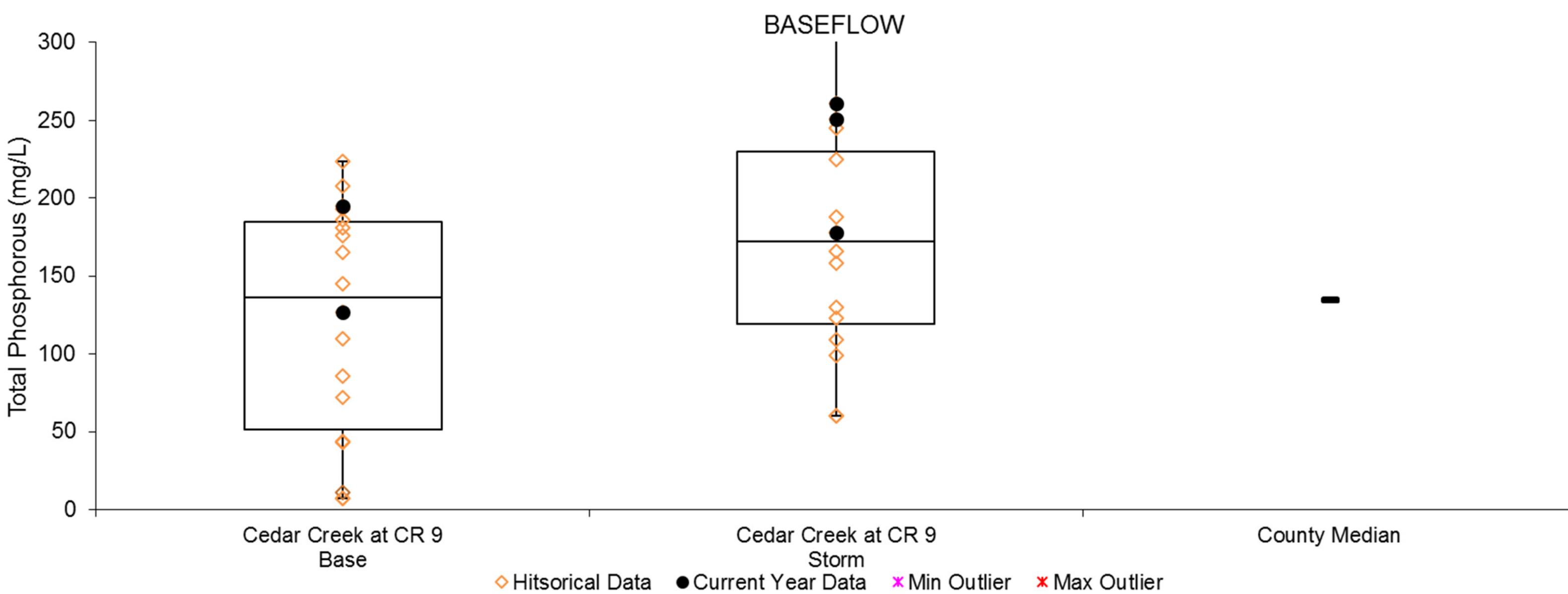


Conductivity is acceptably low in Cedar Creek at CR 9. Median conductivity (all years) is 0.359 mS/cm during baseflow and 0.278 mS/cm during storm events, respectively. Both were lower than the median for Anoka County streams of 0.362 mS/cm. The 2016 maximum observed conductivity in Cedar Creek was 0.501 mS/cm which is the second highest individual reading on record.

Total Phosphorus

Total phosphorus in Cedar Creek remained high in 2016 averaging 201 ug/L, similar to the 2015 average of 204 ug/L for the highest average on record. This nutrient is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. The median phosphorus concentration at Cedar Creek at CR 9 (all years) was 136 ug/L during baseflow and 172 ug/L during storm events. Almost all readings in 2016 had phosphorus concentrations higher than the median for Anoka County streams. In 2016, the highest observed total phosphorus reading was during one particular storm event, with a maximum of 261 ug/L. This is the second highest reading on record. In all, phosphorus in Cedar Creek is at concerning levels, every sample in 2016 exceeding state standards, and should be an area of pollution control efforts.

Total phosphorus during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

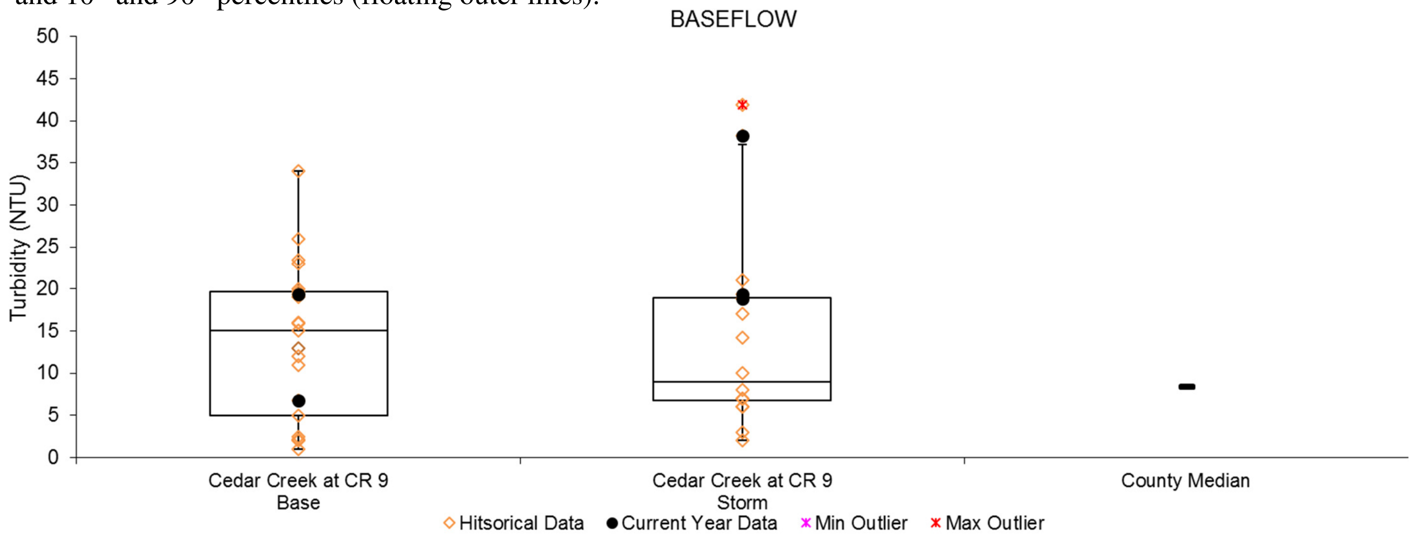


Turbidity and Total Suspended Solids (TSS)

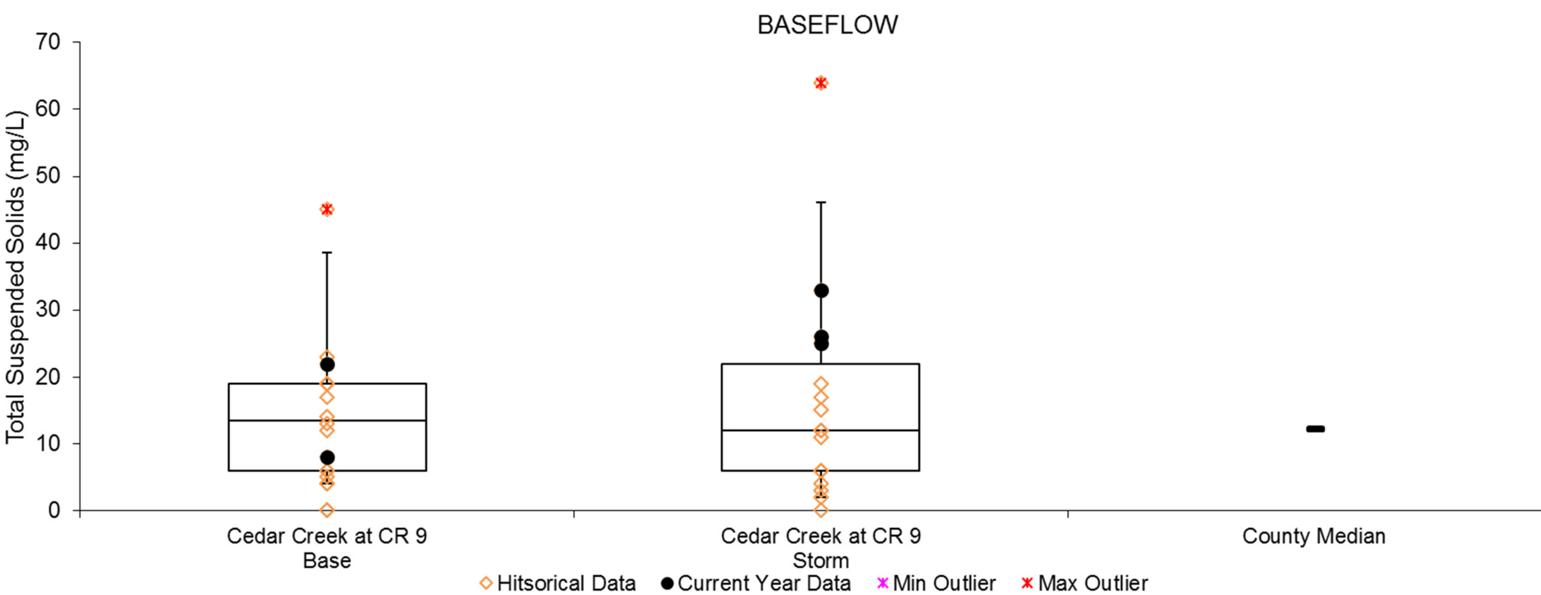
In Cedar Creek, turbidity was slightly elevated in 2016 with all readings except one at or above the long-term median. The median turbidity (all years) is 15 NTU during baseflow and 9 NTU during storm events, which is higher than the median for Anoka County streams of 8.5 FNRU. In 2016 turbidity was elevated on a few occasions, especially during storms. The maximum 2016 observed turbidity was 38 NTU. This is the second highest reading on record for this stream.

TSS was high throughout 2016 with all readings but one being above the median for Anoka County streams of 12 mg/L. In 2016, however, the especially high TSS events measured in 2015 (up to 64 mg/L) did not occur in 2016 when the highest reading was 33 mg/L. Median TSS (all years) is 13.5 mg/L during baseflow and 12 mg/L during storm events.

Turbidity during baseflow and storm conditions   Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Total Suspended Solids during baseflow and storm conditions   Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

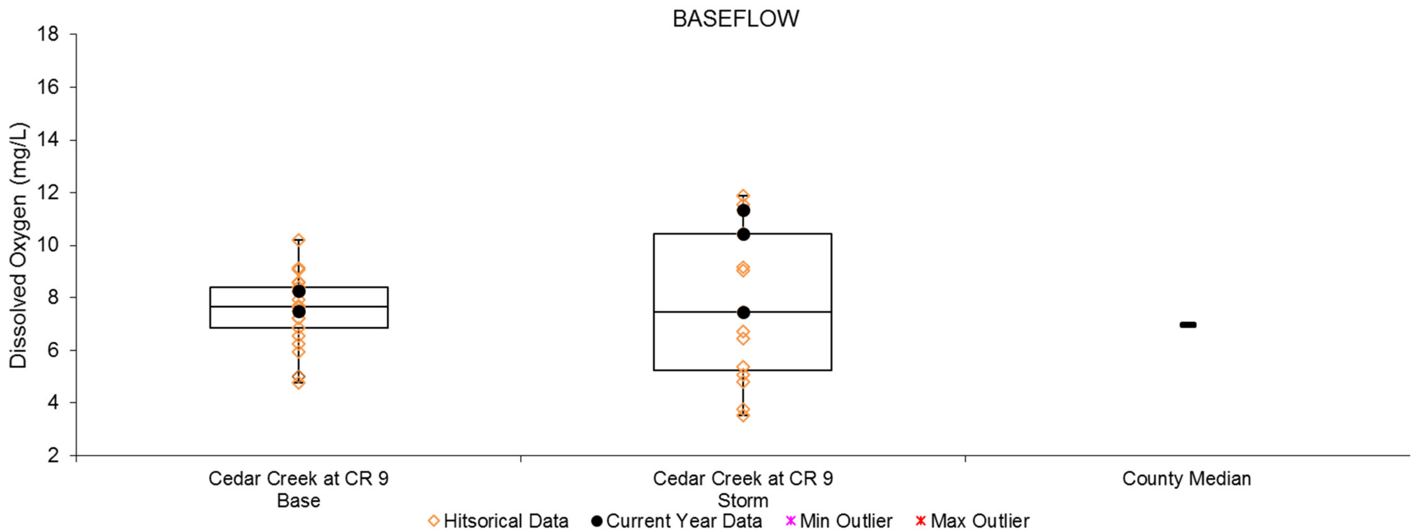


Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below the state standard of 5 mg/L aquatic life begins to suffer. In 2016, dissolved oxygen in Cedar Creek was always above 7.0 mg/L. Median dissolved oxygen of all years of data is

7.67mg/L during baseflow and 7.46 mg/L during storm events. Few readings of <5 mg/L, which would be of concern, have been observed at Cedar Creek.

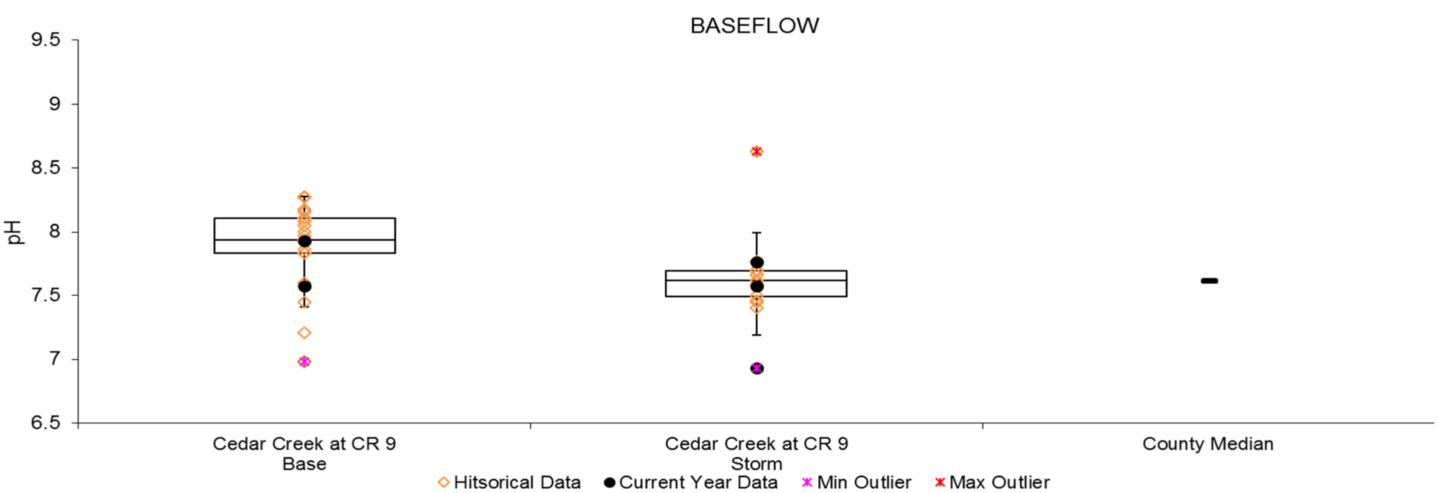
Dissolved oxygen during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

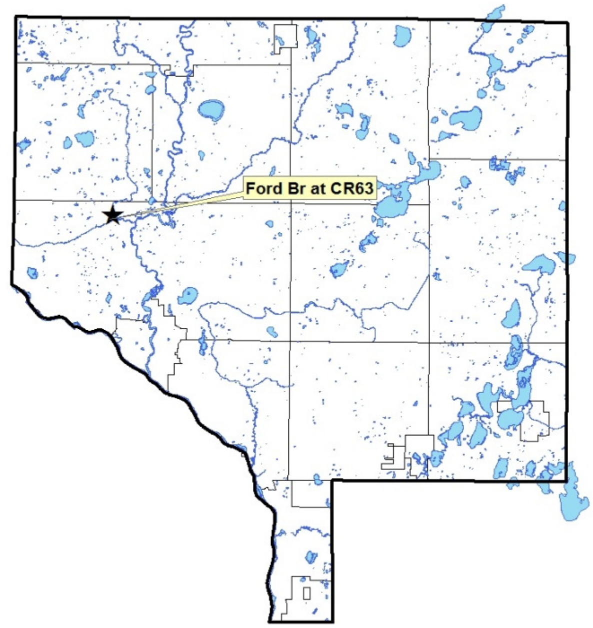
pH refers to the acidity of the water. The Minnesota Pollution Control Agency's water quality standard is for pH to be between 6.5 and 8.5. Cedar Creek has only been recorded outside of this range once historically, and remained well within it in 2016 (see figure below). pH is generally lower during storms than during baseflow. This is because the pH of rain is typically lower (more acidic). While acid rain is a longstanding problem, its effect on this aquatic system is small.

pH during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



FORD BROOK

At CR 63, Nowthen



Background

Ford Brook originates at Goose Lake in northwestern Anoka County and flows south. Ford Brook is a tributary to the Rum River. In northwestern Anoka County, it flows relatively undisturbed through the community of Nowthen before joining Trott Brook just prior to the Rum River.

Ford Brook is one of the smaller streams in Anoka County. The watershed is moderately developed with scattered single-family homes, but continues to be developed.

Results Summary

This report includes data from 2016. The following is a summary of results.

- Dissolved constituents, as measured by conductivity, in Ford Brook were above average when compared to similar Anoka County streams. Conductivity averaged 0.442 mS/cm (maximum of 0.488 mS/cm and a minimum of 0.370 mS/cm).
- Phosphorous averaged well below 2015 levels in 2016, but remained in excess of the MPCA water quality standard of 100 ug/L. Ford Brook often exceeds the limit, even during baseflow periods. Phosphorous results in Ford Brook averaged 121 ug/l (maximum of 145ug/l and a minimum of 104 ug/l).
- Suspended solids and turbidity both average below state standards, but turbidity did exceed 25 NTU twice. Total suspended solids averaged 18.6 mg/l (maximum of 24.0 mg/l and a minimum of 7.0 mg/l). Turbidity averaged 17.88 NTU (maximum of 34.6 NTU and a minimum of 5.2 NTU).
- pH was within the range considered healthy for streams in this area. pH averaged 7.52 (maximum of 7.69 and a minimum of 7.35).
- Dissolved oxygen was within the health range for streams. DO averaged 8.62 mg/l (maximum of 11.60 mg/l and a minimum of 6.65 mg/l).

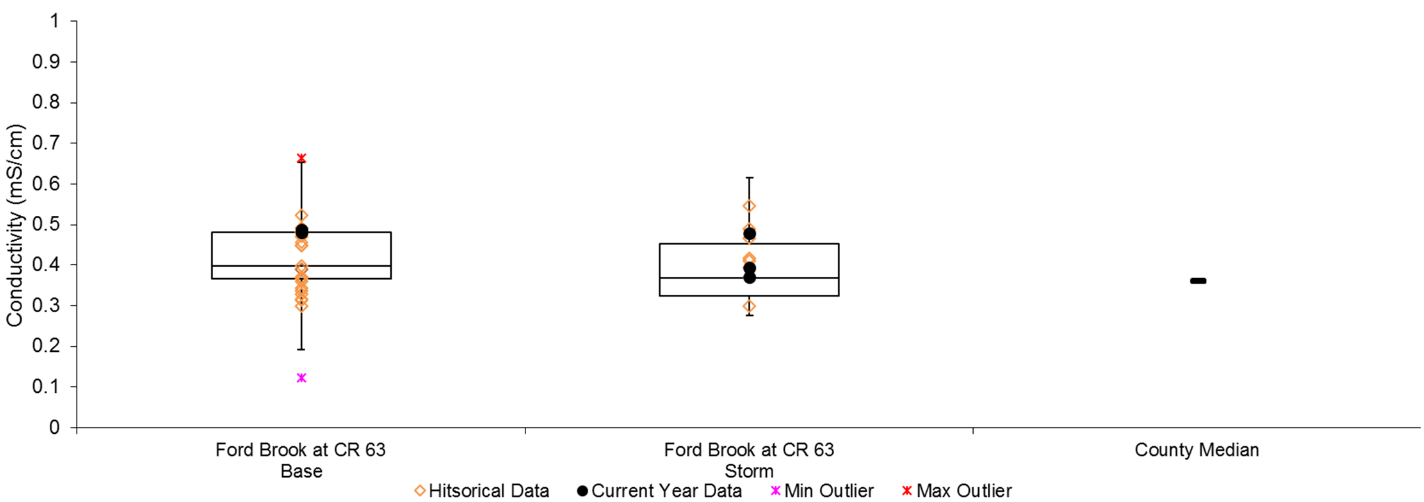
FordBrook at CR63			3/8/2016	3/16/2016	6/1/2016	6/13/2016	8/25/2016				
	Units	R.L.*	Results	Results	Results	Results	Results	Median	Average	Min	Max
pH		0.1	7.69	7.35	7.67	7.48	7.42	7.48	7.52	7.35	7.69
Conductivity	mS/cm	0.01	0.37	0.394	0.481	0.479	0.488	0.479	0.442	0.370	0.488
Turbidity	NTU	1	25.5	11.3	13	34.6	5.2	12.8	17.88	5.20	34.60
D.O.	mg/L	0.01	12.33	11.27	7.41	6.99	6.35	7.41	8.87	6.35	12.33
D.O.	%	1	100.3	91.7	81.2	80.8	72.3	81.2	85.3	72.3	100.3
Temp.	°C	0.1	4.98	4.7	18.2	20.64	20.22	18.16	13.7	4.7	20.6
Salinity	%	0.01	0.17	0.19	0.20	0.23	0.23	0.2	0.20	0.17	0.23
T.P.	ug/L	10	132	121	104	145	104	121	121	104	145
TSS	mg/L	2	22	22	18.0	24	7	22	18.6	7.0	24.0
Secchi-tube	cm		59	66	89	47	>100	62.5	71	47	89

Conductivity

Median conductivity results in Ford Brook were mildly higher than the median for other Anoka County streams (see table and figures below). Median conductivity in Ford Brook was 0.391 mS/cm (all years) during baseflow conditions and 0.368 mS/cm during storms, compared to the countywide median of 0.362 mS/cm.

The baseflow vs storm flow comparison lends some insight into the pollutant sources. If dissolved pollutants were only elevated during storms, stormwater runoff would be suspected as the primary contributor. If dissolved pollutants were highest during baseflow, pollution of the shallow groundwater which feeds the stream during baseflow would be suspected to be a primary contributor. In Ford Brook we find similar, but slightly lower dissolved pollutants during storms. In other words, both stormwater runoff and groundwater are sources of dissolved pollutants, with shallow groundwater contributing slightly more. While storms dilute some of the baseflow pollutants, they also carry additional pollutants, which can offset the dilution. From a management standpoint, it is important to remember that the sources of both stormwater and baseflow dissolved pollutants are generally the same; it is only the timing of delivery to the stream that is different. Preventing their release into the environment and treating them before infiltration should be a high priority.

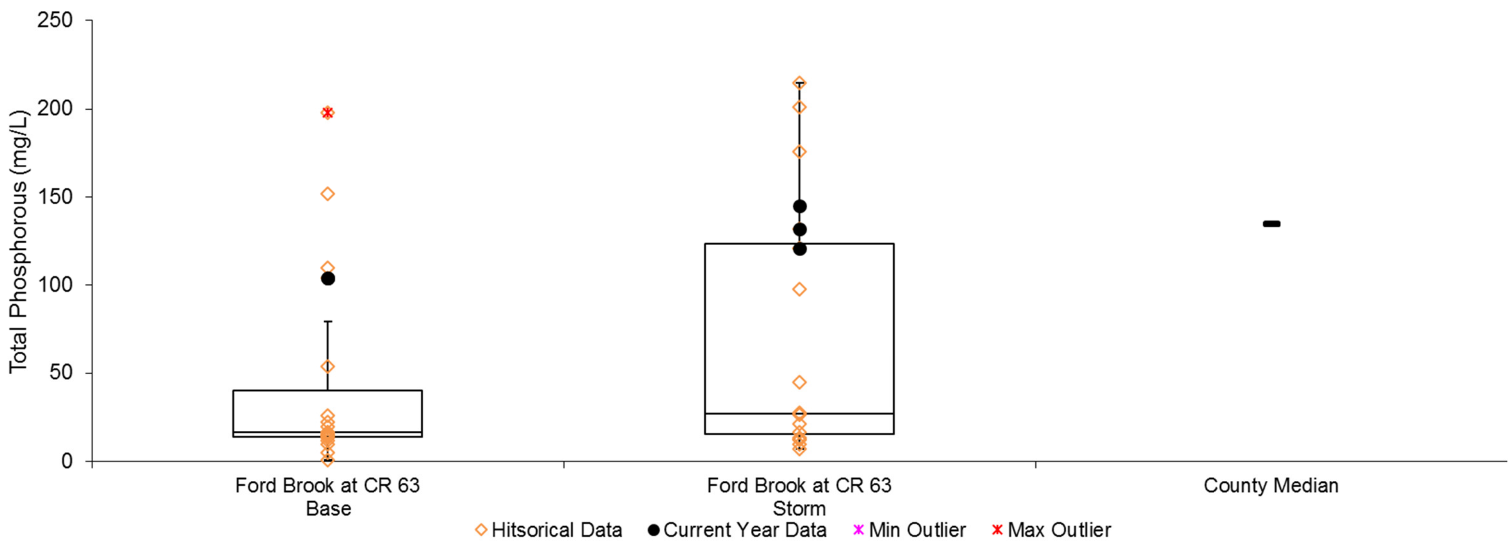
Conductivity at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algae growth. Total phosphorus in Ford Brook has traditionally been low during baseflow conditions and increased during storms (see figures below). In 2016, TP levels in Ford Brook were generally lower than the county median and were considerably down from 2015, but were still in exceedance of the state standard of 100 ug/L. TP was higher during storm events then baseflow. The last three years of data have shown much higher phosphorus levels than previously measured. The median TP level in 2016 was 121 mg/L and ranged from 104 to 145 mg/L.

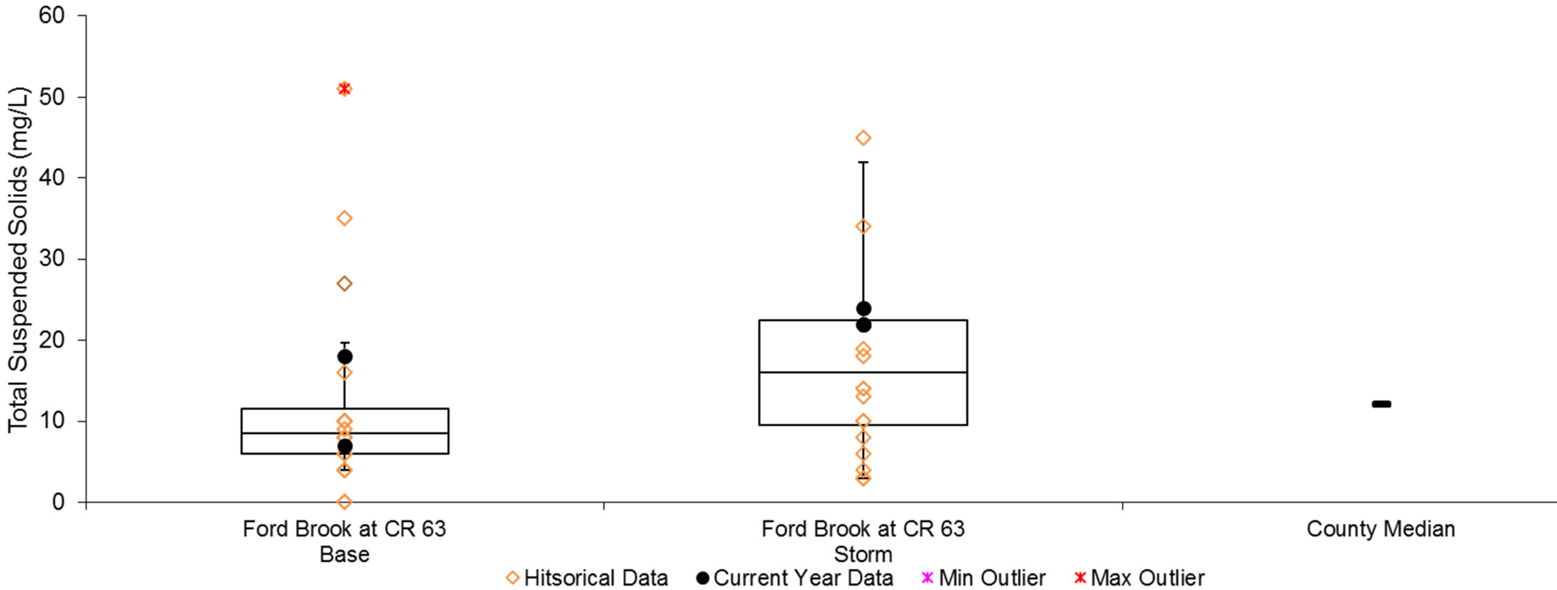
Total Phosphorus at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



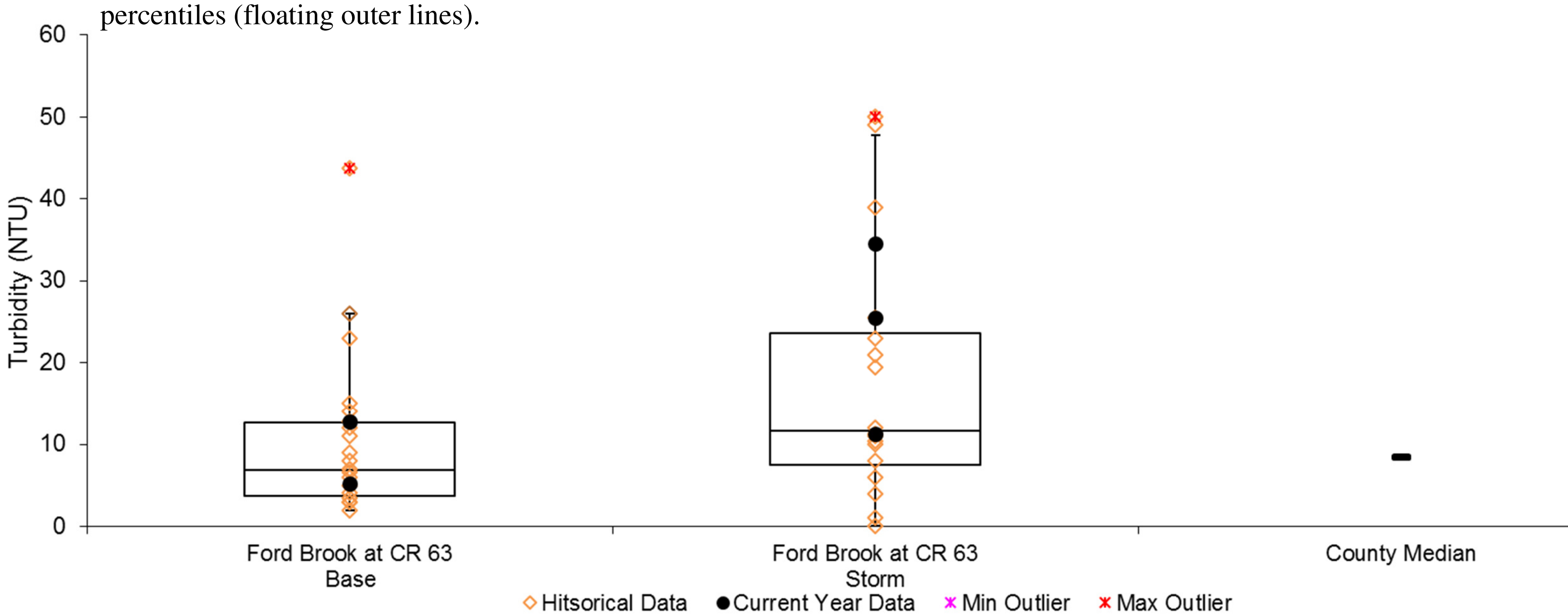
Total Suspended Solids and Turbidity

In Ford Brook both TSS and turbidity are generally low and slightly higher during storm events. Median turbidity for Ford Brook during baseflow (all years) is just 6.8 NTU. Turbidity during storm events is higher with a median (all years) of 11.65 NTU. These medians flank the countywide median of 8.5 NTU for all conditions. In 2016, two of five readings exceeded the MPCA's water quality standard of 25 NTU though only four of thirty-three measurements exceeded it in past years. Median 2016 TSS was 22 mg/L, much higher than last year and higher than the median for streams countywide of 12 mg/L. No individual TSS measurements exceeded the state water quality standard of 30 mg/L in 2016.

Total Suspended Solids at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



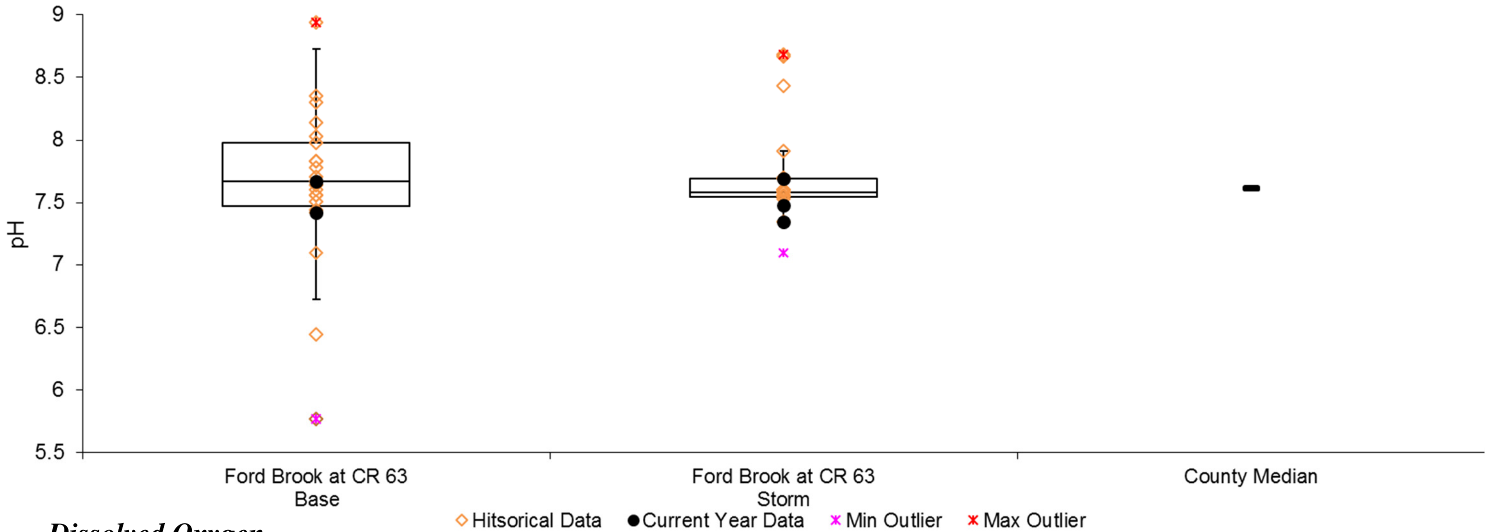
Turbidity at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

pH remained well within the acceptable range in 2016. pH is to be between 6.5 and 8.5 according to MPCA water quality standards. While occasional readings outside of this range have occurred in previous years, they were not large departures that generated concern. In 2016, pH ranged from 7.35 to 7.69, which is well within the acceptable range.

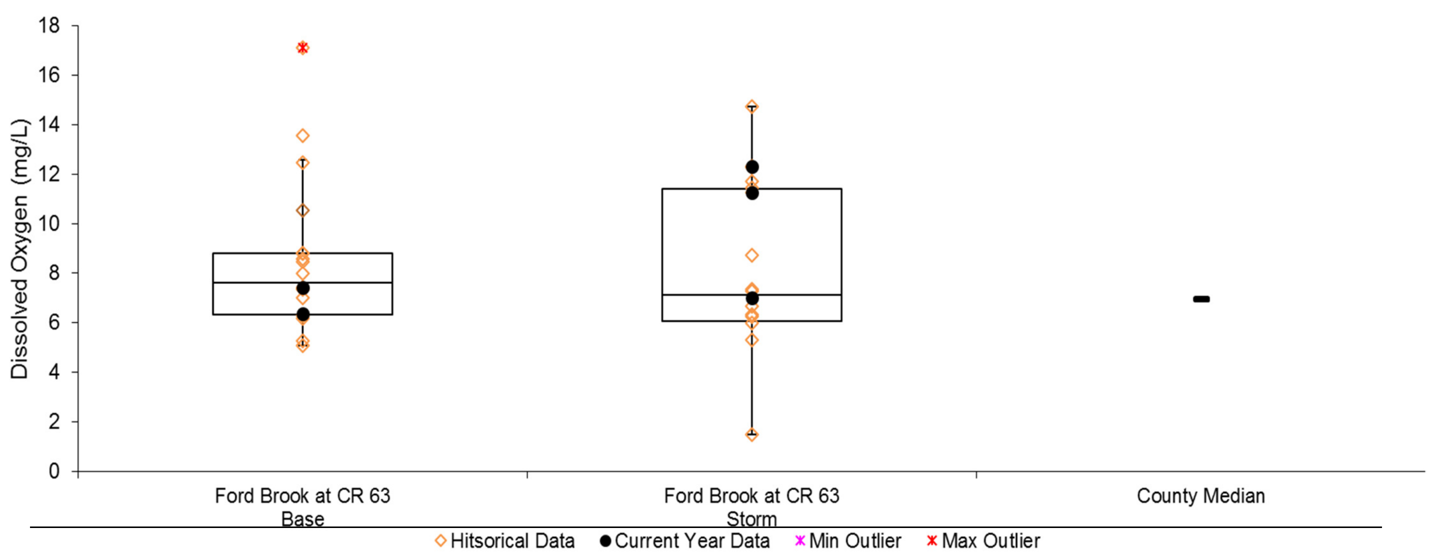
pH at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen in Ford Brook was within acceptable levels. None of the samples collected have been below the 5 mg/L standard, with the lowest recording in 2016 being 6.35 mg/L

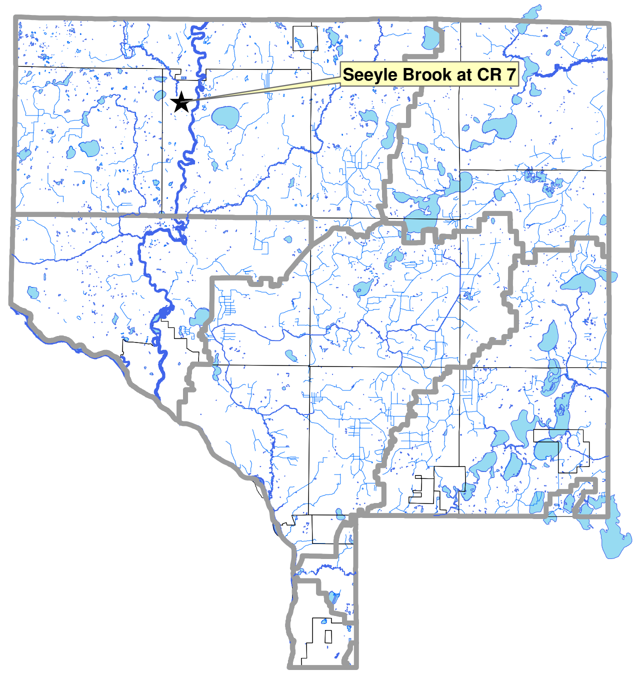
Dissolved Oxygen at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Stream Water Quality Monitoring

SEELYE BROOK

Seelye Brook at Co. Rd. 7, St. Francis STORET SiteID = S003-204



Background

Seelye Brook originates in southwestern Isanti County and flows south through northwest Anoka County, draining into the Rum River just east of the sampling site. This stream is low gradient, like most other streams in the area. It has a silty or sandy bottom and lacks riffle-pool sequences. It is a moderate to large stream for Anoka County, with a typical baseflow width of 20-25 feet.

The sampling site is in the road right of way of the Highway 7 crossing. The bridge footings and poured concrete are significant features of the sampling site, which is otherwise sandy-bottom. This site also experiences scour during high flow because flow is constricted under the bridge. Banks are steep and undercut.

Results Summary

This report includes data from 2016. The following is a summary of results.

- Dissolved constituents, as measured by conductivity and chlorides. Conductivity results in Seelye Brook are considered higher than average when compared to similar Anoka County streams. Conductivity averaged 0.430 mS/cm (maximum of 0.522 mS/cm and a minimum of 0.278 mS/cm).
- Phosphorous averaged above the MPCA water quality standard of 100 ug/L. Seelye Brook often exceeds the limit, even during baseflow periods. Phosphorous in Seelye Brook averaged 133 ug/l (maximum of 163 ug/l and a minimum of 104 ug/l) in 2016.
- Suspended solids and turbidity were generally quite low throughout the season following the high readings right away in March. Suspended solids averaged 9.0 mg/l (maximum of 19.0 mg/l and a minimum of 3.0 mg/l). Turbidity averaged 9.30 NTU (maximum of 25.30 NTU and a minimum of 0.0 NTU)
- pH was within the range considered normal and healthy for streams in this area. pH averaged 7.60 (maximum of 7.86 and a minimum of 7.19).
- Dissolved oxygen was within the healthy range for a stream. DO averaged 9.01 mg/l (maximum of 12.79 mg/l and a minimum of 6.01 mg/l).

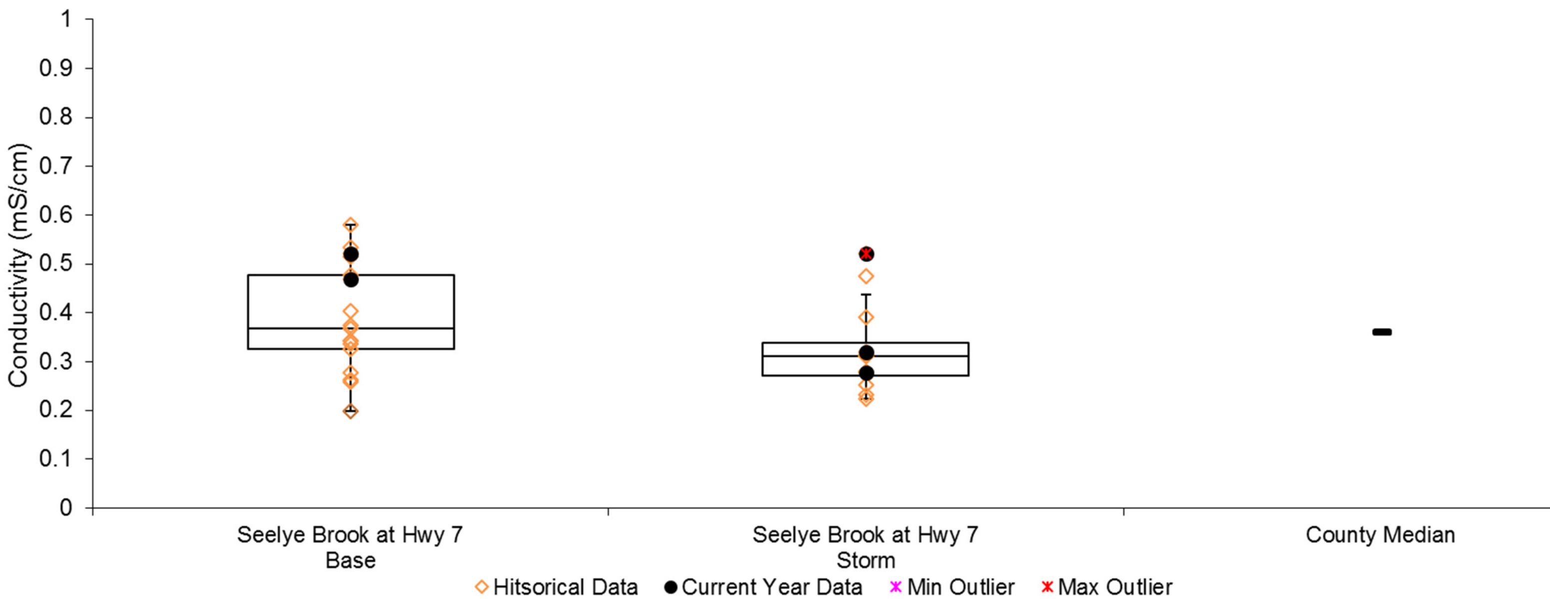
SellyeBrook at Hwy 7			3/8/2016	3/16/2016	6/1/2016	6/13/2016	8/25/2016				
	Units	R.L.*	Results	Results	Results	Results	Results	Median	Average	Min	Max
pH		0.1	7.69	7.19	7.8	7.86	7.34	7.69	7.60	7.19	7.86
Conductivity	mS/cm	0.01	0.32	0.278	0.521	0.522	0.469	0.47	0.430	0.278	0.522
Turbidity	NTU	1	25.3	3.5	8.5	10	0	8.50	9.30	0.00	25.30
D.O.	mg/L	0.01	12.79	10.82	8	8.21	6.01	8.21	9.01	6.01	12.79
D.O.	%	1	101.6	87.5	84.8	92.2	67.1	87.50	86.8	67.1	101.6
Temp.	°C	0.1	3.72	4.54	166.64	19.6	19.49	19.49	38.9	3.7	166.6
Salinity	%	0.01	0.15	0.13	0.25	0.25	0.23	0.23	0.21	0.13	0.25
T.P.	ug/L	10	163	131	139	131	104	131.00	133	104	163
TSS	mg/L	2	19	9	10.0	4	3	9.00	9.0	3.0	19.0
Secchi-tube	cm		74	91	>100	>100	>100	100.00	>100	74	100

CONDUCTIVITY

Conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial chemicals, among many others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we used. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides are the measure of chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community.

Chlorides were not sampled in 2016 and thus not displayed below. Historical chloride data can be obtained from the Anoka Conservation District and is also available through the Minnesota Pollution Control Agency's EQuIS database, which is available through their website.

Conductivity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

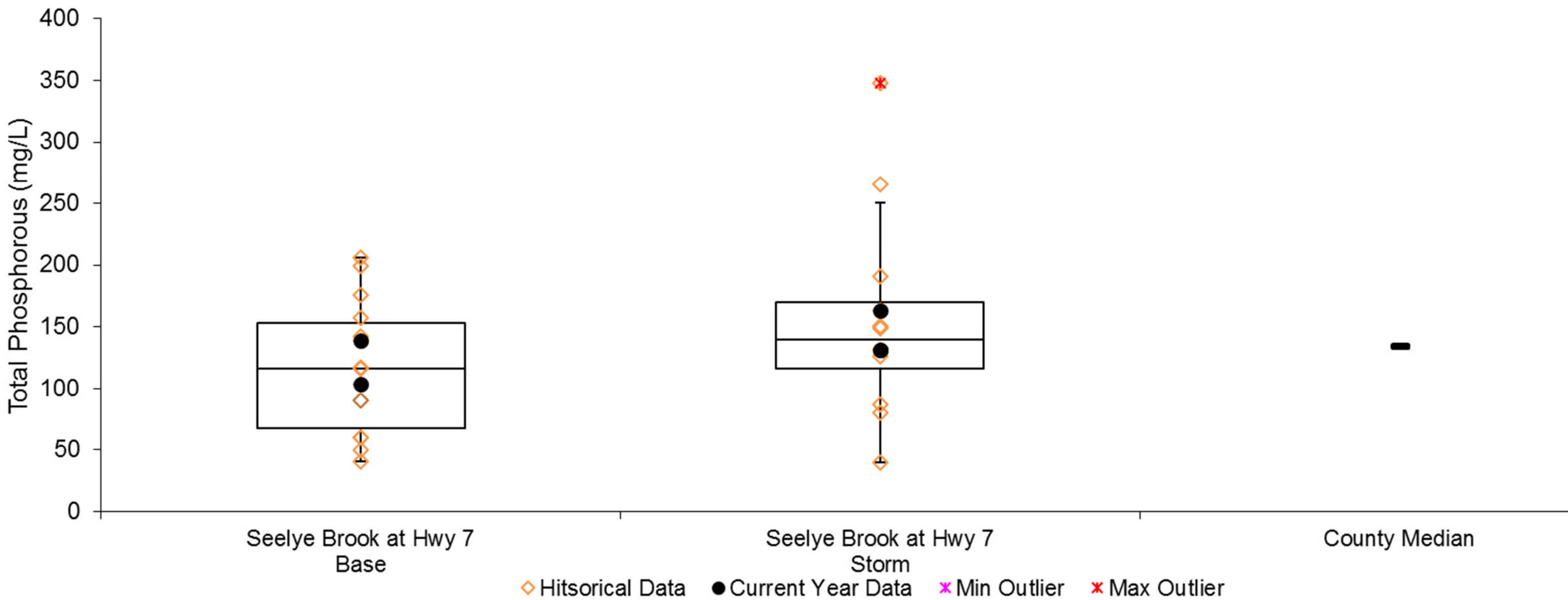


Conductivity has historically been acceptably low in Seelye Brook at Hwy 7. Median conductivity (all years) is 0.368 mS/cm during baseflow and 0.3125 mS/cm during storm events. Both are lower than the median for Anoka County streams of 0.362 mS/cm. From June of 2016 onward, however, the three conductivity readings were all 0.469 mS/cm or higher. These include two of the highest readings ever recorded in Seelye Brook, one during baseflow and one following a storm event.

Total Phosphorus

Total phosphorus in Seelye Brook was high overall in 2016, though slightly down from the previous year. This nutrient is one of the most common pollutants in our region and can be associated with runoff and many other sources. The median phosphorus concentration at Seelye Brook at Hwy 7 (all years) is 116.5 ug/L during baseflow and 140 ug/L during storm events. Each reading in 2016 was over the state standard of 100 ug/L with all but one reading over 130 ug/L. In all, phosphorus in Seelye Brook is at concerning levels and should continue to be an area of pollution control effort as the area urbanizes.

Total phosphorus during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Turbidity and Total Suspended Solids (TSS)

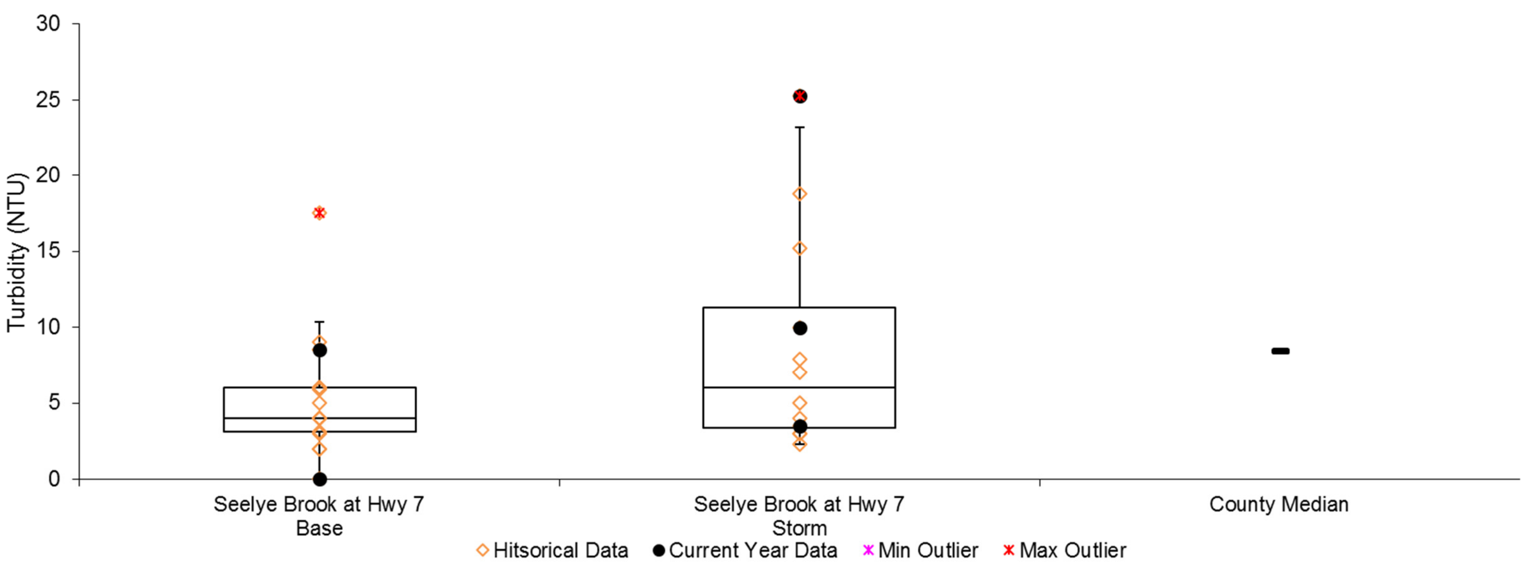
Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by refraction of a light beam passed through a water sample. It is most sensitive to large particles. Total suspended solids are measured by filtering solids from a water sample and weighing the filtered material. The amount of suspended material is important because it affects transparency and aquatic life, and because many other pollutants are attached to particles. Many stormwater treatment practices such as street sweeping, sumps, and stormwater settling ponds target sediment and attached pollutants.

Overall, turbidity in Seelye Brook remains low compared to other streams with its highest reading ever recorded in 2016 of 25.3 NTU. The median turbidity (all years) is 4 NTU during baseflow and 6 NTU during storm events, which is lower than the median for Anoka County streams of 8.5 FNRU. Turbidity was elevated on a few occasions. In 2016 suspended solids and turbidity levels were relatively high (for this site early), but then dipped lower later in the year.

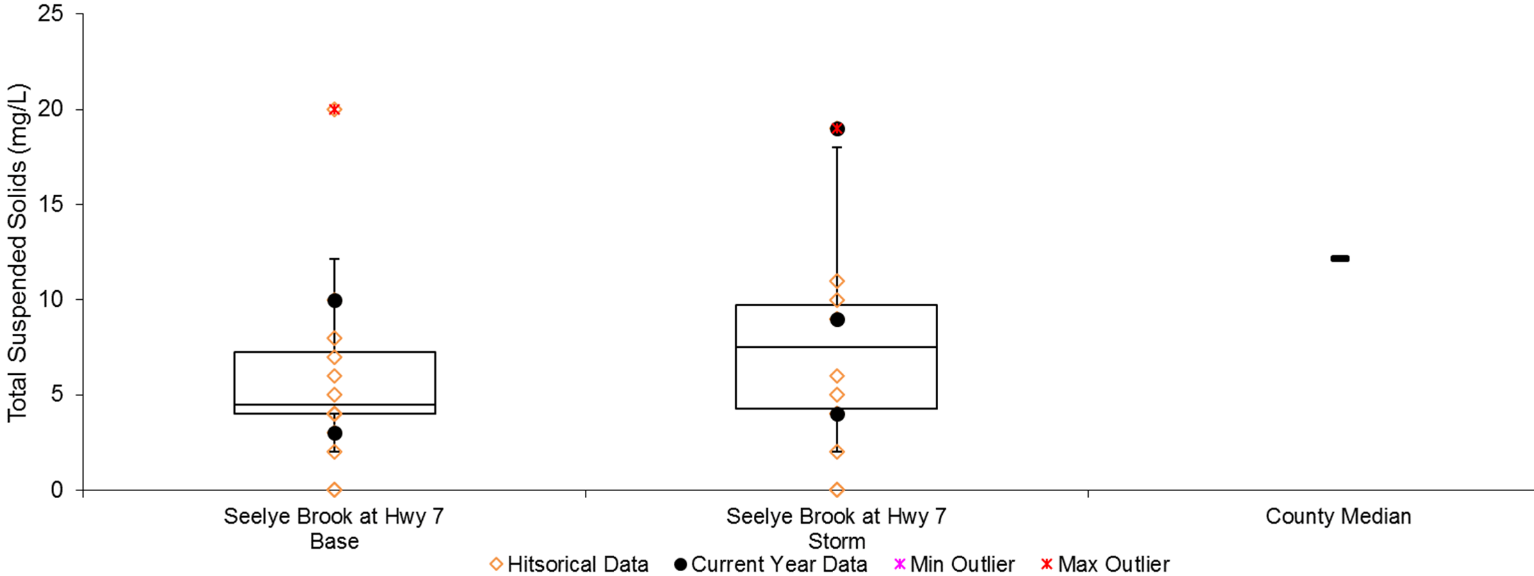
In 2016 suspended solids and turbidity levels were relatively high (for this site early), but then dipped lower later in the year. Both the highest and lowest turbidity readings ever recorded at this site were recorded in 2016, with the highest measured following a storm event.

It is important to note the suspended solids can come from sources within and outside of the river channel. Sources on land include soil erosion, road sanding, and others. Riverbank erosion and movement of the river bottom also contributes to suspended solids. A moderate amount of this “bed load” is natural and expected. Both turbidity and TSS, while low, should continue to be monitored in this watershed. This monitoring can be especially importing as development of the area continues and can be an indicator of poor erosion management practices.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



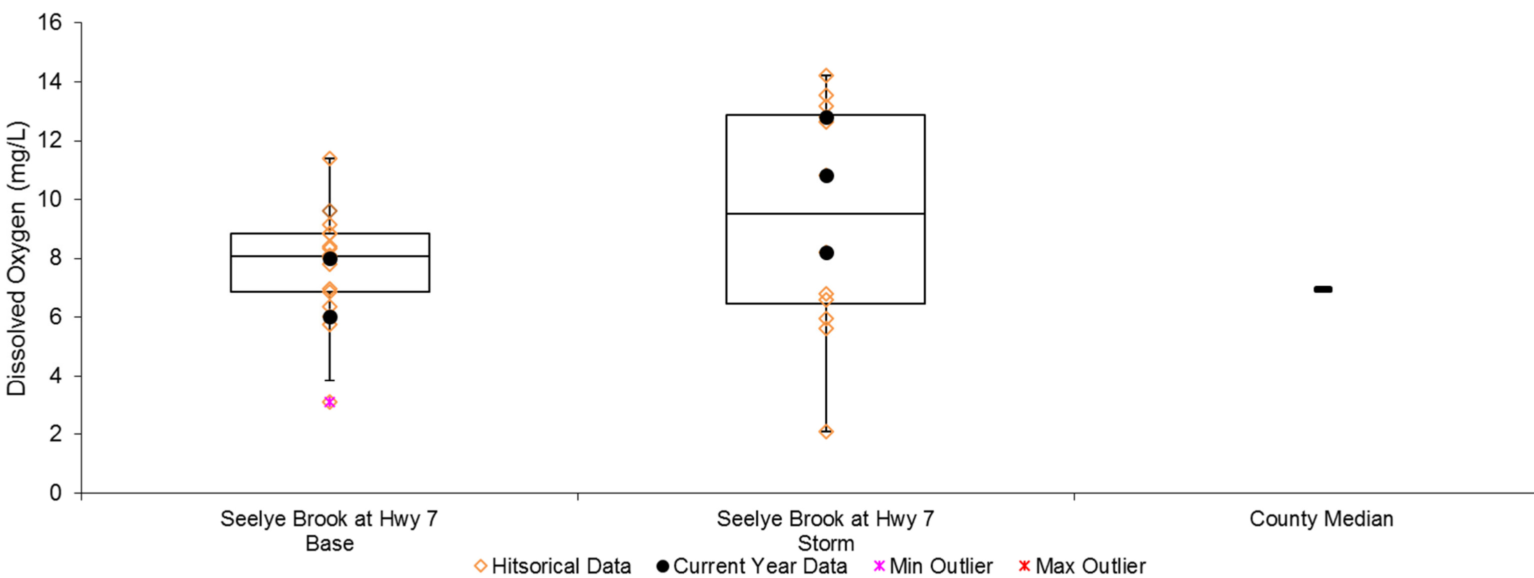
Total Suspended Solids during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below the state standard of 5 mg/L, aquatic life begins to suffer. Seelye Brook's dissolved oxygen levels were typically well above this mark in 2016 with the lowest recorded DO being 6.01 mg/L. Median dissolved oxygen (all years) is 8.08 mg/L during baseflow and 9.51 mg/L during storm events.

Dissolved oxygen during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

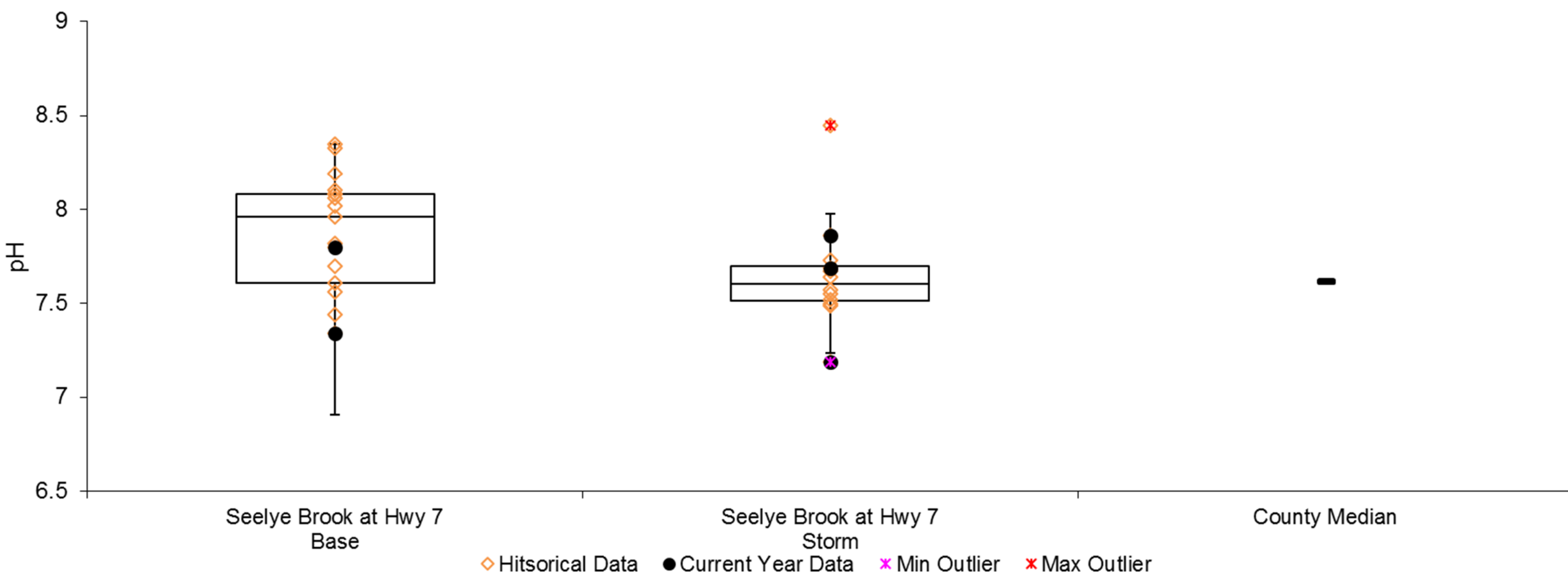


pH

pH refers to the acidity of the water. The Minnesota Pollution Control Agency's water quality standard is for pH to be between 6.5 and 8.5. Seelye Brook has not exceeded this range during any of the years the ACD has sampled it (see figure below).

It is interesting to note that pH is generally slightly lower during storms than during baseflow conditions. This is because the pH of rain is typically lower (more acidic). While acid rain is a longstanding problem, its effect on this aquatic system is small.

pH during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Wetland Hydrology

Description: Continuous groundwater level monitoring at a wetland boundary, to a depth of 40 inches. Countywide, the ACD maintains a network of 23 wetland hydrology monitoring stations.

Purpose: To provide understanding of wetland hydrology, including the impacts of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

Locations: Alliant Tech Reference Wetland, Alliant Tech Systems property, St. Francis

Cedar Creek, Cedar Creek Natural History Area, East Bethel

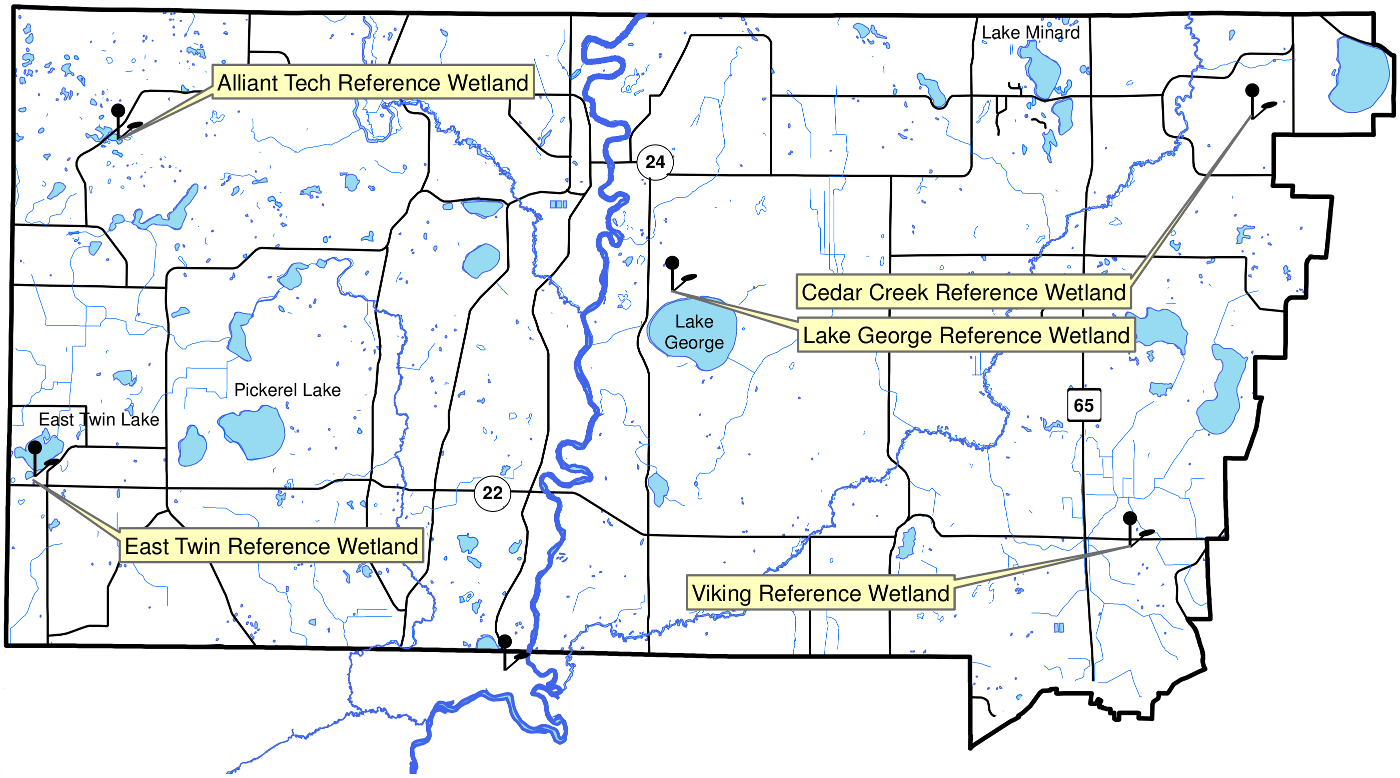
East Twin Reference Wetland, East Twin Township Park, Nowthen

Lake George Reference Wetland, Lake George County Park, Oak Grove

Viking Meadows Reference Wetland, Viking Meadows Golf Course, East Bethel

Results: See the following pages. Raw data and updated graphs can be downloaded from www.AnokaNaturalResources.com using the Data Access Tool.

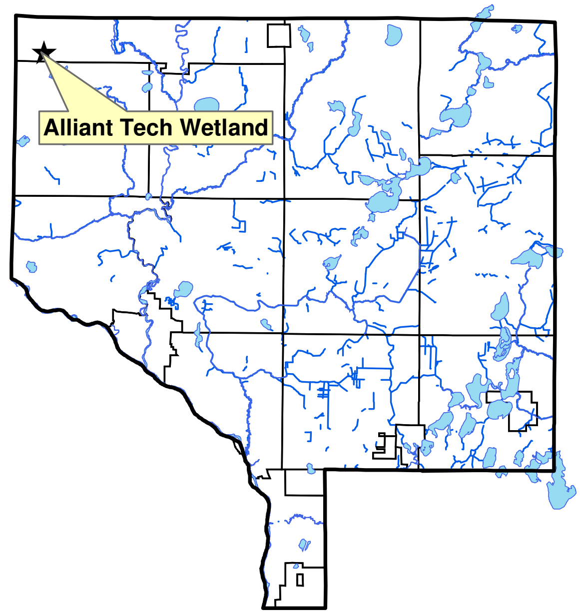
Upper Rum River Watershed Wetland Hydrology Monitoring Sites



ALLIANT TECH REFERENCE WETLAND

Alliant Techsystems Property, St. Francis

Site Information



Monitored Since: 2001

Wetland Type: 5

Wetland Size: ~12 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-8	N2/0	Mucky loam	-
Bg	8-35	5y5/1	Sandy loam	-

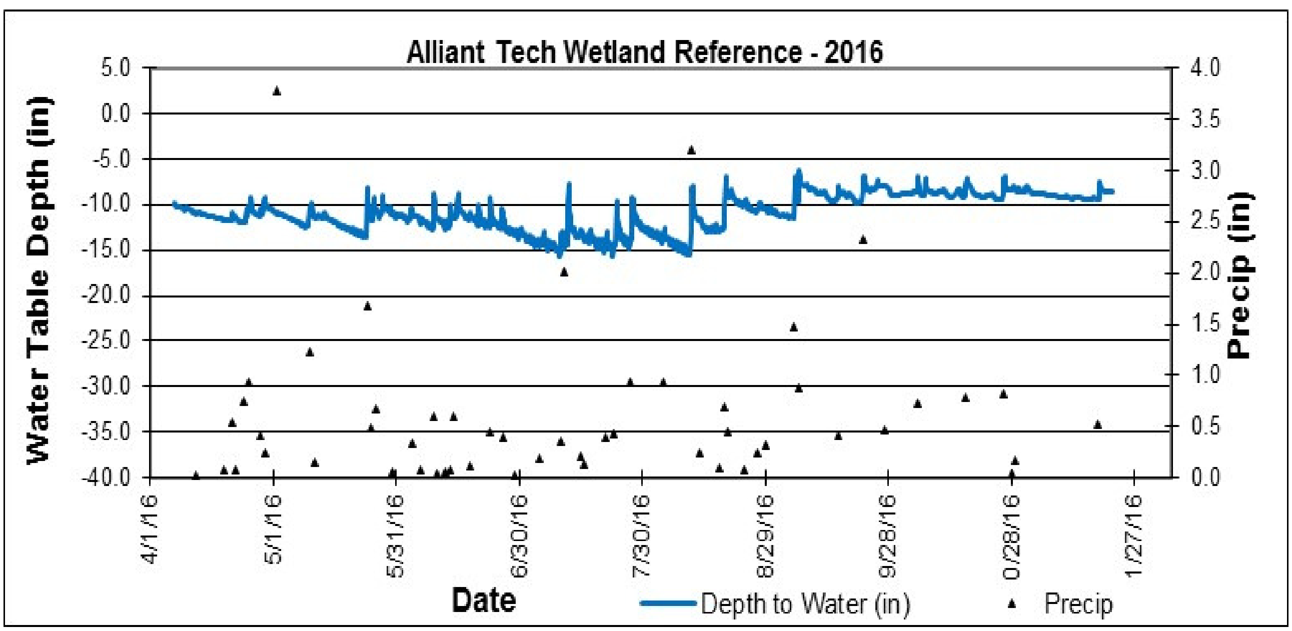
Surrounding Soils: Emmert

Vegetation at Well Location:

Scientific	Common	% Coverage
Carex Spp	Sedge undiff.	90
Lycopus americanus	American Bungleweed	20
Phalaris arundinacea	Reed Canary Grass	5

Other Notes: This wetland lies next to the highway, in a low area surrounded by hilly terrain. It holds water throughout the year, and has a beaver den.

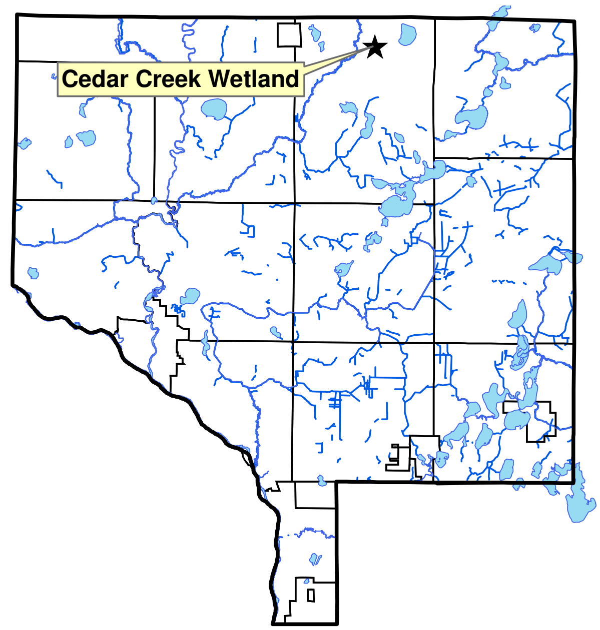
2016 Hydrograph



CEDAR CREEK REFERENCE WETLAND

Univ. of Minnesota Cedar Creek Natural History Area, East Bethel

Site Information



Monitored Since: 1996

Wetland Type: 6

Wetland Size: unknown, likely >150 acres

Isolated Basin? No

Connected to a Ditch? No

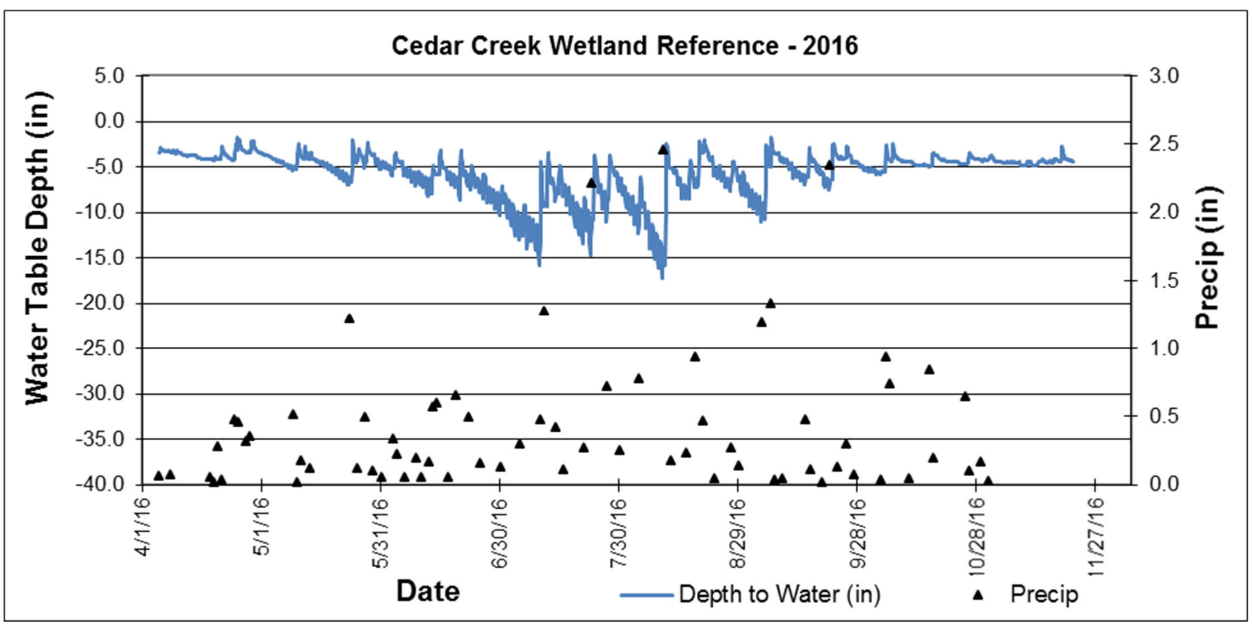
Soils at Well Location: not yet available

Surrounding Soils: Zimmerman

Vegetation at Well Location: not yet available

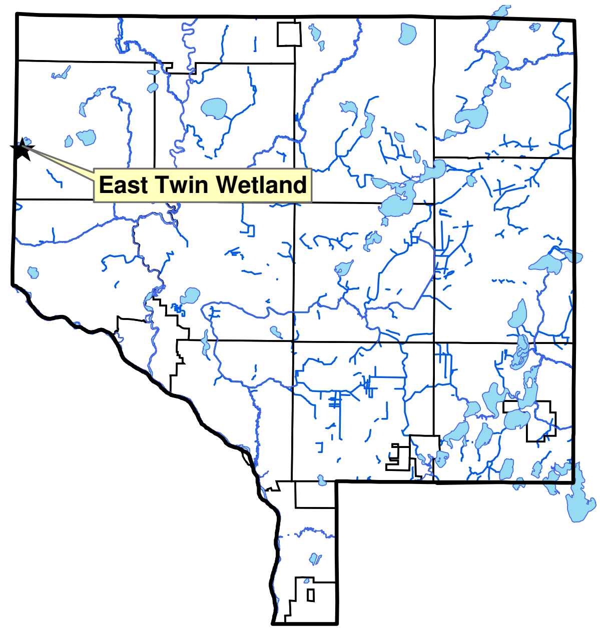
Other Notes: The Cedar Creek Ecosystem Science Reserve, where this wetland is located, is a University of Minnesota research area. Much of this area, including the area surrounding the monitoring site, is in a natural state. This wetland probably has some hydrologic connection to the floodplain of Cedar Creek, which is 0.7 miles from the monitoring site.

2016 Hydrograph



EAST TWIN REFERENCE WETLAND

East Twin Lake Township Park, Nowthen



Site Information

Monitored Since: 2001

Wetland Type: 5

Wetland Size: ~5.9 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-8	10yr 2/1	Mucky Loam	-
Oa	Aug-40	N2/0	Organic	-

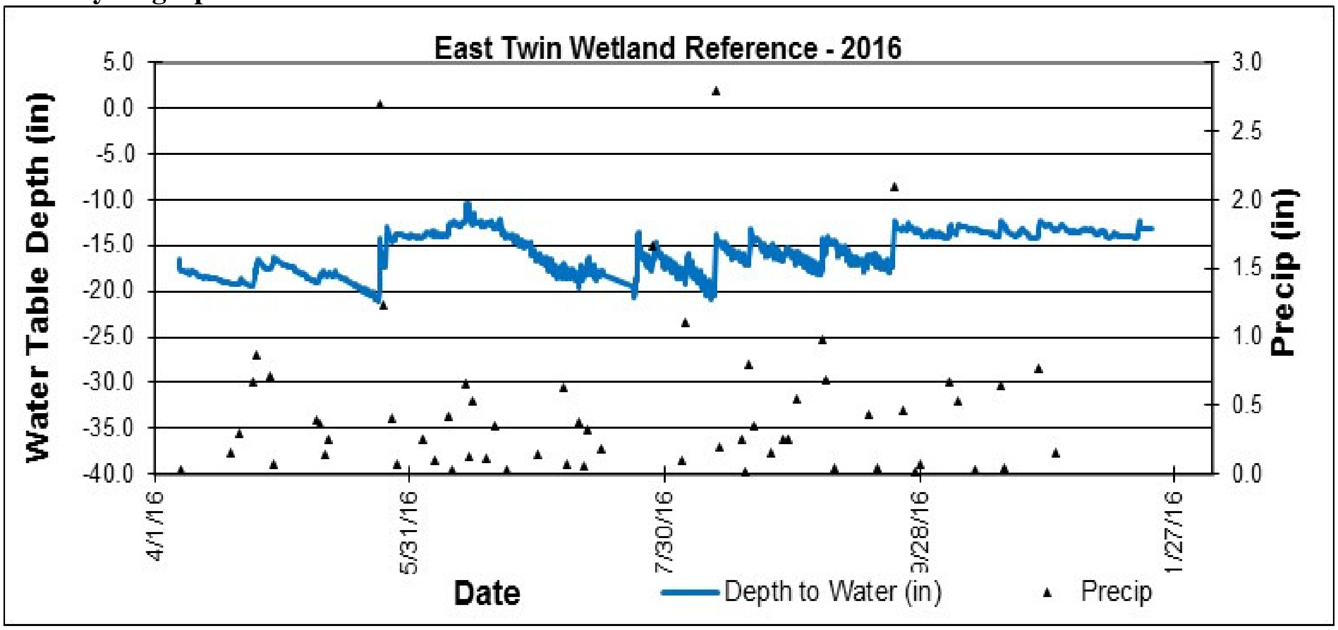
Surrounding Soils: Lake Beach, Growton and Heyder fine sandy loams

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Cornus amomum	Silky Dogwood	30
Fraxinus pennsylvanica	Green Ash	30

Other Notes: This wetland is located within East Twin Lake County Park, and is only 180 feet from the lake itself. Water levels in the wetland are influenced by lake levels.

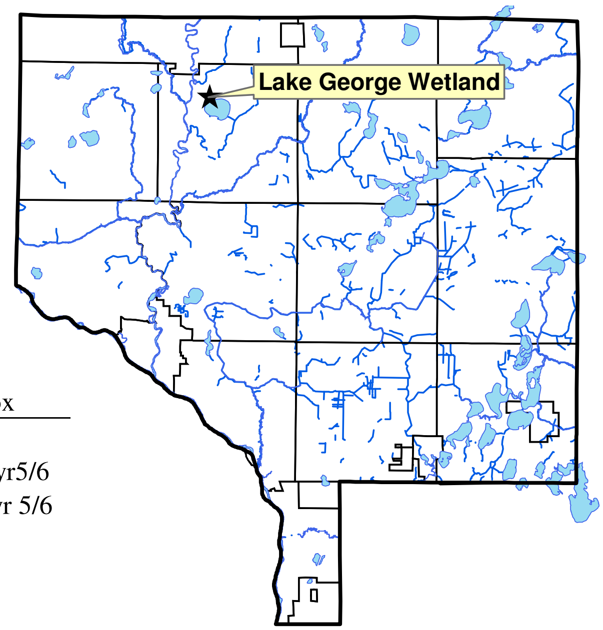
2016 Hydrograph



Wetland Hydrology Monitoring

LAKE GEORGE REFERENCE WETLAND

Lake George County Park, Oak Grove



Site Information

Monitored Since: 1997

Wetland Type: 3/4

Wetland Size: ~9 acres

Isolated Basin? Yes, but only separated from wetland complexes by roadway.

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-8	10yr2/1	Sandy Loam	-
Bg	8-24	2.5y5/2	Sandy Loam	20% 10yr5/6
2Bg	24-35	10gy 6/1	Silty Clay Loam	10% 10yr 5/6

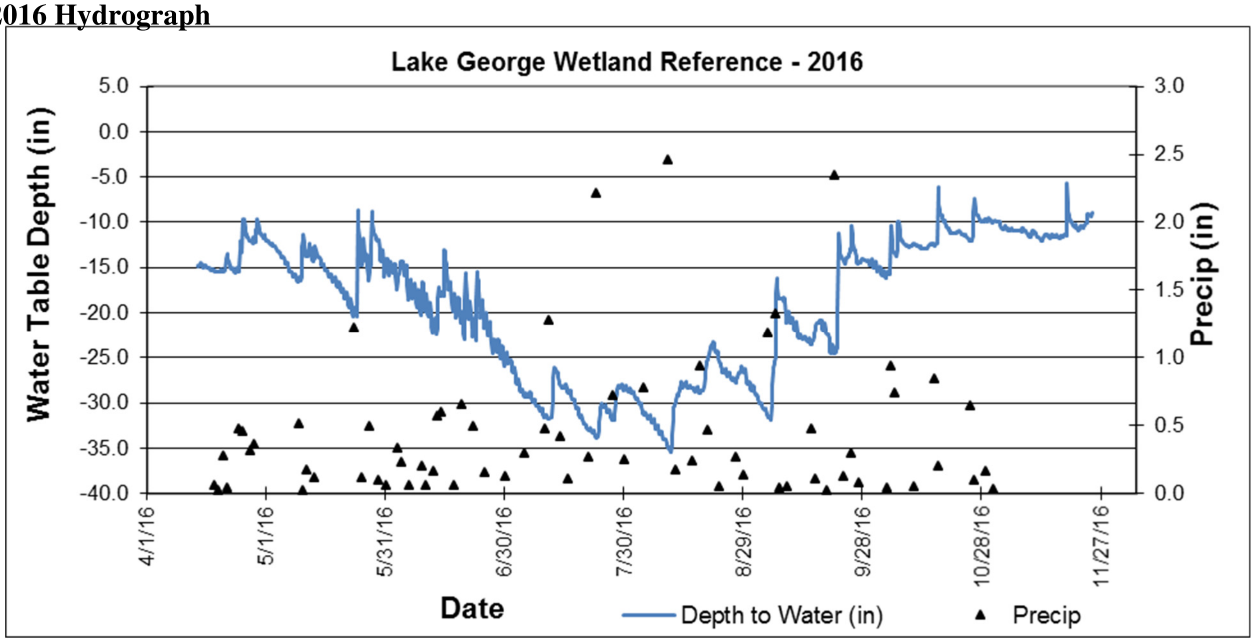
Surrounding Soils: Lino loamy fine sand and Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Cornus stolonifera	Red-osier Dogwood	90
Populus tremuloides	Quaking Aspen	40
Quercus rubra	Red Oak	30
Onoclea sensibilis	Sensitive Fern	20
Phalaris arundinacea	Reed Canary Grass	10

Other Notes: This wetland is located within Lake George County Park, and is only about 600 feet from the lake itself. Much of the vegetation within the wetland is cattails.

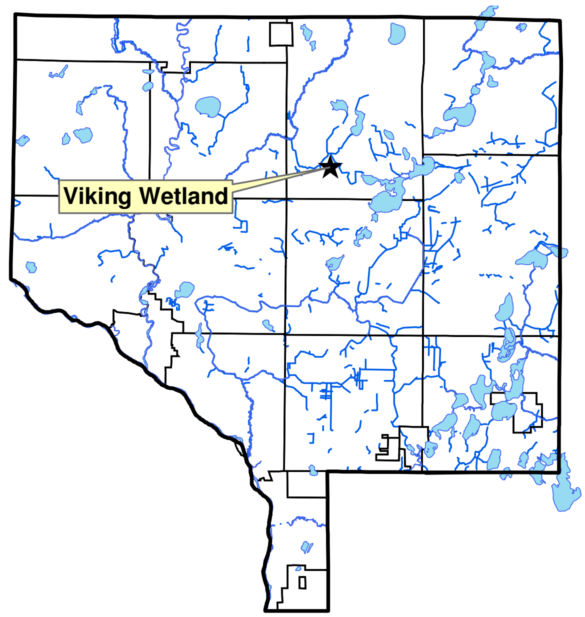
2016 Hydrograph



Wetland Hydrology Monitoring

VIKING MEADOWS REFERENCE WETLAND

Viking Meadows Golf Course, East Bethel



Site Information

Monitored Since: 1999

Wetland Type: 2

Wetland Size: ~0.7 acres

Isolated Basin? No

Connected to a Ditch? Yes, highway ditch is tangent to wetland

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-12	10yr2/1	Sandy Loam	-
Ab	12-16	N2/0	Sandy Loam	-
Bg1	16-25	10yr4/1	Sandy Loam	-
Bg2	25-40	10yr4/2	Sandy Loam	5% 10yr5/6

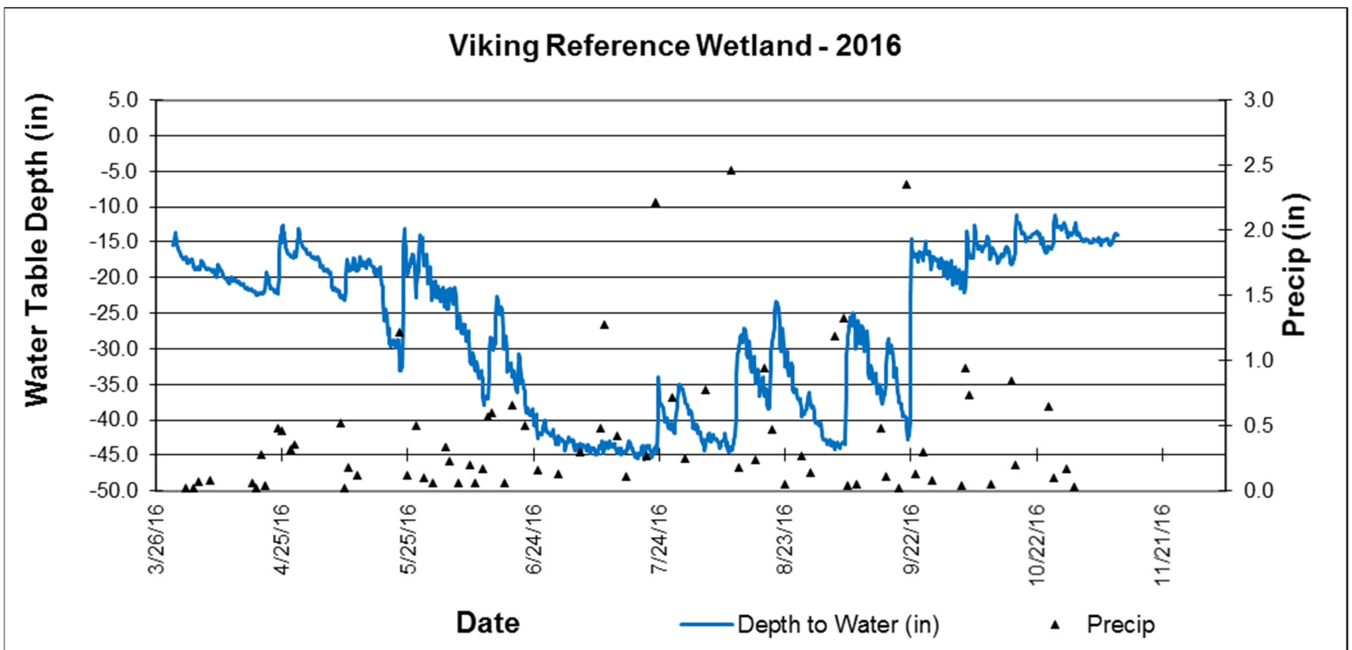
Surrounding Soils: Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Acer rubrum (T)	Red Maple	75
Acer negundo (T)	Boxelder	20

Other Notes: This wetland is located at the entrance to Viking Meadows Golf Course, and is adjacent to Viking Boulevard (Hwy 22).

2016 Hydrograph



Lake George Stormwater Retrofit Analysis – Interim Summary Report

Description: Lake George is a premier recreation lake in Anoka County. Water quality, especially Secchi transparency, has been declining in Lake George in the past decade. The Lake George Improvement District and Anoka Conservation District have partnered on a State Clean Water Fund grant to determine the sources of pollution to Lake George and identify specific projects to correct the lake water quality decline. 2016 was the first year of this multi-year grant and was focused on monitoring and intensive data collection from within the Lake George lakeshed. This monitoring will be continued and followed by modelling of the watershed to help identify sources of pollutant loading and target areas for water quality improvement projects.

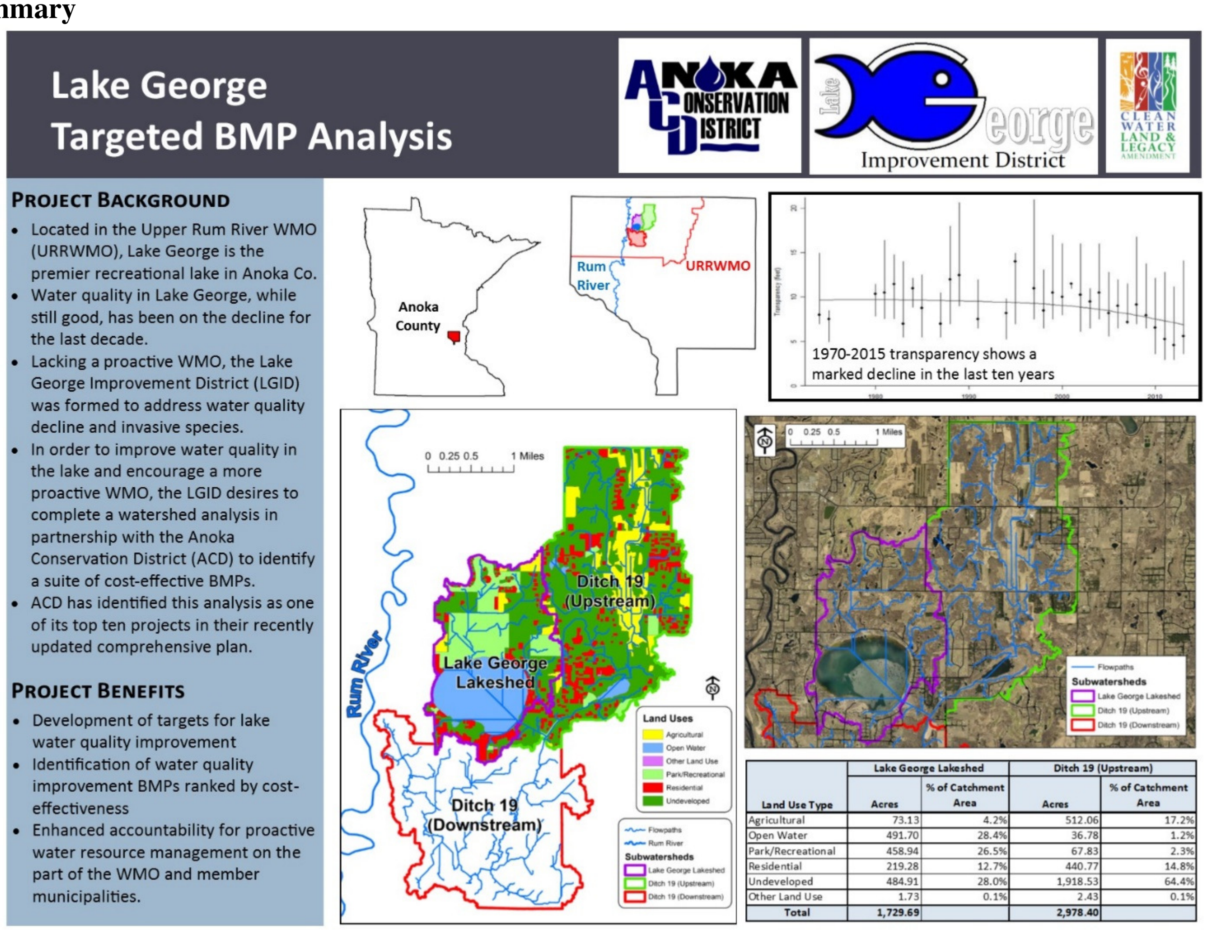
2016 Water Monitoring Locations:

Outfall Lake George at the North side of the Lake
Outfall into Lake George at the NE side of the Lake
Outfall into Lake George at Ditch 19 (alternate site at upstream weir)
Tributary at 221st W of Zion
Tributary at 221st E of Zion
Tributary at 221st E of Nightingale
Ditch 19 at 221st
Ditch 19 at Bluebird and 229th

Purpose: Identify nutrient loading rates from Lake George tributaries to aid in targeting water quality improvement projects. The final work product, due in by December 2018, will be a report detailing specific water quality projects to address the decline in Lake George water quality.

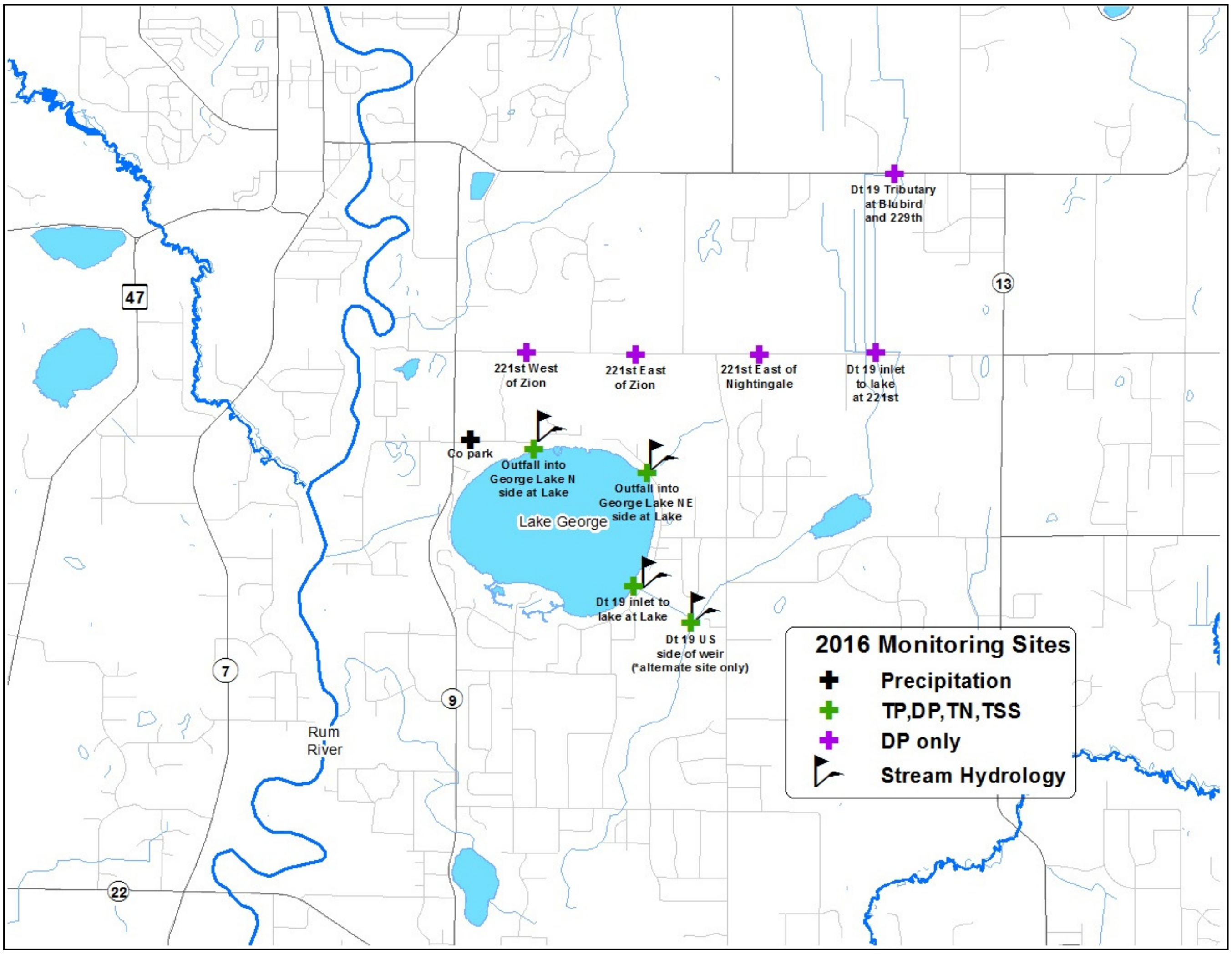
Results: Sampling results and the next steps for this project are provided in detail below

Study Summary



Land Use Type	Lake George Lakeshed		Ditch 19 (Upstream)	
	Acres	% of Catchment Area	Acres	% of Catchment Area
Agricultural	73.13	4.2%	512.06	17.2%
Open Water	491.70	28.4%	36.78	1.2%
Park/Recreational	458.94	26.5%	67.83	2.3%
Residential	219.28	12.7%	440.77	14.8%
Undeveloped	484.91	28.0%	1,918.53	64.4%
Other Land Use	1.73	0.1%	2.43	0.1%
Total	**1,729.69**		**2,978.40**	

Lake George Stormwater Retrofit Analysis Study monitoring sites



TP = total phosphorus, DP = dissolved phosphorus, TN = total nitrogen, TSS = total suspended solids.
*Ditch 19 upstream of the weir was used only as an alternate site when lake levels were high enough to reverse flow at the Ditch 19 outfall.

Stream monitoring data at Lake George outfall sites

Outfall George Lake N Side @ Lake			5/12/2016	5/20/2016	6/2/2016	6/8/2016	6/14/2016	6/20/2016	9/22/2016	11/15/2016			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	7.07	6.9	6.56	6.56	6.83	6.31	6.25	7.19	6.71	6.25	7.19
Conductivity	mS/cm	0.01	0.279	0.286	0.37	0.411	0.38	0.337	0.266	0.187	0.31	0.19	0.41
Turbidity	NTU	1	9	0.4	5	8.1	4.8	14.5	7.7	6.6	6.96	0.40	14.50
D.O.	mg/L	0.01	5.06	3.82	0.99	0.81	0.65	0.77	2.28	5.73	2.51	0.65	5.73
D.O.	%	1	47.6	36.2	10.1	8	7	8.7	22.6	44	23.03	7.00	47.60
Temp.	°C	0.1	11.18	11.8	14.8	14.15	18.38	20.29	15.62	4.38	13.82	4.38	20.29
Salinity	%	0.01	0.13	0.14	0.18	0.2	0.18	0.16	0.13	0.09	0.15	0.09	0.20
T.P.	ug/L	10	25	11	87	95	186	194	100	0.7	87.34	0.70	194.00
TSS	mg/L	2	8	<2	6.0	10	10	9	4	4	6.63	4.00	10.00
Secchi-tube	cm	n/a	>100	>100	80	76	64	63	63	>100	81.00	63.00	80.00
T.D.P	ug/L	5	16	5	36	54	109	79	49	7	44.38	5.00	109.00
T.K.N	mg/L	0.2	1.2	1.7	1.6	2	2.2		1.5	0.9	1.59	0.90	2.20
Nitrate+Nitrite	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
*reporting limit													

Outfall George Lake NE @ Lake			5/12/2016	5/20/2016	6/2/2016	6/8/2016	6/14/2016	6/20/2016	9/22/2016	11/15/2016			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	7.32	7.37	6.24	6.99	6.96	6.33	6.65	6.84	6.84	6.24	7.37
Conductivity	mS/cm	0.01	0.287	0.271	0.366	0.405	0.375	0.381	0.248	0.212	0.32	0.21	0.41
Turbidity	NTU	1	6.4	19.1	12	20.1	14.1	29.9	8.3	8.7	14.80	6.40	29.90
D.O.	mg/L	0.01	7.83	8.67	4.77	4.91	1.15	1.03	2.76	5.11	4.53	1.03	8.67
D.O.	%	1	80.2	99.8	51.9	54.2	13	12.4	28.5	40.3	47.54	12.40	99.80
Temp.	°C	0.1	15.13	21.03	17.5	18.44	20.19	23.57	16.18	5.32	17.17	5.32	23.57
Salinity	%	0.01	0.14	0.13	0.17	0.2	0.18	0.19	0.12	0.1	0.15	0.10	0.20
T.P.	ug/L	10	94	103	199	161	260	376	214	0.6	175.95	0.60	376.00
TSS	mg/L	2	4	<2	4.0	5	12	9	2	2	5.43	<2	12.00
Secchi-tube	cm		>100	>100	>100	>100	64	38	92	55	81.00	38.00	>100
T.D.P	ug/L	5	42	8	18	17	28	91	22	6	29.00	6.00	91.00
T.K.N	mg/L	0.2	0.9	1.7	1.4	1.4	1.7		0.8	1.1	1.29	0.80	1.70
Nitrate+Nitrite	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
*reporting limit													

Ditch 19 Inlet @ Lake			5/12/2016	5/20/2016	6/2/2016	6/8/2016	6/14/2016	6/20/2016	9/22/20116	11/15/2016			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	7.92	7.02	7.25	6.6	6.99	6.94	7.09	8.1	7.24	6.60	8.10
Conductivity	mS/cm	0.01	0.246	0.241	0.267	0.297	0.234	0.23	0.367	0.192	0.26	0.19	0.37
Turbidity	NTU	1	5.9	12.4	0	2.6	1.9	5.8	3.2	0.4	4.08	0.40	12.40
D.O.	mg/L	0.01	10.63	6.77	4.1	1.96	1.96	4.5	5.83	11.95	5.96	1.96	11.95
D.O.	%	1	109.6	69.3	42.5	19.5	22.3	53.3	61.1	100.2	59.73	19.50	109.60
Temp.	°C	0.1	15.4	14.74	15.5	16.4	20.65	21.95	11.27	7.56	15.43	7.56	21.95
Salinity	%	0.01	0.12	0.11	0.13	0.14	0.11	0.11	0.17	0.09	0.12	0.09	0.17
T.P.	ug/L	10	27	63	81	35	76	75	71	<0.5	61.14	27.00	81.00
TSS	mg/L	2	2	4	3.0	2	4	8	2	3	3.50	2.00	8.00
Secchi-tube	cm		>100	>100	87	>100	79	>100		>100	>100	79.00	>100
T.D.P	ug/L	5	<0.005	0.024	0.015	0.007	0.01	<0.005	0.036	<0.005	0.02	<0.005	0.04
T.K.N	mg/L	0.2	0.8	2.1	1	0.9	1.2		1.2	0.8	1.14	0.80	2.10
Nitrate+Nitrite	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.33	<0.05	<0.05	<0.05	0.33
*reporting limit													

Stream monitoring data at watershed tributary sites

Ditch 19 @ Blubird and 229th			5/12/2016	5/20/2016	6/2/2016	6/8/2016	6/14/2016	6/20/2016	9/22/2016	11/15/2016			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.71	8.12	7.94	7.75	7.64	6.67	6.9	7.49	7.65	6.67	8.71
Conductivity	mS/cm	0.01	0.456	0.465	0.52	0.519	0.444	0.348	0.394	0.371	0.44	0.35	0.52
Turbidity	NTU	1	1.2	7.8	2	11.4	0.1	9.4	17	0	6.11	0.00	17.00
D.O.	mg/L	0.01	13.85	11.55	9.73	10.22	7.18	3.52	2.63	6.71	8.17	2.63	13.85
D.O.	%	1	137.1	122.2	97.3	103.4	75.9	39.8	25.7	54.9	82.04	25.70	137.10
Temp.	°C	0.1	13.5	16.86	13.7	14.38	16.76	20.18	14.53	6.46	14.55	6.46	20.18
Salinity	%	0.01	0.22	0.22	0.25	0.25	0.21	0.17	0.19	0.17	0.21	0.17	0.25
T.P.	ug/L	10											
TSS	mg/L	2											
Secchi-tube	cm		>100	>100	>100	>100	>100	>100	39	>100	>100	39	>100
T.D.P	ug/L	5		22	33	36	31	200	428	111	123.00	22.00	428.00
T.K.N	mg/L	0.2											
Nitrate+Nitrite	mg/L	0.05											
*reporting limit													

221st West of Zion			5/20/2016	6/2/2016	6/8/2016	6/14/2016	6/20/2016	9/22/2016	11/15/2016			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	6.59	6.27	6.27	6.25	5.89	6	6.36	6.23	5.89	6.59
Conductivity	mS/cm	0.01	0.263	0.348	0.365	0.302	0.303	0.269	0.212	0.29	0.21	0.37
Turbidity	NTU	1	20.2	4.5	11	19.6	7.2	2.7	3	9.79	2.70	20.20
D.O.	mg/L	0.01	2.05	0.81	1.29	0.79	1.09	0.75	1.22	1.14	0.75	2.05
D.O.	%	1	18.9	8.2	12.5	8.3	11.7	7.7	10.9	11.17	7.70	18.90
Temp.	°C	0.1	11.02	14.7	13.4	16.87	18.11	15.78	6.65	13.79	6.65	18.11
Salinity	%	0.01	0.13	0.17	0.17	0.14	0.14	0.13	0.1	0.14	0.10	0.17
T.P.	ug/L	10										
TSS	mg/L	2										
Secchi-tube	cm		57	74	75	8	81	>100	>100	71.00	8.00	>100
T.D.P	ug/L	5	9	90	91	73	73	42	22	57.14	9.00	91.00
T.K.N	mg/L	0.2										
Nitrate+Nitrite	mg/L	0.05										
*reporting limit												

221st East of Zion			5/20/2016	6/2/2016	6/8/2016	6/14/2016	6/20/2016	9/22/2016	11/15/2016			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	6.67	6.24	6.43	6.43	6.33	6.23	6.22	6.36	6.22	6.67
Conductivity	mS/cm	0.01	0.261	0.154	0.271	0.267	0.207	0.143	0.215	0.22	0.14	0.27
Turbidity	NTU	1	1.6	2.9	11	61.5	12.2	n/a	0	14.83	0.00	61.50
D.O.	mg/L	0.01	4.62	1.61	2.29	3.34	3.11	0.9	1.55	2.49	0.90	4.62
D.O.	%	1	45.8	16.6	23.1	36.4	35.6	12.1	12.6	26.03	12.10	45.80
Temp.	°C	0.1	14.06	15.2	15.0	18.9	19.35	15.01	5.36	14.70	5.36	19.35
Salinity	%	0.01	0.12	0.08	0.01	0.12	0.11	0.07	0.1	0.09	0.01	0.12
T.P.	ug/L	10										
TSS	mg/L	2										
Secchi-tube	cm		76	83	67	10	70	60	>100	66.57	10	>100
T.D.P	ug/L	5	18	72	67	200	64	220	11	93.14	11.00	220.00
T.K.N	mg/L	0.2										
Nitrate+Nitrite	mg/L	0.05										
*reporting limit												

221st East of Nightingale			5/20/2016	6/2/2016	6/8/2016	6/14/2016	6/20/2016	9/22/2016	11/15/2016			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	6.19	5.79	5.76	5.74	5.47	5.7	5.77	5.77	5.47	6.19
Conductivity	mS/cm	0.01	0.237	0.237	0.241	0.2	0.21	0.214	0.171	0.22	0.17	0.24
Turbidity	NTU	1	40.2	3.8	14	17.8	16.5	5.3	31.4	18.40	3.80	40.20
D.O.	mg/L	0.01	2.43	1.22	0.83	0.95	1.17	1.97	4.02	1.80	0.83	4.02
D.O.	%	1	22.1	10.6	7.6	9	11.5	19.5	33.4	16.24	7.60	33.40
Temp.	°C	0.1	10.26	8.47	9.7	11.37	13.64	14.59	6.6	10.66	6.60	14.59
Salinity	%	0.01	0.11	0.11	0.11	0.09	0.1	0.1	0.08	0.10	0.08	0.11
T.P.	ug/L	10										
TSS	mg/L	2										
Secchi-tube	cm		34	>100	>100	>100	77	>100	n/a	>100	34	>100
T.D.P	ug/L	5	52	177	228	291	269	72	112	171.57	52.00	291.00
T.K.N	mg/L	0.2										
Nitrate+Nitrite	mg/L	0.05										
*reporting limit												

Ditch 19 @ 221st			5/12/2016	5/20/2016	6/2/2016	6/8/2016	6/14/2016	6/20/2016	9/22/2016	11/15/2016			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	7.83	7.53	7.39	7.51	7.72	6.9	6.83	7.1	7.35	6.83	7.83
Conductivity	mS/cm	0.01	0.533	0.523	0.587	0.603	0.496	0.415	0.466	0.416	0.50	0.42	0.60
Turbidity	NTU	1	3.4	6.2	9	6.8	3.3	11.2	9.9	0	6.24	0.00	11.20
D.O.	mg/L	0.01	11.11	11.24	8.51	9.12	8.14	5.51	2.72	7.65	8.00	2.72	11.24
D.O.	%	1	108.6	114.3	83.2	92.2	84.8	60.7	26.3	63.8	79.24	26.30	114.30
Temp.	°C	0.1	12.85	15.03	12.7	13.87	15.94	19.39	14.24	6.5	13.82	6.50	19.39
Salinity	%	0.01	0.25	0.25	0.28	0.29	0.23	0.2	0.22	0.19	0.24	0.19	0.29
T.P.	ug/L	10											
TSS	mg/L	2											
Secchi-tube	cm		>100	>100	>100	>100	>100	98	85	>100	>100	85	>100
T.D.P	ug/L	5		15	18	9	27	92	168	9	48.29	9.00	168.00
T.K.N	mg/L	0.2											
Nitrate+Nitrite	mg/L	0.05											
*reporting limit													

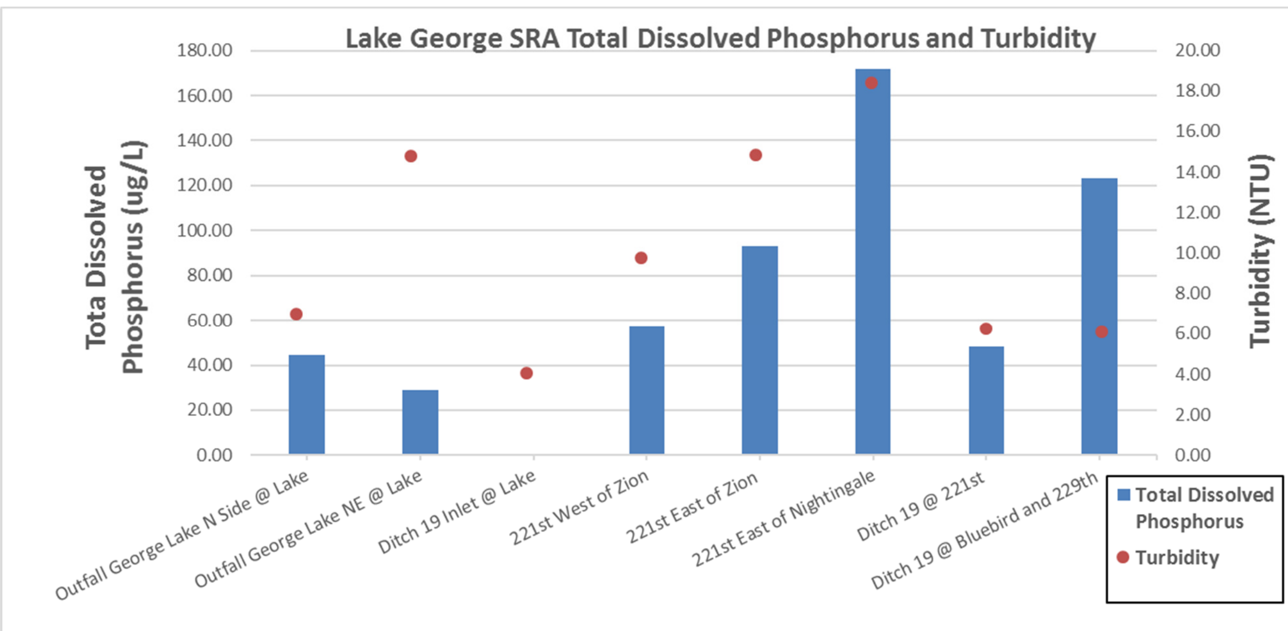
Turbidity and Total Dissolved Phosphorus

For this study, turbidity and total dissolved phosphorus are the two parameters of greatest interest. Therefore, these parameters are explored in depth below and other parameters are reported with less discussion in the tables on the previous pages.

Turbidity is a measurement of solid material suspended in the water. Turbidity is measured by refraction of a light beam passed through a water sample. It is most sensitive to large particles. The amount of suspended material is important because it affects transparency and aquatic life, and because many other pollutants are attached to particles. Phosphorus is one nutrient pollutant that can often be attached to suspended particles, and streams with high turbidity may have high particulate phosphorus. Many stormwater treatment practices such as street sweeping, sumps, and stormwater settling ponds target sediment and attached pollutants.

Total dissolved phosphorus is that portion of phosphorus which is not particulate (attached to particles). It is a good indicator of upstream loading from natural systems like wetland complexes. Since particulate matter is very low in these upstream tributaries, dissolved phosphorus will be a better indicator of the natural loading processes occurring in these systems.

Both turbidity and dissolved phosphorus levels for the monitored lake tributaries are presented in the graph below. The results help indicate which streams may be of greatest interest for water quality improvement projects.



Monitoring Results Discussion

Based on monitoring in 2016, it appears that the largest concentrations of dissolved phosphorus and turbidity exist in the small ditch systems that enter the lake from the north and northeast, especially from the ditch that flows under 221st East of Nightingale and leads directly to the NE outfall at the lake. Although the northern portion of Ditch 19 flows through mostly agricultural land and has extremely high levels of dissolved phosphorus, it appears that the large open-water wetland to the east of Lake George filters out the dissolved phosphorus from Ditch 19 before it reaches the lake. It is also possible that high lake levels caused backflow at the Ditch 19 inlet and dilution of dissolved phosphorus and turbidity occurred in the lowest portions of the ditch.

ACD are collecting flow measurements and developing rating curves at each of these sites, which will be completed in 2017. The purpose of these rating curves is to allow us to analyze how much water is flowing through the tributary and entering the lake (rating curves are the mathematical relationship between water level and flow). These flow volumes, when paired with pollutant concentration measurements, will allow us to quantify the mass of each pollutant entering the lake from each tributary (often called pollutant load). Until this work is done, the pollutant concentration results presented above should be interpreted with the understanding that tributaries with the highest concentrations may not be the biggest contributors of pollutants to the lake because of lower flows.

During the 2017 sampling season ACD will collect additional pollutant concentration measurements while developing rating curves for each tributary. Then we will quantify pollutant loading from each tributary, compare pollutant loads to the overall pollutant budget of the lake to determine the impacts of each tributary on the lake, identify water quality projects that might be installed to improve the lake, evaluate these potential projects by modeling them, and recommend a course of corrective action.

St. Francis Stormwater Retrofit Analysis

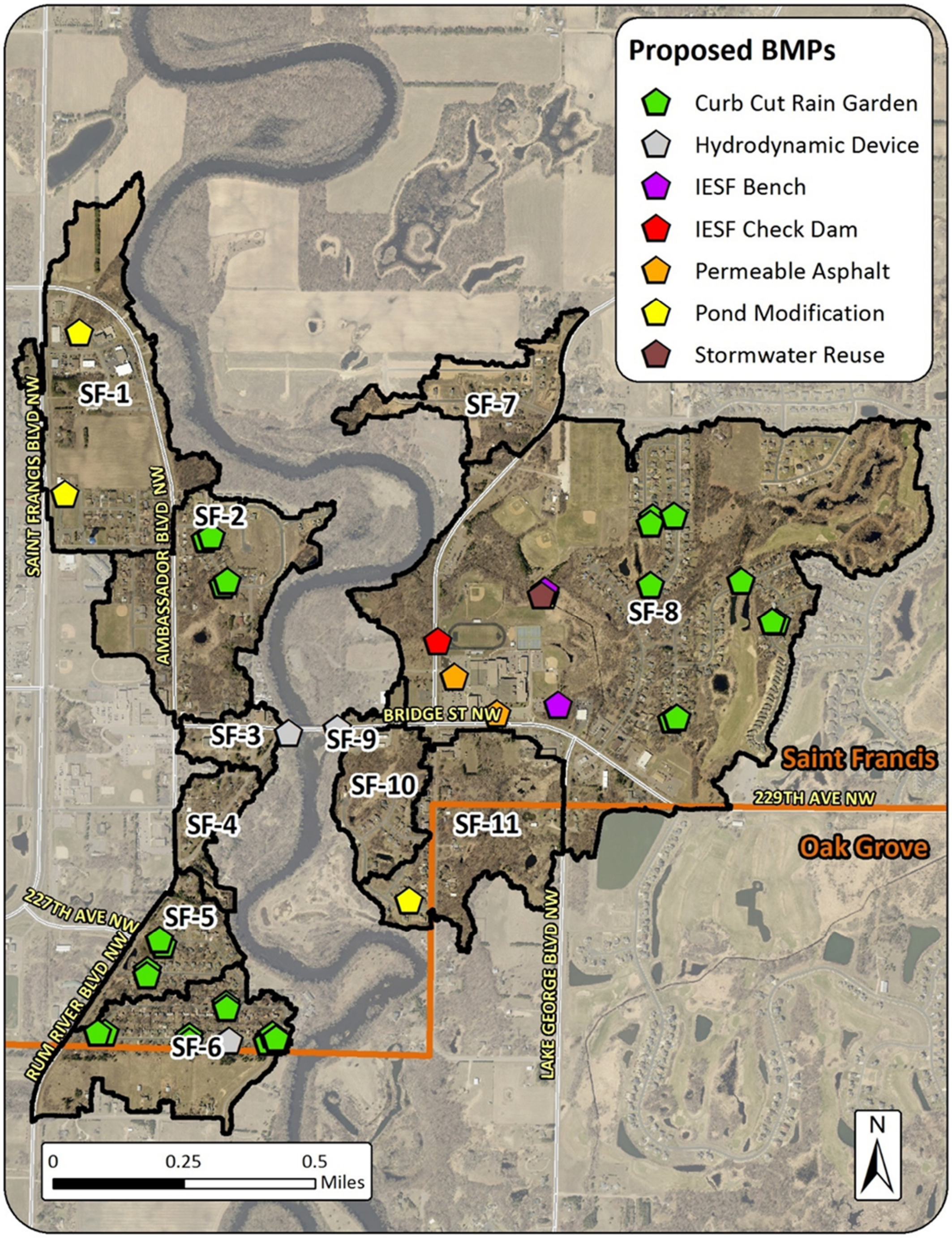
Description: Analysis identified new stormwater treatment opportunities in neighborhoods identified by the city and ranked potential projects by cost effectiveness (amount of pollutant kept out of the Rum River per dollar spent). Water quality benefits associated with the installation of each identified project were individually modeled using the Source Loading and Management Model for Windows (WinSLAMM). WinSLAMM estimates volume and pollutant loading based on acreage, land use, and soils information. The costs associated with project design, administration, promotion, land acquisition, opportunity costs, construction oversight, installation, and maintenance were estimated. The total costs over the assumed effective life of each project were then divided by the modeled benefits over the same time period to enable ranking by cost-effectiveness. It is recommended that projects be installed in order of cost effectiveness. Other factors, including a project's educational value/visibility, construction timing, total cost, or non-target pollutant reduction also affect project installation decisions and need to be weighed by resource managers when selecting projects to pursue. A variety of stormwater retrofit approaches were identified. They include bio-retention, hydrodynamic devices, permeable pavement, iron enhanced sand filter pond benches, iron enhanced sand filter check dams, existing stormwater pond modifications, and water reuse. The analysis provides sufficient detail for pursuit of funds to install the most cost effective projects.

Location: Selected areas in the City of St. Francis.

Purpose: To improve water quality in the Rum River.

Results: Work began in 2015 and was completed in 2016. 17 stormwater retrofit projects were identified and ranked by cost effectiveness. A map showing proposed BMPs is below. A full separate report is available.

City of St. Francis Proposed BMPs



Water Quality Grant Fund

Description: The Upper River Watershed Management Organization (URRWMO) partners with the Anoka Conservation District's (ACD) Water Quality Cost Share Program. The URRWMO contributes funds to be used as cost share grants for projects that improve water quality in lakes, streams, or rivers within the URRWMO area. The ACD provides administration of the grants. Grant awards follow ACD policies and generally cover 50% or 70% of materials cost (see ACD website for full policies). The ACD Board of Supervisors approves any disbursements.

Grant administration is through the Anoka Conservation District for efficiency and simplicity. The ACD administers a variety of other similar grants, thus providing a one-stop-shop for residents. Additionally, the ACD's technical staff provide project consultation and design services at low or no cost, which is highly beneficial for grant applicants. The ACD staff also has expertise to process and scrutinize grant requests. Lastly, the ACD Board meets monthly, and can therefore respond to grant requests rapidly, while URRWMO meetings are much less frequent.

The Anoka Conservation District (ACD) and Upper Rum River WMO have both undertaken efforts to promote these types of projects and the availability of grants. The ACD mentions the grants during presentations to lake associations and other community groups, in newsletters, and in website postings. In order to promote these types of projects the ACD also assists landowners throughout projects, including design, materials acquisition, installation, and maintenance.

Purpose: To improve water quality in area lakes, streams and rivers.

Locations: Throughout the watershed.

Results: Projects are reported in the year they are installed.

URRWMO Cost Share Fund Summary

2006 URRWMO Contribution	+	$ 990.00
2006 Expenditures		$ 0.00
2007 URRWMO Contribution	+	$ 1,000.00
2007 Expenditures		$ 0.00
2008 Expenditures		$ 0.00
2009 Expenditures		$ 0.00
2010 URRWMO Contribution	+	$ 500.00
2011 URRWMO Contribution	+	$ 567.00
2010-11 Expenditure Petro streambank stabilization	-	$1,027.52
2011 Expenditure Erickson lakeshore restoration	-	$ 233.63
2012 Expenditure Erickson lakeshore restoration	-	$ 137.97
2012 URRWMO Contribution	+	$1,000.00
2013 URRWMO Contribution	+	$ 0
2014 Expenditure – Stitt lakeshore restoration	-	$1,059.69
2013 Correction	+	$ 0.48
2014 URRWMO Contribution		$ 0.00
2015 URRWMO Contribution		$ 0.00
2016 URRWMO Contribution		$ 0.00
*2017 Expenditure – Rum River revetments	-	$ 1598.67
Fund Balance		**$ 0.00**

* URRWMO directed ACD to transfer remaining funds into ACD's fund for Rum Riverbank stabilizations using cedar tree revetments.

URRWMO Website

Description: The Upper Rum River Watershed Management Organization (URRWMO) contracted the Anoka Conservation District (ACD) to design and maintain a website about the URRWMO and the Upper Rum River watershed.

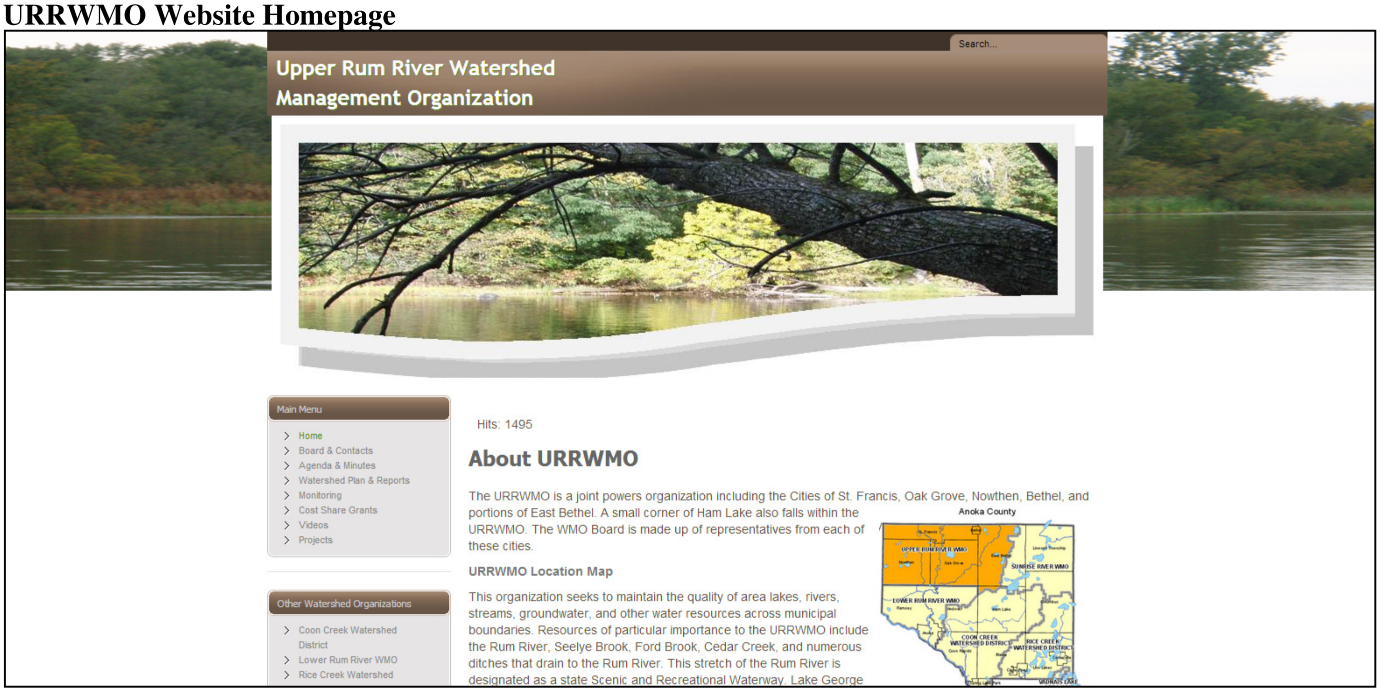
Purpose: To increase awareness of the URRWMO and its programs. The website also provides tools and information that helps users better understand water resources issues in the area.

Location: www.URRWMO.org

Results: Regular website updates occurred throughout the year. The URRWMO website contains information about both the URRWMO and about natural resources in the area. Information about the URRWMO includes:

- a directory of board members,
- meeting minutes and agendas,
- watershed management plan and annual reports,
- descriptions of work that the organization is directing,
- highlighted projects.

URRWMO Website Homepage



URRWMO Annual Newsletter

Description: The URRWMO Watershed Management Plan and state rules call for an annual URRWMO newsletter in addition to the website. The URRWMO will produce a newsletter article including information about the URRWMO, its programs, related educational information, and the URRWMO website address. This article will be provided to each member city, and they will be asked to include it in their city newsletters.

Purpose: To increase public awareness of the URRWMO and its programs as well as receive input.

Locations: Watershed-wide.

Results: The Anoka Conservation District (ACD) assisted the URRWMO by drafting the annual newsletter article about the new management plans upcoming for area streams and lakes. The URRWMO Board reviewed and edited the draft article. The finalized article was posted to the URRWMO website, sent to each member community for publication in their newsletters and provided to the Independent School District 15 publication, "The Courier."

2016 URRWMO Newsletter Article

Upper Rum River
Watershed Management Organization

MEDIA RELEASE

Contact person: Jamie Schurbon 763-434-2030 ext. 12
Date: April 29, 2016

Rum River, Lakes Management Planning Underway

The Rum River, Lake George and Seelye Brook are a few of the waterbodies receiving new management plans in the coming months. Residents interested water quality, aquatic invasive species, flooding and environmental health are invited to contribute to the process. Both local and regional plans are taking shape.

At the local level, the Upper Rum River Watershed Management Organization (URRWMO) is updating its 10-year management plan. The URRWMO was jointly formed by the cities of Bethel, East Bethel, Nowthen, St. Francis, Oak Grove and Ham Lake to manage water issues, including those that tend to flow across city boundaries. It sets consistent minimum regulatory standards across the cities, monitors water quality and may coordinate projects to address problems. The URRWMO will be considering its role relative to cities, as well as its participation in regional management.

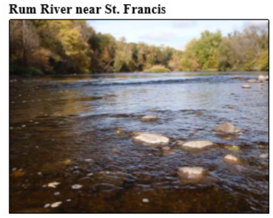
At the regional level, the State is funding a Rum River Watershed Restoration and Protection Plan (WRAPP), which encompasses the watershed from Lake Mille Lacs to Anoka. Lakes and streams draining to the river are included. Each county's soil and water conservation district is serving as a key point of contact in this planning effort. The plan will include how to keep good water quality and address problems.

Lake George and the Rum River are likely to get substantial attention locally. Lake George is a regional attraction with good, but declining water quality. Addressing that decline is likely to be a priority. The Rum River has good water quality and is a state scenic and recreational river which many want to protect.

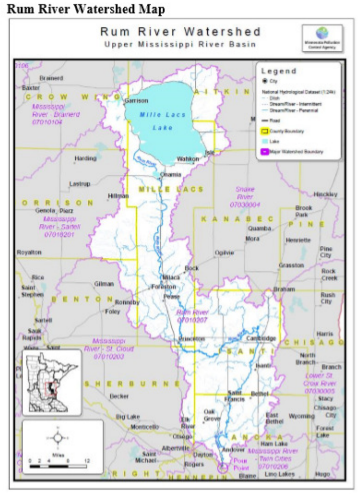
The URRWMO is planning an open house June 29 at 7pm at Oak Grove City Hall. Residents are invited to share their input on priorities for the next ten years. More information is at www.URRWMO.org.

The regional Rum River WRAPP will be holding several opportunities for input between now and the end of the year. Notices of these meetings and draft documents for public review will be posted www.AnokaSWCD.org under the "projects" tab, or contact Jamie Schurbon at 763-434-2030 ext. 12 or jamie.schurbon@anokaswcd.org.

Rum River near St. Francis



Rum River Watershed Map



URRWMO 2015 Annual Reports to the State

Description: The Upper Rum River Watershed Management Organization (URRWMO) is required by law to submit an annual report to the Minnesota Board of Water and Soil Resources (BWSR). This report consists of an up-to-date listing of URRWMO Board members, activities related to implementing the URRWMO Watershed Management Plan, the status of municipal water plans, financial summaries, and other work results. The report is due annually 120 days after the end of the URRWMO's fiscal year (April 30th).

Additionally, the URRWMO is required to perform annual financial reporting to the State Auditor. This includes submitting a financial report and filling out a multi-worksheet form.

Purpose: To document required progress toward implementing the URRWMO Watershed Management Plan and to provide transparency of government operations.

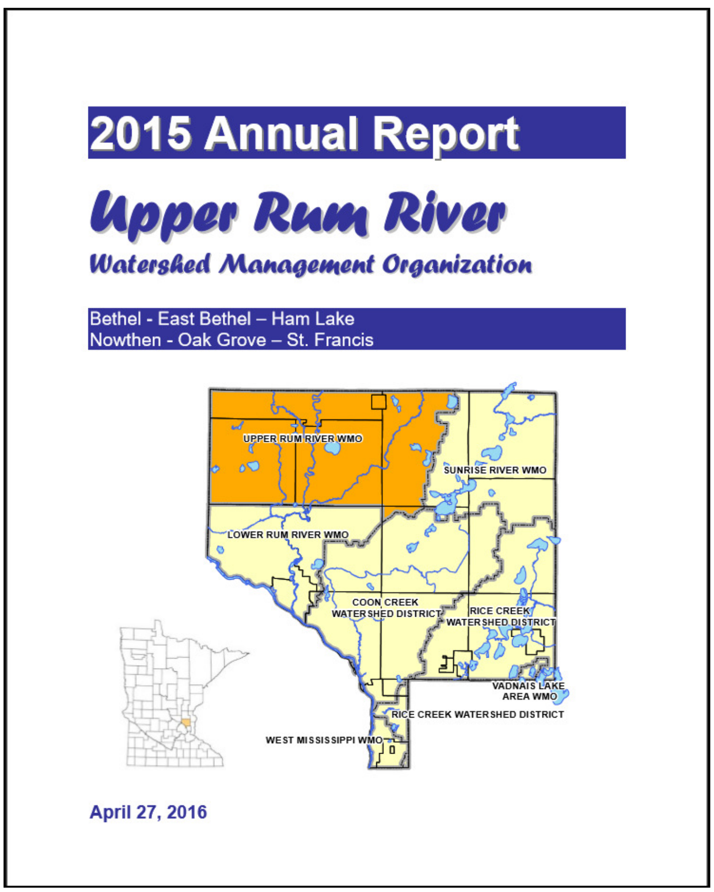
Locations: Watershed-wide

Results: The Anoka Conservation District assisted the URRWMO with preparation of a 2015 Upper Rum River WMO Annual Report to BWSR and reporting to the State Auditor. This included:

- preparation of an unaudited financial report,
- a report to BWSR meeting MN statutes
- and the State Auditor's reporting forms through the State's SAFES website.

All were completed by the end of April 2016. The report to BWSR and financial report are available on the URRWMO website.

Report to BWSR Cover



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Upper Rum River WMO Annual Report 2015

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Upper Rum River Watershed Management Organization
9900 Nightingale Street NW
Oak Grove, MN 55011-9204

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Financial Summary

ACD accounting is organized by program and not by customer. This allows us to track all of the labor, materials and overhead expenses for a program. We do not, however, know specifically which expenses are attributed to monitoring which sites. To enable reporting of expenses for monitoring conducted in a specific watershed, we divide the total program cost by the number of sites monitored to determine an annual cost per site. We then multiply the cost per site by the number of sites monitored for a customer.

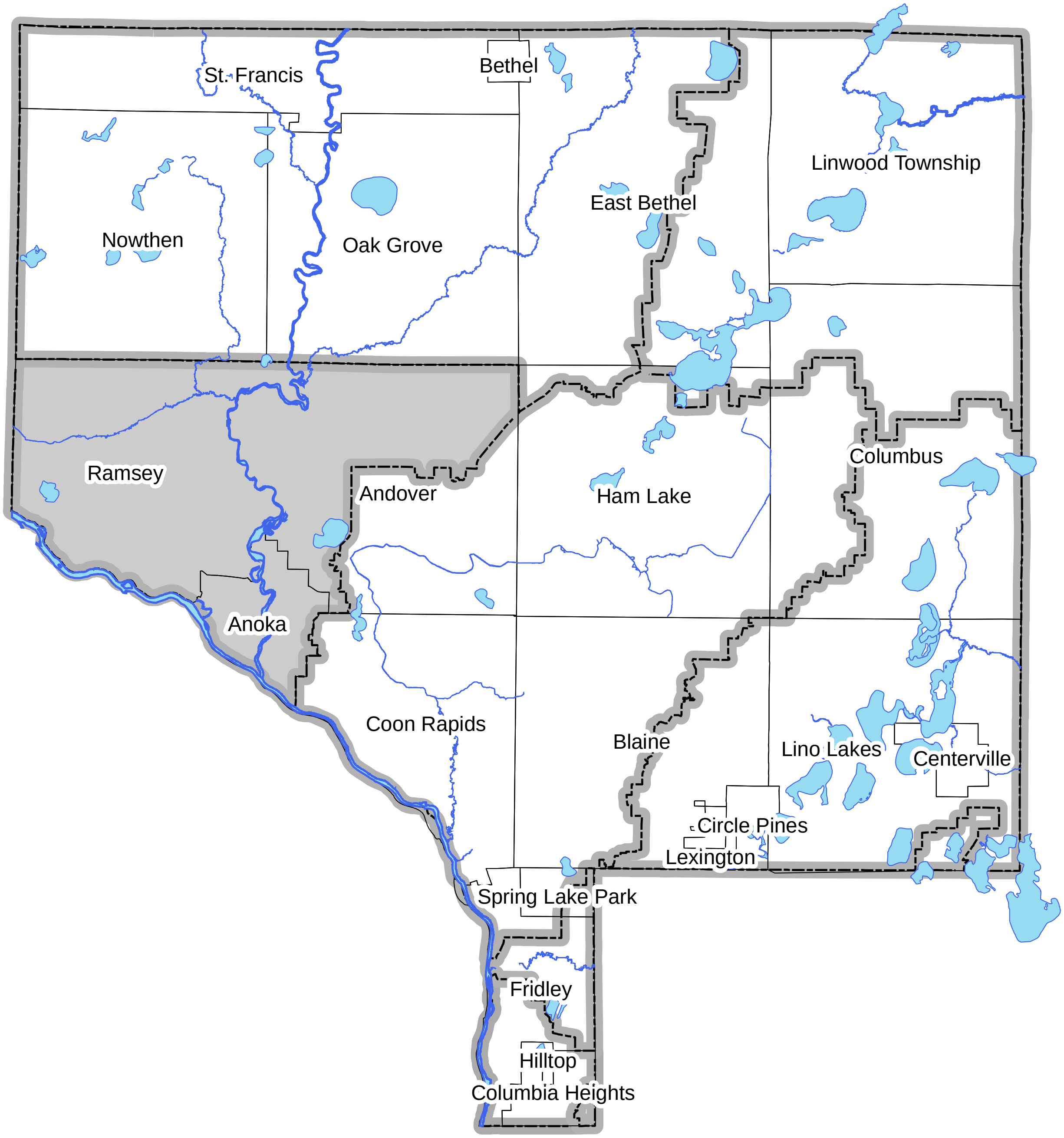
Upper Rum River Watershed Financial Summary

Upper Rum River Watershed	WMO Asst (no charge)	Volunteer Precip	Reference Wetlands	Ob Well	Lake Level	Lake WQ	Stream Level	Stream WQ	WOMP	Student Biomon	Lake George SRA Monitoring	URRWMO Admin	WMO Annual Rpts to State	URRWMO Outreach/Promo	WMO Website Maint	Kern Property Enhancement	Revetments on the Rum	Rum River 1W1P	Rum River WRAPP	Lake George Phase I SRA	City of St. Francis SRA	Lake George CLP Mapping	URRWMO Plan	Total
Revenues																								
URRWMO	0	0	1725	0	1000	0	0	4200	0	825	0	0	1000	500	508	0	0	0	0	0	0	0	0	9758
State	0	0	0	600	0	0	0	0	0	0	0	0	0	0	0	7724	8316	0	86431	4117	5530	0	0	112719
Anoka Co. General Services	390	0	53	586	601	61	24	0	214	407	2985	581	0	0	50	2099	1325	98	0	0	0	267	330	10071
Anoka Conservation District	0	0	115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	160	0	275
County Ag Preserves/Projects	0	0	0	0	0	0	0	0	0	475	9375	0	0	0	0	0	0	0	0	2107	0	0	0	11957
Service Fees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1716	1465	0	0	0	0	0	0	3181
Regional/Local	0	0	80	0	0	139	0	0	800	0	0	0	0	0	0	0	0	0	0	0	6500	1088	0	8608
BWSR Cons Delivery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BWSR Capacity Funds	0	0	3056	0	0	0	0	0	0	0	0	0	0	0	0	0	560	576	0	0	0	0	0	4193
BWSR Cost Share TA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metro ETA & AWQCP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4667	0	0	0	0	0	0	4667
Local Water Planning	0	1101	1519	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2620
TOTAL	390	1101	6549	1186	1601	200	24	4200	1014	1707	12360	581	1000	500	558	11540	16334	674	86431	6224	12030	1515	330	168049
Expenses-																								
Capital Outlay/Equip	5	14	40	14	19	15	22	20	12	19	3615	21	6	2	5	71	718	8	182	73	126	18	4	5026
Personnel Salaries/Benefits	339	1067	2952	1032	1393	1093	1620	1502	883	1432	4697	1590	431	116	352	5323	11766	586	13535	5415	9409	1318	287	68137
Overhead	25	78	217	76	102	80	119	110	65	105	345	117	32	9	26	392	865	43	996	398	692	97	21	5012
Employee Training	2	6	17	6	8	6	9	8	5	8	26	9	2	1	2	30	66	3	76	30	53	7	2	383
Vehicle/Mileage	7	23	62	22	29	23	34	32	19	30	99	34	9	2	7	113	249	12	286	114	199	28	6	1441
Rent	12	38	105	37	50	39	58	54	32	51	168	57	15	4	13	190	420	21	484	193	336	47	10	2435
Program Participants	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Program Supplies	0	-125	4018	0	0	444	5	794	0	61	1476	0	0	0	191	5421	2824	0	65890	0	0	0	0	80998
TOTAL	390	1101	7411	1186	1601	1700	1867	2520	1014	1707	10427	1827	495	134	596	11540	16909	674	81448	6224	10815	1515	330	163432

Recommendations

- **Integrate the Rum River WRAPP (Watershed Restoration and Protection Plan) into the URRWMO's activity plans.** This WRAPP is an assessment of the entire Rum River watershed, including recommended management strategies, that was produced by the MPCA and local water managers.
- **Collaborate on efforts to diagnose declining water quality in Lake George and fix it.** The Lake George Improvement District and the Anoka Conservation District have begun study of the issue and secured a state grant for partial funding.
- **Install projects identified in the St. Francis stormwater assessment** that is aimed at improving Rum River water quality. The study identified numerous stormwater treatment opportunities and ranking them by cost effectiveness. It lays the groundwork for project installations.
- **Participate with county and DNR efforts to upgrade the water control structure in Ditch 19, the main inlet to Lake George**. Residents have complained that condition of the ditch and water control structures are contributing to low lake water levels in recent years.
- **Update the URRWMO's water monitoring plan**, which expired in 2017.
- **Promote groundwater conservation.** Metropolitan Council models predict 3+ft drawdown of surface waters in parts of the URRWMO by 2030, and 5+ft by 2050.
- **Promote water quality improvement projects** for lakes, streams, and rivers. Cost share grants are available through the URRWMO and the ACD to encourage landowners to do projects that will have public benefits to water quality. Technical assistance for landowners is available through the Anoka Conservation District.

Lower Rum River Watershed



Contact Info: Lower Rum River Watershed Management Organization
www.lrrwmo.org
763-421-8999

Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 4:
LOWER RUM RIVER WATERSHED

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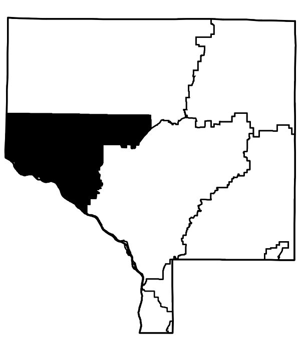
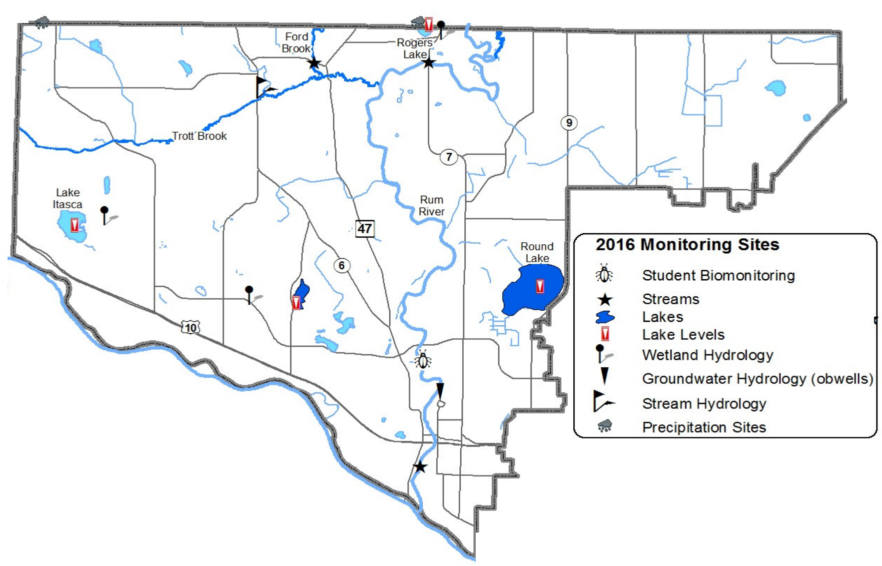
Precipitation	ACD, volunteers	Chapter 1

ACAP = Anoka County Ag Preserves, ACD = Anoka Conservation District, LRRWMO = Lower Rum River Watershed Mgmt. Org, MC = Metropolitan Council, MNDNR = MN Dept. of Natural Resources, LSOHC = Lessard-Sams Outdoor Heritage Council





Lake Level Monitoring

Description: Weekly water level monitoring in lakes. The past five and twenty five years of data are illustrated below, and all historical data are available on the Minnesota DNR website using the "LakeFinder" feature (www.dnr.mn.us.state\lakefind\index.html).

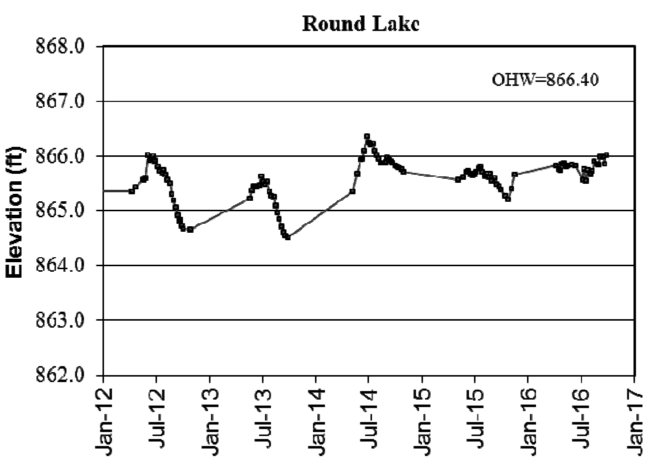
Purpose: To understand lake hydrology, including the impacts of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

Locations: Round, Rogers, Itasca, and Sunfish/Grass Lakes

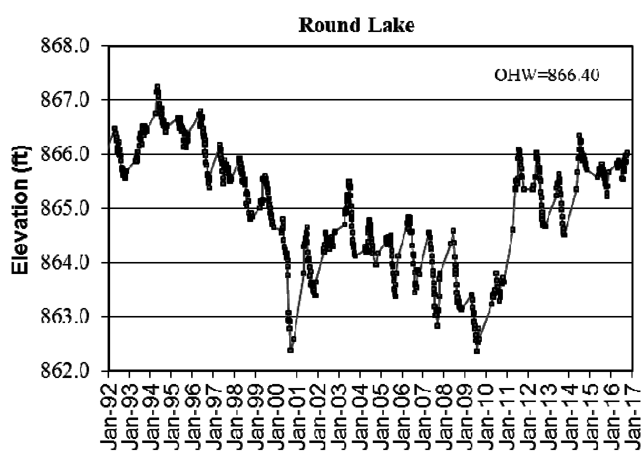
Results: Lake levels were measured by volunteers throughout the 2016 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. 2016 was an especially wet year, and lake levels increased or were maintained throughout the growing season and into late fall/ Average lake levels were similar or slightly higher than 2015.

All lake level data can be downloaded from the MN DNR website's Lakefinder feature. Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is listed for each lake on the corresponding graphs below.

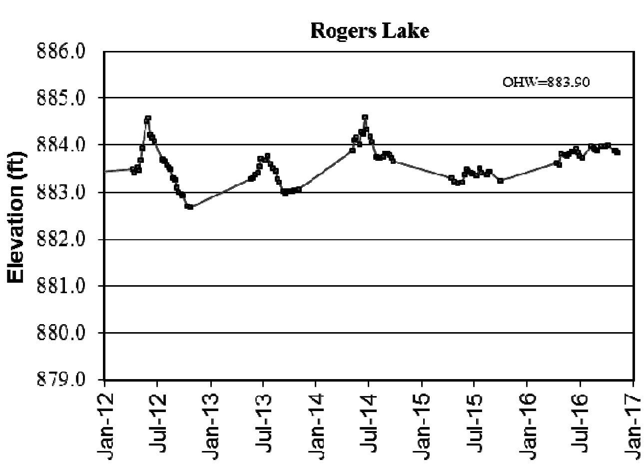
Round Lake Levels – last 5 years



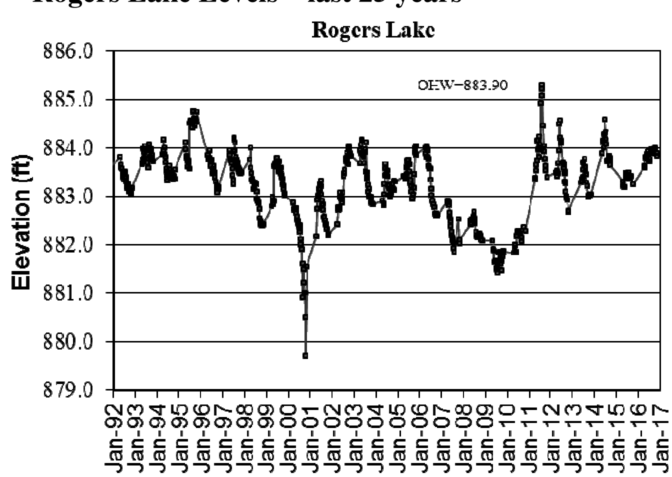
Round Lake Levels – last 25 years



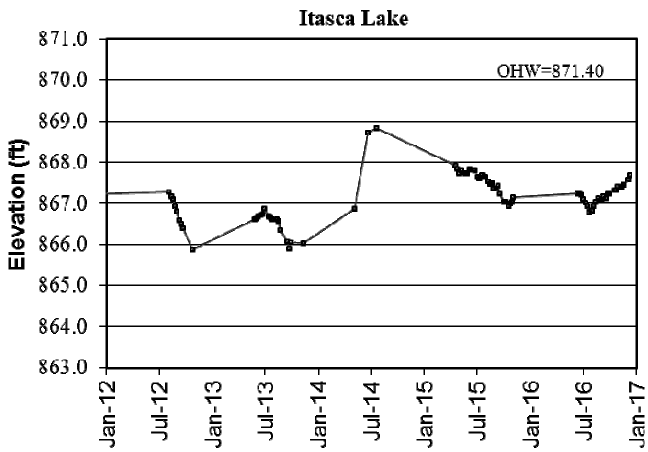
Rogers Lake Levels – last 5 years



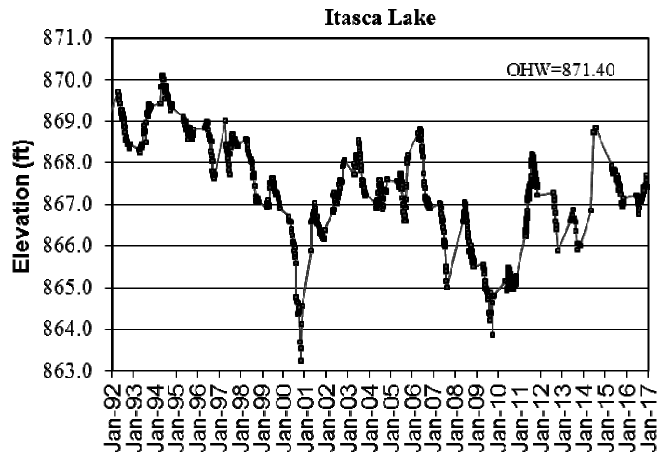
Rogers Lake Levels – last 25 years



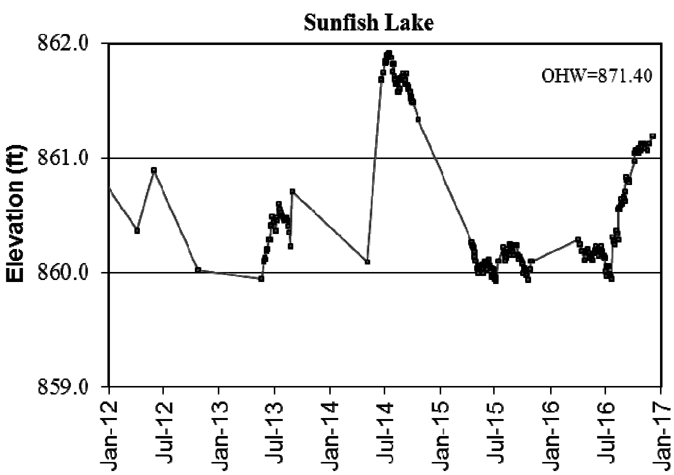
Itasca Lake Levels – last 5 years



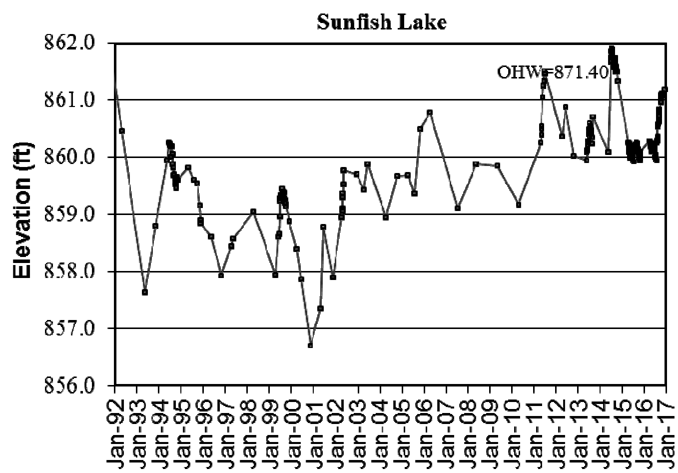
Itasca Lake Levels – last 25 years



Sunfish/Grass Lake Levels – last 5 years



Sunfish/Grass Lake Levels – last 25 years



Lake Water Quality

Description: May through September, every-other-week, monitoring is conducted for the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

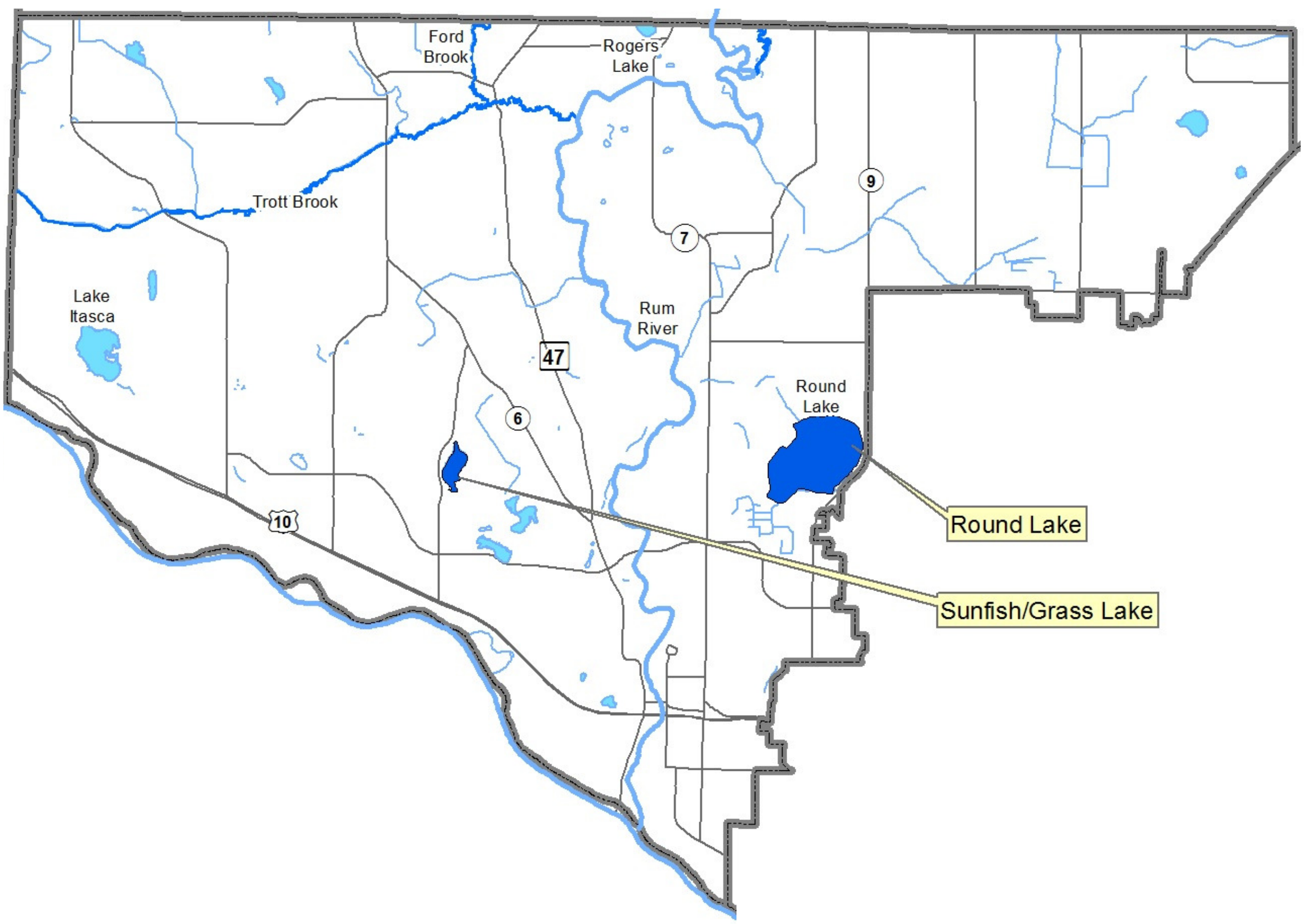
Purpose: To detect water quality trends and diagnose the cause of changes.

Locations: Round Lake

Sunfish/Grass Lake

Results: Detailed data for each lake are provided on the following pages, including summaries of historical conditions and trend analysis. Previous years' data are available from the ACD. Refer to Chapter 1 for additional information on lake dynamics and interpreting the data.

LRRWMO Lake Water Quality Monitoring Sites



Round Lake
City of Andover, Lake ID # 02-0089

Background

Round Lake is located in southwest Anoka County. It has a surface area of 220 acres and maximum depth of 19 feet, though the majority of the lake is less than 4 feet deep. The lake is surrounded by cattails and has submerged vegetation interspersed throughout the basin. This lake has a small watershed, with a watershed to surface area ratio of less than 10:1. Public access is from a dirt ramp on the lake's southeast side. Almost no boating occurs with mostly wintertime fishing on the lake. Wildlife, especially waterfowl, usage of the lake is relatively high.

2016 Results

In 2016 Round Lake's water quality was very good compared with other lakes in this region (NCHF Ecoregion) receiving an overall A letter grade. The average of both total phosphorus (17.0 ug/L) and chlorophyll-a (2.2 ug/L) were the second lowest on record, beat out only by 2015 results. Secchi transparency was 10.9 feet, the third best ever observed. It is important to note that the true Secchi transparency average was deeper than 10.9 feet because one reading was not used in the average calculatin since clarity exceeded the water depth at the sampling point on that day. Phosphorus and algae were fairly consistent without indication of any seasonal fluctuation.

Trend Analysis

Eleven years of water quality monitoring has been conducted by the Anoka Conservation District (1998-2000, 2003, 2005, 2007, and 2009-2010, 2012, 2014, 2016), which is a marginal number of years for a powerful statistical test of trend analysis. In 2010, the results of the analysis indicated a significant trend of declining water quality across the years studied to that point (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,5} = 9.6065$, $p = 0.0194$). When the analysis is run on all data to date, including the exceptional water quality observed since 2012, no significant water quality changes are apparent ($F_{2,8} = 0.41$, $p = 0.49$).

Discussion

2016 was the third consecutive monitoring year in which exceptional water quality was observed in Round Lake, earning an A letter grade each year. There was growing concern about a trend toward poorer water quality before 2010. Phosphorus and chlorophyll-a had increased substantially in each of four monitored years from 2005-2009. These were years of low lake levels. There was speculation that in-lake sources of nutrients, driven by sediment mixing, were a source of phosphorus. During low water conditions, there is more wind mixing due to shallow water depths, and in these years, there was also a conspicuous reduction of chara (a plant-like algae) carpeting the bottom. Since 2012, water levels have recovered substantially and water quality has dramatically improved. It does seem that low water levels in Round Lake lead to poorer water quality. Additional monitoring in the future can help verify this.

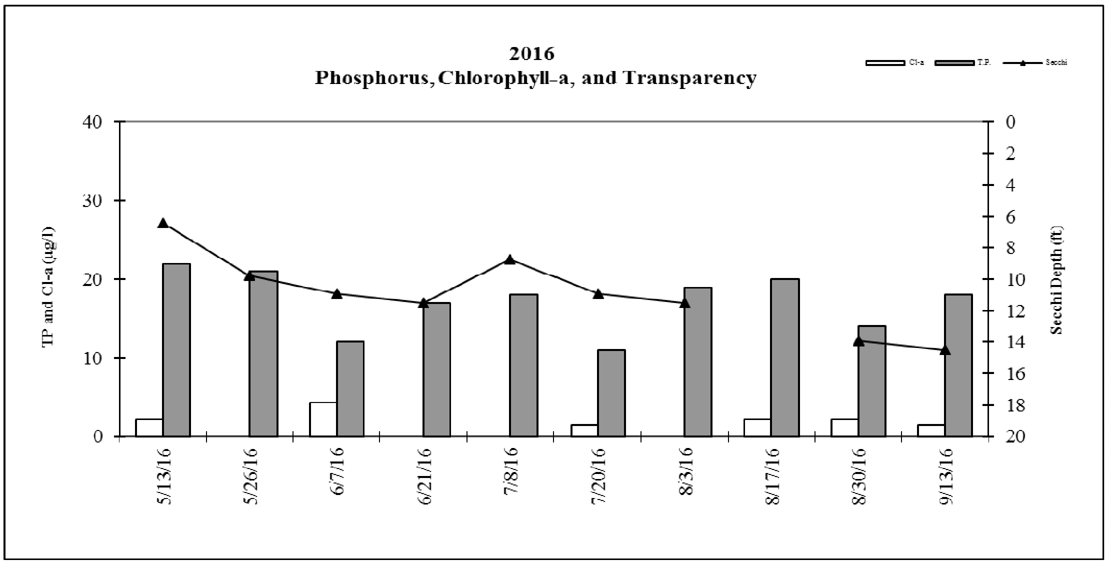
Since at least the 1980s, there have been complaints about low water levels in Round Lake. The lake has few surface water in-flows, so groundwater is important to lake hydrology. There have been concerns that local surficial groundwater levels, and hence the lake, are negatively impacted by a variety of causes including irrigation, residential groundwater use, stormwater management, road embankments, and others. Groups including the MN DNR, the Anoka Conservation District, watershed organizations, and cities have studied each potential cause. None has been found to cause lower-than-expected lake levels. There is evidence that Round Lake levels do behave differently from other nearby lakes. Moreover, studies by the Metropolitan Council and others have found regional surficial water tables are being drawn down by groundwater pumping in some area of the metro metro. Several lakes, including Round and Bunker Lakes, are potentially affected by this groundwater overuse. Conservation of groundwater must become a regional and local priority.

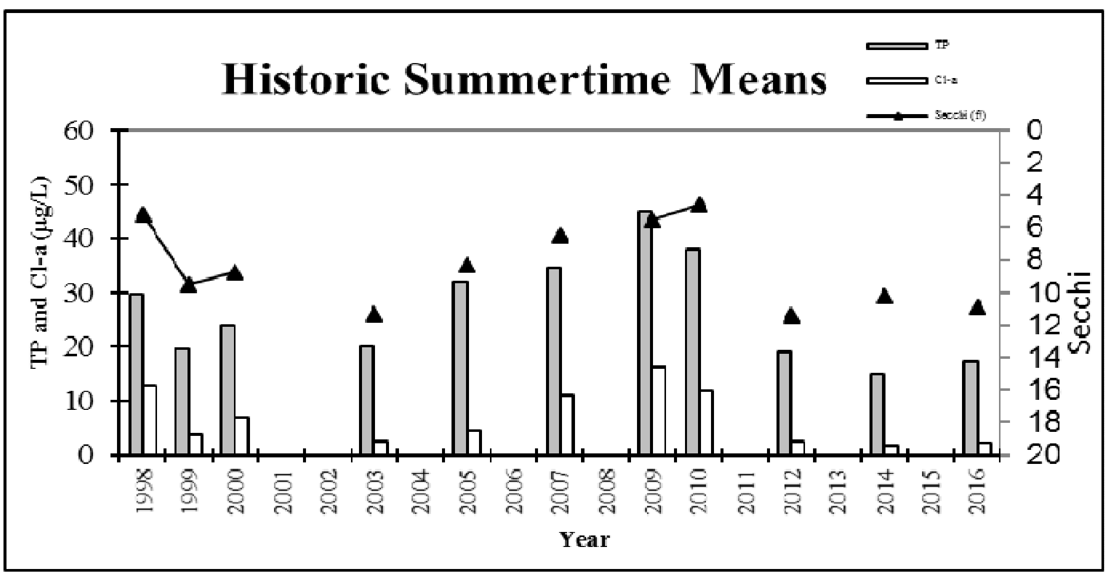
2016 Round Lake Water Quality Data

Round Lake
2016 Water Quality Data

		Date:	5/13/2016	5/26/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/3/2016	8/17/2016	8/30/2016	9/13/2016			
		Time:	11:45	9:45	12:30	10:50	10:25	10:05	11:45	9:45	11:00	9:45			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.55	8.60	8.81	9.04	8.83	9.41	9.32	8.83	8.32	8.20	8.79	8.20	9.41
Conductivity	mS/cm	0.01	0.378	0.369	0.364	0.292	0.299	0.298	0.291	0.321	0.313	0.289	0.321	0.289	0.378
Turbidity	FNRU	1	9.50	2.20	4.80	3.40	13.80		0.00	4.80	2.80	3.30	5	0	14
D.O.	mg/l	0.01	10.18	9.85	10.20	9.26	7.92	10.30	11.01	7.78	8.31	8.41	9.32	7.78	11.01
D.O.	%	1	100%	116%	115%	115%	100%	128%	143%	96%	101%	94%	111%	94%	143%
Temp.	°C	0.1	14.0	21.9	20.2	24.8	24.8	26.6	27.8	24.9	23.6	20.4	22.9	14.0	27.8
Temp.	°F	0.1	57.1	71.3	68.3	76.7	76.7	80.0	82.1	76.8	74.4	68.6	73.2	57.1	82.1
Salinity	%	0.01	0.18	0.18	0.17	0.14	0.14	0.14	0.14	0.15	0.15	0.14	0.15	0.14	0.18
Cl-a	ug/L	0.5	2.1	<1	4.3	<1	<1	1.4	<1	2.1	2.1	1.4	2.2	1.4	4.3
T.P.	mg/l	0.010	0.022	0.021	0.012	0.017	0.018	0.011	0.019	0.020	0.014	0.018	0.017	0.011	0.022
T.P.	ug/l	10	22	21	12	17	18	11	19	20	14	18	17.2	11	22
Secchi	ft		6.4	9.8	10.9	11.5	8.8	10.9	11.5		13.9	14.5	10.9	6.4	14.5
Secchi	m		2.0	3.0	3.3	3.5	2.7	3.3	3.5	0.0	4.2	4.4	3.3	2.0	4.4
Field Observations			Fairly clear.	Light brown	Clear		Fairly clear,	Clear, light g	Very clear	Very clear	Clear				
Physical			2	2.0	1.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.5	1.0	2.0
Recreational			1.5	2.0	1.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.7	1.0	2.0

*reporting limit





Round Lake Historic Summertime Mean Values

Agency	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1998	1999	2000	2003	2005	2007	2009	2010	2012	2014	2016
TP	29.8	19.6	24.1	20.0	32.0	34.7	45.0	38.0	19.0	15.0	17
Cl-a	12.8	3.7	6.9	2.4	4.6	10.9	16.2	11.8	2.5	1.8	2.2
Secchi (n	1.60	2.90	2.67	3.40	2.50	2.00	1.70	1.40	3.50	3.10	3.3
Secchi (f	5.2	9.5	8.8	11.3	8.3	6.5	5.5	4.6	11.4	10.2	10.9

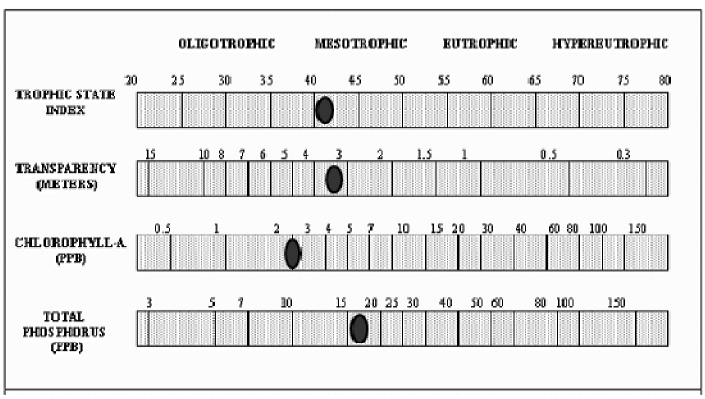
Carlsons Trophic state indices

TSIP	53	47	50	47	54	55	59	57	47	43	45
TSIC	56	44	49	39	46	54	58	55	40	36	38
TSIS	53	45	46	42	47	50	52	55	42	44	43
TSI	54	45	48	43	49	53	56	56	43	41	42

Round Lake Water Quality Report Card

Year	1998	1999	2000	2003	2005	2007	2009	2010	2012	2014	2016
TP	B	A	B	A	B	C	C	C	A	A	A
Cl-a	B	A	A	A	A	B+	B	B	A	A	A
Secchi	C	B	B	A	B	C	C	C	A-	A	A
Overall	**B**	**A**	**B**	**A**	**B**	**C**	**C**	**C**	**A**	**A**	**A**

Carlson's Trophic State Index



Sunfish/Grass Lake

City of Ramsey, Lake ID #02-0113

Background

Grass Lake is located in the City of Ramsey in southwestern Anoka County. It is a rather small lake with a surface area of 35 acres. The lake does not have a public boat landing, but can be accessed through Sunfish Lake Park on the west side of the lake. The park has a fishing pier and kayaks, which can both be used by the public. The lake is quite shallow with floating leaf, emergent and submergent aquatic vegetation throughout. A v portion of the shoreline is developed with most of the lake being surrounded by park or wooded land.

2016 Results

2016 was the first year in which the Anoka Conservation District (ACD) monitored Sunfish/Grass Lake as part of the regular lake sampling efforts. The lake has been monitored two other years through the MPCA Citizen Monitoring Program (CLMP). In 2016 Sunfish Lake's water quality was neither exceptionally good nor especially bad compared with other lakes in this region (NCHF Ecoregion), receiving an overall B letter grade. The average total phosphorus (25 ug/L) was at a typical level for this ecoregion, and was acceptably low compared to the state water quality standard of 60 ug/L for shallow lakes in the NCHF Ecoregion. The average concentration of chlorophyll-a (4.4 ug/L) was the lowest in the three years of data and was acceptably low compared to the state standard of 20 ug/L. On many sampling occasions, the secchi transparency exceeded the lake's depth. .

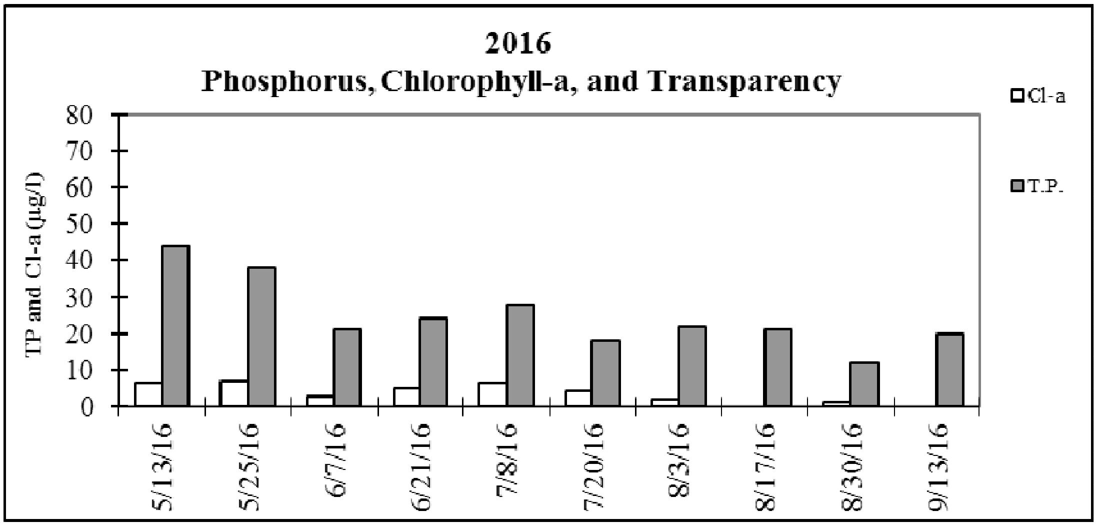
Discussion

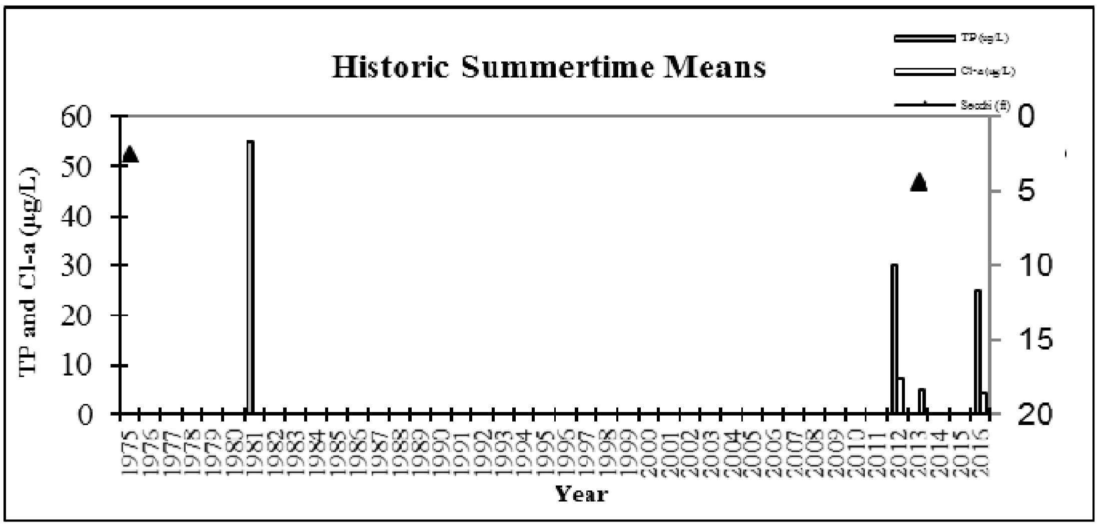
Grass Lake looks to be in good health, receiving an overall B letter grade in each of the three years monitored since 2012. This letter grade would likely be even higher in 2016 if Secchi readings were not limited by the depth of the lake. There is not enough data for a trend analysis. Secchi transparency and chlorophyll-a have improved in each year monitored, but no true trend may exist.

Sunfish Lake
2016 Water Quality Data

			5/13/2016	5/25/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/3/2016	8/17/2016	8/30/2016	9/13/2016			
			11:00	9:45	11:40	10:05	9:45	9:15	11:00	9:00	10:15	9:10			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.61	8.75	8.72	8.71	8.44	9.11	9.36	9.04	8.59	8.17	8.75	8.17	9.36
Conductivity	mS/cm	0.01	0.417	0.417	0.401	0.344	0.364	0.357	0.331	0.357	0.350	0.339	0.368	0.331	0.417
Turbidity	NTU	1	25.9	3.9	12	10	22		0	14	2	10	11	0	26
D.O.	mg/L	0.01	10.99	12.10	11.45	9.37	8.37	10.48	12.80	9.61	9.97	8.94	10.41	8.37	12.80
D.O.	%	1	112	141	132	119	106	136	167	121	121	99	125	99	167
Temp.	°C	0.1	14.9	22.1	21.0	25.7	24.6	26.7	28.1	25.4	24.1	20.4	23.3	14.9	28.1
Temp.	°F	0.1	58.7	71.8	69.7	78.3	76.4	80.1	82.7	77.8	75.4	68.7	74.0	58.7	82.7
Salinity	%	0.01	0.20	0.20	0.19	0.17	0.18	0.17	0.16	0.18	0.17	0.16	0.18	0.16	0.20
Cl-a	ug/L	0.5	6.4	7.1	2.8	5.0	6.4	4.3	2.1	<1	1.4	<1	4.4	1.4	7.1
T.P.	mg/L	0.010	0.044	0.038	0.021	0.024	0.028	0.018	0.022	0.021	0.012	0.020	0.025	0.012	0.044
T.P.	ug/L	10	44	38	21	24	28	18	22	21	12	20	25	12	44
Secchi	ft	0.1	3.6	4.0	4.8	>5.0	3.3	>5.08	>4.83	>4.83	>5.5	5.5	4.2	3.3	5.5
Secchi	m	0.1	1.1	1.2	1.4	>1.52	1.0	>1.55	>1.47	>1.47	>1.68	1.7	1.3	1.0	1.7
Physical			3	3	3	3	3	2	1	1	1	1	2.1	1.0	3.0
Recreational			3	3	3	3	3	2	2	3	2	1	2.5	1.0	3.0

*reporting limit

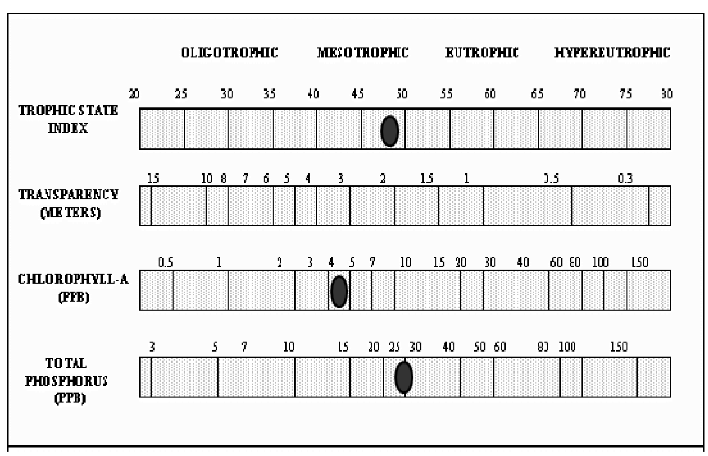




Sunfish Lake Historical Summertime Mean Values

Agency	CLMP	CLMP		ACD
Year	2012	2013	2015	2016
TP (µg/L)	30.0			25.0
Cl-a (µg/L)	7.1	5.0		4.4
Secchi (m)	1.2	1.3		na
Secchi (ft)	3.9	4.4		na
Carlson's Trophic State Index				
TSIP	53			51
TSIC	50	46		45
TSIS	57	56		na
TSI	53	51		48
Sunfish Lake Water Quality Report Card				
Year	2012	2013	2015	2016
TP (µg/L)	B			C
Cl-a (µg/L)	A	A		A
Secchi (m)	C	C		na
Overall	**B**	**B**		**B**

Carlson's Trophic State Index



Stream Water Quality - Chemical Monitoring

Description: In 2016, monitoring events were scheduled May through September for each of the following parameters: total suspended solids, total phosphorus, Secchi tube transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

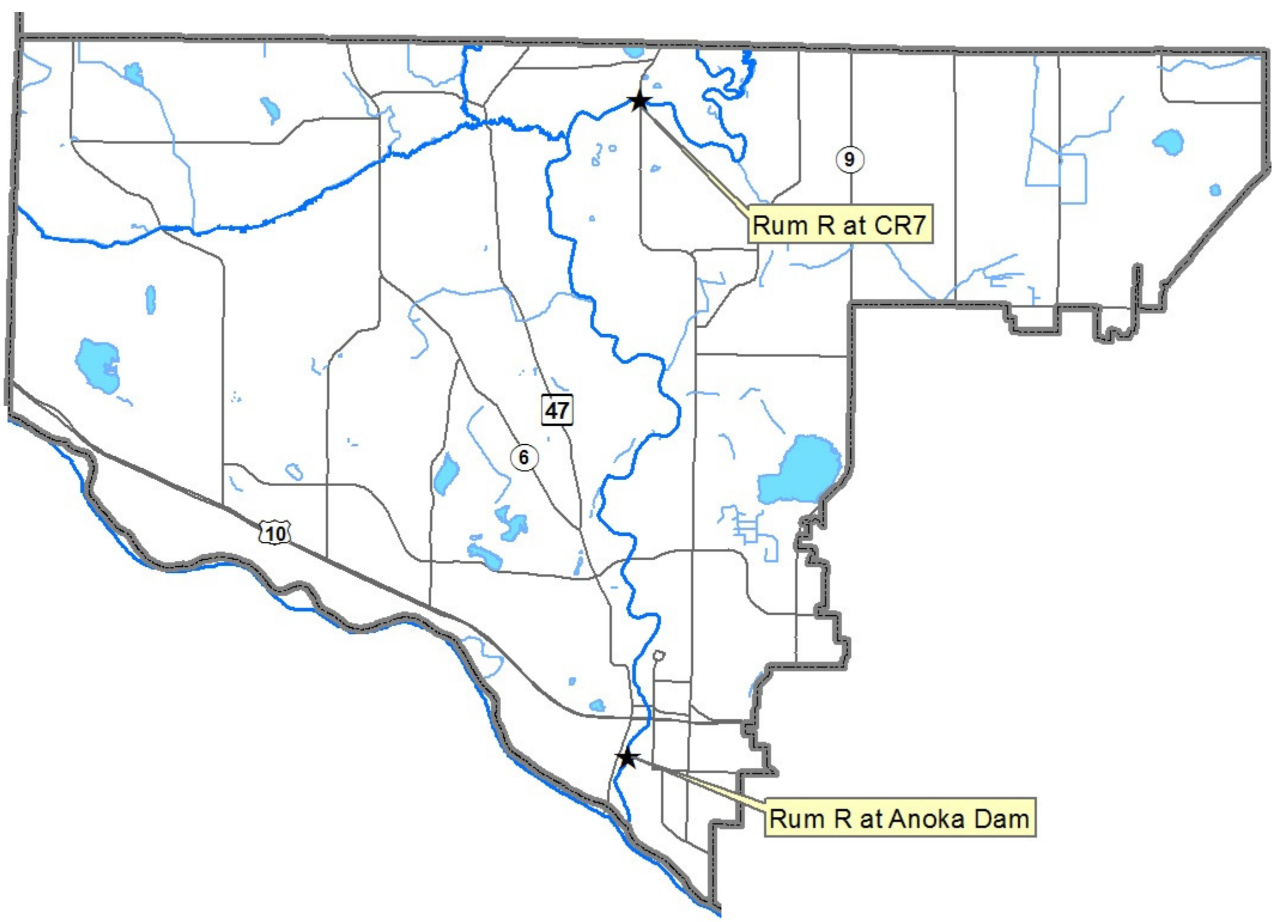
Purpose: To provide an assessment of water quality to be used in the completion of the Rum River Watershed Restoration and Protection Plan (WRAPP).

Locations: Rum River at County Road 7

Rum River at Anoka Dam

Results: Results are presented on the following pages.

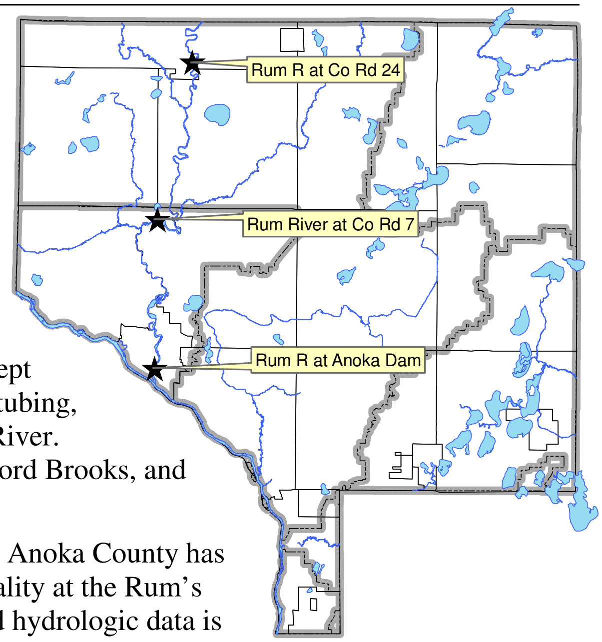
2016 Lower Rum River Monitoring Sites



RUM RIVER

Rum River at Co. Rd. 24 (Bridge St), St. Francis*	STORET SiteID =	S000-066
Rum River at Co. Rd. 7 (Roanoke St), Ramsey	STORET SiteID =	S004-026
Rum River at Anoka Dam, Anoka	STORET SiteID =	S003-183

*Located in and contracted by the URRWMO, but reported with all Rum River data for a more complete analysis of the river.



Years Monitored

At Co. Rd. 24 – 2004, 2009, 2010, 2011, 2014, 2015, 2016

At Co. Rd. 7 – 2004, 2009, 2010, 2011, 2014, 2015, 2016

At Anoka Dam – 1996-2011(MC WOMP), 2015, 2016

Background

The Rum River is regarded as one of Anoka County's highest quality and most valuable water resources. It is designated as a state scenic and recreational river throughout Anoka County, except south of the county fairgrounds in Anoka. It is used for boating, tubing, and fishing. Much of western Anoka County drains to the Rum River. Subwatersheds that drain to the Rum include Seelye, Trott, and Ford Brooks, and Cedar Creek.

The extent to which water quality improves or is degraded within Anoka County has been unclear. The Metropolitan Council has monitored water quality at the Rum's outlet to the Mississippi River since 1996. This water quality and hydrologic data is well suited for evaluating the river's water quality just before it joins the Mississippi River. Monitoring elsewhere has occurred only in more recent years. Water quality changes might be expected from upstream to downstream because land use changes dramatically from rural residential in the upstream areas of Anoka County to suburban in the downstream areas.

Methods

In 2004, 2009- 2011 and 2014-2016 monitoring was conducted to determine if Rum River water quality changes in Anoka County, and if so, generally where changes occur. The data is reported together for a more comprehensive analysis of the river from upstream to downstream.

In 2016 the river was monitored during both storm and baseflow conditions by grab samples. At the two downstream locations, eight water quality samples were taken; half during baseflow and half following storms. At the upstream site, only four samples were taken due to lower funding levels. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. In some years, particularly the drought year of 2009, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus and total suspended solids. During every sampling event, the water level (stage) was recorded. The monitoring station at the Anoka Dam includes automated equipment that continuously tracks water levels and calculates flows. Water level and flow data for other sites was obtained from the US Geological Survey, who maintains a hydrological monitoring site at Viking Boulevard.

The purpose of this report is to make an upstream to downstream comparison of Rum River water quality. It includes only parameters tested in 2016. It does not include additional parameters tested at the Anoka Dam or additional monitoring events at that site. For that information, see Metropolitan Council reports at http://www.metrocouncil.org/Environment/RiversLakes. All other raw data can be obtained from the Anoka Conservation District, and is also available through the Minnesota Pollution Control Agency's EQuIS database, which is available through their website.

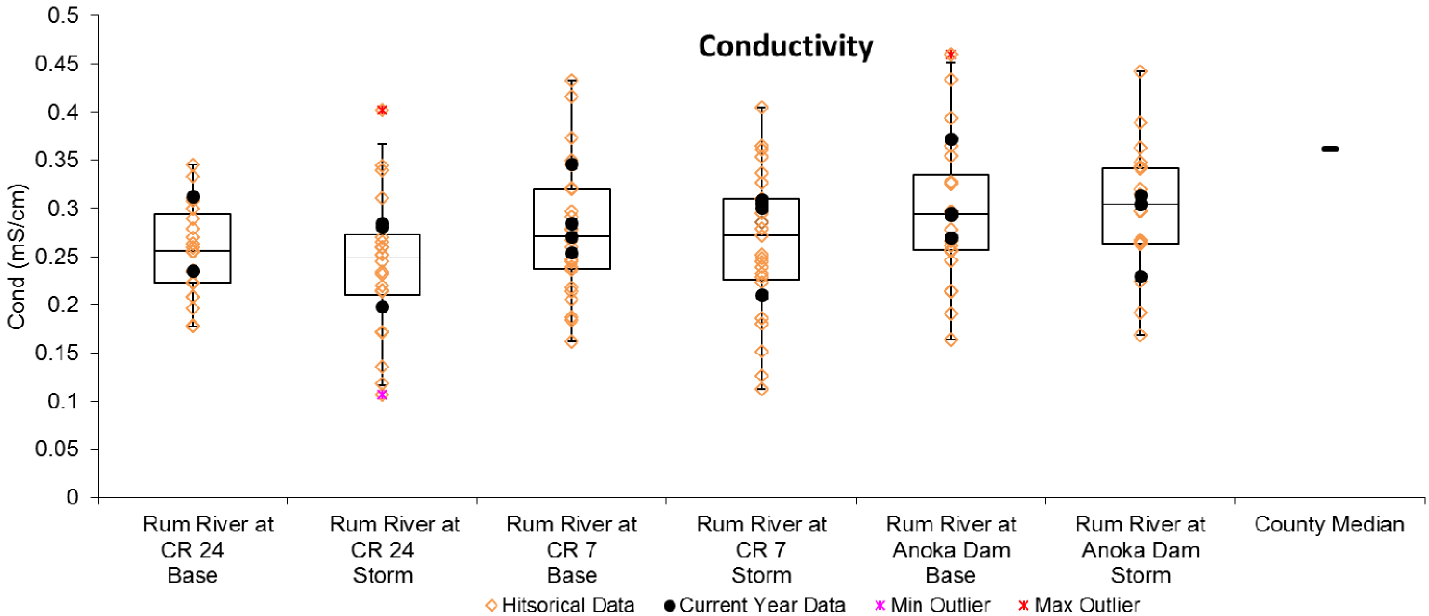
Results and Discussion

On the following pages data are presented and discussed for each parameter. Management recommendations will be included at the conclusion of this report. The Rum River is an exceptional waterbody, and its protection and improvement should be a high priority.

Conductivity

Conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include road runoff and industrial chemicals, among many others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we used. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides are the measure of chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community. They can also be of concern because the Rum River is upstream from the Twin Cities drinking water intakes on the Mississippi River.

Conductivity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Conductivity is acceptably low in the Rum River, but increases downstream (see figures above) and is usually higher during baseflow. Median conductivity from upstream to downstream of the sites monitored in 2016 (all conditions) was 0.281 mS/cm, 0.293 and 0.300 mS/cm, respectively. All three sites are lower than the median for 34 Anoka County streams of 0.362 mS/cm. The 2016 maximum observed conductivity in the Rum River was 0.37 mS/cm which is the close to the median for all other Anoka County streams, and levels in general were far lower than in 2015.

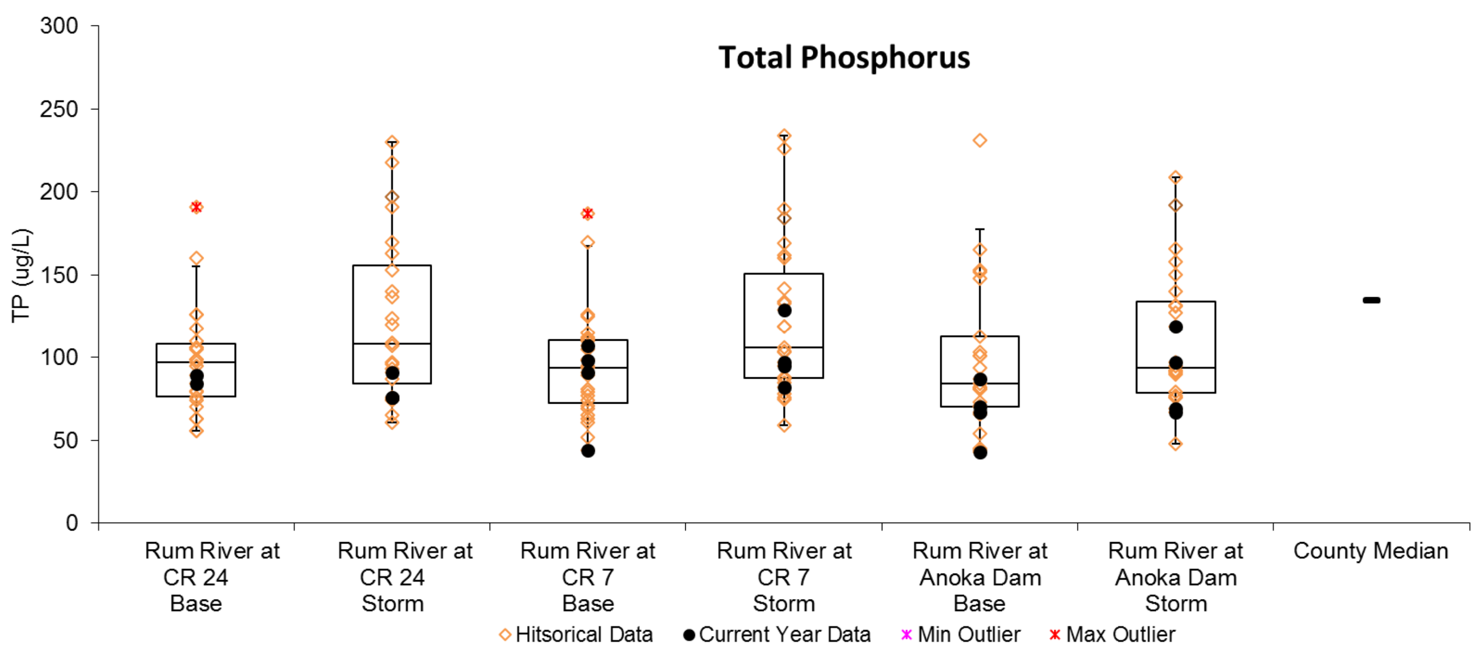
Conductivity was lowest at most sites during storms, suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow conductivity has been observed in most other nearby streams as well. This occurrence has been studied extensively, and the largest cause has been found to be road salts that have infiltrated into the shallow aquifer. Geologic materials also contribute, but to a lesser degree.

Conductivity increased from upstream to downstream. During baseflow, this increase from upstream to downstream reflects greater road densities and deicing salt application. During storms, the higher conductivity downstream is reflective of greater stormwater runoff and pollutants associated with the more densely developed lower watershed.

Total Phosphorus

Total phosphorus in the Rum River is acceptably low and is lower than the median for all other monitored 34 Anoka County streams (see figure below). 2016 readings averaged lower than 2015 results, which had a marked decrease from 2014 results. This nutrient is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. The median phosphorus concentration in 2016 at the three monitored sites (all conditions) was 84, 96 and 87 ug/L. These upstream-to-downstream differences are negligible and there is no trend of increasing phosphorus downstream. All sites in 2016 had phosphorus concentrations lower than the median for Anoka County streams of 135 ug/L. In 2015 the highest observed total phosphorus reading was during one particular storm event, with a maximum of 132. In all, phosphorus in the Rum River is below the state standard of 100 ug/L, but should continue to be an area of pollution control effort as the area continues to be developed.

Total phosphorus during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Turbidity and Total Suspended Solids (TSS)

Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by the refraction of a light beam passed through a water sample. It is most sensitive to large particles. Total suspended solids is measured by filtering solids from a water sample and weighing the filtered material. The amount of suspended material is important because it affects transparency and aquatic life, and because many other pollutants are attached to particles. Many stormwater treatment practices such as street sweeping, sumps, and stormwater settling ponds target sediment and attached pollutants. In 2016, suspended solids in the Rum River were acceptably low.

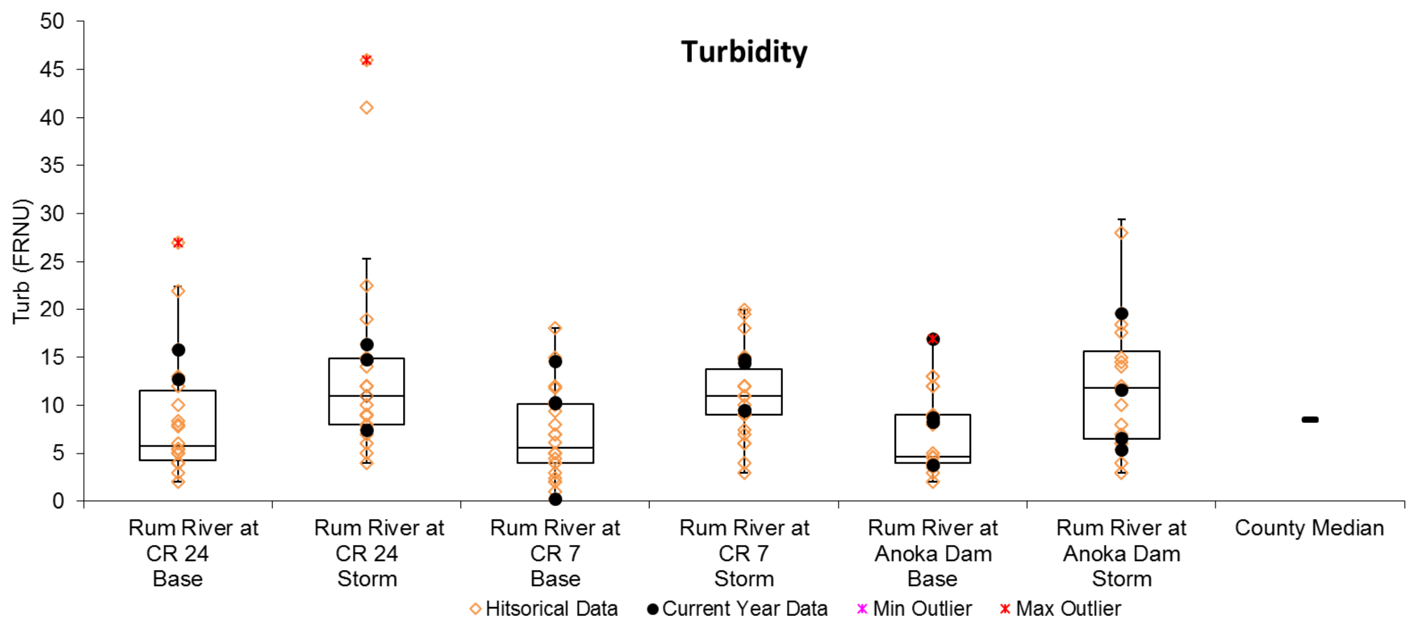
It is important to note the suspended solids can come from sources within and outside of the river channel. Sources on land include soil erosion, road sanding, and others. Riverbank erosion and movement of the river bottom also contributes to suspended solids. A moderate amount of this "bed load" is natural and expected.

In the Rum River, turbidity was low with increases during storms and a slight decrease at downstream monitoring sites (see figure below). The median turbidity, in 2016 (all conditions) was 14.8, 10.3 and 8.5 NTU (upstream to downstream), which is somewhat higher than the median for Anoka County streams of 8.5 NTU. Turbidity was elevated on a few occasions, especially during storms. In 2016 the maximum observed was 19.6 NTU during a mid-season monitoring event.

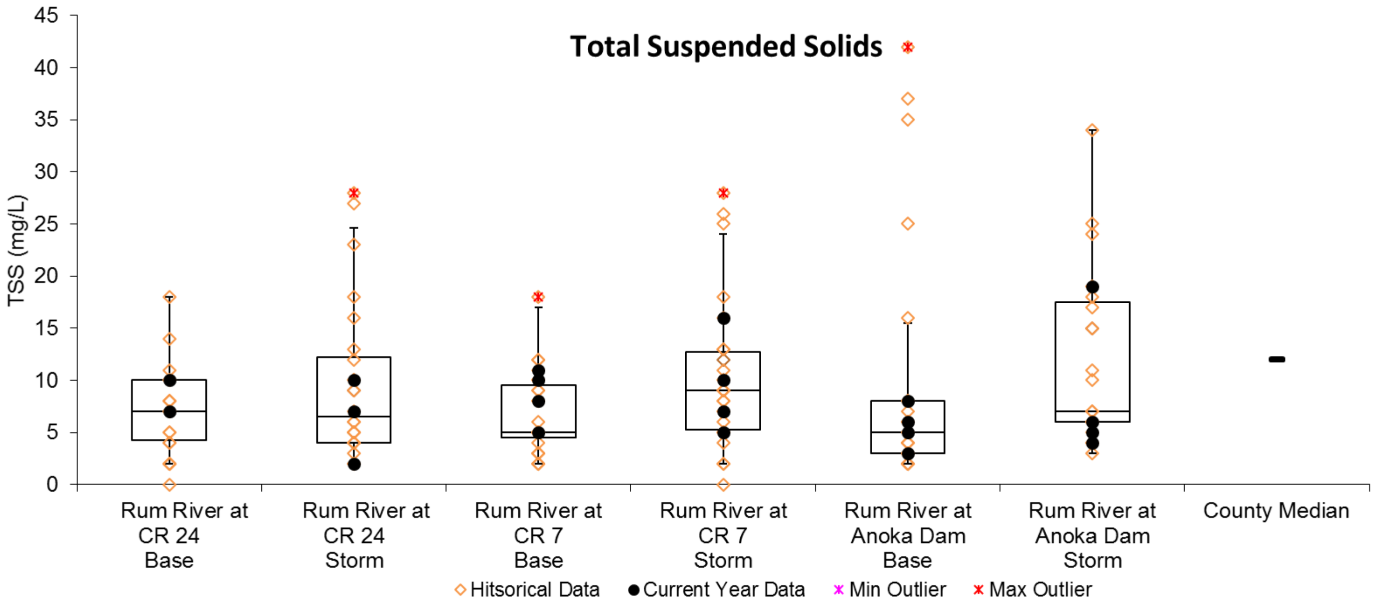
TSS in 2016 was similar to 2015 results. The median TSS, in 2016 (all conditions) was 7, 9 and 5.5 (upstream to downstream). These are all lower than the Anoka County stream median for TSS of 12.

Rigorous stormwater treatment should occur as the Rum River watershed continues to be developed, or the collective pollution caused by many small developments could seriously impact the river. Bringing stormwater treatment up to date in older developments is also important.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



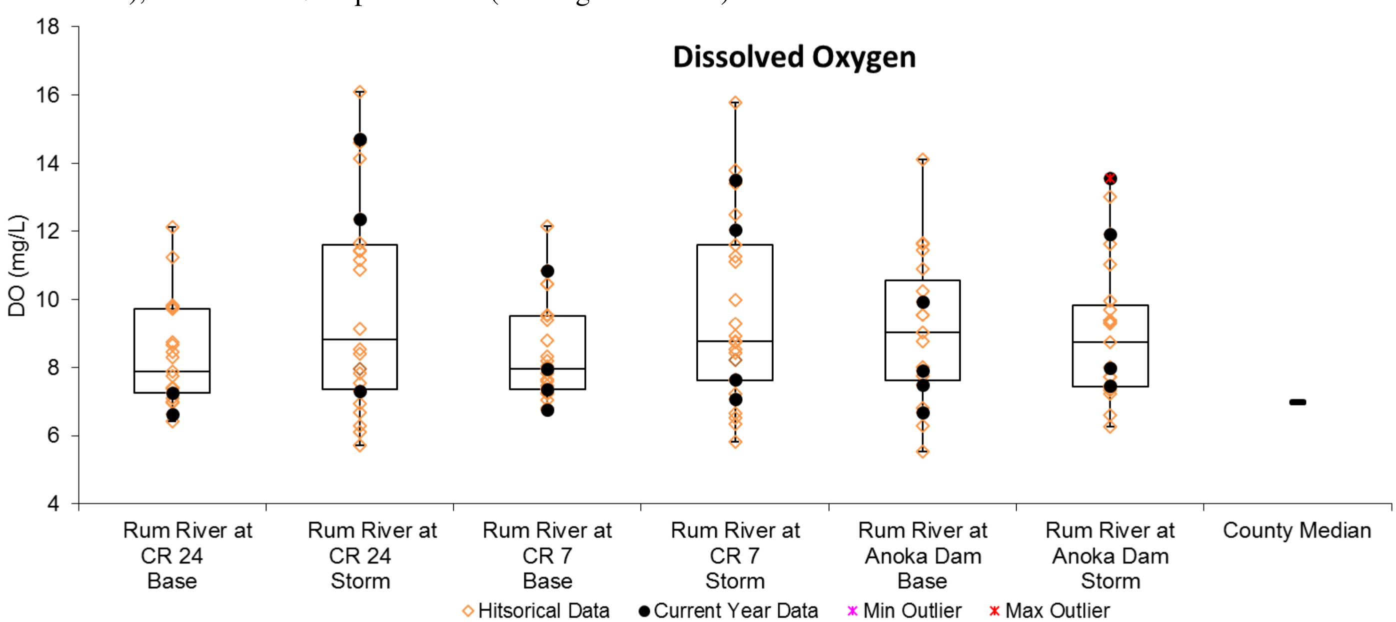
Total suspended solids during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution causes oxygen to be consumed when it decomposes. If oxygen levels fall below the state water quality standard of 5 mg/L, aquatic life begins to suffer. A stream is considered impaired if 10% of observations are below this level in the last 10 years. Dissolved oxygen levels are typically lowest in the early morning because of decomposition consuming oxygen at night without offsetting oxygen production by photosynthesis. In the Rum River, dissolved oxygen was always above 5 mg/L at all monitoring sites, with 6.62 mg/L being the lowest level recorded in 2016.

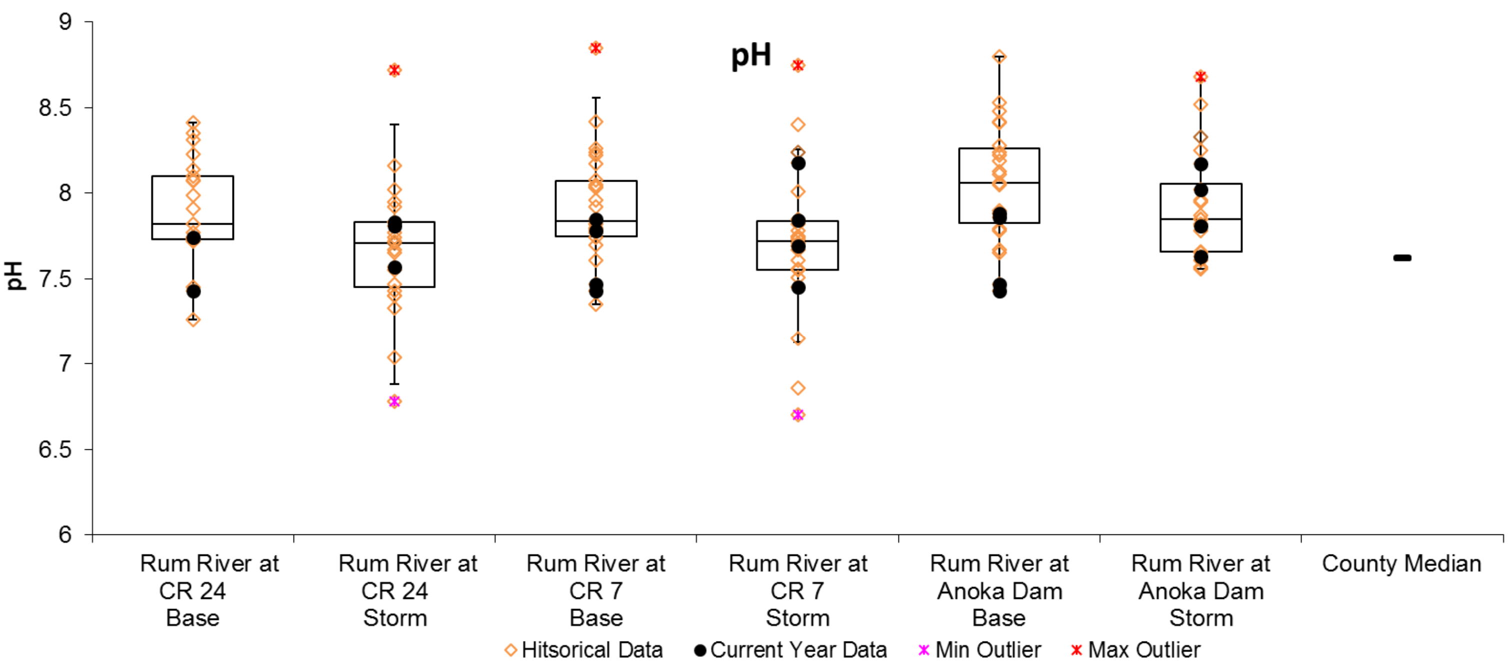
Dissolved oxygen during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

pH refers to the acidity of the water. The Minnesota Pollution Control Agency's water quality standard is for pH to be between 6.5 and 8.5. The Rum River is generally within this range and easily remained so in 2016 (see figure below).

pH during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2016 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Summary and Recommendations

The Rum River's water quality is good. It does show a slight increase in conductivity downstream. Phosphorus levels are near, but slightly below, state water quality standards. Protection of the Rum River should be a high priority for local officials. Large population increases are expected for the Rum River's watershed within Anoka County, and this continued development has the potential to degrade water quality unless carefully planned and managed with the river in mind. Development pressure is likely to be especially high near the river because of its scenic and natural qualities.

Stream Water Quality – Biological Monitoring

Description: This program combines environmental education and stream monitoring. Under the supervision of the ACD staff, high school science classes collect aquatic macroinvertebrates from a stream, identify their catch to the family level, and use the resulting numbers to gauge water and habitat quality. These methods are based upon the knowledge that different families of macroinvertebrates have different water and habitat quality requirements. The families collectively known as EPT (Ephemeroptera, or mayflies; Plecoptera, or stoneflies; and Trichoptera, or caddisflies) are generally pollution intolerant. Other families can thrive in low quality water. Therefore, a census of stream macroinvertebrates yields information about stream health.

Purpose: To assess stream quality, both independently as well as by supplementing chemical data. To provide an environmental education service to the community.

Location: Rum River behind Anoka High School, south side of Bunker Lake Blvd, Anoka

Results: Results for each site are detailed on the following pages.

Tips for Data Interpretation

Consider all biological indices of water quality together rather than looking at each alone, because each gives only a partial picture of stream condition. Compare the numbers to county-wide averages. This gives some sense of what might be expected for streams in a similar landscape, but does not necessarily reflect what might be expected of a minimally impacted stream. Some key numbers to look for include:

Families — Number of invertebrate families. Higher values indicate better quality.

EPT — Number of families of the generally pollution-intolerant orders Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies). Higher numbers indicate better stream quality.

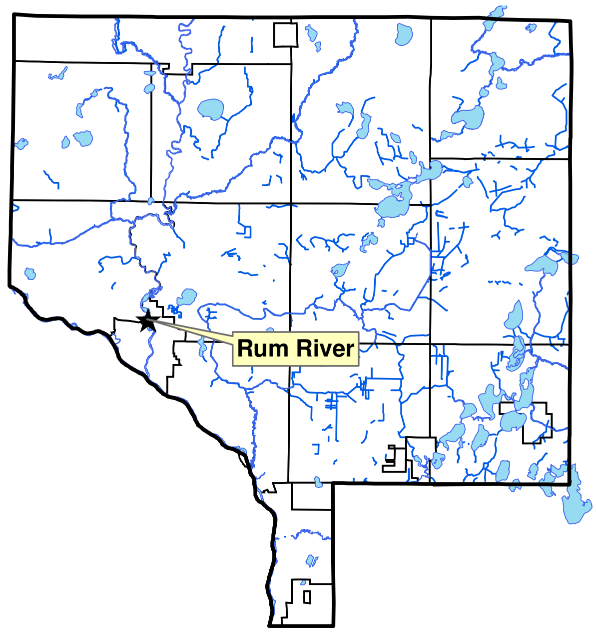
Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

FBI	Stream Quality Evaluation
0.00-3.75	Excellent
3.76-4.25	Very Good
4.26-5.00	Good
5.01-5.75	Fair
5.76-6.50	Fairly Poor
6.51-7.25	Poor
7.26-10.00	Very Poor

% Dominant Family — High numbers indicates an uneven community, and likely poorer stream health.

RUM RIVER

behind Anoka High School, Anoka
STORET SiteID = S003-189



Last Monitored

By Anoka High School in 2016

Monitored Since

2001

Student Involvement

About 150 students in 2016, over 1,000 total since 2001

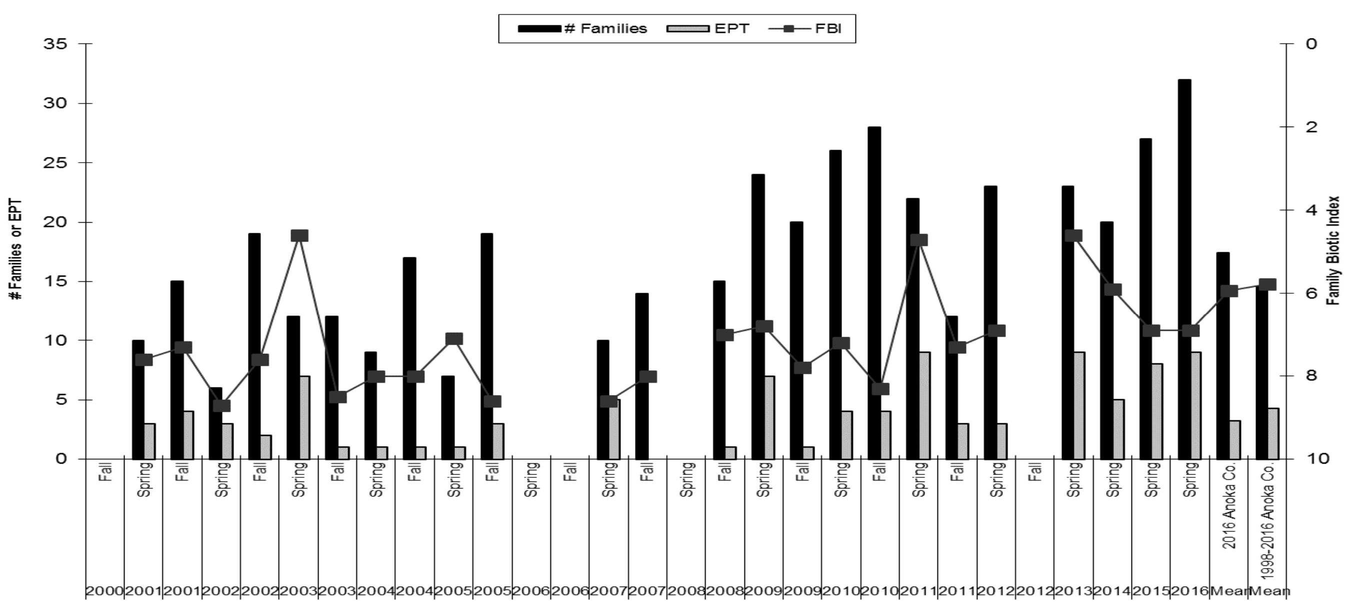
Background

The Rum River originates from Lake Mille Lacs, and flows south through western Anoka County where it joins the Mississippi River in the City of Anoka. In Anoka County the river has both rocky riffles (northern part of county) as well as pools and runs with sandy bottoms. The river's condition is generally regarded as excellent. Most of the Rum River in Anoka County has a state "scenic and recreational" designation. The sampling site is near the Bunker Lake Boulevard bridge behind Anoka High School. Most sampling has been conducted in a backwater rather than the main channel.

Results

Anoka High school classes monitored the Rum River in spring of 2016 with Anoka Conservation District (ACD) oversight. The results for spring 2016 were better than previous years. More families, 32 in total, were found here than in any other Anoka County stream. This was also the highest family total ever collected at this site. The number of sensitive EPT families (9) ties the most ever at this site, and the FBI score (6.9) was the best in Anoka County.

Summarized Biomonitoring Results for Rum River behind Anoka High School



Biomonitoring Data for the Rum River behind Anoka High School

Data presented from the most recent five years. Contact the ACD to request archived data.

Year	2011	2011	2012	2013	2014	2015	2016	Mean	Mean
Season	Spring	Fall	Spring	Spring	Spring	Spring	Spring	2016 Anoka Co.	1998-2016 Anoka Co.
FBI	4.70	7.30	6.90	4.60	5.90	6.90	6.90	5.9	5.8
# Families	22	12	23	23	20	27	32	17.4	14.6
EPT	9	3	3	9	5	8	9	3.2	4.3
Date	10-Jun	5-Oct	8-May	14-May	20-May	11-May	17-May		
sampling by	ACD	ACD	AHS	AHS	AHS	AHS	AHS		
sampling method	MH	MH	MH	MH	MH	MH	MH		
Mean # individuals	604	188	502	357	350	767	3363		
# replicates	1	1	2	4	4	2	1		
Dominant Family	baetidae	hyalellidae	silphonuridae	Perlodidae	Siphlonuridae	Siphlonuridae	Siphlonuridae		
% Dominant Family	57.5	63.3	37.8	42.1	33.4	69.3	74.9		
% Ephemeroptera	59.3	11.2	44.9	19.4	57.8	78.9	78.7		
% Trichoptera	1	0	1.2	0.2	0.1	1.4	0		
% Plecoptera	3.8	0.5	0	42.6	0.5	0	0.4		

Supplemental Stream Chemistry Readings

Data presented from the most recent five years. Contact the ACD to request archived data.

Parameter	5/18/2010	10/7/2010	6/10/2011	10/5/2011	5/8/2012	5/13/2013	5/20/2014
pH	7.24	7.22	7.84	7.98	8.10	7.69	8
Conductivity (mS/cm)	0.207	0.399	0.296	0.296	0.205	0.181	0.237
Turbidity (NTU)	7	7	18	10	7	5	14.2
Dissolved Oxygen (mg/L)	6.93	na	6.85	7.91	7.87	10.00	13.05
Salinity (%)	0	0.01	0.01	0.01	0.00	0.00	0.11
Temperature (°C)	14.8	12.2	20.7	15.3	15.7	13.0	13.5

Discussion

Both chemical and biological monitoring indicate the good quality of this river. Habitat is ideal for a variety of stream life, and includes a variety of substrates, plenty of woody snags, riffles, and pools. Water chemistry monitoring done at various locations on the Rum River throughout Anoka County found that water quality is also good. Both habitat and water quality decline, but are still good, in the downstream reaches of the Rum River where development is more intense and the Anoka Dam creates a slow moving pool.

Historically, biomonitoring near Anoka was conducted mostly in a backwater area that during periods of low water level has a mucky bottom and does not receive good flow. During those conditions the area was unlikely to be occupied by families which are pollution intolerant. Recent monitoring has included sampling the main channel during an extremely low water level condition, followed by multiple years of very high water levels. The main channel and higher water levels offer opportunities for a more diverse habitat. These changes in sampling likely explain the apparent improvement in the invertebrate community in recent years.

Wetland Hydrology

Description: Continuous groundwater level monitoring at a wetland boundary. Countywide, the ACD maintains a network of 23 wetland hydrology monitoring stations.

Purpose: To provide understanding of wetland hydrology, including the impacts of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

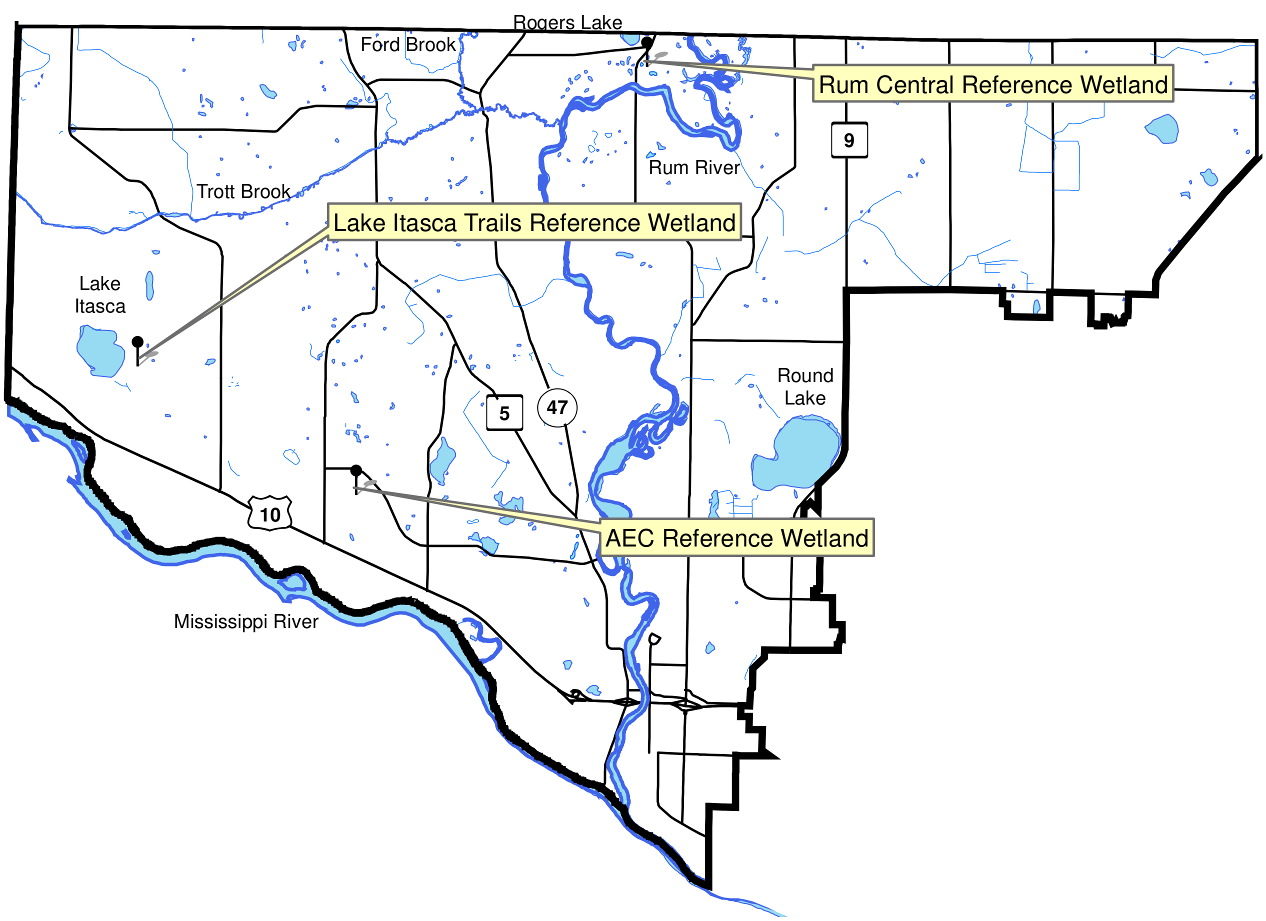
Locations: AEC Reference Wetland, Connexus Energy Property on Bunker Lake Blvd, Ramsey

Rum River Central Reference Wetland, Rum River Central Park, Ramsey

Lake Itasca Trail Reference Wetland, Lake Itasca Park, Ramsey

Results: See the following pages.

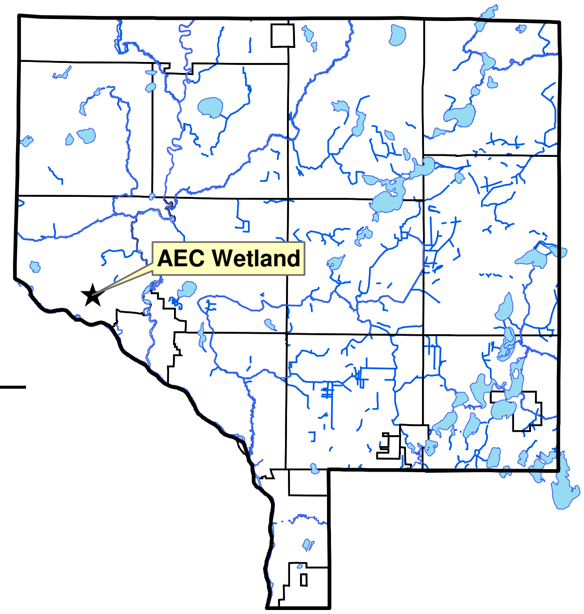
Lower Rum River Watershed Wetland Hydrology Monitoring Sites



Wetland Hydrology Monitoring

AEC REFERENCE WETLAND

Cottonwood Park, adjacent to Connexus Energy Offices (formerly Anoka Electric Coop), Ramsey



Site Information

Monitored Since: 1999

Wetland Type: 3

Wetland Size: ~18 acres

Isolated Basin? No, probably receives storm water

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-15	10yr2/1	Sandy Loam	-
Bw	15-40	10yr3/2	Gravelly Sandy loam	-

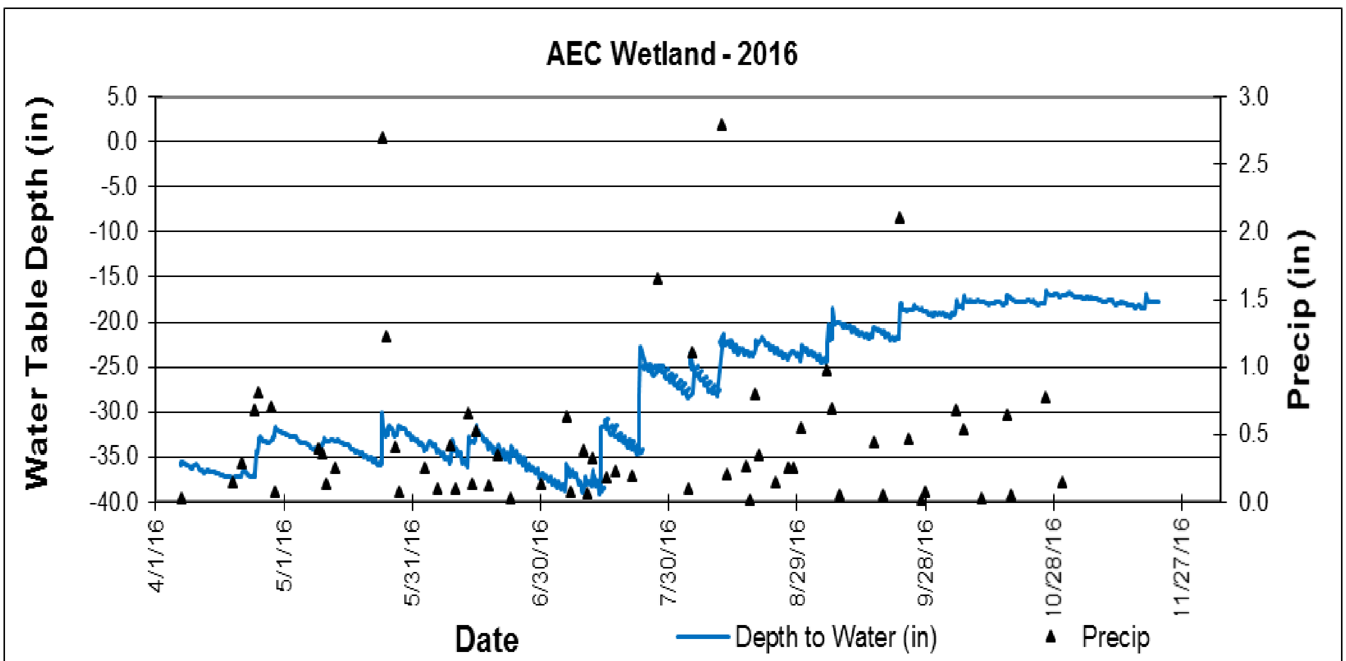
Surrounding Soils: Hubbard coarse sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Populus tremuloides	Quaking Aspen	30
Salix bebbiana	Bebb Willow	30
Carex Spp	Sedge undiff.	30
Solidago canadensis	Canada Goldenrod	20

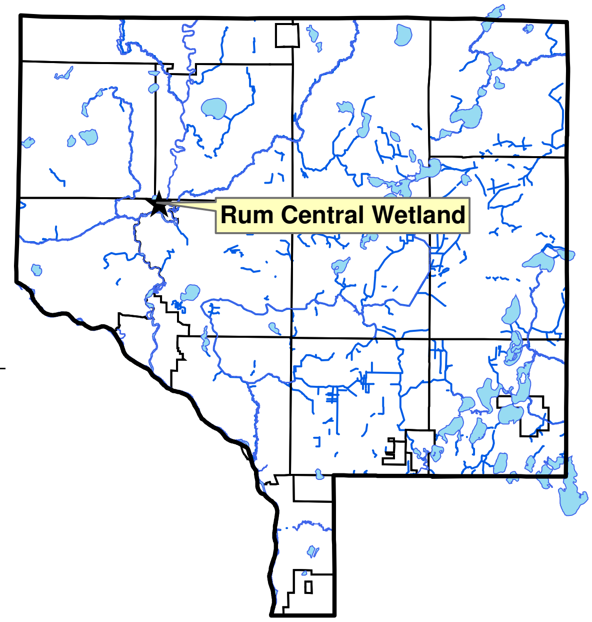
Other Notes: Well is located at the wetland boundary.

2016 Hydrograph



RUM RIVER CENTRAL REFERENCE WETLAND

Rum River Central Regional Park, Ramsey



Site Information

Monitored Since: 1997

Wetland Type: 6

Wetland Size: ~0.8 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-12	10yr2/1	Sandy Loam	-
Bg1	12-26	10ry5/6	Sandy Loam	-
Bg2	26-40	10yr5/2	Loamy Sand	-

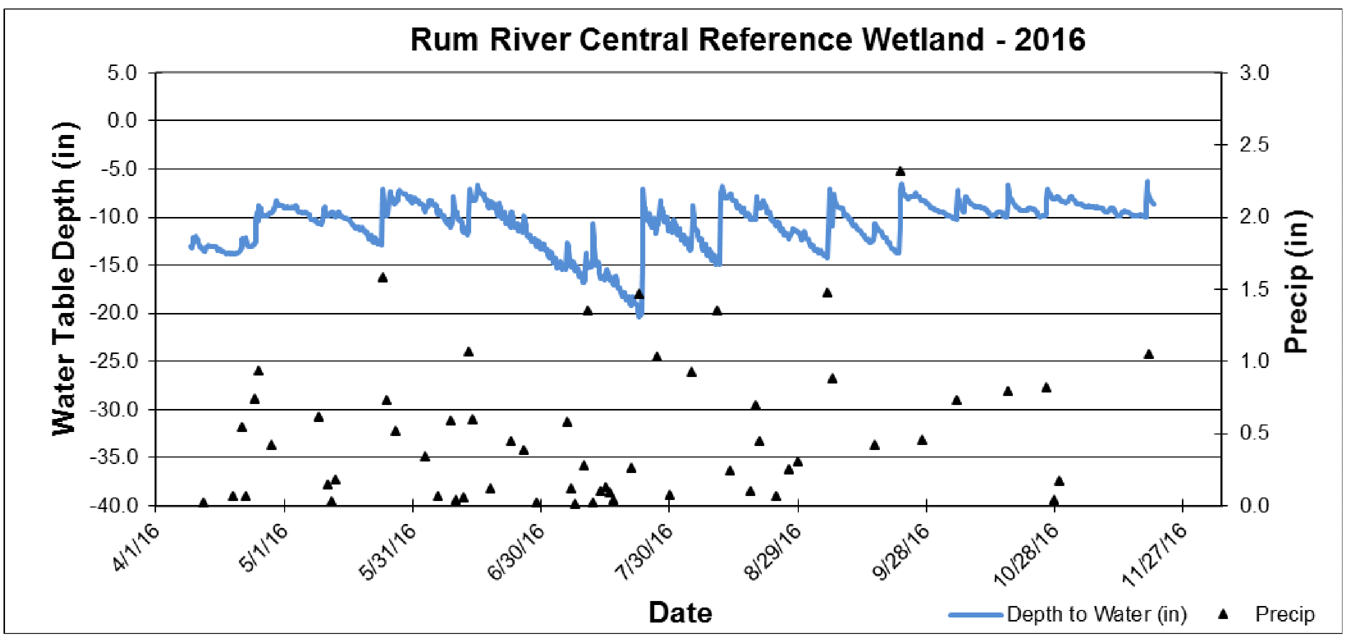
Surrounding Soils: Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	40
Corylus americanum	American Hazelnut	40
Onoclea sensibilis	Sensitive Fern	30
Rubus strigosus	Raspberry	30
Quercus rubra	Red Oak	20

Other Notes: Well is located at the wetland boundary.

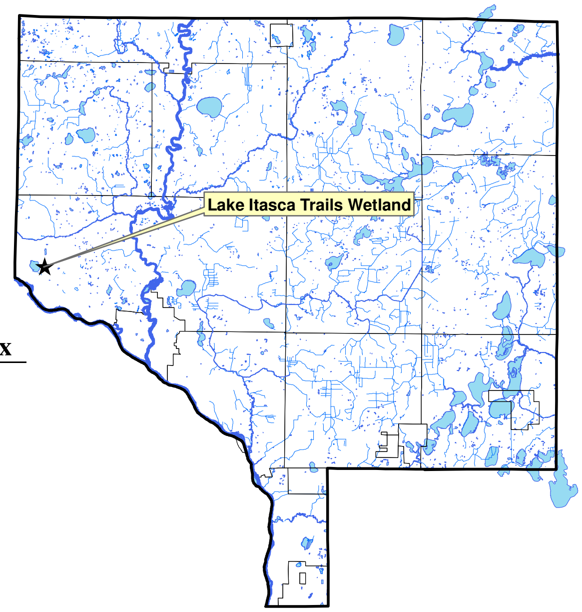
2016 Hydrograph



Wetland Hydrology Monitoring

LAKE ITASCA TRAILS REFERENCE WETLAND

Lake Itasca Trails Park, Ramsey



Site Information

Monitored Since: 2013

Wetland Type: 2/6

Wetland Size: ~10 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A1	0-12	10yr2/0	Mucky sand	-
A2	12-20	10ry2/1	Sand	-
B1	20-36	10yr4/1	Sand and fine gravel	-
B2	36-48	10yr6/1	Sand and fine gravel	-

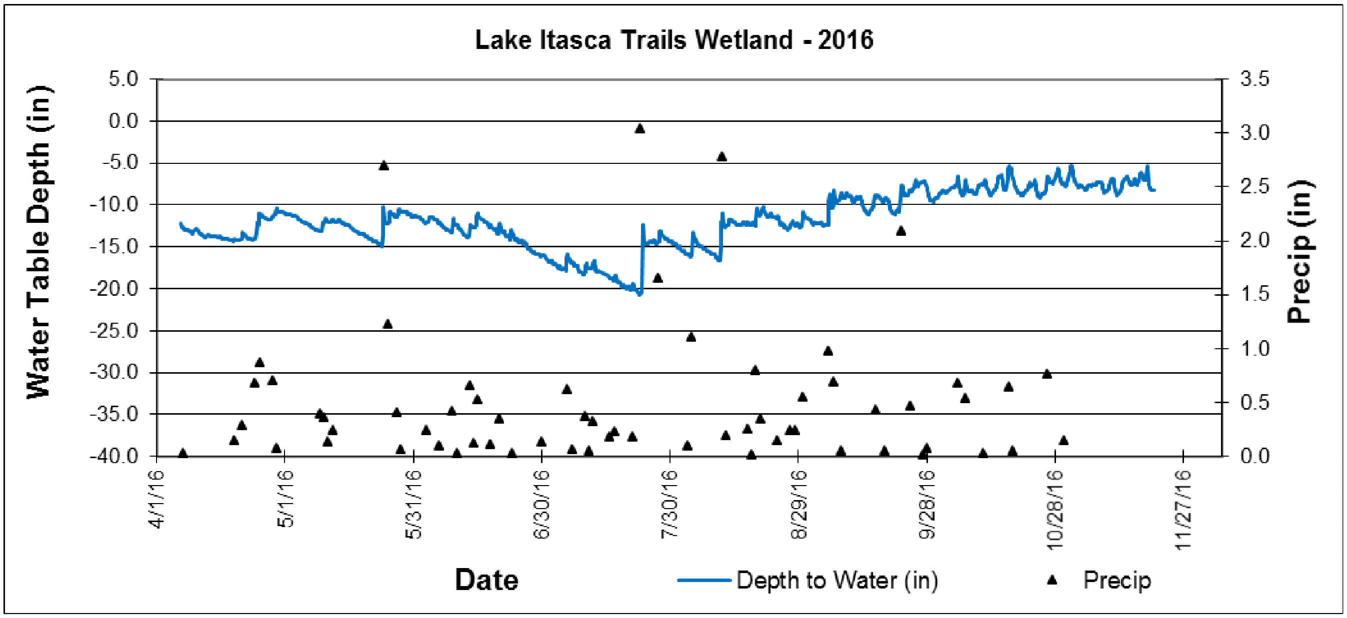
Surrounding Soils: Hubbard coarse sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Carex stricta	Hummock Sedge	80
Phalaris arundinacea	Reed Canary Grass	20
Salix sp.	Willow	20
Rubus sp.	Bristle-berry	5

Other Notes: Well is located about 10 feet east and about 6 inches downslope of the wetland boundary. DNR Public Water Wetland 2-339.

2016 Hydrograph



Water Quality Grant Fund

Description: The LRRWMO provides cost share for projects on either public or private property that will improve water quality, such as repairing streambank erosion, restoring native shoreline vegetation, or rain gardens. This funding is administered by the Anoka Conservation District, which works with landowners on conservation projects. Projects affecting the Rum River are given the highest priority because it is viewed as an especially valuable resource.

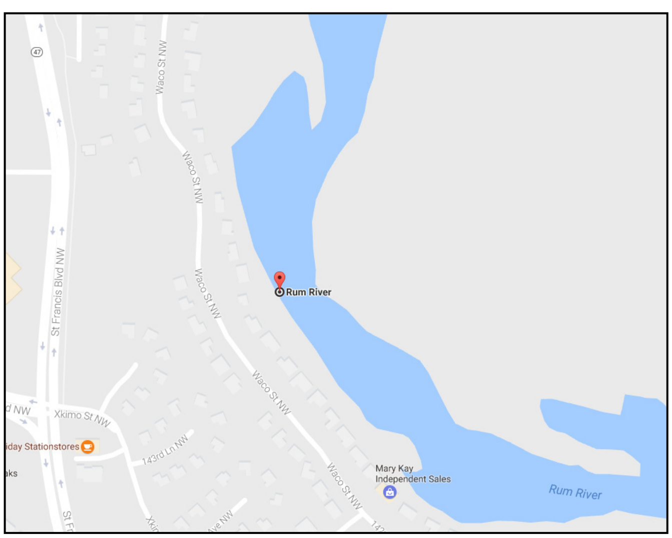
Purpose: To improve water quality in lakes, streams and rivers by correcting erosion problems and providing buffers or other structures that filter runoff before it reaches the water bodies.

Results: Projects reported in the year they are installed. One riverbank stabilization project was installed in 2016 with LRRWMO cost share.

LRRWMO Cost Share Fund Summary

2006 LRRWMO Contribution	+	$1,000.00
2008 Expense – Herrala Rum Riverbank stabilization	-	$ 150.91
2008 Expense – Rusin Rum Riverbank stabilization	-	$ 225.46
2009 LRRWMO Contribution	+	$1,000.00
2009 Expense – Rusin Rum Riverbank bluff stabilization	-	$ 52.05
2010 LRRWMO Contribution	+	$ 0
2010 LRRWMO Expenses	-	$ 0
2011 LRRWMO Contribution	+	$ 0
2011 Expense - Blackburn Rum riverbank	-	$ 543.46
2012 LRRWMO Contribution	+	$1,000.00
2012 Expense – Smith Rum Riverbank	-	$1,596.92
2013 LRRWMO Contribution	+	$1,000.00
2013 Expense – Geldacker Mississippi Riverbank	-	$1,431.20
2014 LRRWMO Contribution	+	$2,050.00
2015 LRRWMO Contribution	+	$1,000.00
2015 Expense – Smith Rum Riverbank	-	$ 533.65
2016 Expense – Brauer Rum Riverbank	-	$ 1,150.00
Fund Balance		**$1,366.35**

2016 funded project – Brauer Rum Riverbank, City of Ramsey
Approximately 90 feet of undercut, eroding riverbank was stabilized using a cedar tree revetment. This project was funded with direct landowner contributions, LRRWMO cost share dollars, as well as a Conservation Corps of MN crew labor grant. Installation was done by the Minnesota Conservation Corps with oversight from the Anoka Conservation District in the fall of 2016.



Mississippi River Bank Stabilization

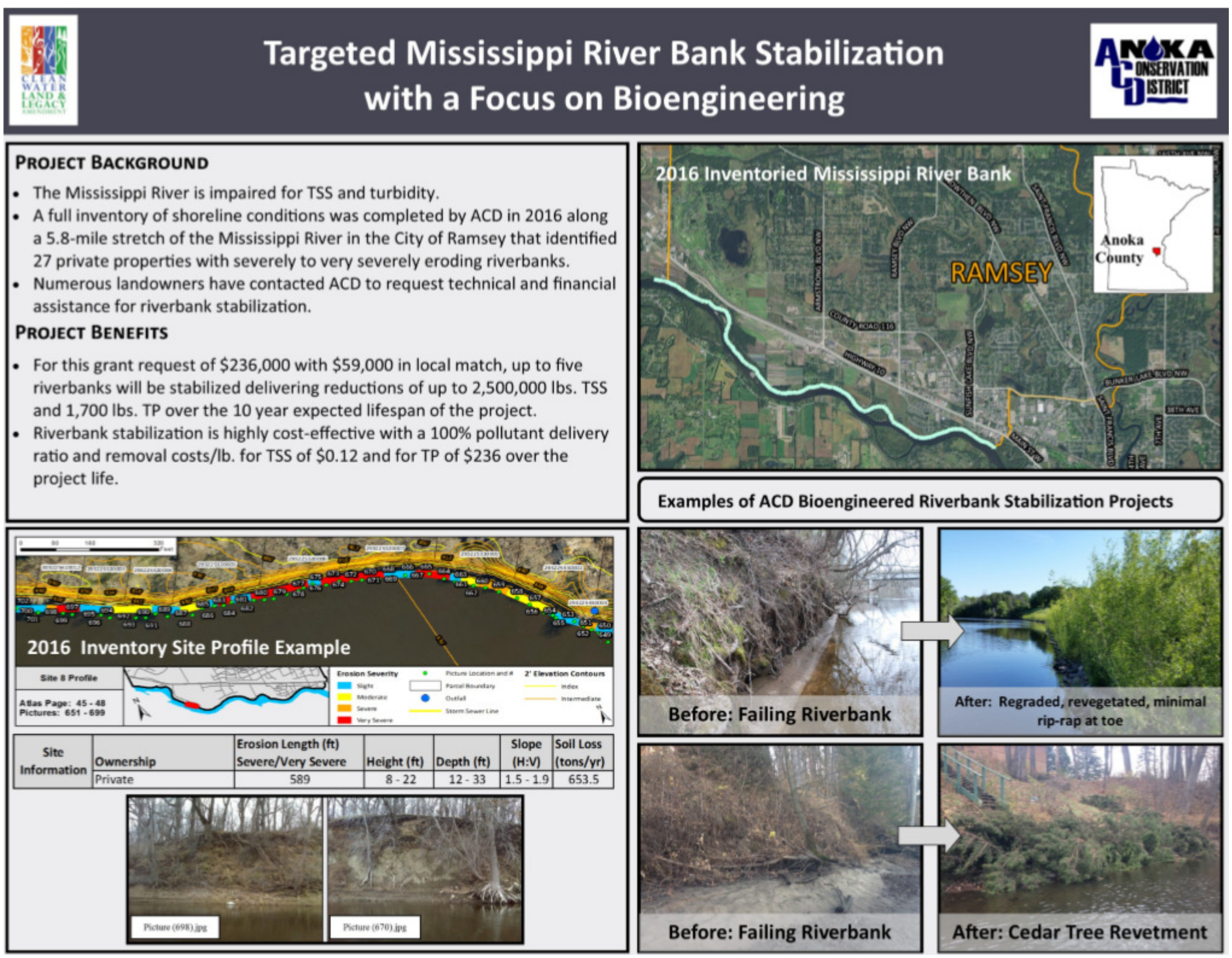
Description: The City of Ramsey contracted the Anoka Conservation District to complete an inventory of riverbank condition along the 5.8 miles of city that border the Mississippi River in 2015. This inventory led to a grant application and acquisition of $236k from BWSR's Clean Water Fund in 2016. This money, along with a 25% match from individual property owners, will be utilized to implement $295k worth of bio-engineered bank stabilization projects along 500 feet of Mississippi River bank.

Location: City of Ramsey

Purpose: To use a bioengineering approach to stabilize previously identified high-priority areas of severe erosion along the Mississippi River within the City of Ramsey

Results: The inventory led to the successful acquisition of $236k in state grant funding for the ACD to complete bio-engineered bank stabilization projects along the Mississippi River bank in Ramsey. The original inventory report is available from the ACD.

Grant Application Image



Rum River Stabilizations

Description: Six riverbank stabilization projects were installed on the Rum River in 2016. At these sites, cedar tree revetments and willow stakes were used to stabilize eroding banks. The projects were installed in partnership with the Conservation Corps Minnesota (CCM). Funding for four of the projects was received from the Lessard-Sams Outdoor Heritage Council, a Clean Water Fund CCM crew labor grant and landowner contribution. Funding for one project was provided by Lower Rum River WMO cost-share, a Clean Water Fund CCM crew labor grant and landowner contribution. Funding for the final project came from the Anoka County Parks Department.

Location: Rum River Central Regional Park, three residential properties in Ramsey and two residential properties in Andover.

Purpose: To stabilize areas of riverbank with mild to moderate erosion, in order to reduce sediment loading in the Rum River, as well as to reduce the likelihood of a much larger and more expensive corrective project in the future.

Results: Stabilized 1,316 linear feet of riverbank on the Rum River.

Anoka and Ramsey Stormwater Retrofit Analyses

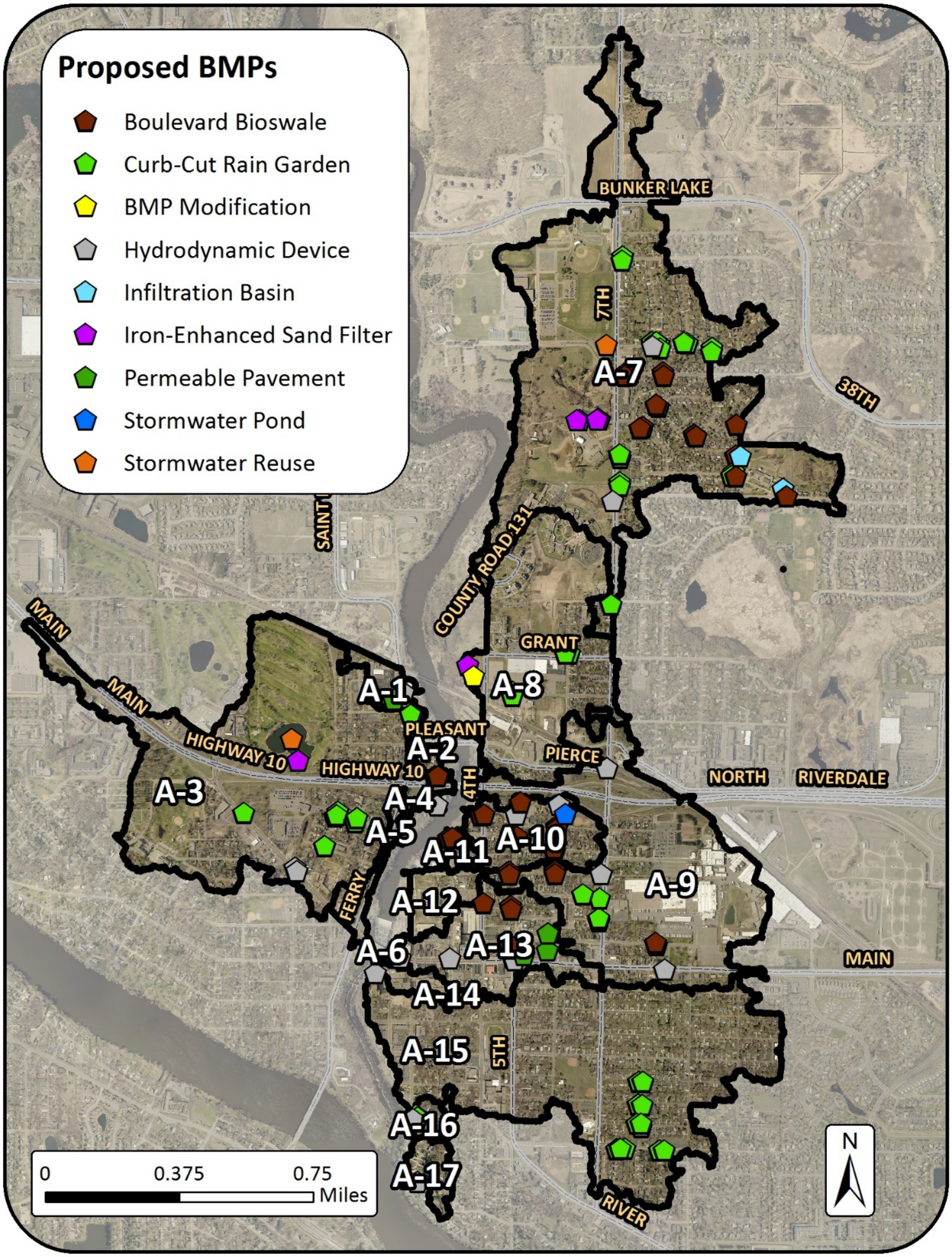
Description: Identified new stormwater treatment opportunities in older, built-out neighborhoods identified by the cities and ranked projects by cost effectiveness (amount of pollutant kept out of area rivers per dollar spent). Water quality benefits associated with the installation of each identified project were individually modeled using the Source Loading and Management Model for Windows (WinSLAMM). WinSLAMM estimates volume and pollutant loading based on acreage, land use, and soils information. The costs associated with project design, administration, promotion, land acquisition, opportunity costs, construction oversight, installation, and maintenance were estimated. The total costs over the assumed effective life of each project were then divided by the modeled benefits over the same time period to enable ranking by cost-effectiveness. It is recommended that projects be installed in order of cost effectiveness (pounds of pollution reduced per dollar spent). Other factors, including a project's educational value/visibility, construction timing, total cost, or non-target pollutant reduction also affect project installation decisions and need to be weighed by resource managers when selecting projects to pursue.

Location: Selected areas in the Cities of Ramsey and Anoka.

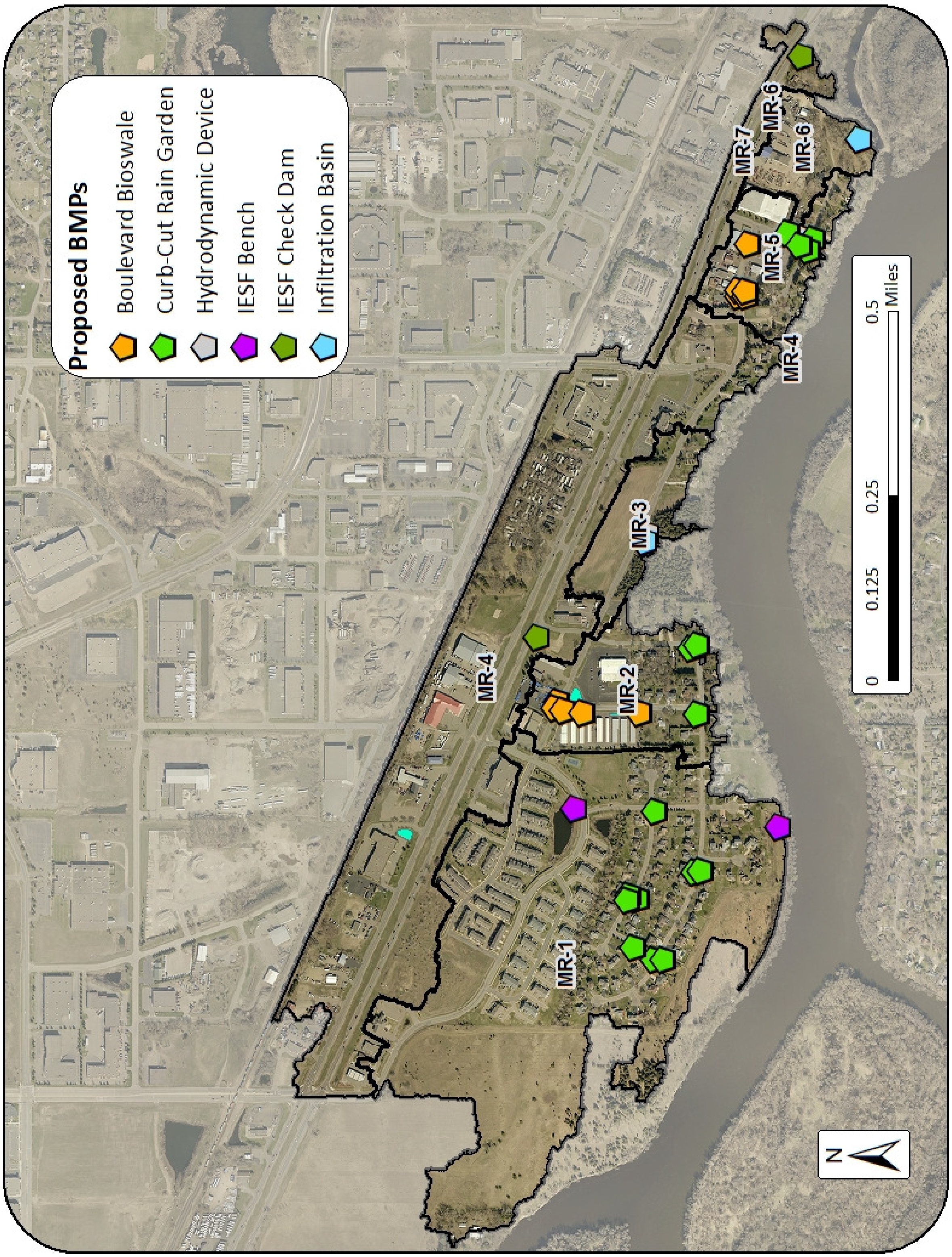
Purpose: To improve water quality in the Rum and Mississippi Rivers.

Results: Work began in 2015 and was completed in 2016. A variety of stormwater retrofit approaches were identified. They include bio-retention, hydrodynamic devices, permeable pavement, iron enhanced sand filter pond benches, existing stormwater pond modifications, new stormwater ponds, and water reuse. The studies provide sufficient detail to pursue installation funds. The LRRWMO and ACD have since partnered to secure a $50,577 Metropolitan Council grant for installations in 2017-18. Maps showing proposed BMPs are on the following pages.

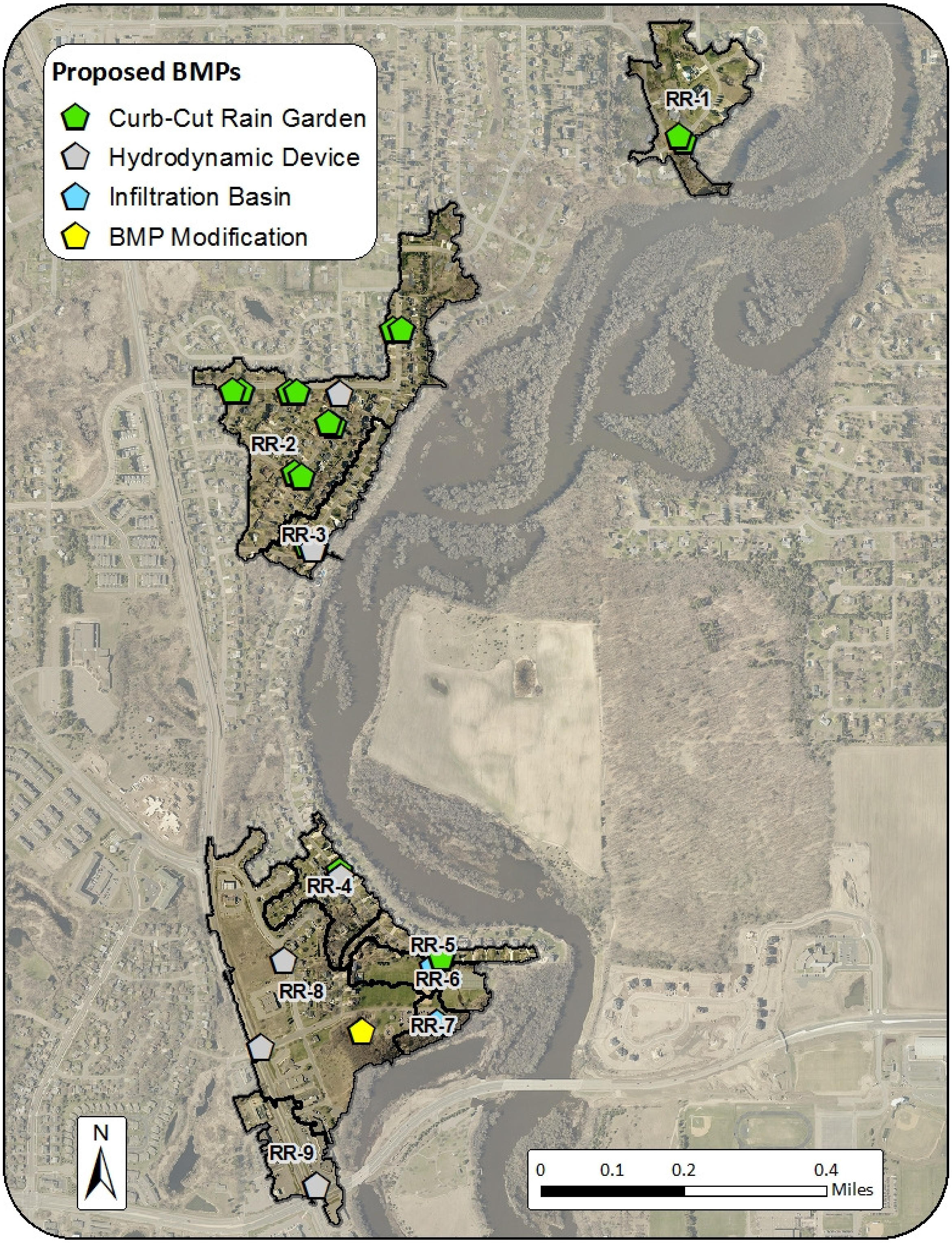
City of Anoka Proposed BMPs



City of Ramsey Proposed BMPs in Mississippi River Network



City of Ramsey Proposed BMPs in Rum River Network



Newsletters

Description: The Lower Rum River Watershed Management Organization (LRRWMO) contracted the Anoka Conservation District (ACD) to create a series of public education newsletter articles. The LRRWMO is required to publish an annual newsletter under State Rules.

Purpose: To improve public understanding of the LRRWMO, its functions, and accomplishments.

Location: Watershed-wide

Results: In 2016, the Anoka Conservation District (ACD) drafted two newsletter articles and sent them to cities for inclusion in their newsletters.

The First newsletter article announced grant funding available to landowners in the LRRWMO interested in having a revetment installed on their riverbank. The other focused on the findings of a watershed-wide study into the health of the Rum River and its watershed.

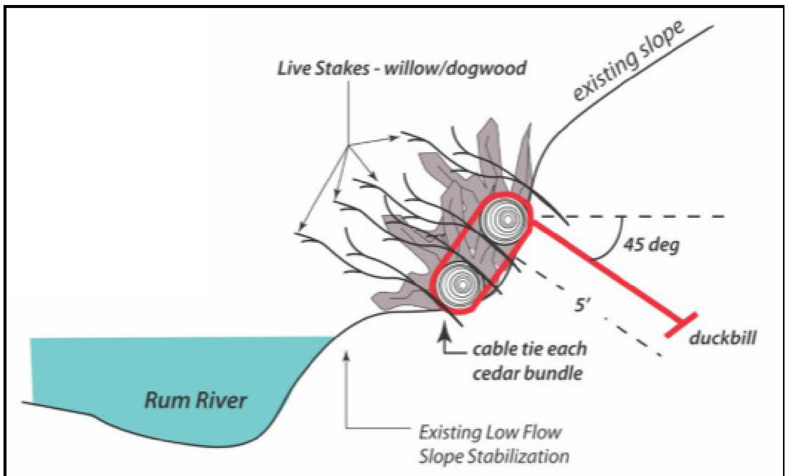
2016 Newsletter Articles

Revetments on the Rum River - Grants Available to Landowners

Landowners on the Rum River will soon have access to funding to address riverbank erosion with a unique method – cedar tree revetments. The Anoka Conservation District, with partners including the Lower Rum River Watershed Management Organization (LRRWMO), has secured a $97,000 grant from the State's Outdoor Heritage Fund which is funded by the Clean Water Land and Legacy Amendment. They plan to install 10-20 projects addressing Rum riverbank erosion, beginning in fall 2016.

CLEAN WATER LAND & LEGACY AMENDMENT

Cedar tree revetments are a low cost, but effective, means to address minor bank erosion before it gets worse. It's not appropriate for major bank erosion, such as on outside bends of the river. The technique involves cable-anchoring cut cedar trees alongside the bank. Their dense branches and naturally rot-resistant wood provide many years of bank armoring. In doing so, they protect property, help improve the river's water quality and provide fish habitat.



Cross - Section : Typical along revetment location

Residents interested in having their riverbank evaluated for a cedar tree revetment should contact Jamie Schurbon at the Anoka Conservation District (763-434-2030 ext. 12; jamie.schurbon@anokaswcd.org). Most projects cost $5,000-$10,000. Landowners must provide 10% of that amount; the remainder is grant-funded.

Rum River Watershed Gets Checkup; New Management Plan

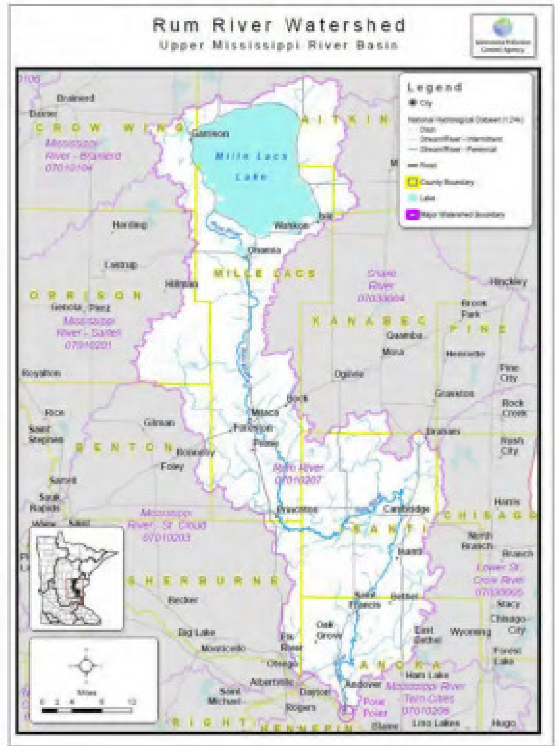
The Rum River runs from Lake Mille Lacs to Anoka. It is one of only seven State Scenic and Recreational Waterways, and part of the State's water trails system. Soil and water conservation districts and watershed organizations recently joined with the Minnesota Pollution Control Agency (MPCA) to test the health of the river and the surrounding watershed. They are developing a new management plan for the river, streams and lakes.

The results of a recent water quality check-up was mixed with some areas being in good shape and others not so good. Within Anoka County, Rogers Lake (partially in Ramsey, Oak Grove and Nowthen) had excessive nutrients that cause algae blooms. Trott Brook (City of Ramsey) and Crooked Brook (City of East Bethel) had too little oxygen for fish. High E.coli bacteria was found in Cedar Creek and Seeyle Brook. Mahoney Brook (City of Oak Grove) had a fish community indicative of poor conditions. There are studies underway to gather more information on these impaired waterbodies to determine the amount of nutrient reductions needed and strategies.

The Rum River and other lakes and streams are in good shape. Still, researchers noted reason for continued vigilance. For example, the Rum River in Isanti and Anoka County is approaching state standards for nutrients and Lake George in Oak Grove has a declining water quality trend, which is being further investigated.

The findings of these studies are being compiled into a new management plan for the watershed, set to be finalized in late 2016. The Lower Rum River Watershed Management Organization (LRRWMO; www.LRRWMO.org), a joint powers board formed by the Cities of Ramsey, Anoka and Andover, is representing local points of view in the development of these plans. They will also be a key player in putting the management plan into action.

The public is invited to participate in the discussion about managing these waterbodies. Throughout summer and fall 2016, draft management plans will be posted to www.AnokaSWCD.org. Residents may also contact Jamie Schurbon, Water Resource Specialist at 763-434-2030 ext. 12 or jamie.schurbon@anokaswcd.org or their representative on the LRRWMO.



LRRWMO Website

Description: The Lower Rum River Watershed Management Organization (LRRWMO) contracted the Anoka Conservation District (ACD) to design and maintain a website about the LRRWMO and the Lower Rum River watershed. The website has been in operation since 2003.

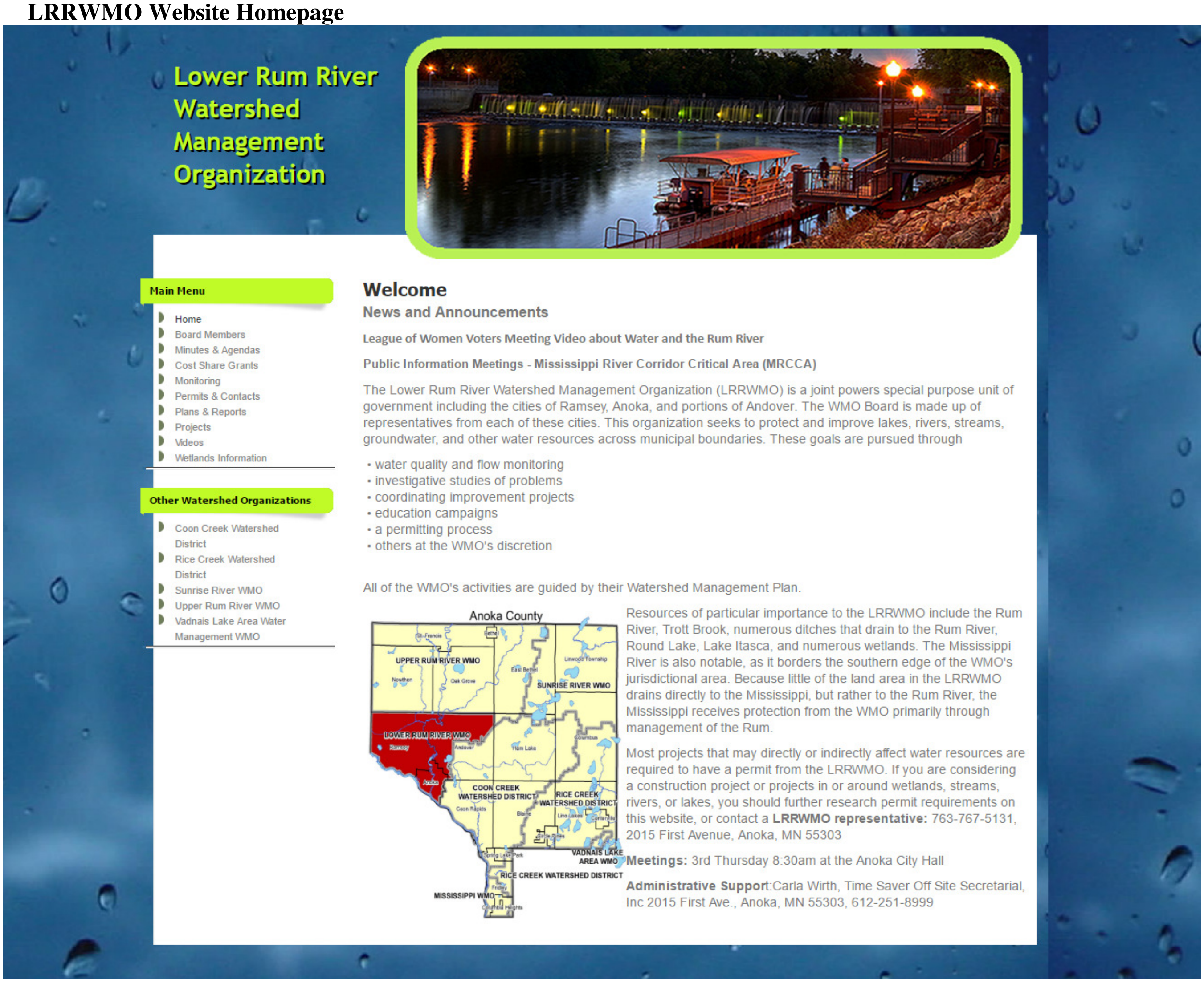
Purpose: To increase awareness of the LRRWMO and its programs. The website also provides tools and information that helps users better understand water resources issues in the area.

Location: LRRWMO.org

Results: Regular website updates occurred throughout the year. The LRRWMO website contains information about both the LRRWMO and about natural resources in the area. Information about the LRRWMO includes:

- a directory of board members,
- meeting minutes and agendas,
- watershed management plan and annual reports,
- descriptions of work that the organization is directing,
- highlighted projects.

LRRWMO Website Homepage



Financial Summary

The ACD accounting is organized by program and not by customer. This allows us to track all of the labor, materials and overhead expenses for a program. We do not, however, know specifically which expenses are attributed to monitoring which sites. To enable reporting of expenses for monitoring conducted in a specific watershed, we divide the total program cost by the number of sites monitored to determine an annual cost per site. We then multiply the cost per site by the number of sites monitored for a customer.

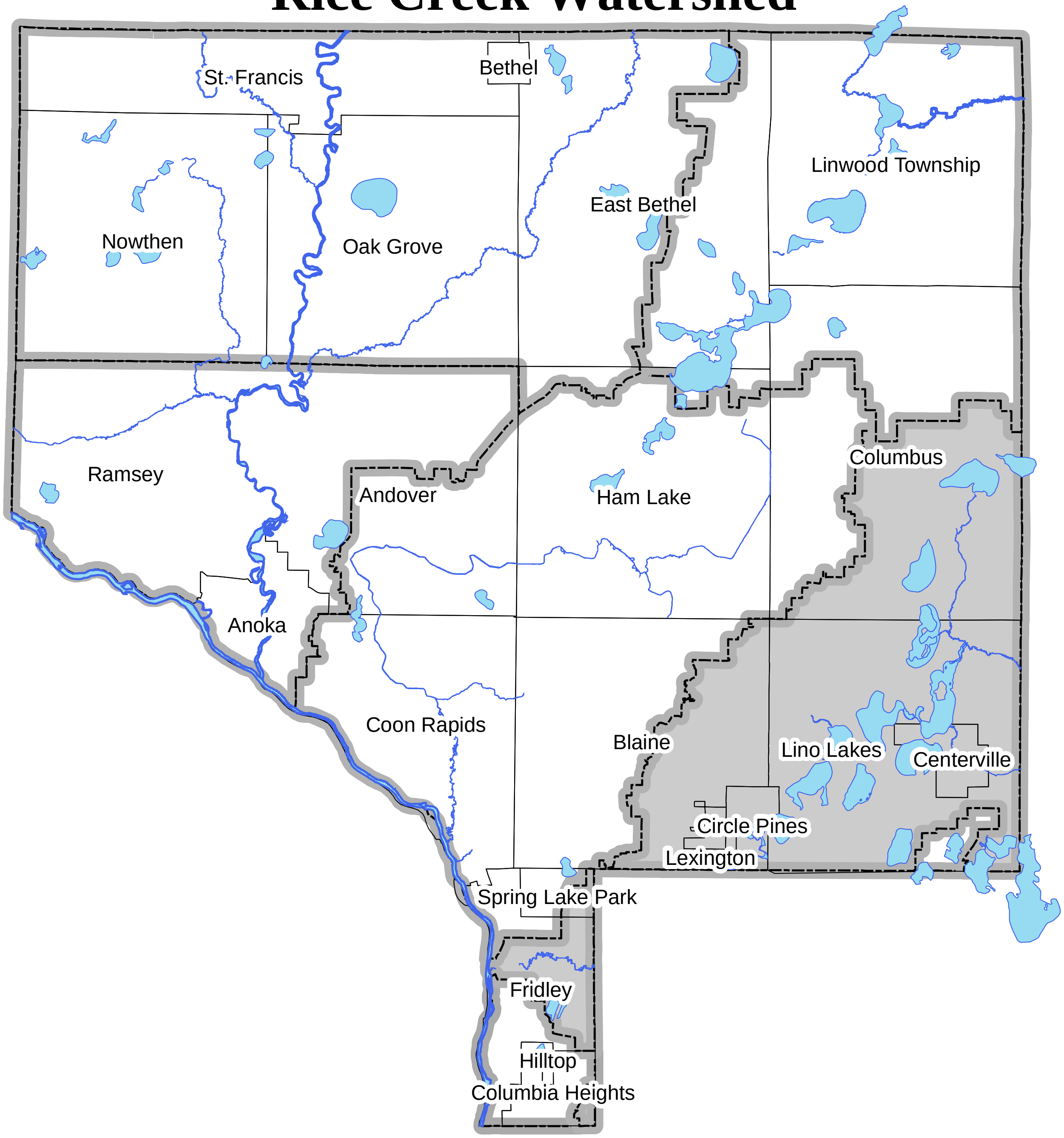
Lower Rum River Watershed Financial Summary

Lower Rum River Watershed	WMO Asst (no charge)	Reference Wetlands	Ob Well	Lake Level	Lake WQ	Stream WQ	WOMP	Student Biomon	LRRWMO Admin	WMO Annual Rpts to State	LRRWMO Outreach/Promo	WMO Website Maint	Anoka Nat. Pres. Restoration	Revetments on the Rum	Rum River Stabilization	Rum River 1W1P	Rum River WRAPP	City of Anoka SRA	City of Ramsey SRA	City of Ramsey Riverbank Inventory	Total
Revenues																					
LRRWMO	0	1725	0	1000	3350	2450	0	825	0	850	1120	625	0	1150	0	0	0	1102	898	0	15095
State	0	0	120	0	0	0	0	0	0	0	0	0	0	8316	0	0	86431	6534	6844	0	108245
Anoka Co. General Services	390	32	117	601	121	0	214	407	0	0	518	50	4449	1325	0	98	0	58	0	836	9217
Anoka Conservation District	0	69	0	0	0	0	0	0	0	0	2034	0	0	0	0	0	0	0	0	0	2103
County Ag Preserves/Projects	0	0	0	0	0	0	0	475	0	0	0	0	0	0	7304	0	0	0	0	0	7779
Service Fees	0	0	0	0	0	0	0	0	0	0	0	0	0	1465	0	0	0	0	0	0	1465
Regional/Local	0	48	0	0	278	0	800	0	0	0	0	0	0	0	0	0	0	5656	3441	2005	12229
BWSR Cons Delivery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BWSR Capacity Funds	0	1834	0	0	0	0	0	0	0	0	2811	0	0	560	243	576	0	0	0	0	6023
BWSR Cost Share TA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1636	0	0	0	0	0	1636
Metro ETA & AWQCP	0	0	0	0	0	0	0	0	0	0	0	0	0	4667	2689	0	0	0	0	0	7356
Local Water Planning	0	911	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	911
TOTAL	390	4619	237	1601	3749	2450	1014	1707	0	850	6483	675	4449	17484	11871	674	86431	13350	11183	2841	172059
Expenses-																					
Capital Outlay/Equip	5	24	3	19	29	11	12	19	3	5	52	5	46	718	117	8	182	164	122	33	1575
Personnel Salaries/Benefits	339	1771	206	1393	2185	801	883	1432	211	366	3865	352	3448	11766	8746	586	13535	12212	9131	2472	75701
Overhead	25	130	15	102	161	59	65	105	16	27	284	26	254	865	643	43	996	898	672	182	5568
Employee Training	2	10	1	8	12	5	5	8	1	2	22	2	19	66	49	3	76	69	51	14	426
Vehicle/Mileage	7	37	4	29	46	17	19	30	4	8	82	7	73	249	185	12	286	258	193	52	1600
Rent	12	63	7	50	78	29	32	51	8	13	138	13	123	420	313	21	484	436	326	88	2705
Program Participants	0	0	0	0	0	0	0	0	0	0	0	0	0	0	441	0	0	0	0	0	441
Program Supplies	0	2411	0	0	889	423	0	61	0	0	2040	191	486	2824	1377	0	65890	0	0	0	76591
TOTAL	390	4447	237	1601	3400	1344	1014	1707	243	421	6483	596	4449	16909	11871	674	81448	14037	10495	2841	164608

Recommendations

- **Install projects identified in the stormwater retrofitting studies for the Cities of Anoka and Ramsey.** This project has identified and ranked projects that would improve stormwater runoff before it is discharged to the Rum or Mississippi Rivers. A Metropolitan Council grant for construction has been secured for 2017-18.
- **Implement the MPCA Rum River WRAPP (Watershed Restoration and Protection Plan).** This WRAPP was an assessment of the entire Rum River watershed. It outlines regional priorities and management strategies, and attempts to coordinate them across jurisdictions.
- **Engage in the Upper Rum River WMO's watershed plan update** process. The draft 10-year Watershed Management Plan was completed in late 2016 and will undergo comment and review stages in early 2017.
- **Implement water conservation measures** throughout the watershed and promote it metro-wide. Depletion of surficial water is a concern.
- **Continue lake level monitoring, especially on Round Lake** where residents have expressed concerns with levels. Other nearby lakes should be monitored for comparison and problems.

Rice Creek Watershed



Contact Info:

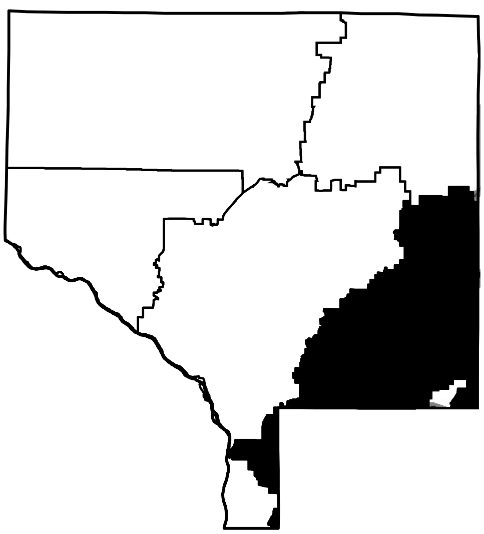
Rice Creek Watershed District
www.ricecreek.org
763-398-3070

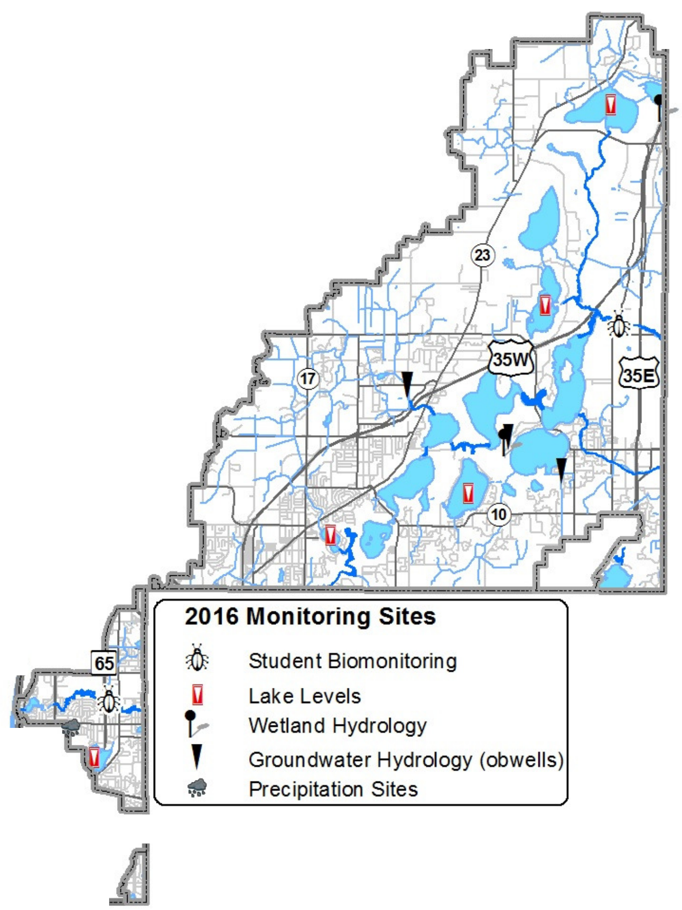
Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 5: RICE CREEK WATERSHED

Task	Partners	Page
Lake Levels	RCWD, ACD	5-160
Wetland Hydrology	RCWD, ACD	5-162
Stream Water Quality – Biological	RCWD, ACD, ACAP, Forest Lake Area Learning Center, Totino Grace HS	5-165
Water Quality Grant Administration	RCWD, ACD	5-170
Financial Summary		5-171
Recommendations		5-172
Precipitation	ACD, volunteers	see Chapter 1
Ground Water Hydrology (obwells)	ACD, MNDNR	see Chapter 1
Additional work not reported here	RCWD	contact RCWD

ACD = Anoka Conservation District, RCWD = Rice Creek Watershed District, MNDNR = Minnesota Dept. of Natural Resources, ACAP = Anoka County Ag Preserves





Lake Levels

Description: Weekly water level monitoring in lakes. Graphs for the past five years as well as historical data from the last 25 years are shown below. All data are available on the Minnesota DNR website using the "LakeFinder" feature (www.dnr.mn.us.state\lakefind\index.html).

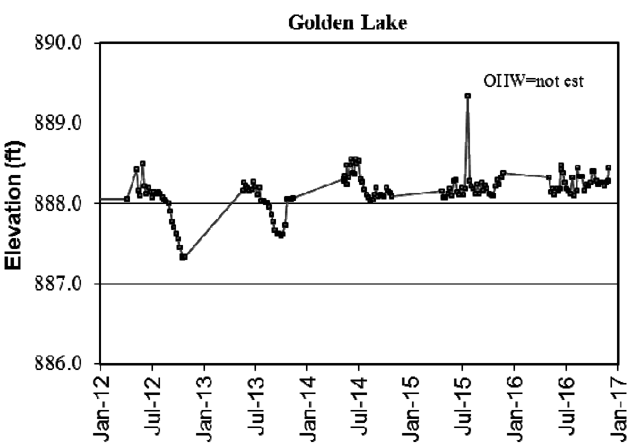
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

Locations: Golden Lake, Howard Lake, Moore Lake, Reshanau Lake, and Rondeau Lake

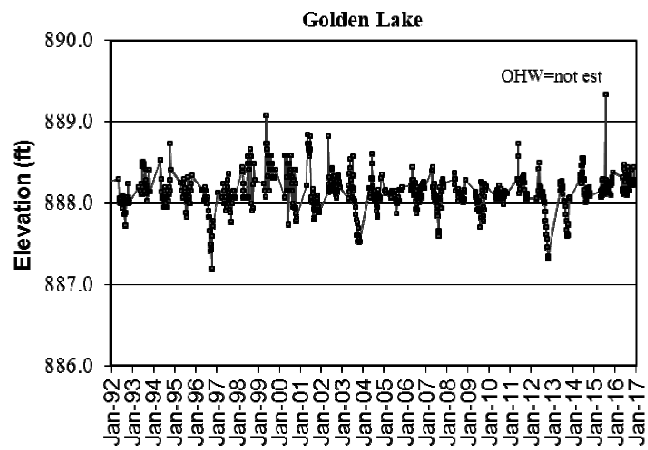
Results: Lake levels were measured by volunteers throughout the 2016 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes followed the expected pattern of increasing water levels in spring and early summer and then fell later in the summer due to less rainfall. High rainfall amounts late into fall cause a spike in lake levels at the end of the year, with some lakes rising right into December and freeze up. Average lake levels were similar or slightly higher than 2015

All lake level data can be downloaded from the MN DNR website's Lakefinder feature. Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is listed for each lake on the corresponding graphs below.

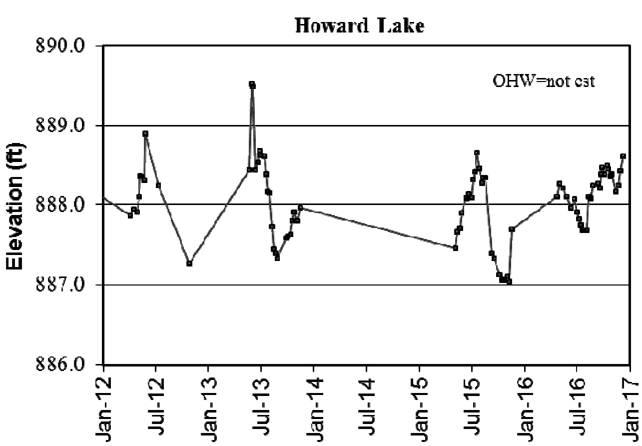
Golden Lake Levels- Last 5 Years



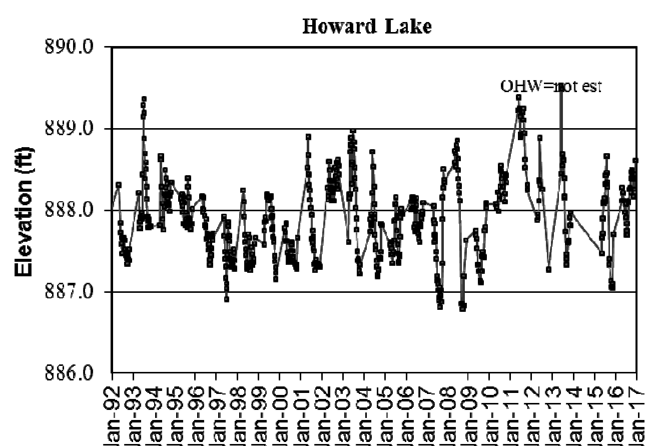
Golden Lake Levels- Last 25 Years



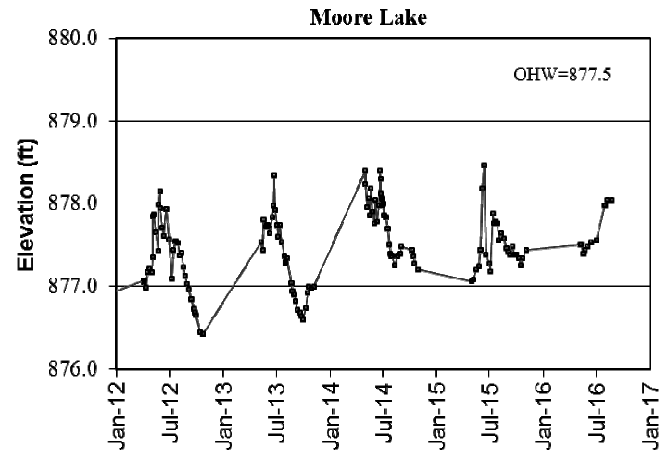
Howard Lake Levels- Last 5 Years



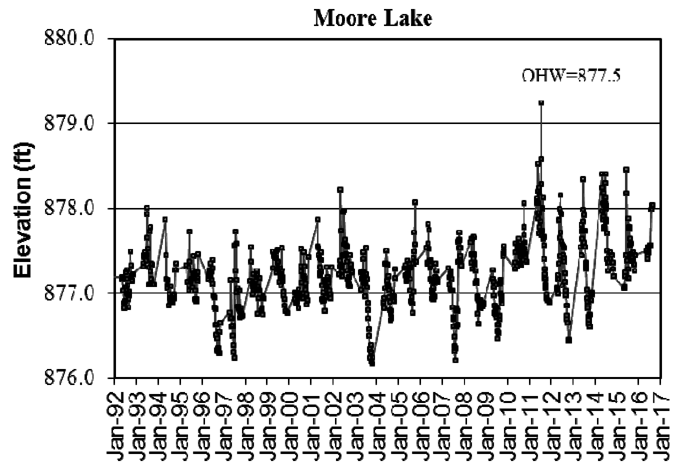
Howard Lake Levels- Last 25 Years



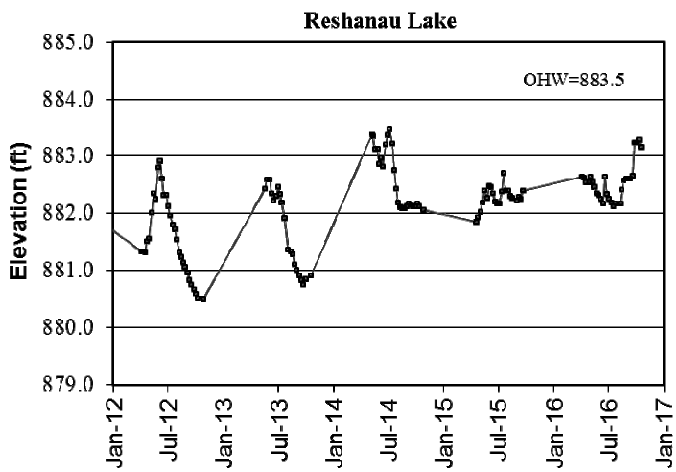
Moore Lake Levels- Last 5 Years



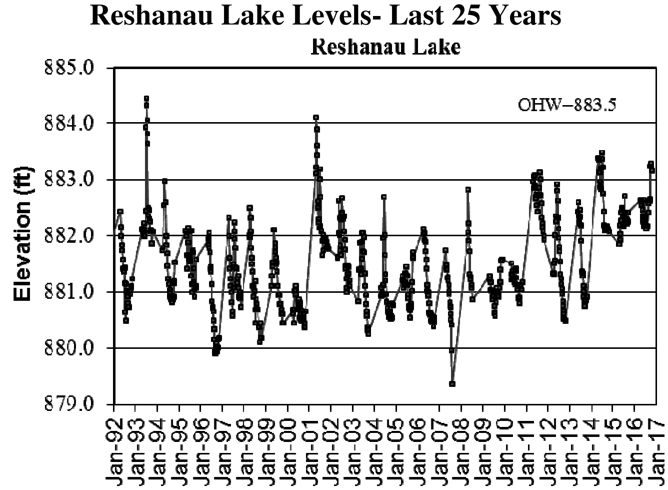
Moore Lake Levels- Last 25 Years



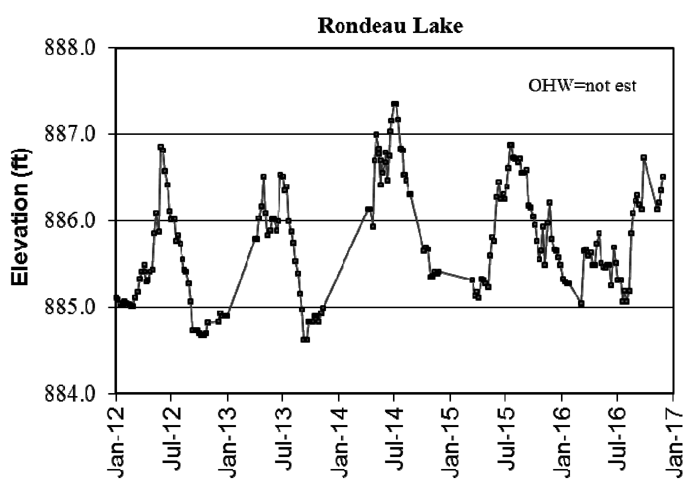
Reshanau Lake Levels- Last 5 Years



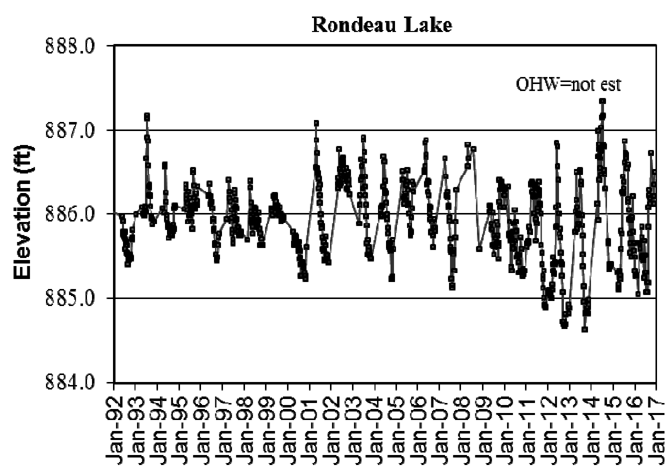
Reshanau Lake Levels- Last 25 Years



Rondeau Lake Levels- Last 5 Years



Rondeau Lake Levels- Last 25 Years



Wetland Hydrology

Description: Continuous groundwater level monitoring at a wetland boundary, to a depth of 40 inches. County-wide, the ACD maintains a network of 23 wetland hydrology monitoring stations.

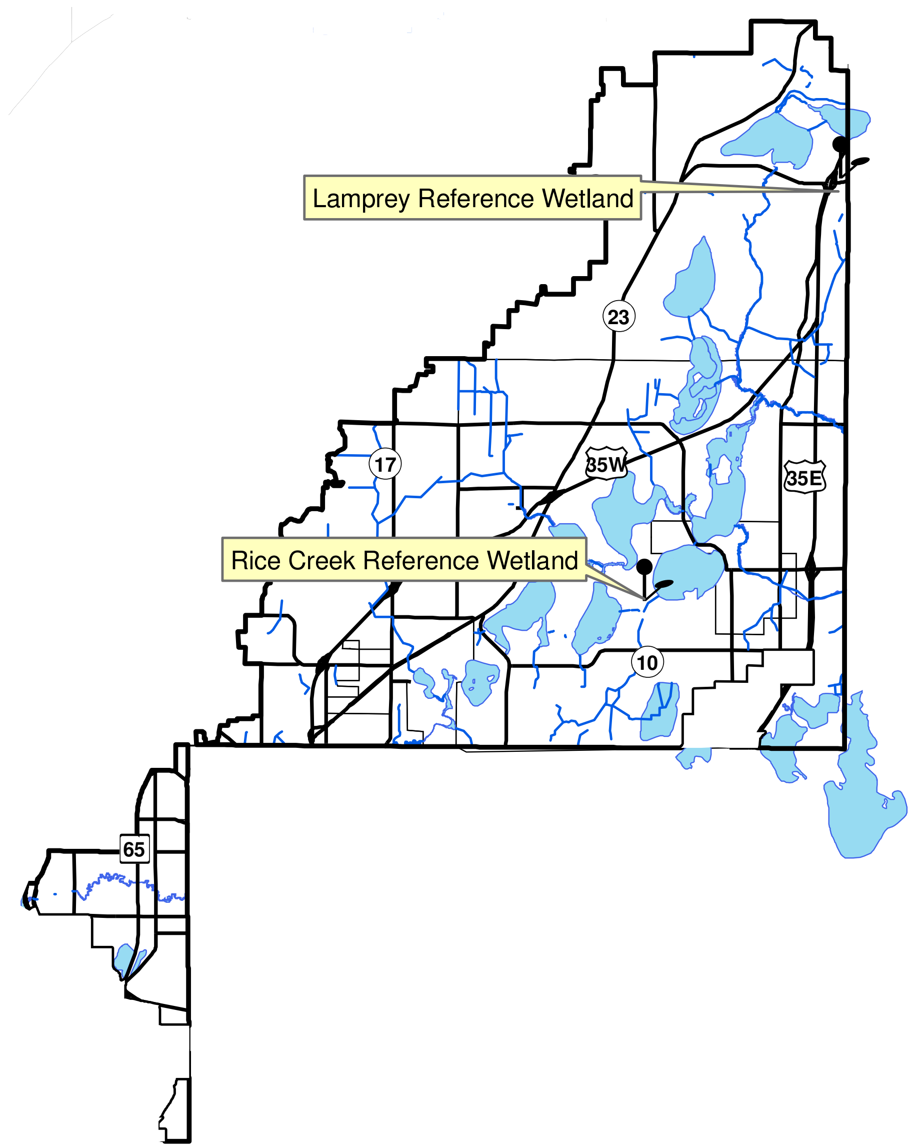
Purpose: To provide an understanding of wetland hydrology, including the impact of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

Locations: Lamprey Reference Wetland, Lamprey Pass Wildlife Management Area, Columbus

Rice Creek Reference Wetland, Rice Creek Chain of Lakes Regional Park Reserve

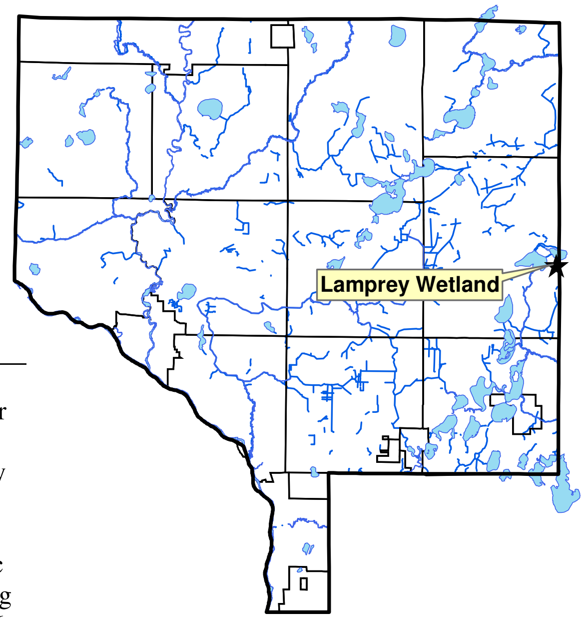
Results: See the following pages.

Rice Creek Watershed Wetland Hydrology Monitoring Sites



LAMPREY REFERENCE WETLAND

Lamprey Pass Wildlife Mgmt Area, Columbus



Site Information

Monitored Since: 1999

Wetland Type: 4

Wetland Size: ~0.5 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-9	10yr 2/1	Fine Sandy Loam	-
AB	9-19	10yr 2/1	Fine Sandy Loam	2% 10yr 5/6
Bw	19-35	10ry 3/1	Loam	2% 10ty 5/4
2C1	35-42	5y 5/2	Clay Laom	5y 3/1 Organic Streaking
2C2	42-48	2.5y 5/1	Sandy Loam	2.5y 5/6

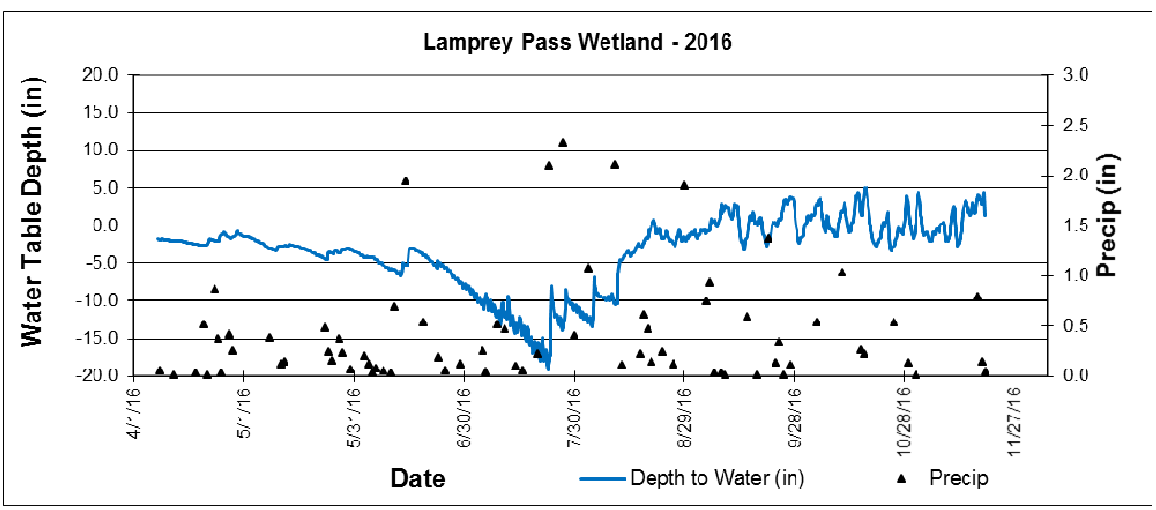
Surrounding Soils: Braham loamy fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Carex pennsylvanica	Pennsylvania Sedge	50
Cornus stolonifera (S)	Red-osier Dogwood	20
Fraxinus pennslyvanicum (T)	Green Ash	40
Xanthoxylum americanum	Pricly Ash	20
Bare Ground		20

Other Notes: Wetland is about 200 feet west of Interstate Highway 35, but within a state wildlife management area. Well is located at the wetland boundary.

2016 Hydrograph

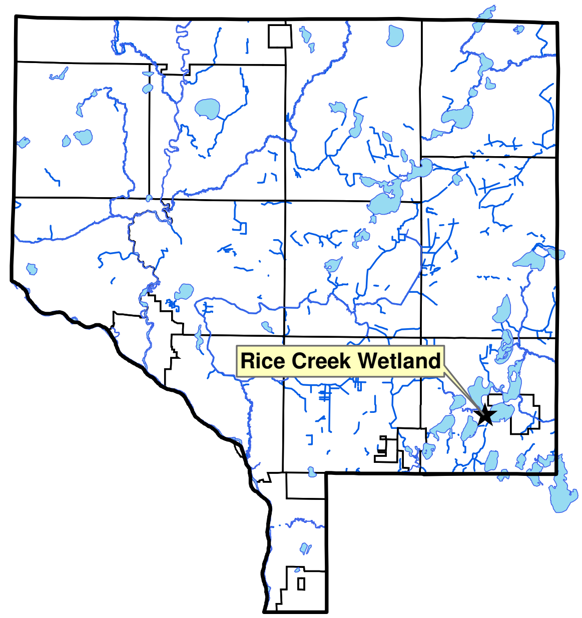


Well depth was 40 inches, so a reading of –43 indicates water levels were at an unknown depth greater than or equal to 43 inches.

Wetland Hydrology Monitoring

RICE CREEK REFERENCE WETLAND

Rice Creek Chain of Lakes Regional Park, Lino Lakes



Site Information

Monitored Since: 1996

Wetland Type: 7

Wetland Size: ~0.5 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-12	10yr 3/1	Sandy Loam	-
Ab	12-16	10yr 2/1	Sandy Loam	-
Bg1	16-21	10yr4/1	Sandy Loam	-
Bg2	21-35	10yr5/2	Sandy Loam	5% 10yr 5/6
2Cg	35-42	2.5y 5/2	Silt Loam	5% 10yr 5/6

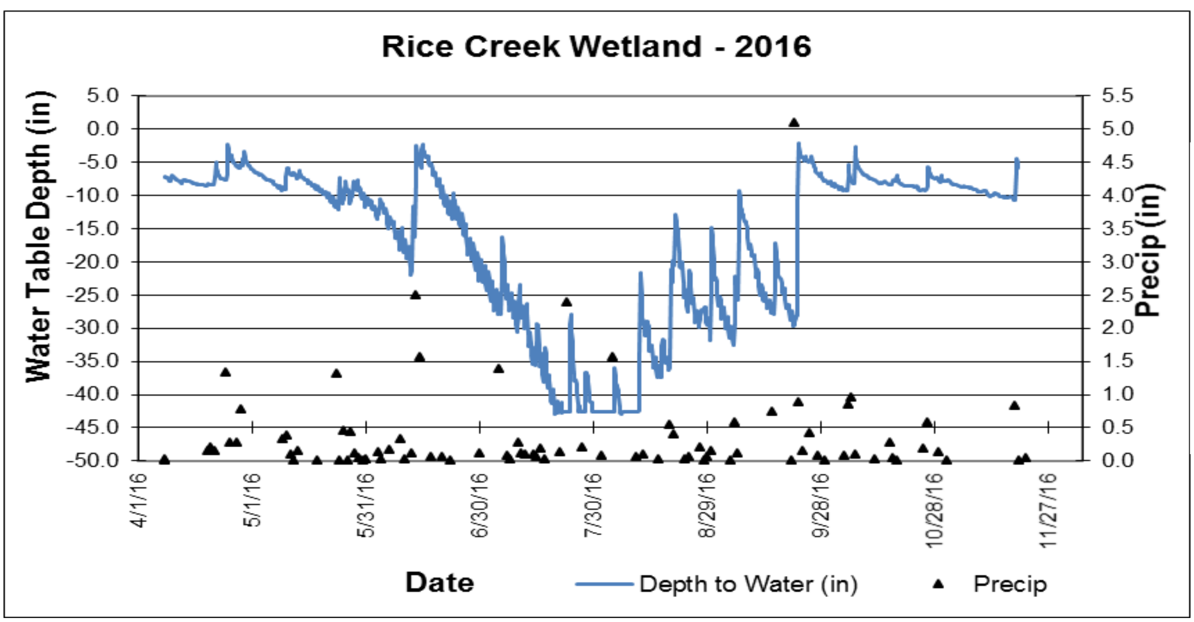
Surrounding Soils: Nessel fine sandy loam and Blomford loamy fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Rubus strigosus	Raspberry	30
Onoclea sensibilis	Sensitive Fern	20
Fraxinus pennsylvanica	Green Ash	40
Amphicarpa bracteata	Hog Peanut	20

Other Notes: This is an intermittent, forested wetland within the regional park between Centerville and George Watch Lakes. It is about 900 feet from George Watch Lake and 800 feet from Centerville Lake. Well is at wetland boundary.

2016 Hydrograph



Well depth was 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

Stream Water Quality – Biological Monitoring

Description: This program combines environmental education and stream monitoring. Under the supervision of ACD staff, high school science classes collect aquatic macroinvertebrates from a stream, identify their catch to the family level, and use the resulting numbers to gauge water and habitat quality. These methods are based upon the knowledge that different families of macroinvertebrates have different water and habitat quality requirements. The families collectively known as EPT (Ephemeroptera, or mayflies; Plecoptera, or stoneflies; and Trichoptera, or caddisflies) are generally pollution intolerant. Other families can thrive in low quality water. Therefore, a census of stream macroinvertebrates yields information about stream health.

Purpose: To assess stream quality, both independently as well as by supplementing chemical data.
To provide an environmental education service to the community.

Locations: Clearwater Creek at Centerville City Hall, Centerville

Hardwood Creek at several locations, Lino Lakes

Rice Creek at Hwy 65, Fridley

Results: Results for each site sampled in 2016 are detailed on the following pages.

Tips for Data Interpretation

Consider all biological indices of water quality together rather than looking at each alone, as each gives only a partial picture of stream condition. Compare the numbers to county-wide averages. This gives some sense of what might be expected for streams in a similar landscape, but does not necessarily reflect what might be expected of a minimally impacted stream. Some key numbers to look for include:

Families — Number of invertebrate families. Higher values indicate better quality.

EPT — Number of families of the generally pollution-intolerant orders Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies). Higher numbers indicate better stream quality.

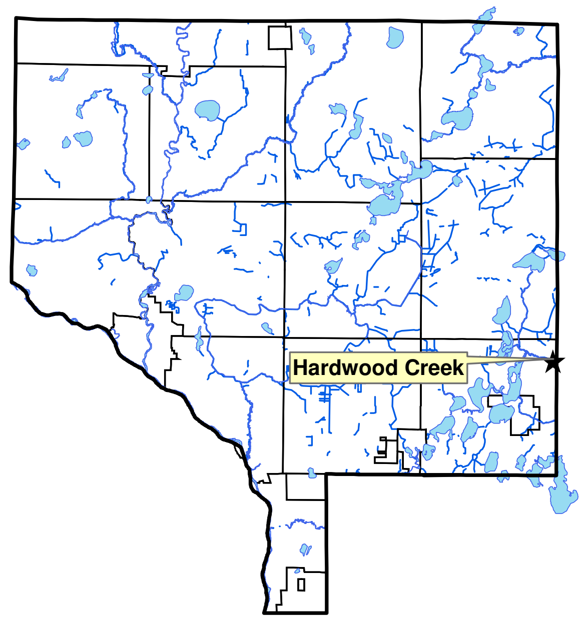
Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

FBI	Stream Quality Evaluation
0.00-3.75	Excellent
3.76-4.25	Very Good
4.26-5.00	Good
5.01-5.75	Fair
5.76-6.50	Fairly Poor
6.51-7.25	Poor
7.26-10.00	Very Poor

% Dominant Family — High numbers indicate an uneven community, and likely poorer stream health.

HARDWOOD CREEK

see list of monitoring locations below



Last Monitored

By Forest Lake Area Learning Center in fall of 2016

Monitored Since

1999 to fall 2007 at Hwy 140
Fall 2007 at 165th Ave NW
2008 SW of intersection of 170th St and Fenway Ave
2009-2016 at Cecelia LaRoux property 600 m W of I-35

Student Involvement

8 students in 2016, approximately 260 since 2001

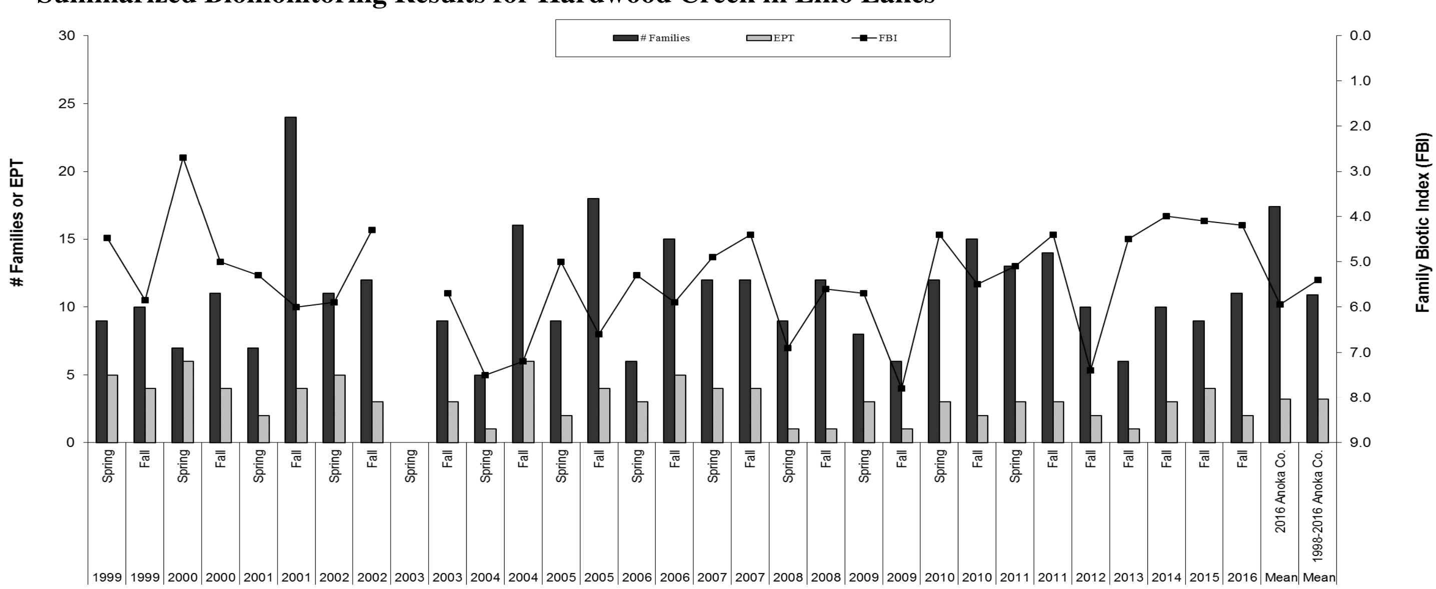
Background

Hardwood Creek originates in Washington County and flows west to Rice Creek and the Rice Creek Chain of Lakes. This is a small creek with a width at baseflow of approximately 10-15 feet and depth of approximately 6-12 inches. The surrounding land use is primarily agricultural, with some residential areas. The stream bottom is sand, gravel, and some cobble in some locations such as at Highway 140 where the creek was monitored until fall 2007. The current monitoring site was the subject of a stream restoration project in 2008. All other monitoring sites have had poor habitat.

Results

A Forest Lake Area Learning Center class monitored Hardwood Creek in the fall of 2016, facilitated by the Anoka Conservation District. This site was the subject of a stream restoration project that included rock veins, brush bundles and willow staking. An improvement in stream health documented in 2010-11 has been followed up by consecutive years of decrease in number of families and EPT in 2012-13. A slight rebound in both was observed in 2014-15. A rebound in the FBI was observed in 2013 through 2015. EPT also saw an increase in 2015 suggesting improving water quality, although these changes could reflect normal variation. A slight dip in FBI and EPT in 2016 was likely due to the creek being in flood stage during fall sampling.

Summarized Biomonitoring Results for Hardwood Creek in Lino Lakes



Biomonitoring Data for Hardwood Creek in Lino Lakes

Data presented from the most recent five years. Contact the ACD to request archived data.

Year	2012	2013	2014	2015	2016	Mean	Mean
Season	Fall	Fall	Fall	Fall	Fall	2016 Anoka Co.	1998-2016 Anoka Co.
FBI	7.4	4.5	4.0	4.1	4.2	5.9	5.4
# Families	10	6	10	9	11	17.4	10.9
EPT	2	1	3	4	2	3.2	3.2
Date	11-Oct	10-Oct	10-Oct	8-Oct	10-Oct		
Sampled By	FLALC	FLALC	FLALC	FLALC	FLALC		
Sampling Method	MH	MH	MH	MH	MH		
Mean # Individuals/Rep.	83	87	359	158	469		
# Replicates	1	1	1	1	1		
Dominant Family	Hyalellidae	Gammarid	Gammarid	Gammaridae	Gammaridae		
% Dominant Family	73	87.4	97.2	62.7	91.7		
% Ephemeroptera	12	3.4	0.8	32.3	2.3		
% Trichoptera	0	0	0.3	0.6	0		
% Plecoptera	0.0	0.0	0.0	0.0	0.0		

Supplemental Stream Chemistry Readings

Data presented from the most recent five years. Contact the ACD to request archived data.

	Fenway Ave Site		C. LaRoux Property						
Parameter	5/15/2008	10/8/2008	5/19/2009	10/8/2009	5/5/2010	10/14/2010	5/11/2011	10/5/2011	10/11/2012
pH	7.13	7.46	8.1	7.43	na	7.57	7.76	7.97	8.04
Conductivity (mS/cm)	0.361	0.431	0.426	0.37	0.457	0.509	0.411	0.314	0.405
Turbidity (NTU)	13	11	6	22	7	6	13	4	na
Dissolved Oxygen (mg/L)	10.88	7.14	12.3	11.5	11.6	na	9.67	7.01	5.27
Salinity (%)	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
Temperature (°C)	12.4	12.4	16.5	9.7	10.4	9.8	17.3	14.5	7.6

Discussion

Hardwood Creek is on the Minnesota Pollution Control Agency's 303(d) list of impaired waters for impaired biota and dissolved oxygen. The Rice Creek Watershed District has conducted a TMDL investigative study. Our biological monitoring does indicate a below or near average biological community, but lends only modest insight into what might be causing this impairment. Habitat seems to be an important factor. Biological indices of stream health have improved at the stream restoration site.

Three sites on this creek have been monitored and provided differing results. The earliest monitoring until 2007 was on the north side of Highway 140 (170th St, W crossing), where habitat was moderate to good and invertebrate communities indicated the best stream health. In spring 2008 it was monitored farther to the east Highway 140, near Fenway Ave, and conditions were somewhat poorer. Since that time monitoring has been just north of Hwy 140, one third mile east of County Road 20 on the C. LaRoux Property, where conditions have been mid-range. Substantial variation among samplings is seen at all sites.

Forest Lake Area Learning Center students at Hardwood Creek.

Rice Creek

at Hwy 65, Locke Park, Fridley

Last Monitored

By Totino Grace High School in fall 2016

Monitored Since

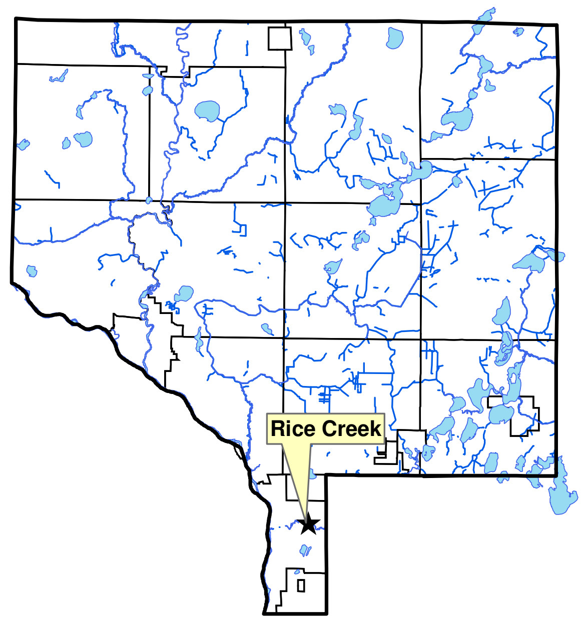
1999

Student Involvement

68 students in 2016, approximately 1,144 since 2001

Background

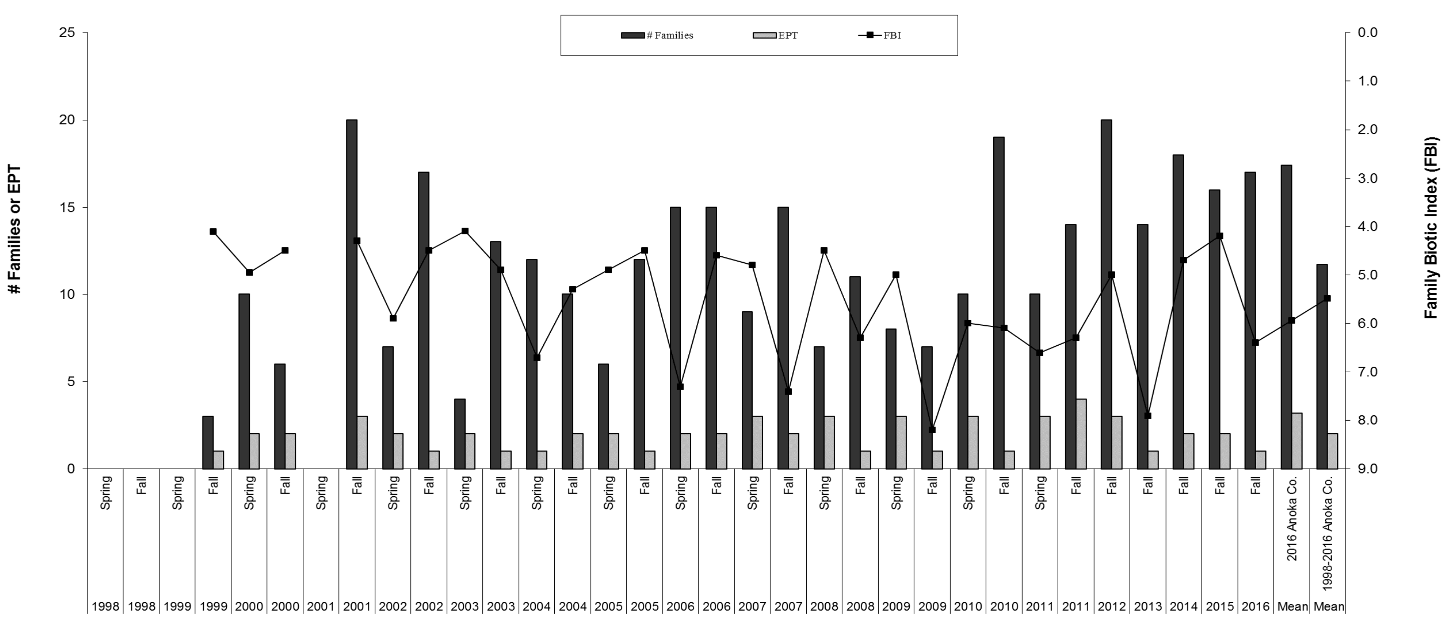
Rice Creek originates from Howard Lake in east-central Anoka County and flows south and west through the Rice Creek Chain of Lakes and eventually to the Mississippi River. Sampling is conducted in Locke Park, which encompasses a large portion of the stream's riparian zone in Fridley. This site is wooded. Outside of this buffer, though, the watershed is highly urbanized and the stream receives runoff from a variety of urban sources. The stream has a rocky bottom with pools and riffles, some due to stream bank stabilization projects.



Results

Totino Grace High School monitored this stream in fall of 2016, facilitated by the Anoka Conservation District. At this site, Rice Creek has a macroinvertebrate community indicative of poor stream health. While the number of families present has been similar to, or above the average for Anoka County streams on several occasions (fall 2010, 2011, 2012, 2013 and 2014), most of these are generalist species that can tolerate polluted conditions. The number of EPT families present has been below the county average in all years. EPT are generally pollution-sensitive, but the EPT family most often found in Rice Creek the caddisfly family Hydropsychidae, is an exception to that rule. It thrives in relatively poor environmental conditions. In addition to being the dominant species found in Rice Creek historically, Hydropsychidae was the only EPT taxon collected in 2016.

Summarized Biomonitoring Results for Rice Creek at Hwy 65, Fridley



Biomonitoring Data for Rice Creek at Hwy 65, Fridley

Data presented from the most recent five years. Contact the ACD to request archived data.

Year	2012	2013	2014	2015	2016	Mean	Mean
Season	Fall	Fall	Fall	Fall	Fall	2016 Anoka Co.	1998-2016 Anoka Co.
FBI	5	7.9	4.7	4.2	6.4	5.9	5.5
# Families	20	14	18	16	17	17.4	11.7
EPT	3	1	2	2	1	3.2	2.0
Date	5-Oct		16-Oct	13-Oct	18-Oct		
Sampled By	TGHS	TGHS	TGHS	TGHS	TGHS		
Sampling Method	MH	MH	MH	MH	MH		
# Individuals	248	107	670.5	730	272		
# Replicates	2	2	2	1	1		
Dominant Family	Philopotamidae	Corixidae	Hydropsychidae	Hydropsychidae	Hydropsychidae		
% Dominant Family	38.0	38.0	76.7	92.6	41.5		
% Ephemeroptera	10.9	0.0	0.1	0.4	0		
% Trichoptera	43.1	6.4	76.7	92.6	41.5		
% Plecoptera	0.0	0.0	0.0	0.0	0		

Supplemental Stream Chemistry Readings

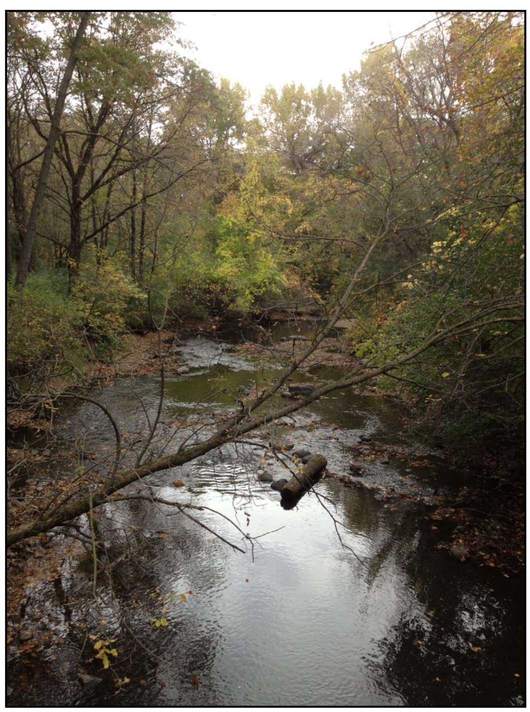
Data presented from the most recent five years. Contact the ACD to request archived data.

Parameter	10/10/2008	5/11/2009	10/8/2009	5/14/2010	10/13/2010	5/31/2011	10/7/2011	10/5/2012	10/16/2014
pH	7.73	8.23	4.76	7.85	7.92	7.62	8.02	8.17	8.62
Conductivity (mS/cm)	0.639	0.624	0.638	0.545	0.535	0.504	0.364	0.460	0.363
Turbidity (NTU)	13	16	18	13	15	0	6	na	15.6
Dissolved Oxygen (mg/L)	9.01	12.29	10.74	12.64	na	7.94	7.34	7.82	10.06
Salinity (%)	0.02	0.02	0.02	0.02	0.02	na	0.01	0.01	0.34
Temperature (°C)	12.9	14.5	11.2	12.8	16.5	19.6	17.1	9.6	11.23

Discussion

The poor macroinvertebrate community in this creek is likely due to poor water quality, not poor habitat. Habitat at the sampling site and nearby is good, in part because of past stream habitat improvement projects. The stream has riffles, pools, and runs with a variety of snags and rocks. The area immediately surrounding the stream is wooded, with walking trails. However, outside of this natural corridor around the stream, the watershed is urbanized and storm water inputs are likely the cause of degraded water quality.

Totino Grace High School students at Rice Creek.



Water Quality Grant Administration

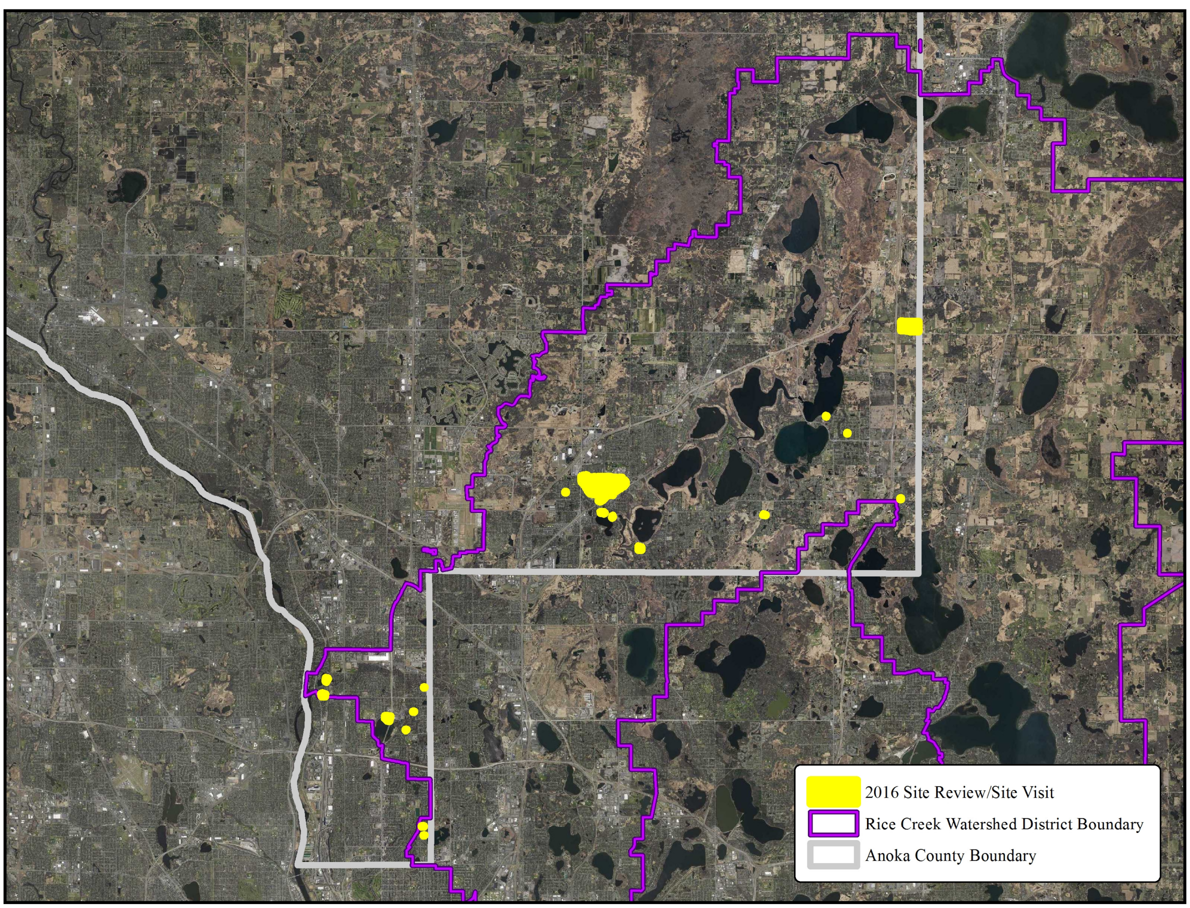
Description: RCWD contracted the ACD to provide technical assistance for the RCWD Water Quality Grant Program. Tasks could include landowner outreach and education, site reviews, site visits, project evaluations, BMP design, contractor assistance, construction oversight, long-term project monitoring and other services as needed.

Purpose: To assist property owners within the Rice Creek Watershed District with the design and installation of water quality improvement BMPs.

Results: Below is a summary of technical assistance provided in 2016.

Project Details:

- 19 formal property reviews/site visits throughout the Rice Creek Watershed District in Anoka County
- Property prioritization for potential curb-cut rain gardens throughout the GL-4 catchment in Circle Pines
- Survey work for three properties in preparation for design development
- Finalized design for pretreatment retrofit to existing swale at St. Philip's Church in Fridley
- Concept design for curb-cut rain garden at Redeemer Church in Fridley
- Concept design for curb-cut rain garden in Columbia Heights
- Approved cost-share application for pretreatment retrofit to existing curb-cut rain garden in Circle Pines



Financial Summary

ACD accounting is organized by program and not by customer. This allows us to track all of the labor, materials and overhead expenses for a program, such as our lake water quality monitoring program. We do not, however, know specifically which expenses are attributed to monitoring which lakes. To enable reporting of expenses for monitoring conducted in a specific watershed, we divide the total program cost by the number of sites monitored to determine an annual cost per site. We then multiply the cost per site by the number of sites monitored for a customer. The process also takes into account equipment that is purchased for monitoring in a specific area.

Rice Creek Watershed Financial Summary

Rice Creek Watershed	WMO Asst (no charge)	Volunteer Precip	Reference Wetlands	Ob Well	Lake Level	Student Biomon	RCWD Cost Share Admin	RCWD Project Hours	Total
Revenues									
RCWD	0	0	1150	0	1250	1650	3030	8723	15802
State	0	0	0	480	0	0	0	0	480
Anoka Co. General Services	390	0	21	469	751	814	0	0	2446
Anoka Conservation District	0	0	46	0	0	0	0	0	46
County Ag Preserves/Projects	0	0	0	0	0	950	0	0	950
Service Fees	0	0	0	0	0	0	0	0	0
Regional/Local	0	0	32	0	0	0	0	0	32
BWSR Cons Delivery	0	0	0	0	0	0	0	0	0
BWSR Capacity Funds	0	0	1223	0	0	0	0	0	1223
BWSR Cost Share TA	0	0	0	0	0	0	0	0	0
Metro ETA & AWQCP	0	0	0	0	0	0	0	0	0
Local Water Planning	0	184	608	0	0	0	0	0	791
TOTAL	390	184	3079	949	2001	3414	3030	8723	21769
Expenses-									
Capital Outlay/Equip	5	2	16	11	23	38	34	99	228
Personnel Salaries/Benefits	339	178	1181	826	1741	2865	2505	7380	17015
Overhead	25	13	87	61	128	211	184	543	1251
Employee Training	2	1	7	5	10	16	14	42	96
Vehicle/Mileage	7	4	25	17	37	61	53	156	360
Rent	12	6	42	30	62	102	90	264	608
Program Participants	0	0	0	0	0	0	0	0	0
Program Supplies	0	-21	1607	0	0	121	0	0	1708
TOTAL	390	184	2964	949	2001	3414	2880	8483	21266

Recommendations

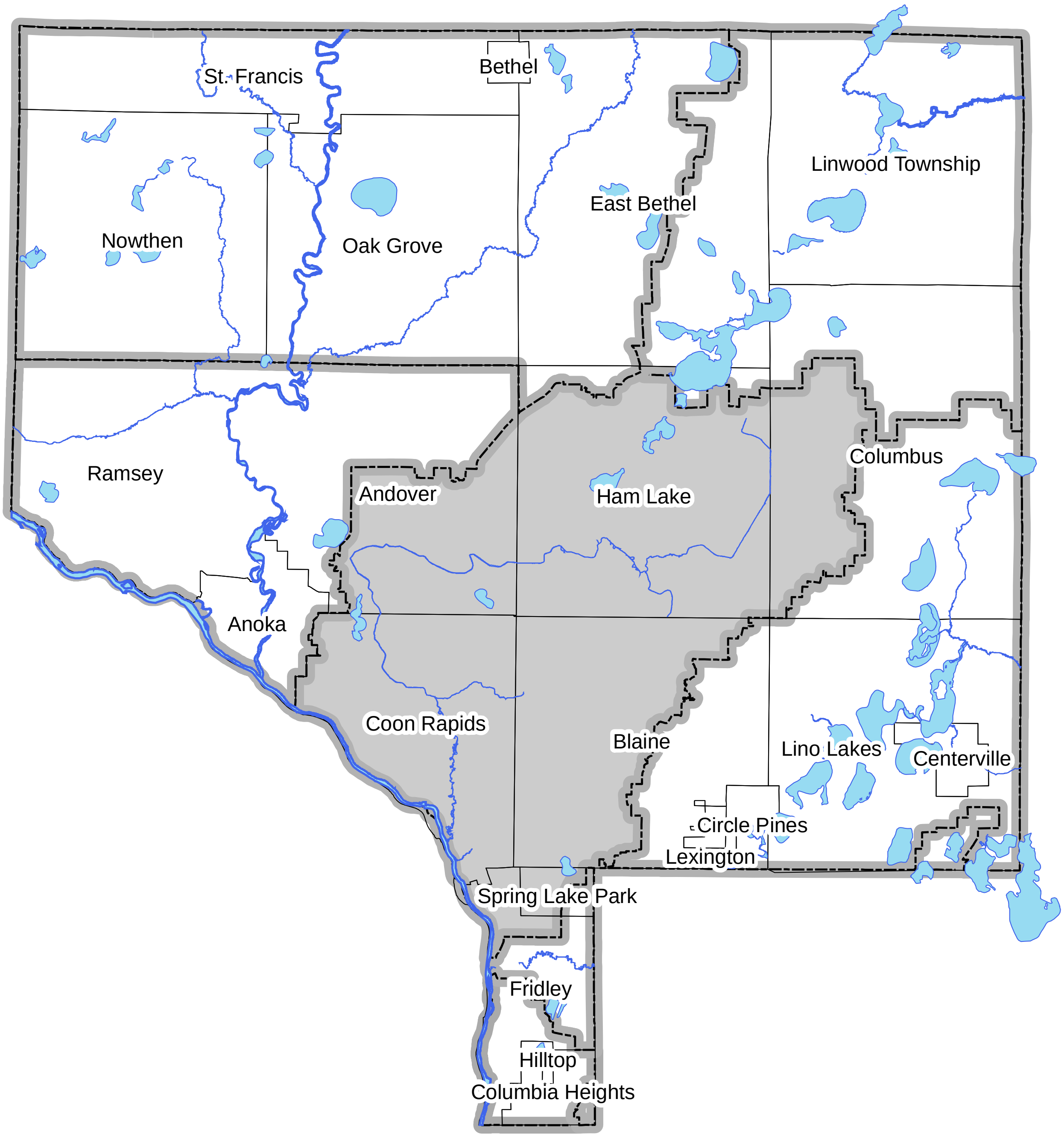
- **Continue the biomonitoring program** with area schools. This program provides dual benefit in monitoring known impairments as well as educating local youth on their natural resources.

- **Continue to install cost effective projects** identified in previously completed Subwatershed Retrofit Analyses and prioritized in newly completed sub-catchment analyses. Install and maintain water quality improvement projects.

- **Continue work to improve the ecological health of Clearwater, Hardwood, and Rice Creeks.** Clearwater Creek is designated as impaired for aquatic life based on fish and invertebrate IBIs. Hardwood Creek is impaired based on invertebrate data and low dissolved oxygen. Rice Creek is impaired for both fish and invertebrate IBIs downstream of Baldwin Lake in Anoka County. The Anoka County invertebrate data for Rice Creek continue to indicate a depleted invertebrate community.

- **Continue efforts to reduce road salt use.** Chlorides are pervasive throughout shallow aquifers and the streams that feed them.

Coon Creek Watershed

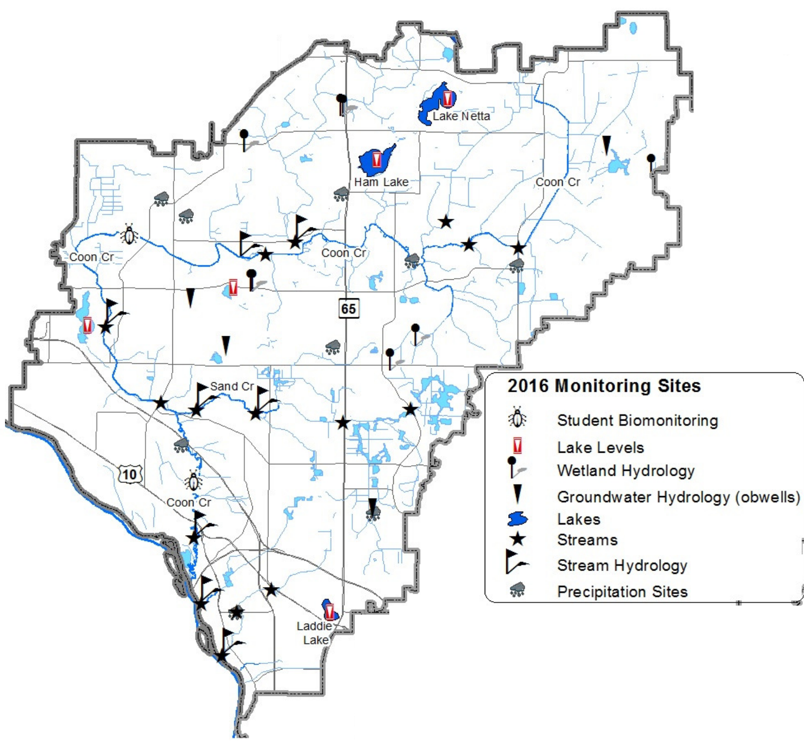


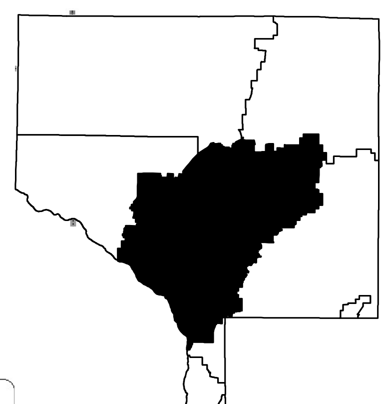
Contact Info: Coon Creek Watershed District
www.cooncreekwd.org
763-755-0975

Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 6:
COON CREEK WATERSHED

ACAP = Anoka County Ag Preserves, ACD = Anoka Conservation District,
CCWD = Coon Creek Watershed District, MNDNR = MN Dept. of Natural Resources





Summary of Findings

Description:

This is a brief summary of new findings and notable results from the 2016 monitoring season. Detailed analyses for all individual sites can be found below in the appropriate section of the work results.

Lake Water Quality:

- Ham Lake received an overall B grade in 2016, which is a decline compared to the A grade received in 2012 and 2014. An increase of Chlorophyll-a levels caused this drop in letter grade after the last two years sampled resulted in record lows. Increased algal growth was also likely the reason for low Secchi transparency. This increase in algal growth could be due to a warm winter leading to warmer water temperatures earlier in the season than usual.

- Laddie Lake achieved an overall A letter grade in 2016 for the first time in its sampled history. Water quality in Laddie Lake continues to show a trend of improvement dating back to the 1980s. The lake is quite clear and maintains a healthy community of aquatic macrophytes that aid in nutrient reduction.

- Lake Netta continued a trend of good water quality in 2016, receiving an overall A letter grade for the third consecutive year sampled. Low levels of TP and chlorophyll-a were each only beat out by 2015 and 2013 results respectively for the second lowest average recorded for each parameter.

Lake AIS Surveys

- AIS early detection surveys were conducted on Ham, Laddie and Netta Lakes on 6/17/2016 and 8/18/2016. No new infestations were found.

Stream Hydrology:

- Stream levels for the two new sites from 2015, Coon Creek at 131st Avenue NW and Coon Creek at Prairie Rd., had similar results in 2016. Levels at Prairie Rd. were almost identical to 2015 levels, and levels at 131st ranged about 0.5 to 1.0 foot higher than the previous year.

- Pleasure Creek had its highest level on recorded of 825.33, as well as its highest ever median of 822.54.

Precipitation:

- A 100 Year rain event was recorded at the Springbrook Nature Center gauge with 7.17 inches of rain falling in 13.25 hours. The event took place 9/21/2016-9/22/2016. This storm was the most intense in the southern portions of the watershed.

- With the exception of the month of May, rainfall exceeded the 30 year average in every month from April through November.

Recommendations

- **Continue to phase out RDS dataloggers** and budget for replacement with OTT Orpheus Mini dataloggers. The RDS loggers have a history of unreliable functionality. RDS has closed its business so replacement of equipment and technical support is no longer possible.
- **Consider updating rating curve measurements.** The site at Vale last had rating curve measurements in 2010. It may be time to consider another round to keep the curve up to date. Development of rating curves on Stonybrook and Oak Glen Creek should be considered as well. All other rating curve sites were last updated in 2013.
- **Continue installing stormwater retrofits for water quality improvement.** Water quality monitoring shows most water quality problems are associated with storms; baseflow water quality is good in most locations.
- **Promote the availability of reference wetland data** among wetland regulatory personnel as well as consultants as a means for efficient, accurate wetland determinations. We're finding these data to be more and more helpful in developing areas and have seen demand increase accordingly.
- **Continue hydrolab continuous water quality monitoring of creeks.** This continuous data is useful for diagnosing pollutant magnitudes, sources, and developing management strategies.

Precipitation

Description: Continuous monitoring of precipitation with both data-logging rain gauges and non-logging rain gauges that are read daily by volunteers. Rain gauges are placed around the watershed in recognition that rainfall totals and storm phenology are spatially variable, and these differences are critical to understanding local hydrology, including flood prediction.

Purpose: To aid in all types of hydrologic analyses, predictions, and regulatory decisions within the watershed.

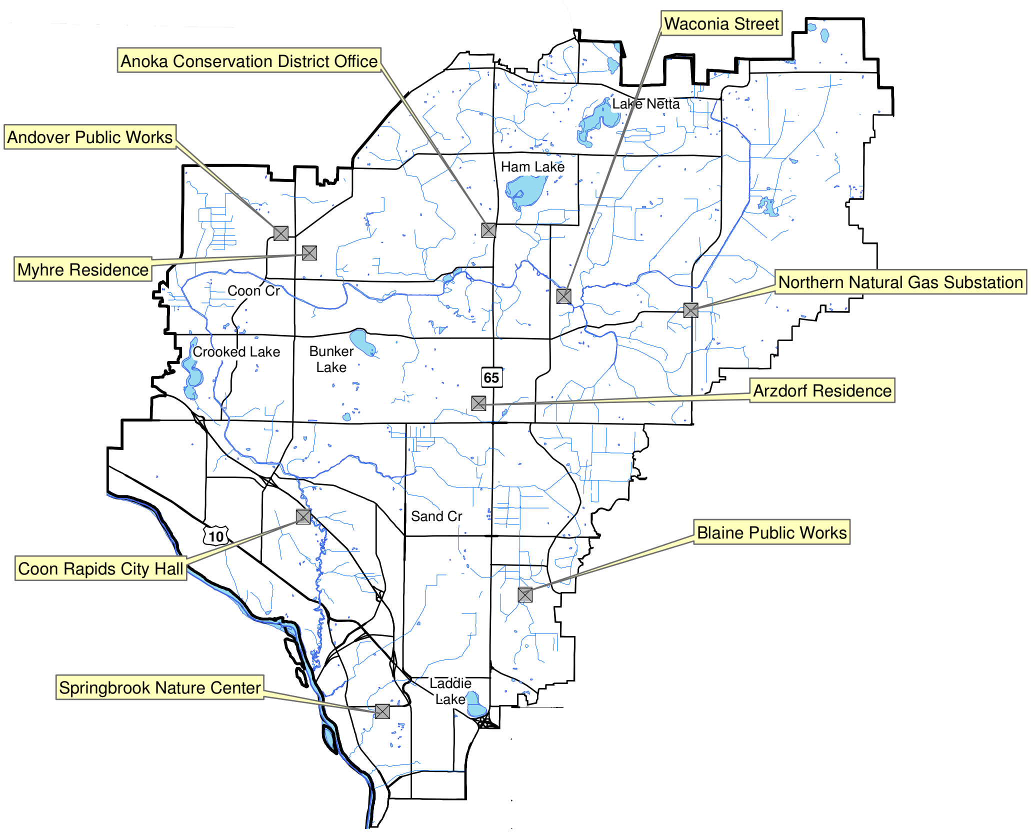
Locations:

Type	Site	City
Data Logging	Andover City Hall	Andover
Data Logging	Anoka Conservation District Office	Ham Lake
Data Logging	Blaine Public Works	Blaine
Data Logging	Coon Rapids City Hall	Coon Rapids
Data Logging	Waconia St.	Ham Lake
Data Logging	Northern Natural Gas Substation	Ham Lake
Cylinder - Volunteer	Arzdorf residence	Blaine
Cylinder – Volunteer	Myhre residence	Andover

Note: Additional county-wide precipitation summaries can be found in Chapter 1.

Results: Precipitation data were reported to the Coon Creek Watershed in digital format. A summary table and graph are presented on the following page.

Coon Creek Watershed 2016 Precipitation Monitoring Sites

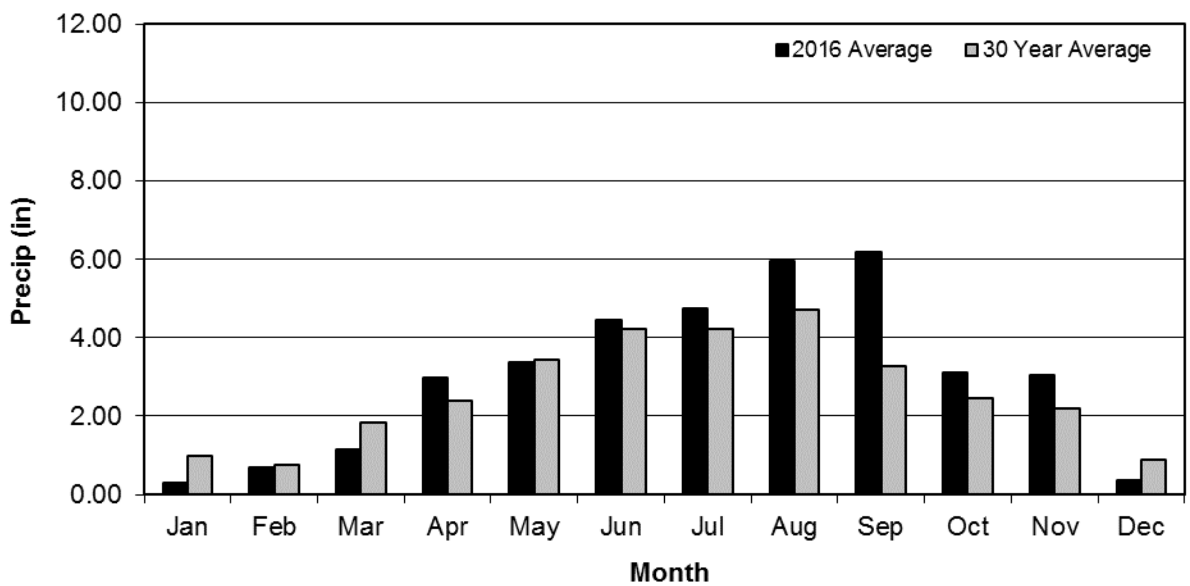


Coon Creek Watershed 2016 Precipitation Summary Table and Graph

Location or Volunteer	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total	Growing Season (May-Sept)
Tipping bucket, datalogging rain gauges (Time and date of each 0.01" is recorded)															
Andover City Hall	Andover			0.38	2.54	0.89*	0.18*	1.87	6.29	4.82	3.76	2.90	0.17	22.73	12.98
Blaine Public Works	Blaine			0.61	3.39	3.47	5.19	5.15	1.69	7.43	3.29	3.59	0.13	33.94	22.93
Coon Rapids City Hall	Coon Rapids			1.9	3.21	3.36	5.04	4.45	7.54	6.86	3.1	3.35	0.21	39.02	27.25
Anoka Cons. District office	Ham Lake			0.07	2.48	3.08	4.13	5.63	6.54	5.08	3.48	2.33	0.12	32.94	24.46
Waconia Street	Ham Lake							4.51	6.63	4.89	3.21	3.27	0.16	22.67	16.03
Northern Nat. Gas substation	Ham Lake						3.97	4.32	3.02	0.86*	3.08	2.74	0.14	17.27	11.31
Springbrook Nature Center	Fridley			1.08	3.54	3.42	4.53	4.72	8.38	9.92	0.96	2.87	0.21	39.63	30.97
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.29	0.68	1.89	2.70	3.87	3.78	6.63	5.97	4.74	3.75	3.24	1.77	37.54	24.99
J. Arzdorf	Blaine			2.18	3.11	3.02	4.53	5.39	7.71	5.80	3.37			35.11	26.45
2016 Average	County-wide	0.29	0.68	1.16	3.00	3.37	4.45	4.74	5.97	6.19	3.11	3.04	0.36	28.30	24.73
30 Year Average	Cedar	0.99	0.76	1.84	2.40	3.43	4.22	4.21	4.70	3.29	2.44	2.18	0.90	31.36	19.85

precipitation as snow is given in melted equivalents

*Incomplete monthly data not included in averages



Precipitation Analyses

Description: Two different precipitation analyses were done – 1) 2016 storm analyses and 2) long term precipitation trend analysis.

1.) **2016 Storm Analyses:** Precipitation events at each of the six Coon Creek Watershed District data-logging rain gauges were analyzed. Total precipitation, storm duration, intensity, and recurrence interval were determined for all precipitation events of >0.03 inches. Storms with a recurrence interval of one year or greater on the NOAA Atlas 14 table for Blaine, MN @ Highway 65 and 125th Ave were analyzed further. For each storm, intensity was tracked throughout the duration and graphed. The rate of effective precipitation was determined from the rainfall intensity and surrounding soil type. Effective precipitation was defined as precipitation occurring at an intensity that is lower than the soil infiltration rate (i.e. rain that soaks in and doesn't run off).

   The results of this analysis were delivered to the Coon Creek Watershed District in digital form and are not reported here due to complexity and lengthiness.

2.) **Long Term Precipitation Trends Analysis:** Monthly rainfall deviations from normal were graphed for 1986 to present. Data utilized were from the "Coon Creek-211785" National Weather Service (NWS) station until 2005 when that station was abandoned. Thereafter, the NWS station "Andover-210190" was used. Normal precipitation totals for each month are from the NWS Cedar station. Deviation from normal during the preceding 6-, 12-, and 24-month time periods were calculated and graphed. This is presented on the following page.

Purpose: To aid in hydrologic modeling of the watershed. Also useful for all types of hydrologic analyses, predictions, and regulatory decisions within the watershed.

Locations:

Site	City
Andover City Hall	Andover
Anoka Conservation District Office	Ham Lake
Blaine Public Works	Blaine
Coon Rapids City Hall	Coon Rapids
Waconia Street	Ham Lake
Northern Natural Gas Substation	Ham Lake
Springbrook Nature Center	Fridley

Results:

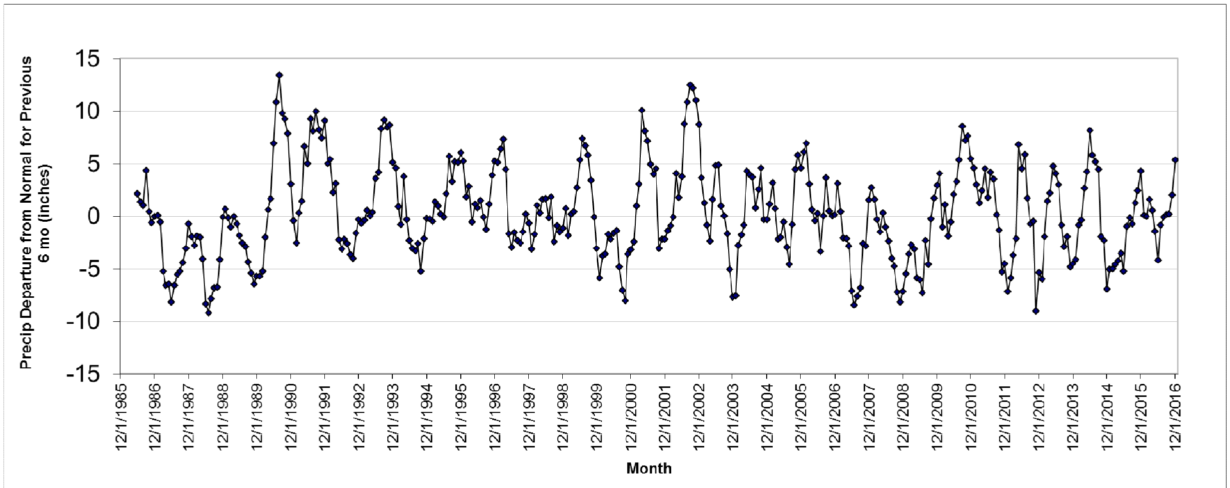
1.) **2016 Storm Analyses:** The results of these analyses were delivered to the Coon Creek Watershed District in digital form and are not reported here due to complexity and lengthiness.

2.) **Long Term Precipitation Trends Analysis:** Results are presented on the following page.

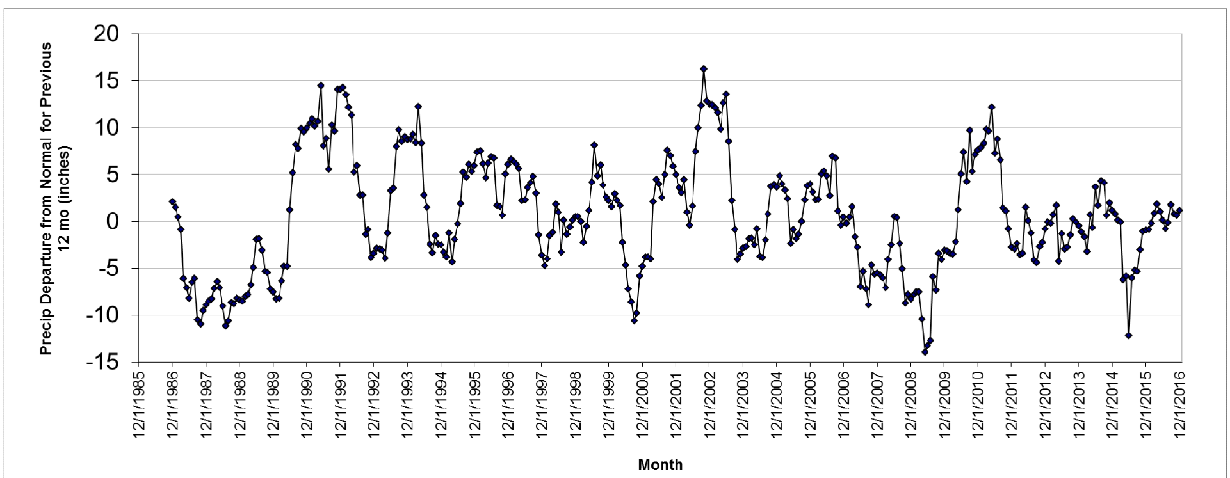
Long Term Precipitation Trends

Notes: Period is 1986 to present. Monthly precipitation totals are from the NWS station nearest the center of the Coon Creek Watershed District with available data (MN State Climatology website). Normal precipitation totals for each month are from the NWS Cedar station.

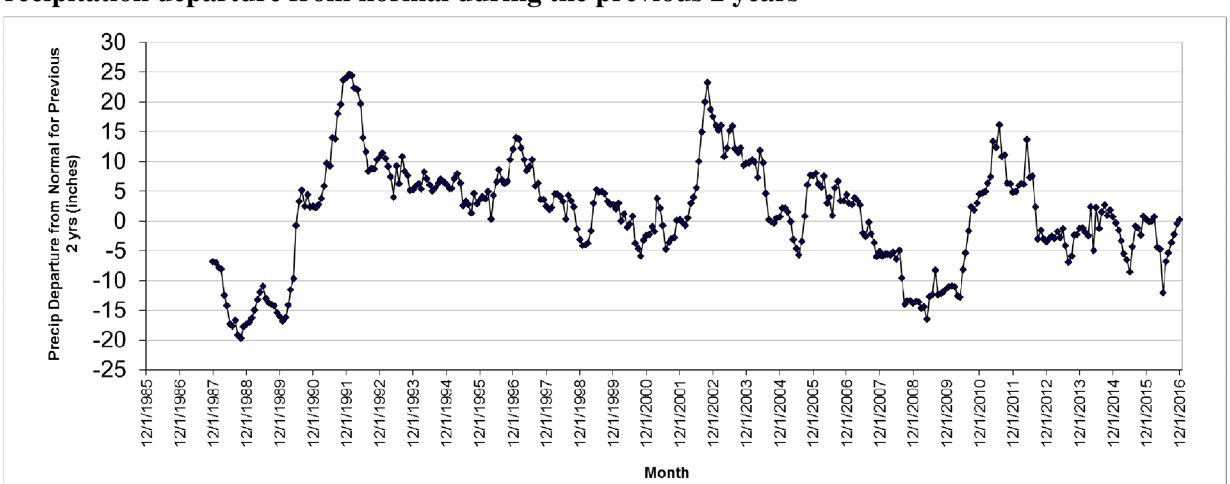
Precipitation departure from normal during the previous 6 months



Precipitation departure from normal during the previous 12 months



Precipitation departure from normal during the previous 2 years



Lake Levels

Description: Weekly water level monitoring in lakes. The past five years are shown below, and all historic data are available on the Minnesota DNR website using the "LakeFinder" feature (www.dnr.mn.us.state\lakefind\index.html).

Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

Locations:

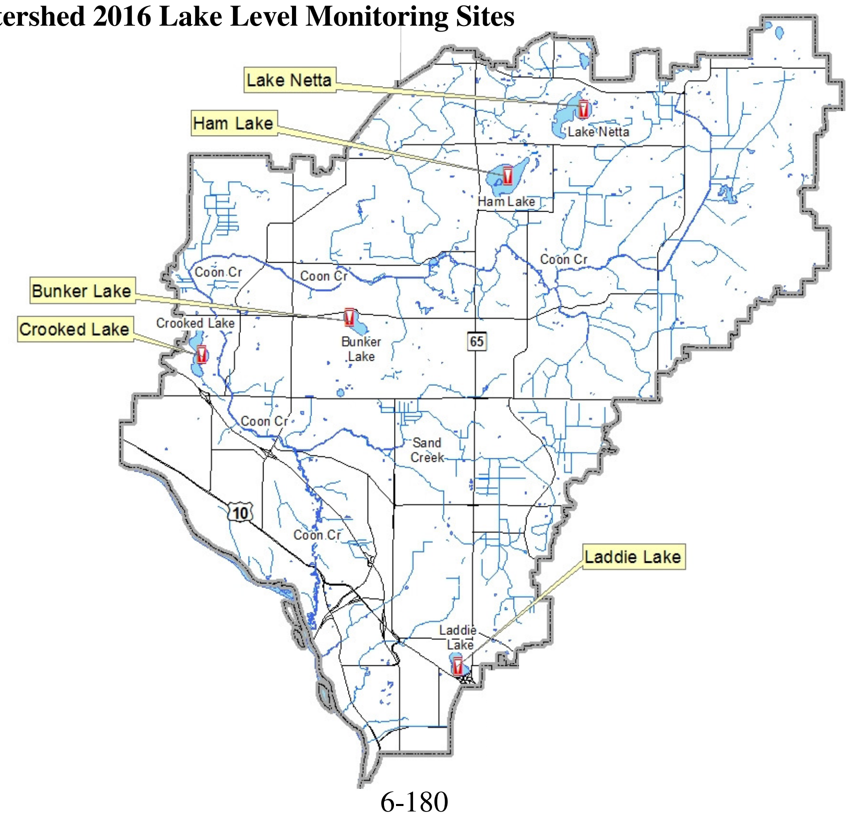
Site	City
Bunker Lake	Andover
Crooked Lake	Andover/Coon Rapids
Ham Lake	Ham Lake
Lake Netta	Ham Lake
Laddie Lake	Blaine

Results: Lake Levels were measured by volunteers 35 times at Crooked Lake, 66 times at Ham Lake, 28 times at Lake Netta, and 39 times at Laddie Lake. Levels in Bunker Lake were monitored using an electronic gauge, which resulted in 229 days of measurements generated by averaging six readings from each day.

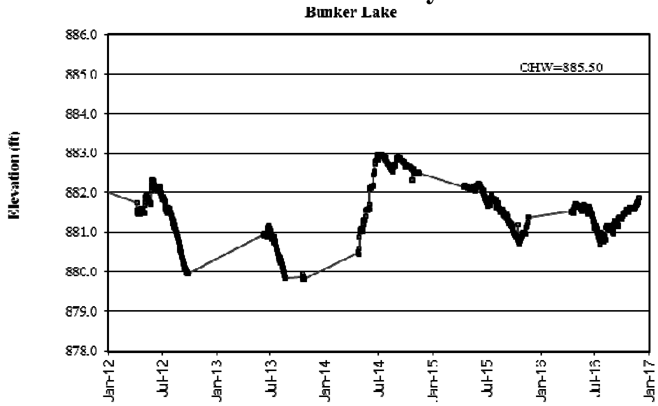
Lakes had increasing water levels in spring and early summer and dropped steadily by mid-summer. A resurgence of rainfall late into fall caused a spike in lake levels at the end of the year, and many lakes remained high right to freeze up. Overall lake levels were similar or slightly higher than 2015.

Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is listed for each lake on the corresponding graphs below.

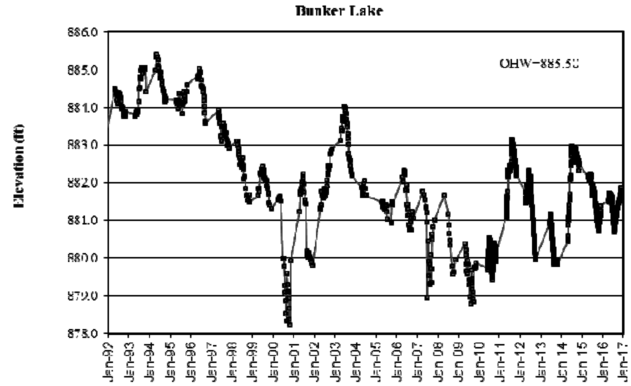
Coon Creek Watershed 2016 Lake Level Monitoring Sites



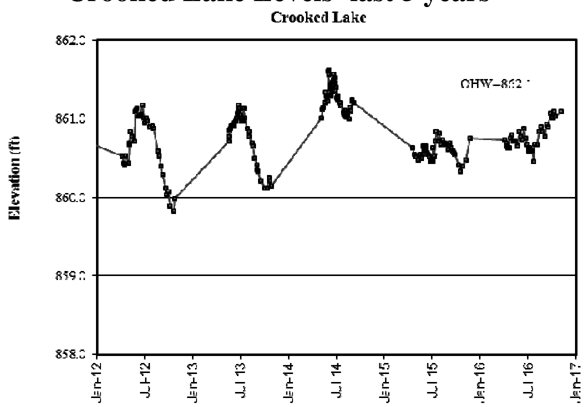
Bunker Lake Levels – last 5 years



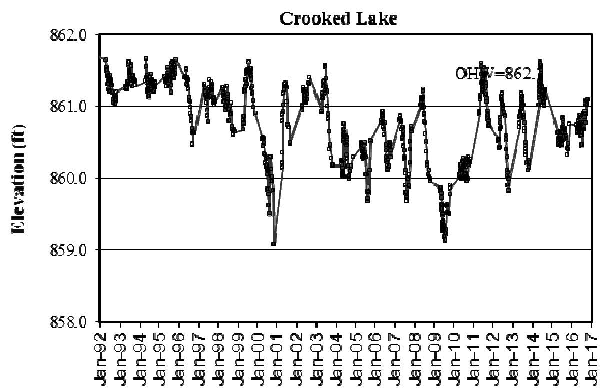
Bunker Lake Levels- last 25 years



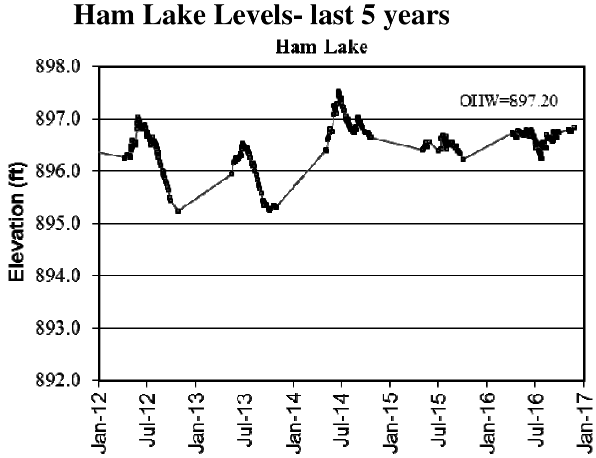
Crooked Lake Levels- last 5 years



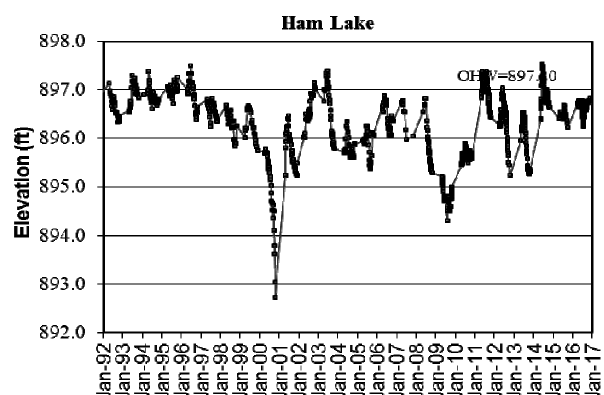
Crooked Lake Levels- last 25 years



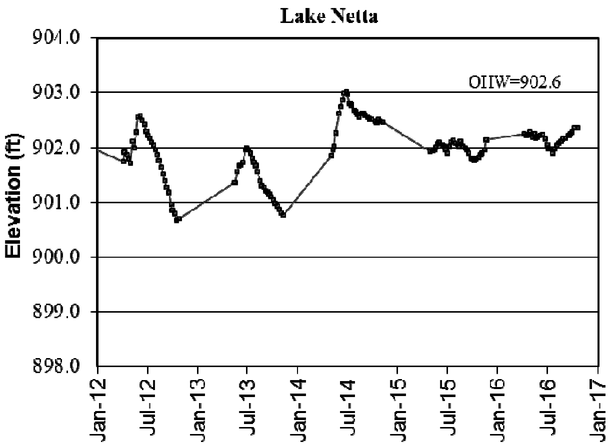
Ham Lake Levels- last 5 years



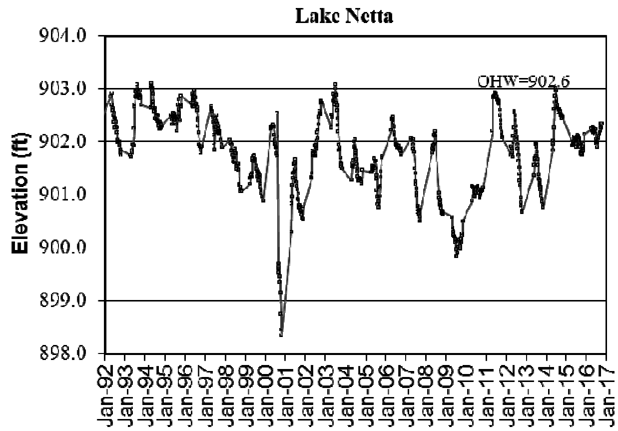
Ham Lake Levels- last 25 years



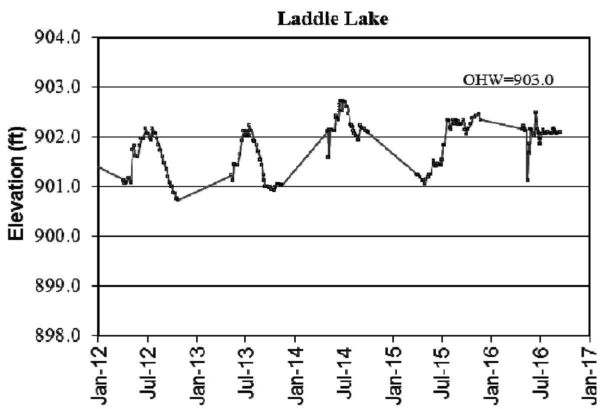
Lake Netta Levels- last 5 years



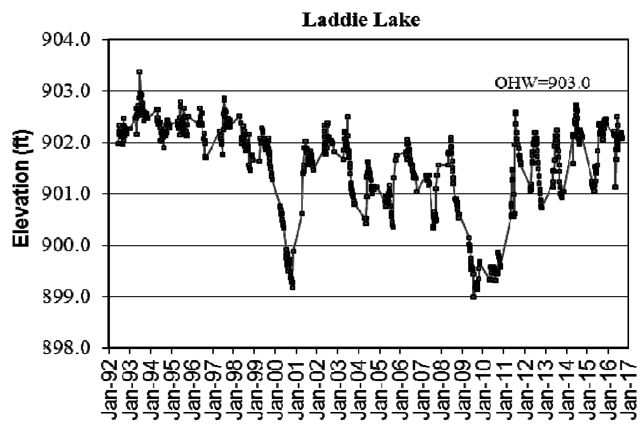
Lake Netta Levels- last 25 years



Laddie Lake Levels- last 5 years



Laddie Lake Levels- last 25 years



Annual average, minimum, and maximum levels for each of the past 5 years

Lake	Year	Average	Min	Max
Bunker	2012	881.45	879.96	882.32
	2013	880.57	879.81	881.17
	2014	882.40	880.45	882.96
	2015	881.61	880.72	882.23
	2016	881.37	880.70	881.88
Crooked	2012	860.64	859.83	861.17
	2013	860.76	860.11	861.17
	2014	861.28	861.00	861.62
	2015	860.58	860.33	860.83
	2016	860.77	860.45	861.09
Ham	2012	896.40	895.24	897.05
	2013	896.04	895.29	896.54
	2014	896.97	896.39	897.53
	2015	896.49	896.23	896.69
	2016	896.637	896.24	896.84

Lake	Year	Average	Min	Max
Netta	2012	901.76	900.67	902.57
	2013	901.40	900.76	901.98
	2014	902.56	901.84	903.02
	2015	901.97	901.76	902.14
	2016	902.16	901.89	902.35
Laddie	2012	901.58	900.72	902.18
	2013	901.47	900.93	902.23
	2014	902.30	901.59	902.73
	2015	901.83	901.05	902.45
	2016	902.07	901.12	902.50

Lake Water Quality

Description: May through September twice-monthly monitoring of the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

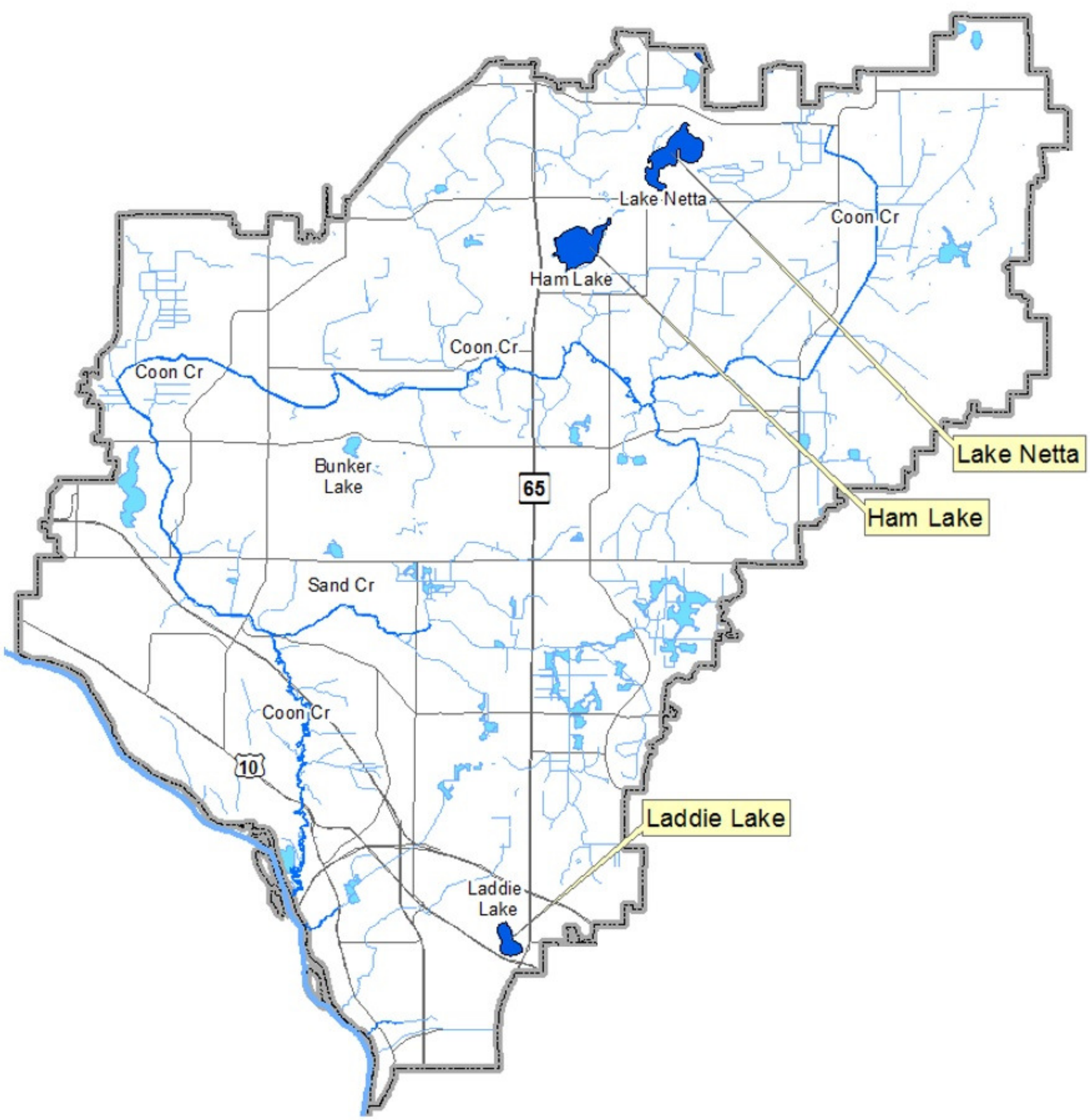
Purpose: To detect water quality trends and diagnose the cause of changes.

Locations:

Site	City
Ham Lake	Ham Lake
Lake Netta	Ham Lake
Laddie Lake	Blaine/Spring Lake Park

Results: Detailed data for each lake are provided on the following pages, including summaries of historical conditions and trend analysis. Previous years' data are available from the ACD. Refer to Chapter 1 for additional information on interpreting the data and on lake dynamics.

Coon Creek Watershed 2016 Lake Water Quality Monitoring Sites



HAM LAKE

CITY OF HAM LAKE, LAKE ID # 02-0053

Background

Ham Lake has a surface area of 193 acres with a maximum depth of 22 feet (6.7 m). Public access is from Ham Lake City Park on the south side of the lake, which includes a boat landing. The lake is used extensively by recreational boaters and fishers. Ham Lake has a winter aeration system to prevent winter fish kills. The lake is surrounded by single-family homes of moderate density and vacant/forested land. The watershed is a mixture of residential, commercial and vacant land.

2016 Results

Ham Lake water quality received a slightly above-average rating for this region of the state (NCHF Ecoregion) in 2016, receiving a B letter grade. The average of total phosphorus was higher than the last couple of years monitored at 24.1 ug/L. Chlorophyll-a, a measure of algal growth, was at its highest average level since 2007 at 6.9 ug/L. This is following two consecutive monitoring years that set the all-time record lows for Chl-a. Transparency was the lowest measured in Ham Lake since 2001 an average of 6.6 feet.

Trend Analysis

Eighteen years of water quality data have been collected by the Minnesota Pollution Control Agency (between 1984 and 1997) and the Anoka Conservation District (between 1998 and 2016). Lake water quality has fluctuated from "A" to "C" and back to "A" water quality grades, but there is no significant long-term trend (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,15}$ = 2.78, p = 0.09). We also examined variables TP, Cl-a, and Secchi depth across all years of existing data using a one-way ANOVA. Including all years, a significant trend of improving Cl-a ($F_{1,16}$=6.37, p=0.02) is found. While not statistically significant, Secchi transparency and total phosphorus appear to be improving as well.

Discussion

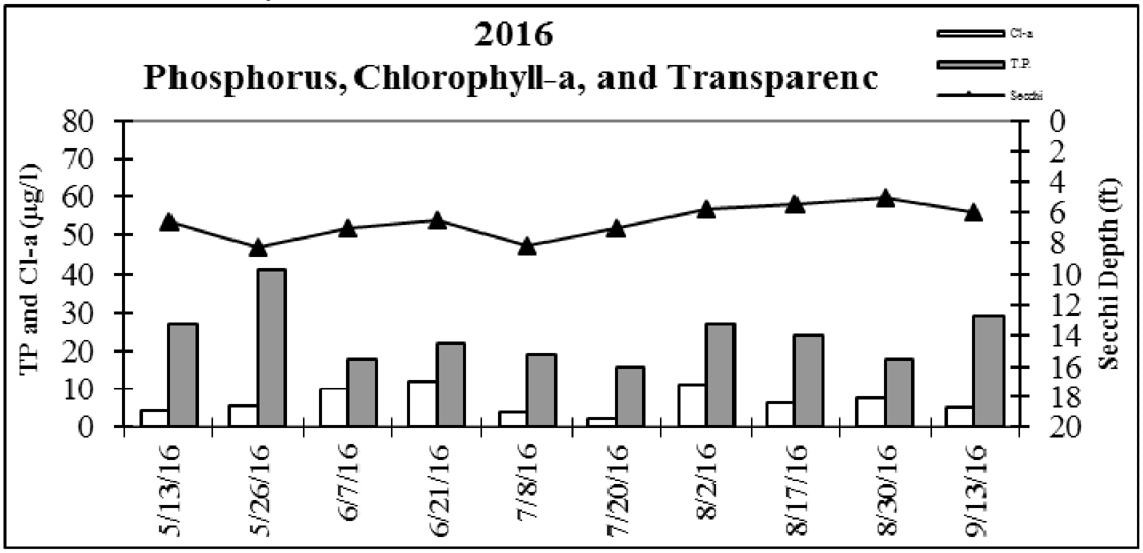
Water quality in Ham Lake remains good for a metro-area lake, even though 2016 did not continue the trends of improving quality observed the previous three years monitored. Current threats to lake water quality include shoreline activities, aquatic plant removal by lakeshore homeowners, curly leaf pondweed, and as of 2013 (EWM) Eurasian and hybrid water milfoil. In June 2013, Eurasian water milfoil was discovered in Ham Lake. Since its discovery, mapping efforts estimate that approximately 12% of the littoral area of Ham Lake is infested with EWM. Lake residents have organized a lake association and raised funds to begin management of the invasive plants. Chemical treatment began in 2014 and continues annually.

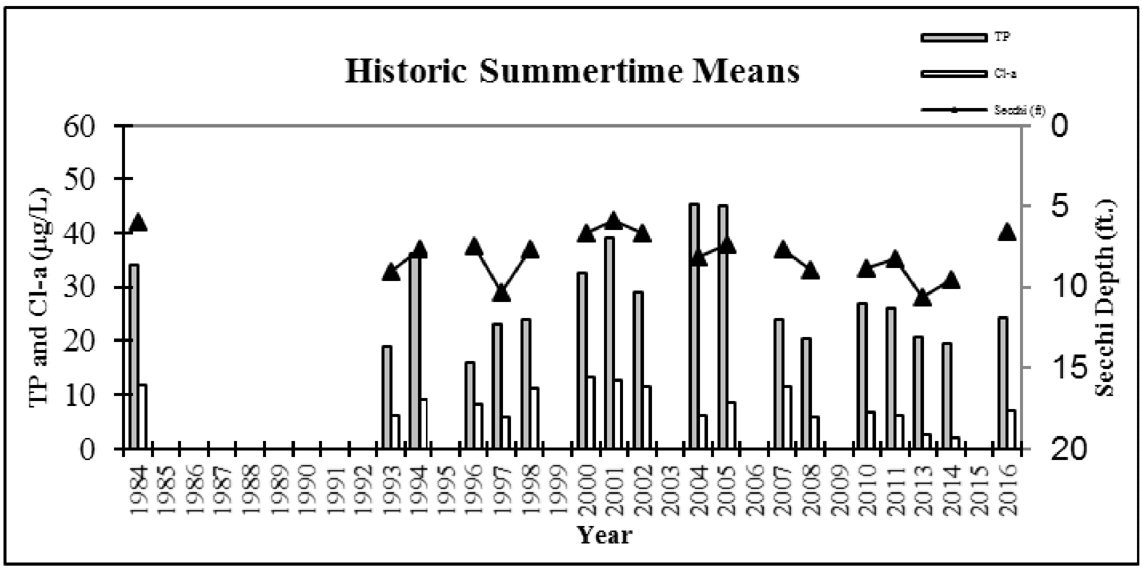
2016 Ham Lake Water Quality Data

Ham Lake			5/13/2016	5/26/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/2/2016	8/17/2016	8/30/2016	9/13/2016			
2016 Water Quality Data			8:15	8:45	8:20	8:15	6:30	7:35	8:35	7:25	7:20	7:40			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.76	8.76	8.44	8.39	8.36	8.21	8.26	8.03	7.88	7.69	8.28	7.69	8.76
Conductivity	mS/cm	0.01	0.355	0.371	0.379	0.327	0.336	0.355	0.335	0.372	0.356	0.335	0.352	0.327	0.379
Turbidity	NTU	1.00	43.90	4.70	8.80	16.80	24.00		9.20	16.60	6.40	7.10	15	5	44
D.O.	mg/L	0.01	10.46	10.80	9.64	8.75	9.40	8.25	9.00	6.90	7.84	8.06	8.91	6.90	10.80
D.O.	%	1	104%	124%	108%	108%	120%	105%	115%	87%	96%	91%	106%	87%	124%
Temp.	°C	0.1	15.0	21.0	19.7	24.5	25.8	26.1	26.2	25.7	23.4	21.3	22.9	15.0	26.2
Temp.	°F	0.1	59.0	69.7	67.5	76.0	78.4	78.9	79.1	78.2	74.1	70.3	73.1	59.0	79.1
Salinity	%	0.01	0.17	0.18	0.18	0.16	0.16	0.17	0.16	0.18	0.17	0.16	0.17	0.16	0.18
Cl-a	ug/L	0.5	4.3	5.7	10.0	12.1	3.8	2.1	11.4	6.4	7.8	5.0	6.9	2.1	12.1
T.P.	mg/L	0.010	0.027	0.041	0.018	0.022	0.019	0.016	0.027	0.024	0.018	0.029	0.024	0.016	0.041
T.P.	ug/L	10	27	41	18	22	19	16	27	24	18	29	24.1	16.0	41.0
Secchi	ft	0.1	6.6	8.3	7.1	6.5	8.2	7.1	5.8	5.5	5.1	6.0	6.6	5.1	8.3
Secchi	m	0.1	2.0	2.5	2.2	2.0	2.5	2.2	1.8	1.7	1.5	1.8	2.0	1.5	2.5
Physical			3.0	3.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.9	1.0	3.0
Recreational			3.0	3.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.9	1.0	3.0

*reporting limit

Ham Lake Water Quality Results





Ham Lake Summertime Historic Mean

Agency	MC	MC	MC	MC	MC	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	84	93	94	96	97	98	2000	2001	2002	2004	2005	2007	2008	2010	2011	2013	2014	2016
TP	34.0	19.0	36.0	16.0	23.0	24.0	32.6	39.1	29.1	45.2	45.0	24.0	20.5	27.0	26.0	20.8	19.6	24.1
Cl-a	11.8	6.2	9.1	8.3	5.9	11.3	13.1	12.7	11.5	6.3	8.4	11.4	6.0	6.7	6.2	2.6	1.9	6.9
Secchi (m)	1.8	2.8	2.4	2.3	3.1	2.4	2.0	1.8	2.1	2.5	2.2	2.3	2.7	2.7	2.5	3.2	2.9	2.0
Secchi (ft)	6.0	9.1	7.7	7.4	10.3	7.7	6.7	5.9	6.7	8.2	7.4	7.7	9.0	8.9	8.3	10.6	9.6	6.6

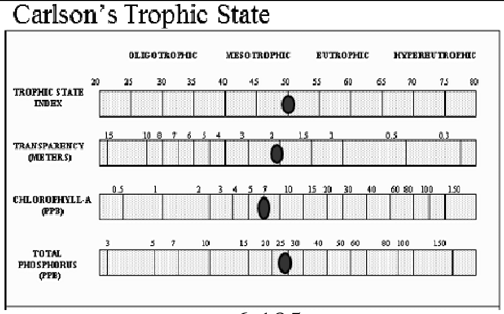
Carlson's Trophic State Indices

TSIP	55	47	56	44	49	50	54	57	53	59	59	50	48	52	51	48	47	50
TSIC	55	49	52	51	48	54	56	56	55	49	52	55	48	49	49	40	37	50
TSIS	51	45	48	48	43	48	50	51	50	47	49	48	45	46	47	43	45	50
TSI	54	47	52	48	47	51	53	55	52	52	53	51	47	49	49	44	43	50

Ham Lake Water Quality Report Card

Year	84	93	94	96	97	98	2000	2001	2002	2004	2005	2007	2008	2010	2011	2013	2014	2016
TP	C	A	C	A	A	B	C	C	B	C	C	B	A	B	B	A	A	B
Cl-a	B	A	A	A	A	B	B	B	B	A	A	B	A	A	A	A	A	A
Secchi	C	B	B	B	A	B	C	C	C	B	B	B	B	B	B	A	B	C
Overall	**C**	**A**	**B**	**A**	**A**	**B**	**C**	**C**	**B**	**B**	**B**	**B**	**A**	**B**	**B**	**A**	**A**	**B**

Carlson's Trophic State



Laddie Lake

Cities of Blaine and Spring Lake Park, Lake ID # 02-0072

Background

Laddie Lake is located in south-central Anoka County, half in Blaine and half in Spring Lake Park. It has a surface area of 77 acres and maximum depth of 4 feet (1.2 m). Public access is limited to a city park at the north end of the lake. There is no easy access to the water's edge from this park, as the lake's cattail fringe is wide. The lake is used little for recreation because of its shallow depths, abundance of aquatic plants, and lack of public access to the water's edge. It does, however, attract waterfowl. The west side of the lake is bordered by single-family homes, the south and east by four-lane highways and associated businesses, and the north by the city park. An AIS survey in 2016 showed no new infestations.

2016 Results

Laddie Lake was monitored in 2016 for the first time since 2011. Water quality was above-average for this lake and this region, receiving an overall A grade for the first time. Total phosphorus averaged 20 ug/L, tied with the lowest ever recorded in 1998. Chlorophyll-a averaged 2.9 ug/L, the lowest recorded since 2002. Secchi transparency exceeded the 3-4 feet lake depth on all occasions.

The lake is slightly eutrophic, but much of the plant growth is manifested as marcophytes (large plants), not algae. Large numbers of plants are healthy in a shallow lake such as this one. Macrophytes grew to the surface on 95% of the lake from June through September. Even when they reached the surface, the plants were not excessively dense from an ecological perspective, spaced about 1-2 feet apart. However, these plants do limit most recreational uses of the lake such as boating, swimming, and fishing.

Trend Analysis

Fifteen years of water quality data have been collected by the Metropolitan Council and the Anoka Conservation District. This lake was first monitored in 1980. After 1980 there was a 13 year hiatus from monitoring. From 1993 to the present, monitoring has occurred regularly, though not every year.

In 1980 water quality was quite poor but has greatly improved since the early 1990s. To analyze trends since 1993, a repeated measures MANOVA with response variables total phosphorus and Chlorophyll-a was used on those years only. Secchi depth was excluded because measurements were not available in all years. No statistically significant water quality trend was detected ($F_{1,12}=0.82$, $p=0.38$). We also examined variables TP and Cl-a across all years of existing data, excluding 1980, using a one-way ANOVA. While neither parameter changed significantly, it is interesting to note that total phosphorus appears to trend upward while Cl-a appears to trend downward.

It is likely that additional phosphorus is consumed by macrophytes, and therefore algae are not increasing and water clarity is not suffering. If phosphorus continues to increase, however, macrophytes could be overwhelmed by phosphorus and the lake could shift toward algal domination.

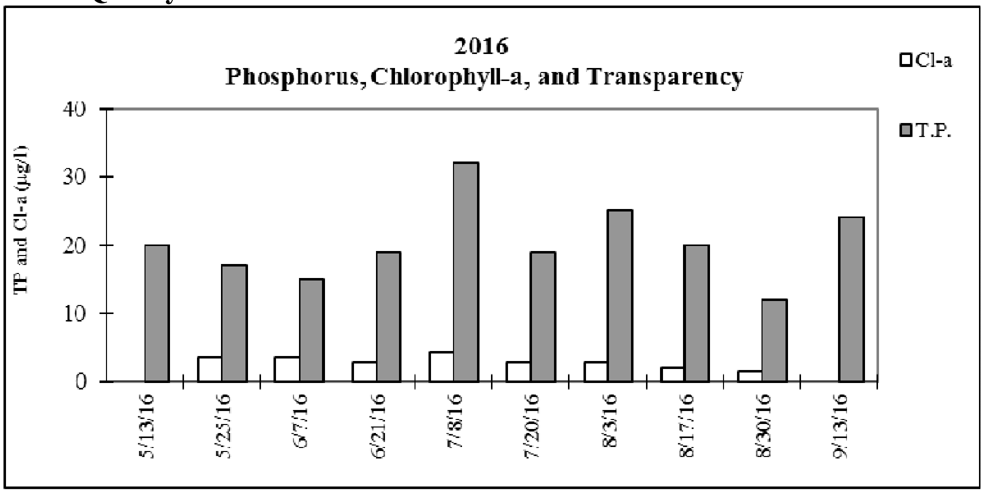
Discussion

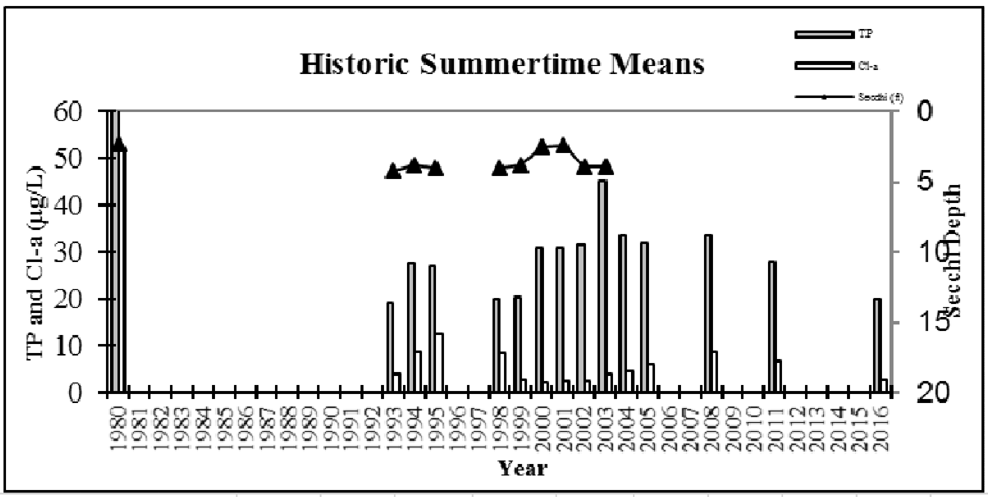
Abundant macrophytes in this lake are an indication of a healthy system, not an impairment. As a shallow lake, macrophytes should be expected throughout and contribute to clear water. Macrophytes consume nutrients that would otherwise fuel algae blooms and they provide excellent waterfowl habitat. The lake should be watched closely for any water quality deterioration. Given the lake's setting, changes to stormwater management are likely to be means for improving the lake.

2016 Laddie Lake Water Quality Data

Laddie Lake 2016		Date:	5/13/2016	5/25/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/3/2016	8/17/2016	8/30/2016	9/13/2016			
		Time:	9:10	9:00	9:20	9:15	7:50	8:25	8:40	8:10	8:20	8:15			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	9.64	10.05	9.90	9.62	8.36	9.66	9.68	9.67	8.98	8.66	9.42	8.36	10.05
Conductivity	mS/cm	0.010	0.602	0.678	0.688	0.601	0.631	0.665	0.674	0.620	0.590	0.549	0.630	0.549	0.688
Turbidity	FNRU	1	12	1	4	13	21		5	15	4	5	9	1	21
D.O.	mg/L	0.01	10.23	10.09	8.73	7.59	8.19	8.83	11.17	9.98	9.34	8.12	9.23	7.59	11.17
D.O.	%	1	100%	121%	99%	94%	103%	115%	144%	124%	113%	90%	110%	90%	144%
Temp.	°C	0.1	13.9	22.4	19.6	24.4	24.7	26.0	27.2	24.4	23.7	19.8	22.60	13.85	27.20
Temp.	°F	0.1	56.9	72.4	67.2	76.0	76.4	78.7	81.0	76.0	74.6	67.7	73	57	81
Salinity	%	0.01	0.29	0.33	0.34	0.29	0.31	0.33	0.33	0.31	0.29	0.26	0.31	0.26	0.34
Cl-a	ug/L	0.5	<1	3.6	3.6	2.8	4.3	2.8	3	2.1	1.4	<1	2.9	1.4	4.3
T.P.	mg/L	0.01	0.020	0.017	0.015	0.019	0.032	0.019	0.025	0.020	0.012	0.024	0.020	0.012	0.032
T.P.	ug/L	10	20	17	15	19	32	19	25	20	12	24	20	12	32
Secchi	ft	0.1	>3.0	>4.0	>4.0	>4.0	>3.5	>3.5	>4.08	>4.33	>3.91666	3.75	4	3.75	3.75
Secchi	m	0.1											#DIV/0!	0.00	0.00
Physical			1.00	1.00	2.00	1.00	2.00	2.00	1.00	1.00	1.00	1.00	1.3	1.0	2.0
Recreational			1.00	2.00	2.00	1.00	3.00	3.00	2.00	3.00	3.00	3.00	2.3	1.0	3.0
*reporting limit															

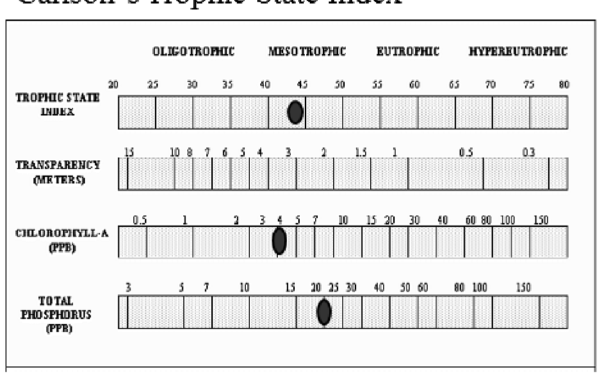
Laddie Lake Water Quality Results





Laddie Lake Historic Summertime Mean Values															
Agency	MC	MC	MC	MC	ACD	ACD	MC	MC	MC	MC	ACD	ACD	ACD	ACD	ACD
Year	80	93	94	95	98	99	2000	2001	2002	2003	2004	2005	2008	2011	2016
TP	78.0	19.1	27.5	27.0	20.0	20.4	31.0	30.9	31.7	45.2	33.8	32	34	28	20
Cl-a	51.6	4.0	8.9	12.6	8.5	2.9	2.3	2.5	2.6	4.0	4.6	6.2	9.0	6.7	2.9
Secchi (m)	0.70	1.30	1.18	1.23	1.22	1.18	0.77	0.75	1.20	1.20	na	na	na	na	na
Secchi (ft)	2.3	4.3	3.9	4.0	4.0	3.9	2.5	2.5	3.9	3.9	na	na	na	na	na
Carlson's Trophic State Indices															
TSIP	67	47	52	52	47	48	54	54	54	59	55	54	55	52	47
TSIC	69	44	52	56	52	41	39	40	40	44	46	49	52	49	41
TSIS	65	56	58	57	57	58	64	64	57	57	na	na	na	na	na
TSI	67	49	54	55	52	49	52	52	50	54	50	51	54	51	44
Laddie Lake Water Quality Report Card															
Year	80	93	94	95	98	99	2000	2001	2002	2003	2004	2005	2008	2011	2016
TP	D	A	B	B	B	B	B	B	B	C	C	B	C	B	A
Cl-a	D	A	A	B	A	A	A	A	A	A	A	A	A	A	A
Secchi	D	C	C	C	C	C	D	C	C	C	na	na	na	na	na
Overall	**D**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**A**

Carlson's Trophic State Index



LAKE NETTA

City of Ham Lake, Lake ID # 02-0052

Background

Lake Netta is located in the central portion of Anoka County, southwest of Coon Lake. It has a surface area of 168 acres and a maximum depth of 19 feet (5.8 m). There is a small, rugged public access on the west side of the lake in a neighborhood park. This access can accommodate canoes only. The lake receives little recreational use due to the difficulty of public access. The lakeshore is only lightly developed, with a few small lakeside neighborhoods and scattered housing elsewhere. The watershed is a mixture of residential, commercial and vacant land, but is under development pressure. No exotic plant species have been documented in Lake Netta.

2016 Results

Lake Netta once again had above-average water quality for this region of the state (NCHF Ecoregion) in 2016. The overall A grade for the third year in a row was driven by low concentrations of total phosphorus and chlorophyll-*a* as well as high Secchi transparency. The 2016 average for total phosphorus (20 ug/L) was the second best recorded since monitoring began, beat out only by 2015. The chlorophyll-*a* average was also the second lowest (2.6 ug/L). Other water quality parameters were similar to previous years and indicate the stability of the clear water and healthy submerged vegetation community in this system. An invasive species survey was conducted in 2016 throughout the littoral zone and high priority areas of Lake Netta. No infestations were observed.

Trend Analysis

Fourteen years of water quality data have been collected by the Anoka Conservation District (1997-1999, 2001, 2003-2004, 2006-2007, 2009-2010, 2012-2013 and 2015-2016), along with Secchi depth measurements by citizens five additional years. Lake water quality has fluctuated between “A” and “B” grades. Until 2016, a statistically significant change in water quality was not reported. With the inclusion of this year’s data, however, a statistically significant improvement in water quality is shown (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,11} = 3.87$, $p = 0.05$). While overall water quality has statically improved, only Cl-a has changed significantly using a one-way ANOVA ($F_{1,12} = 6.34$, $p = 0.03$). Both total phosphorus and Secchi transparency, while not statistically significant, do show improving trends.

Discussion

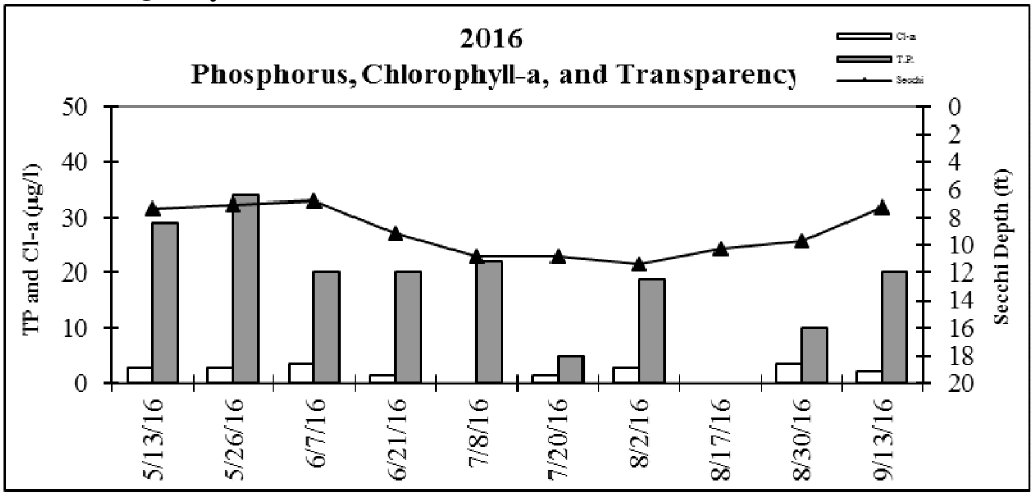
Good water quality in Lake Netta has been maintained since 1997, when ACD began regularly monitoring water quality. Good water quality in this lake is due in part to its small watershed; it receives little direct runoff and no streams of any consequence enter this lake. Primary production in the lake is dominated by the submerged macrophyte (large plant) community, as opposed to being dominated by algae. The plants are essential to maintaining good water quality because they sequester nutrients from the water column, making them unavailable to algae. They also minimize sediment disturbance by wind or boats and provide refuges for zooplankton, which consume algae. Maintaining good water quality in this lake will be, in large part, dependent upon protecting the in-lake aquatic vegetation, as well as maintenance of vegetated buffers near the water’s edge by property owners.

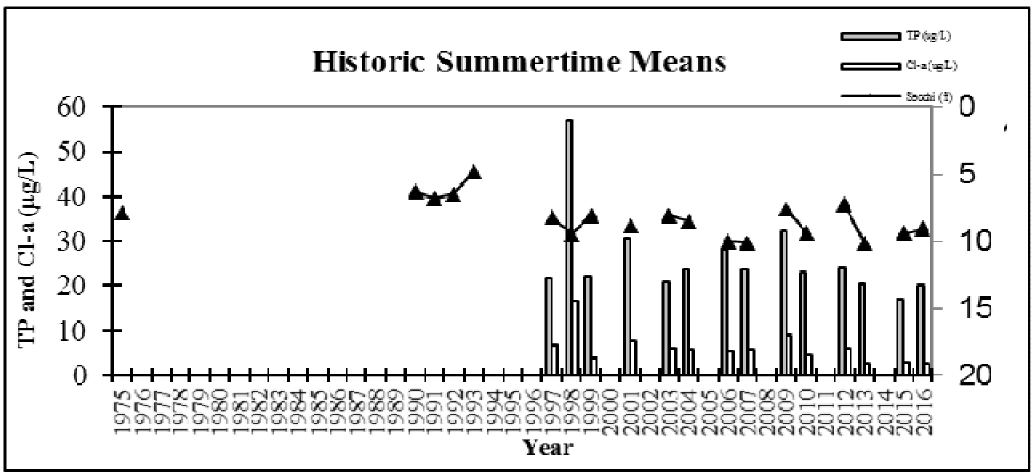
Lake Netta
2016 Water Quality Data

	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
		Date:	5/13/2016	5/26/2016	6/7/2016	6/21/2016	7/8/2016	7/20/2016	8/2/2016	8/17/2016	8/30/2016	9/13/2016			
		Time:	15:45	15:20	17:00	15:00	14:30	14:25	9:40	14:20	14:45	14:00			
pH		0.1	7.89	8.25	8.11	7.94	7.59	8.39	8.20	7.54	7.63	7.18	7.87	7.18	8.39
Conductivity	mS/cm	0.01	0.271	0.299	0.300	0.257	0.258	0.252	0.224	0.233	0.227	0.212	0.253	0.212	0.300
Turbidity	FNRU	1	16.0	1.0	5	0	6		1	0	3	4	4	0	16
D.O.	mg/l	0.01	8.46	10.37	9.56	8.77	8.30	9.39	9.25	6.49	7.79	6.61	8.50	6.49	10.37
D.O.	%	1	88	120	111	111	105	121	118	83	95	75	103	75	121
Temp.	°C	0.1	14.7	23.1	21.8	25.7	25.2	27.2	26.3	26.1	24.4	21.5	23.6	14.7	27.2
Temp.	°F	0.1	58.4	73.6	71.2	78.2	77.4	81.0	79.3	78.9	75.8	70.7	74.5	58.4	81.0
Salinity	%	0.01	0.13	0.14	0.14	0.13	0.12	0.12	0.11	0.11	0.11	0.10	0.12	0.10	0.14
Cl-a	ug/L	0.5	2.8	2.8	3.6	1.4	<1	1.4	2.8	<1	3.6	2.1	2.6	1.4	3.6
T.P.	mg/l	0.010	0.029	0.034	0.020	0.020	0.022	0.005	0.019	<0.02	0.010	0.020	0.020	0.005	0.034
T.P.	ug/l	10	29	34	20	20	22	5	19	#VALUE!	10	20	20	#VALUE!	#VALUE!
Secchi	ft		7.3	7.1	6.8	9.1	10.8	10.8	11.4	10.3	9.8	7.3	9.1	6.8	11.4
Secchi	m		2.2	2.2	2.1	2.8	3.3	3.3	3.5	3.1	3.0	2.2	2.8	2.1	3.5
Field Observations/Appearance			Clear, dark ti	Clear. Bog-st	Fairly clear, light brown tir		Clear, light gr	Clear, light br	Clear, light l	very clear	clear	clear			
Physical			1	1	1	2	2	1	1	1	1	1	1.2	1.0	2.0
Recreational			1	1	1	2	2	1	1	1	2	3	1.5	1.0	3.0

*reporting limit

Lake Netta Water Quality Results





Lake Netta Historical Summertime Mean Values

Agency	CLMP	CLMP	CLMP	CLMP	CLMP	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1975	1990	1991	1992	1993	1997	1998	1999	2001	2003	2004	2006	2007	2009	2010	2012	2013	2015	2016
TP (µg/L)						21.8	56.9	22.2	30.7	20.8	23.8	28.0	23.5	32.2	23.0	24.0	20.6	17.0	20.0
Cl-a (µg/L)						6.7	16.6	3.8	7.7	6.2	5.7	5.5	5.6	8.9	4.5	6.2	2.4	2.8	2.6
Secchi (m)	2.4	1.9	2.1	2.0	1.5	2.5	2.9	2.5	2.7	2.5	2.6	3.0	3.1	2.3	2.9	2.2	3.1	3.0	2.8
Secchi (ft)	7.9	6.3	6.8	6.5	4.8	8.3	9.5	8.1	8.9	8.1	8.5	10.0	10.1	7.6	9.4	7.3	10.1	9.7	9.1

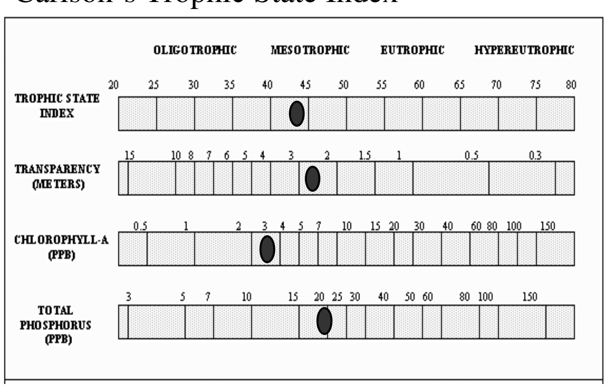
Carlson's Trophic State Index

TSIP						49	62	49	54	48	50	52	50	54	49	50	48	45	47
TSIC						49	58	44	51	48	48	47	48	52	45	48	39	41	40
TSIS	47	51	49	50	54	47	45	47	46	47	46	44	44	48	45	49	44	44	45
TSI						48	55	47	50	48	48	48	47	51	46	49	44	43	44

Lake Netta Water Quality Report Card

Year	1975	1990	1991	1992	1993	1997	1998	1999	2001	2003	2004	2006	2007	2009	2010	2012	2013	2015	2016
TP (µg/L)						A	C	A	B	A	B+	B	B	C	A-	B+	A	A	A
Cl-a (µg/L)						A	B	A	A	A	A	A	A	A	A	A	A	A	A
Secchi (m)	B	C	C	C	C	B	B	B	B	B	B	B+	A	B	B+	B	A	B	B
Overall						**B**	**B**	**A**	**B**	**A**	**A**	**B+**	**B+**	**B**	**A-**	**B+**	**A**	**A**	**A**

Carlson's Trophic State Index



Stream Hydrology and Rating Curves

Description: Continuous water level monitoring in streams.

Purpose: To provide understanding of stream hydrology, including the impact of climate, land use or discharge changes. These data also facilitate calculation of pollutant loads, use of computer models for developing management strategies, and water appropriations permit decisions.

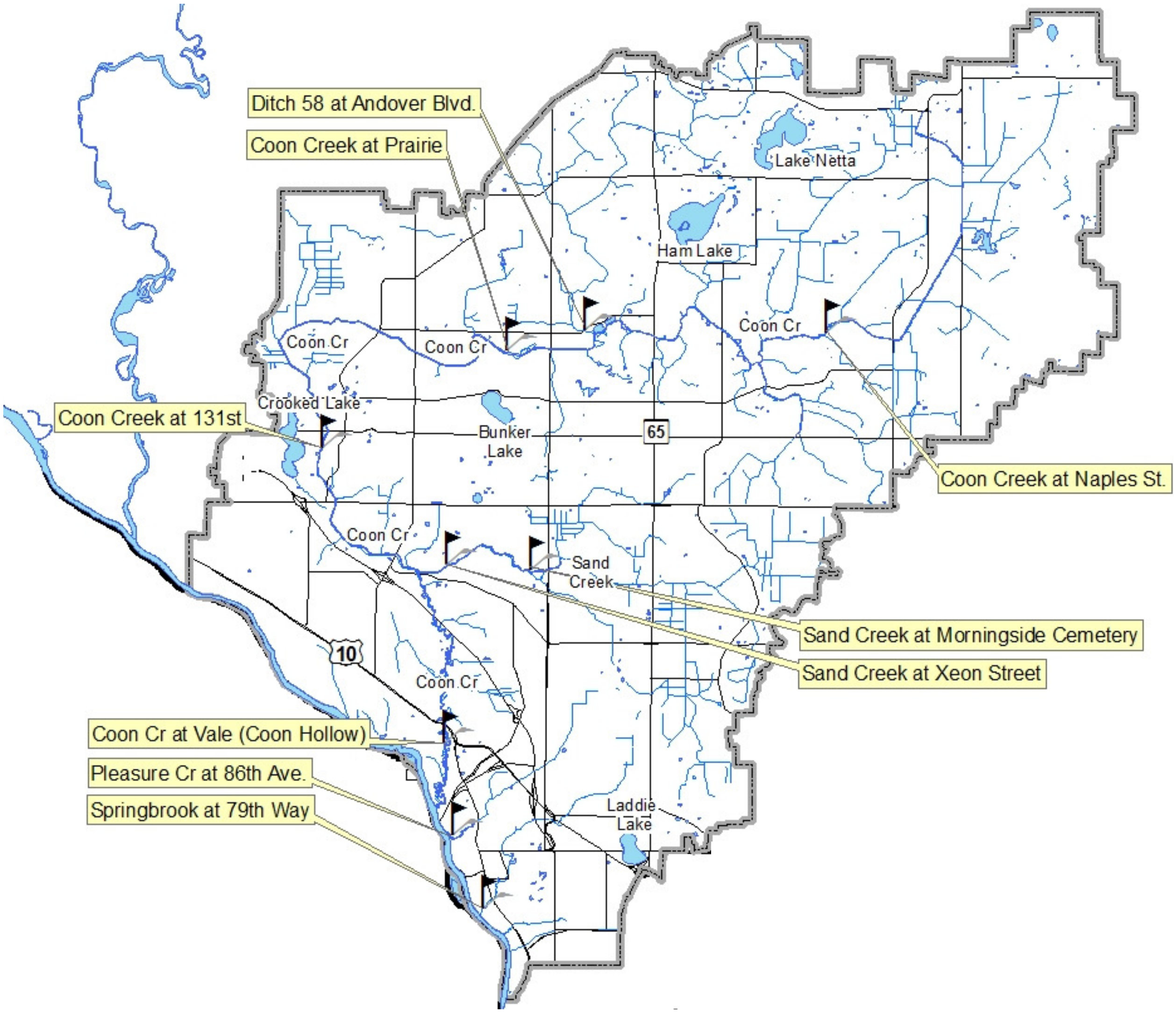
Locations:

Stream	Location	City
Coon Creek	Coon Hollow	Coon Rapids
Coon Creek	Prairie Road	Andover
Coon Creek	131st Avenue	Coon Rapids
Ditch 58	Andover Blvd.	Ham Lake

Stream	Location	City
Sand Creek	Xeon St.	Coon Rapids
Sand Creek	Morningside Cemetery	Coon Rapids
Springbrook	79th Way NE	Fridley
Pleasure Creek	86th Ave. NW	Coon Rapids

Results: Results for each site are on the following pages.

Coon Creek Watershed 2016 Stream Hydrology and Rating Curves Monitoring Sites

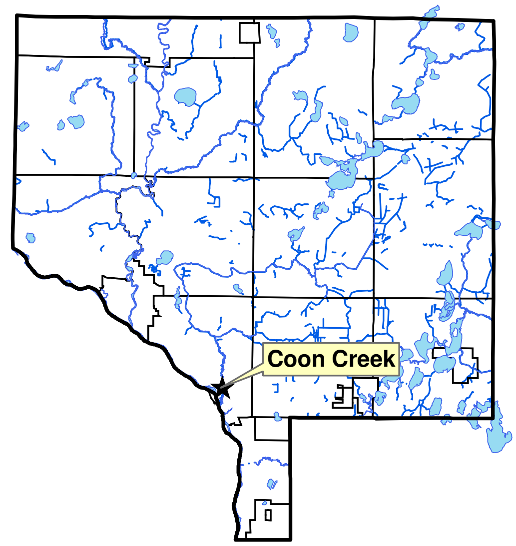


COON CREEK

at Coon Creek Hollow, Vale Street, Coon Rapids

Notes

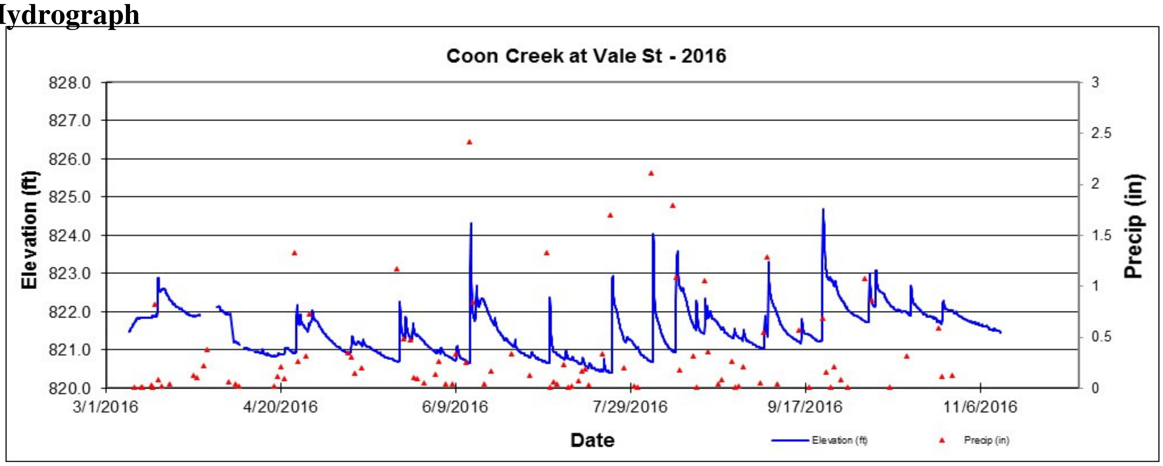
Coon Creek is a major drainage through central Anoka County. This monitoring location is the closest to the outlet to the Mississippi River that is accessible and does not have backwater effects from the Mississippi during high water. Land use in the upstream watershed ranges from rural residential upstream to highly urbanized downstream. The creek is about 30 feet wide and 1.5 to-2 feet deep at the monitoring site during baseflow. Both creek water levels and flow are available for this site.



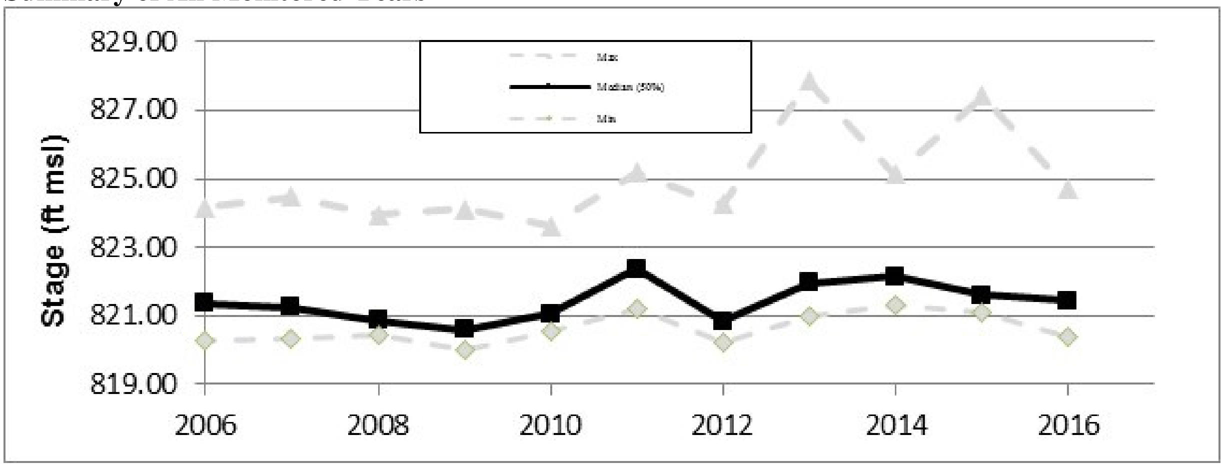
In 2016 Coon Creek water levels spanned a range of 3.95 feet (see hydrograph on next page). The maximum observed stream level (825.08 feet) was recorded in early April, while below average rainfall from August to October resulted in little water level fluctuation and the lowest stream level of the year (821.13).

Coon Creek has flashy responses to storms, as displayed in the hydrograph on the next page. Water levels rise quickly in response to precipitation, but return to baseflow conditions more slowly. The quick, intense response to rainfall is runoff from the urbanized downstream watershed near the monitoring station. The slower return to baseflow is probably due, in large part, to water being released more slowly from the less-developed upstream portions of the watershed. Several storms in 2006-2016 serve to illustrate this phenomenon. In the few hours following larger storms, water levels can rise nearly 4 feet. During 2006's largest storm, a 2.23-inch storm on June 16, water levels rose 3.4 feet in the first 16 hours, including one two-hour period when the creek rose 2.23 feet. It took about 15 days for the water level to return to pre-storm levels, despite only three rain events of less than 0.15 inches during that time. During 2008's largest storm, 1.54-inches on August 27, creek levels rose 2.42 feet during a two hour period, rising a total of 3.46 feet in response to the storm. A 2.11-inch rainfall on August 19th, 2009 caused the creek to rise 3.62 feet within 16 hours. The largest storm of 2010, 1.62 inches on June 25th, resulted in an increase in stream elevation of 2.83 feet over approximately 10 hours. During a particularly intense rainstorm in 2011, 2.10-inches fell on August 18, creek levels rose 1.99 feet during a two hour period, rising a total of 2.42 feet in response to the storm. A 1.83-inch rain event in May of 2012 caused the stream level to rise by 2.58 feet during a six hour period. During a 2.21-inch storm on May 31, 2014 the creek levels rose 2 feet in a two hour period. On July 28, 2015 the creek rose 2.17 feet in response to a 1.17-inch storm. In September of 2016 the creek rose 3.42 feet in response to a 3.19 inch storm.

2016 Hydrograph



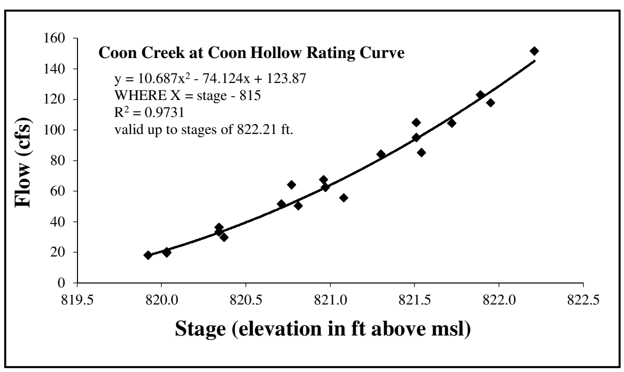
Summary of All Monitored Years



Summary of All Monitored Years

Percentiles	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Min	820.04	820.26	820.33	820.43	820.03	820.54	821.23	820.22	820.97	821.35	821.13	820.39
2.5%	820.06	820.42	820.40	820.52	820.12	820.64	821.27	820.28	820.99	821.47	821.19	820.58
10.0%	820.19	820.53	820.53	820.57	820.20	820.73	821.31	820.33	821.00	821.51	821.31	820.78
25.0%	820.57	820.78	820.73	820.63	820.35	820.85	821.83	820.45	821.20	821.67	821.41	820.99
Median (50%)	820.91	821.35	821.25	820.88	820.61	821.05	822.38	820.85	821.95	822.15	821.60	821.44
75.0%	821.26	821.78	821.88	821.78	820.93	821.32	822.99	821.28	827.87	823.33	821.92	821.91
90.0%	821.77	822.27	822.63	822.26	821.31	821.68	823.70	821.89	827.87	824.38	822.30	822.24
97.5%	822.92	822.76	823.21	822.79	822.05	822.33	824.56	823.60	827.87	824.87	823.08	822.76
Max	823.26	824.18	824.47	823.96	824.11	823.62	825.18	824.25	827.87	825.13	827.42	824.70

Rating Curve (2010 - updated)



Stream Hydrology Monitoring

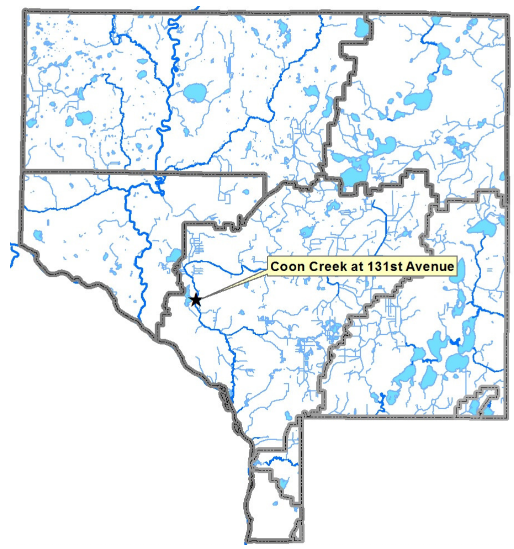
COON CREEK

at 131st Avenue NW, Coon Rapids

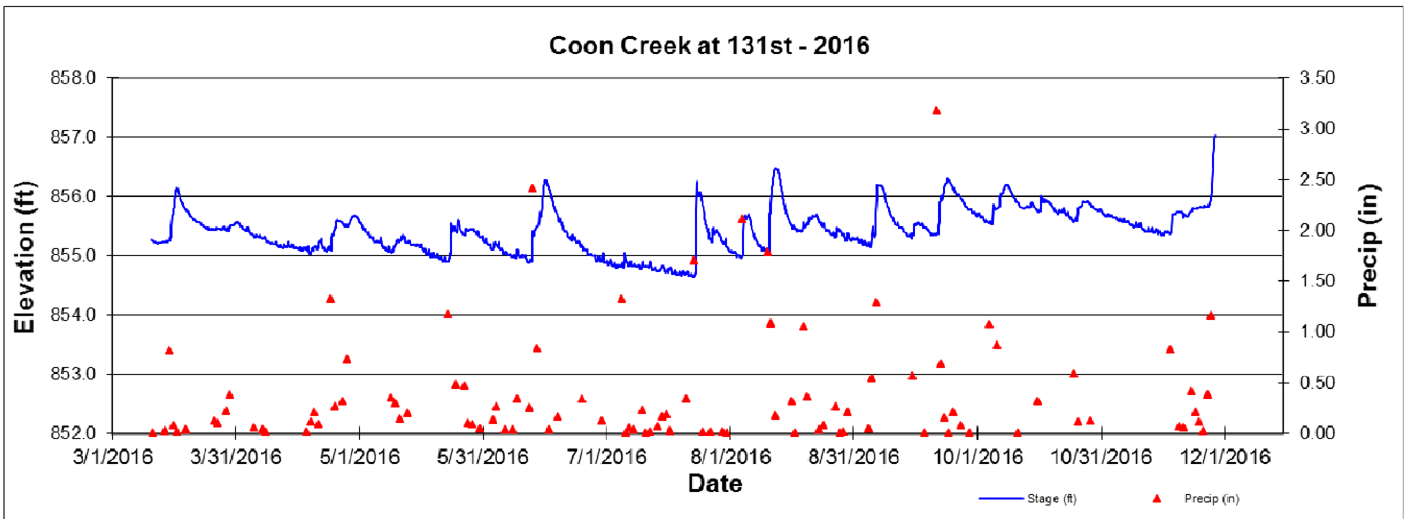
Notes

Coon Creek is a major drainage through central Anoka County. This monitoring location is within a residential neighborhood in Coon Rapids, located just upstream of the intersection of Coon Creek with 131st St. Land use in the upstream watershed ranges from rural residential to highly urbanized. The creek is approximately 35 feet wide and 2 to 2.5 feet deep at the monitoring site during baseflow.

Stream levels were monitored for the first time at this site in 2015. This site showed little variation in water levels, taking over 24 hours to raise just 0.6 feet in response to a 3.19 inch storm event. Throughout 2016, stream levels spanned 2.50 feet, with a maximum stream level of 857.04 feet and a minimum of 854.64 feet.



2016 Hydrograph



Summary of All Monitored Years

Percentiles	2015	2016
Min	854.03	854.64
2.5%	854.09	854.74
10.0%	854.16	854.94
25.0%	854.27	855.17
Median (50%)	854.41	855.43
75.0%	854.68	855.68
90.0%	855.03	855.89
97.5%	855.79	856.19
Max	856.66	857.04

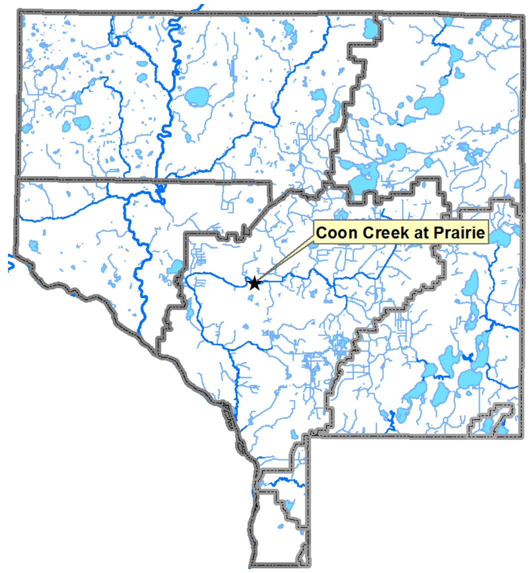
COON CREEK

at Prairie Road, Coon Rapids

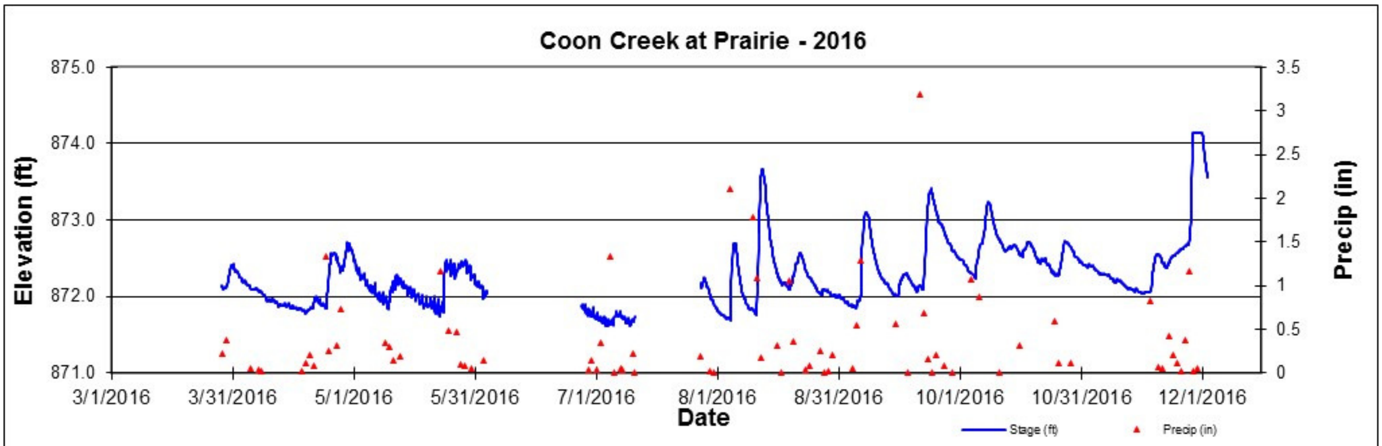
Notes

Coon Creek is a major drainage through central Anoka County. This monitoring location is just upstream of the intersection of Coon Creek with Prairie Road. Land use in the upstream watershed is comprised of residential and sod fields. The creek is approximately 15 feet wide and 3to 4 feet deep at the monitoring site during baseflow.

Stream level was monitored for the first time at this site in 2015. In 2016, stream level ranged 2.53 feet, having a minimum elevation of 871.61 feet and reaching a maximum elevation of 874.15 feet. This site seems to react slowly to precipitation in the area. For example, in in response to a 3.19 inch storm event in September, 2016 it took the stream 36 hours to rise just 0.08 feet. Stream level rose into the beginning of December when equipment was collected because of many late fall rain events.



2016 Hydrograph



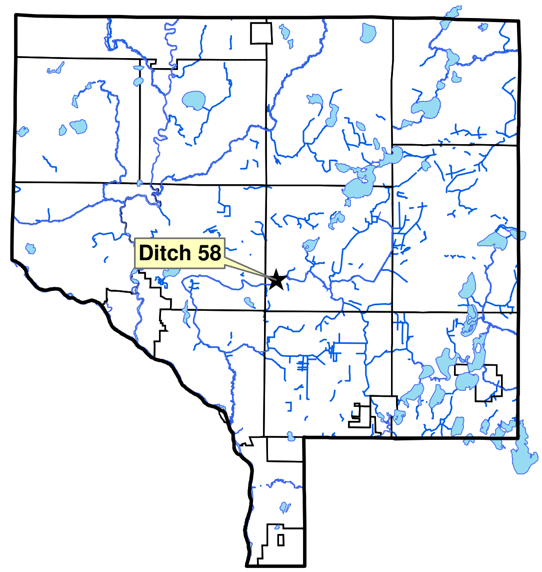
Summary of All Monitored Years

Percentiles	2015	2016
Min	871.62	871.61
2.5%	871.70	871.70
10.0%	871.78	871.83
25.0%	871.92	872.00
Median (50%)	872.15	872.22
75.0%	872.49	872.50
90.0%	872.84	872.71
97.5%	873.49	873.47
Max	874.42	874.15

DITCH 58

at Andover Boulevard, Ham Lake

Notes

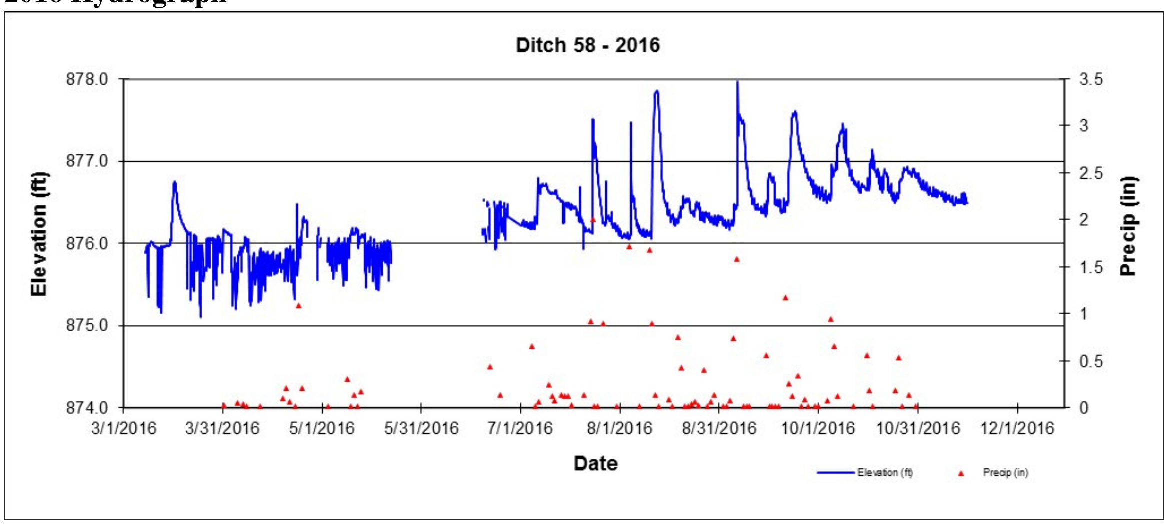


Ditch 58 is a tributary to Coon Creek. Upstream of the monitoring site are 20 miles of ditch, including many small tributaries. Its light bulb-shaped watershed is roughly delimited by Lake Netta to the northeast, Crosstown Boulevard to the northwest and southwest, and highway 65 to the southeast. Watershed land uses are primarily suburban residential and sod fields. The ditch is about 10 feet wide and 2 feet deep at the monitoring site during baseflow.

Ditch 58 water levels fluctuated quite substantially in 2016 in response to rain events. Water levels spanned a range of 2.85 feet. Ditch 58 has been flashy during rain events in previous years. Of particular note was a 1.6 foot increase in water level in 4 hours during a 3.19 inch rain event on 9/21/2016. In 2014 during a 2.28 inch rain event the water level rose 2.08 feet over a 14 hour period.

Several manual flow measurements were done in 2013 to inform rating curve development by CCWD's consulting engineer. The engineer plans to use the stream cross section and desktop analysis for rating curve generation.

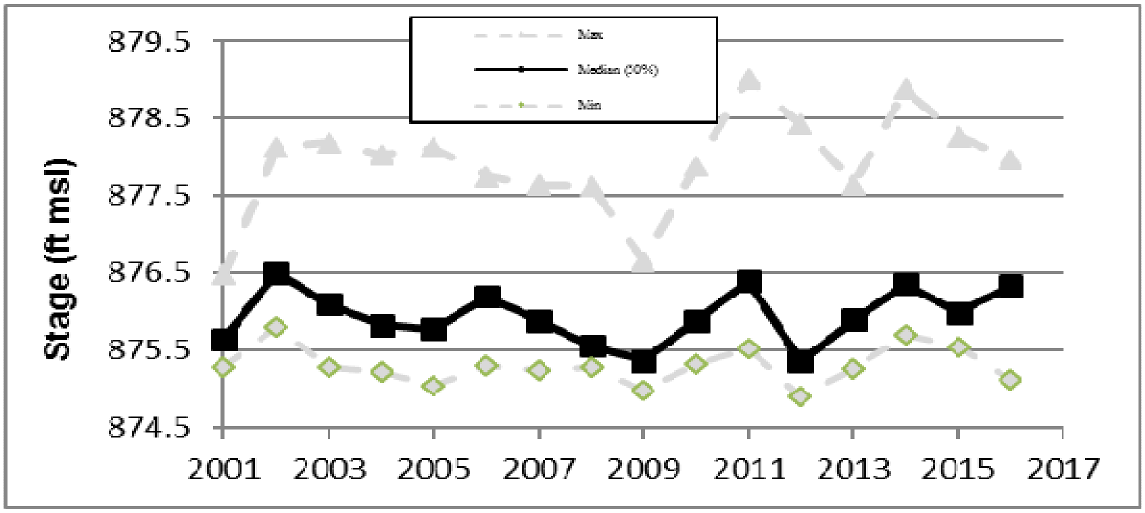
2016 Hydrograph



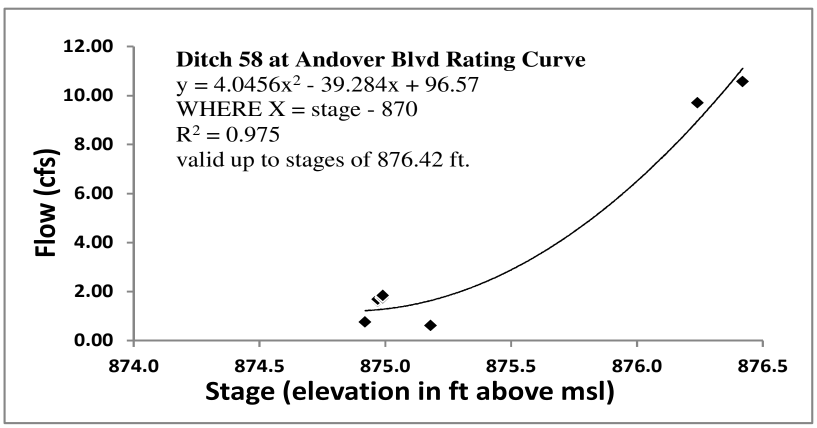
Summary of All Monitored Years

Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Min	875.29	875.81	875.28	875.23	875.05	875.31	875.24	875.29	874.98	875.33	875.52	874.90	875.27	875.70	875.54	875.12
2.5%	875.35	876.18	875.57	875.63	875.54	875.91	875.29	875.33	875.01	875.39	875.62	875.02	875.52	876.07	875.70	875.55
10.0%	875.48	876.33	875.64	875.51	875.37	875.66	875.37	875.36	875.16	875.48	875.65	875.06	875.57	876.10	875.79	875.80
25.0%	875.58	876.41	875.74	875.63	875.54	875.91	875.49	875.39	875.29	875.58	875.79	875.12	875.64	876.16	875.87	876.06
Median (50%)	875.65	876.51	876.10	875.83	875.78	876.20	875.89	875.56	875.37	875.88	876.40	875.36	875.90	876.35	875.99	876.34
75.0%	875.77	876.73	876.59	876.05	876.04	876.35	876.16	876.06	875.46	876.25	876.92	875.51	876.24	877.05	876.14	876.62
90.0%	876.23	877.42	877.01	876.45	876.22	876.47	876.40	876.28	875.54	876.49	877.67	875.79	876.48	878.30	876.43	876.88
97.5%	876.30	878.13	878.16	877.04	876.98	876.89	876.90	876.61	875.79	877.13	878.55	877.02	877.00	878.80	877.28	877.45
Max	876.48	878.13	878.19	878.03	878.12	877.75	877.64	877.63	876.65	877.88	879.02	878.42	877.65	878.88	878.27	877.97

Summary of All Monitored Years



Ratings Curve (2013)

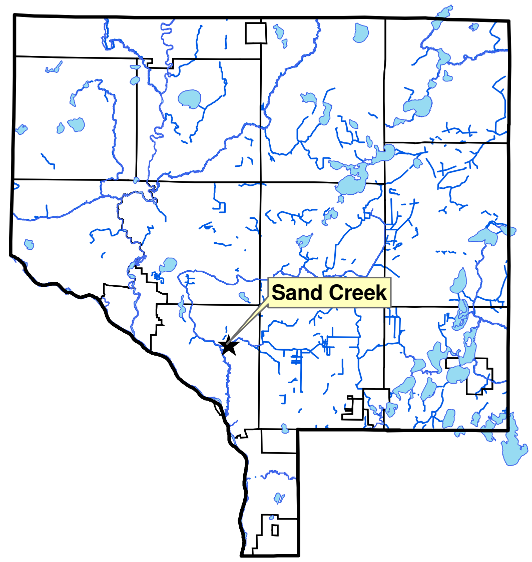


SAND CREEK

at Xeon Street, Coon Rapids

Notes

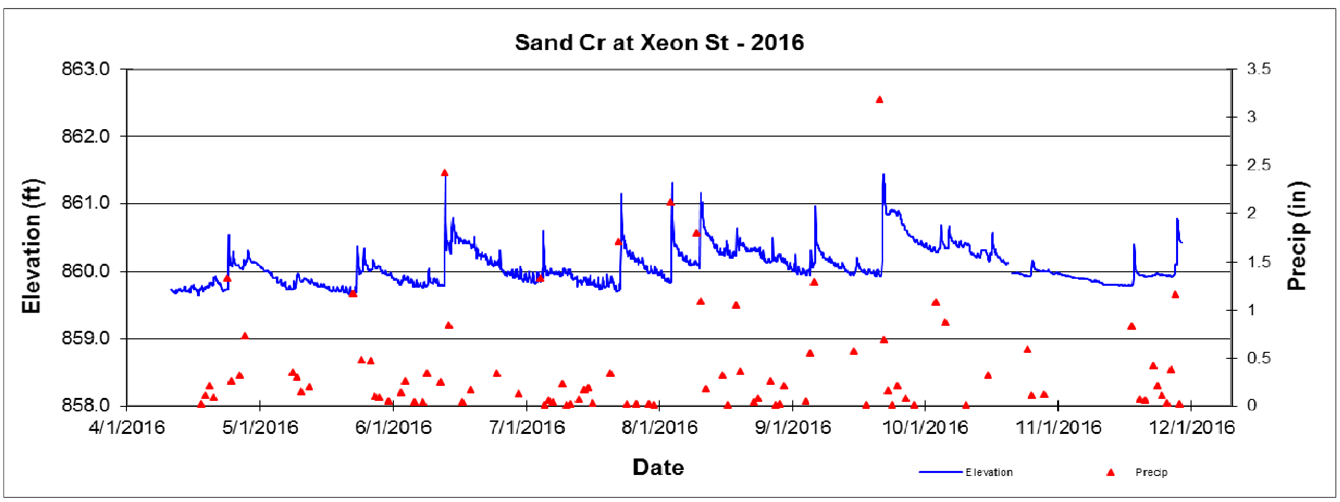
Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial and retail areas throughout northeastern Coon Rapids and western Blaine. The stream is about 15 feet wide and 3 feet deep at the monitoring site during baseflow.



In most years, Sand Creek shows little variation in water levels. Occasionally, large storms cause water level increases of up to two feet, but these are short-lived. For example, in 2011 storms of 1.42 (July 30) and 2.10 (Aug 16) inches caused stream levels to rise 1.49 and 1.17 feet, respectively, within two hours and then recede. 2014 water levels reacted similarly, rising 1.79 feet over a 4 hour span in response to a 1.79 inch rain event on May 19. In 2015, Sand Creek at Xeon recorded its lowest water level to date (858.69) as well as the lowest recorded maximum water level (860.48). This resulted in the smallest change in water level (1.79 ft.) for any monitoring season. These levels rebounded to more average levels in 2016 with a range of 1.79 feet from elevations of 859.64 to 861.43.

Additional measurements were conducted in 2013 to refine the rating curve and are presented below.

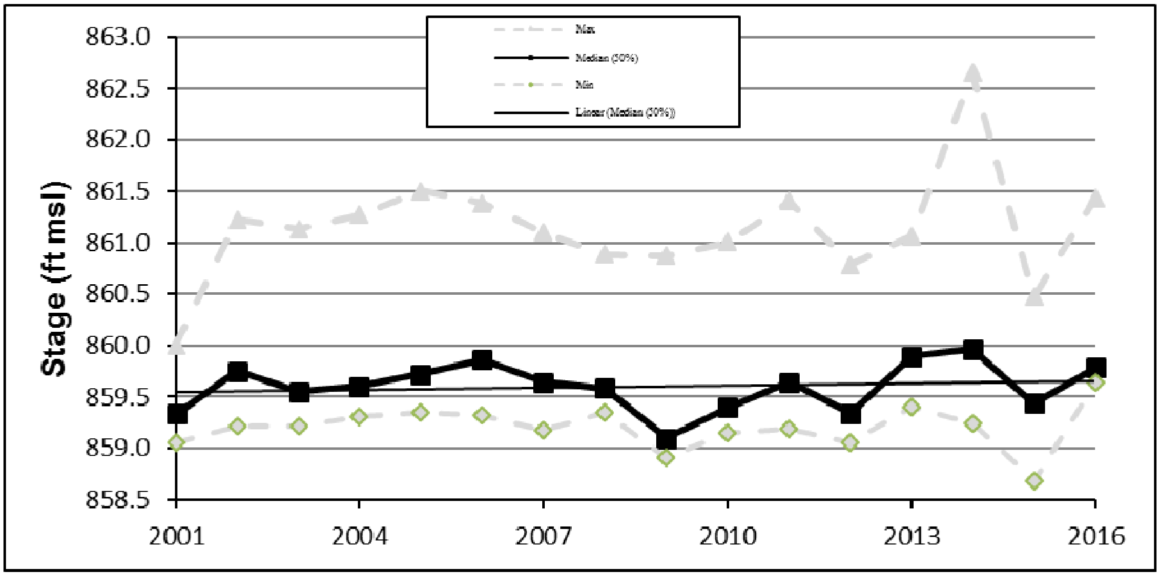
2016 Hydrograph



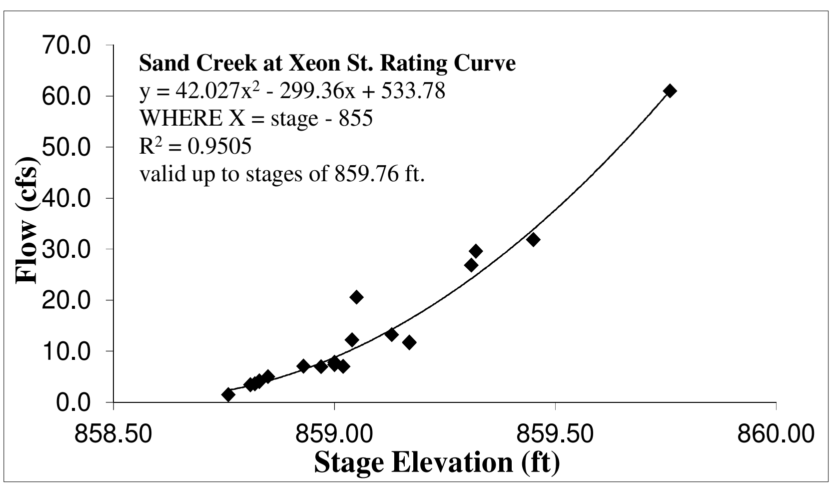
Summary of All Monitored Years

Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Min	859.06	859.22	859.21	859.31	859.35	859.32	859.17	859.35	858.91	859.15	859.19	859.06	859.40	859.23	858.69	859.64
2.5%	859.09	859.44	859.26	859.33	859.41	859.43	859.30	859.44	858.99	859.24	859.22	859.07	859.53	859.42	858.96	859.67
10.0%	859.15	859.48	859.32	859.40	859.45	859.54	859.41	859.48	859.03	859.28	859.28	859.11	859.60	859.61	859.03	859.70
25.0%	859.23	859.61	859.41	859.46	859.55	859.70	859.47	859.53	859.05	859.33	859.47	859.18	859.70	859.79	859.16	859.73
Median (50%	859.33	859.75	859.55	859.60	859.72	859.86	859.64	859.58	859.10	859.40	859.65	859.33	859.90	859.96	859.44	859.78
75.0%	859.49	859.93	859.75	859.80	859.97	860.01	859.81	859.78	859.29	859.52	859.89	859.53	860.04	860.28	859.66	859.84
90.0%	859.54	860.09	860.00	860.03	860.21	860.12	859.98	859.94	859.38	859.60	860.08	859.76	860.18	861.08	859.82	860.00
97.5%	859.65	860.32	860.28	860.32	860.51	860.27	860.11	860.13	859.54	859.75	860.33	860.11	860.37	861.93	860.04	860.38
Max	860.00	861.22	861.13	861.27	861.50	861.38	861.10	860.88	860.87	861.01	861.40	860.78	861.06	862.65	860.48	861.43

Summary of All Monitored Years



Ratings Curve (2013)



SAND CREEK

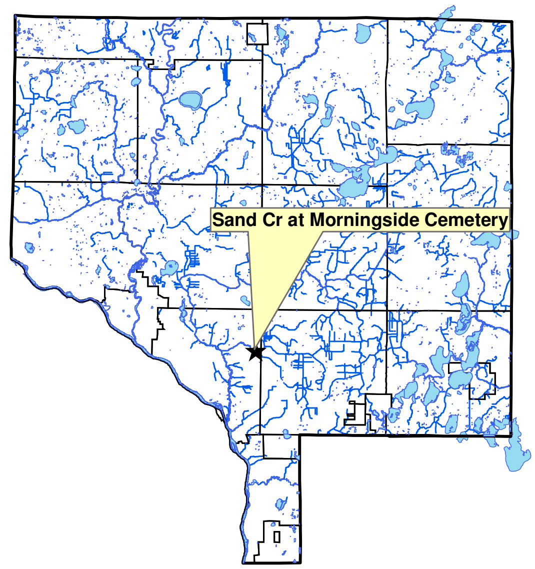
at Morningside Cemetery, Coon Rapids

Notes

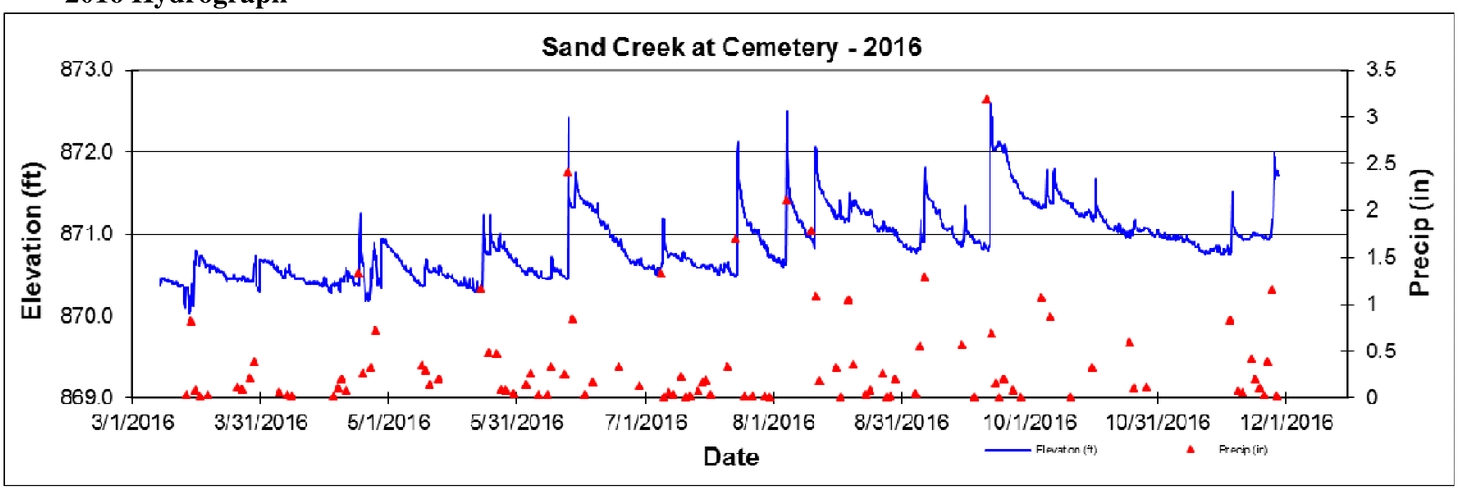
Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial and retail areas throughout northeastern Coon Rapids and western Blaine. The stream is approximately 8 feet wide and 3 feet deep at the monitoring site during baseflow.

Sand Creek at Morningside Cemetery was monitored for the first time in 2010. The site was added because of its position between the cities of Blaine and Coon Rapids, which provides an estimate of the stormflow contributions from Blaine. In addition, the site is located immediately downstream of the confluence of Ditch 39 with Sand Creek.

Interestingly, creek levels often rise at this site more than downstream at Xeon Street following rainstorms. 2015 water levels acted similarly with a rise of 1.5 feet in 18 hours in reaction to a 3.19 inch rain event in September. It is likely that flow volumes are similar or less at the cemetery, but because the channel is narrow the vertical rise in water levels is greater. No rating curve exists at this site.

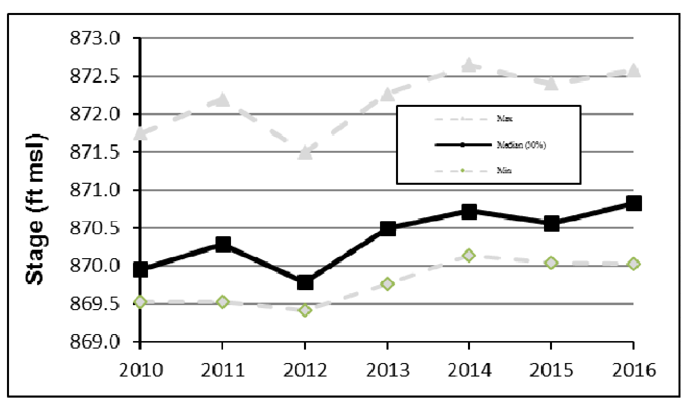


2016 Hydrograph



Summary of All Monitored Years

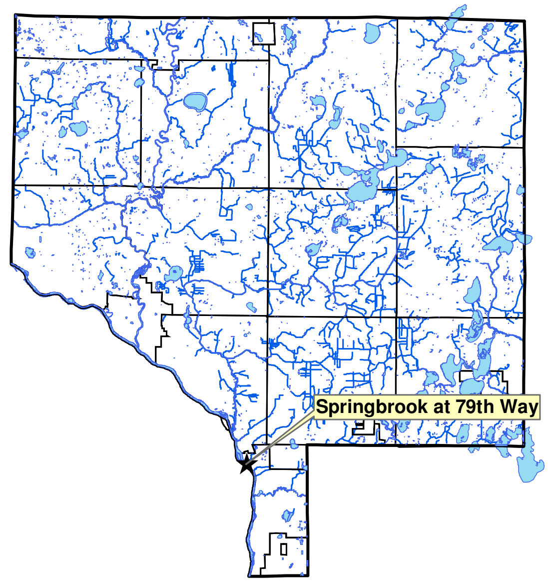
Percentiles	2010	2011	2012	2013	2014	2015	2016
Min	869.53	869.53	869.42	869.76	870.14	870.04	870.03
2.5%	869.61	869.59	869.44	869.99	870.19	870.10	870.34
10.0%	869.70	869.67	869.47	870.09	870.25	870.24	870.43
25.0%	869.79	870.03	869.59	870.19	870.44	870.38	870.55
Median (50%)	869.96	870.29	869.79	870.50	870.73	870.57	870.83
75.0%	869.96	870.53	870.09	870.74	871.06	870.77	871.11
90.0%	870.29	870.86	870.38	871.23	871.35	870.97	871.39
97.5%	870.60	871.17	870.82	871.56	871.79	871.28	871.78
Max	871.75	872.20	871.50	872.27	872.65	872.40	872.58



SPRINGBROOK

at 79th Way, Fridley

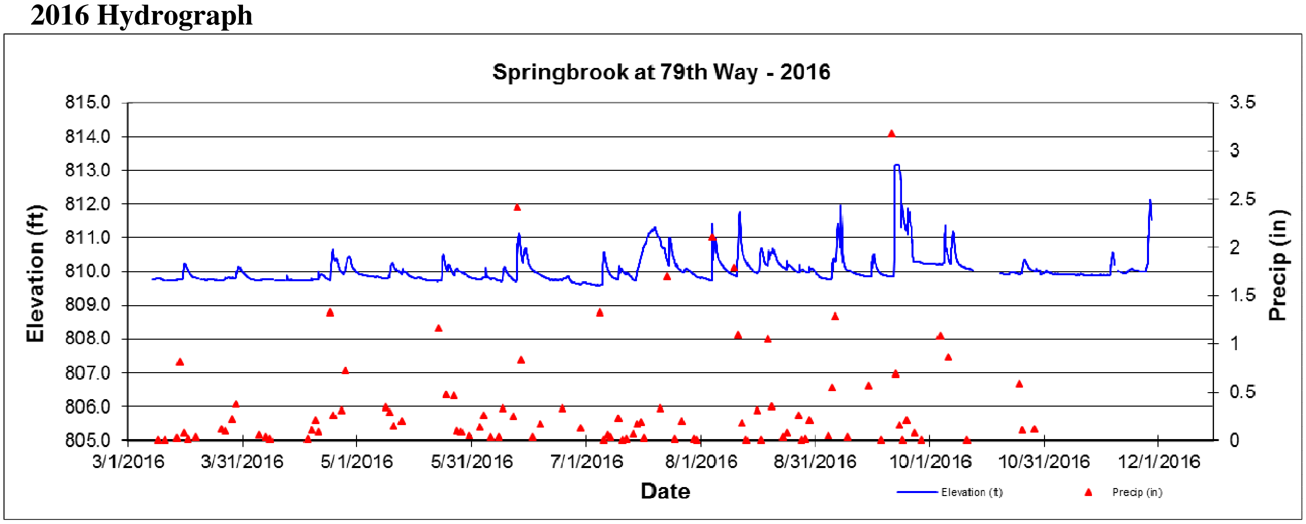
Notes



Springbrook is a small waterway draining an urbanized and highly modified subwatershed. The watershed includes portions of the Cities of Blaine, Coon Rapids, Spring Lake Park and Fridley. Several tributaries, or stormwater systems contributing to the creek, join at the Springbrook Nature Center Impoundment. From the outlet of the Nature Center, the Creek flows a short distance to the Mississippi River. At its outlet, Springbrook is about 10 feet wide and 1 foot deep at baseflow.

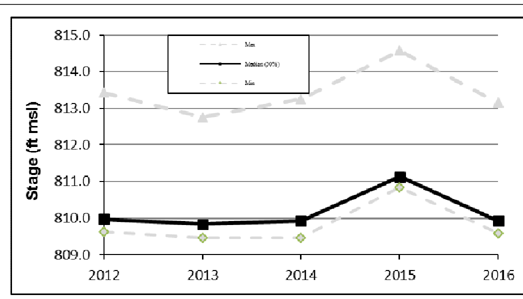
Springbrook at 79th Way was monitored for the first time in 2012. The stream is flashy, with water levels that increase dramatically following rainfall and quickly recede thereafter. This occurs despite the possible dampening effect of the stream flowing through the Springbrook Nature Center impoundment just upstream. For example, in 2016 water levels jumped 3.28 feet in just 4 hours after a 3.19 inch storm in September. In 2016, water levels fluctuated 3.57 feet reaching a maximum of 813.16 feet, slightly lower than the maximum of 814.57 in 2015. An additional aspect which makes this site unique is its proximity to the Mississippi River. Influence of the river is illustrated in 2012-2014 when the river water levels rose to such an elevation that backfilling into Springbrook occurred. These events resulted in the highest water level of the season and held for a period of time until the river receded. It is also common for the outlet to the Mississippi to become clogged with debris resulting in an artificial backup of water. Because of this influence the true max water level is still unknown.

2016 Hydrograph



Summary of All Monitored Years

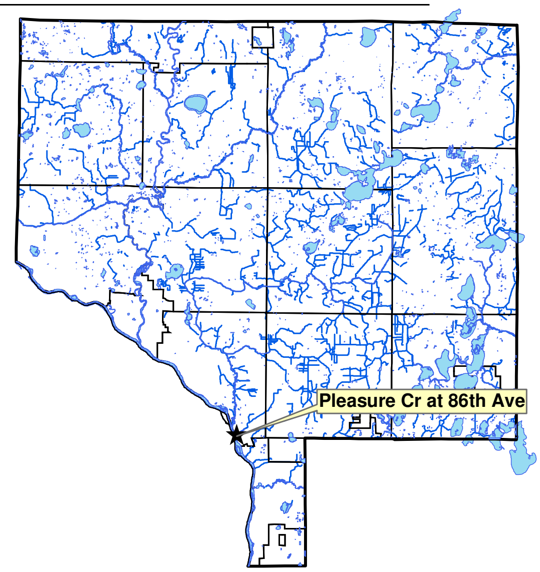
Percentiles	2012	2013	2014	2015	2016
Min	809.62	809.47	809.46	810.85	809.59
2.5%	809.65	809.54	809.63	810.91	809.67
10.0%	809.69	809.60	809.66	810.96	809.74
25.0%	809.76	809.67	809.72	811.04	809.79
Median (50%)	809.97	809.84	809.93	811.13	809.93
75.0%	810.29	810.08	811.62	811.30	810.13
90.0%	811.24	810.71	812.99	811.73	810.50
97.5%	812.87	812.17	813.18	812.63	811.28
Max	813.43	812.76	813.25	814.57	813.16



PLEASURE CREEK

at 86th Ave, Fridley

Notes

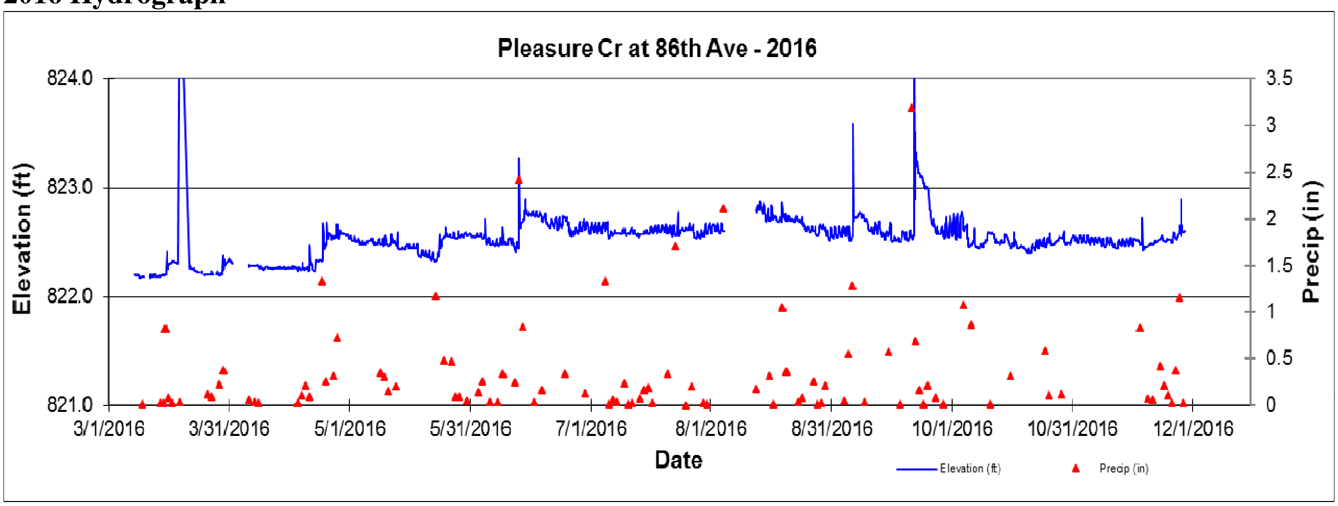


Pleasure Creek flows through the southwestern portion of Blaine and southern Coon Rapids. The watershed is urbanized. The creek is about 8-10 feet wide and 0.5 to 1 foot deep during baseflow. It flows through an interconnected network of stormwater ponds in the upper part of the watershed.

Variations in the water level at Pleasure Creek are seldom more than one foot and happen with extreme rapidity. As an example, a 2.27 inch storm in 2014 caused the creek to rise 0.75 feet in the first two hours and had retreated 0.64 feet in the following two hours. A 1.99 inch storm in 2015 reacted similarly rising 0.81 feet in the first two hours and then retreating 0.42 feet in the following two hours. In September of 2016, a 3.19 inch storm caused a spike of 1.6 feet in 4 hours, which the stream dropped back 0.95 feet of in the following 6 hours.

Several manual flow measurements were done in 2013 to inform rating curve development by CCWD's consulting engineer. The engineer plans to use the stream cross section and desktop analysis for rating curve generation.

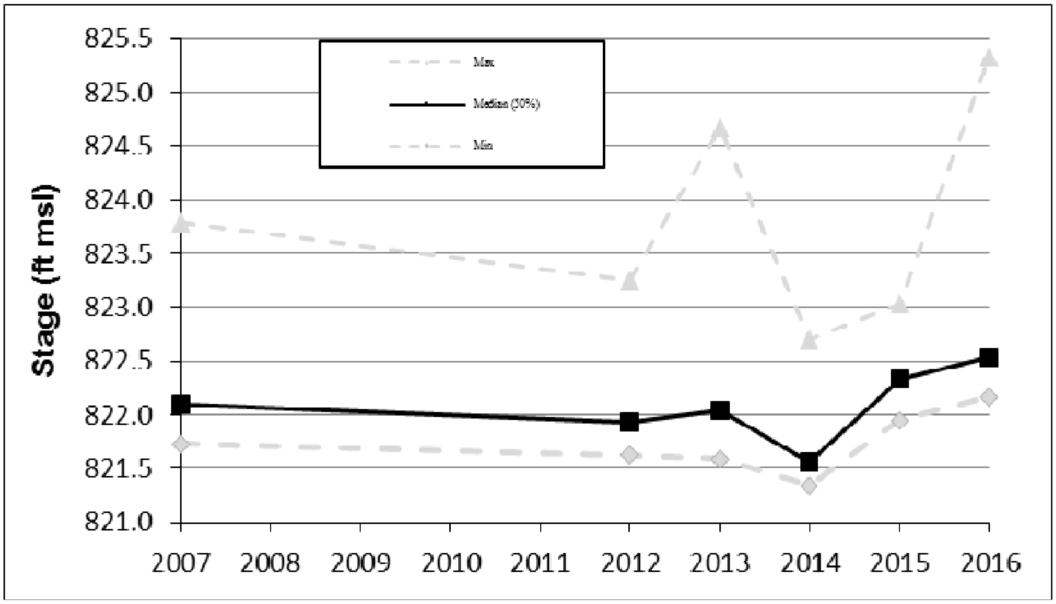
2016 Hydrograph



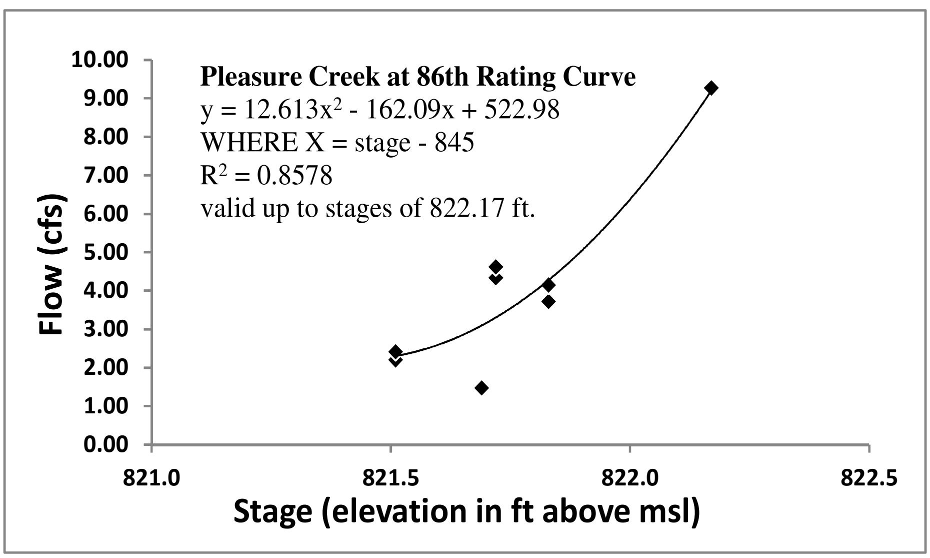
Summary of All Monitored Years

Percentiles	2007	2012	2013	2014	2015	2016
Min	821.73	821.63	821.60	821.34	821.95	822.17
2.5%	821.77	821.69	821.63	821.38	821.98	822.20
10.0%	821.84	821.77	821.73	821.42	822.02	822.27
25.0%	821.95	821.80	821.78	821.45	822.26	822.46
Median (50%)	822.10	821.93	822.04	821.57	822.34	822.54
75.0%	822.32	822.04	824.67	821.82	822.46	822.61
90.0%	822.49	822.19	824.67	821.98	822.56	822.70
97.5%	822.63	822.33	824.67	822.19	822.61	822.81
Max	823.79	823.25	824.67	822.70	823.04	825.33

Summary of All Monitored Years



Ratings Curves (2013)



Stream Water Quality – Chemical Monitoring

Description: Each stream was monitored eight times during the open water season; four times during baseflow and four times during storm flow. Storm flow events were defined as an approximately one-inch rainfall in 24 hours, though totals vary from location to location. Each stream was tested for pH, conductivity, turbidity, dissolved oxygen, temperature, total suspended solids, and total phosphorus and E. coli.

Purpose: To detect water quality trends and problems, and diagnose the source of problems.

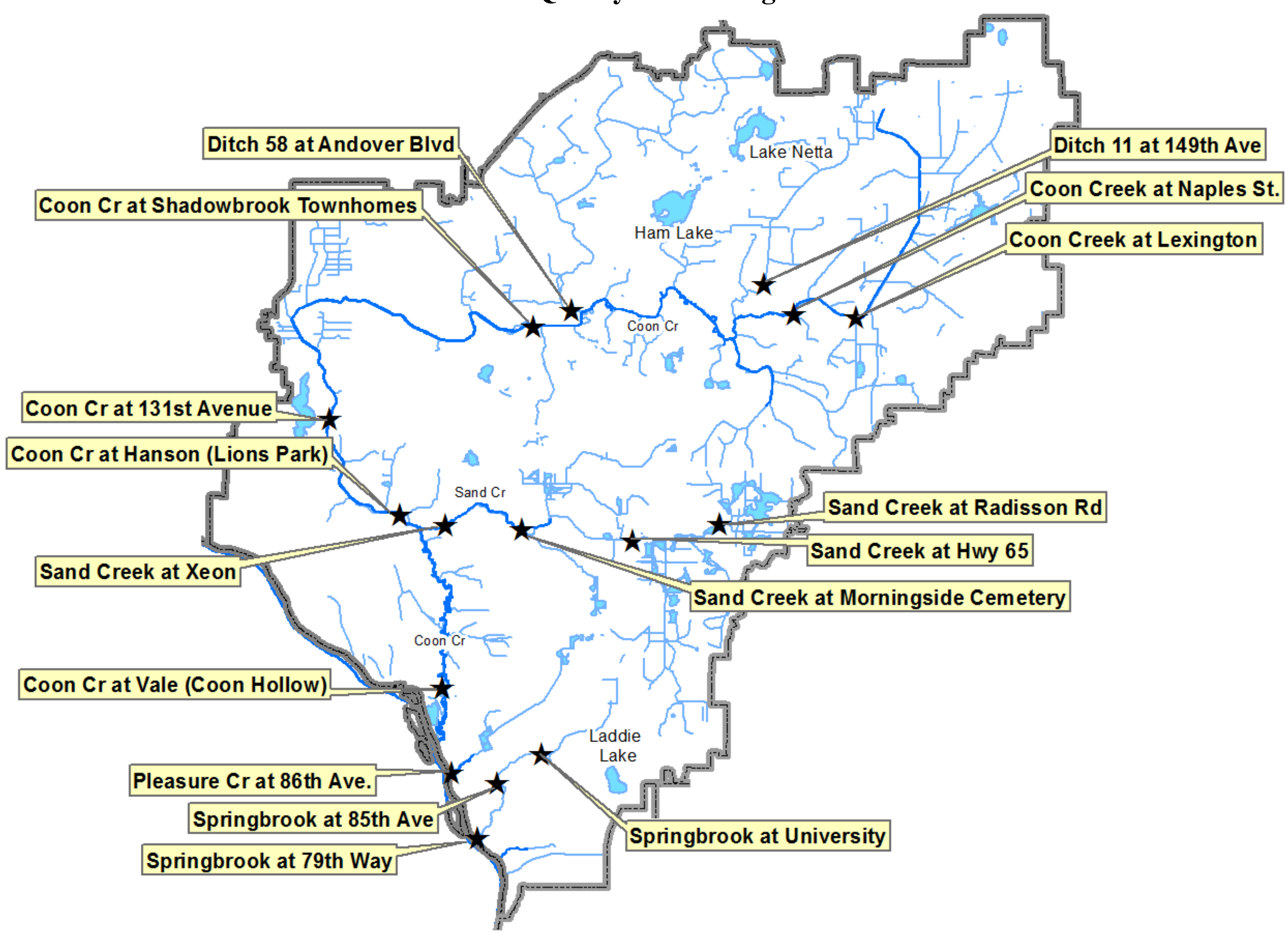
Locations:

Stream	Location	City
Coon Creek	Lexington Blvd	Ham Lake
Coon Creek	Naples	Ham Lake
Ditch 11	149st Ave.	Ham Lake
Ditch 58	Andover Blvd	Ham Lake
Coon Creek	Shadowbrook Townhomes	Andover
Coon Creek	131st Ave.	Coon Rapids
Coon Creek	Lions Park	Coon Rapids
Coon Creek	Coon Hollow (Vale)	Coon Rapids

Stream	Location	City
Sand Creek	Radisson Road	Blaine
Sand Creek	Hwy. 65	Blaine
Sand Creek	Morningside Cemetery	Coon Rapids
Sand Creek	Xeon Street	Coon Rapids
Pleasure Creek	86th Ave.	Coon Rapids
Springbrook	University Ave.	Blaine
Springbrook	85th Ave.	Fridley
Springbrook	79th Way	Fridley

Results: Results for each stream are presented on the following pages.

Coon Creek Watershed 2016 Stream Water Quality Monitoring Sites



Median pollutant concentrations for waterways in the Coon Creek Watershed District. The reader is warned that differing amounts of sampling have been done at each stream. Also, in some cases, the extreme measurements are more important than the median values presented. Please see detailed results from each stream for more insight.

For Coon Creek, Sand Creek, Springbrook, and Pleasure Creek the numbers shown are medians of all readings from all sites. All data through 2016 is included for the individual creeks.

	Springbrook Cr	Pleasure Cr	Sand Cr	Coon Cr	Median for Anoka Co Streams	State Water Quality Standard
Conductivity (mS/cm)	0.851	0.911	0.749	0.519	0.362	none
Chlorides (mg/L)	159	125	67	40	17	860 - acute 230 - chronic
Turbidity (NTU)	5.8	11.95	7.7	14.3	8.5	None
Total Suspended Solids (mg/L)	5	9	6	9	12	30
Total Phosphorus (ug/L)	104	72.0	59.0	116	135	100
Dissolved Oxygen (mg/L)	8.475	8.0	7.92	8.09	6.97	≥ 5
pH	7.78	7.98	7.74	7.62	7.62	6.5-8.5

Hydrolab/YSI Continuous Stream Water Quality Monitoring

COON CREEK

Coon Creek at 131st Street, Ham Lake STORET SiteID = S003-993

Years Monitored

Coon Creek at 131st Street, 2015-2016

Background

Coon Creek is a major drainage through central Anoka County. Development in the watershed ranges from rural residential to urbanized. Upstream reaches were ditched in the early 1900s for agriculture. There are many ditch tributaries in the upper reaches. Lower reaches of the creek were not ditched. The entire ditch system serves as an important stormwater conveyance for the Cities of Ham Lake, Andover, Blaine, and Coon Rapids. The creek outlets into the Mississippi River.

Coon Creek and its tributaries have been monitored by grab samples during storms and baseflow over the course of several years. Several water quality concerns have been noted, including dissolved pollutants, phosphorus, turbidity and total suspended solids. Continuous monitoring is needed to gain further insight into the nature and possible corrective actions for problems.

The purpose of hydrolab continuous water quality monitoring is to document water quality changes throughout a storm. This should help diagnose water quality problems and analyze differences in runoff from upper and lower parts of the watershed. Runoff that passes the monitoring site most immediately following a storm is from the lower, urbanized part of the watershed while later runoff is mostly from upper portions of the watershed.

Methods

Coon Creek at 131st Street was chosen for monitoring because it is further downstream in a highly urbanized area on Coon Creek and is an easily accessible site. This was the second year of continuous stream water quality monitoring at this site.

Coon Creek at 131st Street was monitored immediately before, during, and after storms with either a YSI Exo or Hydrolab MS5 water quality sonde. The sonde was suspended inside a PVC pipe by a chain from a locked lid. The PVC pipe was secured to a metal fence post. The sonde sensors protruded from the bottom of the pipe approximately 6-12 inches from the stream bottom, ensuring they would stay submerged even if flow was low. The sonde was programmed to take readings every 30 minutes. Readings included pH, salinity, specific conductance, temperature, dissolved oxygen, and turbidity. The sonde was calibrated before each deployment.

Staff deploying the Hydrolab MS5. In the background are the Hydrolab casing (shorter) and an RDS continuous water level monitoring device.

The Hydrolab was deployed into the stream when a storm predicted to drop at least 0.5 inches of rain, and preferably greater, was approaching. Past grab sample monitoring had found that the greatest water quality problems occurred after storms exceeding one inch. In some instances, water level was already high before the storm and remained high after the storm. At other times, predicted rain did not fall and we were monitoring baseflow conditions. In all instances, the Hydrolab was left in the field for several days.

Water levels were continuously monitored throughout the open water season. An RDS Ecotone WM-40 water level monitoring device recorded water levels every two hours. This stream stage data is presented with the water quality data. It would be preferable to present flow, and a rating curve does exist, however during some sampling events water was exceptionally high and exceeded the capacity of the rating curve so that flow could not be accurately calculated. To make graphs from all storms comparable, stage is shown for all.

Precipitation data are provided with the water quality results. These data were taken from the datalogging rain gauge at the Andover Public Works building, which is approximately 3.0 miles north of the stream monitoring site. In our analysis we also looked at precipitation totals in other portions of the watershed and noted any large differences.

Results and Discussion

A variety of storm sizes were analyzed. Rainfall during the monitored time periods ranged from 0.43 to 3.07 inches. The wide distribution is helpful in discerning the creek's response to different storms.

Only 2016 individual storm results are presented in this report. The individual storm results for other locations of Coon Creek, and last year's storms at this site are not presented in this report but are available upon request from the Anoka Conservation District. Each year the findings of storm analysis are reviewed and re-evaluated.

On the following pages results from each storm monitored are shown. The graphs show precipitation and the stream hydrograph approximately one day before and after water quality monitoring began. Separate graphs show each water quality parameter. The text below discusses summarizes findings across all storms for each parameter.

Turbidity

- A brief turbidity spike is observed during, or immediately following, rainfall. This is likely due to the flush of stormwater from upstream farm fields as well as the developments nearby. Turbidity retreats to much lower levels within a few days.
- Because turbidity does not closely follow stream stage, bed load is not the primary driver of high turbidity.

Specific Conductance

- Specific conductance, a measure of dissolved pollutants, is inversely related to water level. When creek water rises, conductance drops. During brief, intense rainfall the stream conductance drops sharply. The shallow groundwater that feeds the stream during baseflow has higher conductance than stormwater runoff, and storm runoff dilutes it. Infiltration of road deicing salts is a likely source of high conductance in stream baseflow year round.

Dissolved Oxygen

- The observed dissolved oxygen concentrations in Coon Creek were within the healthy, desirable range.
- Dissolved oxygen stayed above 5 mg/L, the state water quality standard, in all events monitored. Below this level, aquatic life begins to suffer.
- When stream levels rise, dissolved oxygen often rises as well. Levels remained high at this site throughout.
- Dissolved oxygen consistently drops overnight, indicating diel-cycling hypoxia. This is likely caused by excess nutrients fueling algae which release large amounts of oxygen through photosynthesis during the day, but respire and draw in oxygen at night. This results in large swings from day to night.

Temperature

- Water temperature is generally not considered a concern in Coon Creek because there are no trout or other temperature sensitive resources.
- Cycles of day warming and night cooling are apparent in the data as well as high influxes of runoff resulting in cooling of the system.

pH

- pH is inversely related to water level in Coon Creek. When water level rises, pH declines. This is because rainwater has a lower pH than that of local shallow groundwater.
- pH stayed within the desired range of 6.5 to 8.5 that is specified in state water quality standards and is not presently a concern at this site.

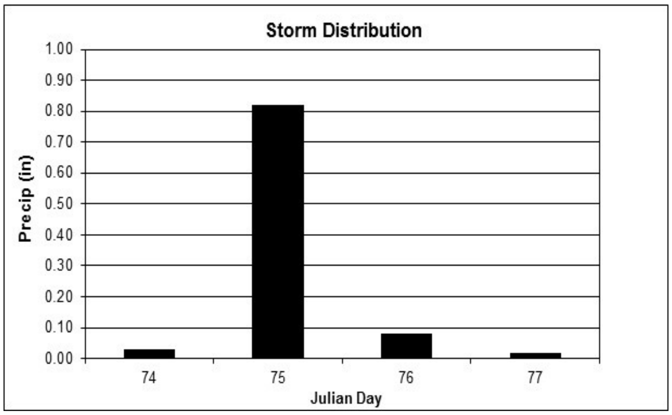
Hydrolab Continuous Monitoring
Storm 1 - 2016

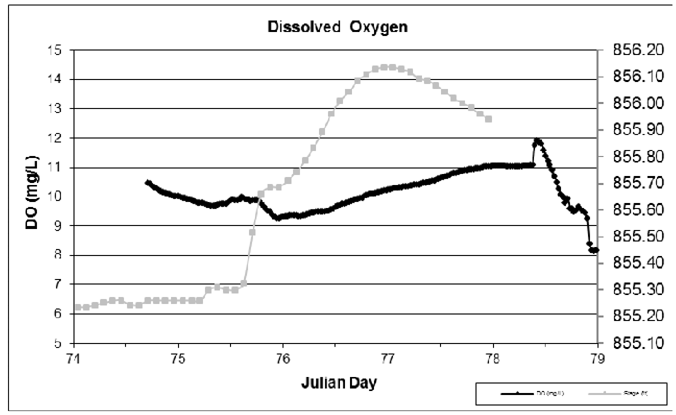
Coon Creek at 131st Street

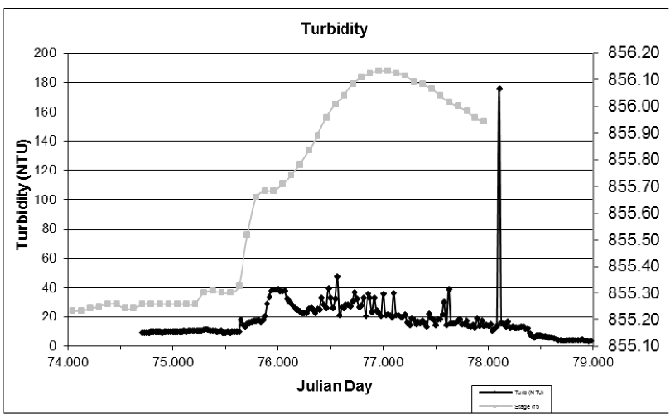
<u>Storm Summary:</u>

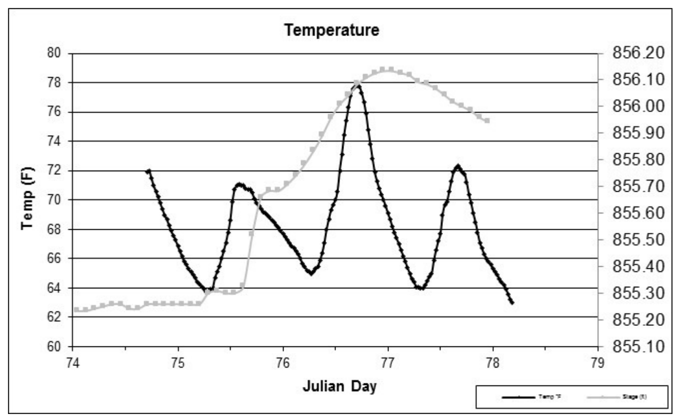
Dates: 14 March 2016 (day 74) to 18 March 2016 (day 78)

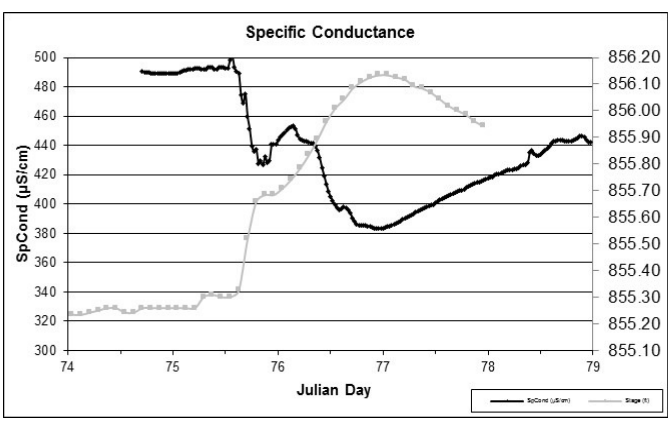
Precipitation: 0.95 inches

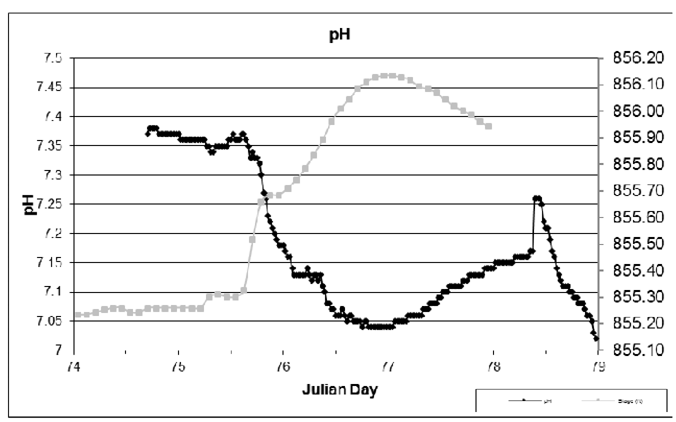






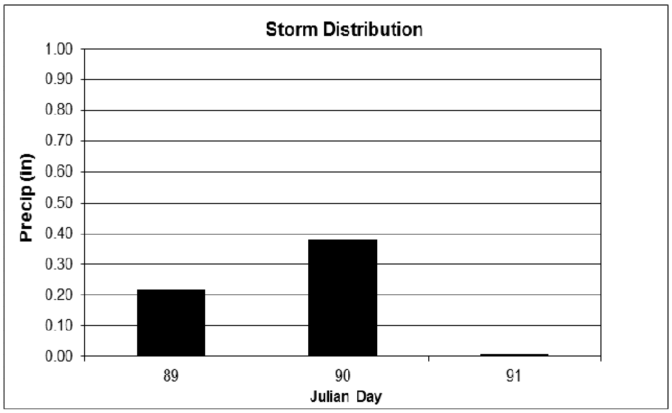


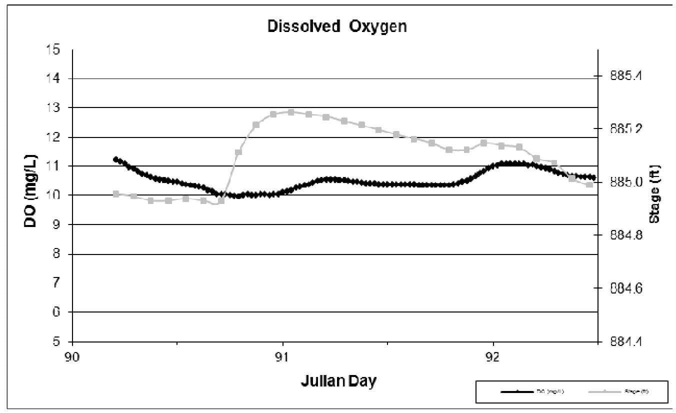


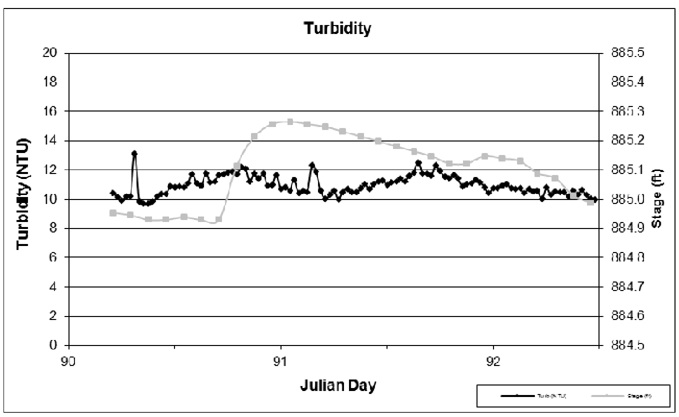


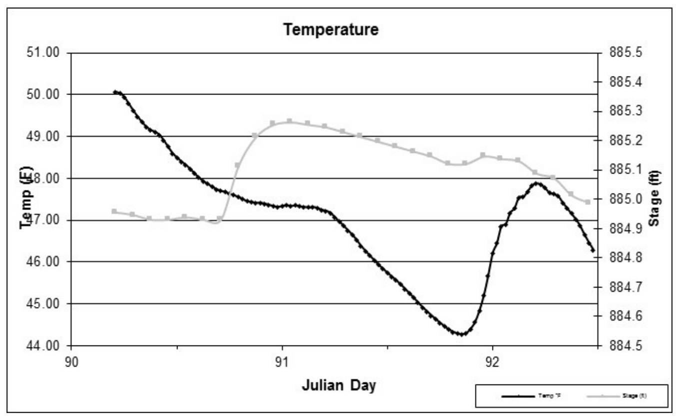
Hydrolab Continuous Monitoring
Storm 2 - 2016

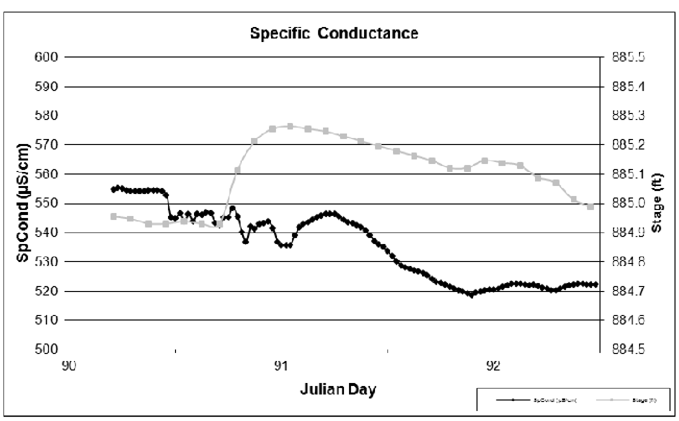
Coon Creek at 131st Street
Storm Summary:
Dates: 29 March 2016 (day 89) to 31 March 2016 (day 91)
Precipitation: 0.61 inches

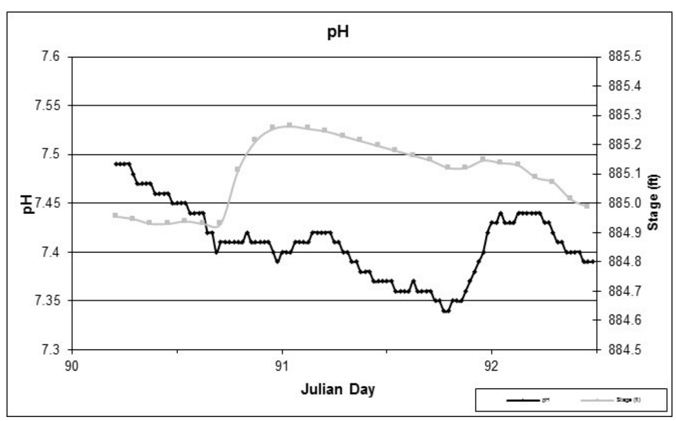






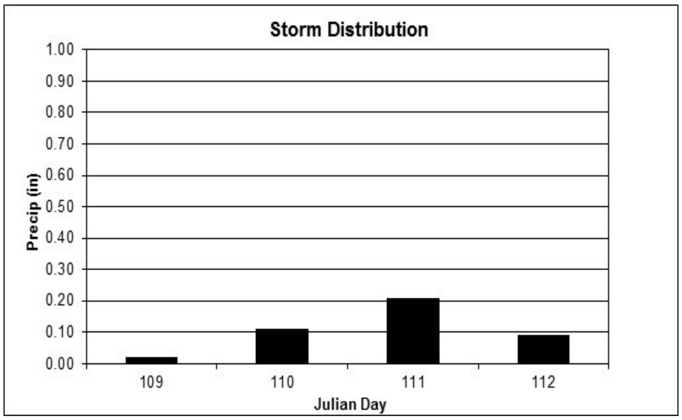


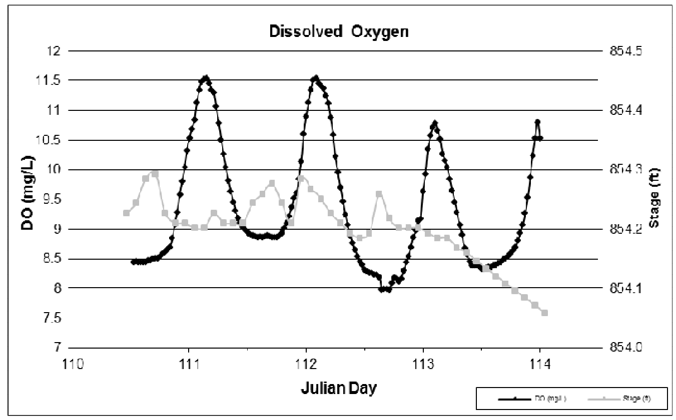


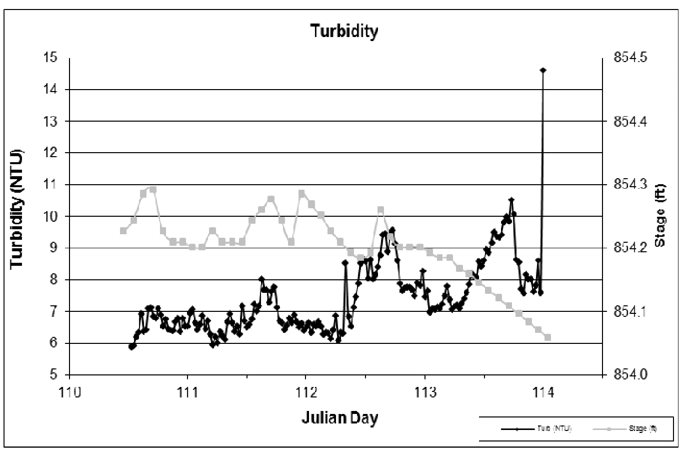


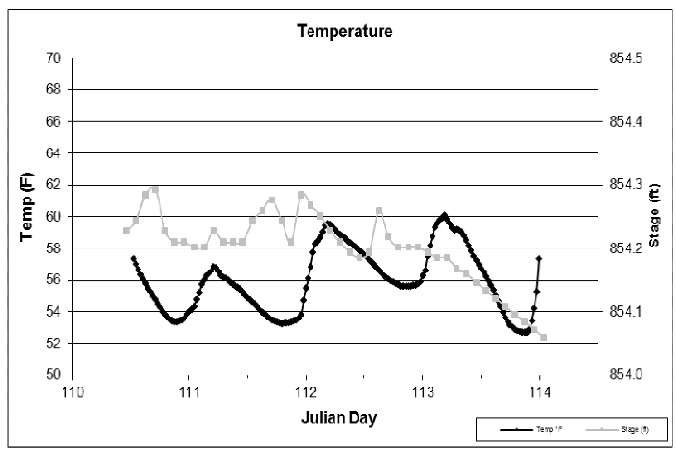
Hydrolab Continuous Monitoring
Storm 3 - 2016

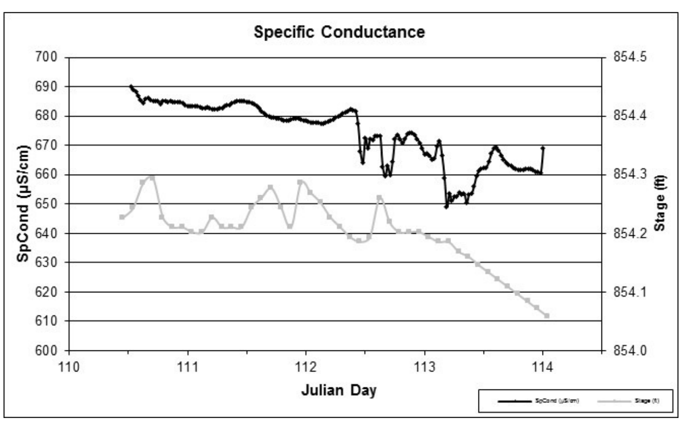
Coon Creek at 131st Street
<u>Storm Summary:</u>
Dates: 18 April 2016 (day 109) to 22 April 2016 (day 113)
Precipitation: 0.43 inches

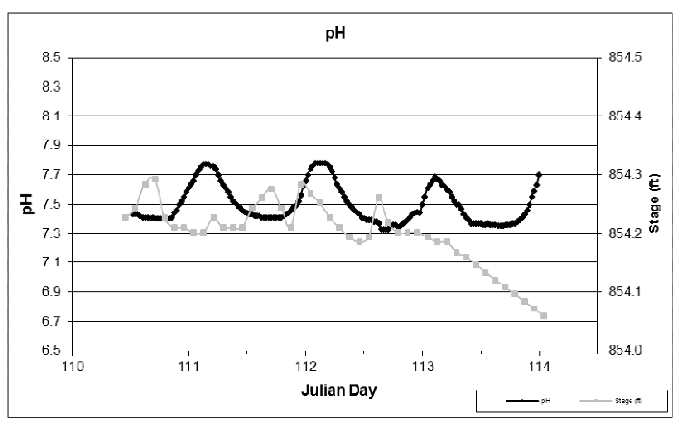






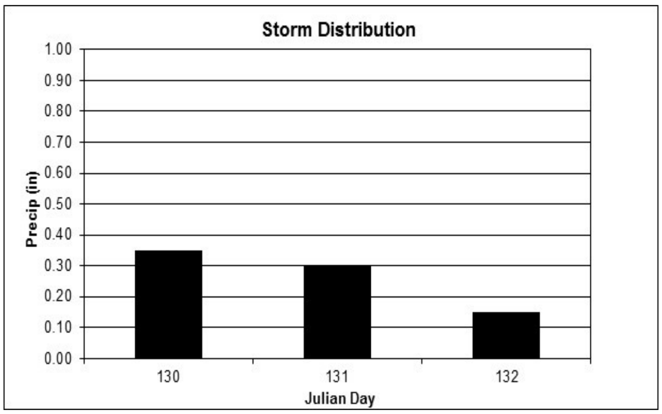


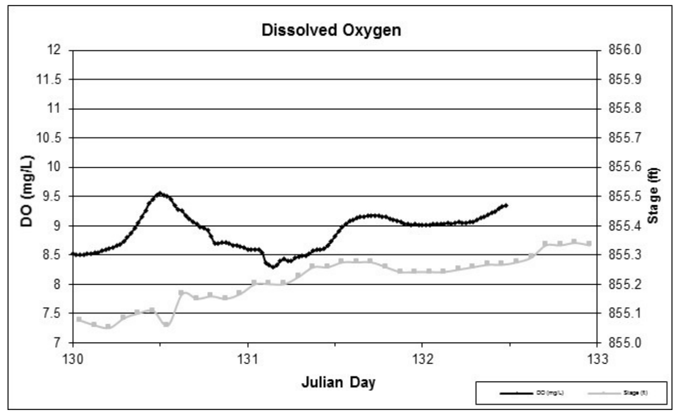


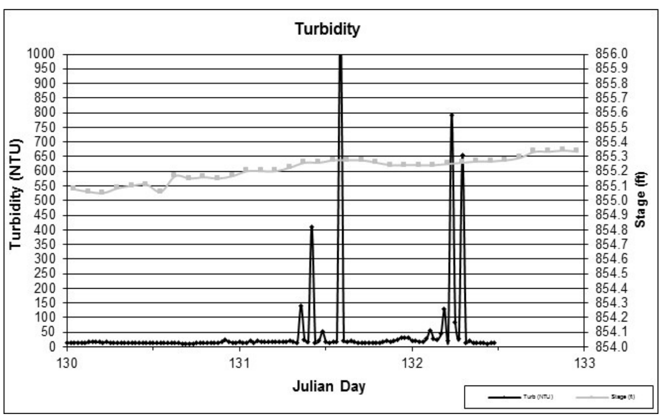


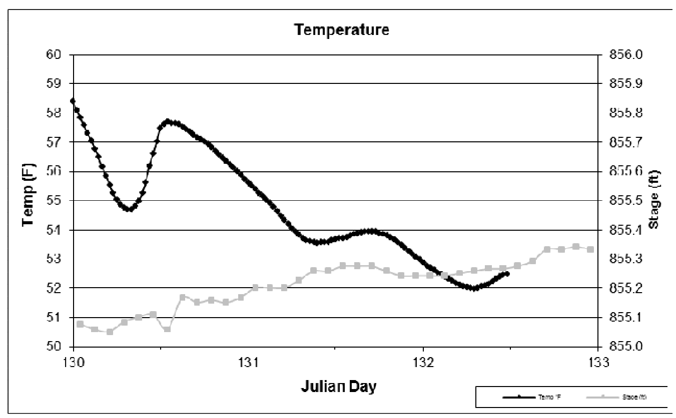
Hydrolab Continuous Monitoring
Storm 4 - 2016

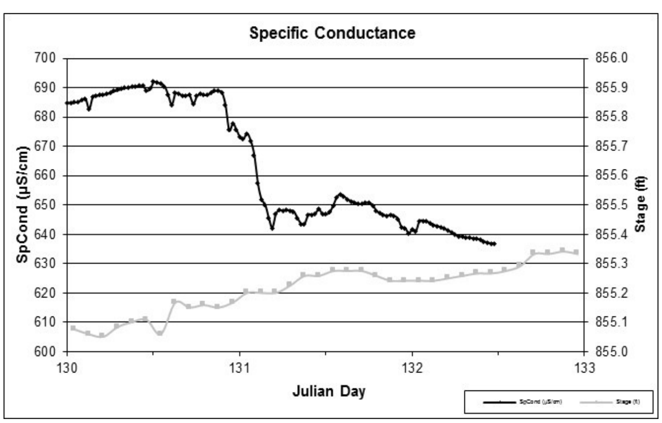
Coon Creek at 131st Street
<u>Storm Summary:</u>
Dates: 9 May 2016 (day 130) to 11 May 2016 (day 132)
Precipitation: 0.80 inches

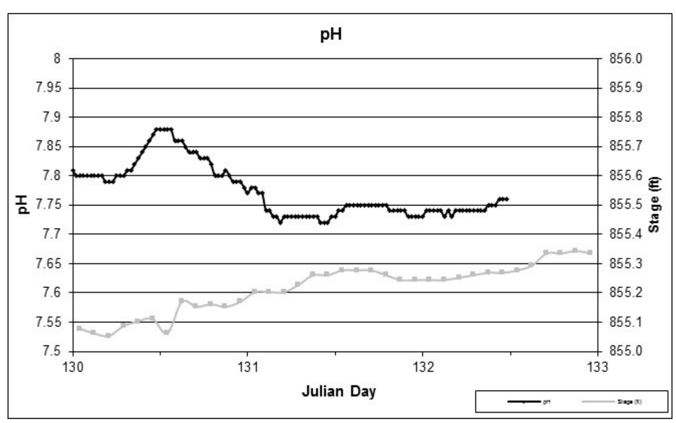












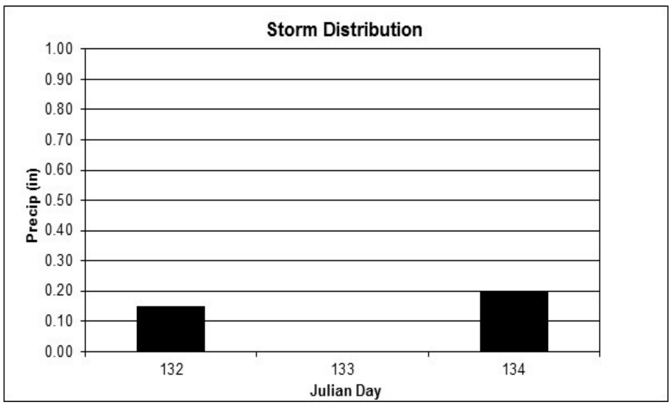
Hydrolab Continuous Monitoring
Storm 5 - 2016

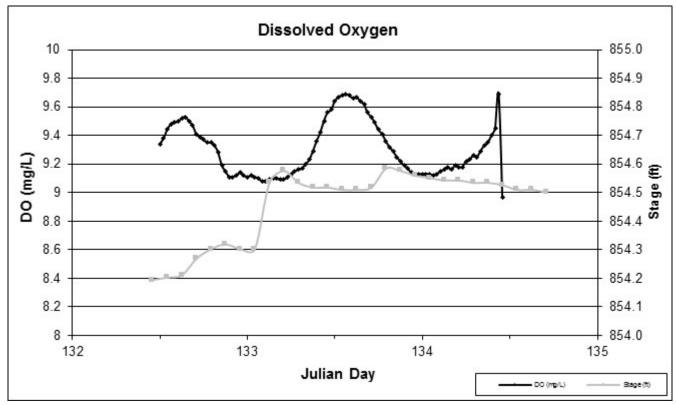
Coon Creek at 131st Street

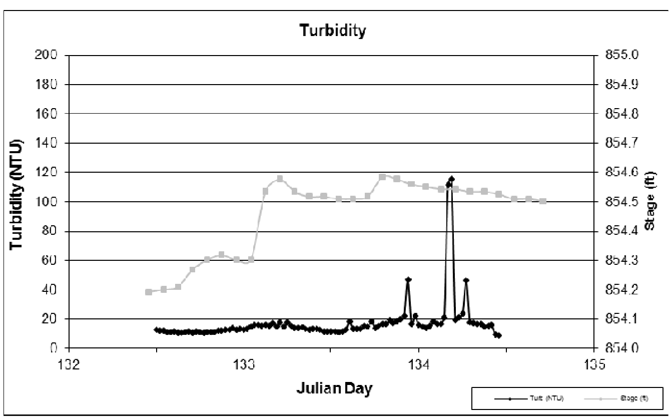
Storm Summary:

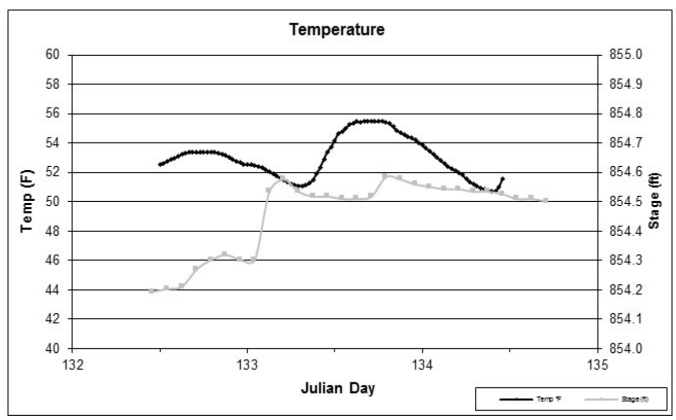
Dates: 11 May 2016 (day 132) to 13 May 2016 (day 134)

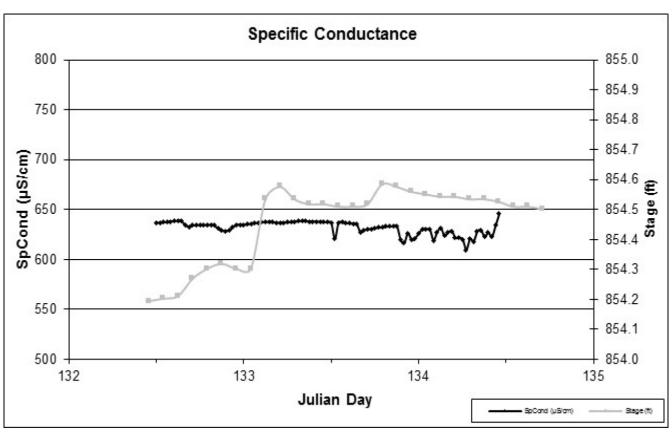
Precipitation: 0.55 inches

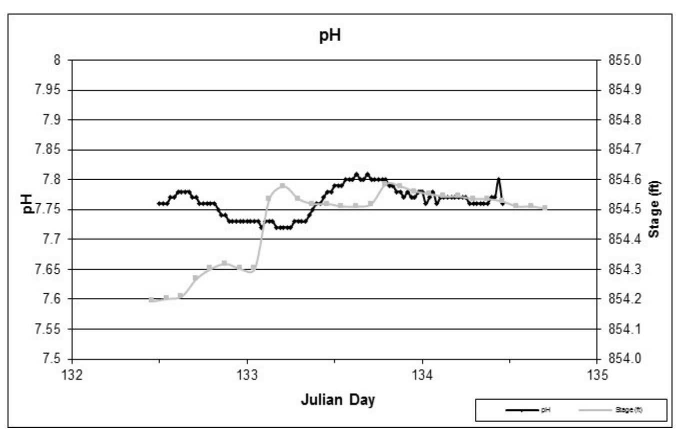






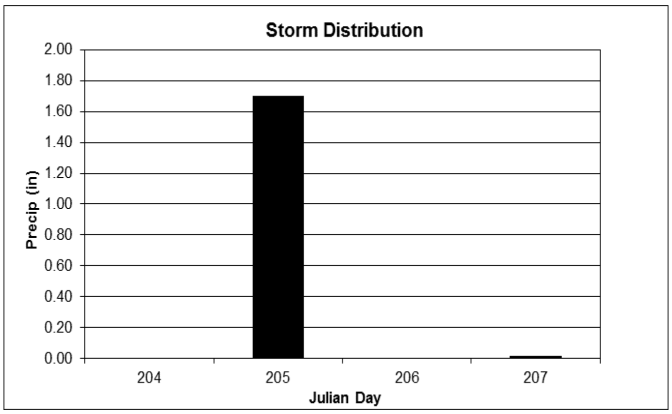


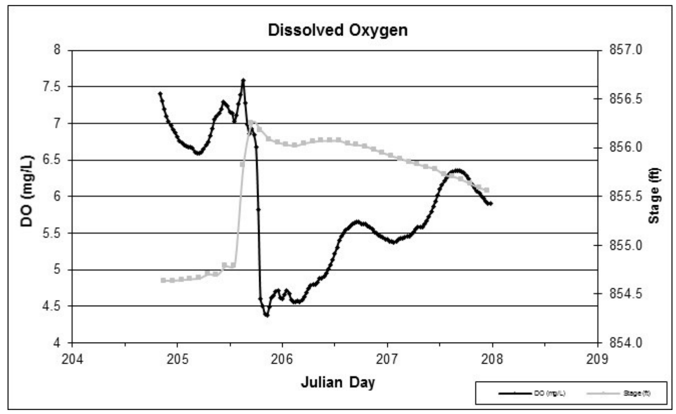


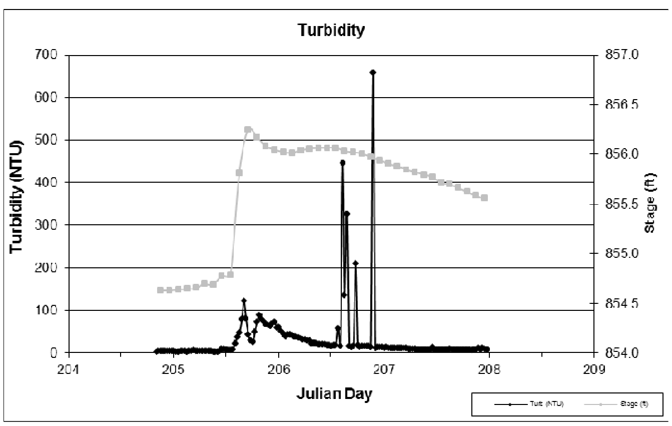


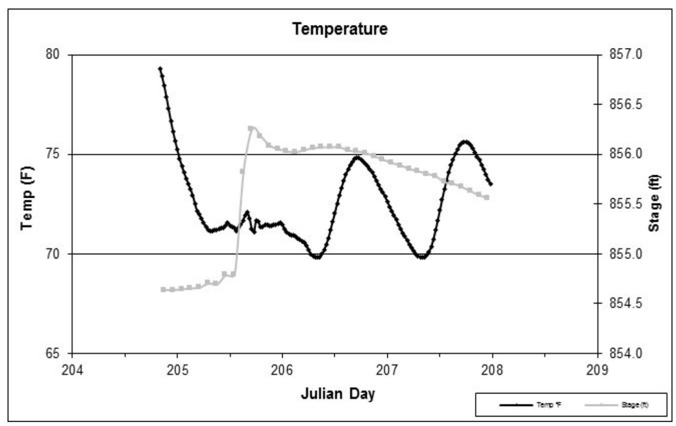
Hydrolab Continuous Monitoring
Storm 6 - 2016

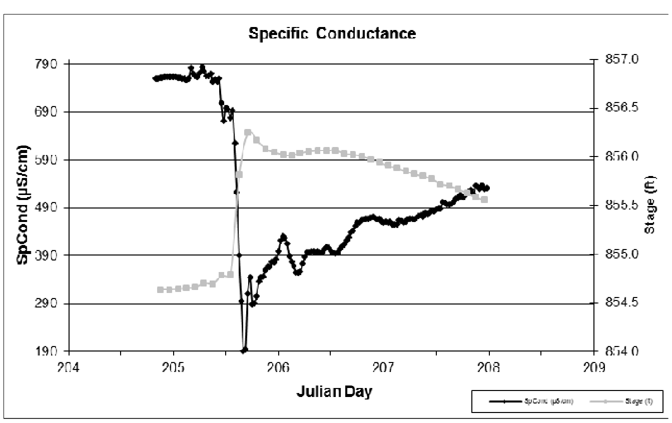
Coon Creek at 131st Street
<u>**Storm Summary:**</u>
Dates: 22 July 2016 (day 204) to 25 July 2016 (day 207)
Precipitation: 1.72 inches

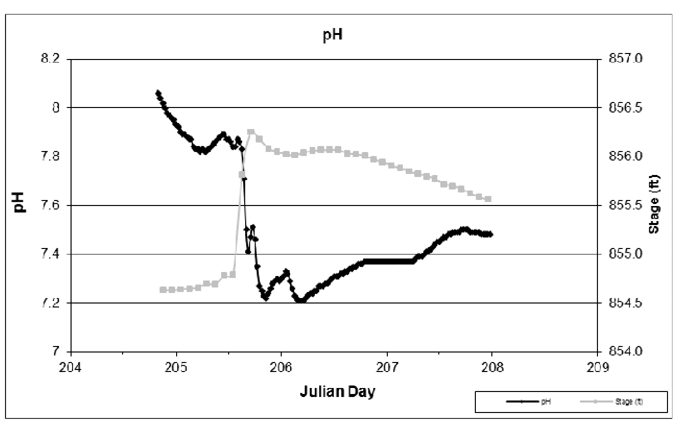






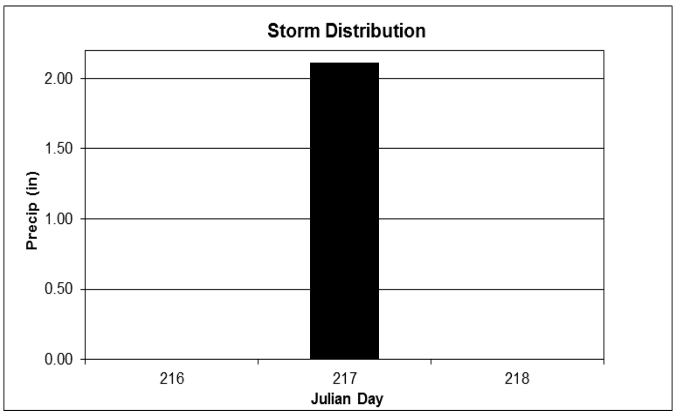


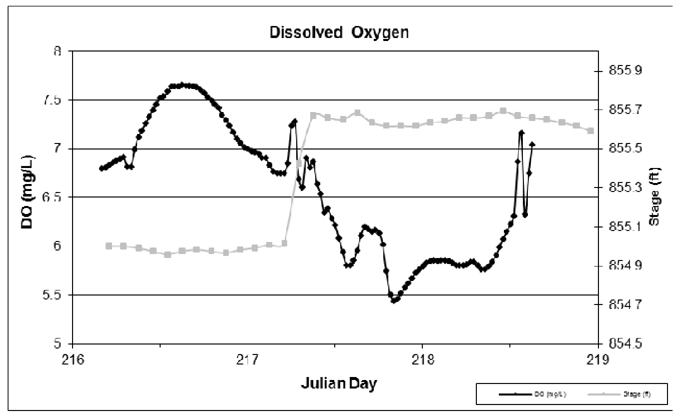


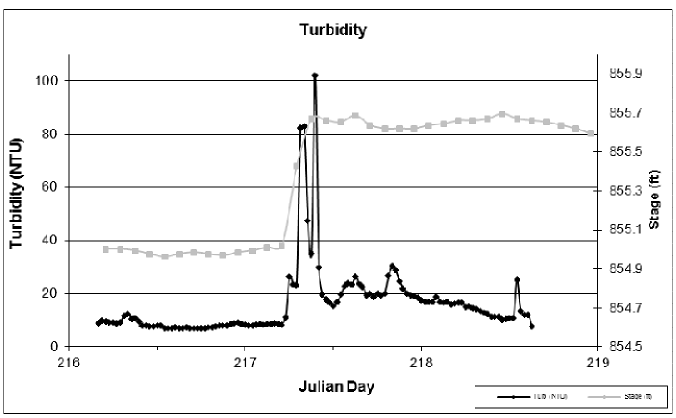


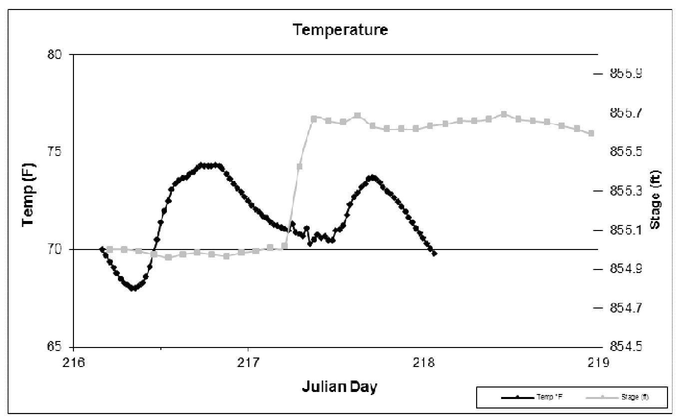
Hydrolab Continuous Monitoring
Storm 7 - 2016

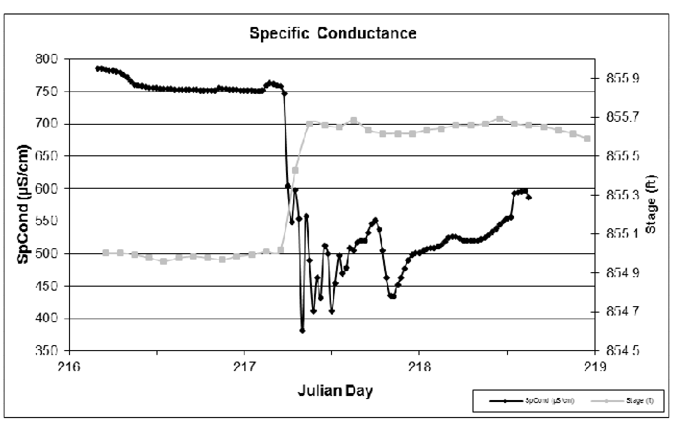
Coon Creek at 131st Street
<u>Storm Summary:</u>
Dates: 3 August 2016 (day 216) to 5 August 2016 (day 218)
Precipitation: 2.11 inches

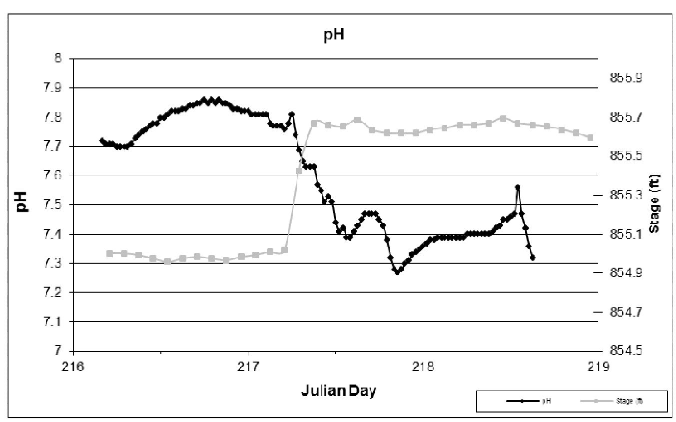






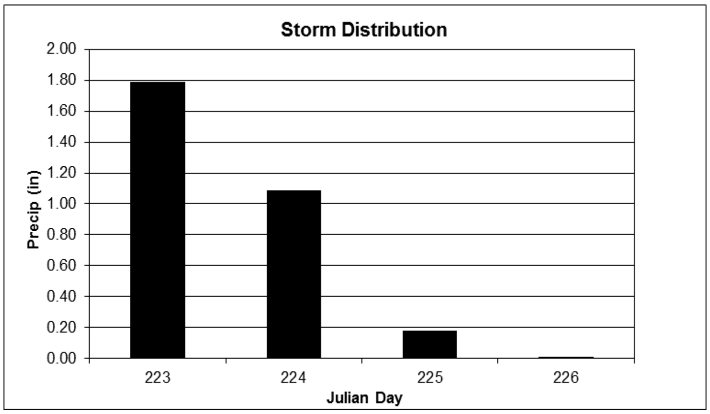


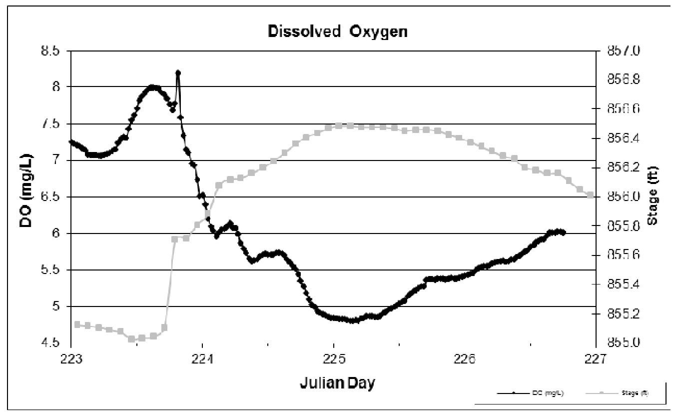


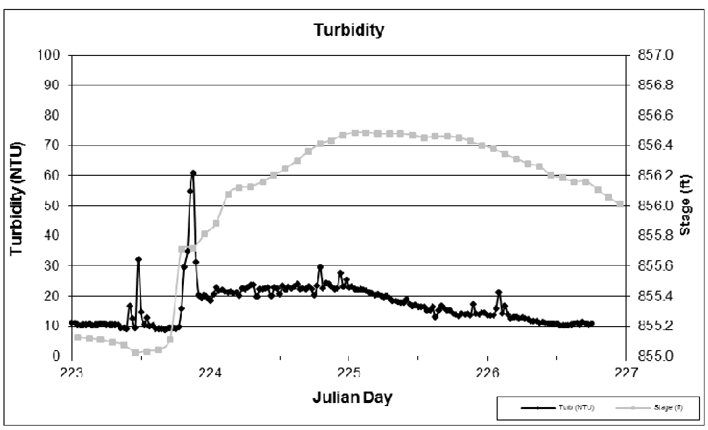


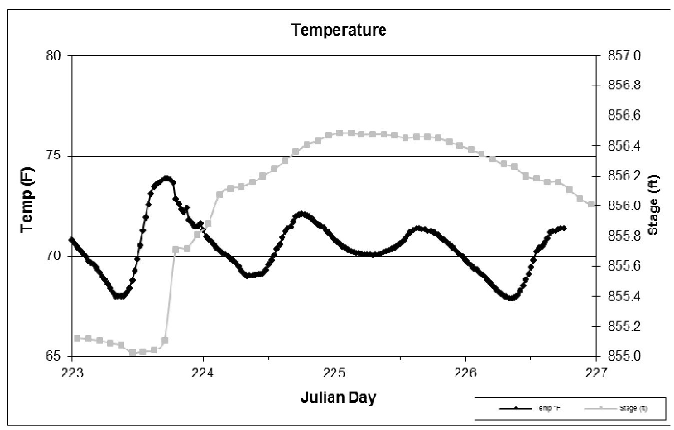
Hydrolab Continuous Monitoring
Storm 8 - 2016

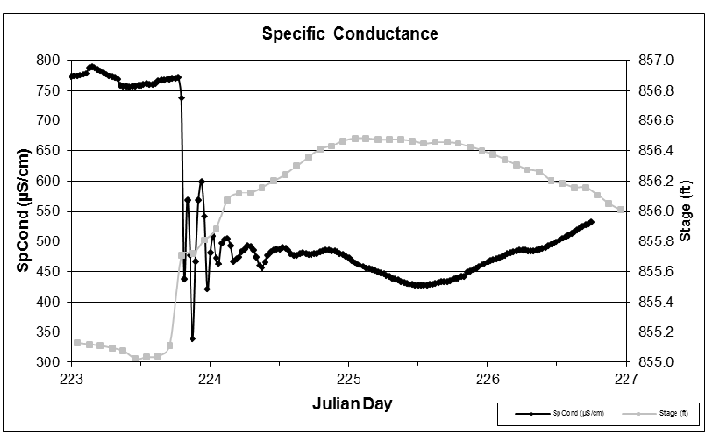
Coon Creek at 131st Street
Storm Summary:
Dates: 10 August 2016 (day 223) to 13 August 2016 (day 226)
Precipitation: 3.07 inches

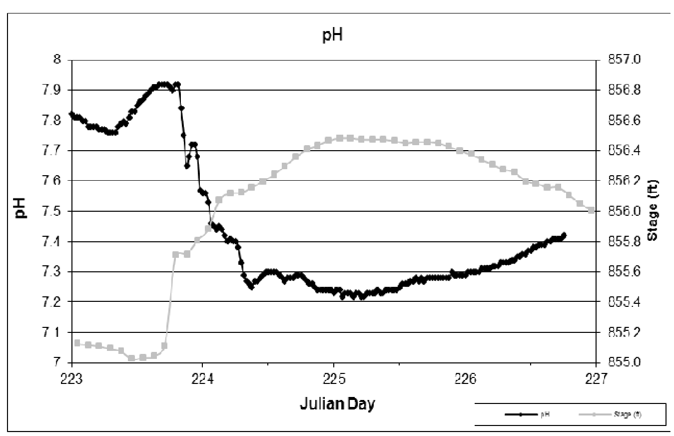












Hydrolab Continuous Stream Water Quality Monitoring

COON CREEK

Coon Creek at Prairie Rd., Ham Lake STORET SiteID = S003-993

Years Monitored

Coon Creek at Prairie Road 2015-2016

Background

Coon Creek is a major drainage through central Anoka County. Development in the watershed ranges from rural residential to urbanized. Upstream reaches were ditched in the early 1900s for agriculture. There are many ditch tributaries in the upper reaches. Lower reaches of the creek were not ditched. The entire ditch serves as an important stormwater conveyance for the Cities of Ham Lake, Andover, Blaine, and Coon Rapids. Coon Creek outlets into the Mississippi River.

Coon Creek and its tributaries have been monitored by grab samples during storms and baseflow over the course of several years. Several water quality concerns have been noted, including dissolved pollutants, phosphorus, and turbidity and total suspended solids. Continuous monitoring is needed to gain further insight into the nature and possible corrective actions for problems.

The purpose of hydrolab continuous water quality monitoring is to document water quality changes throughout a storm. This should help diagnose water quality problems and analyze differences in runoff from upper and lower parts of the watershed. Runoff that passes the monitoring site most immediately following a storm is from the lower, urbanized part of the watershed while later runoff is mostly from upper portions of the watershed.

Methods

Coon Creek at Prairie Road was chosen for monitoring because it is an easy accessible site on Coon Creek in a highly developed part of the watershed. 2016 was the second year of continuous stream water quality monitoring at this site.

Coon Creek at Prairie Road was monitored immediately before, during, and after storms with either a YSI Exo or Hydrolab MS5 water quality sonde. The sonde was suspended inside a PVC pipe by a chain from a locked lid. The PVC pipe was secured to a metal fence post. The sonde sensors protruded from the bottom of the pipe approximately 6-12 inches from the stream bottom, ensuring they would stay submerged even if flow was low. The sonde was programmed to take readings every 30 minutes. Readings included pH, salinity, specific conductance, temperature, dissolved oxygen, and turbidity. The sonde was calibrated before each deployment.

Staff deploying the Hydrolab MS5. In the background are the Hydrolab casing (shorter) and an RDS continuous water level monitoring device.

The Hydrolab was deployed into the stream when a storm predicted to drop at least 0.5 inches of rain, and preferably greater, was approaching. Past grab sample monitoring had found that the greatest water quality problems occurred after storms exceeding one inch. In some instances, water level was already high before the storm and remained high after the storm. At other times, predicted rain did not fall and we were monitoring baseflow conditions. In all instances, the Hydrolab was left in the field for several days.

Water levels were continuously monitored throughout the open water season. An RDS Ecotone WM-40 water level monitoring device recorded water levels every two hours. This stream stage data is presented with the water quality data. Coon Creek at Prairie Rd. did not have previous stage readings. It would be preferable to present flow, but a rating curve does not currently exist for this site. To make graphs from all storms comparable, stage is shown for all.

Precipitation data are provided with the water quality results. This data was taken from the datalogging rain gauges at the Anoka Conservation District and the Andover Public Works building, which are both approximately 3.0 miles from the stream monitoring site. In our analysis we also looked at precipitation totals in other portions of the watershed and noted any large differences.

Results and Discussion

A variety of storm sizes were analyzed. Rainfall during the monitored time periods ranged from 0.24 inches to 2.11 inches. This distribution is helpful in displaying the creek's response to storms of varying intensity.

Only 2016 individual storm results are presented in this report. The individual storm results for other locations of Coon Creek, and last year's storms at this site, are not presented in this report but are available upon request from the Anoka Conservation District. Each year the findings of storm analysis are reviewed and re-evaluated.

On the following pages results from each storm monitored are shown. The graphs show precipitation and the stream hydrograph approximately one day before and after water quality monitoring began. Separate graphs show each water quality parameter. The text below discusses summarizes findings across all storms for each parameter.

Turbidity

- A brief turbidity spike is often observed during or immediately following rainfall. This is likely due to the flush of stormwater from upstream farm fields and wetlands. Turbidity retreats to much lower levels within a few hours.
- Throughout the majority of storm events turbidity averaged fairly low, usually staying between 20 and 50 NTU respectively. During large intense events, turbidity spikes much higher but returns to low levels very quickly.
- Because turbidity does not closely follow stream stage, bed load is not the primary driver of high turbidity.

Specific Conductance

- Specific conductance, a measure of dissolved pollutants, is inversely related to water level. When the creek rises, conductance drops. During brief, intense rainfall the stream conductance drops sharply. This shows that the shallow groundwater that feeds the stream during baseflow has higher conductance than stormwater runoff. Infiltration of road deicing salts are a likely source of high conductance in stream baseflow year round.

Dissolved Oxygen

- The observed dissolved oxygen concentrations at this site fell below the healthy, desirable range on multiple occasions during storm monitoring.
- Dissolved oxygen fell below 5 mg/L during three of the storm events recorded in 2016.
- When stream levels rise, dissolved oxygen rises quickly, but quickly returns to its diurnal pattern.
- Dissolved oxygen consistently drops overnight, indicating diel-cycling hypoxia. This is likely caused by excess nutrients fueling algae which release large amounts of oxygen through photosynthesis during the day, but respire and draw in oxygen at night. This results in large swings from day to night.

Temperature

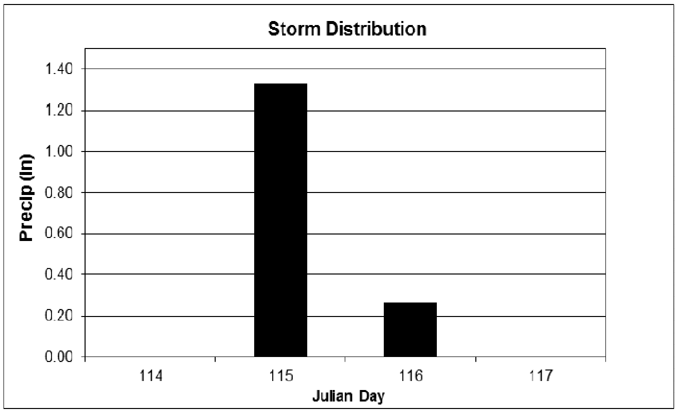
- Water temperature is generally not considered a concern in Coon Creek because there are no trout or other temperature sensitive resources.
- Cycles of day warming and night cooling are apparent in the data.

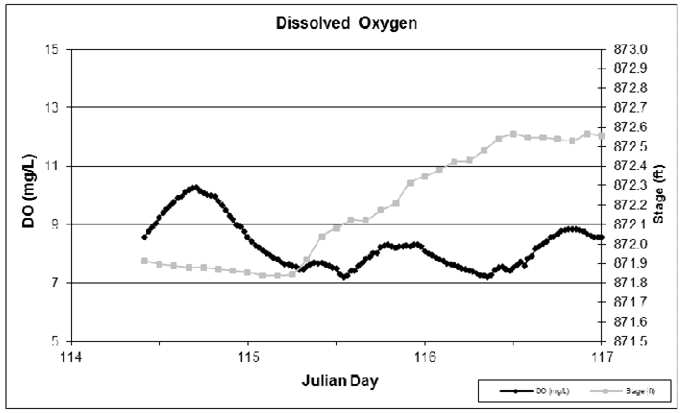
pH

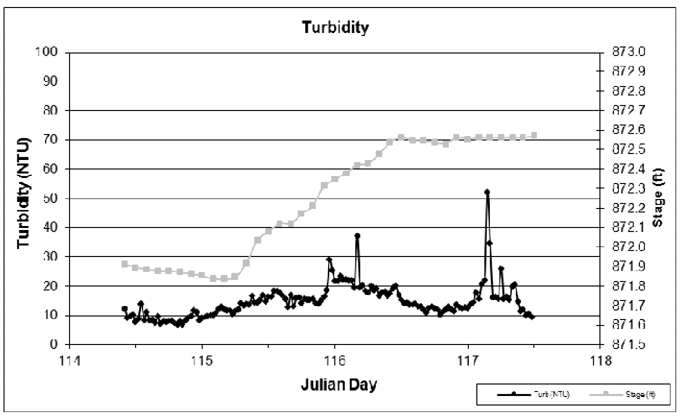
- pH is inversely related to water level in Coon Creek. When water level rises, pH declines. This is because rainwater has a lower pH than that of local shallow groundwater.
- pH stayed within the desired range of 6.5 to 8.5 that is specified in state water quality standards.
- pH fluctuates diurnally indicating that photosynthesis and respiration of excessive aquatic plants is likely the driving force of poor dissolved oxygen levels at this site.

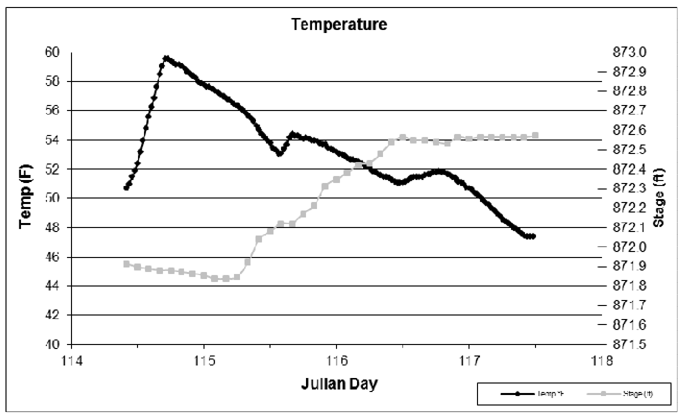
Hydrolab Continuous Monitoring
Storm 1 - 2016

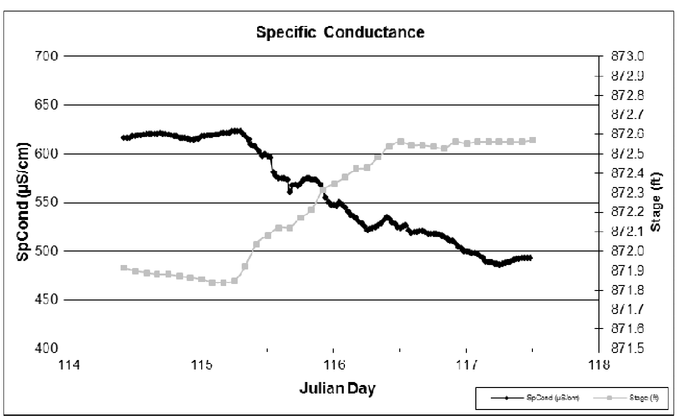
Coon Creek at Prairie Road
<u>Storm Summary:</u>
Dates: 23 April 2016 (day 114) to 26 April 2016 (day 117)
Precipitation: 1.59 inches

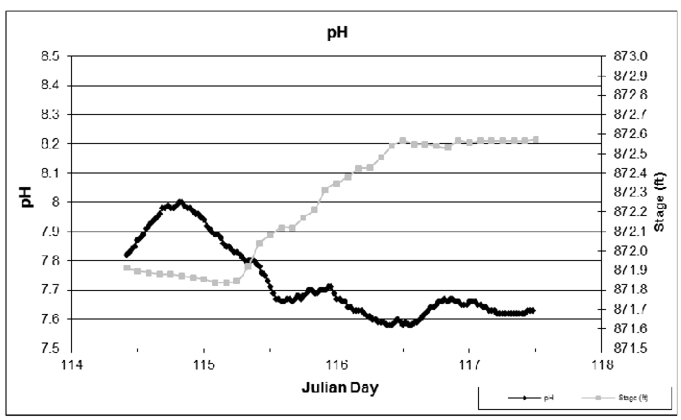












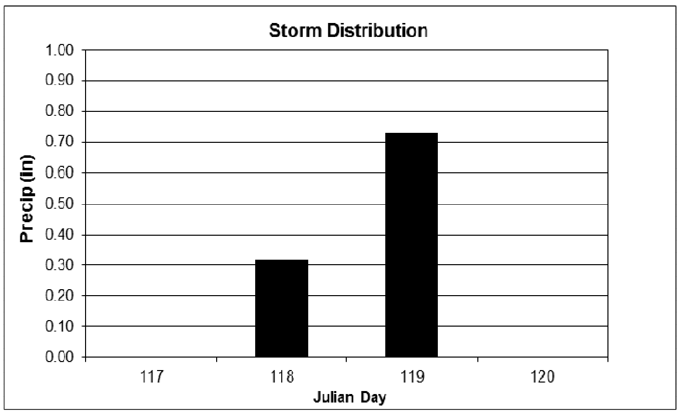
Hydrolab Continuous Monitoring
Storm 2 - 2016

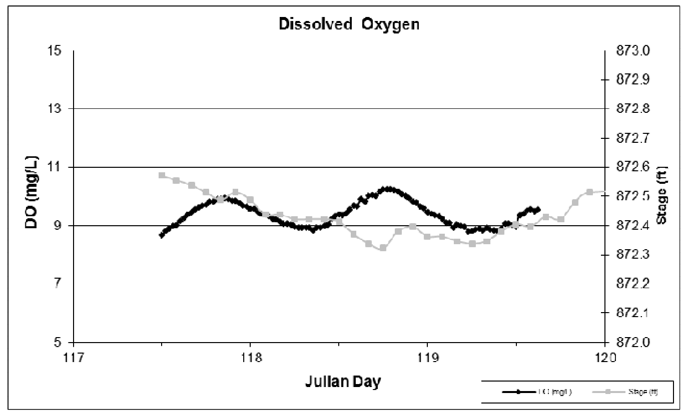
Coon Creek at Prairie Road

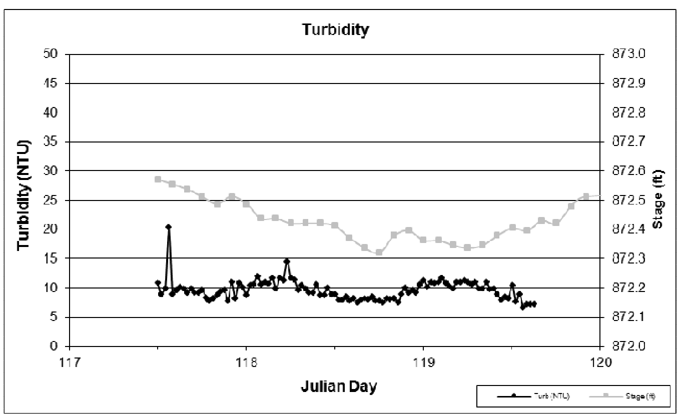
<u>Storm Summary:</u>

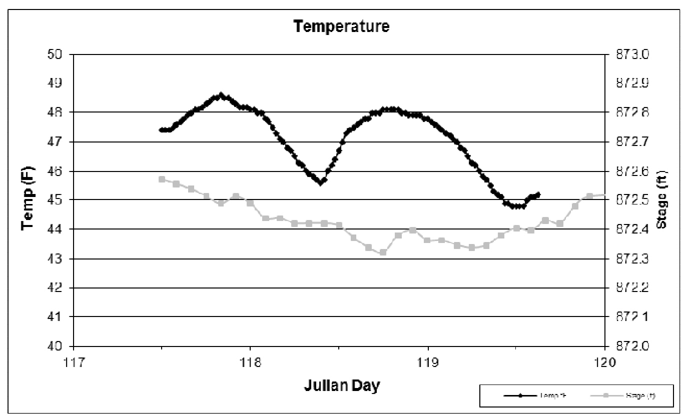
Dates: 26 April 2016 (day 117) to 29 April 2016 (day 120)

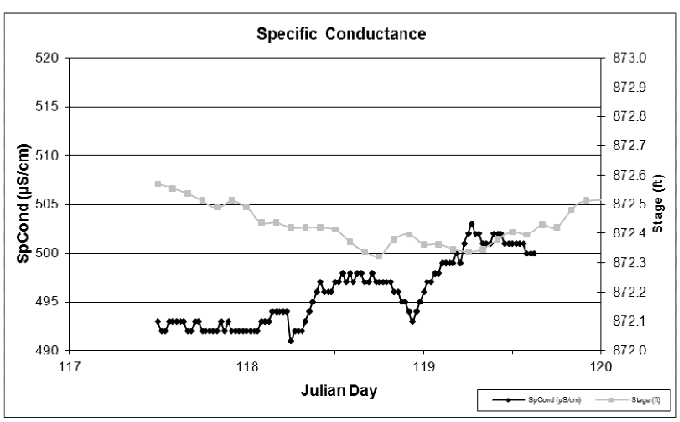
Precipitation: 1.05 inches

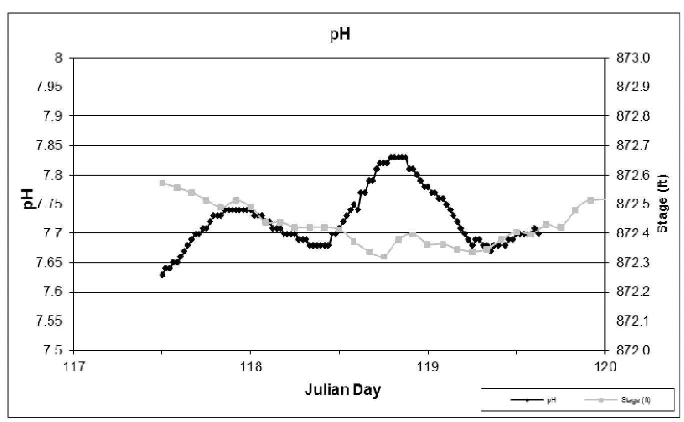






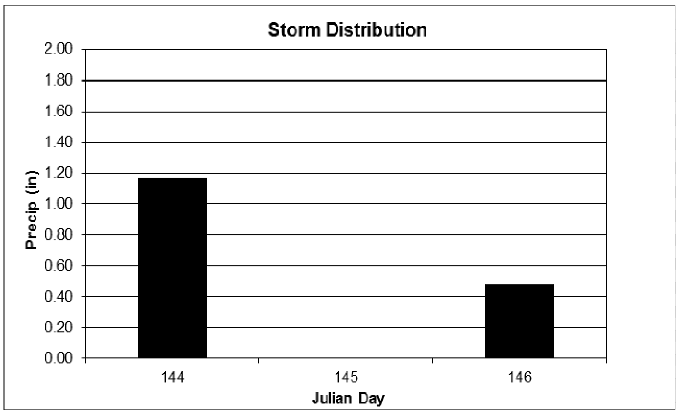


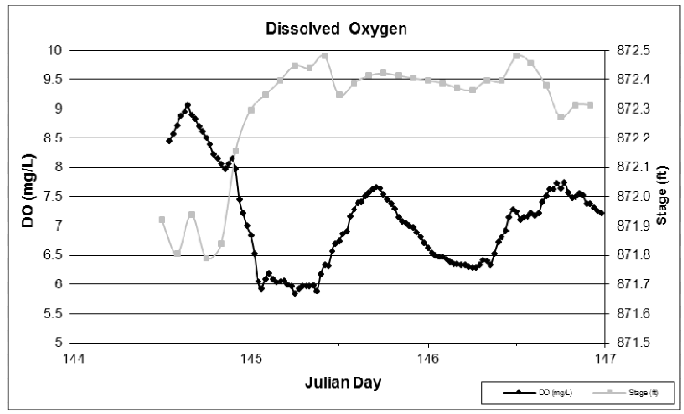


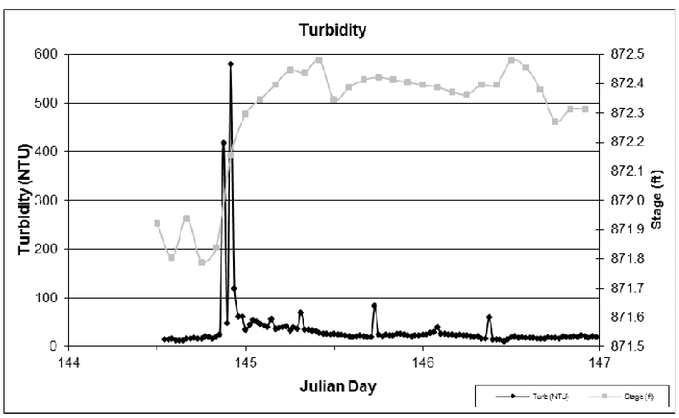


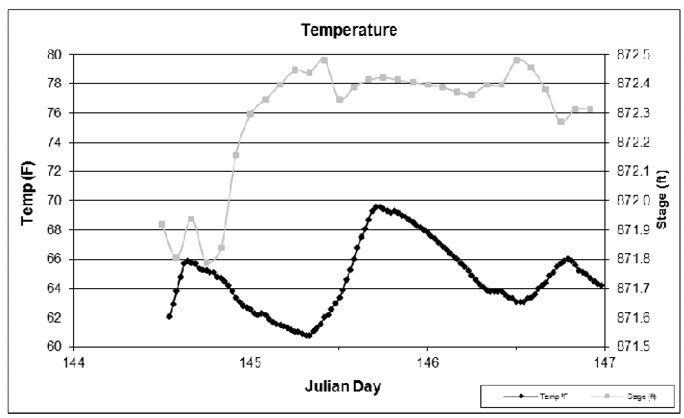
Hydrolab Continuous Monitoring
Storm 3 - 2016

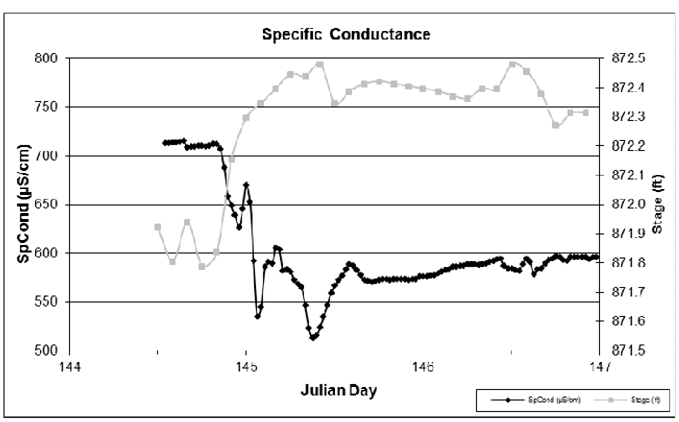
Coon Creek at Prairie Road
Storm Summary:
Dates: 23 May 2016 (day 144) to 25 May 2016 (day 146)
Precipitation: 1.65 inches

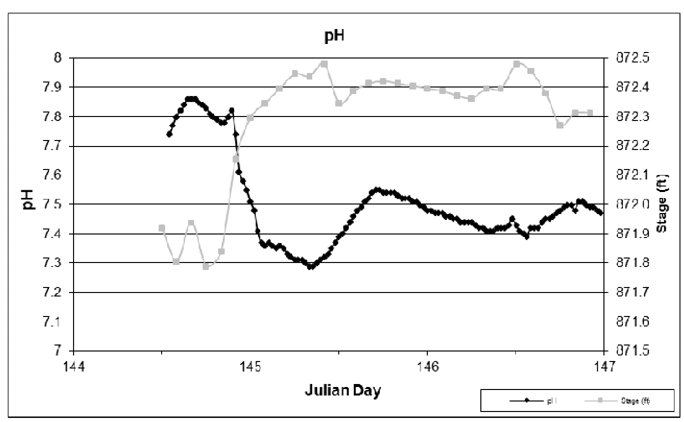












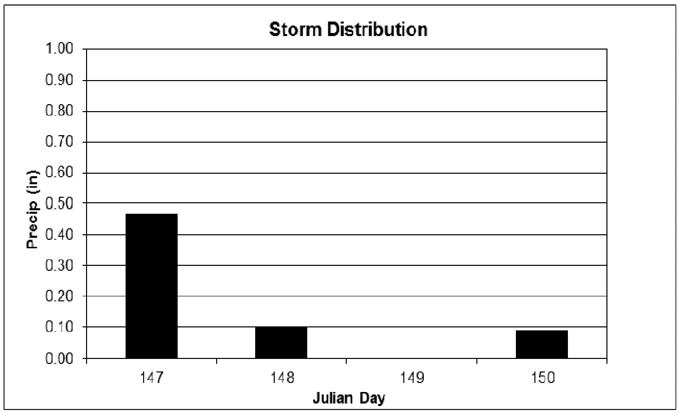
Hydrolab Continuous Monitoring
Storm 4 - 2016

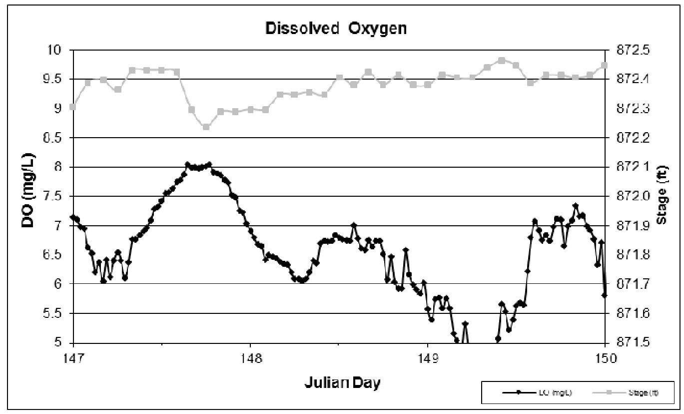
Coon Creek at Prairie Road

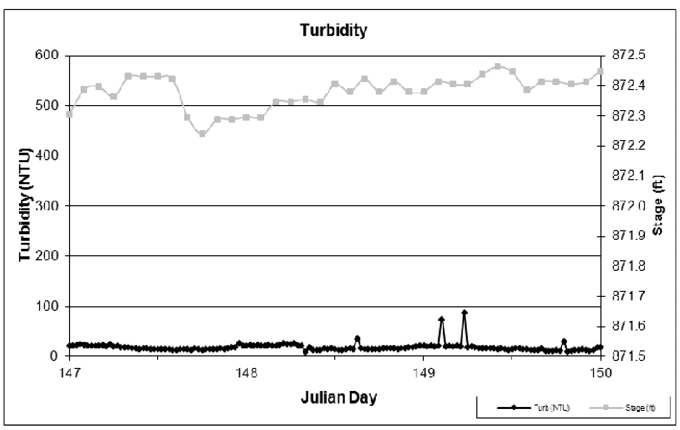
<u>Storm Summary:</u>

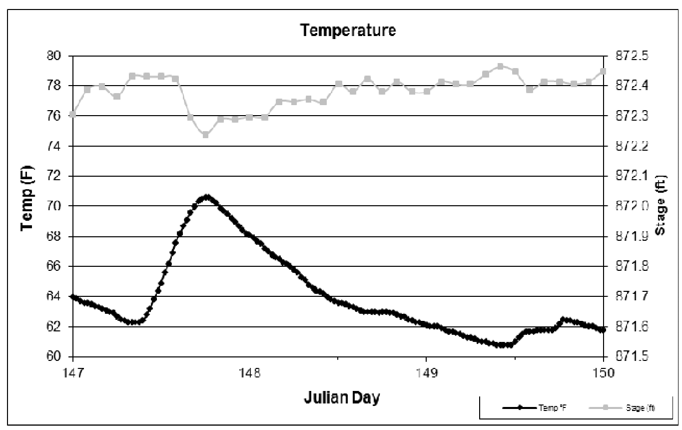
Dates: 26 May 2016 (day 147) to 29 May 2016 (day 150)

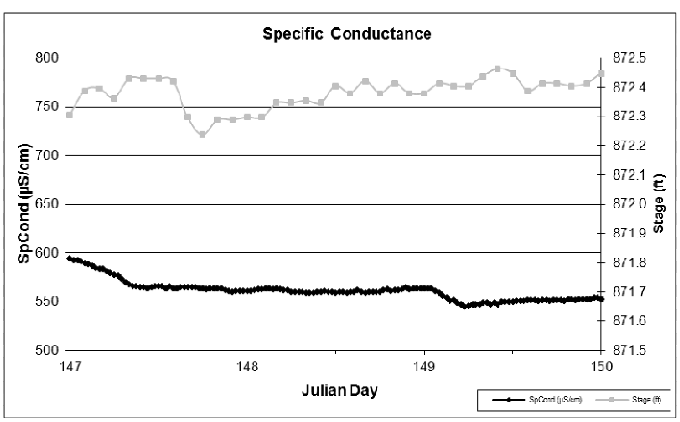
Precipitation: 0.66 inches

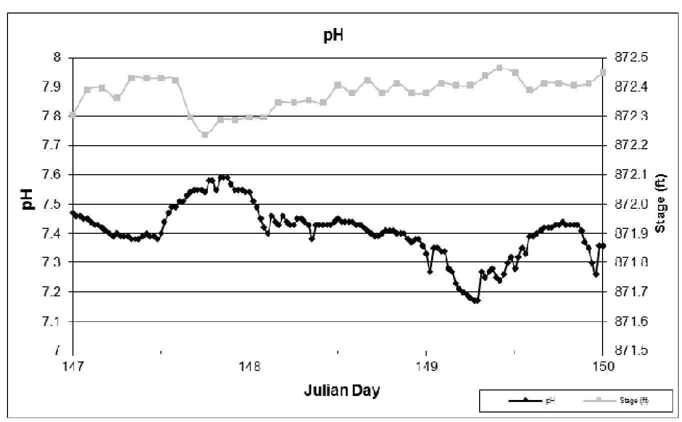






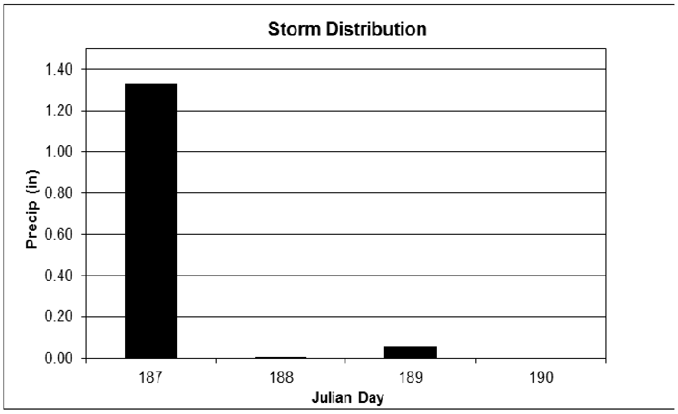


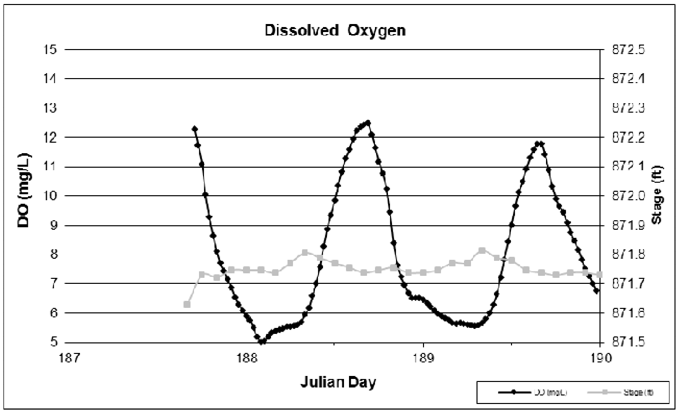


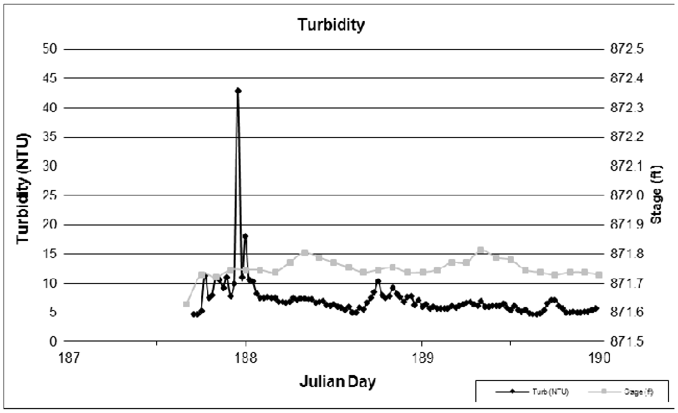


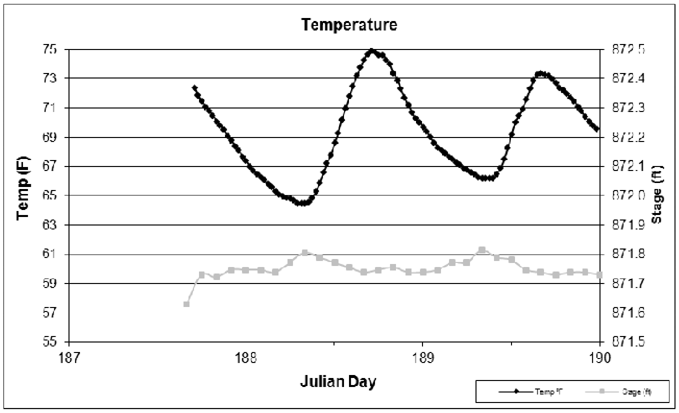
Hydrolab Continuous Monitoring
Storm 5 - 2016

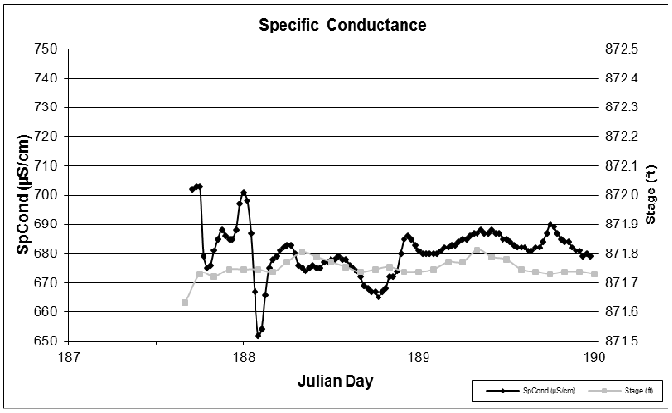
Coon Creek at Prairie Road
<u>Storm Summary:</u>
Dates: 5 July 2016 (day 187) to 7 July 2016 (day 189)
Precipitation: 1.40 inches

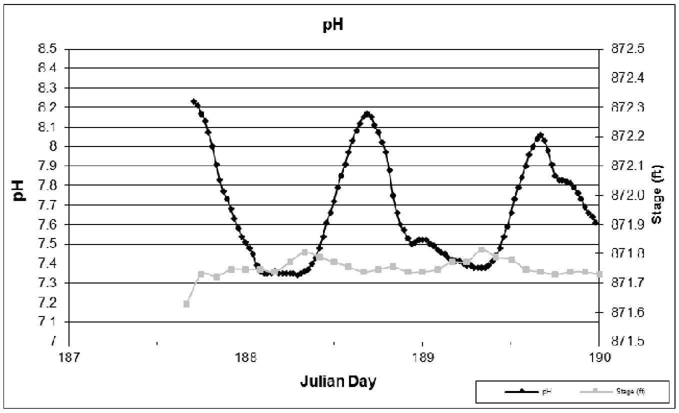






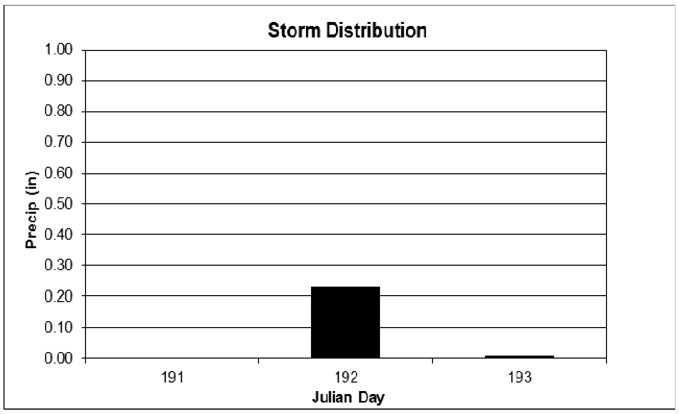


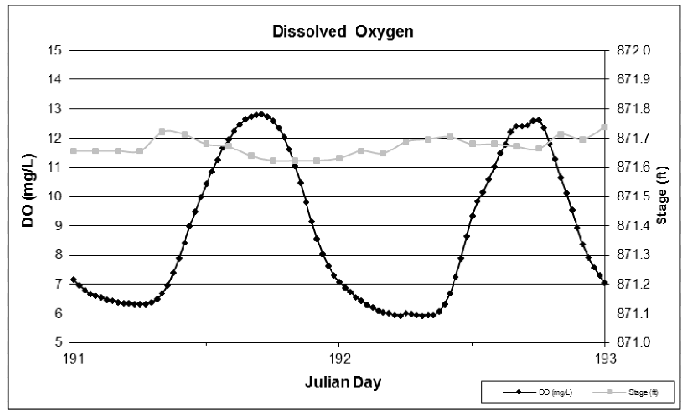


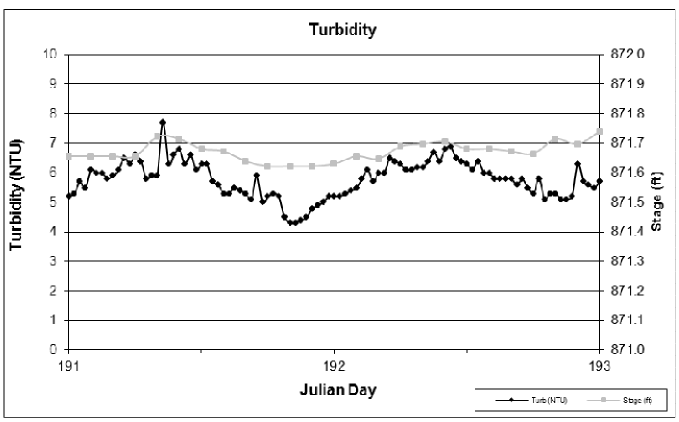


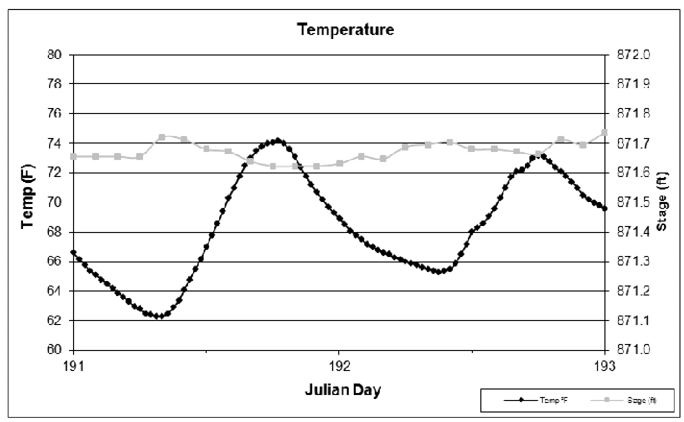
Hydrolab Continuous Monitoring
Storm 6 - 2016

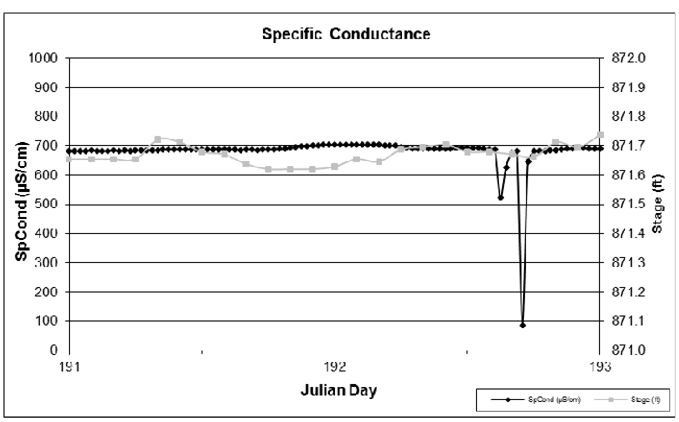
Coon Creek at Prairie Road
<u>Storm Summary:</u>
Dates: 9 July 2016 (day 191) to 10 July 2016 (day 192)
Precipitation: 0.24 inches

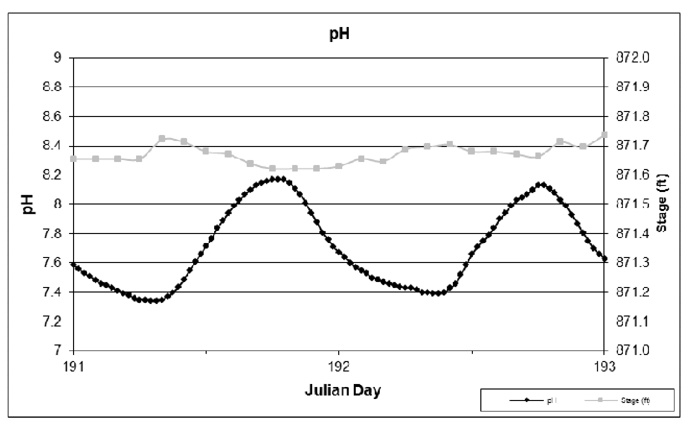






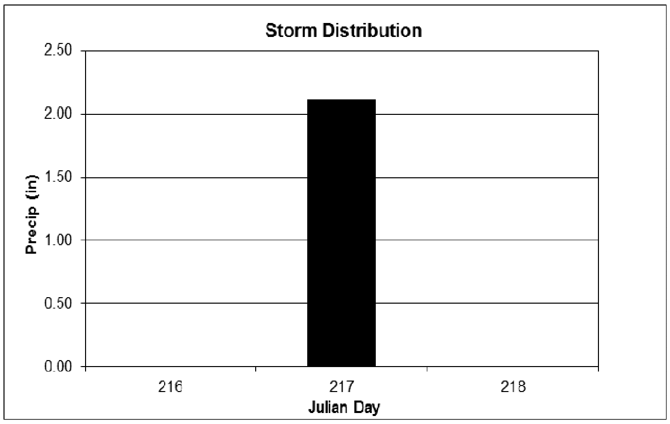


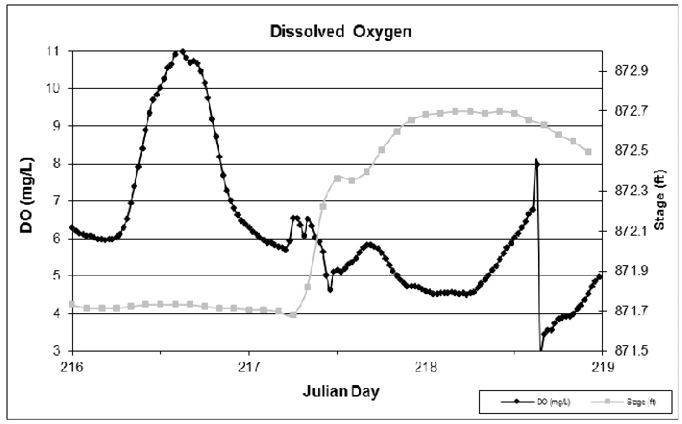


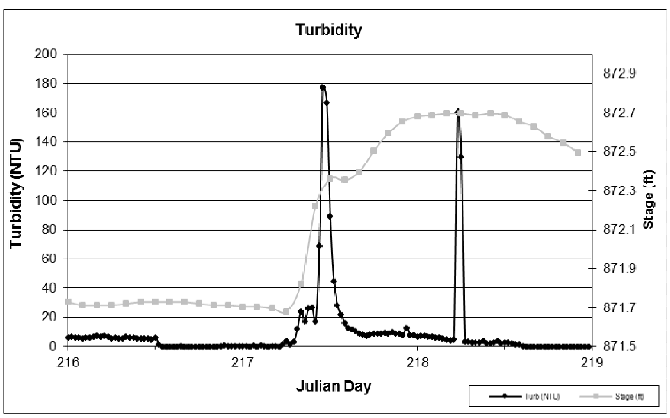


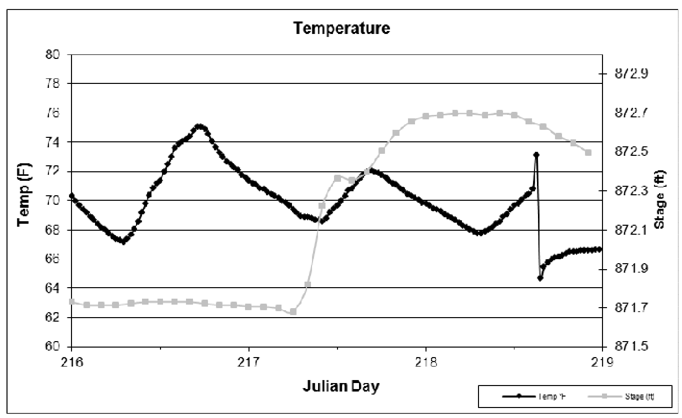
Hydrolab Continuous Monitoring
Storm 7 - 2016

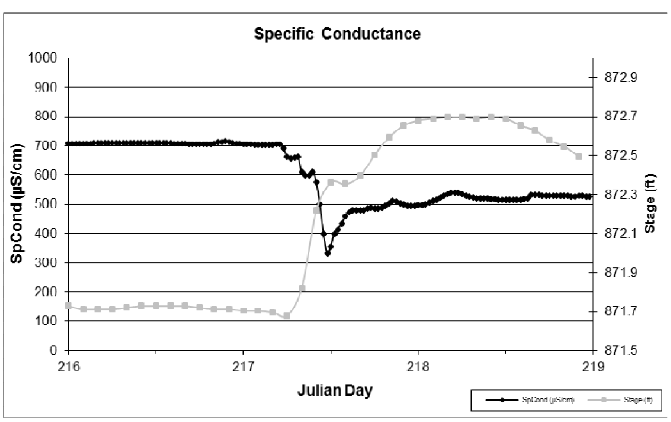
Coon Creek at Prairie Road
<u>Storm Summary:</u>
Dates: 3 August 2016 (day 216) to 5 August 2016 (day 218)
Precipitation: 2.11 inches
*pH sensor malfunction on this deployment

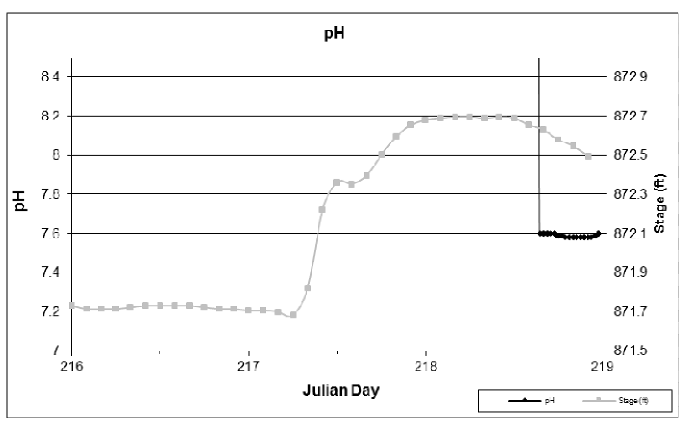












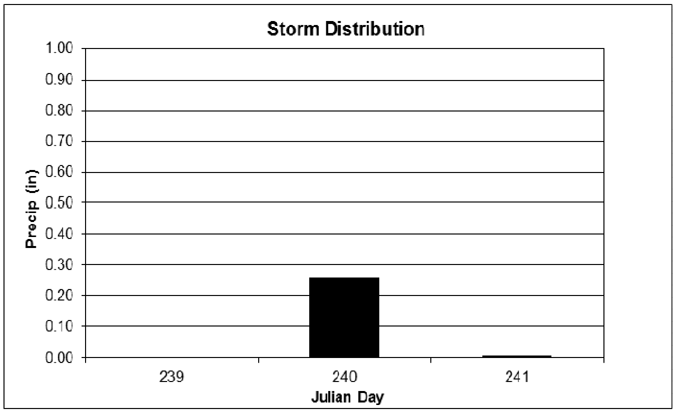
Hydrolab Continuous Monitoring
Storm 8 - 2016

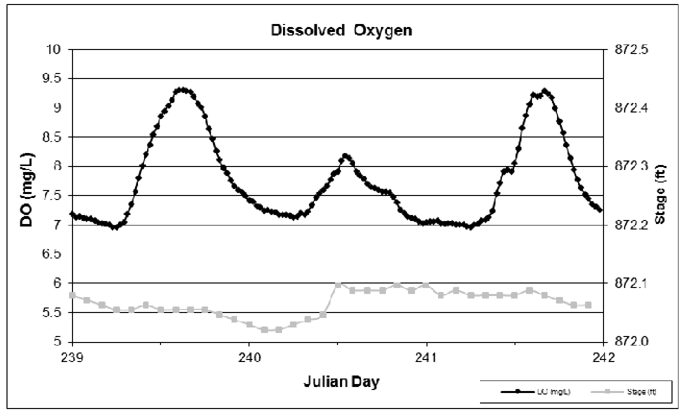
Coon Creek at Prairie Road

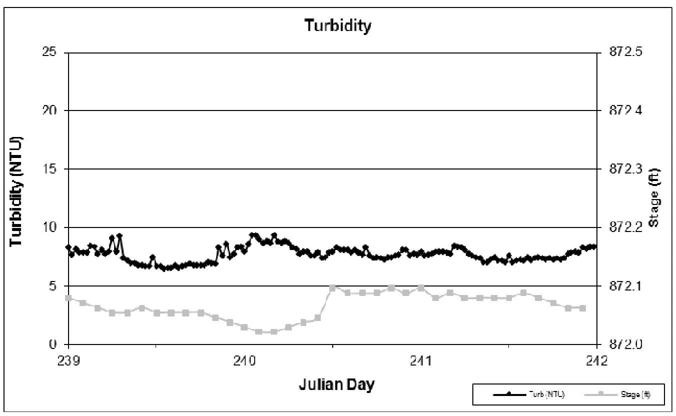
<u>Storm Summary:</u>

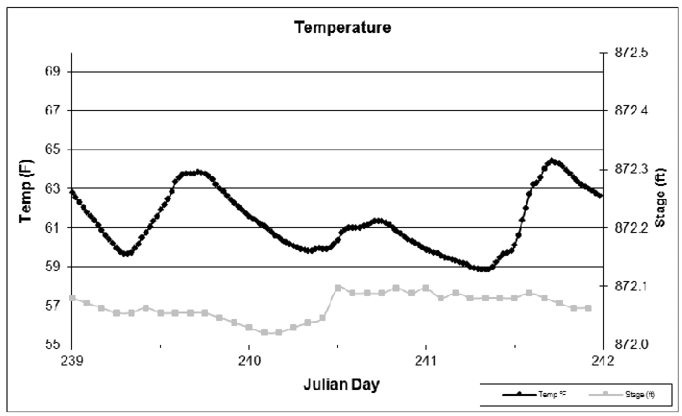
Dates: 26 August 2016 (day 239) to 28 August 2016 (day 241)

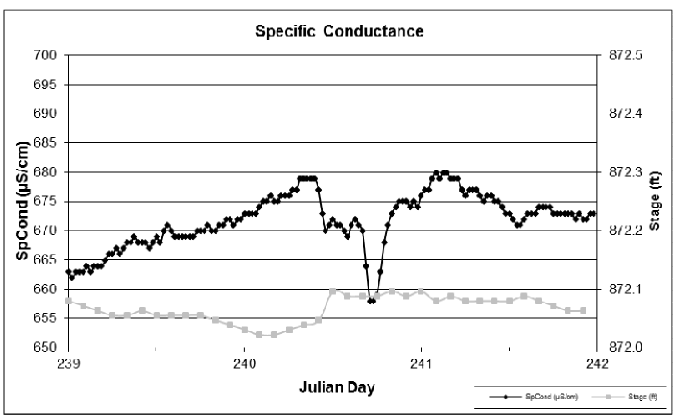
Precipitation: 0.27 inches

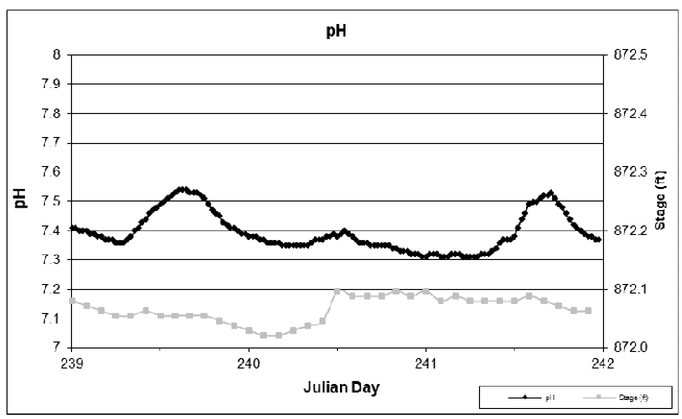












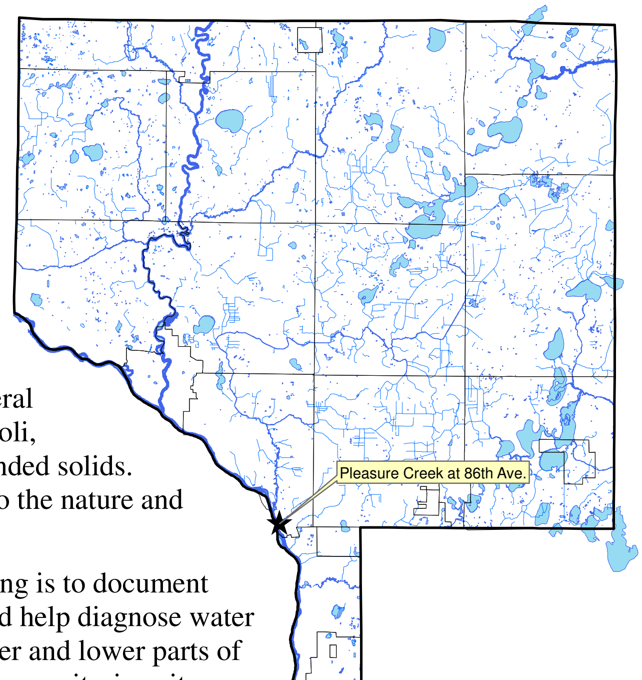
Hydrolab Continuous Stream Water Quality Monitoring

PLEASURE CREEK

Pleasure Creek at 86th, Coon Rapids STORET SiteID = S003-993

Years Monitored

Pleasure Creek at 86th Avenue 2013-2016



Background

Pleasure Creek flows through the southwestern portion of Blaine and southern Coon Rapids. The watershed is entirely urbanized. The creek is about 8-10 feet wide and 0.5 to 1 foot deep during baseflow. It flows through an interconnected network of stormwater ponds in the upper part of the watershed.

Pleasure Creek has been monitored by grab samples during storms and baseflow over the course of several years. Several water quality concerns have been noted, including high E.coli, dissolved pollutants, phosphorus, turbidity, and total suspended solids. Continuous monitoring is needed to gain further insight into the nature and possible corrective actions for problems.

The purpose of hydrolab continuous water quality monitoring is to document water quality changes throughout storm events. This should help diagnose water quality problems and reflect differences in runoff from upper and lower parts of the watershed. Runoff from within the watershed passes the monitoring site quickly following a storm.

Methods

Pleasure Creek at 86th Street was chosen for monitoring because it is the farthest downstream, easily accessible, site on Pleasure Creek. Access might be achieved farther downstream, but backwater influences from the Mississippi River occur during high flow. This site has been used for past monitoring efforts.

Hydrolab MS5 casing (taller) and an RDS continuous water level monitoring device in Pleasure Creek. A staff gauge is shown in the middle.

Pleasure Creek at 86th Street was monitored immediately before, during, and after storms with either a YSI Exo or Hydrolab MS5 water quality sonde. The sonde was suspended inside a PVC pipe by a chain from a locked lid. The PVC pipe was secured to a metal fence post. The sonde sensors protruded from the bottom of the pipe approximately 6-12 inches from the stream bottom, ensuring they would stay submerged even if flow was low. The sonde was programmed to take readings every 30 minutes. Readings included pH, salinity, specific conductance, temperature, dissolved oxygen, and turbidity. The sonde was calibrated before each deployment.

The sonde was deployed into the stream when a storm predicted to drop at least 0.5 inches of rain, and preferably greater, was approaching. In some instances, water level was already high before the storm and remained high after the storm. At other times, predicted rain did not fall and we were monitoring baseflow conditions. In all instances, the Hydrolab was left in the field for several days.

Water levels were continuously monitored throughout the open water season. An RDS Ecotone 40 water level monitoring device recorded water levels every two hours. This stream stage is presented with the water quality data. It would be preferable to present flow, and a rating curve does exist, however during some sampling events water was exceptionally high and exceeded the capacity of the rating curve so that flow could not be accurately calculated. To make graphs from all storms comparable, stage is shown for all.

Precipitation data are provided with the water quality results. These data were taken from the datalogging rain gauge at Springbrook Nature Center or Coon Rapids City Hall, which are approximately 2 miles and 4 miles respectively from the stream monitoring site. In our analysis we also looked at precipitation totals in other portions of the watershed and noted any large differences.

Results and Discussion

A variety of storm sizes were analyzed. Rainfall during the monitored time periods ranged from 0.20 to 1.95 inches. This wide distribution is helpful in discerning the creek's response to different events.

The discussion below incorporates results from 2016 monitoring. 2013 was the first season of continuous storm monitoring on Pleasure Creek.

On the following pages results from each storm monitored are shown. The graphs show precipitation and the stream hydrograph approximately one day before and after water quality monitoring began. Separate graphs show each water quality parameter. The text below discusses summarizes findings across all storms for each parameter.

Turbidity

- For most storms there is a brief, large turbidity spike during or immediately following rainfall. For smaller rain events the change in stream turbidity was minimal or not noticeable. For larger storms turbidity immediately rose sharply though stream water levels changed only modestly. Turbidity typically retreated to lower levels within hours. This suggests that most of this turbidity is coming from the lower watershed. The upper watershed is treated by large regional ponds.
- Brief but intense storms cause dramatic increases in turbidity from single digits to 1000+ NTU.
- There is substantial variability among storms. Storms with similar rainfall totals may produce dramatically different turbidity in the creek. Intervening factors include storm intensity, whether snowmelt is occurring synchronously, and the amount of time since the last runoff event.

Specific Conductance

- Specific conductance, a measure of dissolved pollutants, is inversely related to water level. When creek water rises, conductance drops. During brief, intense rainfall the stream conductance drops sharply. The shallow groundwater that feeds the stream during baseflow has higher conductance than stormwater runoff, and storm runoff dilutes it. Infiltration of road deicing salts are a likely source of high conductance in stream baseflow year round.

Dissolved Oxygen

- The observed dissolved oxygen concentrations in Pleasure Creek stayed mostly within the healthy, desirable range.
- Dissolved oxygen stayed above 5 mg/L, the state water quality standard, in all but one event monitored. Below this level some aquatic life begins to suffer.
- When stream levels rise, dissolved oxygen often drops, but typically not to critically low levels.

Temperature

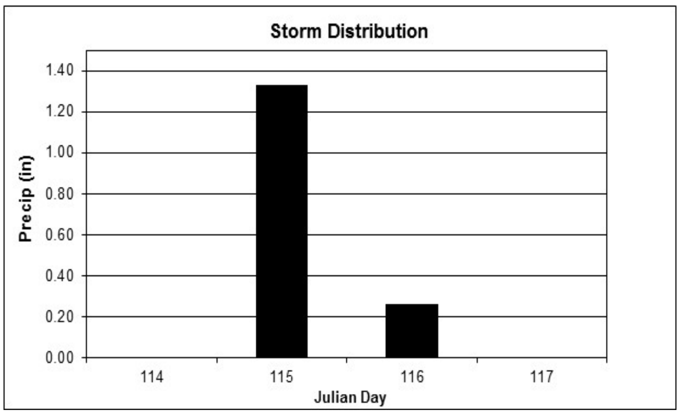
- Water temperature is generally not considered a concern in Pleasure Creek because there are no trout or other temperature sensitive resources.
- Cycles of day warming and night cooling are apparent in the data.

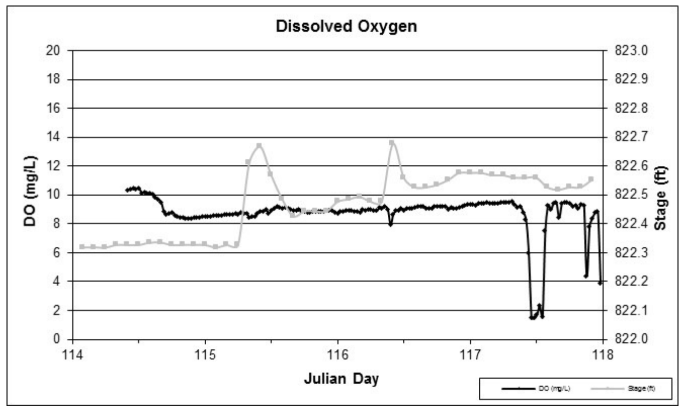
pH

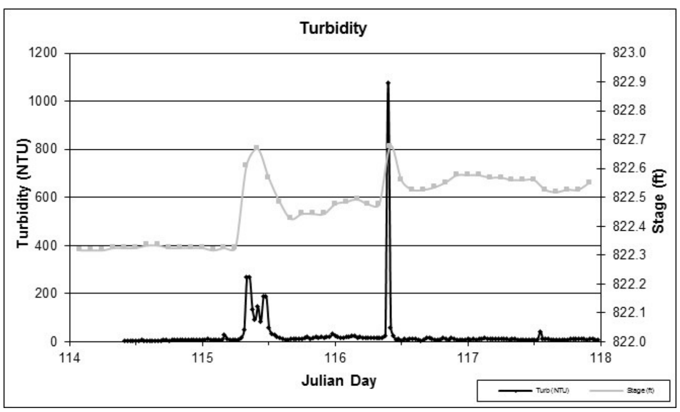
- pH is inversely related to water level in Pleasure Creek. When water level rises, pH declines. This is because rainwater has a lower pH than that of local shallow groundwater.
- pH remain within the desired range of 6.5 to 8.5 that is specified in state water quality standards.

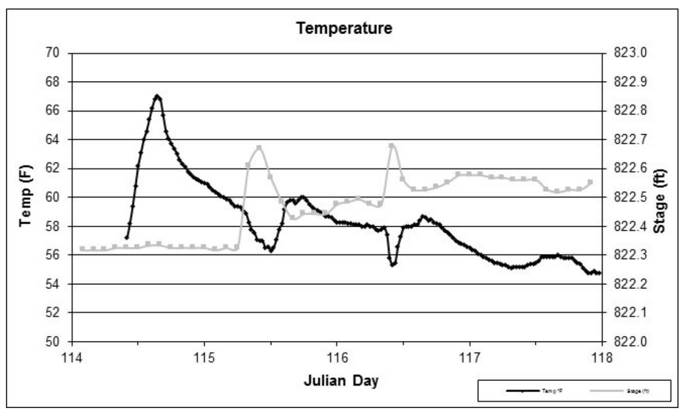
Hydrolab Continuous Monitoring
Storm 1 - 2016

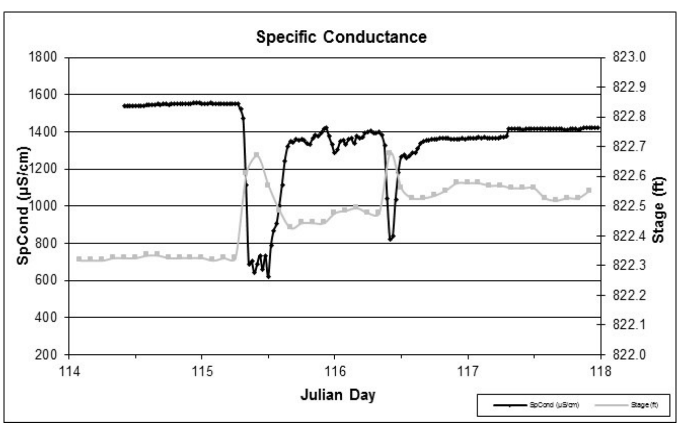
Pleasure Creek at 86th Ave
Storm Summary:
Dates: 23 April 2016 (day 114) to 26 April 2016 (day 117)
Precipitation: 1.59 inches

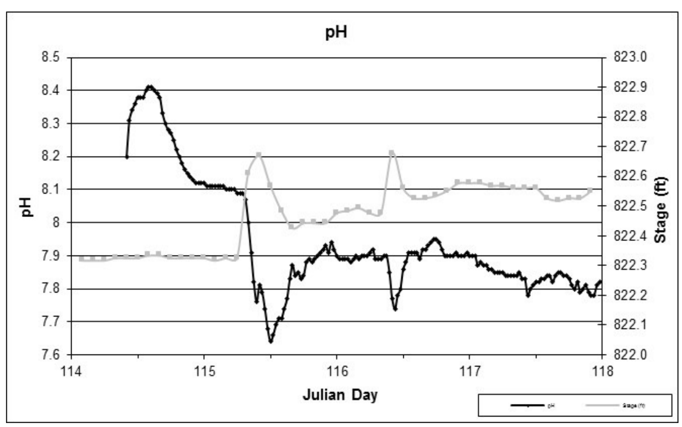






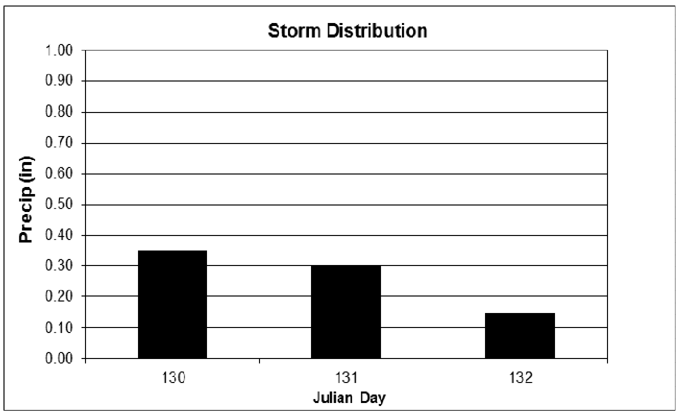


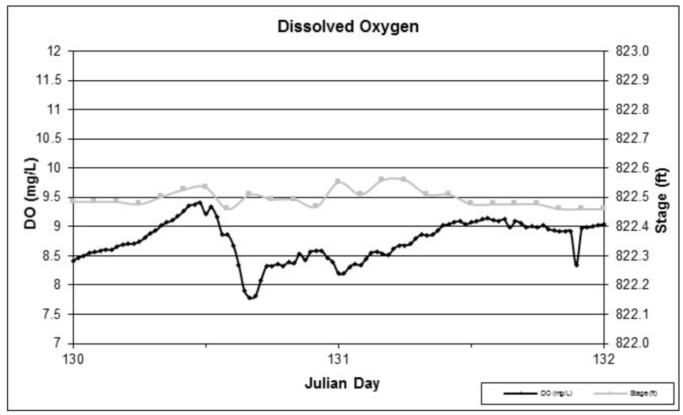


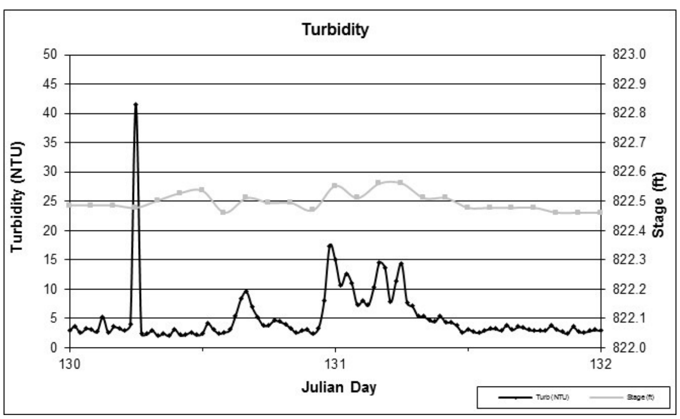


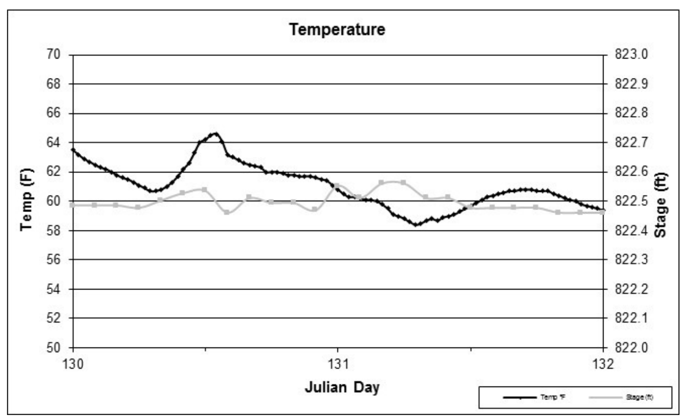
Hydrolab Continuous Monitoring
Storm 2 - 2016

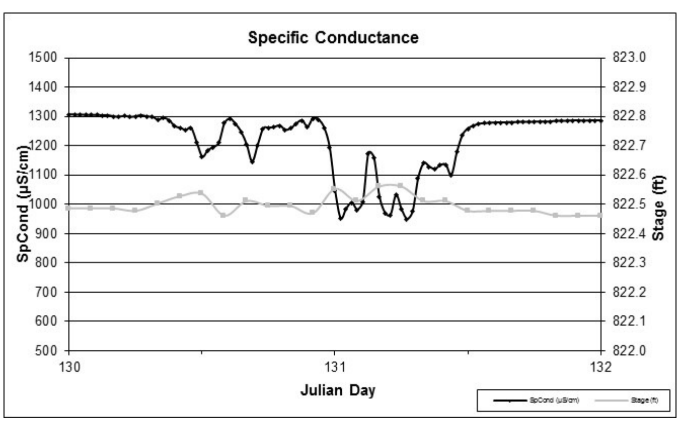
Pleasure Creek at 86th Ave
Storm Summary:
Dates: 9 May 2016 (day 130) to 11 May 2016 (day 132)
Precipitation: 0.80 inches

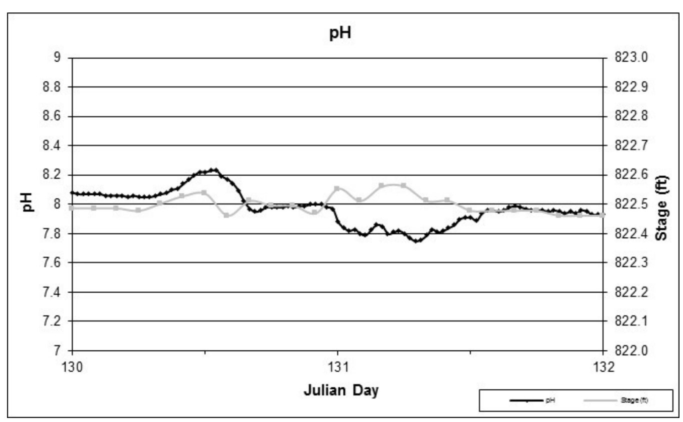






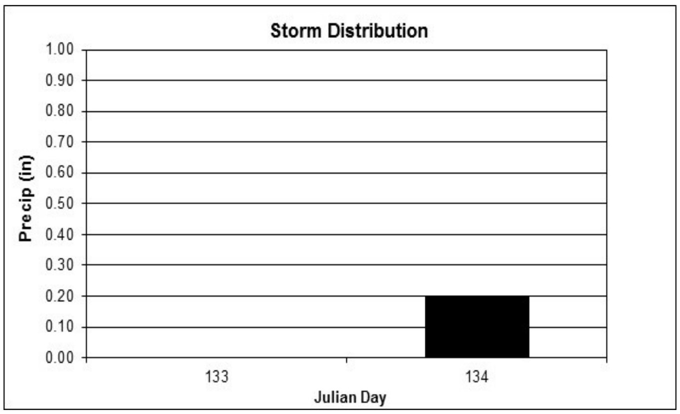


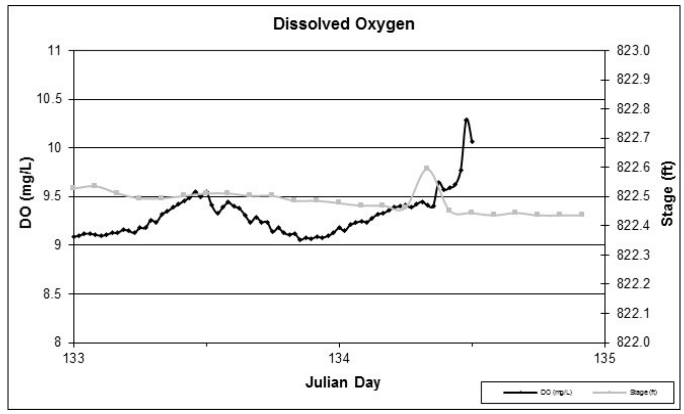


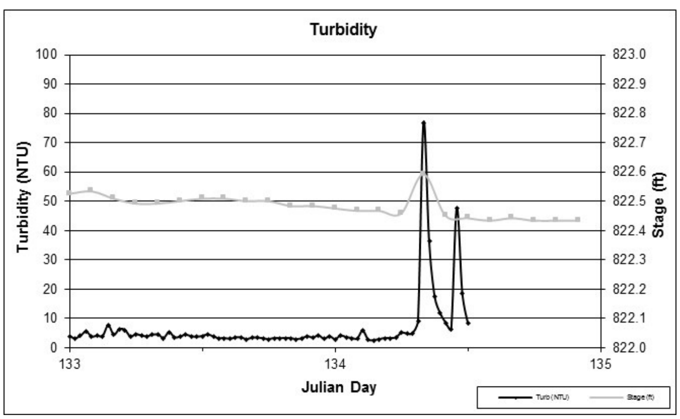


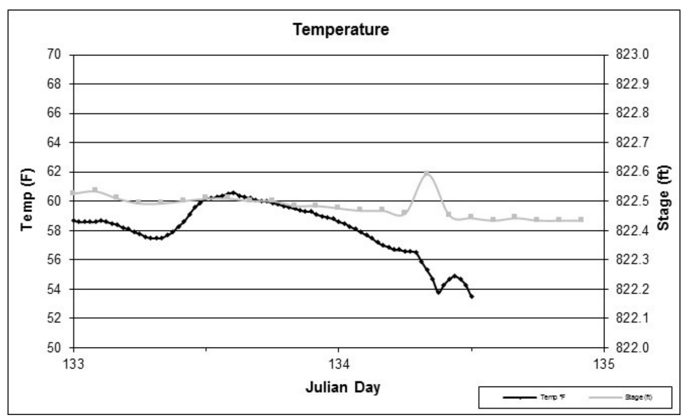
Hydrolab Continuous Monitoring
Storm 3 - 2016

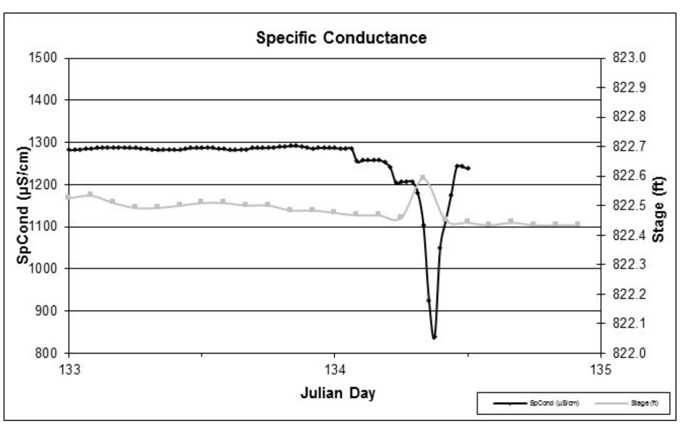
Pleasure Creek at 86th Ave
<u>Storm Summary:</u>
Dates: 12 May 2016 (day 133) to 13 May 2016 (day 134)
Precipitation: 0.20 inches

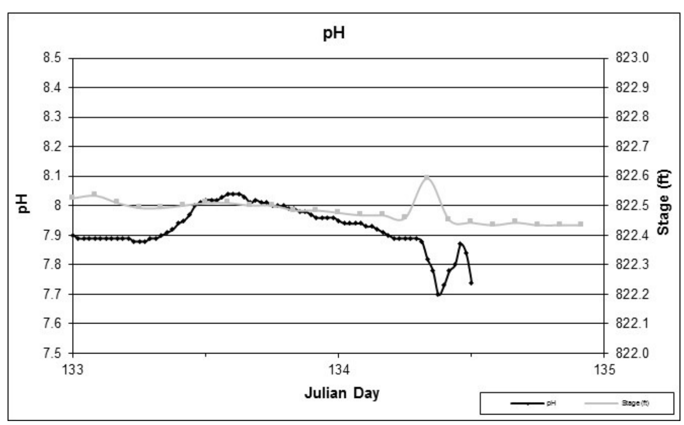






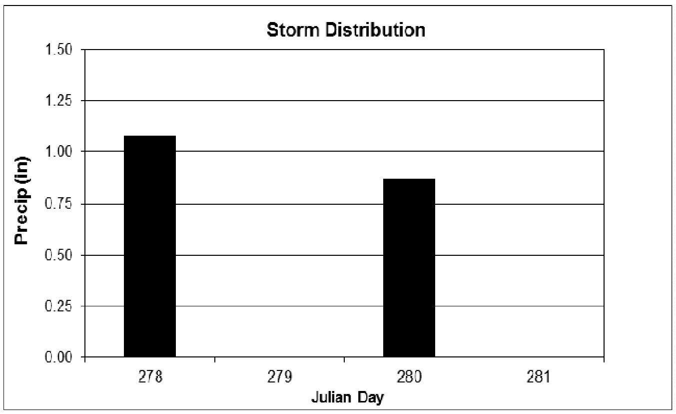


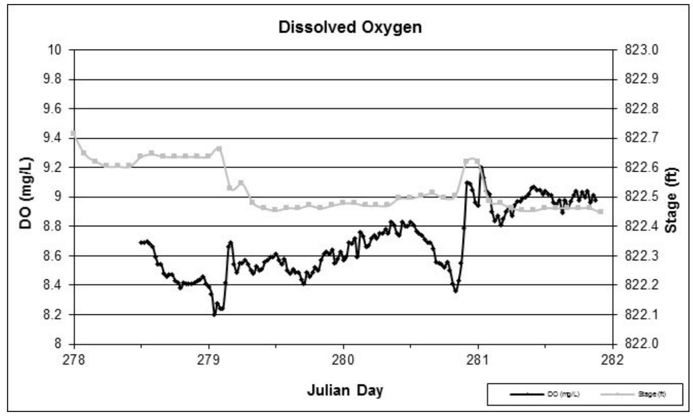


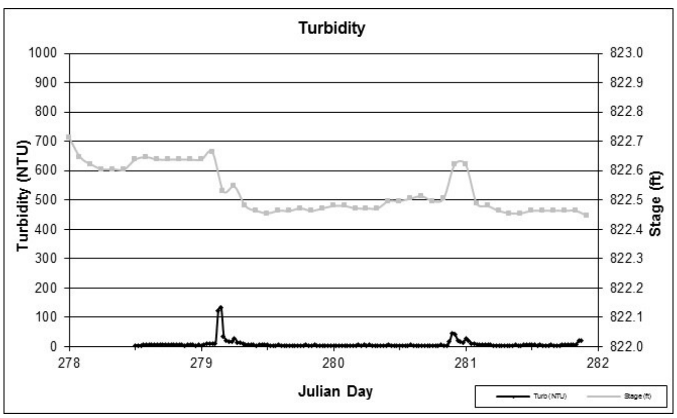


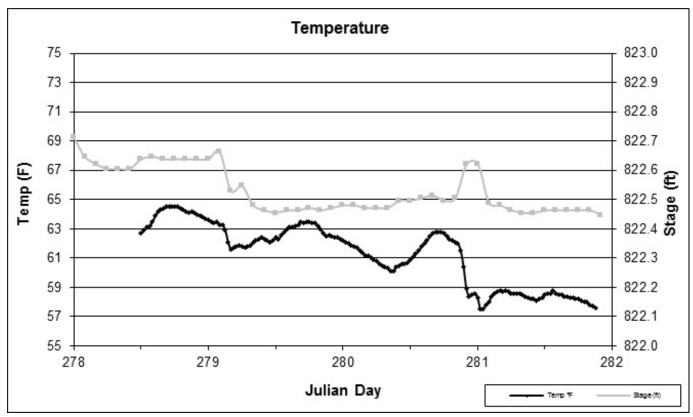
Hydrolab Continuous Monitoring
Storm 4 - 2016

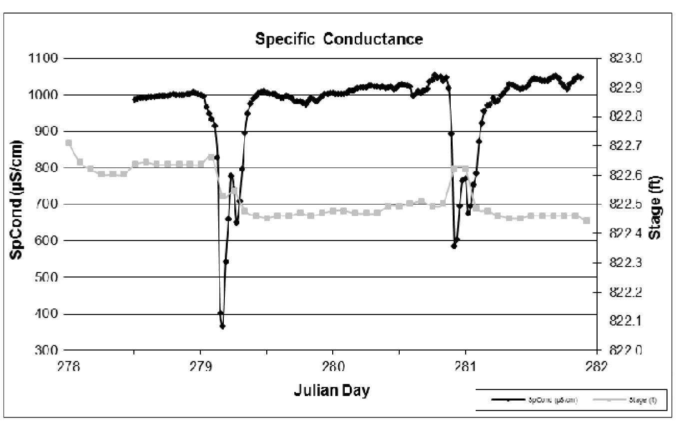
Pleasure Creek at 86th Ave
Storm Summary:
Dates: 4 October 2016 (day 278) to 7 October 2016 (day 281)
Precipitation: 1.95 inches

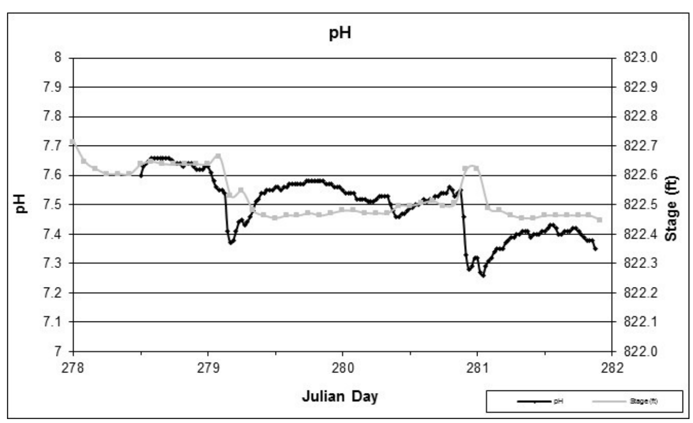












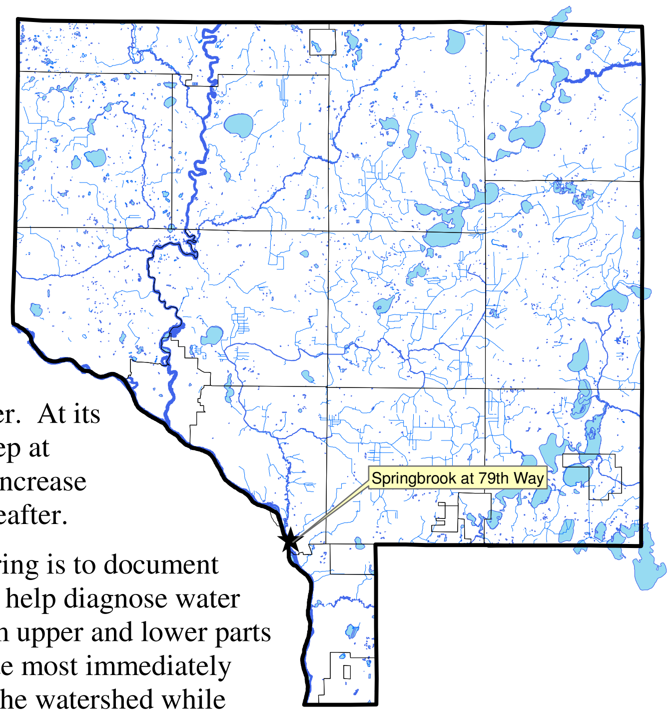
Hydrolab Continuous Stream Water Quality Monitoring

SPRINGBROOK

Springbrook at 79th, Coon Rapids   STORET SiteID = S003-993

Years Monitored

Springbrook at 79th Way   2013-2016



Background

Springbrook is a small waterway draining an urbanized and highly modified subwatershed. The watershed includes portions of the cities of Blaine, Coon Rapids, Spring Lake Park and Fridley. Several tributaries, or stormwater systems contributing to the creek, join at the Springbrook Nature Center Impoundment. From the outlet of the Nature Center, the Creek flows a short distance to the Mississippi River. At its outlet, Springbrook is about 10 feet wide and 1 foot deep at baseflow. The stream is flashy, with water levels that increase dramatically following rainfall and quickly recede thereafter.

The purpose of continuous storm water quality monitoring is to document water quality changes throughout a storm. This should help diagnose water quality problems and analyze differences in runoff from upper and lower parts of the watershed. Runoff that passes the monitoring site most immediately following a storm is from the lower, urbanized part of the watershed while later runoff is mostly from upper portions of the watershed.

Methods

Springbrook at 79th Way was chosen for monitoring because it is the farthest downstream, easily accessible site on Springbrook Creek. This site can occasionally become compromised due to backwater influences from the Mississippi River during high flow. This site has been used for past monitoring efforts.

Springbrook at 79th Way was monitored immediately before, during, and after storms with either a YSI Exo or Hydrolab MS5 water quality sonde. The sonde was suspended inside a PVC pipe by a chain from a locked lid. The PVC pipe was secured to a metal fence post. The sonde sensors protruded from the bottom of the pipe approximately 6-12 inches from the stream bottom, ensuring they would stay submerged even if flow was low. The sonde was programmed to take readings every 30 minutes. Readings included pH, salinity, specific conductance, temperature, dissolved oxygen, and turbidity. The sonde was calibrated before each deployment.

Hydrolab MS5 casing (taller) and an RDS continuous water level monitoring device at Springbrook Creek.

The sonde was deployed into the stream when a storm predicted to drop at least 0.5 inches of rain, and preferably greater, was approaching. In some instances, water level was already high before the storm and remained high after the storm. At other times, predicted rain did not fall and we were monitoring baseflow conditions. In all instances, the Hydrolab was left in the field for several days.

Water levels were continuously monitored throughout the open water season. An RDS Ecotone-40 water level monitoring device recorded water levels every two hours. This stream stage is presented with the water quality data. It would be preferable to present flow, though a rating curve does not currently exist. To make graphs from all storms comparable, stage is shown for all.

Precipitation data are provided with the water quality results. These data were taken from the datalogging rain gauge at the Springbrook Nature Center or Coon Rapids City Hall, which are approximately 2 miles and 4 miles respectively from the stream monitoring site. In our analysis we also looked at precipitation totals in other portions of the watershed and noted any large differences.

Results and Discussion

A variety of storm sizes were analyzed. Rainfall during the monitored time periods ranged from 0.20 to 3.07 inches. The wide distribution is helpful in discerning the creek's response to different events.

The discussion below incorporates results from 2016 continuous storm monitoring. 2013 was the first season of continuous storm monitoring on Springbrook Creek.

On the following pages results from each storm monitored are shown. The graphs show precipitation and the stream hydrograph approximately one day before and after water quality monitoring began. Separate graphs show each water quality parameter. The text below discusses summarizes findings across all storms for each parameter.

<u>Turbidity</u>

- For most storms there is a brief, large turbidity spike during or immediately following rainfall. Even during smaller storms turbidity immediately rose sharply though stream water levels changed only modestly. Turbidity typically retreated to lower levels within hour. This suggests that most of this turbidity is coming from the lower watershed. The upper watershed is treated by large regional ponds.
- Brief but intense storms cause dramatic increases in turbidity from single digits to up to 1,800 NTU.
- There is substantial variability among storms. Storms with similar rainfall totals may produce dramatically different turbidity in the creek. Intervening factors include storm intensity, whether snowmelt is occurring synchronously, and the amount of time since the last wash off event.

<u>Specific Conductance</u>

- Specific conductance, a measure of dissolved pollutants, is inversely related to water level. When creek water rises, conductance drops. During brief, intense rainfall the stream conductance drops sharply. The shallow groundwater that feeds the stream during baseflow has higher conductance than stormwater runoff, and storm runoff dilutes it. Infiltration of road deicing salts are a likely source of high conductance in stream baseflow year round.

<u>Dissolved Oxygen</u>

- The observed dissolved concentrations in Springbrook generally stayed within the healthy, desirable range.
- Dissolved oxygen stayed above 5 mg/L, the state water quality standard, in all events monitored except for one very brief drop on July 22, only lasting for one measurement. Below this level aquatic life begins to suffer.
- When stream levels rise, dissolved oxygen often drops to lower levels.

Temperature

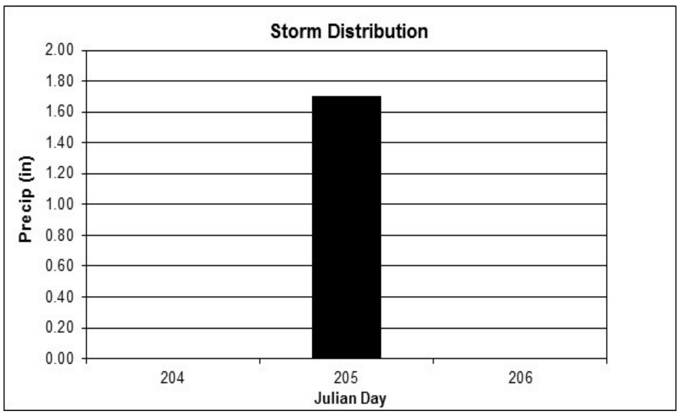
- Water temperature is generally not considered a concern in Springbrook Creek because there is no trout or other temperature sensitive resource.
- Cycles of day warming and night cooling are apparent in the data.

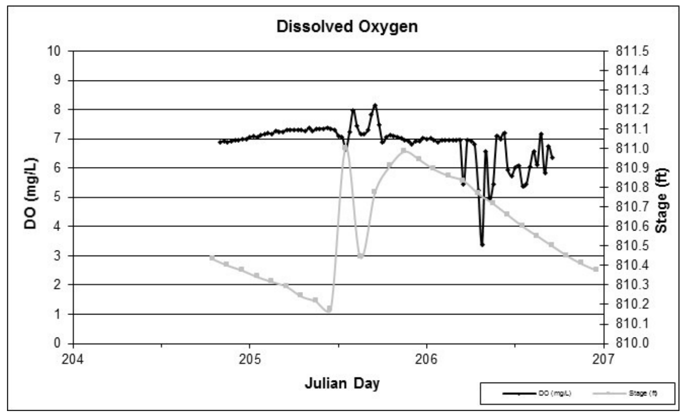
pH

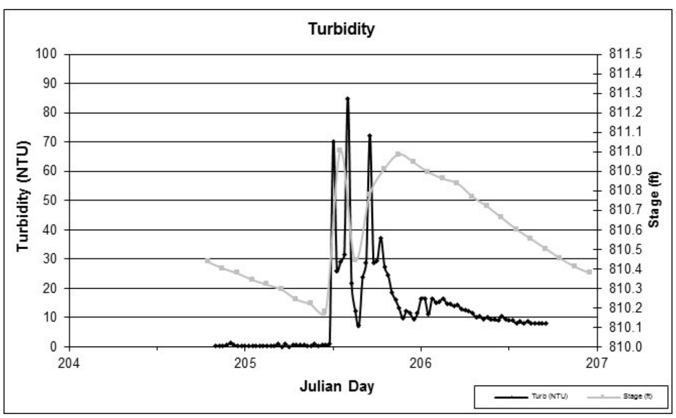
- pH is inversely related to water level in Springbrook Creek. When water level rises, pH declines. This is because rainwater has a lower pH than that of local shallow groundwater.
- pH remained within the desired range of 6.5 to 8.5 that is specified in state water quality standards.

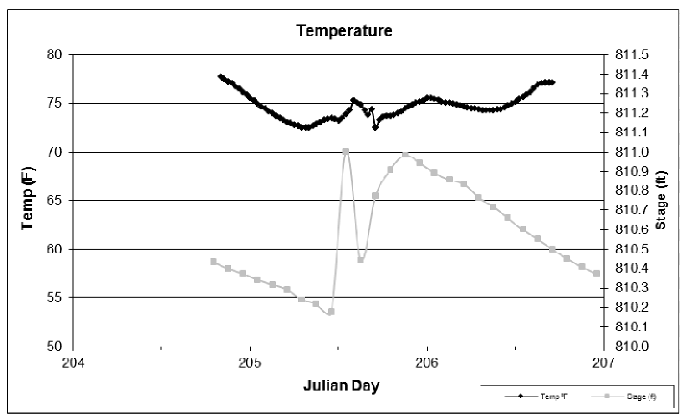
Hydrolab Continuous Monitoring
Storm 1 - 2016

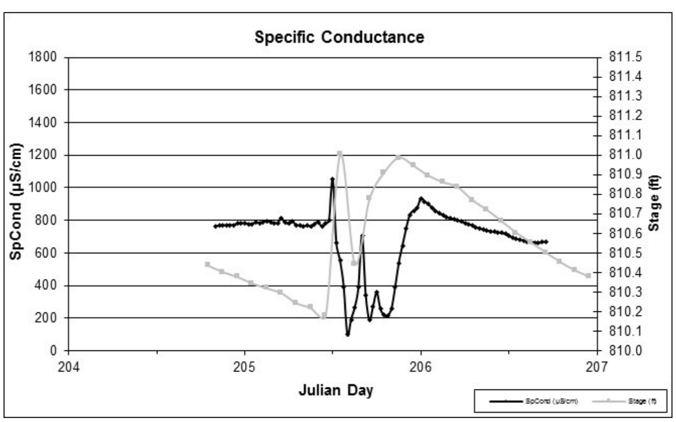
Springbrook at 79th Way
<u>Storm Summary:</u>
Dates: 22 July 2016 (day 204) to 24 July 2016 (day 206)
Precipitation: 1.70 inches

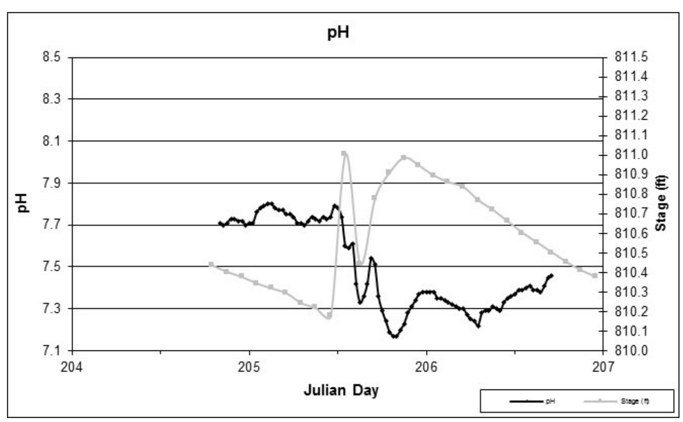












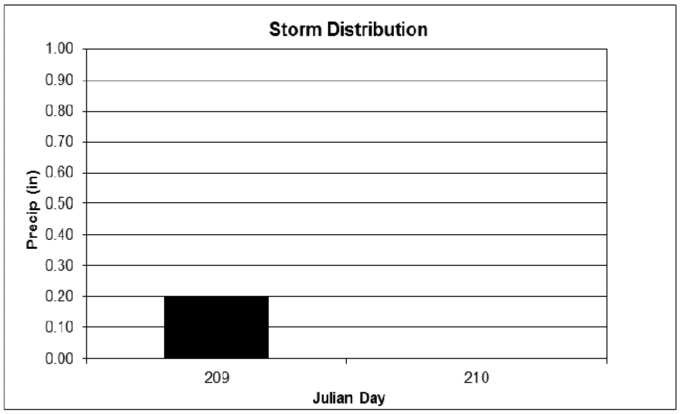
Hydrolab Continuous Monitoring
Storm 2 - 2016

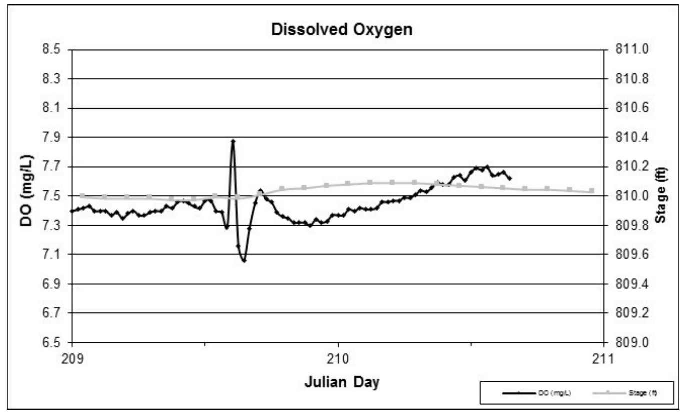
Springbrook at 79th Way

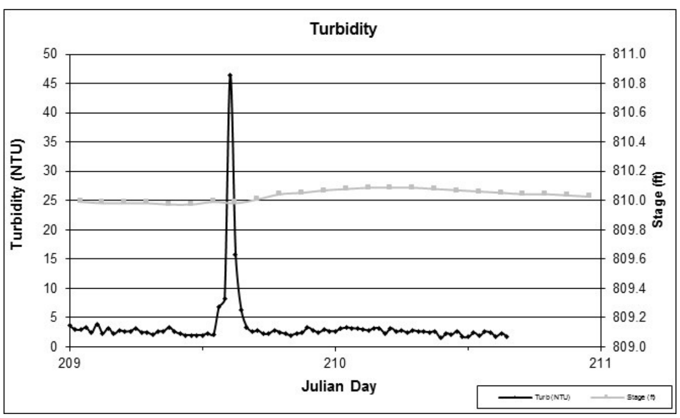
<u>Storm Summary:</u>

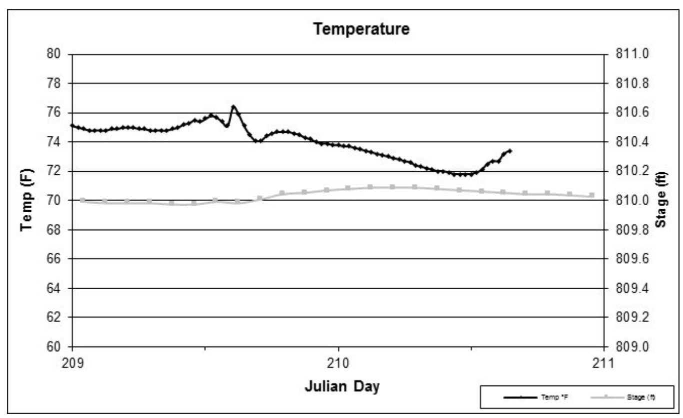
Dates: 27 July 2016 (day 209) to 28 July 2016 (day 210)

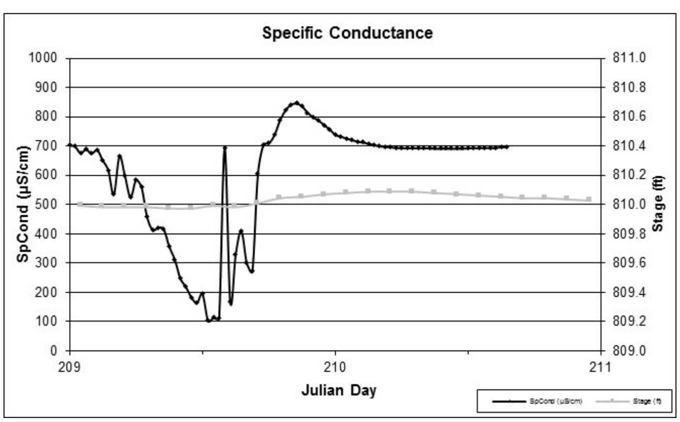
Precipitation: 0.20 inches

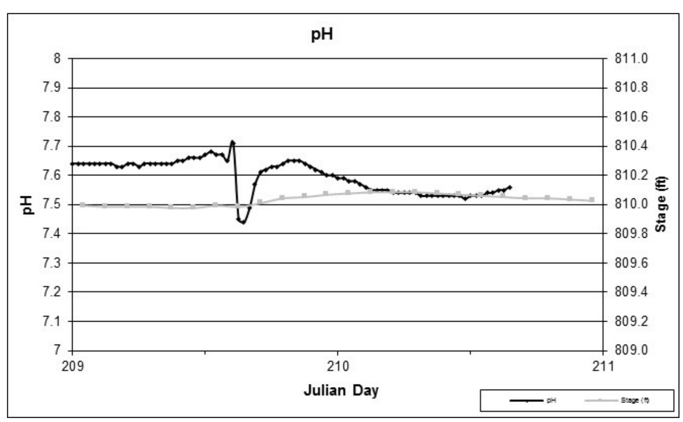












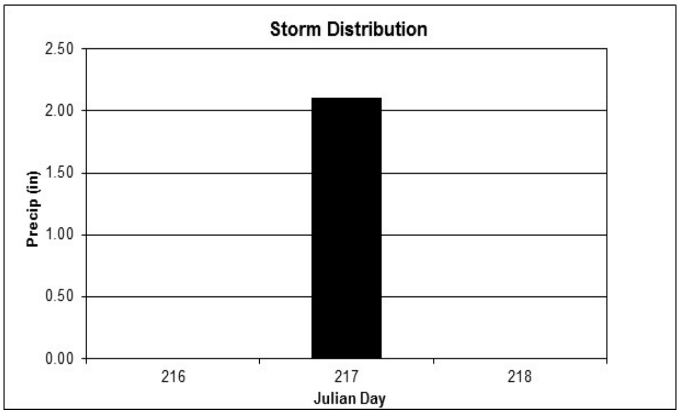
Hydrolab Continuous Monitoring
Storm 3 - 2016

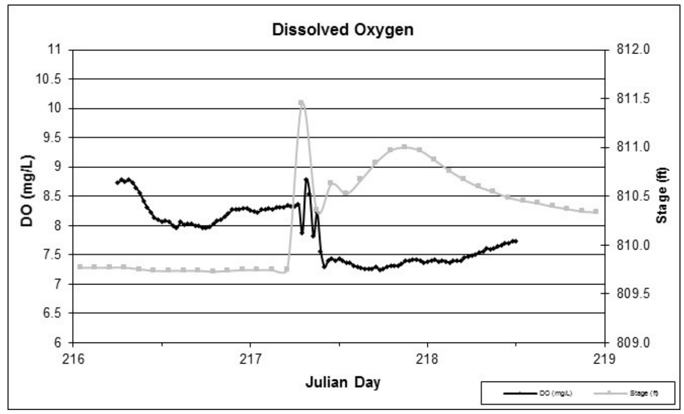
Springbrook at 79th Way

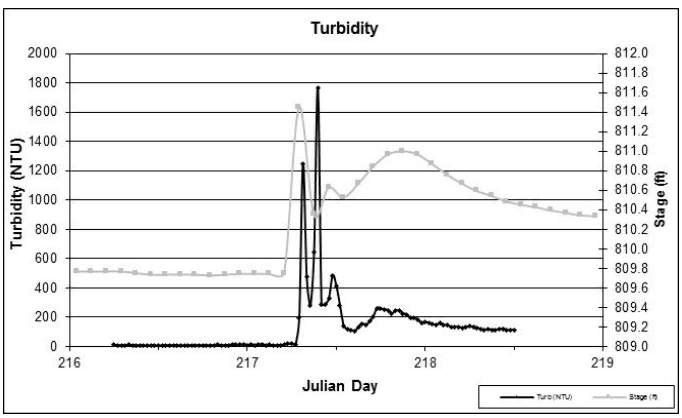
<u>Storm Summary:</u>

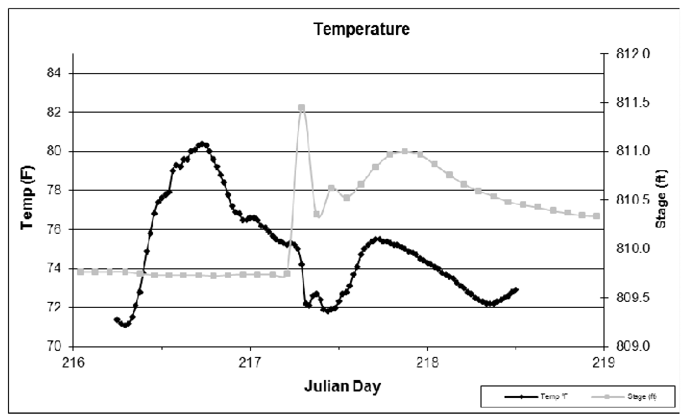
Dates: 3 August 2016 (day 216) to 5 August 2016 (day 218)

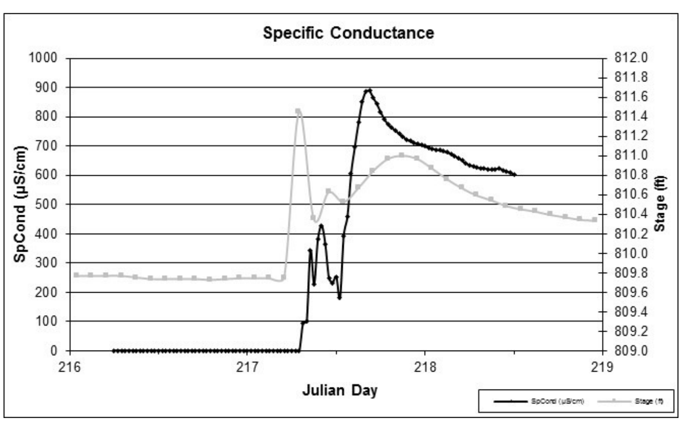
Precipitation: 2.11 inches

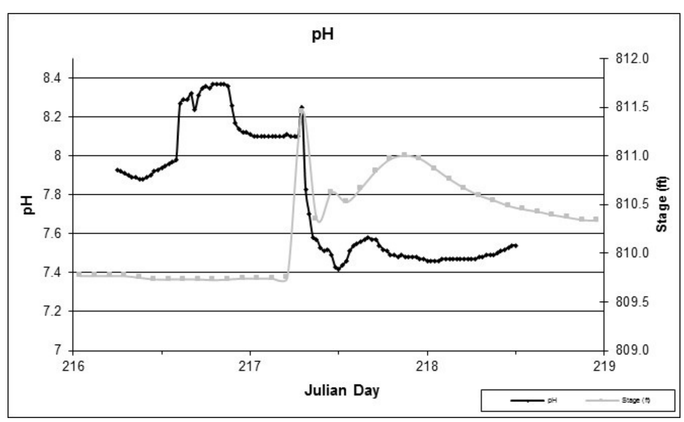






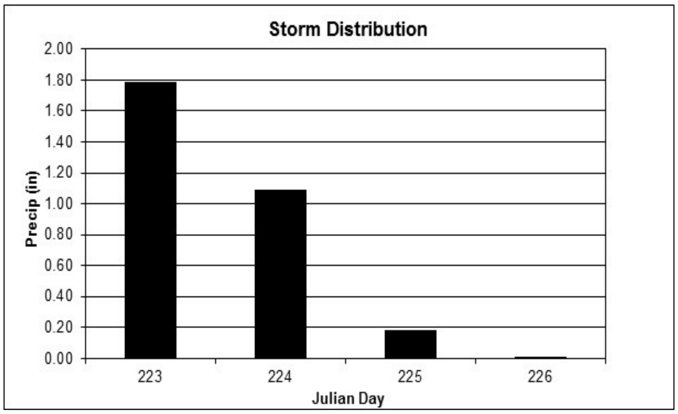


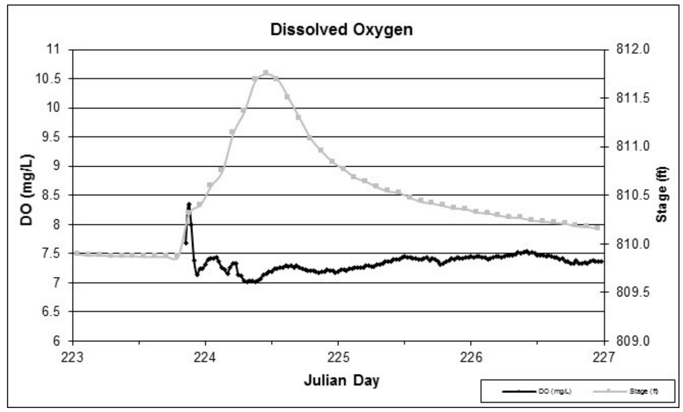


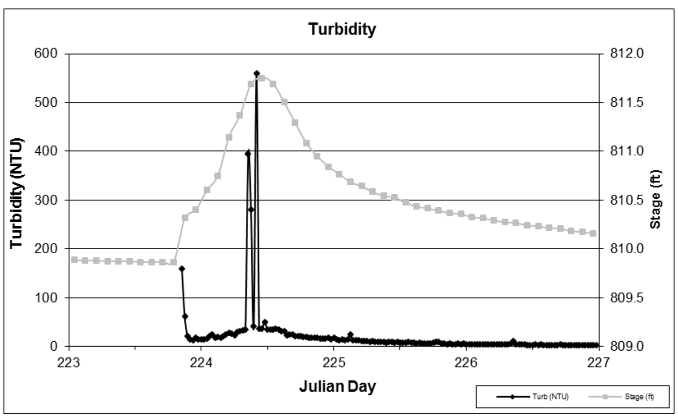


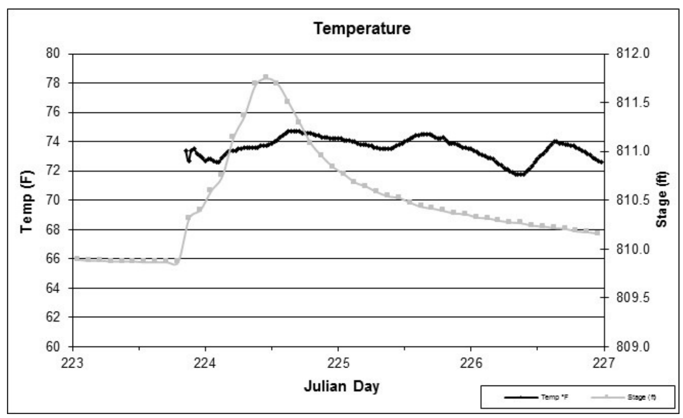
Hydrolab Continuous Monitoring
Storm 4 - 2016

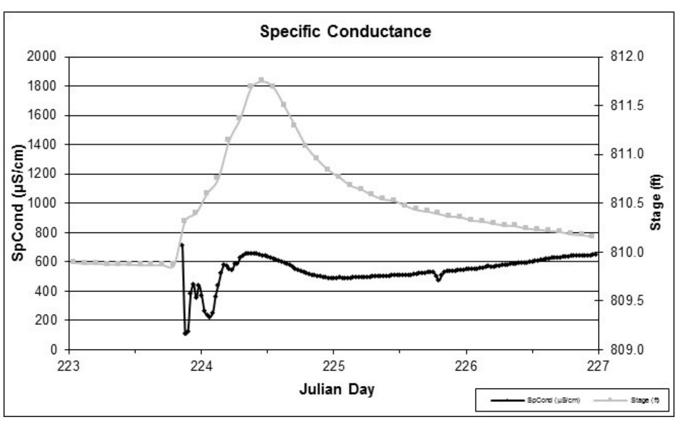
Springbrook at 79th Way
Storm Summary:
Dates: 10 August 2016 (day 223) to 13 August 2016 (day 226)
Precipitation: 3.07 inches

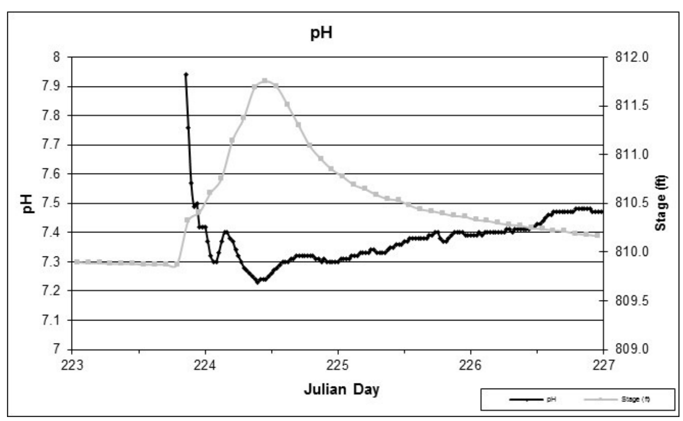












Stream Water Quality Monitoring

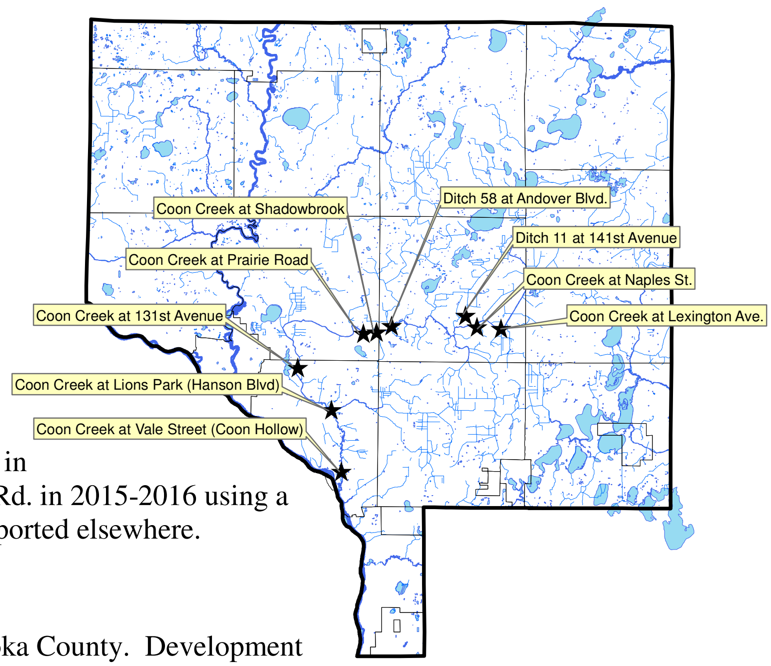
COON CREEK

Coon Creek at Lexington, Ham Lake	STORET SiteID = S007-539
Ditch 11 at 149st Avenue, Ham Lake	STORET SiteID = S007-541
Coon Creek at Naples Street, Ham Lake	STORET SiteID = S007-057
Ditch 58 at Andover Blvd, Ham Lake	STORET SiteID = S005-830
Coon Creek at Shadowbrook Townhomes, Andover	STORET SiteID = S004-620
Coon Creek at Prairie Road, Andover	STORET SiteID = S007-540
Coon Creek at 131st Avenue, Coon Rapids	STORET SiteID = S005-257
Coon Creek at Lions Park, Coon Rapids	STORET SiteID = S004-171
Coon Creek at Vale Street, Coon Rapids	STORET SiteID = S003-993

Years Monitored

Coon Cr at Lexington	2013-2016
Ditch 11 at 149st Ave	2013-2016
Coon Cr at Naples St	2012-2016
Ditch 58 at Andover Blvd	2013-2016
Coon Cr at Shadowbrook Townhomes	2007-2016
Coon Cr at 131st Ave	2010-2016
Coon Cr at Lions Park (Hanson Blvd)	2007-2016
Coon Cr at Vale St	2005-2016

Additional, intermittent data available at some other sites



Note that continuous water quality monitoring has been conducted at Vale Street in 2011-2015, Naples in 2014, Lexington in 2014 and both 131st and Prairie Rd. in 2015-2016 using a Hach Hydrolab and YSI Exo Sonde. That data is reported elsewhere.

Background

Coon Creek is a major drainage through central Anoka County. Development in the watershed ranges from rural residential to urbanized. Upstream reaches were ditched in the early 1900's for agriculture. There are many ditch tributaries in the upper reaches. Lower reaches of the creek were not ditched. The entire creek serves as an important stormwater conveyance for the Cities of Ham Lake, Andover, Blaine, and Coon Rapids. Coon Creek outlets into the Mississippi River.

Methods

Coon Creek was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were taken each year; half during baseflow and half following storms. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. In some years smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Eleven water quality parameters were tested. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009, transparency tube measurements were added and are reported to MPCA. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, and E.coli.

During every sampling the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using continuous data logging gauges at various sites. That data can be found in the hydrology section of this chapter.

Results and Discussion

This report includes data from all years and all sites to provide a broad view of Coon Creek's water quality under a variety of conditions. We focus upon an upstream-to-downstream comparison of water quality, a comparison of baseflow and storm conditions, and an overall assessment. There are water quality concerns throughout Coon Creek. Following is a summary, including a management discussion:

- Dissolved pollutants, as measured by conductivity and chlorides, in Coon Creek were approximately double the median for other streams in Anoka County during baseflow conditions. They are highest in downstream reaches and during baseflow. Coon Creek is well below the state water quality standard for chlorides. Chlorides were last monitored 2012.

  Management discussion: Dissolved pollutants enter the stream both directly through surface runoff and also by infiltrating into the shallow groundwater that feeds the stream during baseflow. A variety of sources appear to be likely, including road deicing salts, agricultural chemicals, and road runoff. Because these are difficult to remove, every effort should be made to minimize their release into the environment.

- Phosphorus was at acceptably low levels during baseflow, but was much more variable and elevated during storms. During baseflow, phosphorus was lower than the median for streams in Anoka County and often lower than the MPCA's water quality standard of 100 ug/L. However, phosphorus approximately doubles during storms, exceeding state standards. Phosphorus is higher in downstream reaches than upstream. The exception to this is Ditch 11 at 149th, an upstream tributary. This ditch has constantly high phosphorus and flows through agricultural land.

  Management discussion: Phosphorus needs to be reduced in both the upper and lower watershed, though the sources are likely different. A major source upstream appears to be the agricultural land that Ditch 11 flows through.

- Suspended solids and turbidity were low upstream and during baseflow, but increase dramatically during storms. During baseflow, suspended sediment was below state standards, but increased drastically during storms, sometime exceeding state standards. Suspended solids were high at all sites during storms, though the source likely differs in different parts of the watershed. Both baseflow and storm event median values for all years approximately double from upstream to downstream for both TSS and turbidity. While bedload is a concern, Hydrolab monitoring has shown that suspended solids concentration does not follow stream flows, suggesting is it not the primary source.

  Management discussion: There are at least two sources of suspended solids and turbidity that seem to be impacting Coon Creek. These will require a variety of management techniques to address. First, suspended solids and turbidity are greatest during storms and in the lower, fully-developed part of the watershed, suggesting that stormwater treatment is an important way to address this problem. Storms greater than one-inch produce the worst creek water quality, so practices aimed at reducing suspended solids and phosphorus entering the creek during those storms are especially important. Most stormwater practices were designed to treat storms up to one inch in size.

  Secondly, there are likely near and in-stream sediment sources, like bedload and streambank erosion. High flows are a common aggravator of this type sediment source. We would anticipate near and in-stream sources to be impacting Coon Creek because much of it is ditched, and ditches generally have unstable banks, as well as the highly erodible nature of the soils in the watershed. Yet continuous monitoring of turbidity with a Hydrolab/YSI during storms and in the days after storms paints a more complex picture. Turbidity does rise quickly during storms (presumably runoff from the lower watershed). Turbidity then increases slowly and continuously after the storms (presumably sediment from the upper watershed). The

Hydrolab/YSI found it was common for turbidity to increase for several days after a storm, even when flows were dropping. We would expect bedload and streambank erosion to increase with flow.

- pH and dissolved oxygen: pH levels remained within the range considered normal and healthy for streams in this area. All measurements were in the desired range of 6.5-8.5. Dissolved oxygen levels were very poor in Ditch 11 throughout the season in all conditions. During storm events, the upper reaches of the main channel had low DO levels as well. This, paired with lagging turbidity spikes found by continuous storm monitoring, suggest that much of the pollutants associated with storm runoff entering the creek do so in the upper reaches of the watershed.
- E. coli bacteria are high throughout Coon Creek, though insufficient data exists to fully compare it to state standards. During baseflow, E. coli modestly and periodically was above the state standard thresholds, and this primarily occurred in the lower portion of the watershed. E. coli was generally low in the upper watershed during baseflow. During storms E coli was much higher in all locations and generally was higher in the lower watershed.

  Management discussion: Because E. coli is pervasive in the environment and neighborhoods there will be difficulty reducing E. coli levels below state water quality standards. Addressing E. coli should be part of an effort to improve overall water quality.

Conductivity and Chlorides

Conductivity, chlorides, and salinity are all measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial sources, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we use. It measures the electrical conductivity of water; pure water with no dissolved constituents has zero conductivity. Chlorides tests for chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community; however it is also noteworthy that Coon Creek is upstream from the drinking water intakes on the Mississippi River for the Twin Cities. Note that chlorides have not been sampled since 2012.

Median conductivity results in Coon Creek were notably higher than the median for other Anoka County streams (see table and figures below). Median conductivity in Coon Creek (Vale St., all conditions) was 0.570 mS/cm compared to the countywide median of 0.362 mS/cm.

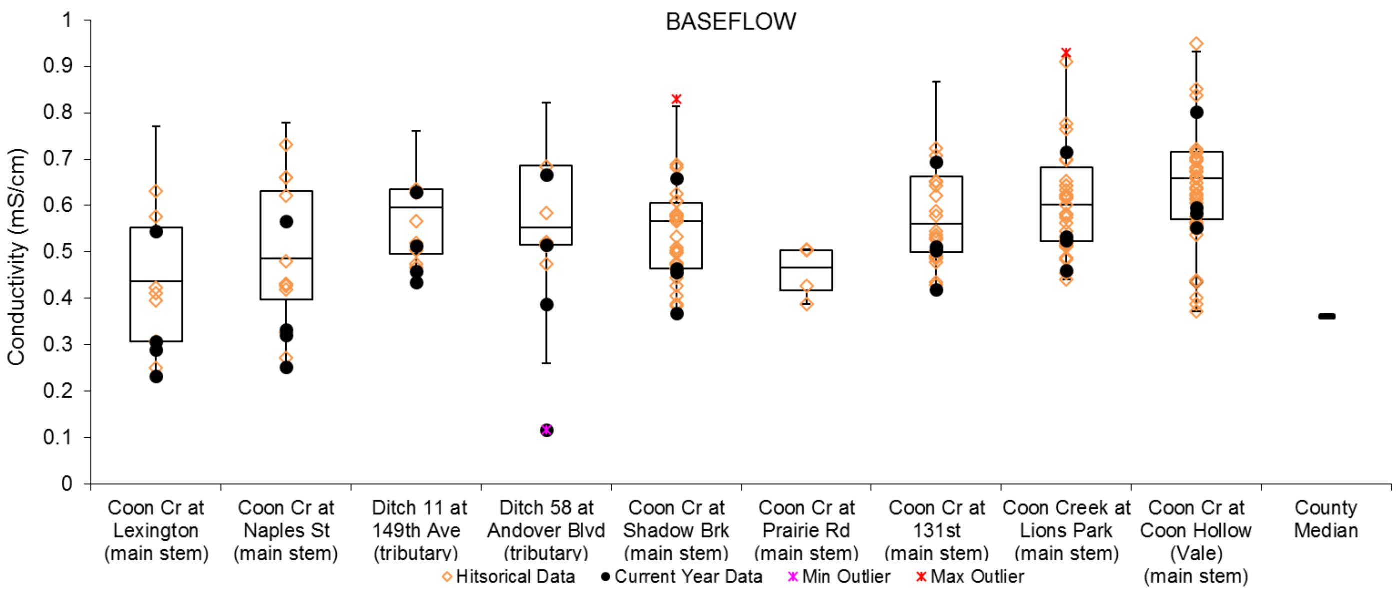
Dissolved pollutants were higher in downstream reaches of Coon Creek, where there is more impervious area (see figures below). Median conductivity (all years) increases gradually from upstream (0.437 mS/cm) to downstream (0.571 mS/cm) during baseflow. Median conductivity (all years) for storm events showed a smaller difference between upstream and downstream, ranging from 0.411 to 0.461 mS/cm.

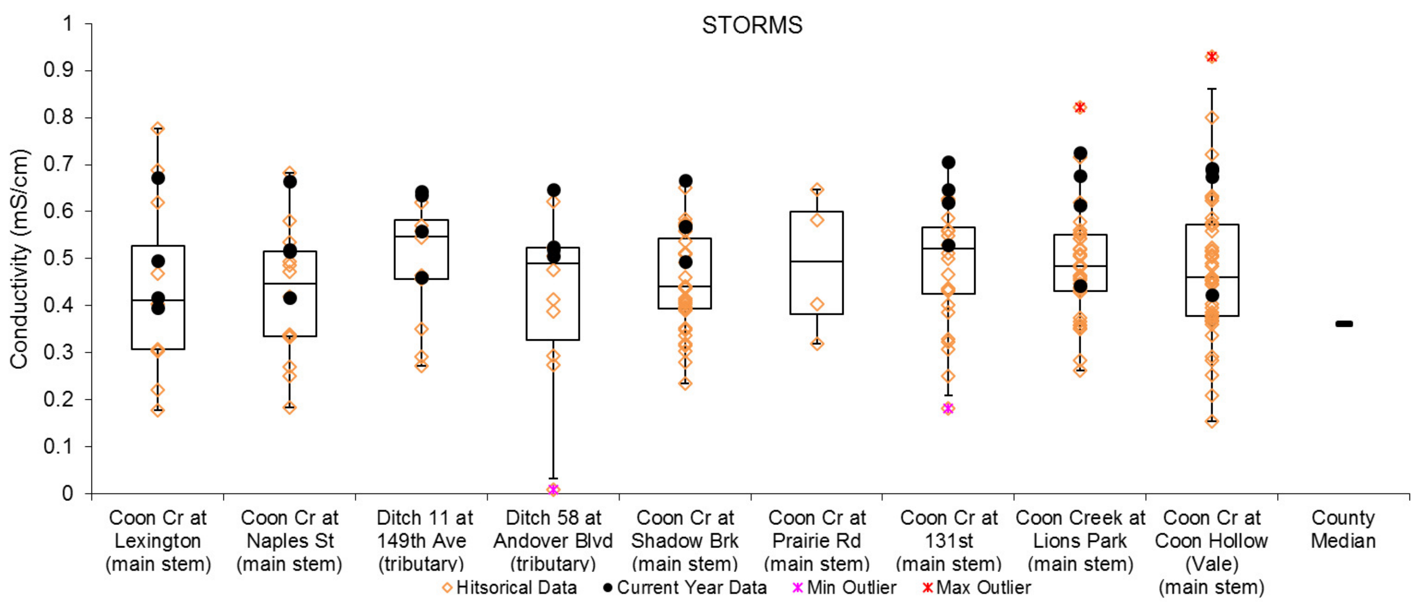
This lends some insight into the pollutant sources. If dissolved pollutants were only elevated during storms, stormwater runoff would be suspected as the primary contributor. If dissolved pollutants were highest during baseflow, pollution of the shallow groundwater which feeds the stream during baseflow would be suspected to be a primary contributor. In Coon Creek we find similar, but slightly lower dissolved pollutants during storms. In other words, both stormwater runoff and groundwater are sources of dissolved pollutants, with shallow groundwater being slightly worse. While storms dilute some of the baseflow pollutants, they also carry additional pollutants which somewhat offset the dilution. From a management standpoint it is important to remember that the sources of both stormwater and baseflow dissolved pollutants are generally the same; it is only the timing of delivery to the stream that is different. Preventing their release into the environment and treating them before infiltration should be a high priority.

Median conductivity and chlorides in Coon Creek. Data is from Vale St for conductivity all years through 2016, for chlorides all years through 2012.

	Conductivity (mS/cm)	Chlorides (mg/L)	State Standard	N
Baseflow	0.659	64.7	Conductivity – none	47
Storms	0.461	52.25	Chlorides 860 mg/L acute, 230 mg/L chronic	48
All	0.570	60.5		95
Occasions > state standard				0

Conductivity at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algae growth. Total phosphorus in Coon Creek was generally low during baseflow conditions and increased substantially during storms (see figures below). The Minnesota Pollution Control Agency has a TP water quality standard for streams (100 mg/L) and Coon Creek eventually may be designated as impaired for exceeding it during storms in the lower part of the watershed. Best management practices for this stream are needed to address stormwater phosphorus along the entire monitored stream length. In 2016, eight Coon Creek watershed sites were monitored (two are tributaries).

Baseflow TP was higher in 2016 than the previous year. During baseflow conditions, the eight monitoring sites had median TP of 38.5, 59.5, 114, 70.5, 74.5, 106.5, 82 and 82 ug/L, from upstream to downstream. All were lower than the countywide median for streams of 135ug/L. It is also generally lower than the state water quality standard of100 ug/L, although 17 of 47 measurements at the Vale Street site have been above100 ug/L. There was little variability among baseflow samples.

TP was generally higher at downstream sites than upstream during storms, with the exception of Ditch 11 upstream having extremely high TP. Median storm TP, upstream to downstream, in 2016 were 82, 119, 210, 134.5, 171, 168, 152, and 168 ug/L, respectively.

TP at all downstream sites regularly exceeded the state standard of 100 ug/L. At Vale Street only four of 44 TP measurements during storms have been lower than100 ug/L. The maximum observed was 672ug/L in 2009.

In addition to monitoring sites on the main stem of Coon Creek, two tributaries were also monitored in 2013-2016 Ditch 11 and Ditch 58. Median TP for both baseflow and storms are generally higher than those observed on the main stem of the creek. In 2016 median TP for baseflow was 114 and 70.5 ug/L, respectively. Median TP during storm events in 2016 was 210 and 134.5 ug/L, with much greater variation amongst readings.

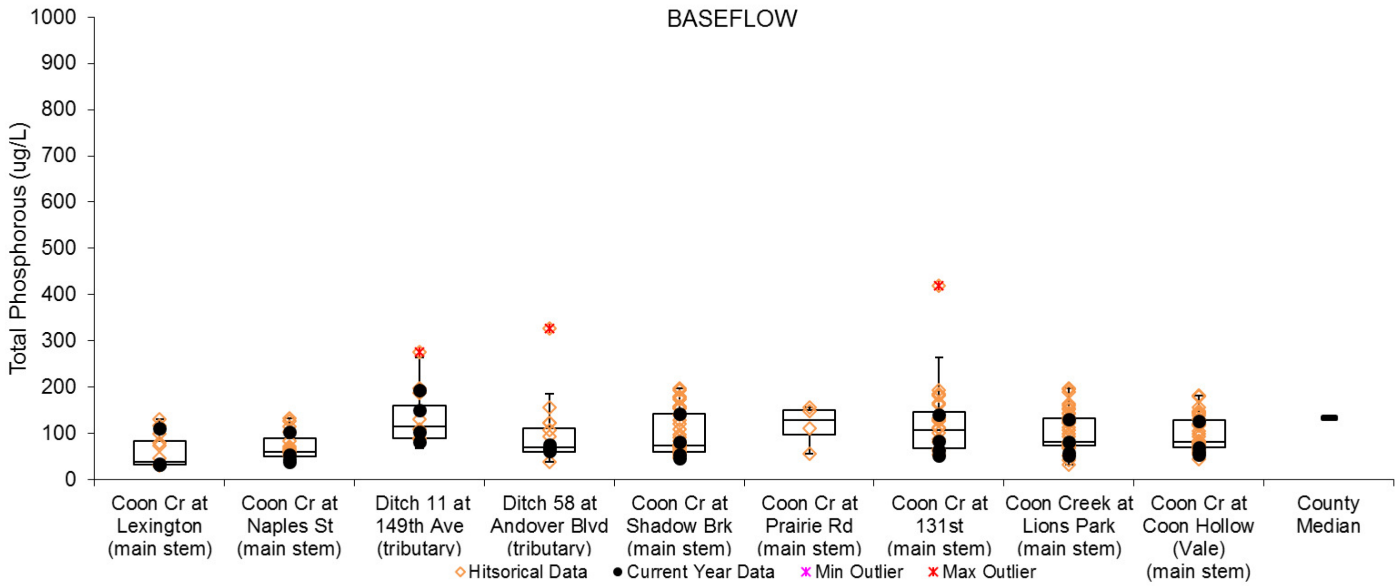
The dominant phosphorus source is likely different in upstream and downstream stream reaches. Upstream is less developed and any development has occurred more recently with more stringent stormwater treatment requirements. Here, mobilization of in-stream sediments and agricultural runoff are likely important phosphorus sources. Drained, organic wetland soils may be another source; many ditch tributaries exist. Downstream parts of the watershed are fully developed, and some areas developed before modern-day stormwater treatment requirements. Here, flows are often higher and flashy, so mobilization of in-stream sediments may be important, but stormwater runoff from impervious surfaces is likely quite important.

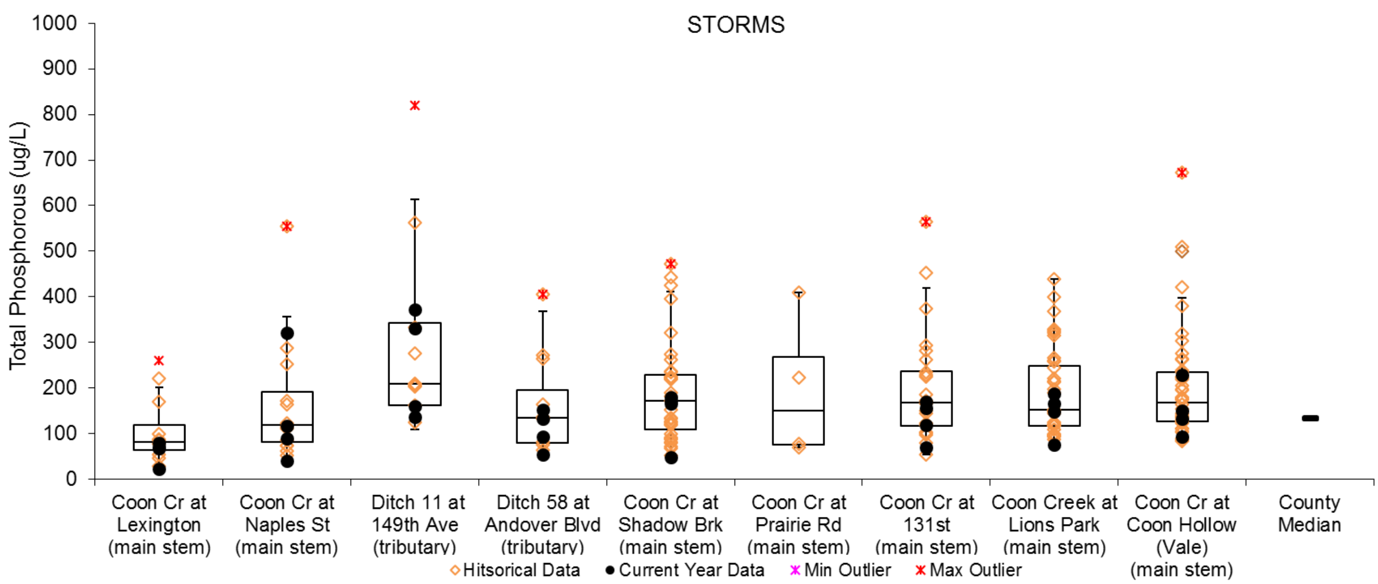
Phosphorus reduction needs to occur throughout the watershed. The highest priority should be addressing phosphorus from urban stormwater runoff in the lower portion of the watershed, and agricultural and drained wetland inputs in the upper watershed. These sources seem to be the likely contributor of TP. In addition, these are likely the causes of the highest levels of other pollutants, such as total suspended solids. Improvements to stormwater treatment in the urban area, and reduced nutrient loading in the upstream tributary ditches would address the problem from multiple fronts.

Median total phosphorus in Coon Creek. Data is from Vale St for all years through 2016.

	Total Phosphorus (ug/L)	State Standard	N
Baseflow	82	100	47
Storms	168		48
All	127		95
Occasions > state standard			61 (44 storms, 17 baseflow)

Total Phosphorus at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Total Suspended Solids and Turbidity

Total suspended solids (TSS) and turbidity both measure solid particles in the water. TSS measures these particles by weighing materials filtered out of the water. Turbidity is measured by the diffraction of a beam of light sent though the water sample, and is therefore most sensitive to large particles.

In Coon Creek TSS and turbidity were low upstream and during baseflow, but increase dramatically during storms and in downstream reaches (see figures below). Presently, the state water quality standard allows TSS of 30 mg/L. The stream often exceeds the state water quality standard at Vale St. during storms.

During baseflow turbidity and TSS were reasonably low and showed slight upstream to downstream increase. Median turbidity of sites sampled in 2016 (all sites, all years) during baseflow from upstream to downstream were 6.3, 10.1, 3.7, 7.8, 10, 12, 11, 12 NTU, respectively. These are similar to the countywide median of 8.5 NTU. Median TSS (all sites, all years) during baseflow from upstream to downstream were 5, 5, 5, 5, 6.5, 7, 9, and 9 mg/L, respectively. This is lower than the median for streams county-wide of 12 mg/L. At Vale, the furthest downstream reach, only 1 of 48 (2%) baseflow TSS measurements exceeded the water quality standard of 30 mg/L.

During storms TSS and turbidity were higher, and there was some modest increase from upstream to downstream. Median TSS and turbidity during storms were both generally 2-5 times higher than during baseflow (comparison is among site medians). Median TSS during storms at sites sampled in 2016 (all years) were 8, 10, 7, 6, 13.5, 19, 19, and 32.5 mg/L from upstream to downstream. Median turbidity during storms at sites sampled in 2016 (all years) were 12.1, 17.8, 9.75, 16.95, 19.4, 27.6, 27.6, and 29.5 NTU from upstream to downstream. Both turbidity and TSS exceed county-wide medians at all stream sites during storm events.

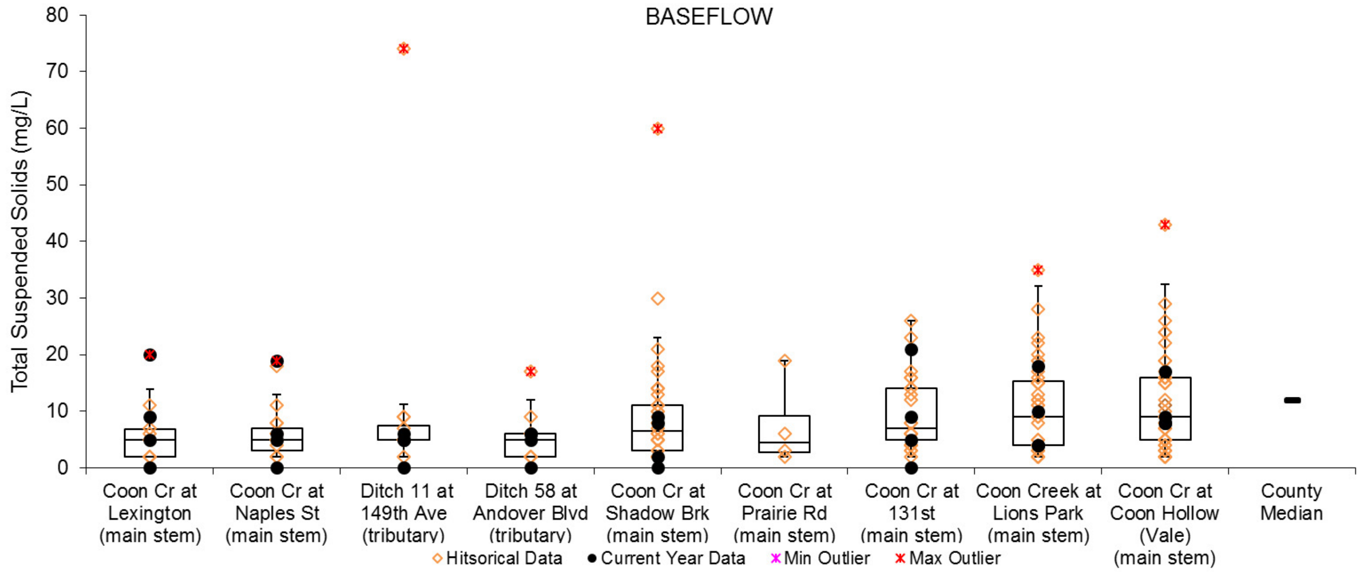
During storms, TSS was often similarly higher at all sites (see figures below). Bank erosion, bedload transport, and stormwater runoff are likely all important sources of suspended solids. Their relative contributions likely differ across the watershed. However, given that suspended solids are high throughout the watershed, it is safe to say the problem is not geographically isolated.

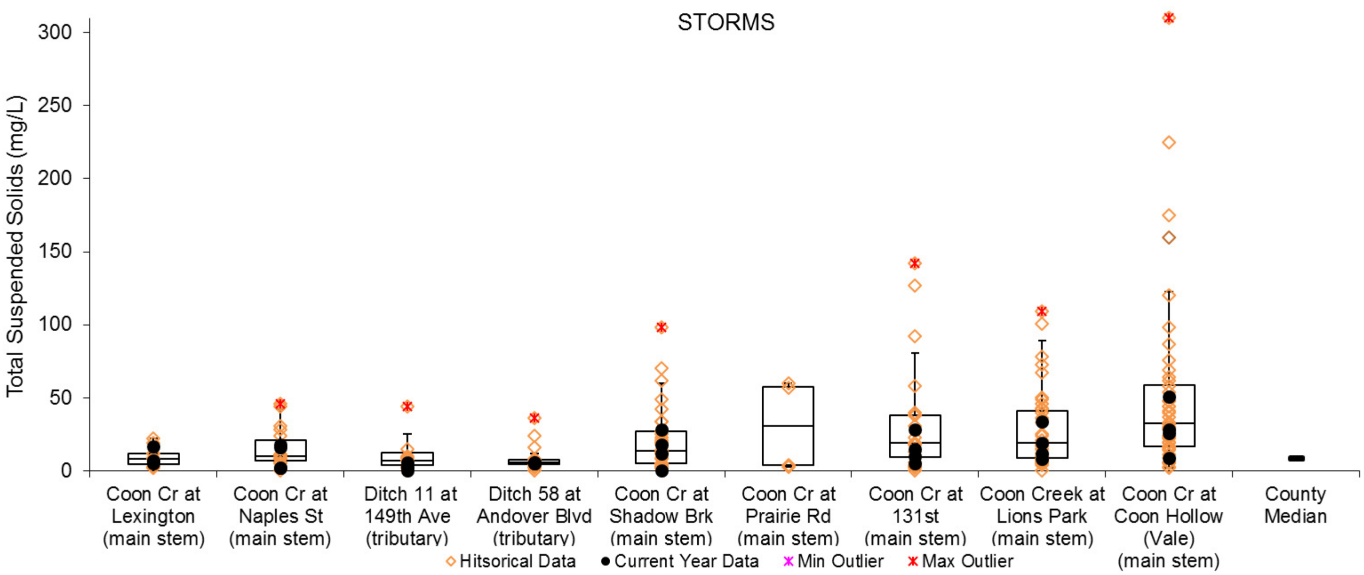
Research should be done to determine the extent to which bed load transport of sediment is contributing to high turbidity and TSS. Presently, it appears that it has the potential to be important. High suspended solids in the upper watershed, where land uses are rural residential and sod fields is surprising, given that these are not often sources of high suspended solids. This lends suspicion that near-channel and in-channel sources may be important in the upper watershed. It may be important farther downstream too. On the other hand, Hydrolab continuous turbidity monitoring during storms has found that turbidity does not increase as flow increases, as would be expected if bed load were dominant. It does, however, spike immediately following rain, indicating runoff contribution.

Median turbidity and suspended solids in Coon Creek. Data is from Vale St for all years through 2016.

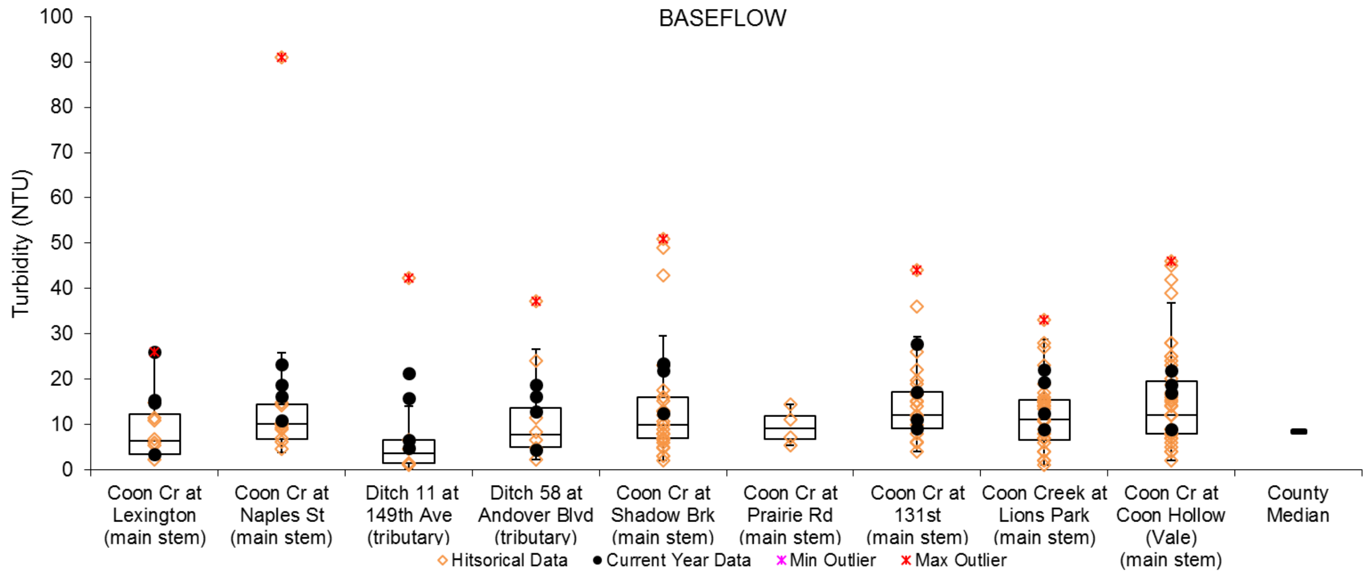
	Turbidity (NTU)	Total Suspended Solids (mg/L)	State Standard	N
Baseflow	12	9	30 mg/L TSS	47
Storms	29.5	32.5		48
All	19	16		95
Occasions > state TSS standard				26

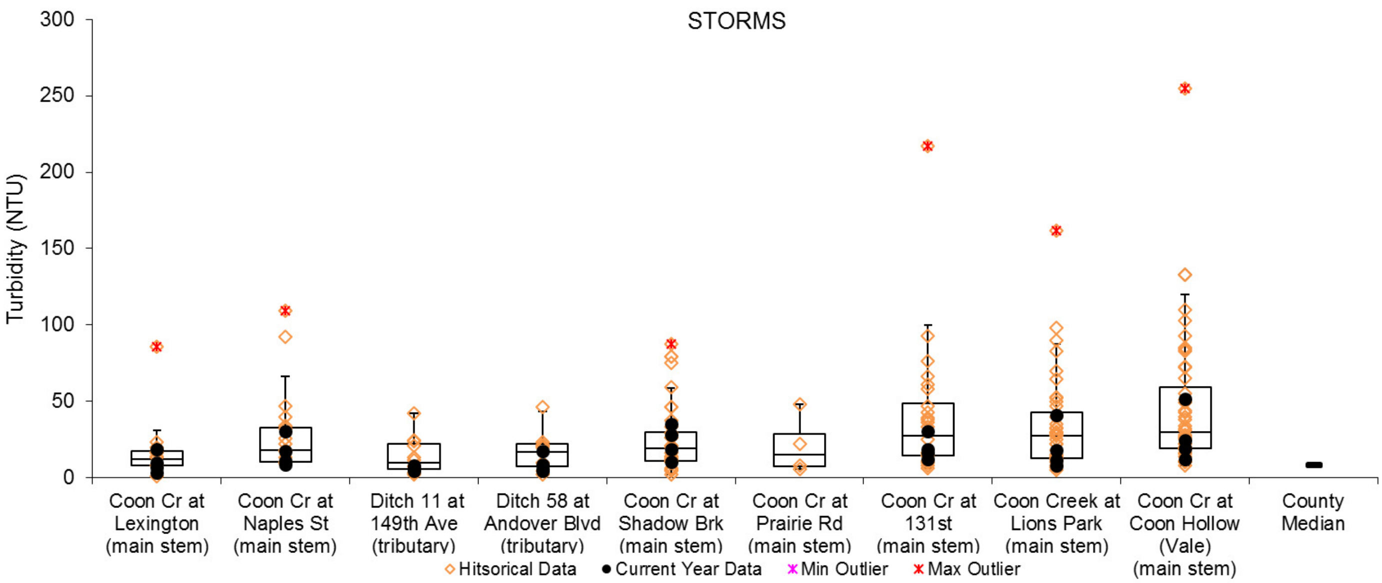
Total Suspended Solids at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





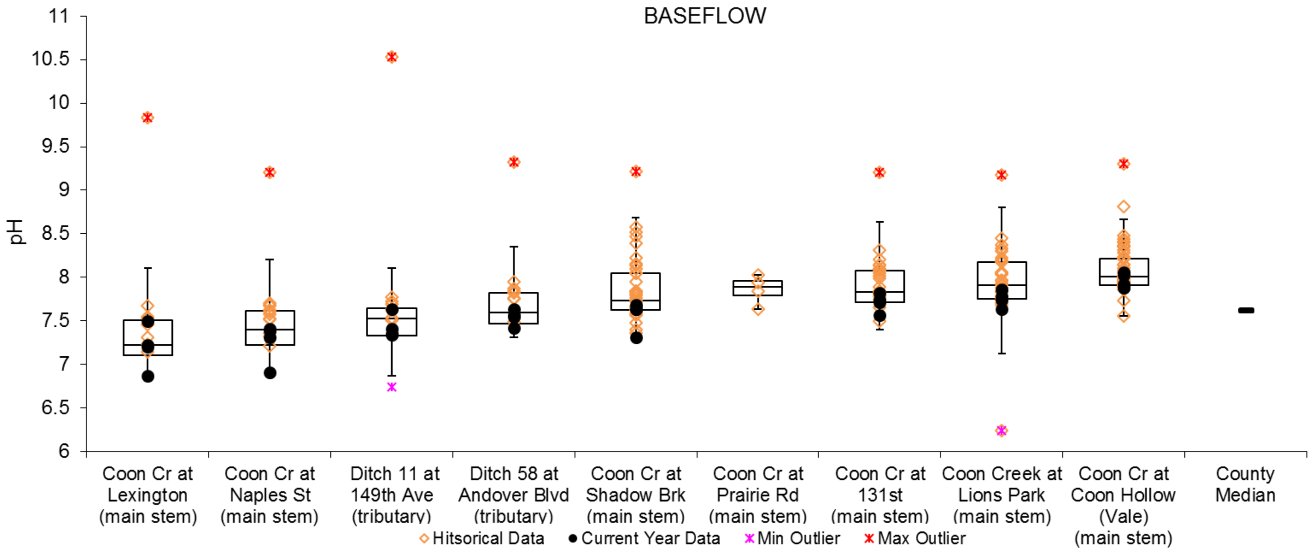
pH

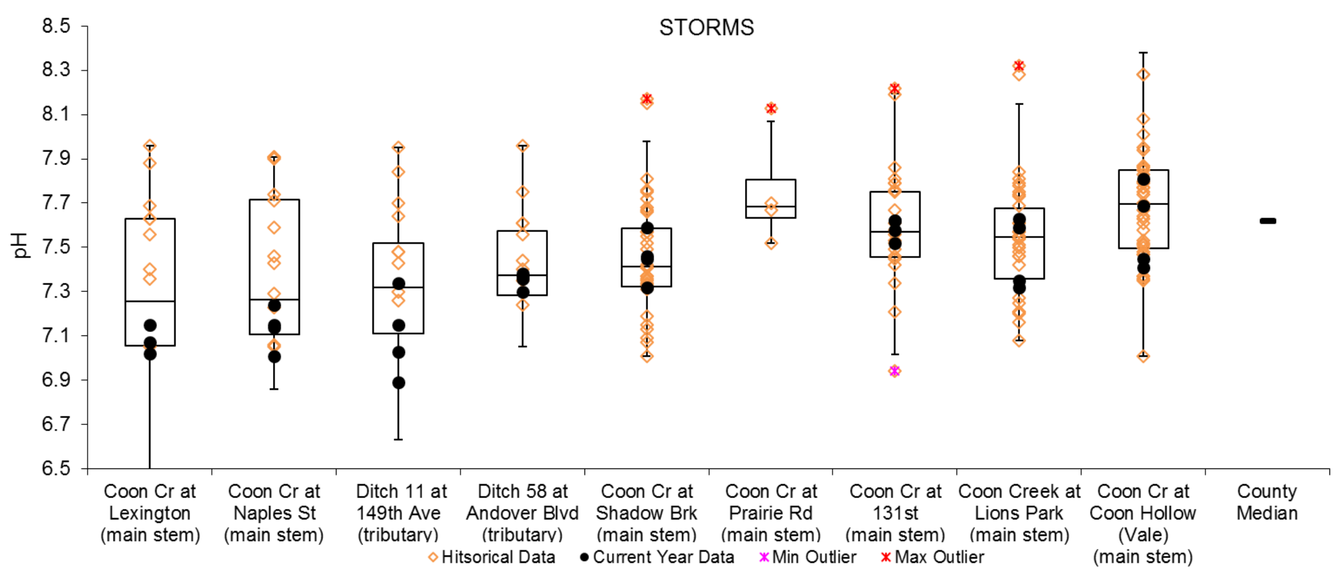
pH was within the expected range at all sites for 2016. pH is expected to be between 6.5 and 8.5 according to MPCA water quality standards. While occasional readings outside of this range have occurred in previous years, they were not large departures that generate concerns. pH was notably lower during all storm events, but this is not surprising because rainfall has a lower pH and the creek serves as a stormwater conveyance for four cities.

Median pH in Coon Creek. Data is from Vale St for all years through 2016.

	pH	State Standard	N
Baseflow	8.01	6.5-8.5	47
Storms	7.70		44
All	7.89		91
Occasions outside state standard			1

pH at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





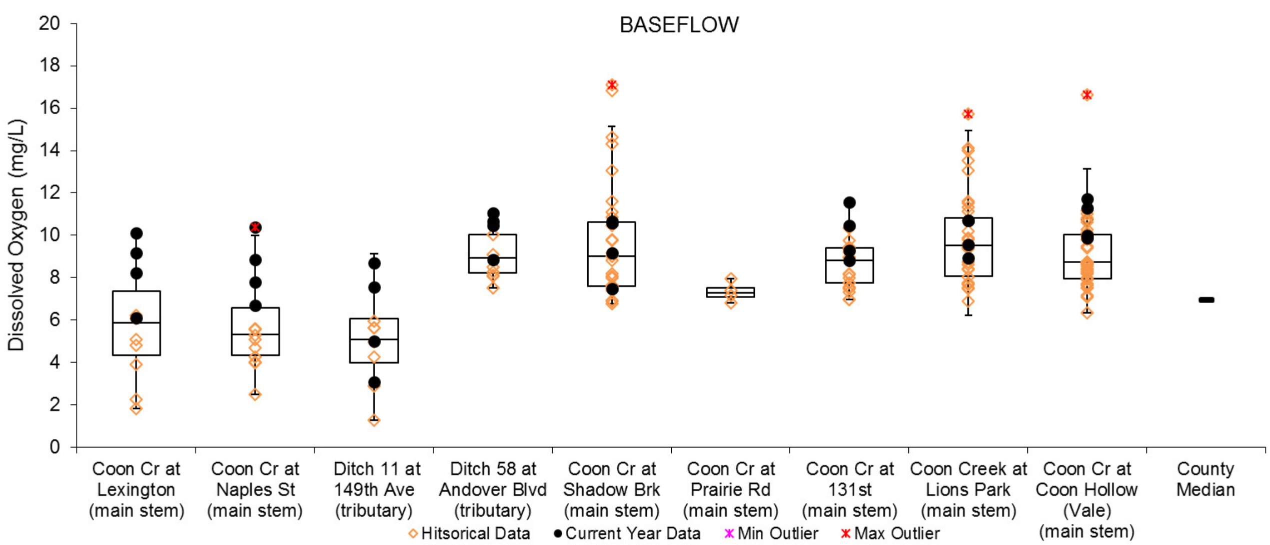
Dissolved Oxygen

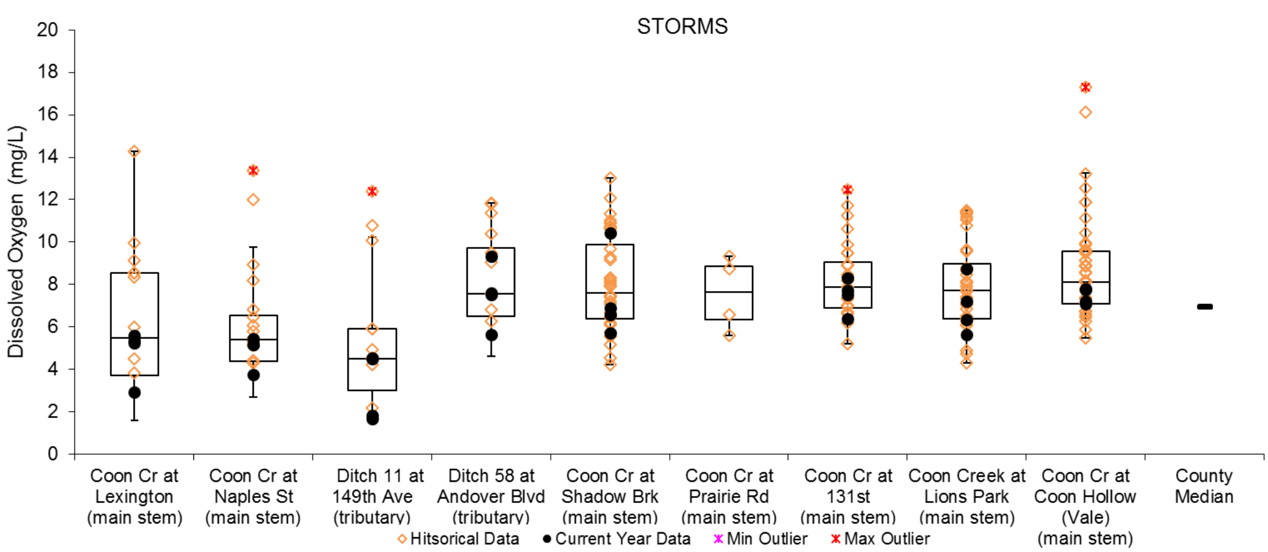
Dissolved oxygen levels were good overall in 2016, especially in the downstream reaches. Of the 64 recordings in 2016, 7 dropped below 5 mg/L. These low readings all occurred in the upstream sites of Coon Creek, and typically during storms. The other sites had no instances of dissolved oxygen below 5 mg/L. Dissolved oxygen levels appear to be poorer in the upstream reaches of Coon Creek and are particularly low in Ditch 11.

Median dissolved oxygen in Coon Creek. Data is from Vale St for all years through 2016.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.73	5 mg/L daily minimum	44
Storms	8.10		46
All	8.57		90
Occasions <5 mg/L			

Dissolved oxygen at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





E. coli

E. *coli* is a bacteria found in the feces of warm blooded animals. E. *coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets E. *coli* standards for contact recreation (swimming, etc.). A stream is designated as “impaired” if 10% of measurements in a calendar month are >1260 most probable number per 100 milliliters of water (MPN) or if the geometric mean of five samples taken within 30 days is greater than 126 MPN.

Our data are not sufficient to determine if the MPCA standards are met. We took samples throughout summer, often with only 1-2 samples in each month, too little for calculation of a monthly geometric mean or to reasonably say that 10% of samples in a month were in exceedance. We can, however, perform other examinations of the data.

During baseflow E. *coli* was acceptably low in the upper Coon Creek system but tends to be higher in the lower watershed (at Shadowbrook townhomes and below). Median E. *coli* for all years at sites sampled in 2016 during baseflow from upstream to downstream were 34, 64, (75, 58tributaries), 91, 145, 144, and 136 MPN, respectively. Though the frequency requirements were not met, bacteria levels during baseflow generally were below the 126 MPN state water quality standard in the upper watershed but routinely exceeded it in the lower watershed.

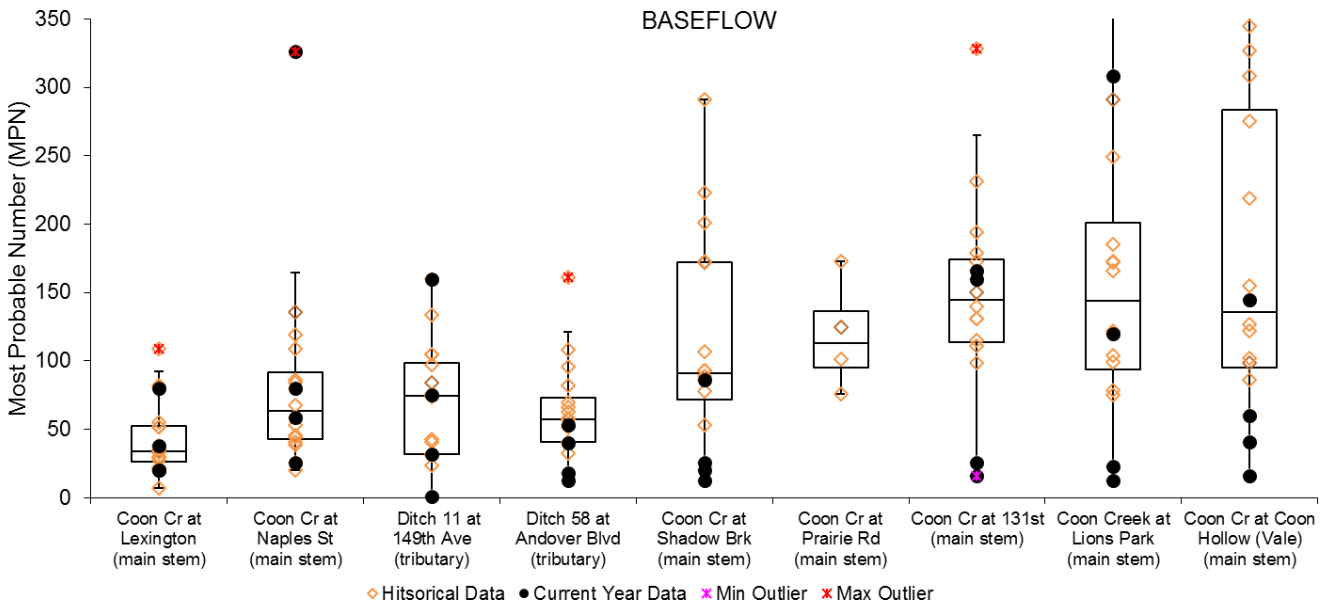
During storms, E. coli was significantly higher and more variable (notice the difference in Y axis scales in the graphs below). Median E. coli for all years at sites sampled in 2016 during storms from upstream to downstream were 236, 367, (340, 377 tributaries), 698, 677, 727, and 687 MPN, respectively. A large part of this variability might be explained by the intensity of the storm, phenology of the storm and when the storm the sampling was done.

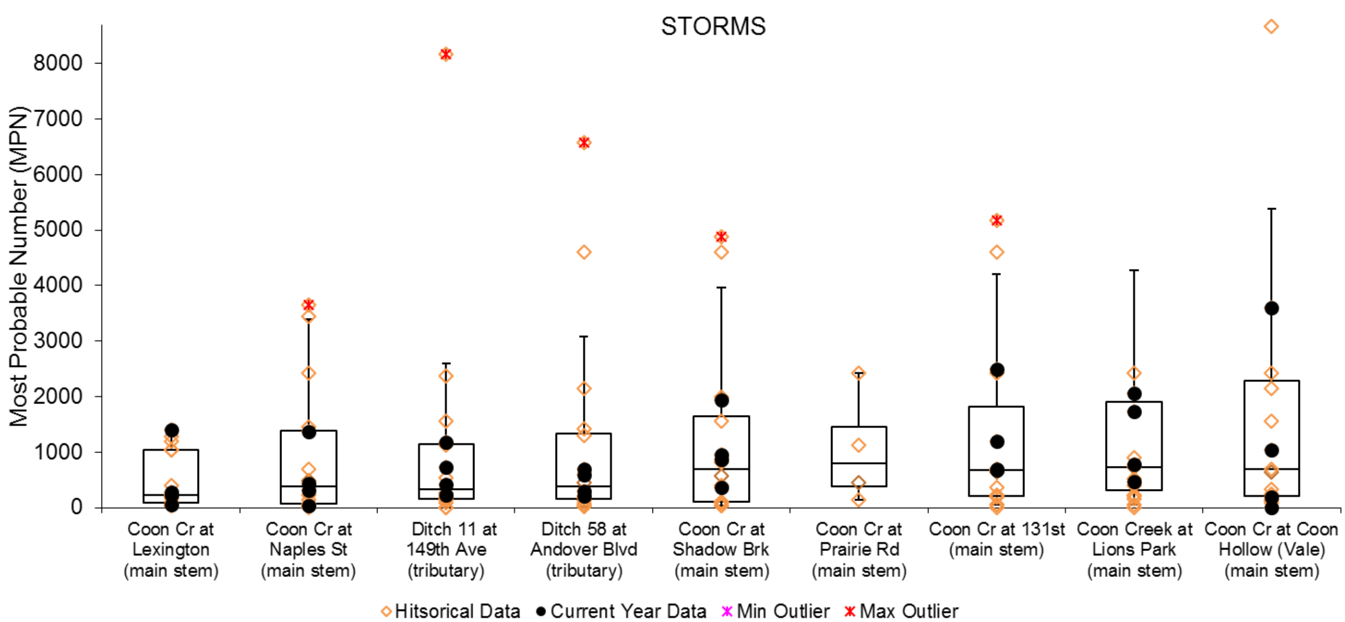
Though the frequency requirements were not met, bacteria levels during storms grossly exceed the 126 MPN state water quality standard in 2016 (30 of 32 or 94% of storm samples taken). Coon Creek also exceeded the standard of 10% of monitoring events in a month above 1260 MPN. It is notable, however, that storm samples are targeted for half of our monitoring, and monitoring is not performed at random.

Median E. *coli* in Coon Creek. Data is from All Sites from 2013-2016.

	E. *coli* (MPN)	**State Standard**	**N**
Baseflow	86	Monthly Geometric Mean >126	132
Storms	464		132
All	150		264
Occasions >126 MPN		Monthly 10% average >1260	39 baseflow, 102 storm
Occasions >1260 MPN			0 baseflow, 36 storm

E. *coli* at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





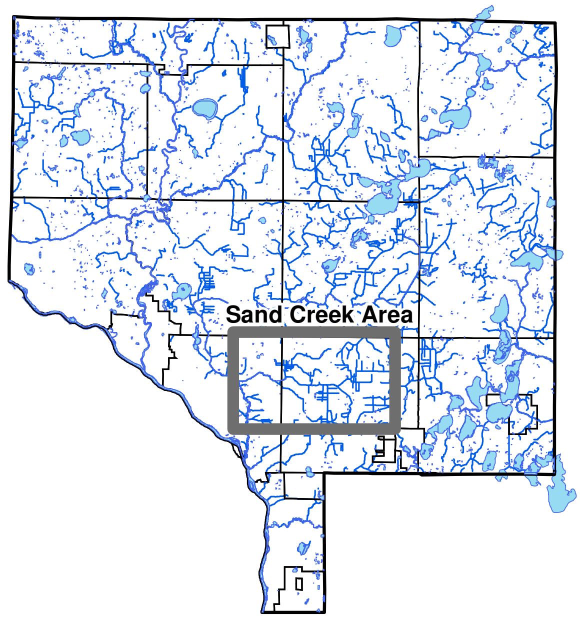
Stream Water Quality Monitoring

SAND CREEK SYSTEM

Sand Cr (Ditch 41) at Radisson Rd, Blaine	STORET SiteID = S006-421
Sand Cr (Ditch 41) at Highway 65, Blaine	STORET SiteID = S005-639
Sand Cr at Happy Acres Park, Blaine	STORET SiteID = S005-641
Ditch 60 at Happy Acres Park, Blaine	STORET SiteID = S005-642
Sand Cr at University Avenue, Coon Rapids	STORET SiteID = S005-264
Ditch 39 at University Avenue, Coon Rapids	STORET SiteID = S005-638
Sand Cr at Morningside Mem. Gardens Cemetery, Coon Rapids	STORET SiteID = S006-420
Sand Cr at Xeon Street, Coon Rapids	STORET SiteID = S004-619

Years Monitored

Sand Cr (Ditch 41) at Radisson Rd	2010-2016
Sand Cr (Ditch 41) at Highway 65	2009-2016
Sand Cr at Happy Acres Park	2009
Ditch 60 at Happy Acres Park	2009
Sand Cr at University Avenue	2008-2016
Ditch 39 at University Avenue	2009
Sand Cr at Morningside Cemetery	2010-2016
Sand Cr at Xeon Street	2007-2016



Background

Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial and retail areas throughout northeastern Coon Rapids and western Blaine. In upper portions of the watershed (upstream of Hwy 65), the creek flows through a network of man-made ponds and lakes which serve stormwater treatment and aesthetic purposes. These areas were developed recently, after 1995. Farther downstream there are no in-line ponds and developments are older. A number of ditch tributaries exist throughout the watershed, and many reaches of Sand Creek itself have been ditched.

Sand Creek drains to Coon Creek, which then drains to the Mississippi River. At its confluence with Coon Creek, Sand Creek it is about 15 feet wide and 2.5-3 feet deep during baseflow. Sand Creek has not been listed as "impaired" by the MN Pollution Control Agency for exceeding any water quality parameters.

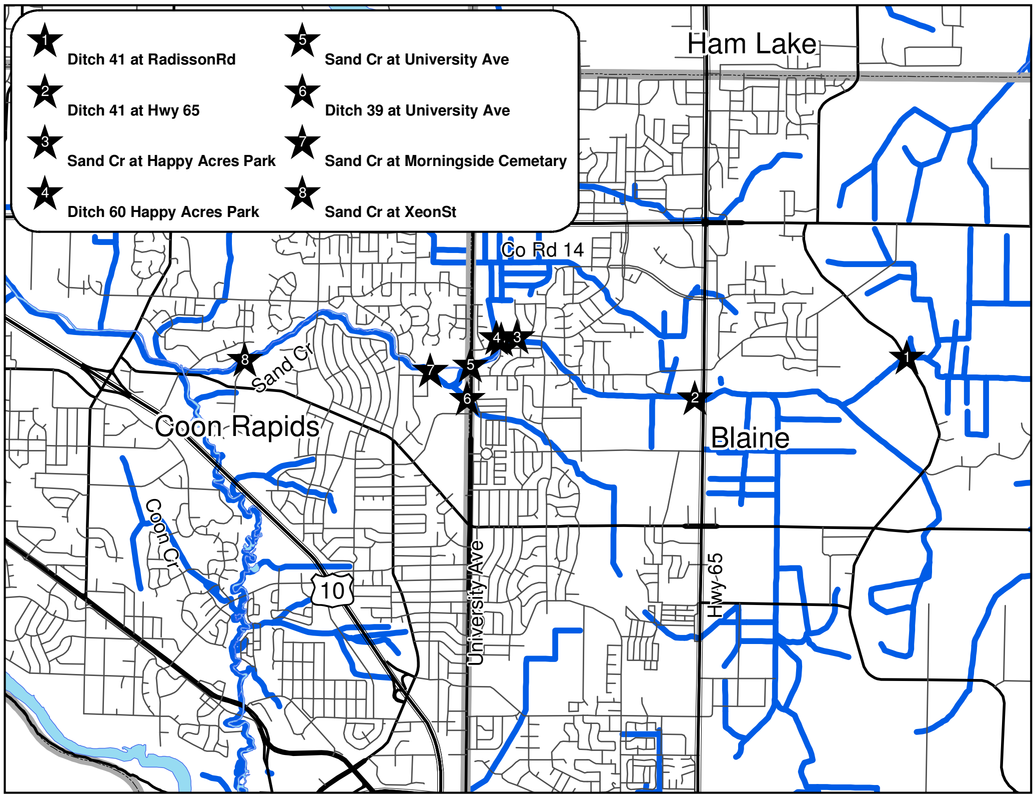
Methods

Sand Creek and its tributaries were monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were taken each year; half during baseflow and half following storms. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. During drought, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Eleven water quality parameters were tested. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009 transparency tube measurements were added and are reported to MPCA. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, and E.coli.

During every sampling the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using electronic continuous data logging gauges at the Morningside Cemetery and Xeon Street stream crossing (farthest downstream).

Sand Creek Monitoring Sites



Results and Discussion

The results presented below include all years of data at sites monitored through 2016. We focus on an upstream-to-downstream comparison of water quality, as well as an overall assessment. Overall, with the exception of dissolved pollutants, water quality in Sand Creek is good for a creek with a suburban watershed.

Sand Creek water degrades Coon Creek for some parameters but not others. Sand Creek phosphorus, total suspended solids, and turbidity were all lower than Coon Creek. Dissolved pollutants were notably higher in Sand Creek than Coon Creek. Coon Creek has several water quality problems, including dissolved pollutants, phosphorus, and suspended solids.

Following is a parameter-by-parameter summary, including a management discussion:

- Dissolved pollutants, as measured by conductivity and chlorides, were substantially higher than the median for other streams in Anoka County. Conductivity reached levels over three times greater than the county median in 2016. There was little change in these parameters from upstream to downstream. Readings for conductivity were higher during baseflow than storms, indicating pollutants migrating through the shallow water table are an important source to the stream. Dissolved pollutants are at a higher concentration in Sand Creek than Coon Creek. Chlorides were last monitored in 2012.

  Management discussion: Dissolved pollutants enter the stream both directly through surface runoff and also by infiltrating into the shallow groundwater that feeds the stream during baseflow. A variety of sources appear to be likely, including road deicing salts, agricultural chemicals, and road runoff.

- Phosphorus was low in Sand Creek compared to other streams in the region but on occasion it may exceed the state standard of 100 ug/L. Only one of Sand Creek samples exceeded that standard in 2016. Most of these exceedances historically occur during storms at the furthest downstream site (Xeon St.). Phosphorus increases upstream to downstream only during storms. Phosphorus in Sand Creek is generally low, especially compared to Coon Creek.

  Management discussion: Some stormwater treatment retrofits, including a new stormwater pond and network of rain gardens, were installed in 2012. These activities, and others like them, will be helpful in lowering storm-related phosphorus in Sand Creek. Achieving state water quality standard compliance is within reach for Sand Creek.

- Suspended solids and turbidity are reasonably low in Sand Creek, with the exception of occasional higher readings during storms further downstream. Median TSS is low compared to the state water quality standard of 30 mg/L.

  Management discussion: Because TSS approaches state standards during storms, and because it flows into Coon Creek which has high suspended solids, continued efforts should be made to lower these pollutants in Sand Creek. The Coon Creek Watershed District is installing projects toward this end.

- pH and dissolved oxygen were with the range considered normal and healthy for streams in this area.

- E. coli bacteria are high throughout Sand Creek during storms, and the problem increases downstream.

  Management discussion: Because E. coli is pervasive in the environment and neighborhoods there will be difficulty reducing E. coli levels below state water quality standards. Addressing E. coli should be part of an effort to improve overall water quality.

Conductivity, Chlorides, and Salinity

Conductivity and chlorides are measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial sources, agricultural chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we use. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides measures for chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community; however it is also noteworthy that Sand Creek is upstream from the drinking water intakes on the Mississippi River for the Twin Cities.

Sand Creek dissolved pollutant levels are often double the level typically found in Anoka County streams, but lower than the levels that broadly impact stream biota (see table and figures below). Considering all sites for all years, median conductivity in Sand Creek is almost two times the median for all Anoka County streams (0.704 mS/cm compared to 0.362 mS/cm for the county overall).

It's not surprising that Sand Creek, which lies in a suburban area, would have greater dissolved pollutants than the county-wide median. The county spans rural to urban areas. Sand Creek's upper watershed has an abundance of current and retired sod farms, where a variety of chemicals is used. The watershed also has an abundance of roads, which are treated regularly with deicing salts. Urban stormwater runoff, which is most abundant in the lower watershed, also contains a variety of other dissolved pollutants. Stormwater treatment practices such as catch basins and settling ponds are relatively ineffective at removing dissolved pollutants. Streams near Sand Creek in similar land use settings have similar dissolved pollutant levels.

From upstream to downstream there is little change in dissolved pollutants in Sand Creek (see figures below). This suggests dissolved pollutant concentrations in all parts of the watershed are similar. Several of the tributaries have dissolved pollutants higher than the main stem.

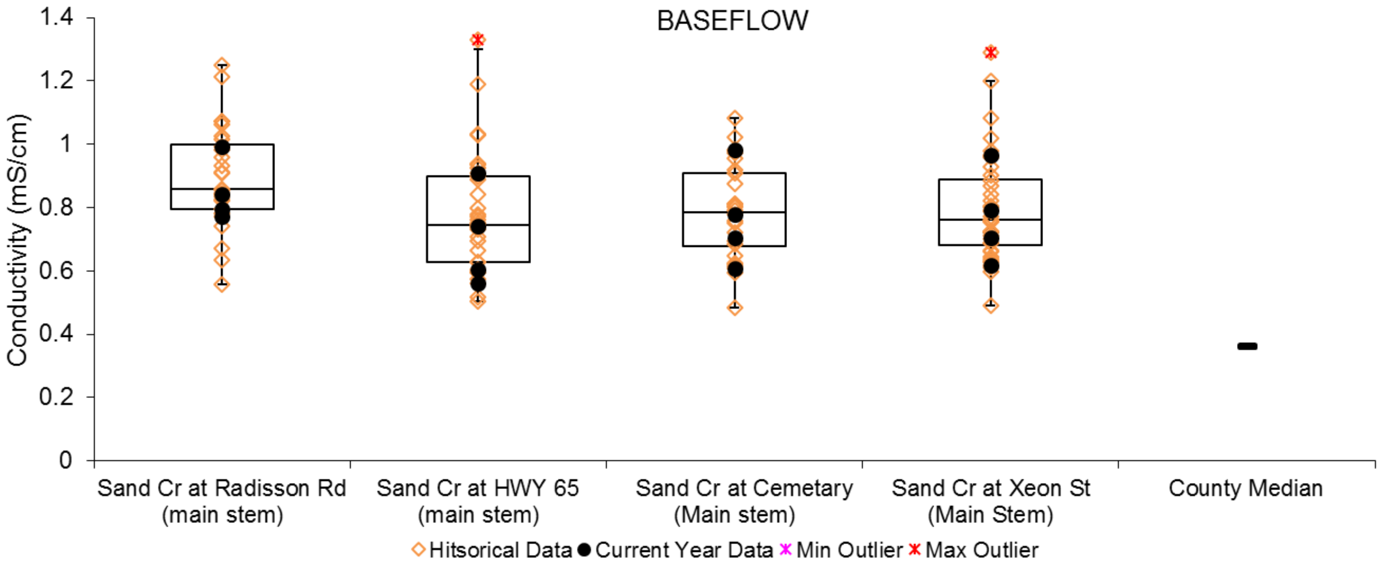
Dissolved pollutants were slightly lower during storms than during baseflow (see figures below). Dissolved pollutants can easily infiltrate into the shallow groundwater that feeds streams during baseflow. If this has occurred, dissolved pollutants will be high during baseflow. If road runoff was the primary dissolved pollutant source, then readings would be highest during storms. The median conductivity for Sand Creek at Xeon during baseflow was higher than during storms in 2016 (0.76 vs 0.60 mS/cm). The last time chlorides were monitored the mean of all Sand Creek sites during baseflow were 11% higher than during storms (68 vs 61 mS/cm). This is not to say that rain runoff is free of dissolved pollutants; rather the concentration is lower than in the shallow groundwater. From a management standpoint it's important to remember that the sources of both stormwater and baseflow dissolved pollutants are generally the same, and preventing their release into the environment and treating them before infiltration should be a high priority.

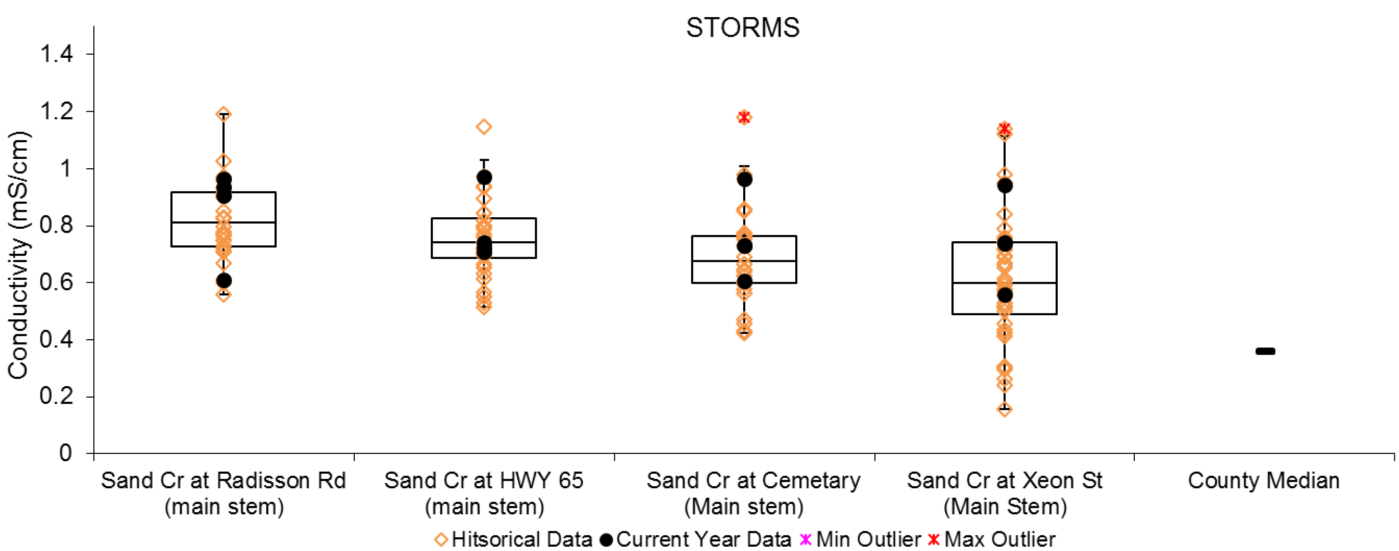
Sand Creek degrades Coon Creek with dissolved pollutants. Both creeks were monitored just before they join (Coon Cr at Lions Park and Sand Cr at Xeon). Across all years monitored, Sand Creek's median conductivity was 32% higher than Coon Creek (0.704 vs 0.533 mS/cm) before this junction. Sand Creek's median chlorides when last monitored were 42% higher than Coon Creek (74 vs 52 mg/L).

Median conductivity and chlorides in Sand Creek. Data is from Xeon St for conductivity all years through 2016, for chlorides all years through 2012.

	Conductivity (mS/cm)	**Chlorides (mg/L)**	**State Standard**	**N**
Baseflow	0.760	75	Conductivity – none	40
Storms	0.60	63.45		40
All	0.704	71.65	Chlorides 860 mg/L acute, 230 mg/L chronic	80
Occasions > state standard				0

Conductivity at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Total Phosphorus

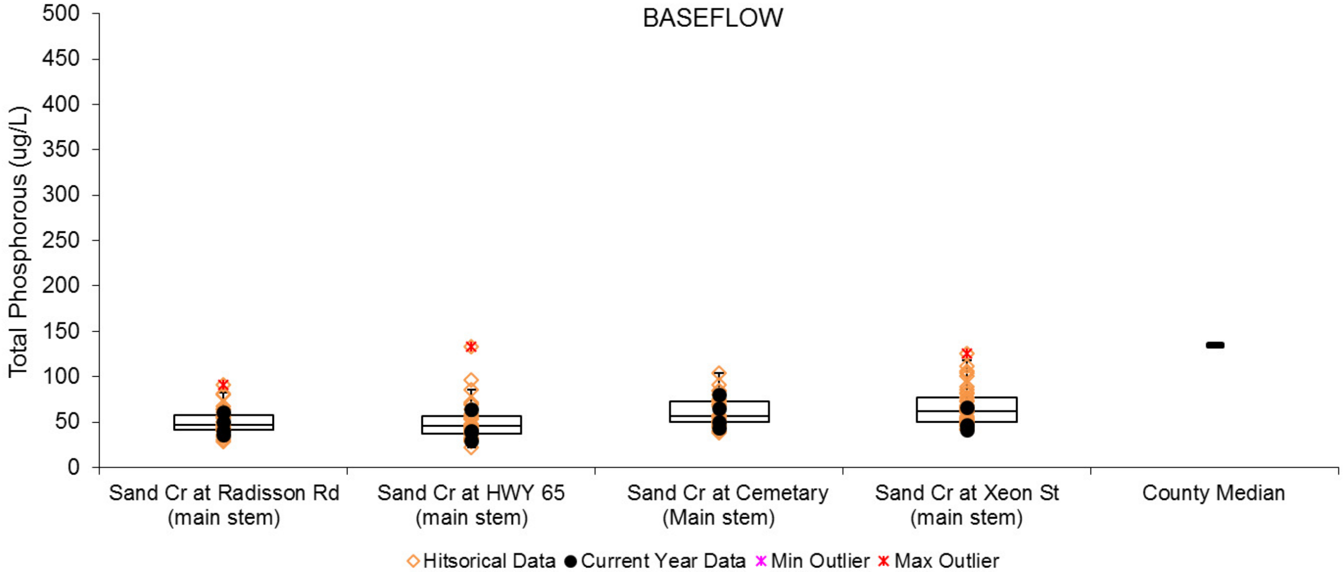
Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algae growth. TP was low in Sand Creek (see table and figures below). Median TP in Sand Creek at Xeon (all years) was 62 ug/L during baseflow and 92 ug/L during storm events. Both were below the median for Anoka County streams (135 ug/L) and below the water quality standard of the MN Pollution Control Agency (100 ug/L).

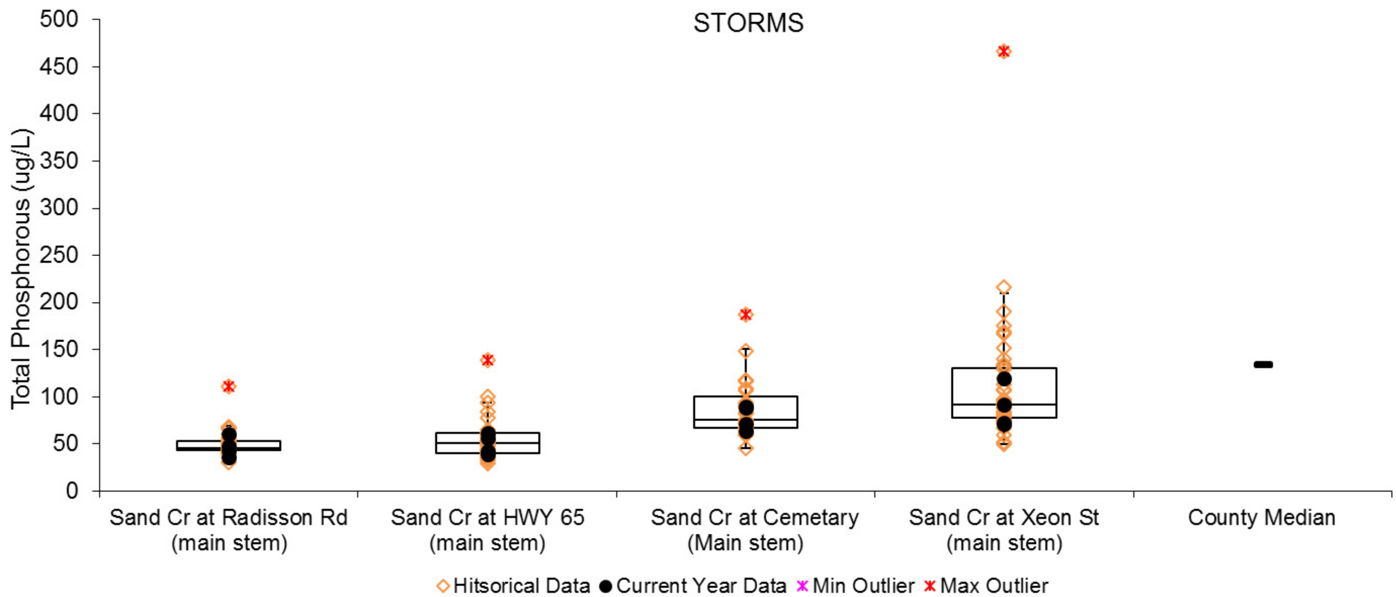
Nonetheless, Sand Creek does have occasions in which phosphorus exceeds state standards. While the median phosphorus level is below 100 ug/L, the stream at Xeon Street exceeds that level in 25% of samples. Most of these exceedances (15 of 20) occured during storms. Retrofitting stormwater treatment for improved phosphorus capture is already a priority of the Coon Creek Watershed District; a new stormwater pond and network of rain gardens were installed in 2012.

Median total phosphorus in Sand Creek. Data is from Xeon St for all years through 2016.

	Total Phosphorus (ug/L)	State Standard*	N
Baseflow	62	100	40
Storms	92		39
All	77		79
Occasions > state standard			15 during storms, 5 baseflow

Total phosphorus at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Total Suspended Solids and Turbidity

Total suspended solids (TSS) and turbidity both measure solid particles in the water. TSS measures these particles by weighing materials filtered out of the water. Turbidity measures by diffraction of a beam of light sent though the water sample, and is therefore most sensitive to large particles.

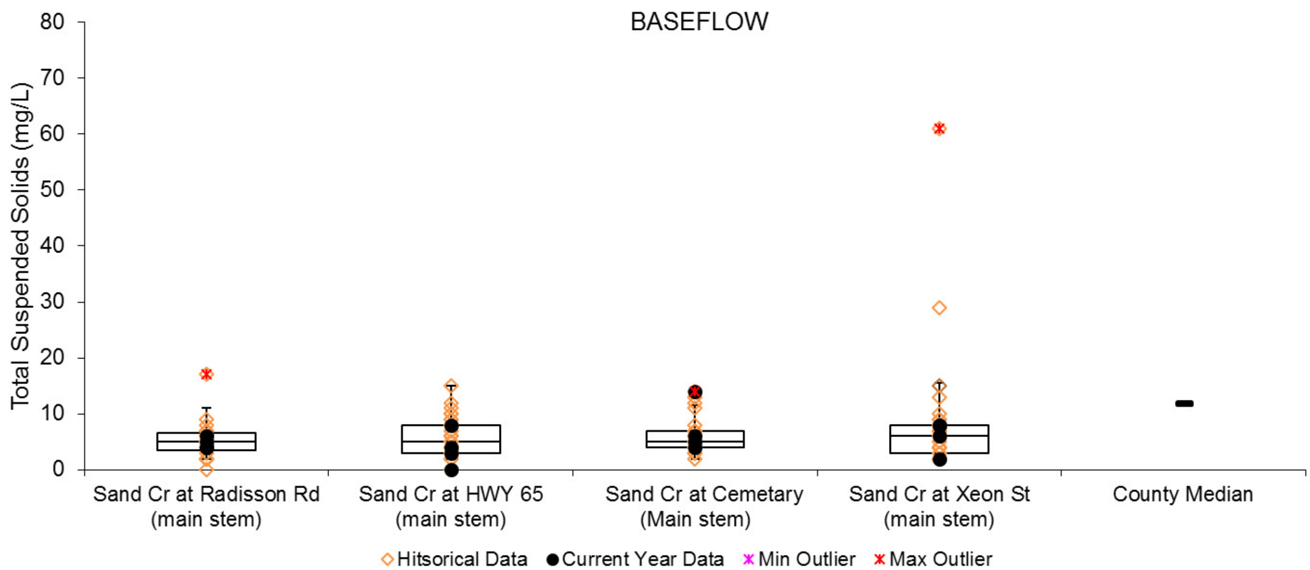
TSS and turbidity are reasonably low in Sand Creek, with the exception of occasional higher readings during storms at Xeon Street (farthest downstream). At Xeon Street, median TSS (all years) during baseflow was 5 mg/L, but it was 12 mg/L during storms. Both are low compared to the state water quality standard of 30 mg/L, but that standard was exceeded in six individual samples (7.5%) historically. None of these exceedances occurred in 2016.

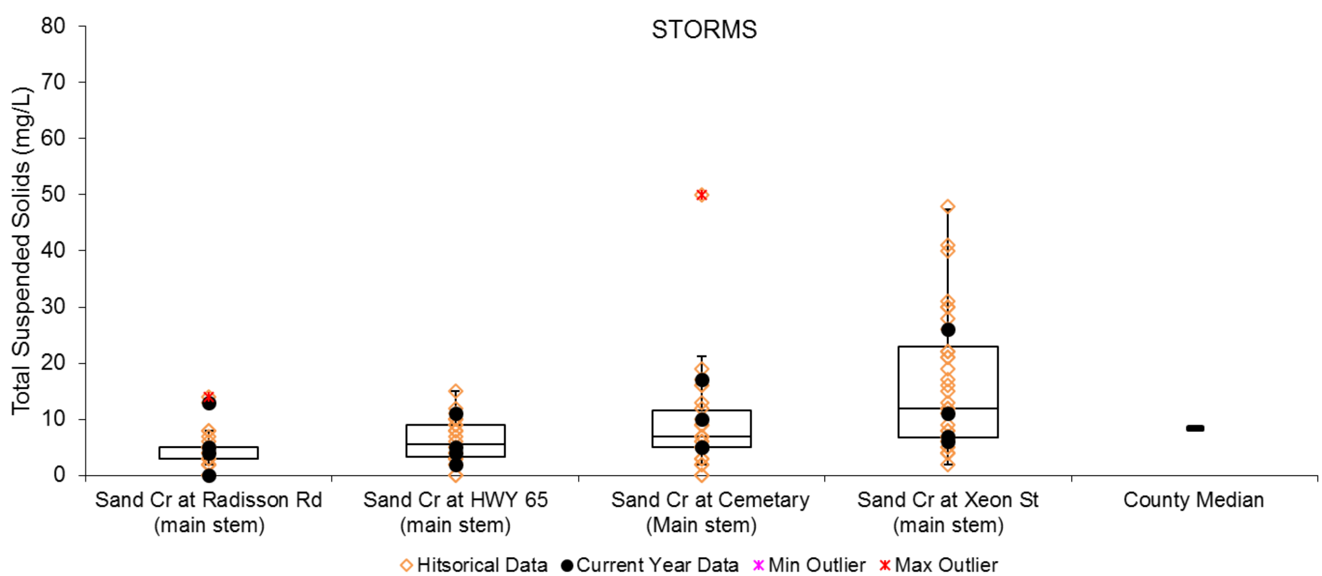
Because it does occasionally approach the water quality standard, and because it flows into Coon Creek which has high suspended solids, efforts should be made to lower these pollutants in Sand Creek.

Median turbidity and suspended solids in Sand Creek. Data is from Xeon St for all years through 2016.

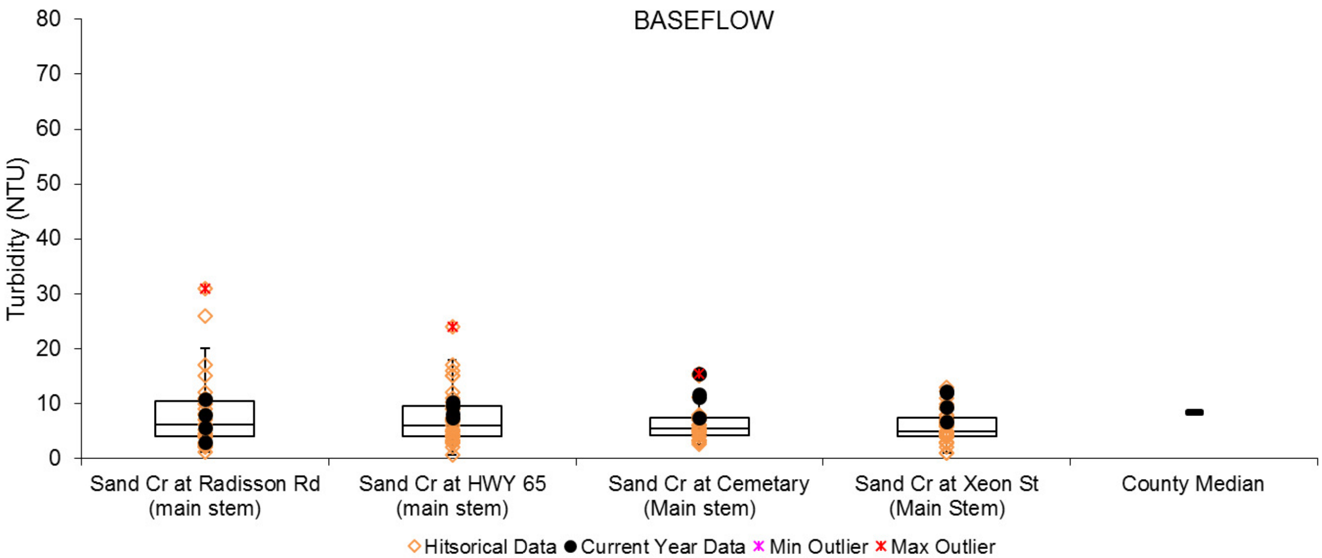
	Turbidity (FNRU)	Total Suspended Solids (mg/L)	State Standard	N
Baseflow	5.0	6.0	30 mg/L TSS	40
Storms	12.0	12.0		40
All	9.0	7.0		80
Occasions > new state TSS standard				5 during storms, 1 baseflow

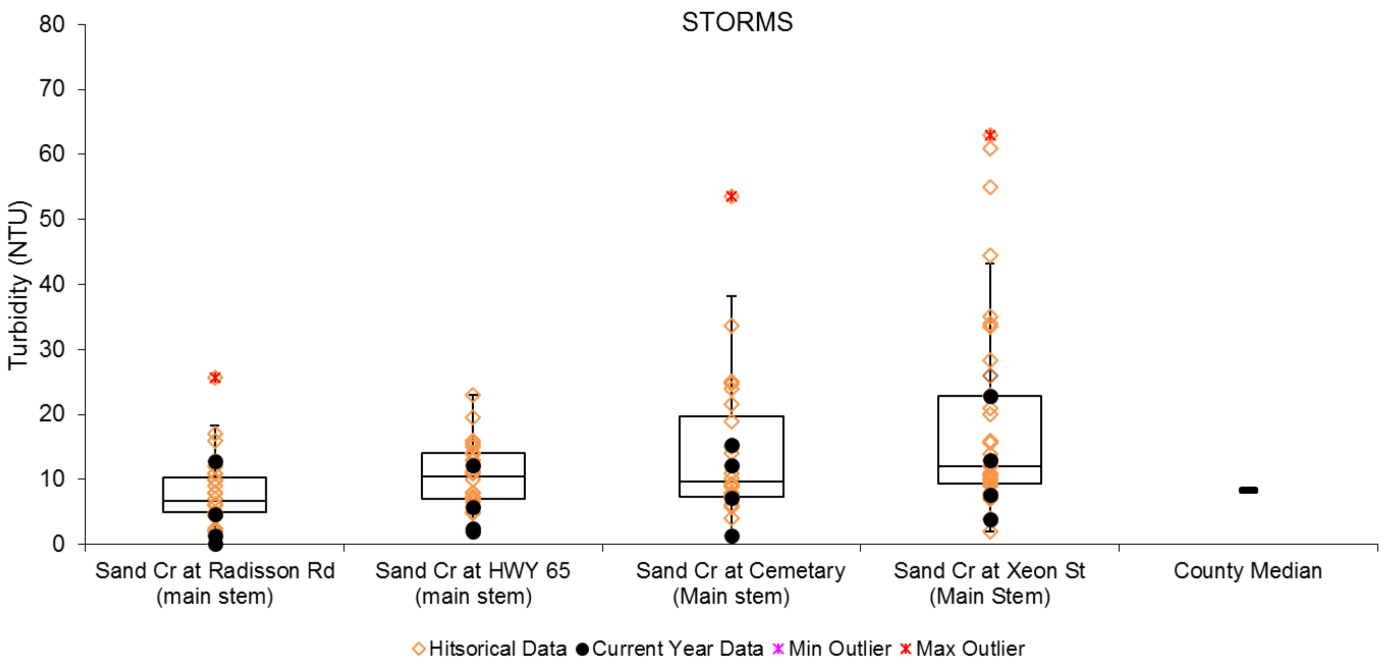
Total suspended solids at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





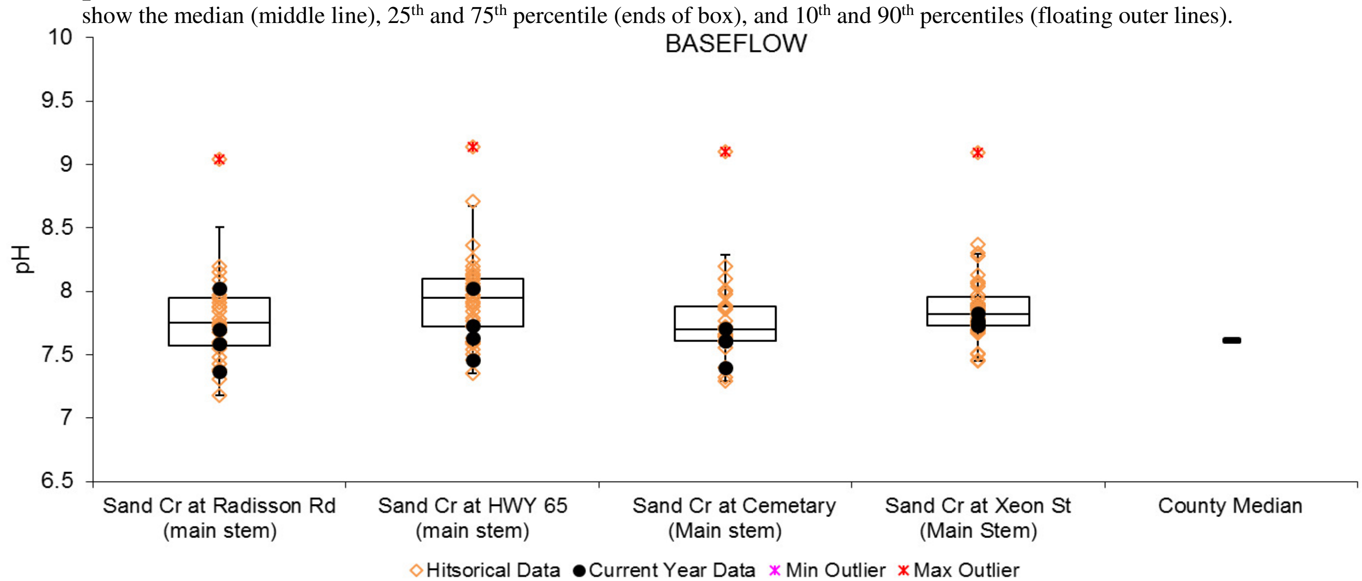
pH

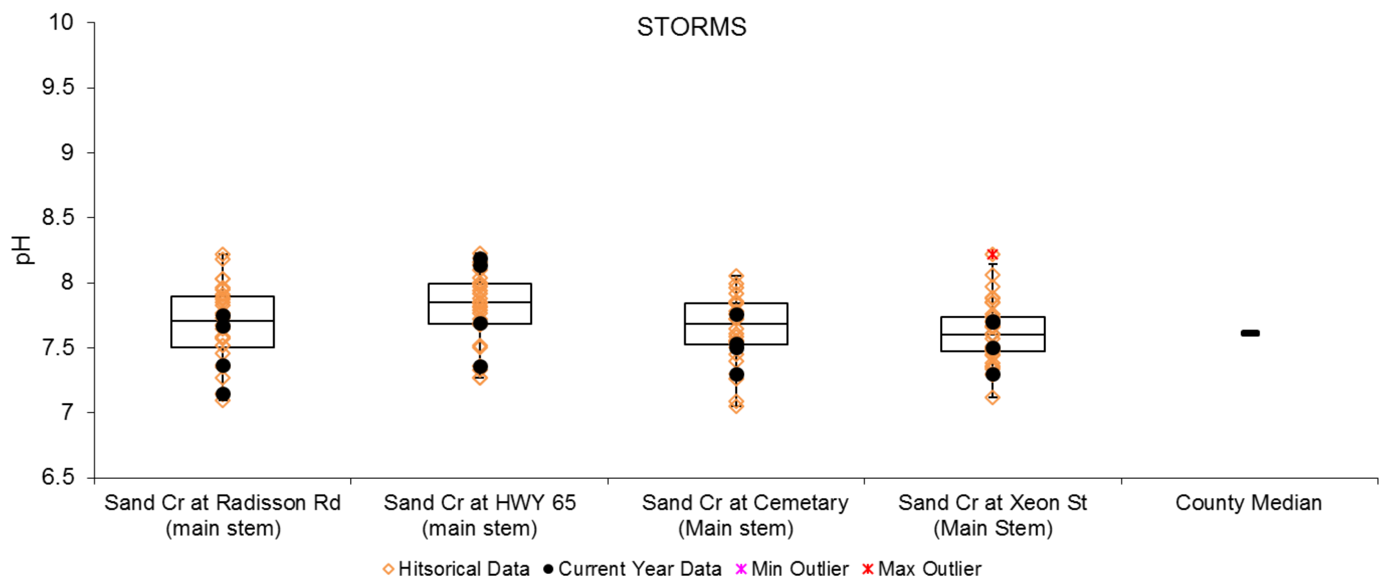
Sand Creek pH for 2016 remained within the acceptable range at all sites and during all conditions (see figures below), ranging from 7.15 to 8.19. The median for all conditions at Xeon was 7.74. The Minnesota Pollution Control Agency water quality standards set a range for pH to remain between 6.5 and 8.5. pH was lower during storms because rainwater has a lower pH.

Median pH in Sand Creek. Data is from Xeon St for all years through 2016.

	pH	State Standard	N
Baseflow	7.82	6.5-8.5	39
Storms	7.64		38
All	7.74		77
Occasions outside state standard			1

pH at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Dissolved Oxygen

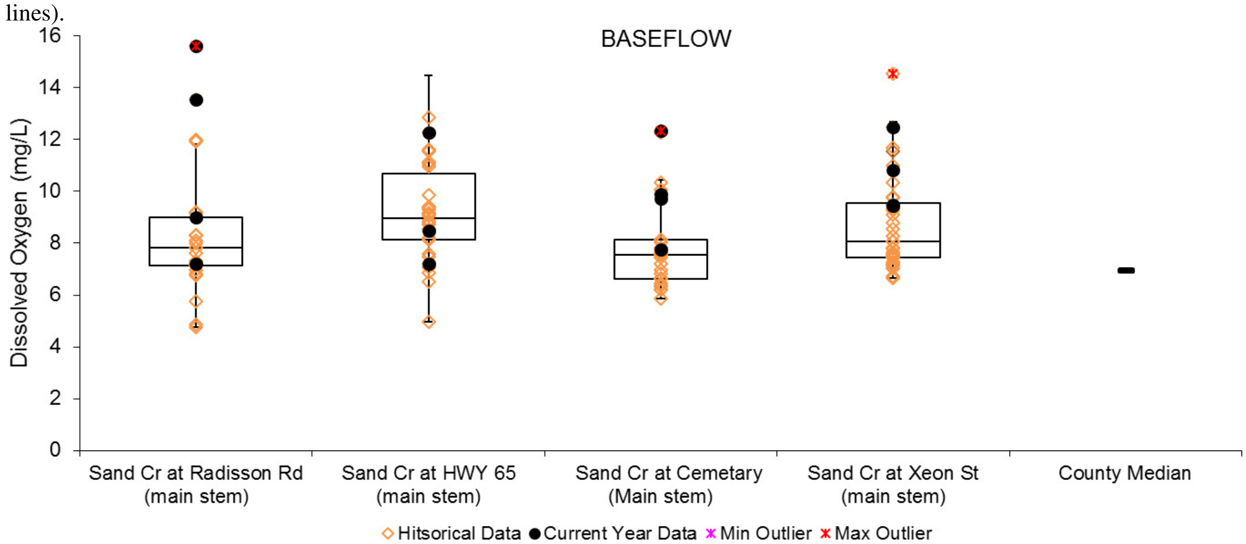
Dissolved oxygen (DO) is essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO falls below 5 mg/L. Low DO can be a result of organic pollution, the decomposition of which consumes oxygen.

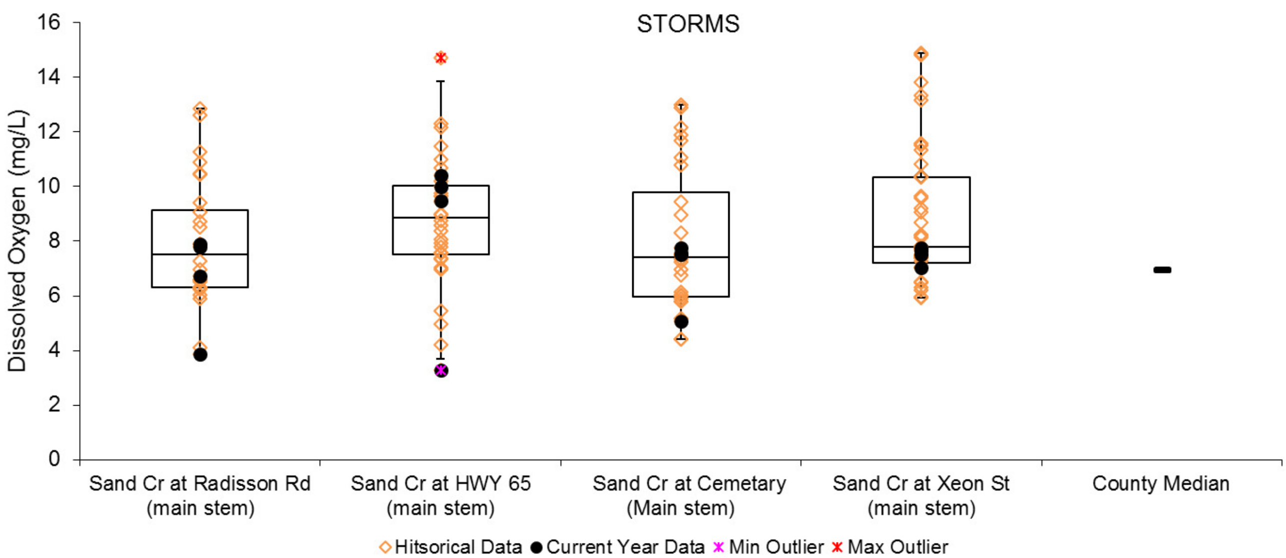
Dissolved oxygen in Sand Creek is generally compliant with state standards (>5 mg/L), falling below this on 13% of samples historically (see table figure below). On ten occasions of all the years monitored at each site, DO dropped below 5 mg/L. Overall, we do not have concerns about dissolved oxygen levels in Sand Creek, but it will continue to be monitored.

Median dissolved oxygen in Sand Creek. Data is from Xeon St for all years through 2016.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.07	5 mg/L daily minimum	38
Storms	7.78		40
All	7.94		78
Occasions <5 mg/L			0 at Xeon St., 10 at other sites

Dissolved Oxygen at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating lines).





E. coli

E. *coli* is a bacteria found in the feces of warm blooded animals. E. *coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets E. *coli* standards for contact recreation (swimming, etc.). A stream is designated as “impaired” if 10% of measurements in a calendar month are >1260 most probable number per 100 milliliters of water (MPN) or if the geometric mean of five samples taken within 30 days is greater than 126 MPN.

Our data are not sufficient to determine if the MPCA standards are met. We took samples throughout summer, often with only 1-2 samples in each month, too little for calculation of a monthly geometric mean or to reasonably say that 10% of samples in a month were in exceedance. We can, however, perform other examinations of the data.

During baseflow E. *coli* was moderate and showed slight upstream to downstream increase after highway 65 Median E. *coli* during baseflow for all years from upstream to downstream were 159, 15.5, 77.5, and 180 MPN, respectively. Other than Sand Creek at Highway 65, E. *coli* levels during baseflow exceeded 126 MPN in one of four baseflow samples at each site in 2016.

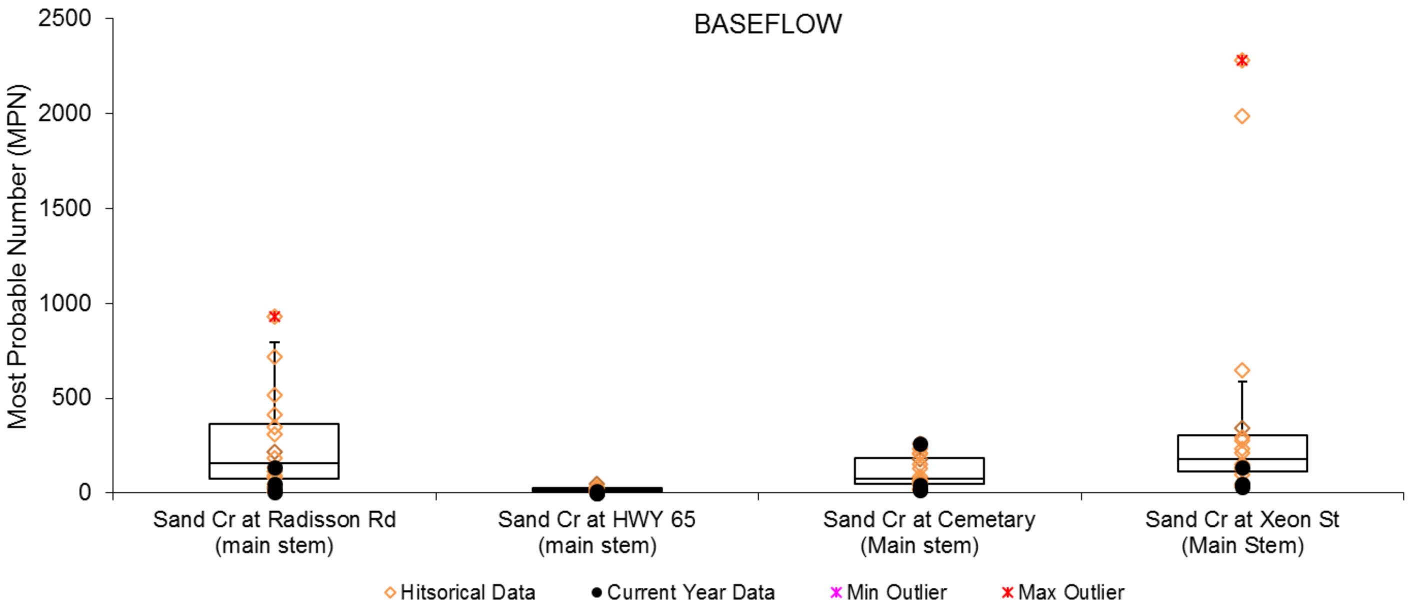
During storms E. coli was significantly higher and more variable, and there was modest increase from upstream to downstream after Highway 65. Median E. *coli* during storms for all years from upstream to downstream were 345, 42.7, 250 and 609 MPN, respectively. Excluding the highway 65 site, E. *coli* levels during storms in 2016 exceed the 126 MPN in all samples but one at each sample location.

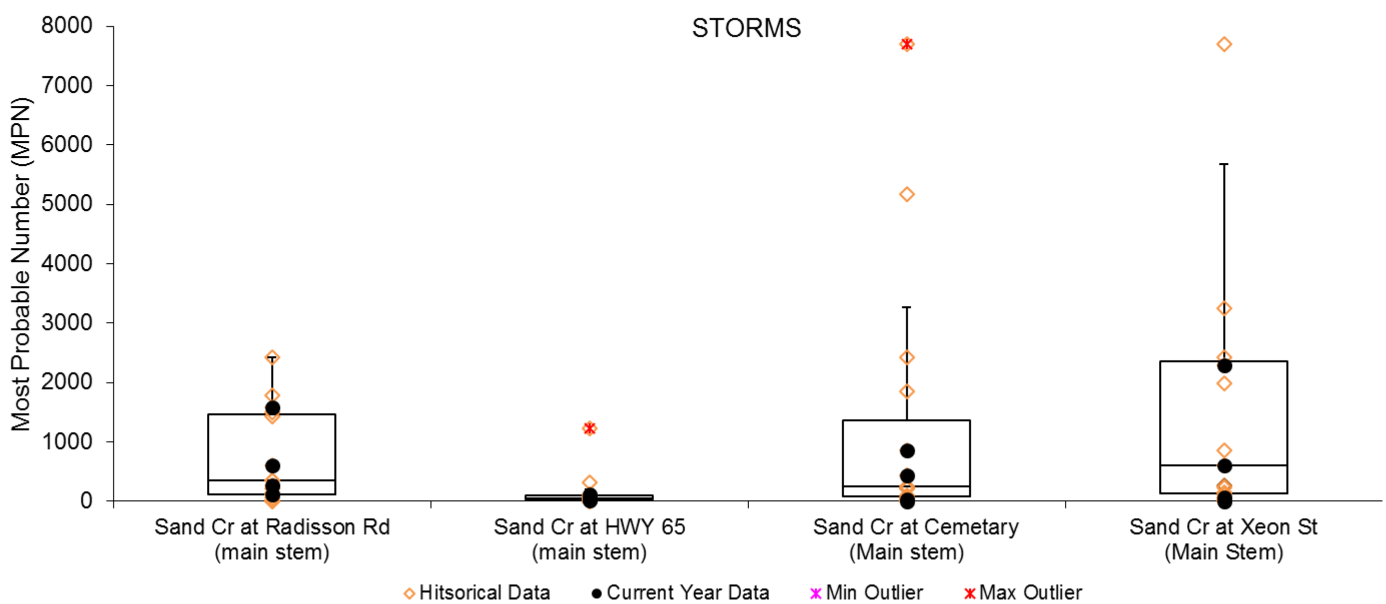
It is notable that E. coli levels are quite elevated at Sand Creek at Radisson Road, the furthest upstream site. These levels then decline through the series of stormwater ponds and development before Highway 65 where levels are quite low compared to all other sites. Levels quickly rebound after Highway 65 before the creek reaches the cemetery.

Median E. *coli* in Sand Creek. Data is from All Sites for all years through 2016.

	E. *coli* (MPN)	**State Standard**	**N**
Baseflow	88.5	Monthly Geometric Mean >126	64
Storms	225		64
All	127.4		128
Occasions >126 MPN		Monthly 10% average >1260	27 baseflow, 34 storm
Occasions >1260 MPN			2 baseflow, 15 storm

E. *coli* at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating lines).





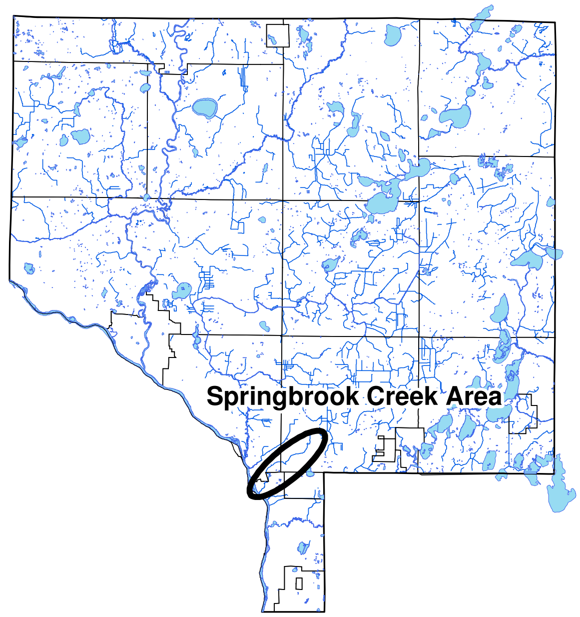
SPRINGBROOK CREEK

Springbrook at University, Blaine	STORET SiteID = S007-542
Springbrook at 85th Avenue, Fridley	STORET SiteID = S007-543
Springbrook at 79th Way, Fridley	STORET SiteID = S006-140

Years Monitored

Springbrook at University 2013-2016
Springbrook at 85th Avenue 2013-2016
Springbrook at 79th Way 2012-2016

Other sites around the Springbrook Nature Center were monitored on a few occasions in the early 2000s but are not included in this report.



Background

Springbrook is a small waterway draining an urbanized and highly modified subwatershed. The watershed includes portions of the Cities of Blaine, Coon Rapids, Spring Lake Park and Fridley. Several tributaries, or stormwater systems contributing to the creek, join at the Springbrook Nature Center Impoundment. From the outlet of the Nature Center, the Creek flows a short distance to the Mississippi River. At its outlet, Springbrook is about 10 feet wide and 1 foot deep at baseflow. The stream is flashy, with water levels that increase dramatically following rainfall and quickly recede thereafter.

In the early 2000s Springbrook was the subject of a multi-partner project to monitor and improve water quality. Funding was from a MN Pollution Control Agency grant and the City of Fridley served as a fiscal agent. During that effort, several projects to better treat stormwater and rehabilitate the nature center impoundment were initiated. Water quality monitoring at that time produced little data, but enough to indicate sizable water quality and hydrology problems existed.

Springbrook Creek is listed as "impaired" by the MN Pollution Control Agency for biota, but new methods (Tiered Aquatic Life Standards) currently under development will take into consideration the fact that the creek is a public ditch and therefore has lower aquatic life expectations, at least in some reaches. While recent monitoring data is insufficient to officially assess Springbrook for other impairments, the data to date suggest that other impairment designations are possible in the near future.

Methods

Springbrook was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were taken each year; half during baseflow and half following storms. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. In cases, especially during drought years, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Eleven water quality parameters were tested. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus and total suspended solids. During every sampling event, the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using an electronic continuous data logging device.

Results and Discussion

Springbrook Creek has some prominent water quality concerns. While it is currently listed as impaired by the State only for poor invertebrate biota, these data suggest that other impairments exist. Chlorides, phosphorus, and suspended solids all approach or exceed State standards at least occasionally.

Following is a parameter-by-parameter summary and management discussion:

- Dissolved pollutants, as measured by conductivity and chlorides, are higher in Springbrook than any other Anoka County stream except nearby Pleasure Creek, which has similar levels. Conductivity has reached four times the median for Anoka County streams, while chlorides have reached nine times the county median when measured in past years. Both were elevated during storms and baseflow, but consistently higher conductivity was recorded during baseflow. On one of eight past monitoring occasions the state chronic standard for chlorides was exceeded.

  Management discussion: Dissolved pollutants enter the stream both directly through surface runoff and also by infiltrating into the shallow groundwater that feeds the stream during baseflow. A variety of sources appear to be likely, including road deicing salts and road runoff. Preventing their release into the environment is important because they are not easily removed.

- Phosphorus was moderate to high in Springbrook Creek, and similar to other nearby waterbodies. Phosphorus is consistently highest during storms in Springbrook, but often exceeds the proposed 100 ug/L limit during baseflow as well.

  Management discussion: Additional treatment within the stormwater conveyance system will help reduce phosphorus.

- Suspended solids and turbidity are low in Springbrook during baseflow, but during storms the downstream site approaches or exceeds the proposed state water quality standard rarely.

  Management discussion: Additional treatment within the stormwater conveyance system will help reduce suspended solids.

- pH and dissolved oxygen were with the range considered normal and healthy for streams in this area. pH during baseflow conditions is slightly elevated, though rarely exceeds the state standard.

- E. coli bacteria are extremely high in Springbrook Creek during storm events.

  Management discussion: Because E. coli is pervasive in the environment and neighborhoods there will be difficulty reducing E. coli levels below state water quality standards. Addressing E. coli should be part of an effort to improve overall water quality.

Conductivity, Chlorides, and Salinity

Conductivity and chlorides are measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial sources, agricultural chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we use. It measures the electrical conductivity of water; pure water with no dissolved constituents has zero conductivity. Chlorides measures for chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community; however, it is also noteworthy that Springbrook Creek discharges into the Mississippi River just upstream from drinking water intakes for the Twin Cities.

Conductivity and chlorides in Springbrook Creek are higher than at any other stream in Anoka County, except nearby Pleasure Creek with similar levels. Springbrook dissolved pollutant levels are multi-fold higher than the concentrations typically found in Anoka County streams and approaching levels that impact stream biota (see table and figures below). Median conductivity in Springbrook was more than two times greater than the median for all Anoka County streams (0.864 mS/cm compared to 0.362 mS/cm). Median conductivity at 79th Way (all years) was high, both during storms events (0.832 mS/cm) and baseflow (0.932 mS/cm).

Chlorides were even higher – nine times higher than the average of other Anoka County streams. The Springbrook median for chlorides at 79th Way (all years) was 159 mg/L compared to 17 mg/L for other Anoka County streams. Median chlorides during storms (216 mg/L) was higher than during baseflow (129 mg/L). During one storm event, chlorides were 253 mg/L, which exceeds the Minnesota Pollution Control Agency's chronic water quality standard of 230 mg/L. No monitoring occurred during snowmelt or mid-winter, when chlorides may have been higher. Chlorides were last monitored in 2012.

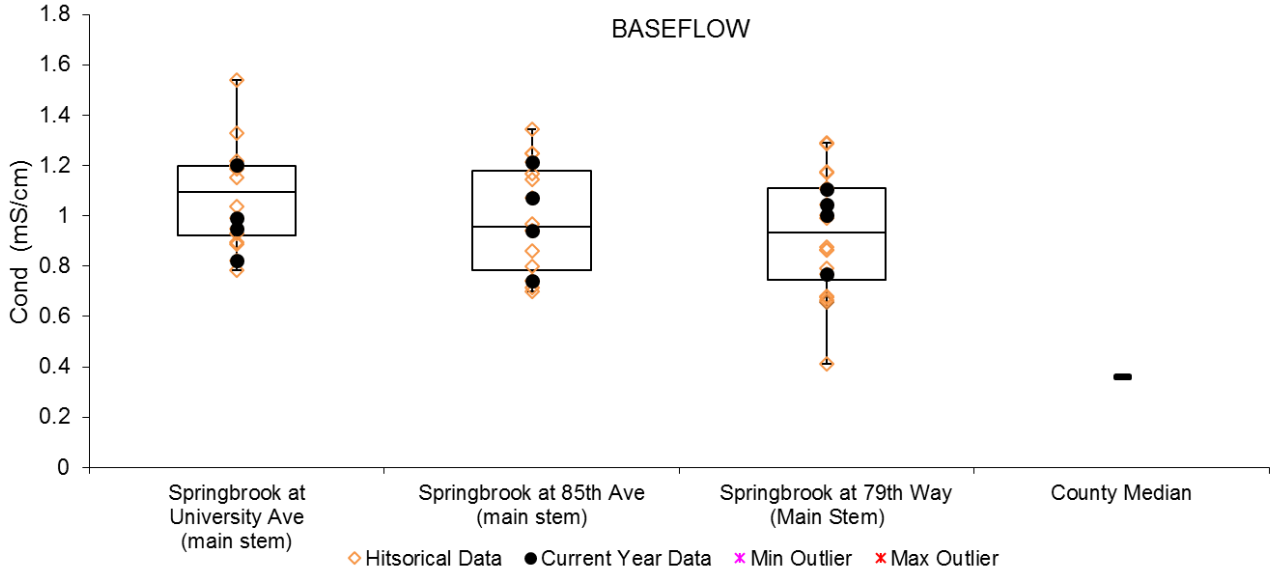
Springbrook's high dissolved pollutants are likely from stormwater runoff, with road deicing salts as one, but not the only, contributor. Greater road densities and a long history of road salting contribute to high chlorides. Chlorides are persistent in the environment and not effectively broken down by stormwater treatment or time. They migrate into the shallow groundwater that feeds the stream during baseflow. This explains why chlorides are high during baseflow. However, at Springbrook, stormwater runoff also carries high concentrations of dissolved pollutants. This is unlike most area streams where baseflow dissolved pollutants are markedly higher, and road deicing salts are likely the largest culprit. The water washing off roads, roofs, and parking lots contains a mixture of different dissolved pollutants.

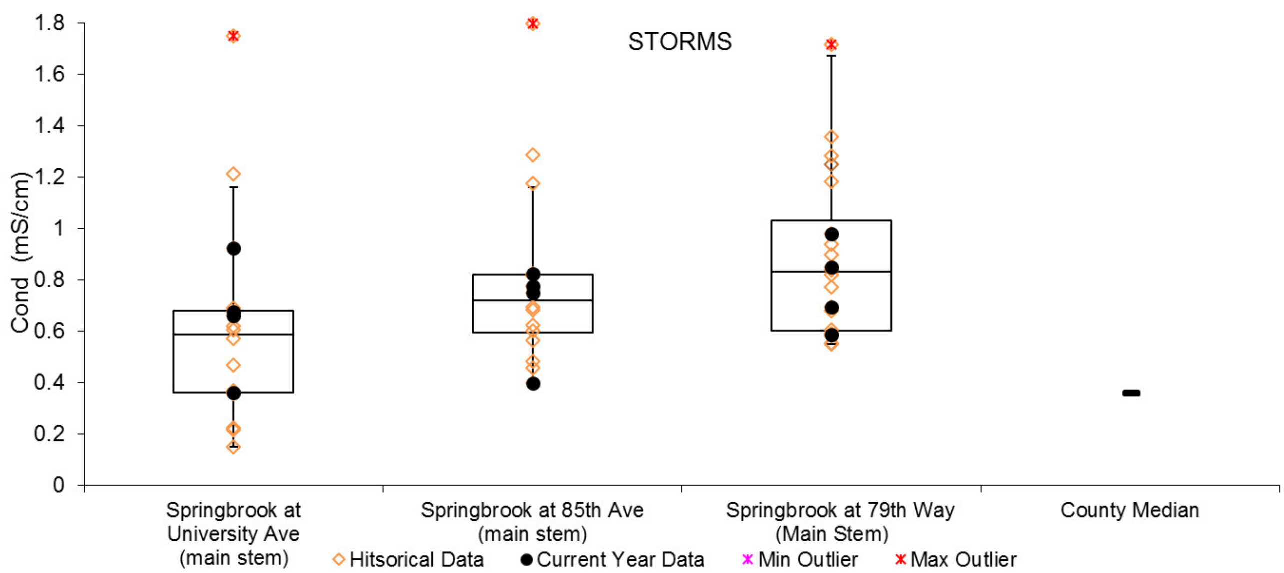
Dissolved pollutants are especially difficult to manage once in the environment. They are not removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also risk contaminating groundwater. The first approach to dissolved pollutant management must be to minimize their release into the environment.

Median conductivity and chlorides in Springbrook Creek. Data is from 79th Way for conductivity all years through 2016, for chlorides all years through 2012.

	Conductivity (mS/cm)	Chlorides (mg/L)	State Standard	N
Baseflow	0.932	129	Conductivity – none Chlorides 860 mg/L acute, 230 mg/L chronic	20
Storms	0.832	216		20
All	0.864	159		40

Conductivity at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Total Phosphorus

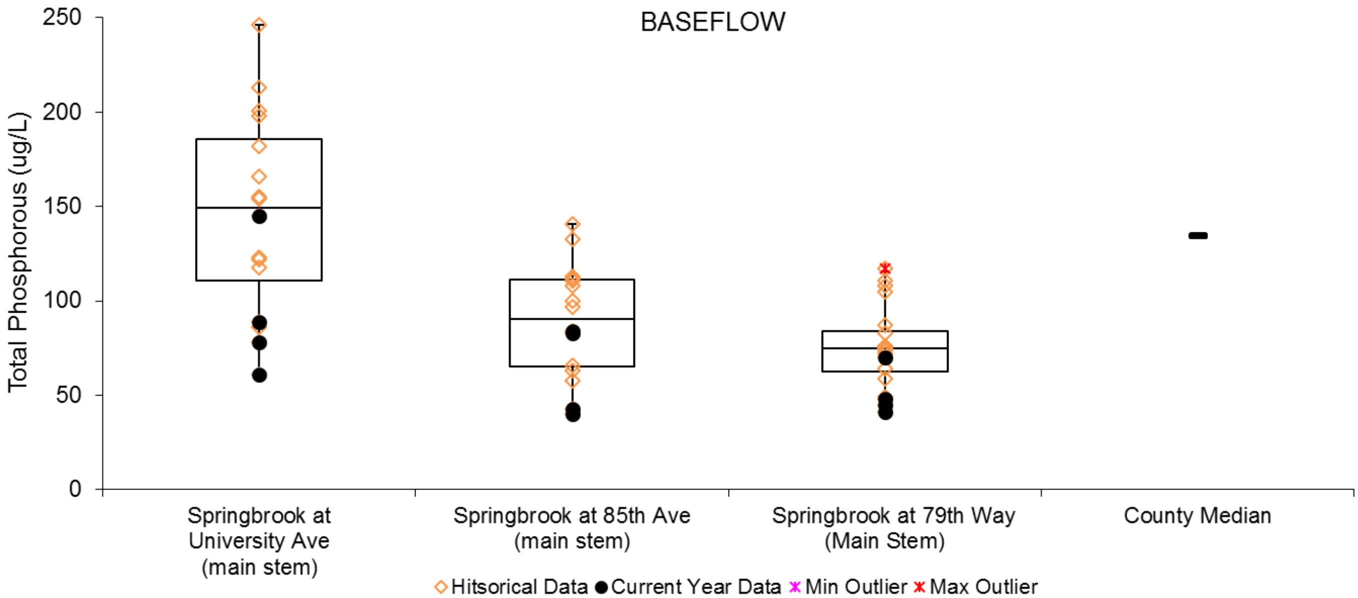
Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algae growth. In 2016, median Springbrook TP at 79th Way during baseflow (75 ug/L) and storm events (130.5 ug/L) were typical for Anoka County streams (135 ug/L; see table and figures below). It is interesting to note that during baseflow conditions, the ponds and wetlands between all of the sites appear to be reducing phosphorous levels.

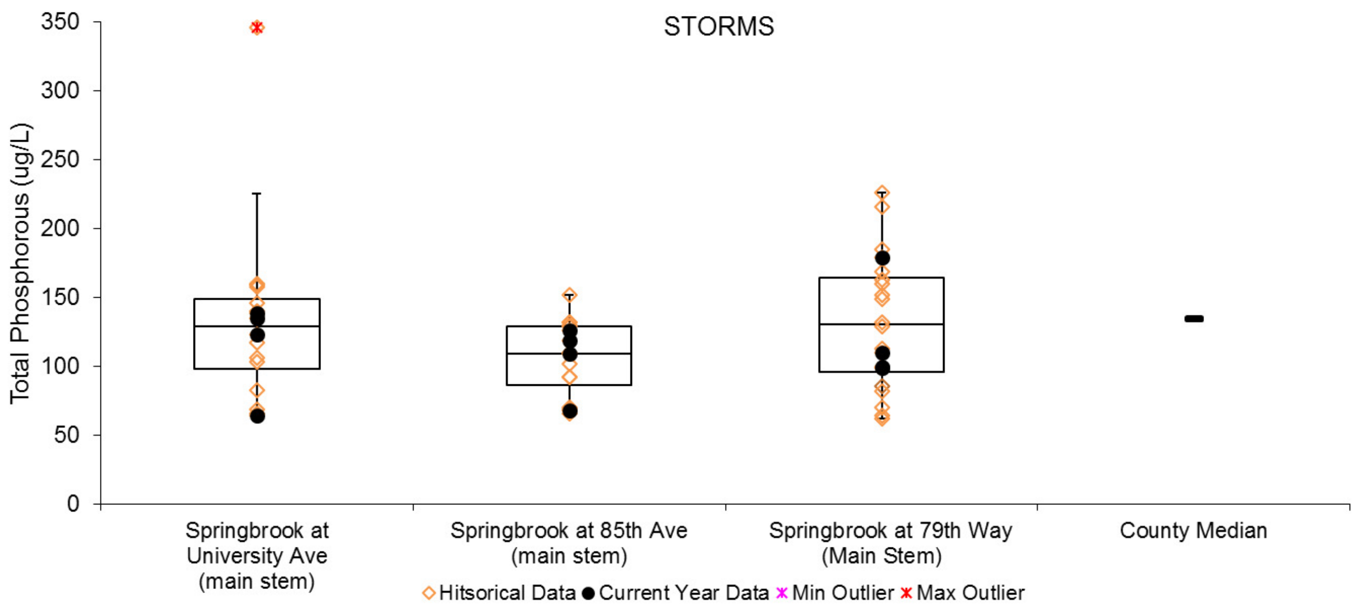
The MN Pollution Control Agency has a phosphorus standard for streams of 100ug/L. Based on data collected to date, Springbrook exceeds this standard often and may be designated as "impaired."

Median total phosphorus in Springbrook Creek. Data is from 79th Way for all years through 2016.

	Total Phosphorus (ug/L)	State Standard	N
Baseflow	75	100	20
Storms	130.5		20
All	86.5		40
Occasions > state standard			4 during Baseflow 14 During storms

Total phosphorus at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Total Suspended Solids and Turbidity

Total suspended solids (TSS) and turbidity both measure solid particles in the water. TSS measures these particles by weighing materials filtered out of the water. Turbidity is measured by the diffraction of a beam of light sent though the water sample, and is therefore most sensitive to large particles. Suspended solids are important because they carry other pollutants, affect water appearance, and can harm stream biota.

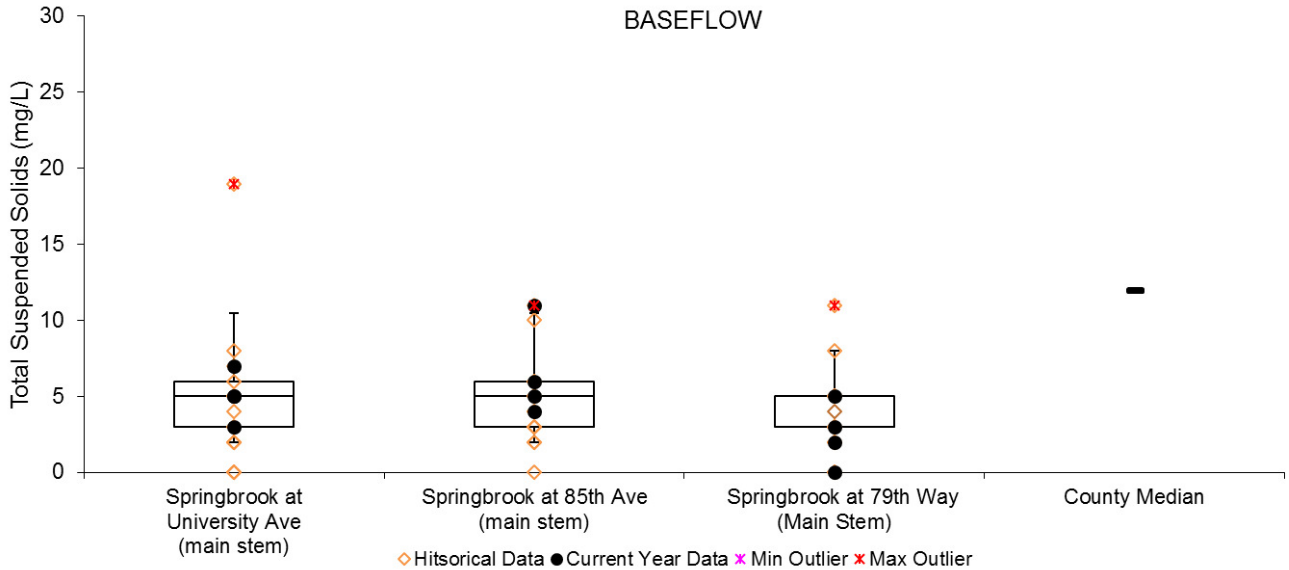
TSS and turbidity were both low during baseflow and higher during storms (see table and figures below). The highest observed TSS in 2016 was 31 mg/L, and the highest turbidity in 2016 was 35.4 NTU. During baseflow conditions, turbidity only exceeded 10 NTU once and even reach 0 NTU on one occasion in 2016. In 2016, TSS during baseflow never exceeded 11 mg/L and averaged less than 5 mg/L. Overall, these levels are low and within the desirable range for streams in this area.

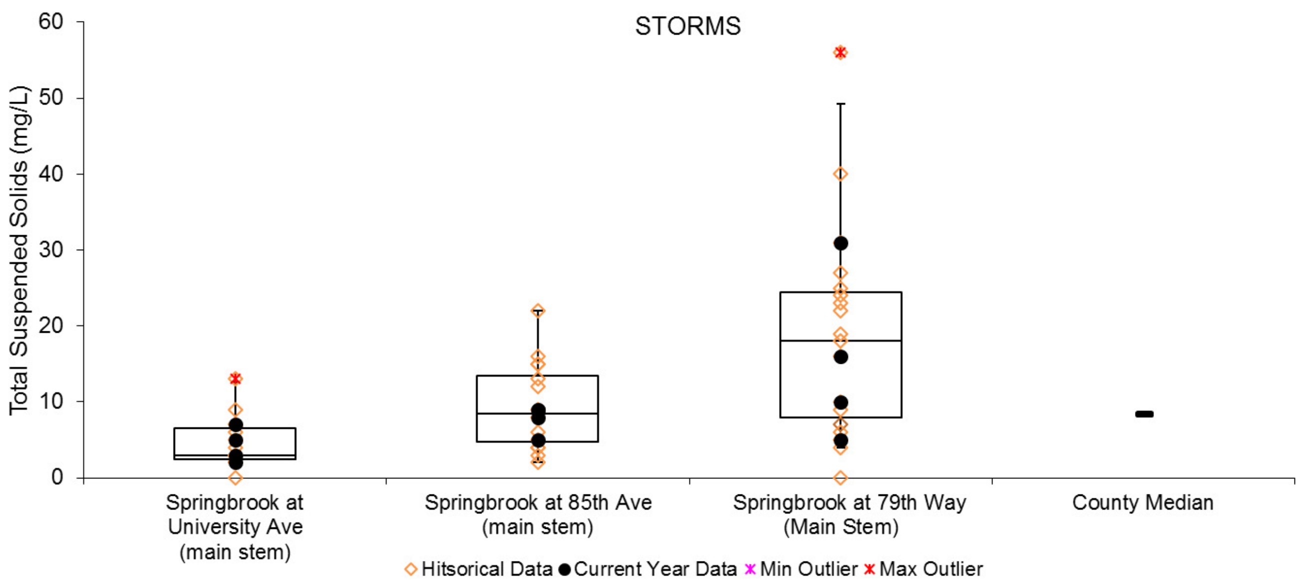
The MN Pollution Control Agency has a state standard for TSS of 30 mg/L. Only three of 104 samples collected at all sites on record have exceeded this standard. All three exceedances occurred at 79th way during storm events.

Median turbidity and suspended solids in Springbrook Creek. Data is from 79th Way for all years through 2016.

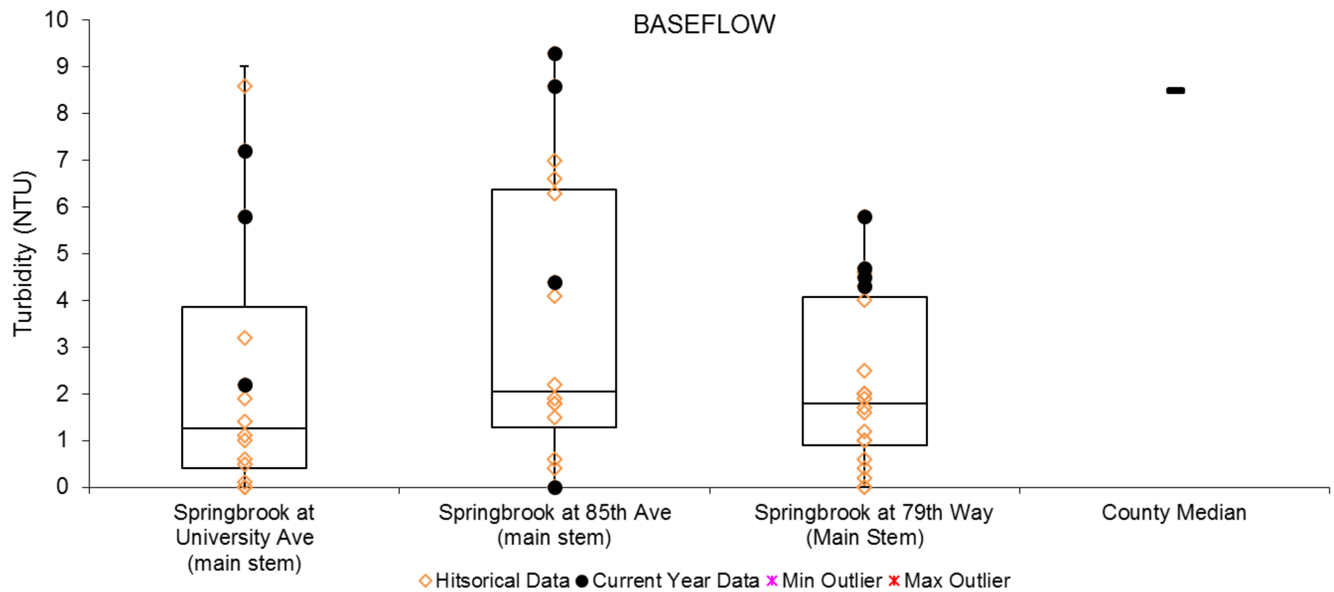
	Turbidity (FNRU)	Total Suspended Solids (mg/L)	State Standard	N
Baseflow	1.8	3	30 mg/L TSS	20
Storms	14.9	18		20
All	4.75	5.5		40
Occasions > state TSS standard				3

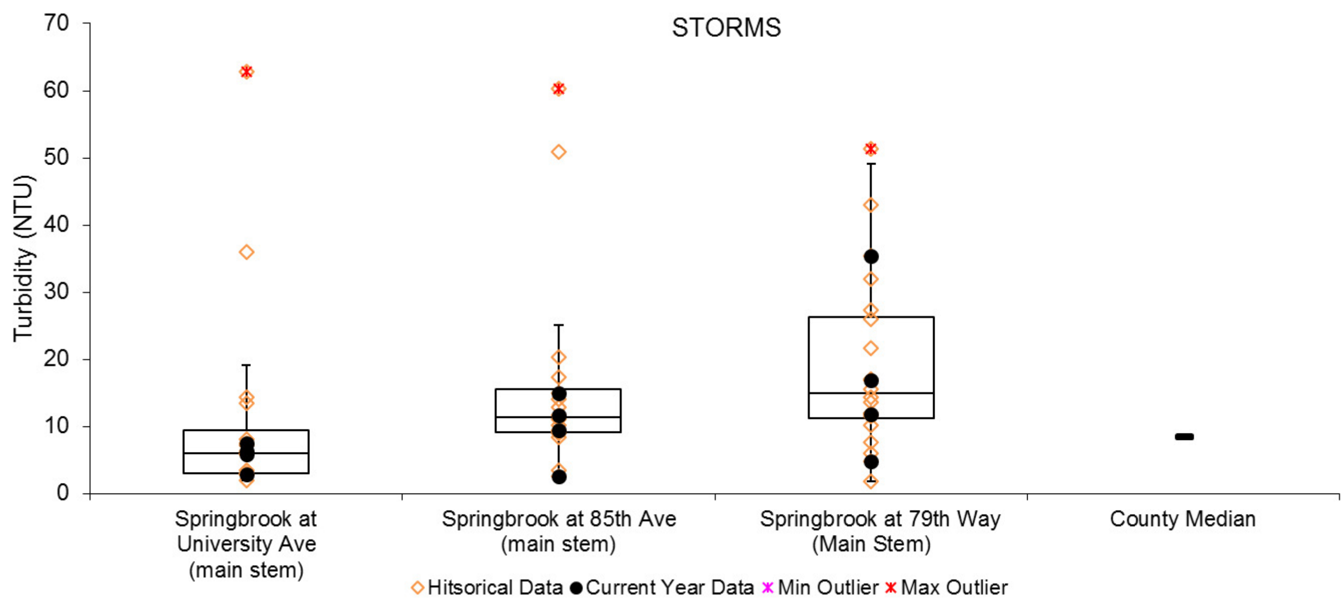
Total suspended solids at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





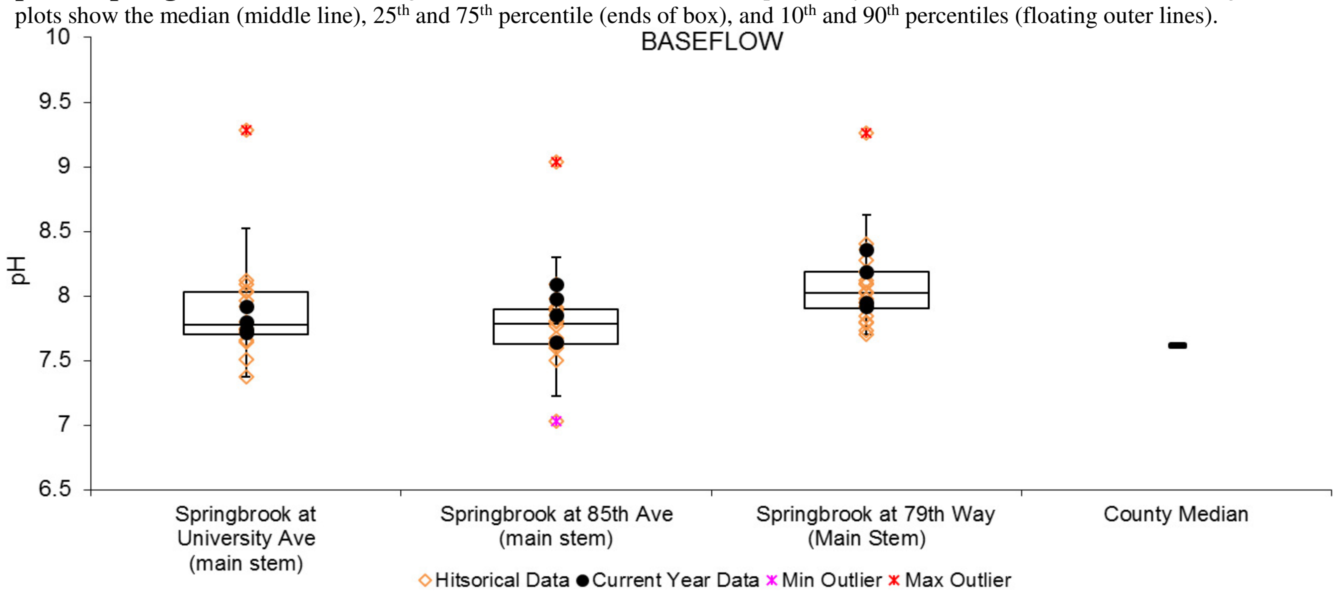
pH

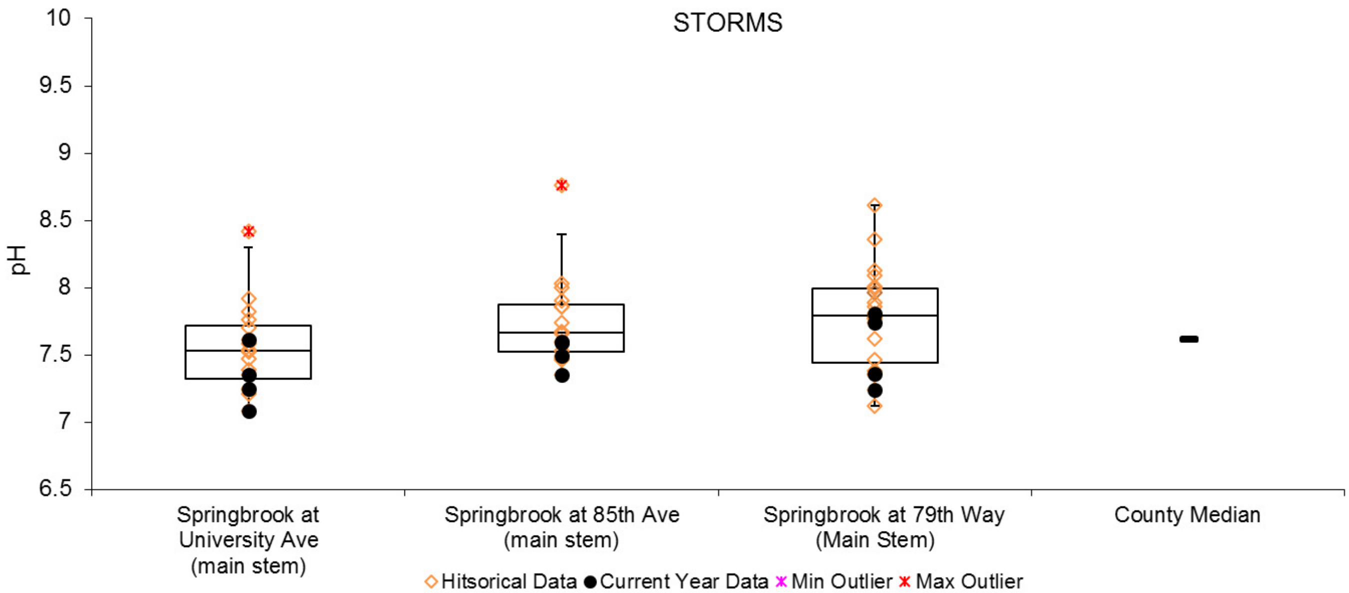
In 2016, Springbrook Creek pH remained within the expected range at all sites and all conditions. All measurements collected for Springbrook pH has ranged from 7.08 to 8.36. The Minnesota Pollution Control Agency water quality standards set the range for pH to remain between 6.5 and 8.5. Conditions during baseflow do have a median of 8.03, which is fairly high. Individual measurements do not exceed the state standard range often enough to warrant concern, but pH will continue to be monitored.

Median pH in Springbrook Creek. Data is from 79th Way for all years through 2016.

	pH	State Standard	N
Baseflow	8.03	6.5-8.5	20
Storms	7.80		20
All	7.95		40
Occasions outside state standard			1

pH at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





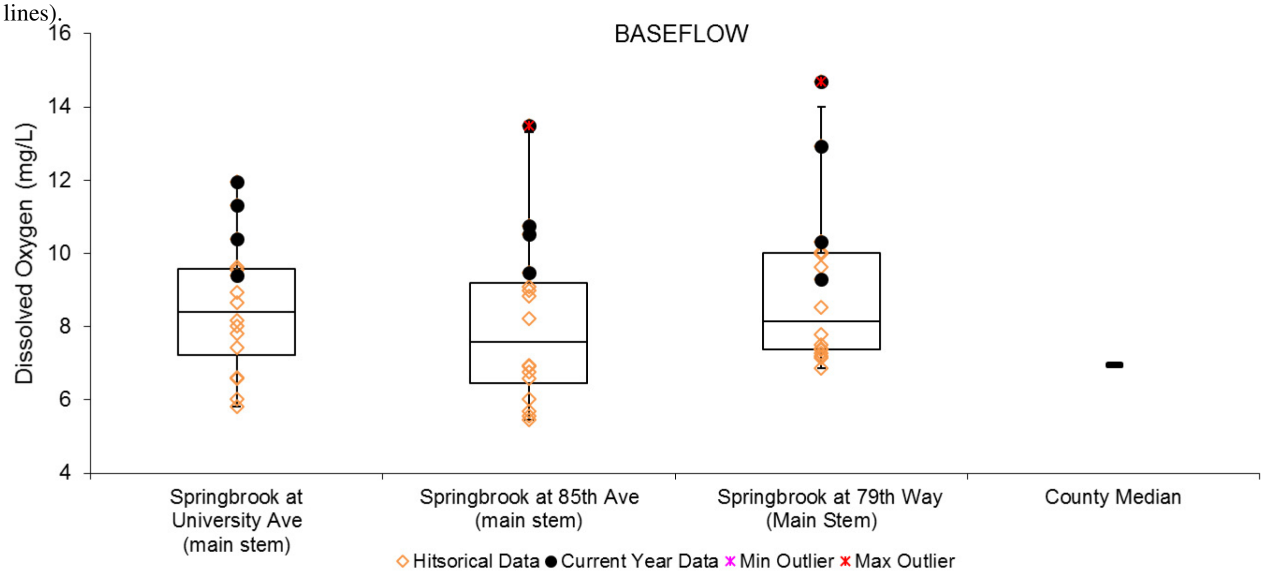
Dissolved Oxygen

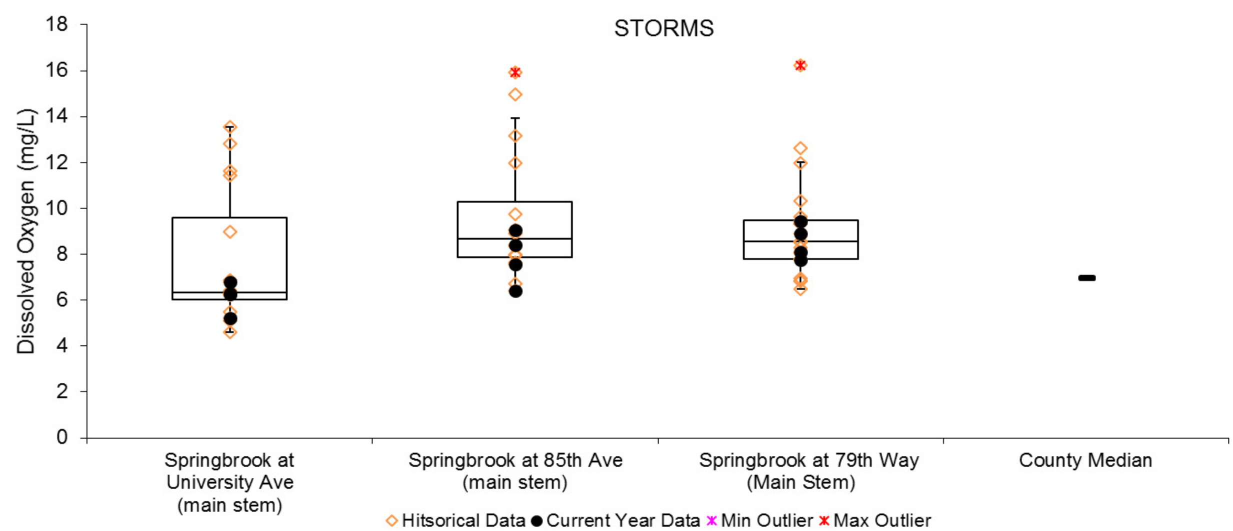
Dissolved oxygen (DO) essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO falls below 5 mg/L. Low DO can be the result of organic pollution, the decomposition of which consumes oxygen. Dissolved oxygen in Springbrook Creek was within the acceptable level (>5 mg/L) during all site visits in 2016. During a storm event in 2013 the most upstream monitoring location fell to 4.61 mg/L. This appears to have been an isolated occurrence.

Median dissolved oxygen in Springbrook Creek. Data is from 79th Way for all years through 2016.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.16	5 mg/L daily minimum	20
Storms	8.56		20
All	8.54		40
Occasions <5 mg/L			0

Dissolved Oxygen at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





E. coli

E. *coli* is a bacteria found in the feces of warm blooded animals. E. *coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets E. *coli* standards for contact recreation (swimming, etc.). A stream is designated as "impaired" if 10% of measurements in a calendar month are >1260 most probable number per 100 milliliters of water (MPN) or if the geometric mean of five samples taken within 30 days is greater than 126 MPN.

Our data are not sufficient to determine if the MPCA standards are met. We took samples throughout summer, often with only 1-2 samples in each month, too little for calculation of a monthly geometric mean or to reasonably say that 10% of samples in a month were in exceedance. We can, however, perform other examinations of the data.

E. *coli* levels in 2016 were generally lower than 2015 levels, but were still quite high. During baseflow median E. *coli* for all years from upstream to downstream were 144, 35.5, and 119.5 MPN, respectively. E. coli during baseflow exceeded 126 MPN in 33% of samples taken in 2016.

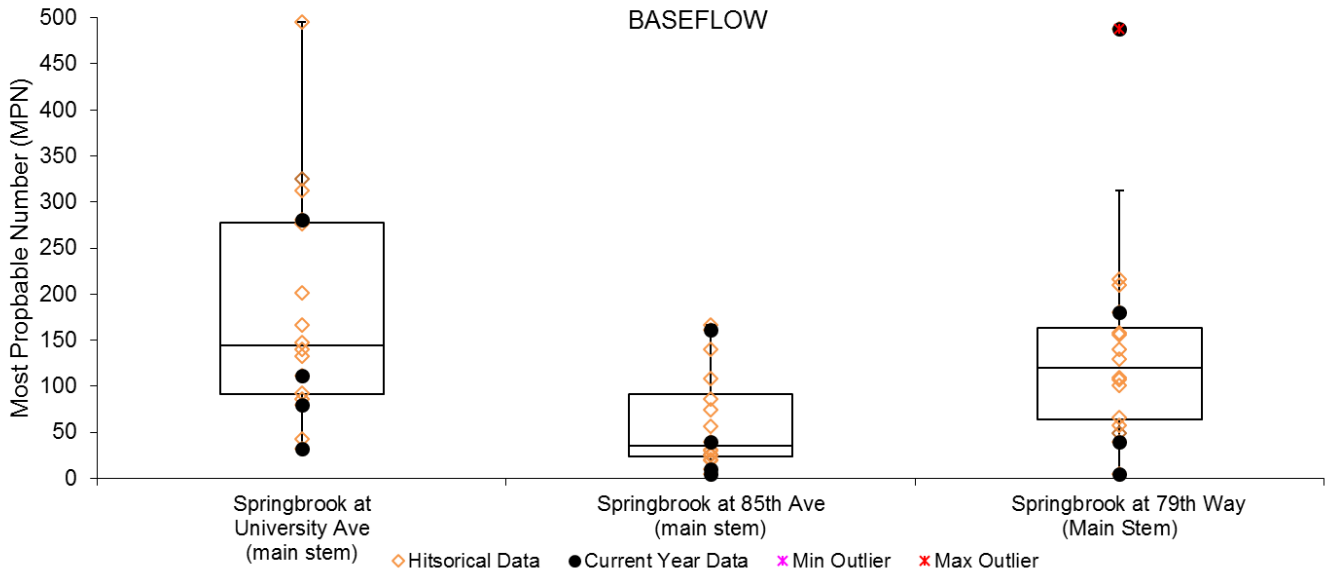
During baseflow the upstream-most site at University Avenue generally has higher E. coli levels that the site further downstream at 85th Ave. It appears that the ponds and wetlands between University Ave and 85th Ave sites may be providing baseflow treatment. Levels tend to rebound again between 85th Ave. and 79th Way, however.

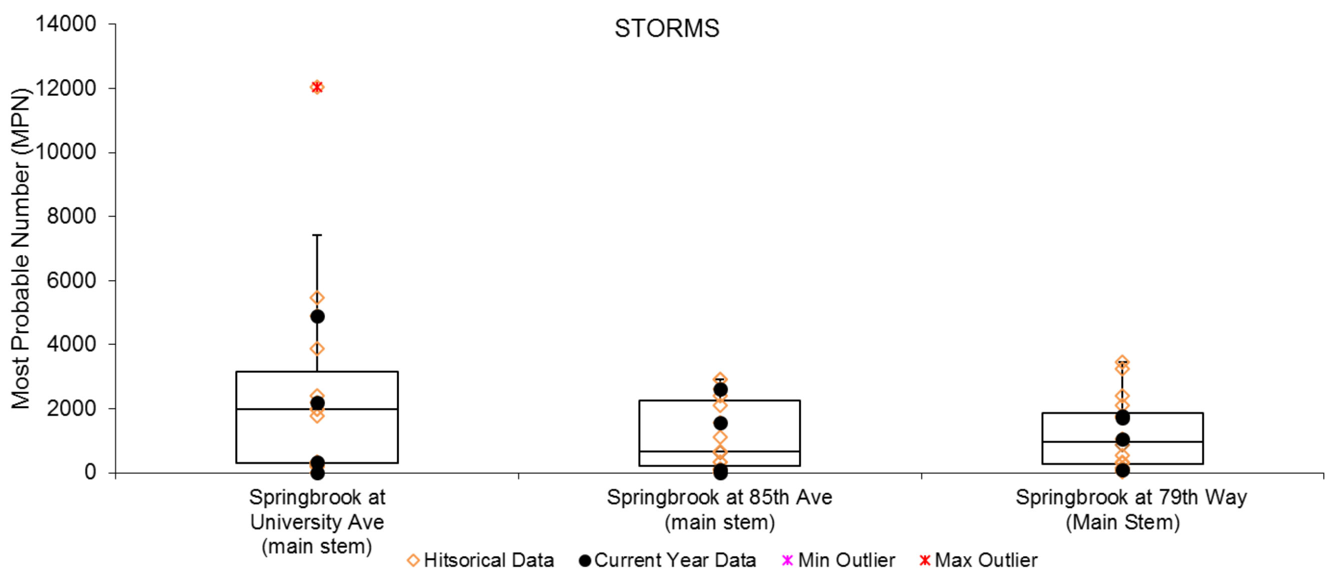
During storms E. coli was significantly higher (note the difference in scale on below charts), but the same pattern remains with the middle site having the lowest levels. Median E. coli during storms for all years from upstream to downstream were 1986, 670, and 956.2 MPN, respectively. 83% of storm samples taken in 2016 exceeded 126 MPN/100ml. Three of the four storm samples collected at each site surpassed the 1260 MPN limit state standard (75% of all storm samples in 2016).

Median E. *coli* in Springbrook Creek. Data is from All Sites through 2016.

<table>
<tr><th></th><th>E. coli (MPN)</th><th>State Standard</th><th>N</th></tr>
<tr><td>Baseflow</td><td>107.55</td><td rowspan="3">Monthly Geometric Mean >126</td><td>48</td></tr>
<tr><td>Storms</td><td>1,083</td><td>48</td></tr>
<tr><td>All</td><td>183.5</td><td>96</td></tr>
<tr><td>Occasions >126 MPN
Occasions >1260 MPN</td><td></td><td>Monthly 10% average >1260</td><td>21 baseflow, 40 storm
0 baseflow, 22 storm</td></tr>
</table>

E. *coli* at Springbrook. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



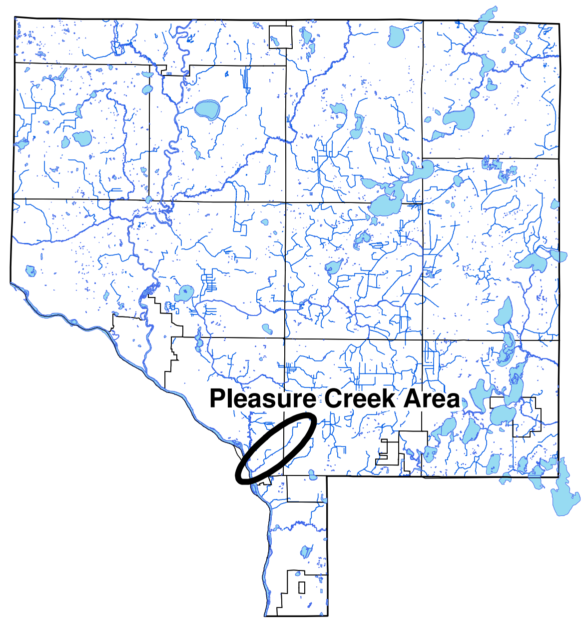


PLEASURE CREEK

Pleasure Cr at Pleasure Cr Parkway, N side of loop	STORET SiteID = S005-636
Pleasure Cr at 99th Ave	STORET SiteID = S005-637
Pleasure Cr at 96th Lane	STORET SiteID = S005-263
Pleasure Creek at 86th Avenue, Coon Rapids	STORET SiteID = S003-995

Years Monitored

Pleasure Cr at Pleasure Cr Parkway	2009
Pleasure Cr at 99th Ave	2009
Pleasure Cr at 96th Lane	2008
Pleasure Cr at 86th Ave	2006, 2007, 2012-2016 And 1-2 measurements per year in 2002, 2003, 2004, 2005, 2008



Background

Pleasure Creek flows through the southwestern portion of Blaine and southern Coon Rapids. The watershed is urbanized. The creek is about 8-10 feet wide and 0.5 to 1 foot deep during baseflow. It flows through an interconnected network of stormwater ponds in the upper part of the watershed.

Monitoring near the creek's outlet to the Mississippi River in 2006-2007 found high levels of dissolved pollutants and E. coli. In 2008, monitoring was moved upstream to begin determining the sources of pollutants, particularly E. coli. In 2009, monitoring moved even farther upstream to further diagnose pollutant sources. In 2012 monitoring was moved back to the lower portions of the watershed to continue overall water quality assessment.

Pleasure Creek is listed as "impaired" by the MN Pollution Control Agency for impaired biota, but new methods (Tiered Aquatic Life Standards) currently under development will take into consideration the fact that the creek is a public ditch and therefore has lower aquatic life expectations, at least in some reaches. While recent monitoring data is insufficient to officially assess Springbrook for most other impairments, the data to date suggest that other impairment designations could occur in the near future, especially E. coli and total phosphorus.

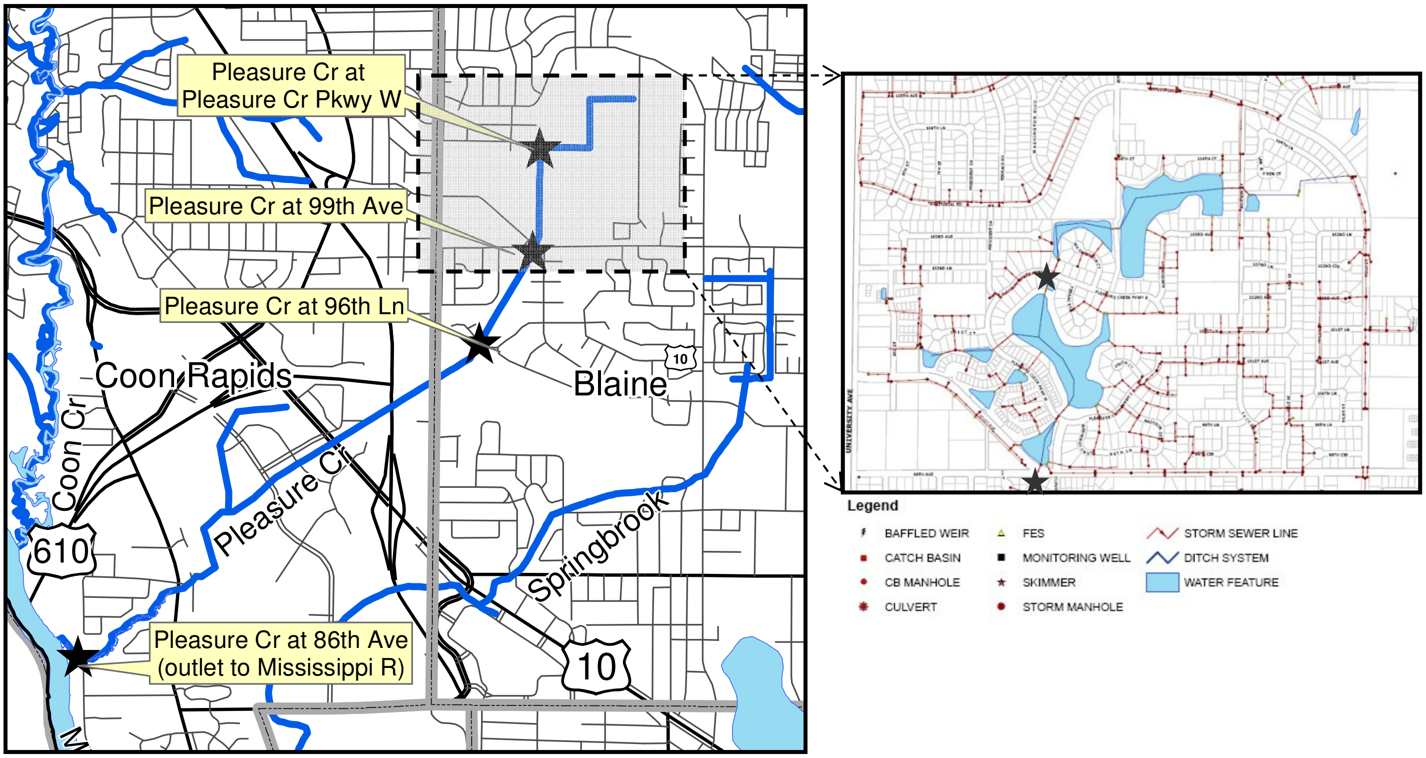
Methods

Pleasure Creek was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were taken each year; half during baseflow and half following storms. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. In some years, particularly during drought, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Eleven water quality parameters were tested. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009, transparency tube measurements were added and are reported to MPCA. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, chlorides, hardness, and sulfate. Hardness and sulfate were monitored only in 2012. Chlorides have not been monitored since 2012.

During every sampling event, the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using an electronic data logging device at the 86th Avenue stream crossing (farthest downstream).

Pleasure Creek Monitoring Sites



Results and Discussion

Pleasure Creek has some prominent water quality concerns. While it is currently listed as impaired by the State only for a poor invertebrate biota, these data suggest that other impairments exist, particularly for total phosphorus and E. coli bacteria.

The following is a parameter-by-parameter summary and management discussion:

- Dissolved pollutants, as measured by conductivity and chlorides, are higher in Pleasure Creek than any other Anoka Count stream monitored. Both were elevated during storms and baseflow, but the highest concentrations were measured during baseflow.

  Management discussion: Dissolved pollutants enter the stream both directly through surface runoff and also by infiltrating into the shallow groundwater that feeds the stream during baseflow. A variety of sources appear to be likely, including road deicing salts and road runoff. Preventing their release into the environment is important because they are not easily removed.

- Phosphorus was relatively low in Pleasure Creek during baseflow, and slightly higher during storms. Due to the higher readings during storms, Pleasure Creek sometimes exceeds the state standard of 100 mg/L. The observed readings during storms are similar to most other streams in the area.

  Management discussion: Additional treatment within the stormwater conveyance system is needed, particularly around East River Road.

- Suspended solids and turbidity were both low during baseflow but much higher during storms. The elevated turbidity and TSS during storm events suggests that current stormwater conveyance systems are not doing a good job of filtering out solids from stormwater runoff.

  Management discussion: Additional treatment within the stormwater conveyance system is needed, particularly around East River Road.

- pH and dissolved oxygen were with the range considered normal and healthy for streams in this area.

- E. coli bacteria are high throughout Pleasure Creek during storms. Investigative monitoring has been done in recent years. Human sewage does not appear to be the source. Stormwater runoff and likely stormwater ponds themselves are likely sources of the bacteria.

  Management discussion: Because E. coli is pervasive in the urban environment, urban neighborhoods will have difficulty reducing E. coli levels below state water quality standards. Addressing E. coli should be part of an effort to improve overall water quality.

Conductivity, Chlorides, and Salinity

Conductivity and chlorides are measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial sources, agricultural chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we use. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides measures for chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community; however it is also noteworthy that Pleasure Creek discharges into the Mississippi River just upstream from drinking water intakes for the Twin Cities.

Conductivity and chlorides in Pleasure Creek are higher than at any other stream in Anoka County, and were especially high in 2016, even for this creek. Median baseflow conductivity for all years at the 86th Ave site is now 0.892 mS/cm after having a long-term median of 0.859 mS/cm last year. By comparison, the median for all streams in Anoka County is 0.362 mS/cm. There is no state water quality standard for conductivity, but these extremely high and continually rising levels are concerning.

Chlorides increased at the downstream site even more dramatically than conductivity when they were last monitored. Median chlorides (all years) at the three upstream sites were 70, 71, and 67 mg/L (upstream to downstream). At the downstream site (86th Ave) median chlorides was 159 mg/L, or about double. The median for all streams in Anoka County is 17 mg/L. The state water quality standards for chlorides are 230 mg/L (chronic) and 860 mg/L (acute). While Pleasure Creek has only been observed to exceed the chronic standard once (262 mg/L), no monitoring occurred during snowmelt when chlorides are likely to be highest. Chlorides were last monitored in 2012.

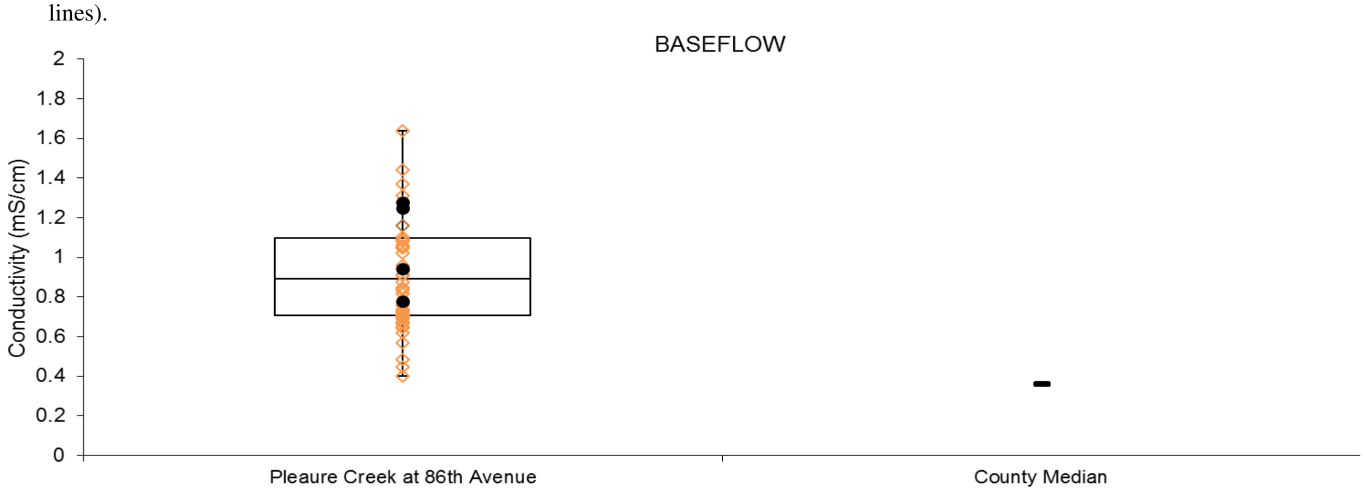
Both conductivity and chlorides where slightly higher during storms than baseflow. Median conductivity at 86th Ave. (all years) is now 0.94 mS/cm after being 0.908 mS/cm in 2015 during storms. This result suggests that dissolved pollutants are quite high in the shallow groundwater that feeds the stream during baseflow and even higher in stormwater runoff. Illicit discharges may be contributing during baseflow. While road deicing salts are likely a prevalent source of dissolved pollutants, they are not the only source, as evidenced by high dissolved pollutants during wash-off from mid-summer storms.

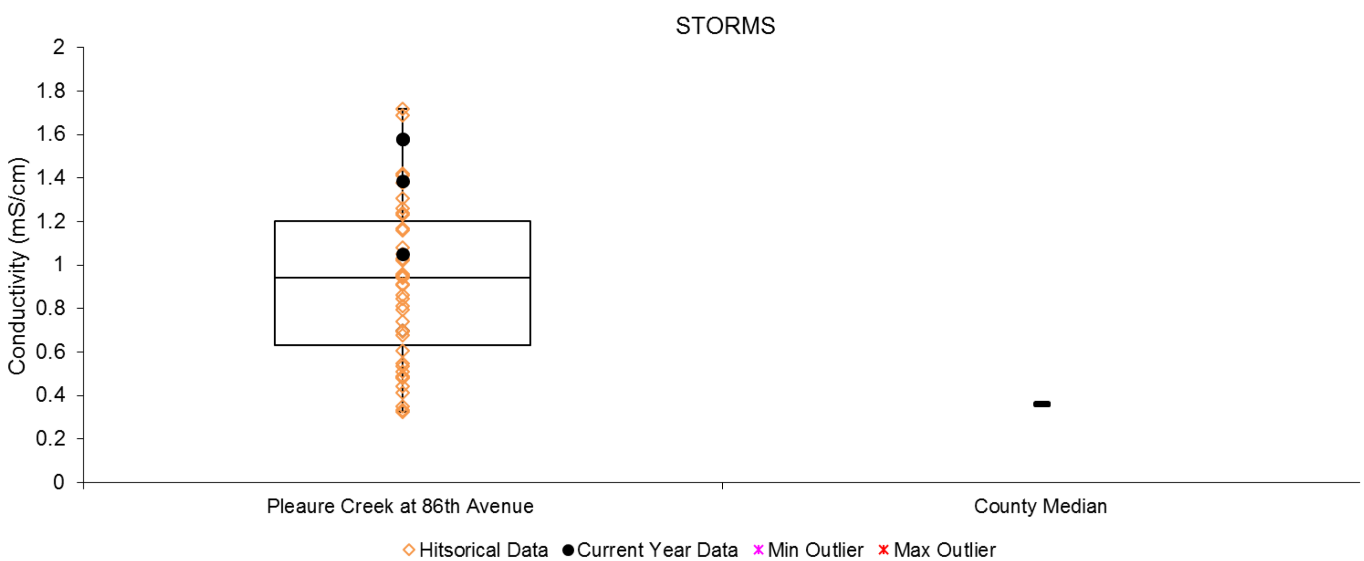
Dissolved pollutants are especially difficult to manage once in the environment. They are not readily removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also risk contaminating groundwater. The first approach to dissolved pollutant management must be to minimize their release into the environment.

Median conductivity and chlorides in Pleasure Creek at 86th Ave. for conductivity all years through 2016, for chlorides all years through 2012.

	Conductivity (mS/cm)	Chlorides (mg/L)	State Standard	N
Baseflow	0.892	146.5	Conductivity – none	50
Storms	0.940	178		47
All	0.911	158.5	Chlorides 860 mg/L acute, 230 mg/L chronic	97

Conductivity at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Total Phosphorus

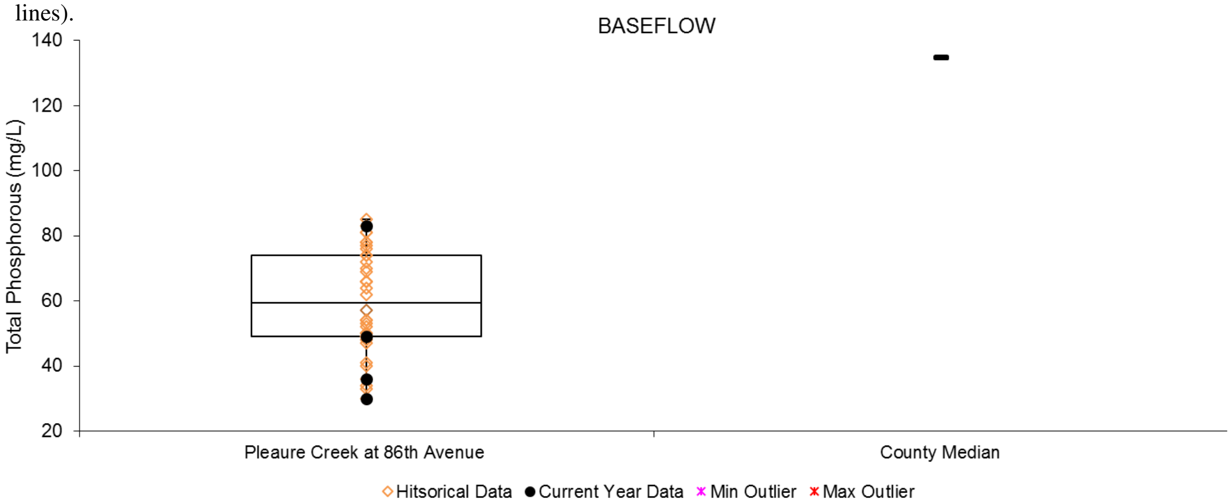
Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algae growth. TP was low in Pleasure Creek during baseflow and slightly higher during storms (see table and figures below). The phosphorus concentrations during baseflow were lower than most other streams in the area and similar to other streams during storms.

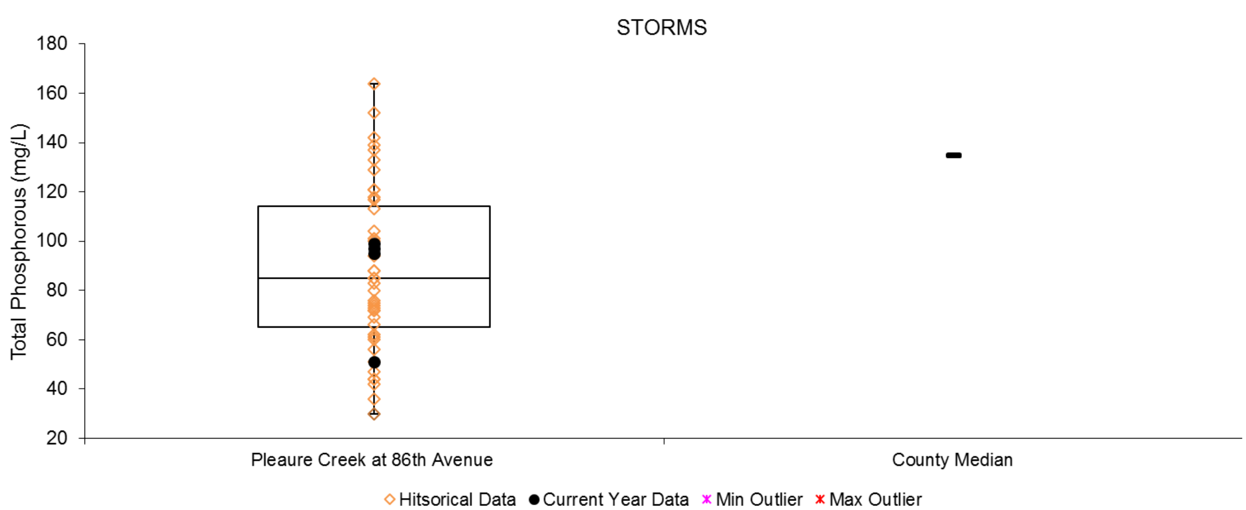
The MN Pollution Control Agency has a state standard of 100 ug/L. Based on data collected to date, Pleasure Creek usually complies with this standard during baseflow and storms.

Median TP in Pleasure Creek. Data is from the 86th Avenue site and all years through 2016.

	Total Phosphorus (ug/L)	State Standard	N
Baseflow	59.5	100	36
Storms	85		44
All	72		80
Occasions > state standard			14, all during storms

Total phosphorus at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Total Suspended Solids and Turbidity

Total suspended solids (TSS) and turbidity both measure solid particles in the water. TSS measures these particles by weighing materials filtered out of the water. Turbidity is measured by the diffraction of a beam of light sent though the water sample, and is therefore most sensitive to large particles. Suspended solids are important because they carry other pollutants, affect water appearance, and can harm stream biota.

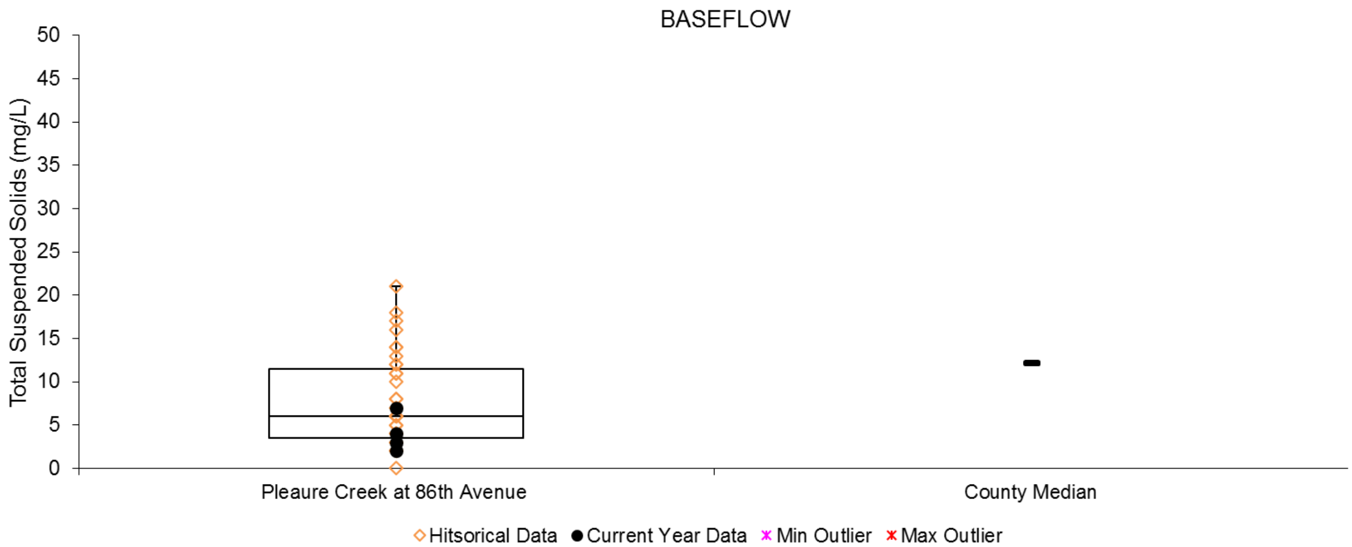
TSS and turbidity were both low during baseflow and higher during storms. The low turbidity and TSS is probably reflective of the effectiveness of large stormwater ponds just upstream of East River Road and the headwaters.

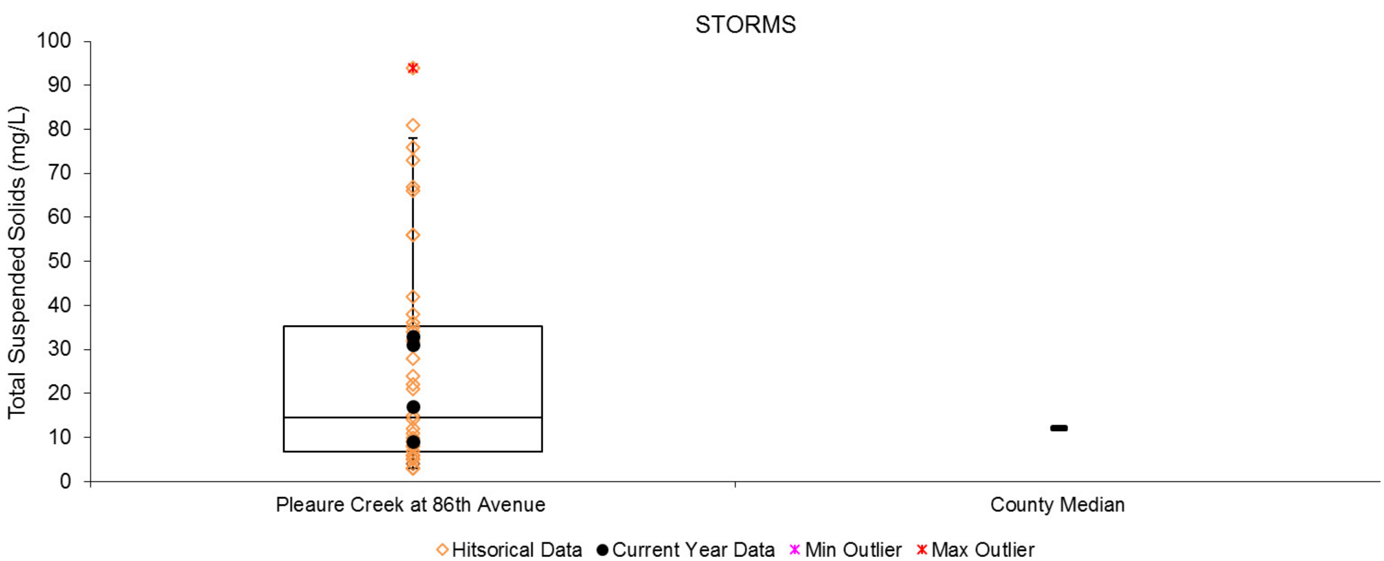
The MN Pollution Control Agency state standard for TSS is 30mg/L in this region. At the outfall to the Mississippi River Pleasure Creek exceeds this standard during storms and may be considered impaired. More than the required 20 samples needed for assessment have been collected, so the impaired designation will likely follow in the near future. Additional stormwater treatment around and downstream of East River Road will be helpful at achieving the water quality standard.

Median turbidity and suspended solids in Pleasure Creek. Data is from the 86th Avenue site and all years through 2016.

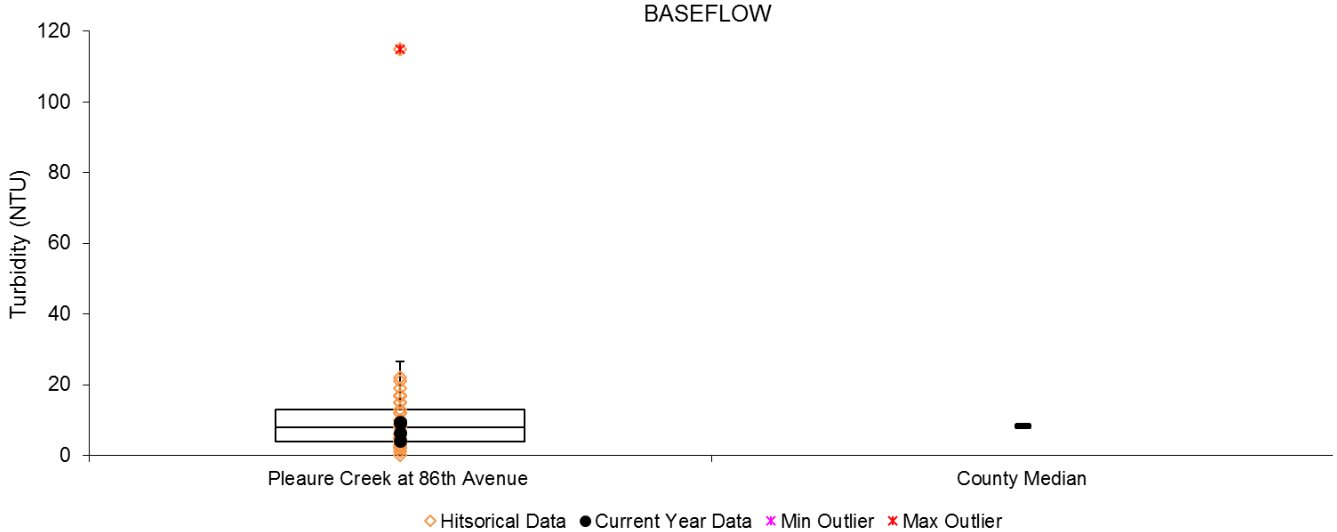
	Turbidity (FNRU)	Total Suspended Solids (mg/L)	State Standard	N
Baseflow	8	6	30 mg/L TSS	49
Storms	19.2	14.5		47
All	11.95	9		96
Occasions > new state TSS standard				16, all during storms

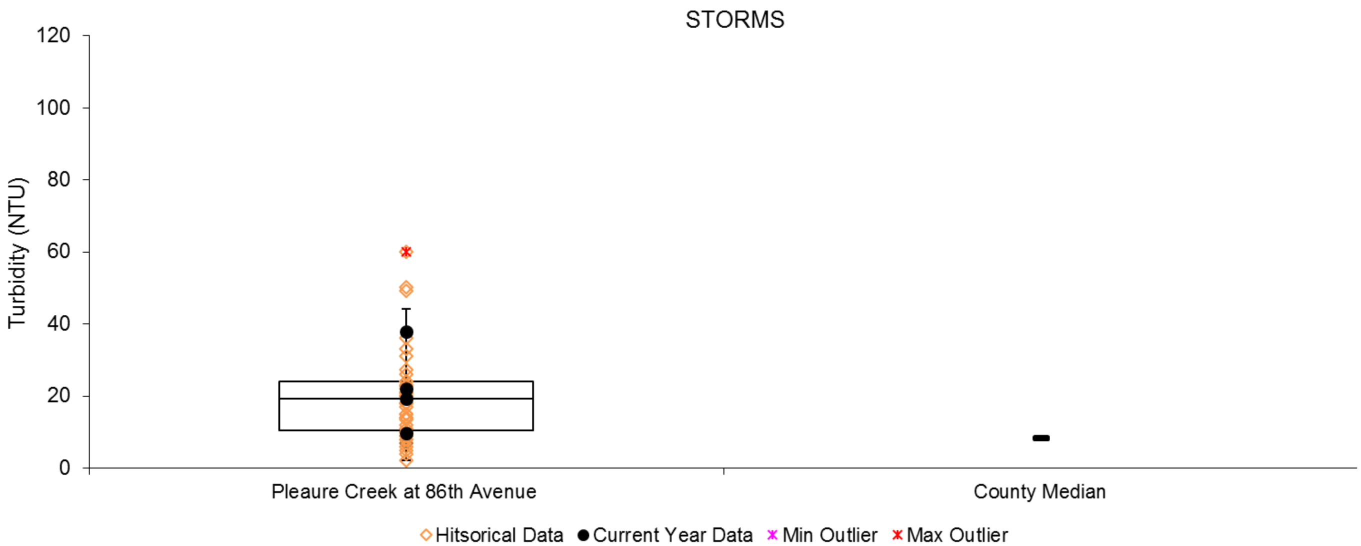
Total suspended solids at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





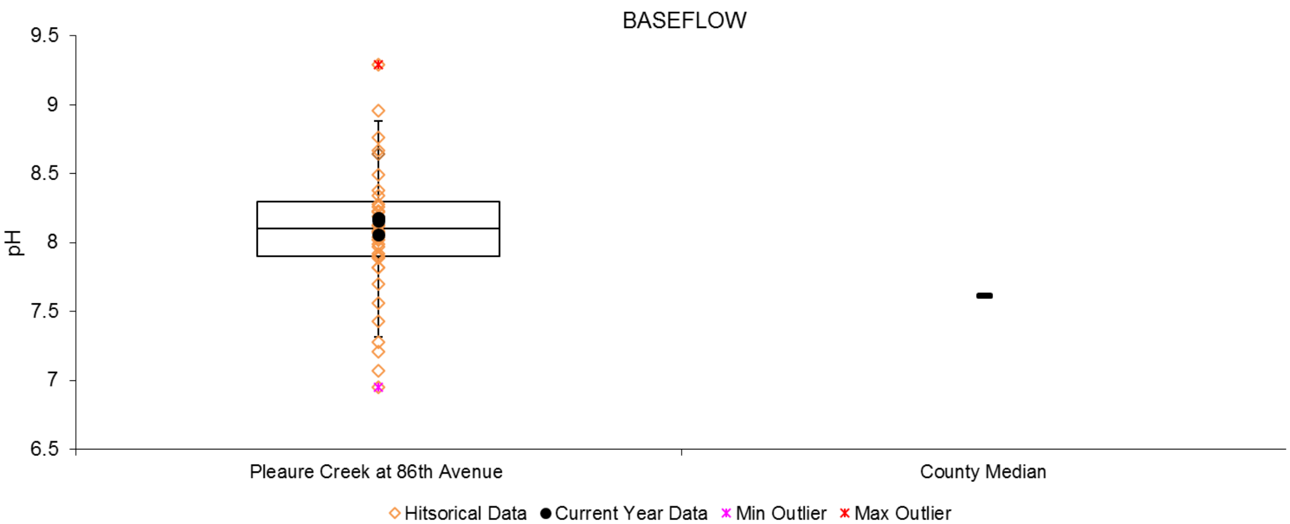
pH

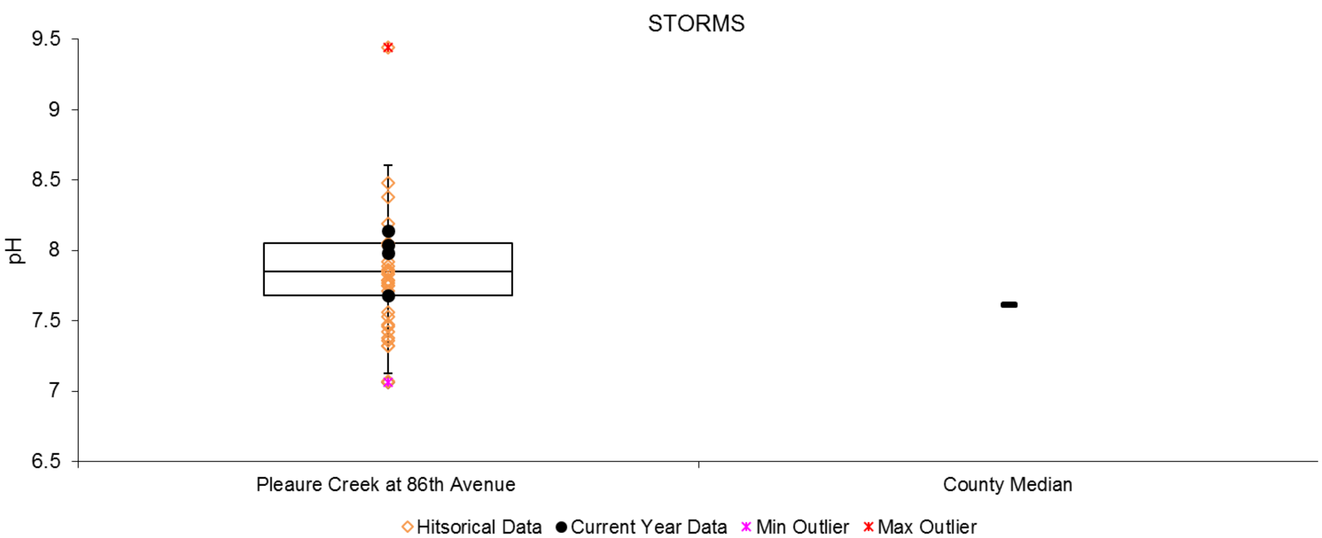
Pleasure Creek pH was within the expected range during all conditions (see figures below). The median for baseflow was 8.10 and the median for storms was 7.85. The Minnesota Pollution Control Agency water quality standards set a range for pH to remain between 6.5 and 8.5.

Median pH in Pleasure Creek. Data is from the 86th Avenue site and all years through 2016.

	pH	State Standard	N
Baseflow	8.10	6.5-8.5	36
Storms	7.85		36
All	7.98		72
Occasions outside state standard			7

pH at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Dissolved Oxygen

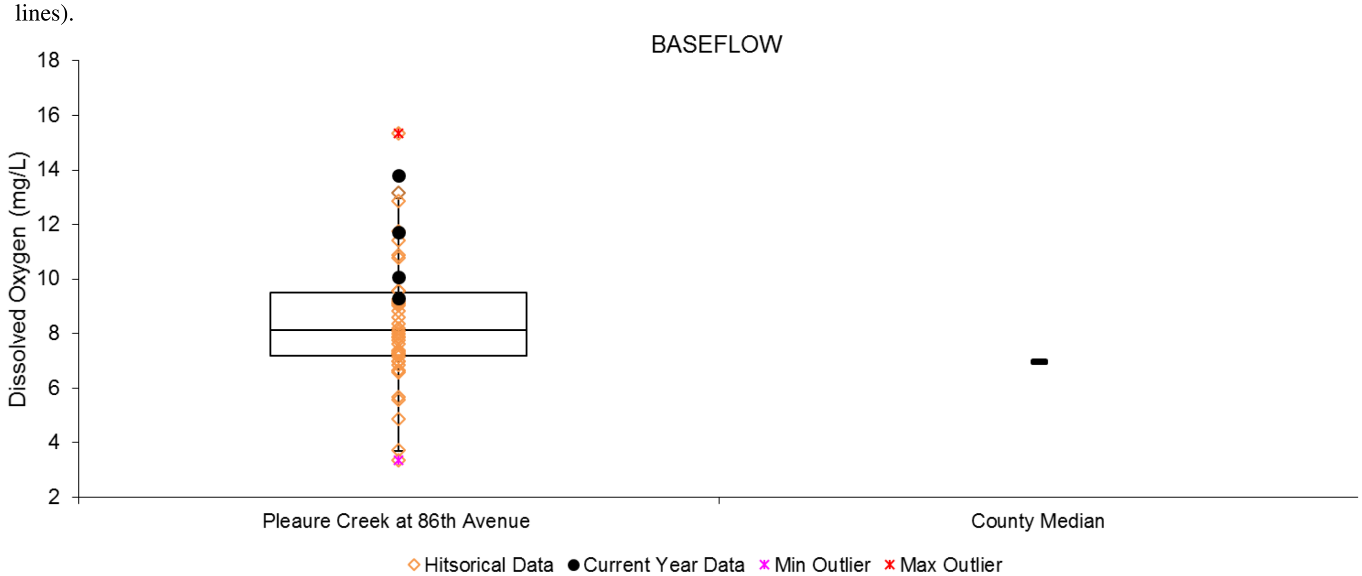
Dissovled oxygen (DO) essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO falls below 5 mg/L. Low DO can be a result of organic pollution, the decomposition of which consumes oxygen.

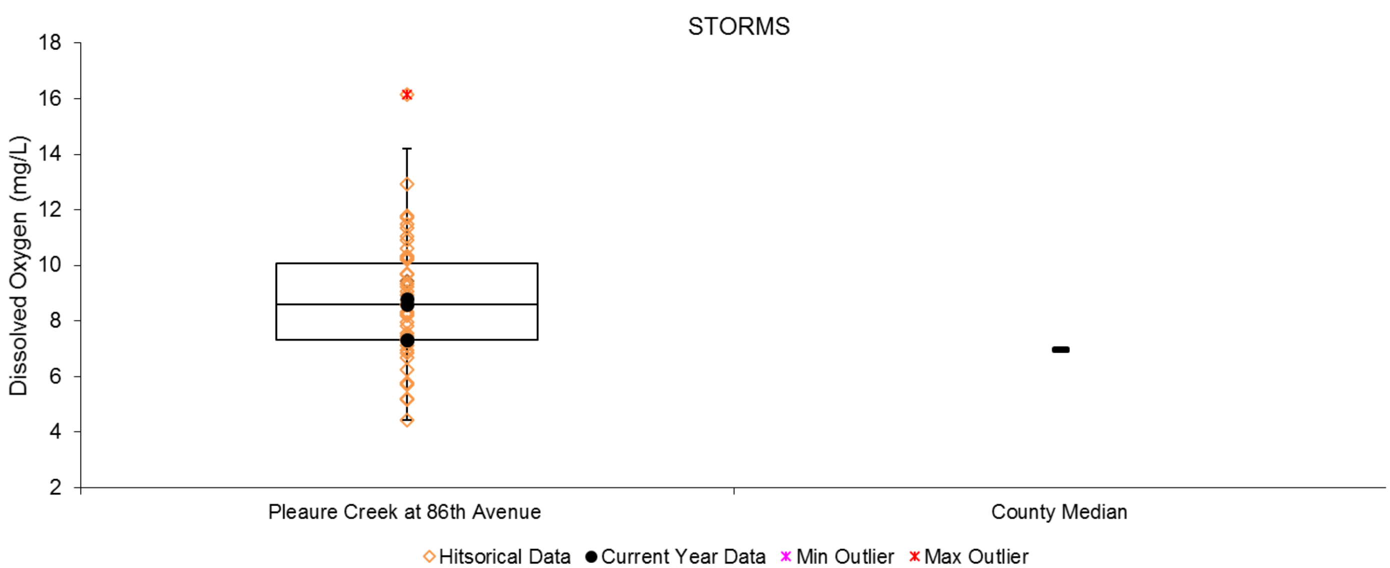
Dissolved oxygen in Pleasure Creek was within the acceptable level (>5 mg/L; see table and figure below). No instances of DO <5mg/L were observed at 86th Avenue in 2016.

Median dissolved oxygen in Pleasure Creek. Data is from the 86th Avenue site and all years through 2016.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.14	5 mg/L daily minimum	46
Storms	8.58		46
All	8.0		92
Occasions <5 mg/L			4

Dissolved Oxygen at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





E. coli Bacteria

E. *coli* is a bacteria found in the feces of warm blooded animals. E. *coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets E. *coli* standards for contact recreation (swimming, etc). A stream is designated as “impaired” if 10% of measurements in a calendar month are >1260 most probable number per 100 milliliters of water (MPN) or if the geometric mean of five samples taken within 30 days is greater than 126 MPN. Pleasure Creek exceeds both criteria (see figure on following page). The creek has not yet been listed as “impaired” by the State, but a water quality problem exists regardless. Sources of the bacteria likely include headwaters storm water ponds and storm water runoff from throughout the watershed.

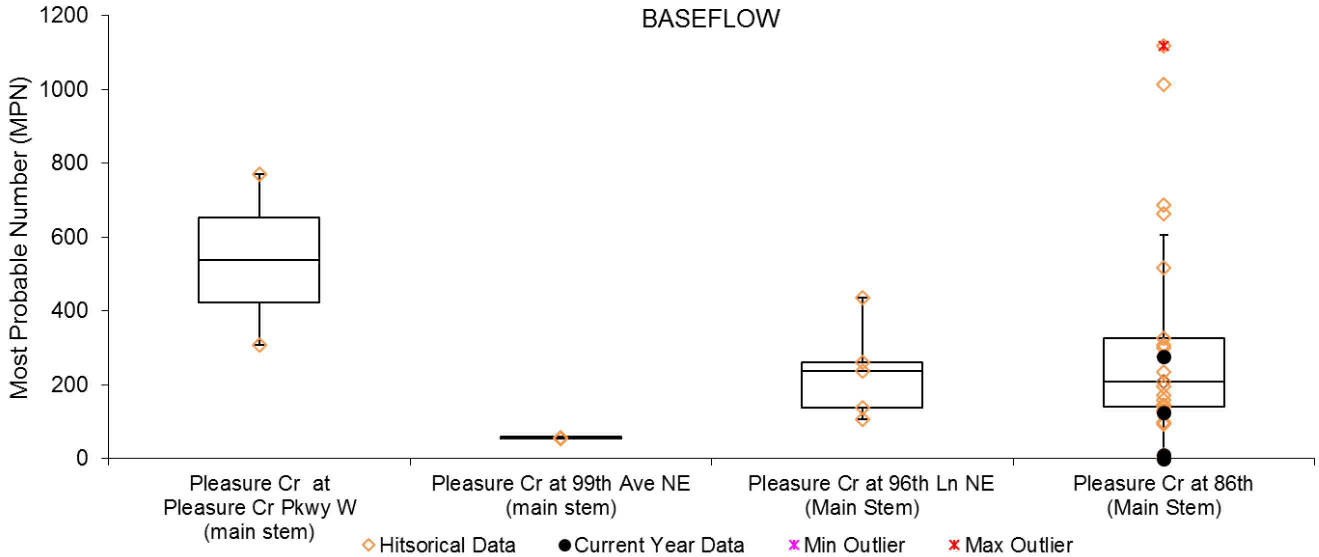
Enough data is available for the downstream monitoring site (outlet to Mississippi River) to clearly document exceedances of the “impaired” criteria. At the upstream sites not enough data has been gathered, but the E. coli values observed are similar to the downstream site. At the farthest-downstream monitoring site three of four samples in May 2007 exceeded 1260 MPN/100mL (261, 1986, and two samples exceeded the test limits of 2420 MPN/100mL). In 2006, five samples taken between 5/24 and 6/21 had a geometric mean of 318 MPN/100mL. In 2007 five samples were taken between 5/24 and 6/20, but calculating their geometric mean is impossible because two of the samples exceed the test’s capacity of 2420 MPN/100mL. If we conservatively replace those readings with 2420 MPN/100mL, then geometric mean is 934 MPN/100mL. It appears the creek at 86th Avenue exceeds state standards quite routinely.

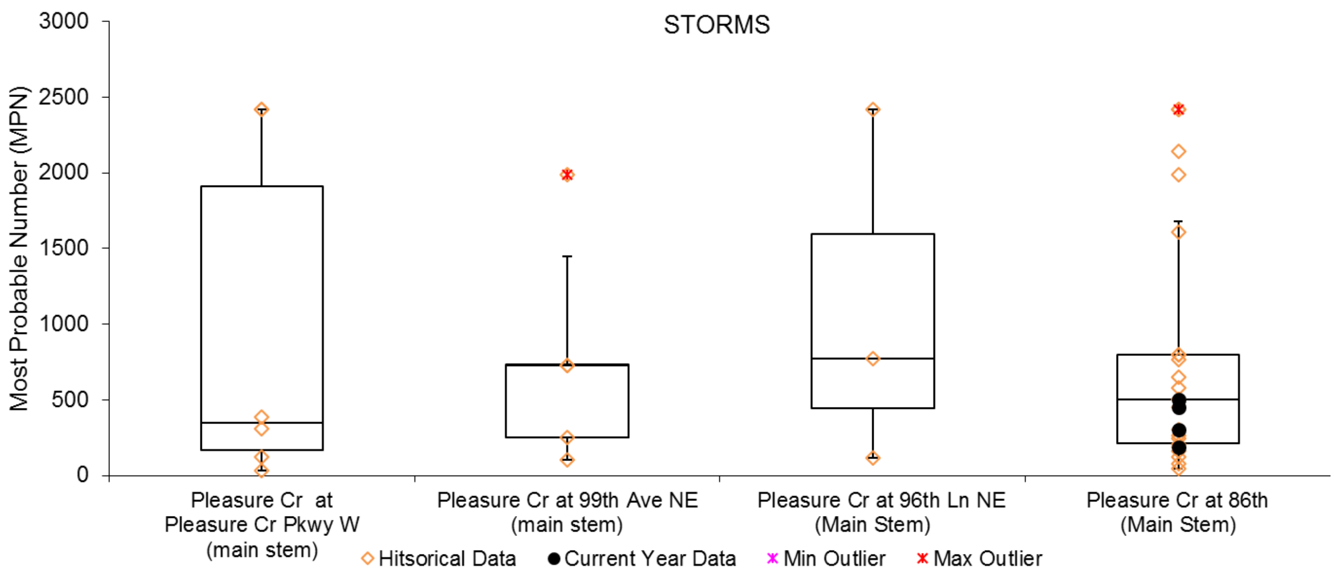
Data collected in 2016 was generally slightly lower than previous years’ results. The baseflow average (107.5 MPN/100mL) is lower than the state chronic standard of 126 MPN/100mL (note this standard is a minimum 5 samples in 30 days geometric mean). The storm event average (360 MPN/100mL) while greatly exceeding state standards (geometric mean), was less than half of the 2015 storm event average (824.25).

Median E. *coli* in Pleasure Creek. Data is from the 86th Avenue site only, all data through 2016.

<table>
<tr><th></th><th>E. coli (MPN)</th><th>State Standard</th><th>N</th></tr>
<tr><td>Baseflow</td><td>210</td><td rowspan="3">Monthly Geometric Mean >126</td><td>22</td></tr>
<tr><td>Storms</td><td>502</td><td>22</td></tr>
<tr><td>All</td><td>300</td><td>44</td></tr>
<tr><td>Occasions >126 MPN
Occasions >1260 MPN</td><td></td><td>Monthly 10% average >1260</td><td>17 baseflow, 19 storm
0 baseflow, 5 storm</td></tr>
</table>

E. *coli* at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2016 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Stream Water Quality – Biological Monitoring (Students)

Description: This program combines environmental education and stream monitoring. Under the supervision of ACD staff, high school science classes collect aquatic macroinvertebrates from a stream, identify their catch to the family level, and use the resulting numbers to gauge water and habitat quality. These methods are based upon the knowledge that different families of macroinvertebrates have different water and habitat quality requirements. The families collectively known as EPT (Ephemeroptera, or mayflies; Plecoptera, or stoneflies; and Trichoptera, or caddisflies) are generally pollution intolerant. Other families can thrive in low quality water. Therefore, a census of stream macroinvertebrates yields information about stream health.

Purpose: To assess stream quality, both independently as well as by supplementing chemical data. To provide an environmental education service to the community.

Locations: Coon Creek at Crosstown Blvd. near Andover High School, Andover

Results: Results for are detailed on the following pages.

Tips for Data Interpretation

Consider all biological indices of water quality together rather than looking at each alone, as each gives only a partial picture of stream condition. Compare the numbers to county-wide averages. This gives some sense of what might be expected for streams in a similar landscape, but does not necessarily reflect what might be expected of a minimally impacted stream. Some key numbers to look for include:

Families — Number of invertebrate families. Higher values indicate better quality.

EPT — Number of families of the generally pollution-intolerant orders Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies). Higher numbers indicate better stream quality.

Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

FBI	Stream Quality Evaluation
0.00-3.75	Excellent
3.76-4.25	Very Good
4.26-5.00	Good
5.01-5.75	Fair
5.76-6.50	Fairly Poor
6.51-7.25	Poor
7.26-10.00	Very Poor

% Dominant Family — High numbers indicates an uneven community, and likely poorer stream health.

Biomonitoring

COON CREEK

at Crosstown Blvd near Andover High School, Andover

Last Monitored

By Andover High School in 2016

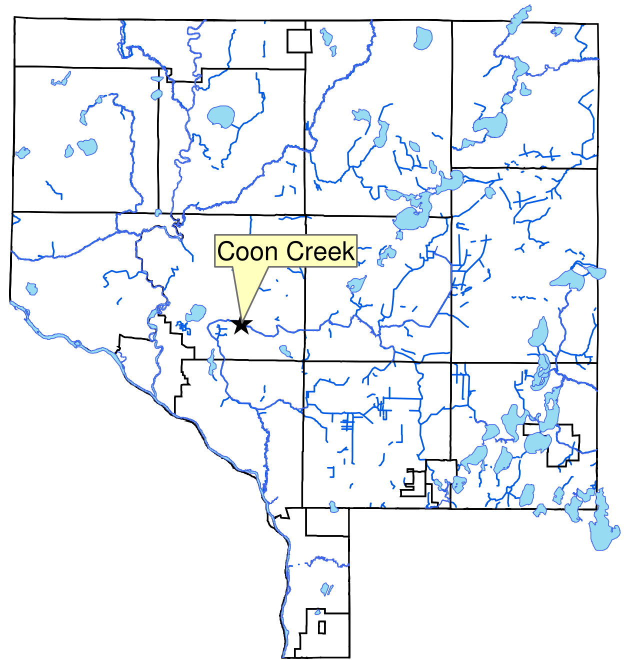
Monitored Since

Fall 2003

Student Involvement

About 90 students in 2016, approx. 1,350 since 2003

Background

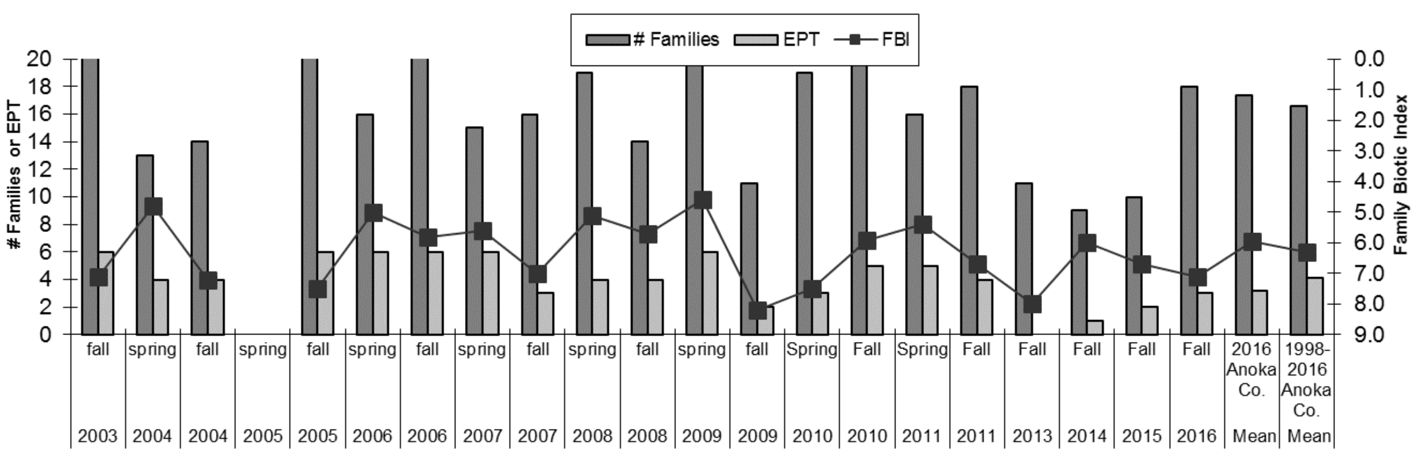


Coon Creek originates in the southern part of the Carlos Avery Wildlife Management Area in the City of Columbus. It flows west, then south, and empties into the Mississippi River at Coon Rapids Dam Regional Park. Coon Creek has a number of ditch tributaries. Land use is an approximately equal mix of residential and vacant/agricultural with some small commercial sites. The land use immediately surrounding the sampling site is residential on the south side of the creek and the high school campus on the north side. A vegetated buffer 20-100 feet wide is present at the sampling site, and is typical elsewhere. The banks are steep with moderate to heavy erosion in spots. The streambed is composed of sand and silt. The stream is 1 to 2.5 feet deep at baseflow and approximately 10-15 feet wide.

Results

Andover High School classes monitored this stream in fall of 2016. Overall, the multi-year dataset suggests the health of Coon Creek at this particular site is similar to the average of other Anoka County streams. However, relatively large fluctuations in the biotic indices are observed within and across years. In 2016, fall samples produced invertebrate indices better than the previous three years at this site and the County median of all streams sampled.

Summarized Biomonitoring Results for Coon Creek in Andover



Biomonitoring data for Coon Creek in Andover

Data presented from the most recent five years. Contact the ACD to request archived data.

Year	2010	2010	2011	2011	2013	2014	2015	2016	Mean	Mean
Season	Spring	Fall	Spring	Fall	Fall	Fall	Fall	Fall	2016 Anoka Co.	1998-2016 Anoka Co.
FBI	7.5	5.9	5.4	6.7	8.0	6.0	6.7	7.1	5.9	6.3
# Families	19	27	16	18	11	9	10	18	17.4	16.6
EPT	3	5	5	4	0	1	2	3	3.2	4.1
Date	13-Apr	5-Oct	10-Jun	23-Sep	28-Oct	3-Oct	25-Sep	7-Oct		
Sampled By	AHS	AHS	ACD	AHS	AHS	AHS	AHS	AHS		
Sampling Method	MH	MH	MH	MH	MH	MH	MH	MH		
Mean # Individuals/Rep.	207	446	165	154	64.5	198	589	568		
# Replicates	1	1	1	1	6	1	1	1		
Dominant Family	Corixidae	alopterygid	Baetidae	Belostomatidae	Corixidae	Corixidae	Siphlonuridae	Calopterygidae		
% Dominant Family	45.4	28.7	24.2	27.9	48.1	37.9	39	33.1		
% Ephemeroptera	0.5	14.1	28.5	10.4	0.0	0.0	39.0	1.2		
% Trichoptera	1.9	2.0	9.7	9.1	0.0	0.0	1.3	1.8		
% Plecoptera	0.0	0.0	9.7	0.0	0.0	0.0	0.0	2.1		

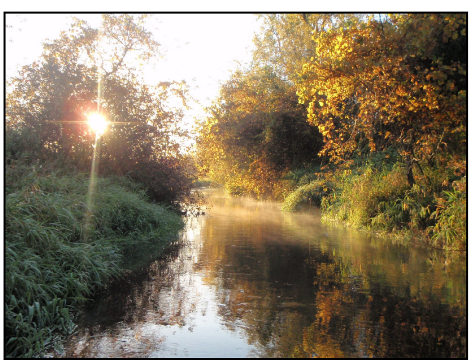
Supplemental Stream Chemistry Readings

Data presented from the most recent five years. Contact the ACD to request archived data.

Parameter	5/30/2008	10/2/2008	5/15/2009	9/29/2009	4/13/2010	10/5/2010	6/10/2011	9/23/2011	10/28/2013
pH	7.41	7.66	7.65	7.79	na	7.65	7.62	8.27	7.7
Conductivity (mS/cm)	0.458	0.609	0.582	0.64	0.553	0.634	0.538	0.470	0.583
Turbidity (NTU)	12	4	15	5	25	6	13	31	8
Dissolved Oxygen (mg/L)	8.79	9.52	8.4	8.6	10.48	na	7.31	8.59	8.72
Salinity (%)	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.28
Temperature (°C)	13	8.2	13	10	11.1	9.3	14.9	10.9	9.17

Discussion

The invertebrate community suggests Coon Creek's health is average compared to other nearby streams. The stream's habitat is relatively sparse, mostly due to past excavations aimed at making the creek perform like a ditch. The supplemental stream water chemistry readings taken during biomonitoring indicate a higher than expected level of dissolved pollutants, as measured by conductivity. Conductivity and salinity were similar to, though not as extreme as, some urbanized streams at the same time of year. The source could be road salts, failing septic systems, and/or chemical wastes. These factors, as well as the general lack of habitat in this ditched stream, probably limit the invertebrate community.

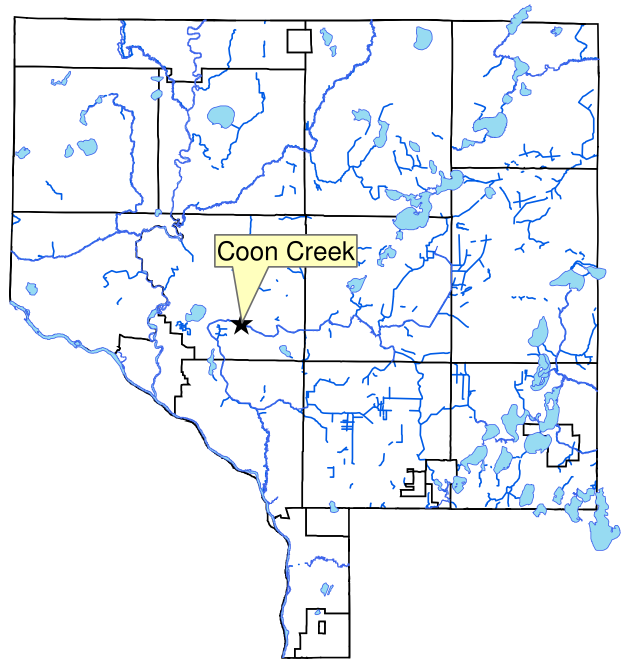


Coon Creek at Andover High School sampling site.

Andover High School Students at Coon Creek.

Coon Creek

at Erlandson Park, Coon Rapids



Last Monitored

By Anoka County 4-H group in 2016

Monitored Since

2016

Student Involvement

About 10 kids in 2016

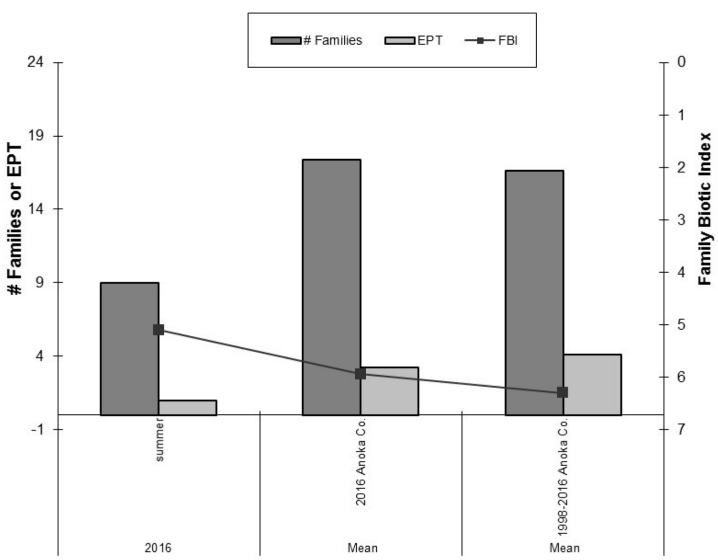
Background

Coon Creek originates in the southern part of the Carlos Avery Wildlife Management Area in the City of Columbus. It flows west, then south, and empties into the Mississippi River at Coon Rapids Dam Regional Park. Coon Creek has a number of ditch tributaries. Land use is an approximately equal mix of residential and vacant/agricultural with some small commercial sites. The land use immediately surrounding the sampling site is residential on the south side of the creek and the high school campus on the north side. A vegetated buffer 20-100 feet wide is present at the sampling site, and is typical elsewhere. The banks are steep with moderate to heavy erosion in spots. The streambed is composed of sand and silt. The stream is 1 to 2.5 feet deep at baseflow and approximately 10-15 feet wide.

Results

This was the first year this site was sampled. A 4-H group of approximately 10 kids collected just 105 individuals so resulting indices are very low. Only one EPT individual was collected, with over half of all individuals being amphipods. Poor results could have been due to the small sample size, mid-summer sampling when water is the warmest and other factors influenced by the sampling itself and are not necessarily reflective of the habitat conditions at this site.

Summarized Biomonitoring Results for Coon Creek at Erlandson Park



Year	2016	Mean	Mean
Season	Summer	2016 Anoka Co.	1998-2016 Anoka Co.
FBI	5.10	5.94	5.78
# Families	9	17.4	14.58
EPT	1	3.2	4.27
Date	21-Jul		
sampling by	4-H		
sampling method	MH		
# individuals	105		
# replicates	1		
Dominant Family	Gammaridae		
% Dominant Family	55.2		
% Ephemeroptera	1.0		
% Trichoptera	0		
% Plecoptera	0		

Wetland Hydrology

Description: Continuous groundwater level monitoring at a wetland boundary. Countywide, the ACD maintains a network of 23 wetland hydrology monitoring stations.

Purpose: To provide understanding of wetland hydrology, including the impact of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

Locations: Bannochie Wetland, SW of Main St and Radisson Rd, Blaine

Bunker Wetland, Bunker Hills Regional Park, Andover
(middle and edge of Bunker Wetland are monitored)

Camp Three Wetland, Carlos Avery WMA on Camp Three Road, Columbus Township

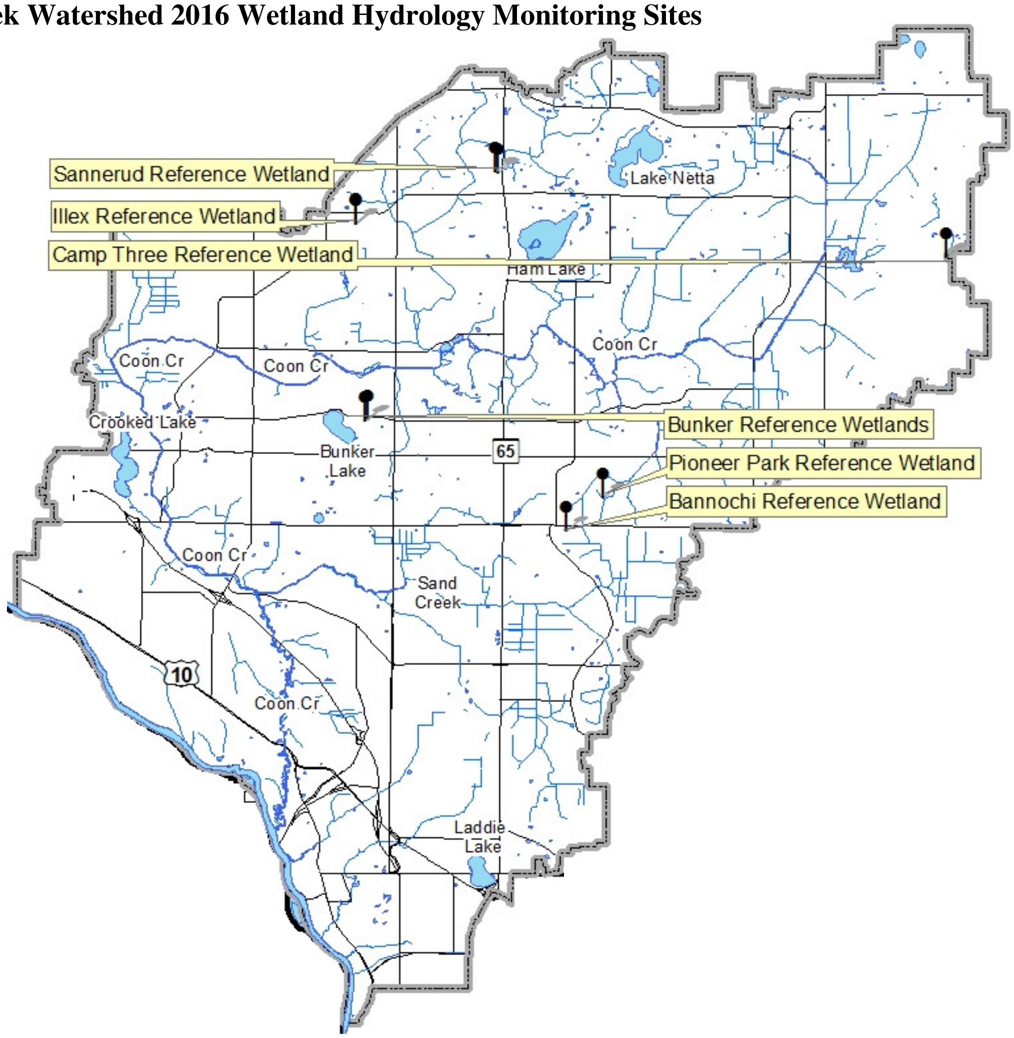
Ilex Wetland, City Park at Ilex St and 159th Ave, Andover
(middle and edge of Ilex Wetland are monitored)

Pioneer Park Wetland, Pioneer Park off Main St., Blaine

Sannerud Wetland, W side of Hwy 65 at 165th Ave, Ham Lake
(middle and edge of Sannerud Wetland are monitored)

Results: See the following pages. Raw data and updated graphs can be downloaded from www.AnokaNaturalResources.com using the Data Access Tool.

Coon Creek Watershed 2016 Wetland Hydrology Monitoring Sites



Wetland Hydrology Monitoring

BANNOCHIE REFERENCE WETLAND

SE quadrant of Radisson Rd and Hwy 14, Blaine

Site Information

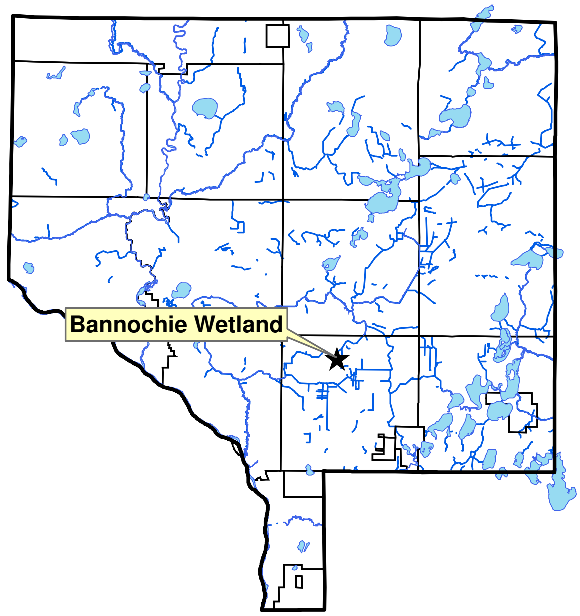
Monitored Since: 1997

Wetland Type: 2

Wetland Size: ~21.5 acres

Isolated Basin? No

Connected to a Ditch? Yes, on edges, but not the interior of wetland



Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oe1	0-6	10yr 2/1	Organic	-
Oe2	6-40	10yr 2/1-7.5yr2.5/1	Organic	-

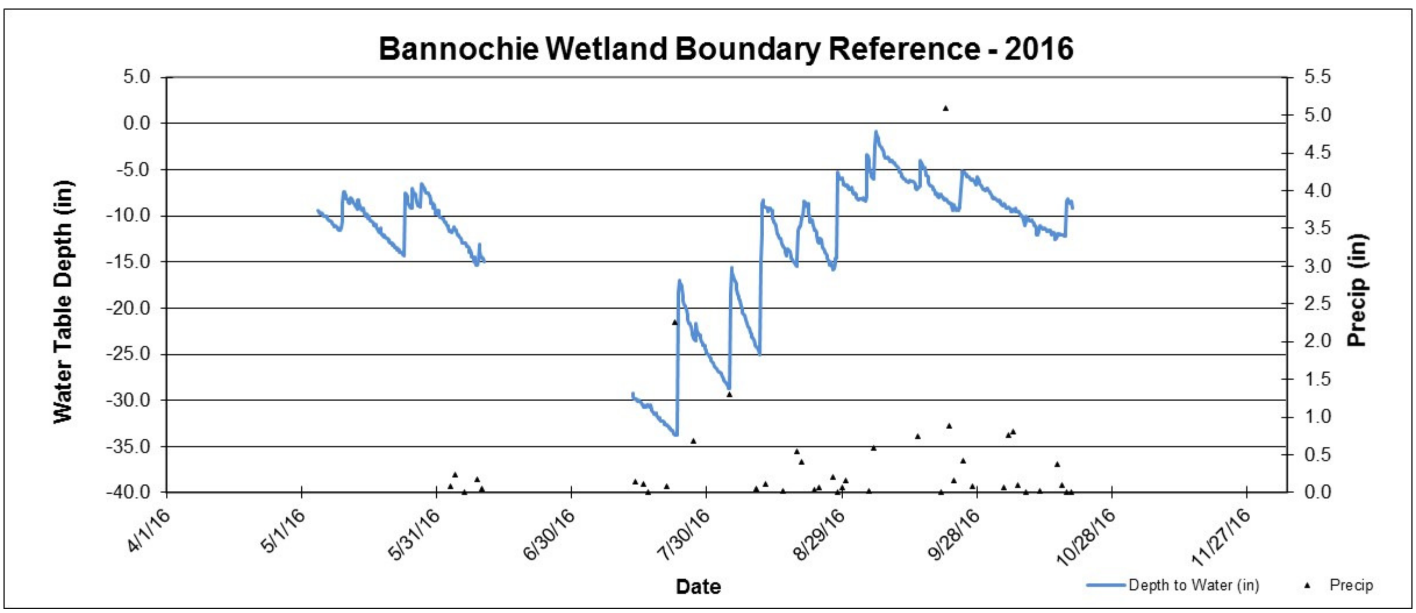
Surrounding Soils: Rifle and some Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phragmites australis	Giant Reed	80
Rubus spp.	Dewberry	100
Onoclea sensibilis	Sensitive Fern	10

Other Notes: This well is not at the wetland boundary, but rather is within the basin. Intense residential construction has occurred nearby in recent years, including construction dewatering.

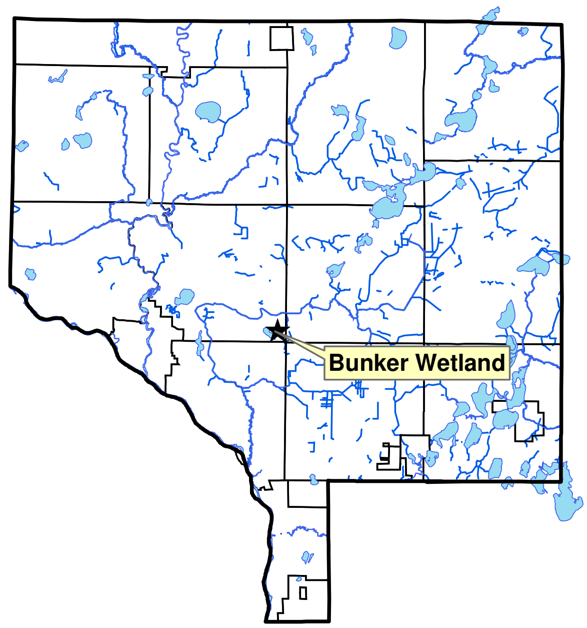
2016 Hydrograph



*Break in readings was due to equipment malfunctioning.

BUNKER REFERENCE WETLAND - EDGE

Bunker Hills Regional Park, Andover



Site Information

Monitored Since: 1996-2005 at wetland edge. In 2006 re-delineated wetland moved well to new wetland edge (down-gradient).

Wetland Type: 2

Wetland Size: ~1.0 acre

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
AC1	0-3	7.5yr3/1	Sandy Loam	50% 7.5yr 4/6
AC2	3-20	10yr2/1-5/1	Sandy Loam	-
2Ab1	20-31	N2/0	Mucky Sandy Loam	-
2Oa	31-39	N2/0	Organic	-
2Oe	39-44	7.5yr 3/3	Organic	-

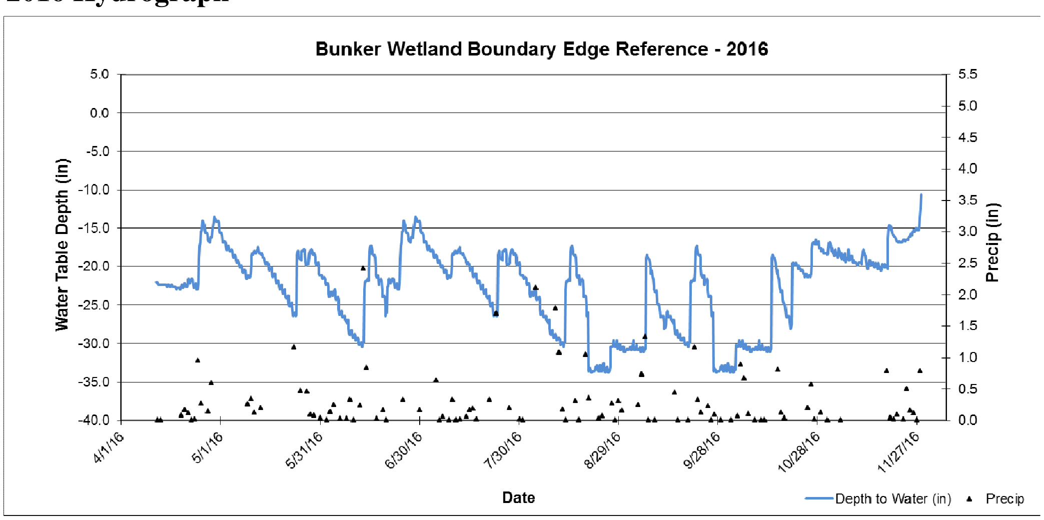
Surrounding Soils: Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Populus tremuloides(T)	Quaking Aspen	30

Other Notes: This well is located at the wetland boundary. In 2000-2005 the water table was >40 inches below the surface throughout most or all of the growing season. This prompted us to re-delineate the wetland and move the well down-gradient to the new wetland edge at the end of 2005. As a result, water levels post-2005 are not directly comparable to previous years.

2016 Hydrograph

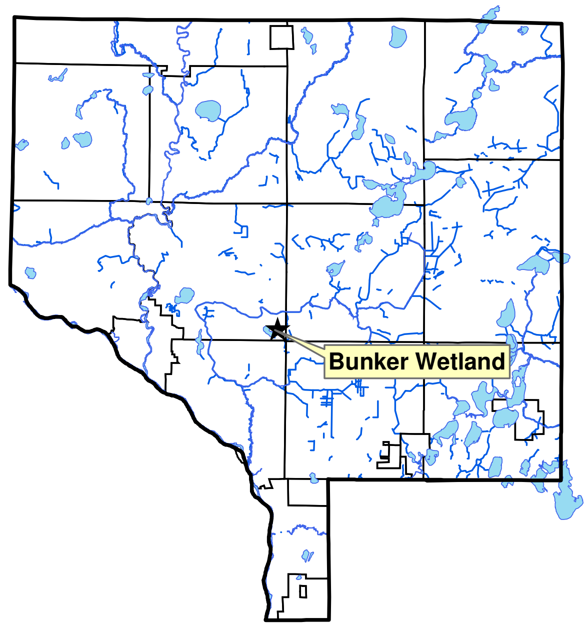


Well depth was 36 inches, so a reading of –36 indicates water levels were at an unknown depth greater than or equal to 36 inches.

BUNKER REFERENCE WETLAND - MIDDLE

Bunker Hills Regional Park, Andover

Site Information



Monitored Since: Wetland edge monitored since 1996, but this well in middle of wetland began in 2006.

Wetland Type: 2

Wetland Size: ~1.0 acre

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa	0-22	N2/0	Organic	-
Oe1	22-41	10yr2/1	Organic	-
Oe2	41-48	7.5yr3/4	Organic	-

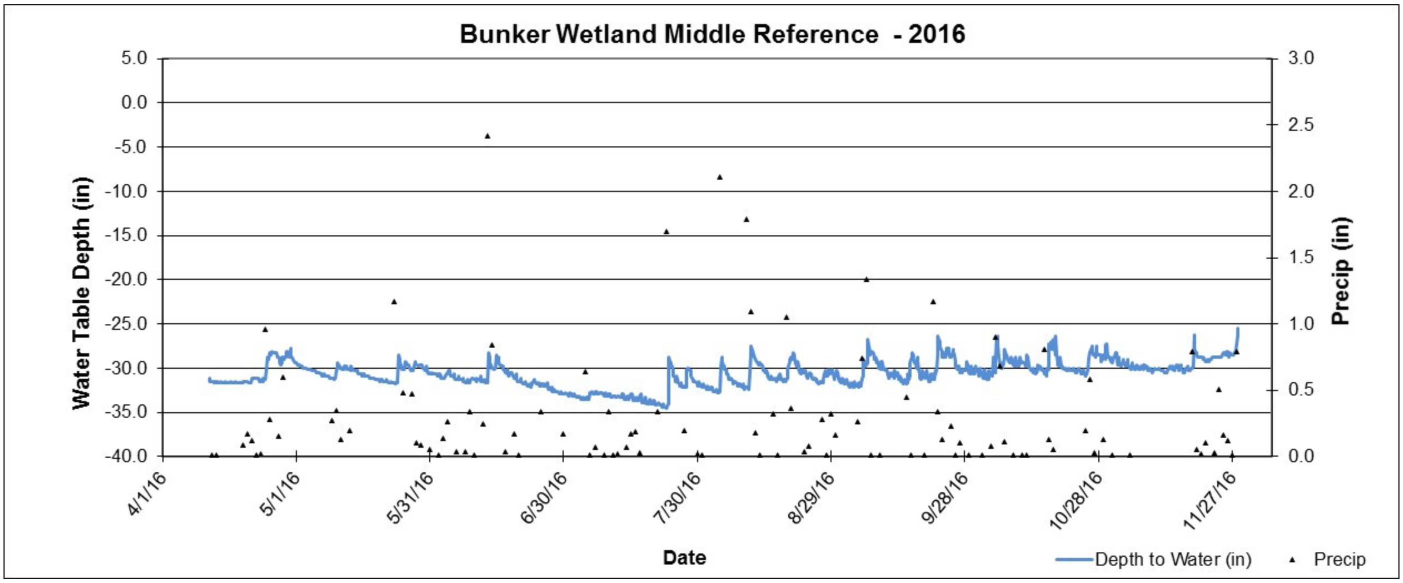
Surrounding Soils: Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Poa palustris	Fowl Bluegrass	90
Polygonum sagitatum	Arrow-leaf Tearthumb	20
Aster spp.	Aster undiff.	10

Other Notes: This well at the middle of the wetland and was installed at the end of 2005 and first monitored in 2006.

2016 Hydrograph

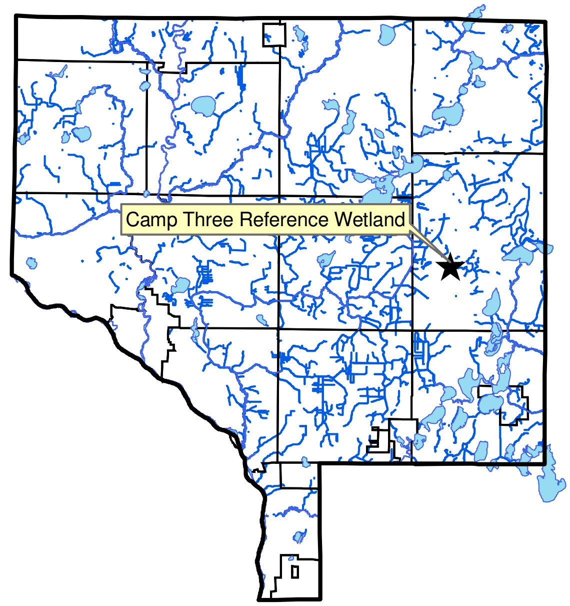


Well depth was 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

Wetland Hydrology Monitoring

CAMP THREE REFERENCE WETLAND

Carlos Avery Wildlife Management Area, Columbus Township



Site Information

Monitored Since: 2008

Wetland Type: 3

Wetland Size: Part of complex > 200 acres

Isolated Basin? No

Connected to a Ditch? Yes

Soils at Well Location: Markey Muck

Horizon	Depth	Color	Texture	Redox
A	0-4	N2/0	Mucky Fine Sandy Loam	-
A2	4-13	10yr 3/1	Fine Sandy Loam	20% 5yr 5/6
Bg1	13-21	10yr 5/1	Fine Sandy Loam	2% 10yr 5/6
Bg2	21-39	10yr 5/1	Fine Sandy Loam	5% yr 5/6
Bg3	39-55	10yr 5/1	Very Fine Sandy Loam	10% 10yr 5/6

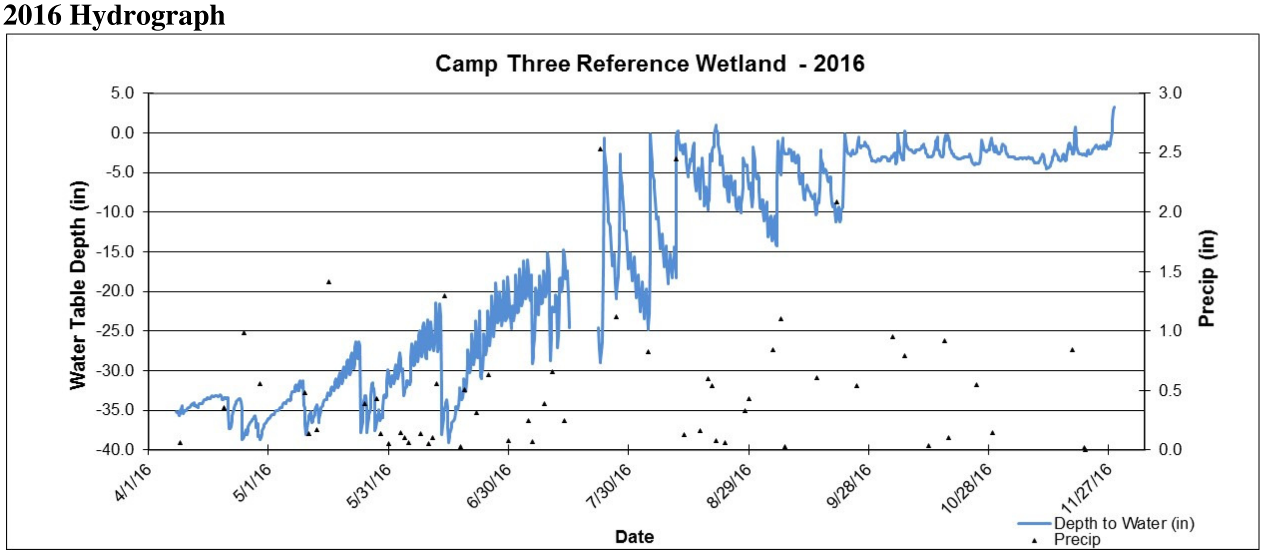
Surrounding Soils: Zimmerman Fine Sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Populus tremuloides (T)	Quaking Aspen	30
Acer negundo (S)	Boxelder	30
Acer rubrum (T)	Red Maple	10

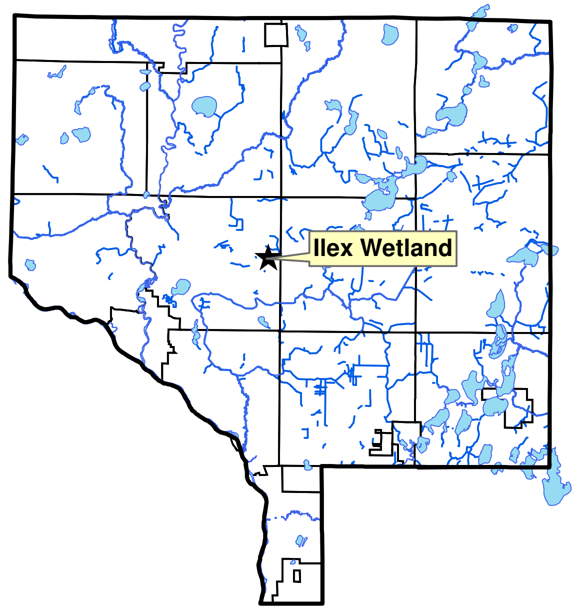
Other Notes: This well is located at the wetland boundary. It maintained a consistent water level of -26 inches throughout summer 2008. This may have been due to water control structures elsewhere in the Carlos Avery Wildlife Management Area.

2016 Hydrograph



ILEX REFERENCE WETLAND - EDGE

City Park at Ilex St and 159th Ave, Andover



Site Information

Monitored Since: 1996

Wetland Type: 2

Wetland Size: ~9.6 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-10	10yr2/1	Fine Sandy Loam	-
Bg	10-14	10yr4/2	Fine Sandy Loam	-
2Ab	14-21	N2/0	Sandy Loam	-
2Bg1	21-30	10yr4/2	Fine Sandy Loam	-
2Bg2	30-45	10yr5/2	Fine Sand	-

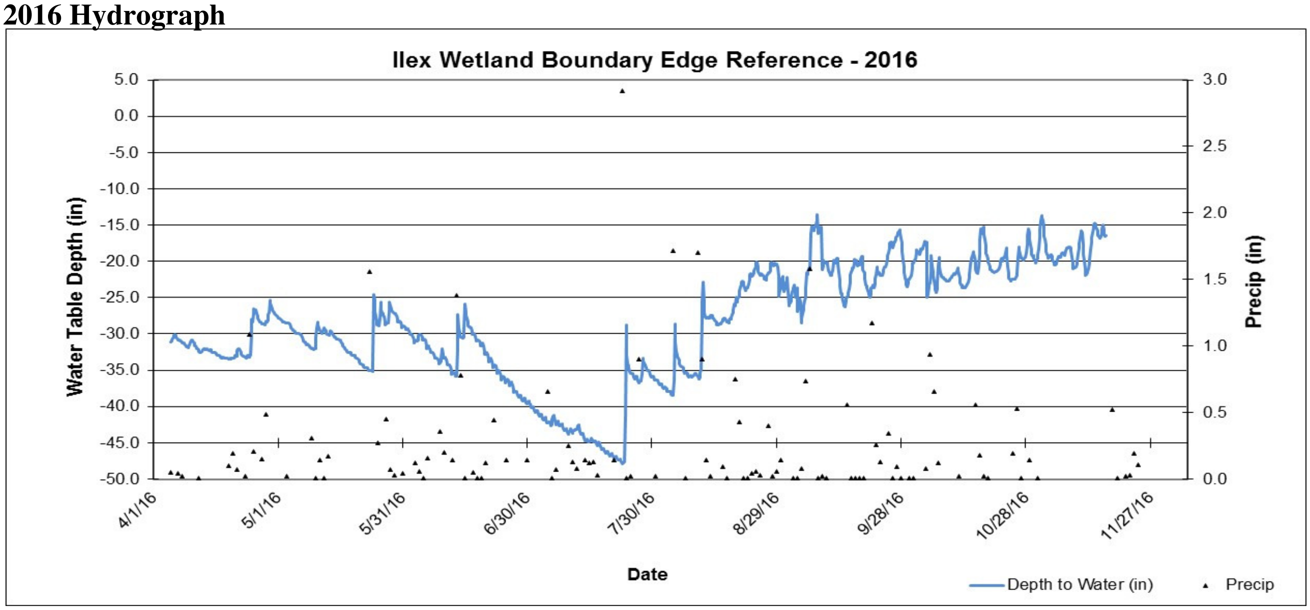
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Solidago gigantia	Giant Goldenrod	20
Populus tremuloides (T)	Quaking Aspen	20
Rubus strigosus	Raspberry	10

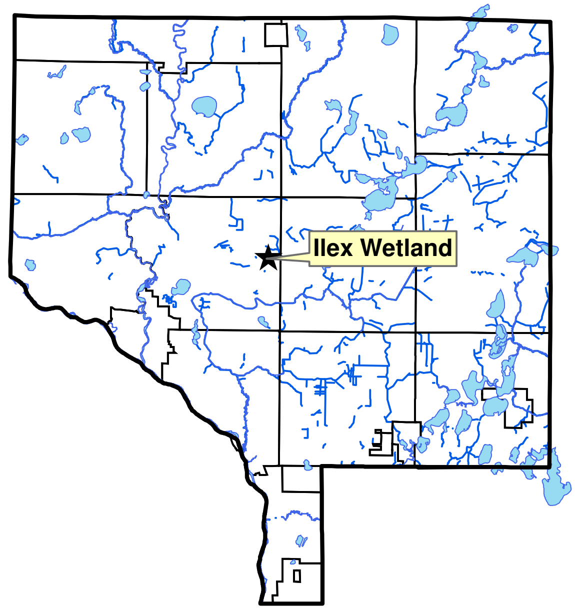
Other Notes: This well is located at the wetland boundary. In 2000-2005 the water table was only once within 15 inches of the surface and seldom within 40 inches. This prompted us to re-delineate the wetland and move the well down-gradient to the new wetland edge at the beginning of 2006. As a result, water levels post-2005 are not directly comparable to previous years.

2016 Hydrograph



ILEX REFERENCE WETLAND - MIDDLE

City Park at Ilex St and 159th Ave, Andover



Site Information

Monitored Since: 2006

Wetland Type: 2

Wetland Size: ~9.6 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa	0-9	N2/0	Organic	-
Bg1	9-19	10yr4/2	Fine Sandy Loam	-
Bg2	19-45	10yr5/2	Fine Sand	-

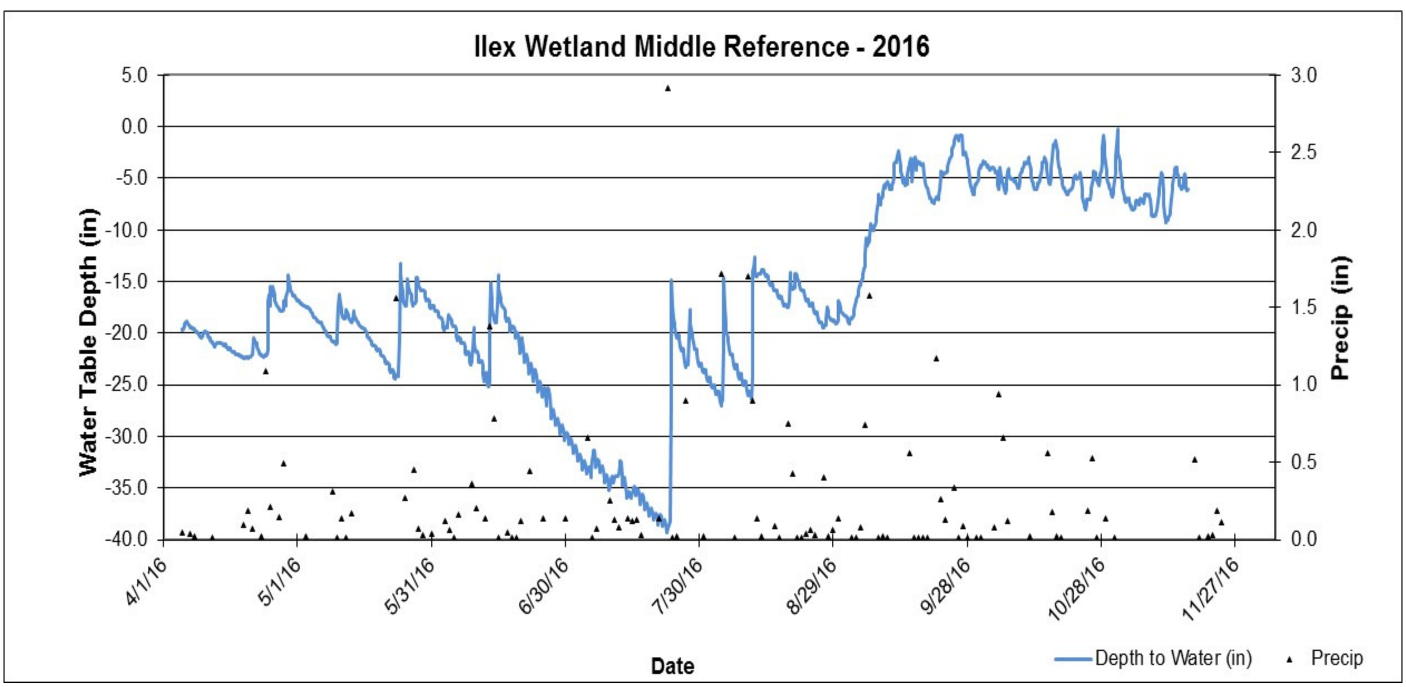
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	80
Typha angustifolia	Narrow-leaf Cattail	40

Other Notes: This well is located near the middle of the wetland basin.

2016 Hydrograph

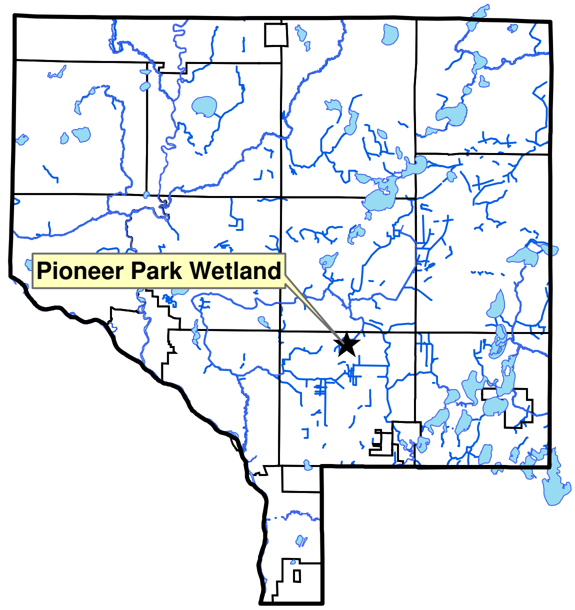


Wetland Hydrology Monitoring

PIONEER PARK REFERENCE WETLAND

Pioneer Park N Side of Main St. E of Radisson Road, Blaine

Site Information



Monitored Since: 2005

Wetland Type: 2

Wetland Size: Undetermined. Part of a large wetland complex.

Isolated Basin? No

Connected to a Ditch? Not directly.Wetland complex has small drainage ways, culverts, & nearby ditches.

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa1	0-4	10yr 2/1	Sapric	-
Oa2	4-8	N 2/0	Sapric	-
AB	8-12	10yr 3/1	Mucky Sandy Loam	-
Bw	12-27	2.5y 5/3	Loamy Sand	-
Bg	27-40	2.5y 5/2	Loamy Sand	-

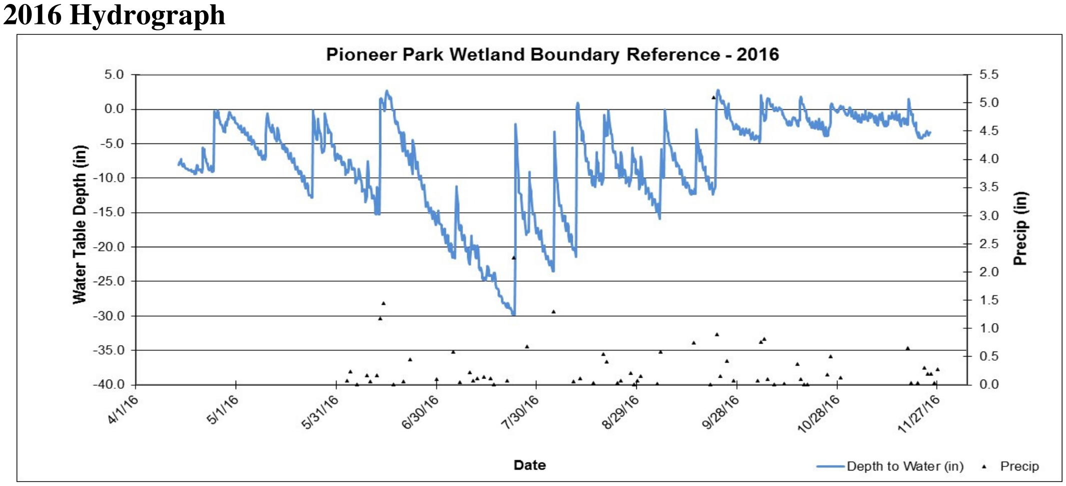
Surrounding Soils: Rifle and loamy wet sand.

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Carex lacustris	Lake Sedge	20
Fraxinus pennsylvanica (T)	Green Ash	30
Rhamnus frangula (S)	Glossy Buckthorn	20
Ulmus americana (T)	American Elm	20
Populus tremuloides (S)	Quaking Aspen	20
Urtica dioica	Stinging Nettle	10

Other Notes: This well is located within the wetland, not at the edge. City of Blaine surveyed calibration line 6-2013. Elevation = 897.366 (NGVD 29)

2016 Hydrograph

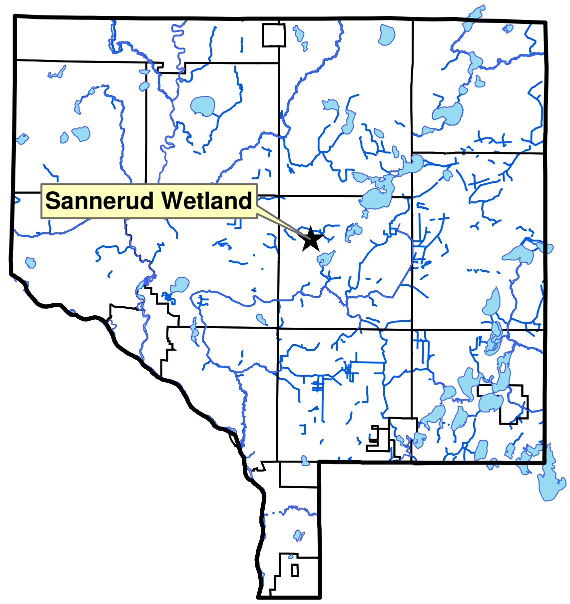


Well depth was 40 inches, so a reading of –40 indicates water levels at an unknown depth greater than or equal to 40 inches.

Wetland Hydrology Monitoring

SANNERUD REFERENCE WETLAND - EDGE

W side of Hwy 65 at 165th Ave, Ham Lake



Site Information

Monitored Since: 2005

Wetland Type: 2

Wetland Size: ~18.6 acres

Isolated Basin? Yes

Connected to a Ditch? Is adjacent to Hwy 65 and its drainage systems. Small remnant of a ditch visible in wetland.

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa	0-8	N2/0	Sapric	-
Bg1	8-21	10yr 4/1	Sandy Loam	-
Bg2	21-40	10yr 4/2	Sandy Loam	-

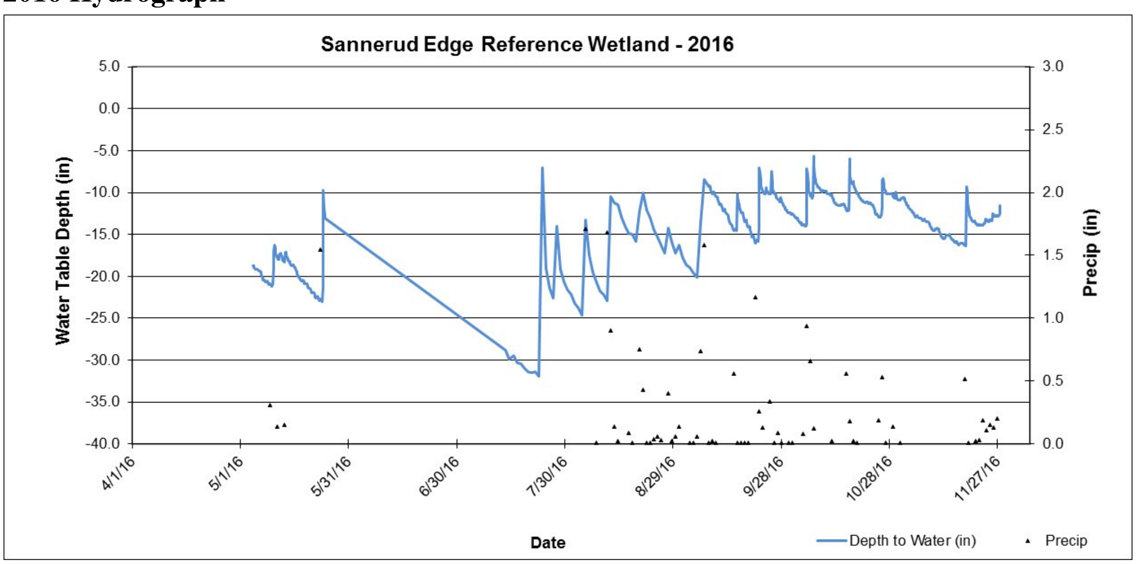
Surrounding Soils: Zimmerman and Lino.

Vegetation at Well Location:

Scientific	Common	% Coverage
Rubus spp.	Undiff Rasberry	70
Phalaris arundinacea	Reed Canary Grass	40
Acer rubrum (T)	Red Maple	30
Populus tremuloides (S)	Quaking Aspen	30
Betula papyrifera (T)	Paper Birch	10
Rhamnus frangula (S)	Glossy Buckthorn	10

Other Notes: This is one of two monitoring wells on this wetland. This one is at the wetland's edge, while the other is near the middle. The wetland edge well is slightly deeper than most reference wetland wells, at 43.5 inches deep.

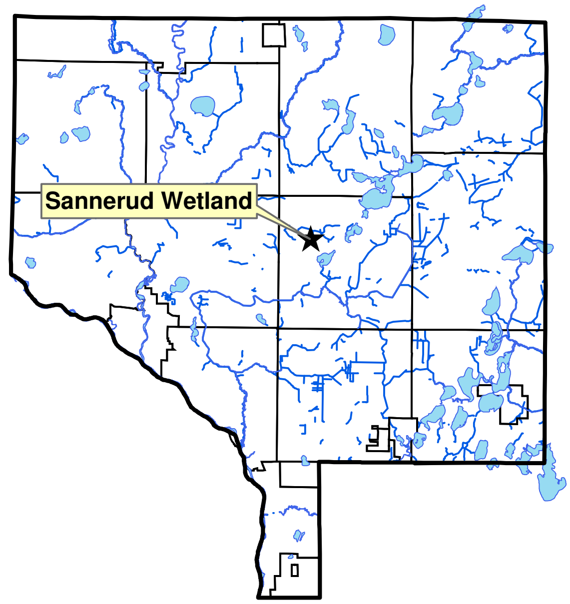
2016 Hydrograph



Well depth was 40.8 inches, so a reading of –40.8 indicates water levels were at an unknown depth greater than or equal to 40.8 inches.

SANNERUD REFERENCE WETLAND - MIDDLE

W side of Hwy 65 at 165th Ave, Ham Lake



Site Information

Monitored Since: 2005

Wetland Type: 2

Wetland Size: ~18.6 acres

Isolated Basin? Yes

Connected to a Ditch? Is adjacent to Hwy 65 and its drainage systems. Small remnant of a ditch visible in wetland.

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oe	0-3	7.5yr 3/1	Organic	-
Oe2	18-Mar	10yr 2/1	Organic	-
Oa	18-48	10yr 2/1	Organic	-

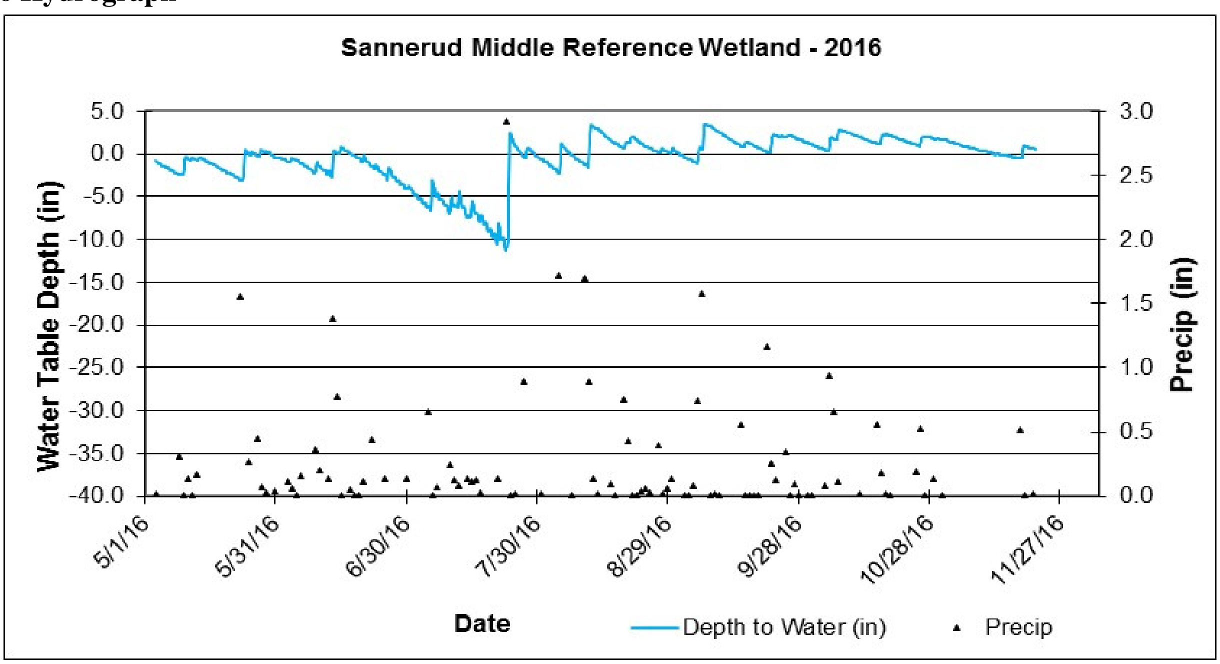
Surrounding Soils: Zimmerman and Lino.

Vegetation at Well Location:

Scientific	Common	% Coverage
Carex lasiocarpa	Wooly-Fruit Sedge	90
Calamagrostis canadensis	Blue-Joint Reedgrass	40
Typha angustifolia	Narrow-Leaf Cattail	5
Scirpus validus	Soft-Stem Bulrush	5

Other Notes: This is one of two monitoring wells on this wetland. This one is near the center of the wetland, while the other is at the wetland's edge.

2016 Hydrograph



Reference Wetland Analyses

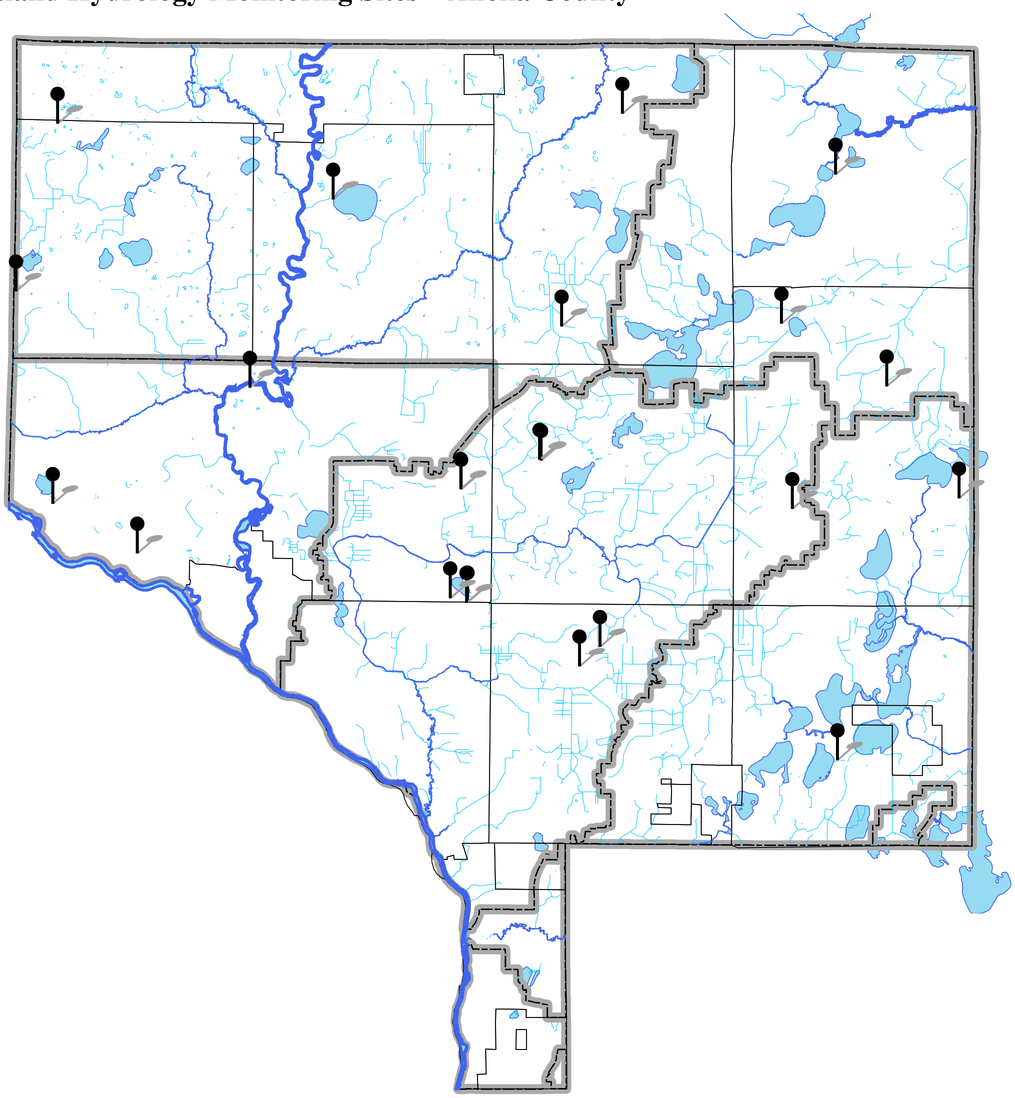
Description: This section includes analyses of wetland hydrology data of 23 reference wetland sites collected at 19 locations. Shallow groundwater levels at the edge of these wetlands are recorded every four hours. Many have been monitored since 1996. These analyses summarize this enormous multi-year, multi-wetland dataset. In the process of doing this analysis, a database summarizing all of the data was created. This database will allow many other, more specific, analyses to be done to answer questions as they arise, particularly through the wetland regulatory process.

Purpose: To provide a summary of the known hydrological conditions in wetlands across Anoka County that can be used to assist with wetland regulatory decisions. In particular, these data assist with deciding if an area is or is not a wetland by comparing the hydrology of an area in question to known wetlands in the area. The database created to produce the summaries below can be used to answer other, more specific, questions as they arise.

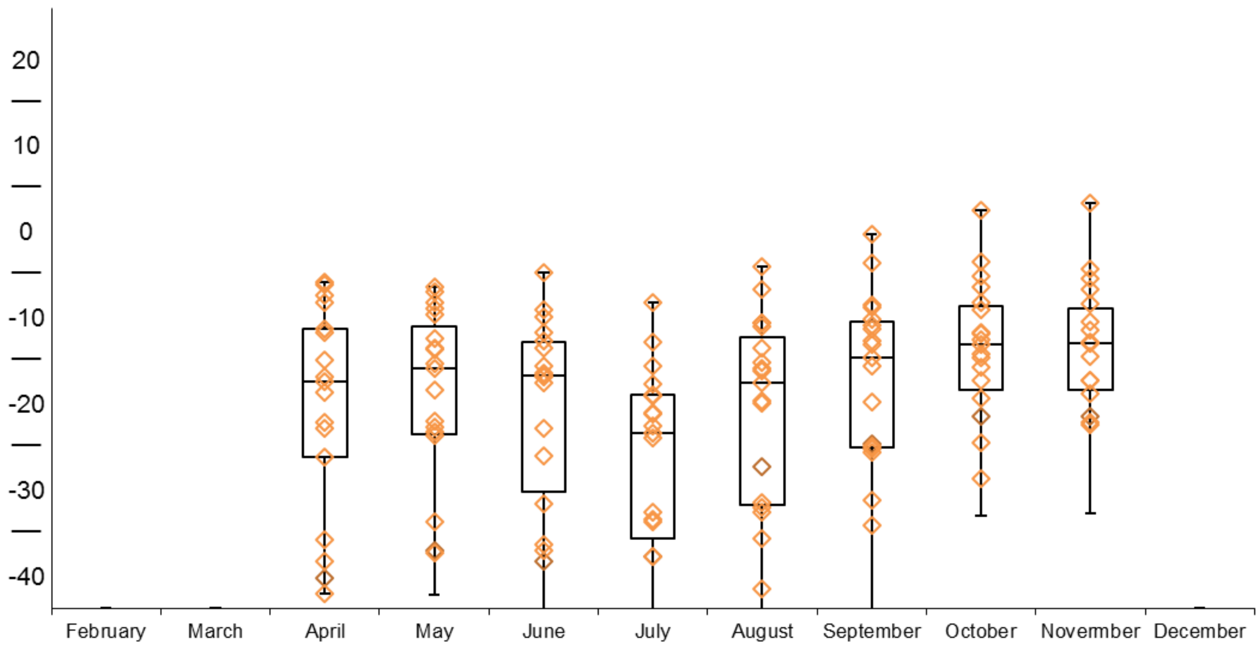
Locations: All 23 reference wetland hydrology monitoring sites in Anoka County.

Results: On the following pages. Data has been summarized for the most recent year alone, as well as across all years with available data.

Reference Wetland Hydrology Monitoring Sites – Anoka County



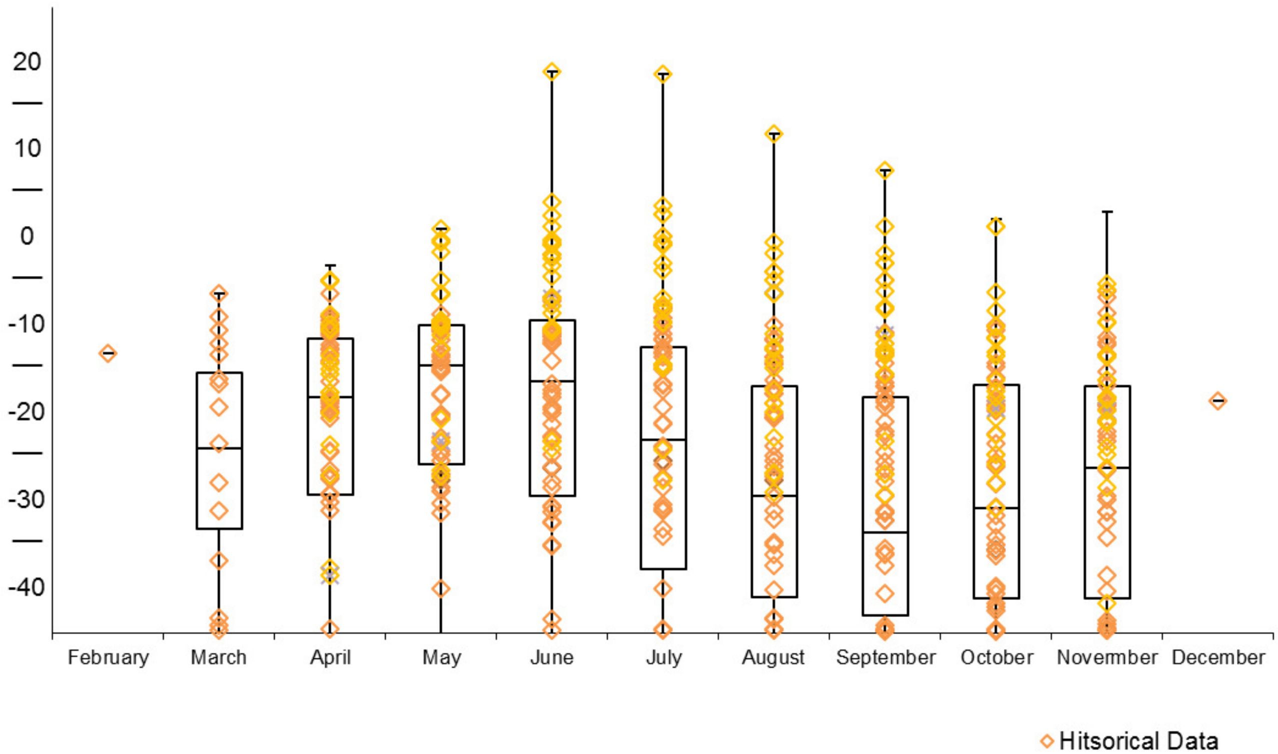
2016 Reference Wetland Water Levels Summary: Each marker represents the median depth to the water table at the edge of one reference wetland for a given month in 2016. The quantile boxes show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (floating horizontal lines). Maximum well depths were 40 to 45 inches, so a reading <40 inches likely indicates water was below the well at an unknown depth.



Quantiles

Month	Min	10%	25%	Median	75%	90%	Max
4	-38.3	-35.4	-22.4	-13.6	-7.5	-3.0	-2.0
5	-41.0	-33.4	-19.7	-12.1	-7.2	-4.1	-2.6
6	-50.5	-33.7	-26.4	-13.0	-9.0	-5.8	-0.9
7	-67.9	-42.8	-32.0	-19.6	-15.2	-11.2	-4.3
8	-50.3	-33.0	-28.0	-13.7	-8.4	-5.9	-0.1
9	-48.8	-28.0	-21.3	-10.9	-6.7	-3.7	3.6
10	-45.0	-21.5	-14.6	-9.2	-4.8	-1.0	6.4
11	-46.9	-18.4	-14.6	-9.1	-5.0	-1.3	7.2

1996-2016 Reference Wetland Water Levels Summary: Each dot represents the mean depth to the water table at the edge of one reference wetland for a month between 1996 and 2016. The quantile boxes show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (floating horizontal lines). Maximum well depths were 40 to 45 inches, so a reading <40 inches likely indicates water was below the well at an unknown depth.



Quantiles

Month	Min	10%	25%	Median	75%	90%	Max
2	-8.6	-8.6	-8.6	-8.6	-8.6	-8.6	-8.6
3	-41.6	-39.1	-28.3	-19.3	-10.8	-6.4	-1.9
4	-41.6	-33.8	-24.5	-13.6	-7.1	-3.7	1.2
5	-41.6	-32.2	-21.0	-10.0	-5.5	-2.1	5.3
6	-50.5	-37.0	-24.6	-11.7	-5.0	0.4	22.9
7	-67.9	-39.6	-32.8	-18.3	-7.9	-2.1	22.6
8	-50.3	-40.1	-36.0	-24.6	-12.3	-4.6	15.9
9	-48.8	-40.4	-37.9	-28.7	-13.5	-6.0	11.8
10	-45.0	-40.1	-36.1	-25.9	-12.2	-6.1	6.4
11	-46.9	-40.1	-36.1	-21.5	-12.4	-5.3	7.2
12	-14.0	-14.0	-14.0	-14.0	-14.0	-14.0	-14.0

Discussion:

The purpose of reference wetland data is to help assure that wetlands are accurately identified by regulatory personnel, as well as to aid understanding of shallow groundwater hydrology. State and federal laws place restrictions on filling, excavating, and other activities in wetlands. Commonly, citizens wish to do work in an area that is sometimes, or perhaps only rarely, wet. Whether this area is a wetland under regulatory definitions is often in dispute. Complicating the issue is that conditions in wetlands are constantly changing—an area that is very wet and clearly wetland at one time may be completely dry only a few weeks later (dramatically displayed in the graphs above). As a result, regulatory personnel look at a variety of factors, including soils, vegetation, and current moisture conditions. Reference wetland data provide a benchmark for comparing moisture conditions in dispute, thereby helping assure accurate regulatory decisions. Likewise, it allows us to compare current shallow water levels to the range of observed levels in the past; this is useful for purposes ranging from flood prediction to drought severity indexing. The analysis of reference wetland data is a quantitative, non-subjective tool.

The simplest use of the reference wetland data in a regulatory setting is to compare water levels in the reference wetlands to water levels in a disputed area. The graphics and tables above are based upon percentiles of the water levels experienced at known wetland boundaries. The quantile boxes in the figures delineate the 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentiles. Water table depths outside of the box have a low likelihood of occurring, or may only occur under extreme circumstances such as extreme climate conditions or in the presence of anthropogenic hydrologic alterations. If sub-surface water levels in a disputed area are similar to those in reference wetlands, there is a high likelihood that the disputed area is a wetland.

This approach can be refined by examining data from only the year of interest and only certain wetland types. This removes much of the variation that is due to climatic variation among years and due to wetland type. Substantial variation in water levels will no doubt remain among wetlands even after these factors are accounted for, but this exercise should provide a reasonable framework for understanding what hydrologic conditions were present in known wetlands during a given time period.

Water table levels are recorded every 4 hours at all 23 reference wetlands (except during winter), and the raw water level data are available through the Anoka Conservation District.

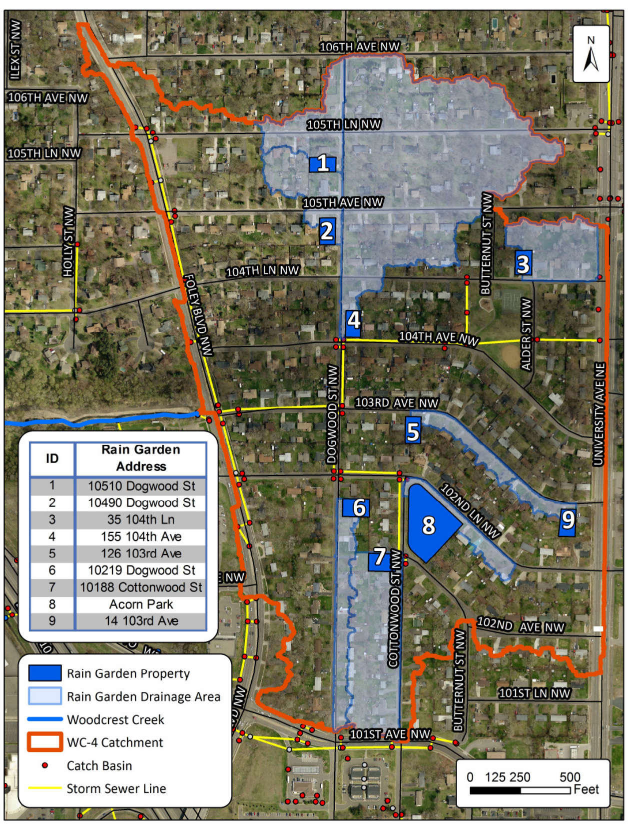
Woodcrest Creek and Sand Creek Rain Garden Install and Planting

Description: The Coon Creek Watershed District (CCWD) contracted with ACD to manage the promotion, design, and construction oversight of a rain garden project in the WC-4 and SC-R3 catchments of the Woodcrest Creek and Sand Creek subwatersheds in 2015. Projects were finished and planted in 2016.

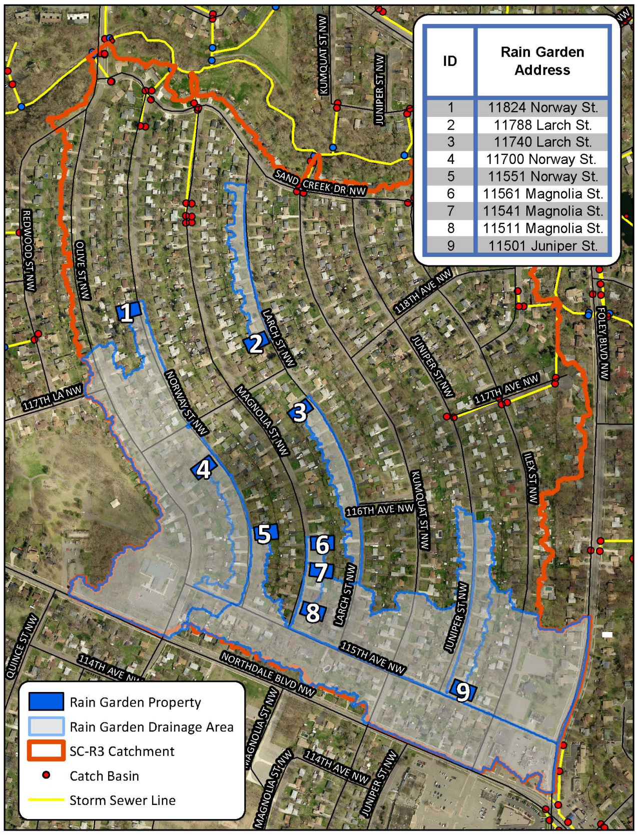
Purpose: To improve stormwater quality and reduce the volume of runoff generated within the WC-4 and SC-R3 catchments. All stormwater runoff from these catchments previously discharged directly into the stormwater system without receiving treatment. This contributes to the degradation of Woodcrest Creek, Sand Creek, and ultimately Coon Creek.

Results: ACD staff targeted priority properties in the residential neighborhoods located within the catchments to identify landowners interested in participating in the rain garden program. Interested landowners attended an educational meeting held by ACD. Those landowners with favorable rain garden sites and willingness to move forward with the program entered into contracts with the CCWD for rain garden construction. ACD staff provided design and construction management for the installation of nine rain gardens throughout the WC-4 catchment and nine rain gardens throughtout the SC-R3 catchment. The rain gardens were installed at strategic locations to ensure sufficient contributing drainage areas and maximize treatment. The planting of the gardens took place in spring 2016. Long-term maintenance will be provided by the landowners under an agreement with the CCWD. Cumulatively, the nine rain gardens of the WC-8 catchment reduce stormwater runoff volumes into Woodcrest Creek by 6.8 acre-ft/yr, total suspended solids by 3,225 lbs/yr, and total phosphorus by 9.9 lbs/yr. The nine rain gardens of the SC-R3 catchment reduce stormwater runoff volumes into Sand Creek by 9.7 acre-ft. /yr., total suspended solids by 4,629 lbs. /yr., and total phosphorus by 13.0 lbs. /yr.

Site map and pictures of nine rain gardens installed in the WC-4 catchment of the Woodcrest Creek subwatershed in 2015 and planted in 2016.



Site map and pictures of nine rain gardens installed in the SC-R3 catchment of the Sand Creek subwatershed in 2015 and planted in 2016.



Financial Summary

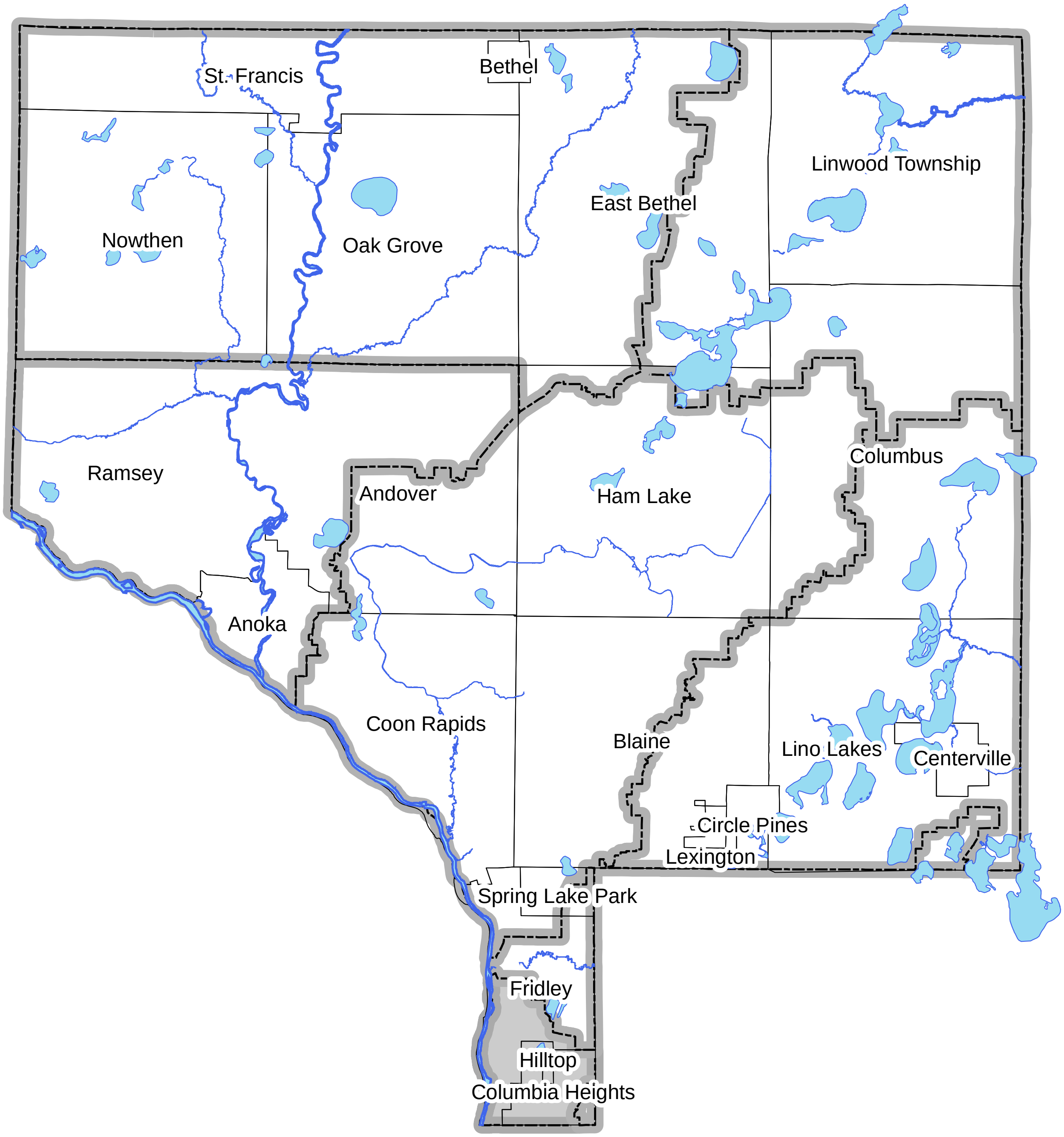
ACD accounting is organized by program and not by customer. This allows us to track all of the labor, materials and overhead expenses for a program, such as our lake water quality monitoring program. We do not, however, know specifically which expenses are attributed to monitoring which lakes. To enable reporting of expenses for monitoring conducted in a specific watershed, we divide the total program cost by the number of sites monitored to determine an annual cost per site. We then multiply the cost per site by the number of sites monitored for a customer. The process also takes into account equipment that is purchased for monitoring in a specific area.

Note in the table below that all precipitation related work, including monitoring and analysis, is grouped as CCWD rain. Likewise, all reference wetland work, including monitoring, analysis, and vegetation mapping, are grouped as Ref Wet.

Coon Creek Watershed Financial Summary

Coon Creek Watershed	WMO Asst (no charge)	Volunteer Precip	CCWD Precip	Reference Wetlands	CCWD Ref Wtld Analyses/Veg Survey	Ob Well	Lake Level	Lake WQ	Stream Level	Stream WQ	CCWD Hydrolab	Oak Glen Pond/IESF CWF - Admin	Oak Glen Pond/IESF CWF - Proj. Dev.	SC-R3/WC-4 Rain Garden Planting	CCWD AIS	Total
Revenues																
CCWD	0	0	5047	4025	322	0	1000	5025	5200	30400	4200	0	0	8105	677	64001
State	0	0	0	0	0	660	0	0	0	0	0	0	0	0	0	660
Anoka Co. General Services	390	0	0	74	28	645	601	182	48	0	2664	160	2157	0	174	7123
Anoka Conservation District	0	0	0	161	0	0	0	0	0	0	0	0	0	0	0	161
County Ag Preserves/Projects	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Service Fees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regional/Local	0	0	0	113	0	0	0	417	0	0	0	0	0	0	0	530
BWSR Cons Delivery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BWSR Capacity Funds	0	0	0	4279	0	0	0	0	0	0	0	0	0	0	0	4279
BWSR Cost Share TA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metro ETA & AWQCP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Local Water Planning	0	367	0	2126	0	0	0	0	0	0	0	0	0	0	0	2493
TOTAL	390	367	5047	10778	350	1305	1601	5624	5248	30400	6864	160	2157	8105	850	79248
Expenses-																
Capital Outlay/Equip	5	5	55	55	0	15	19	44	43	146	79	2	25	40	10	543
Personnel Salaries/Benefits	339	356	4098	4132	25	1135	1393	3278	3240	10861	5887	139	1877	2968	740	40468
Overhead	25	26	301	304	2	84	102	241	238	799	433	10	138	218	54	2977
Employee Training	2	2	23	23	0	6	8	18	18	61	33	1	11	17	4	228
Vehicle/Mileage	7	8	87	87	1	24	29	69	69	230	124	3	40	63	16	856
Rent	12	13	146	148	1	41	50	117	116	388	210	5	67	106	26	1446
Program Participants	0	0	0	0	0	0	0	0	0	0	0	0	0	3941	0	3941
Program Supplies	0	-42	280	5625	0	0	0	1333	9	5742	97	0	0	0	0	13045
TOTAL	390	367	4991	10375	28	1305	1601	5100	3734	18226	6864	160	2157	7352	850	63502

Mississippi Watershed

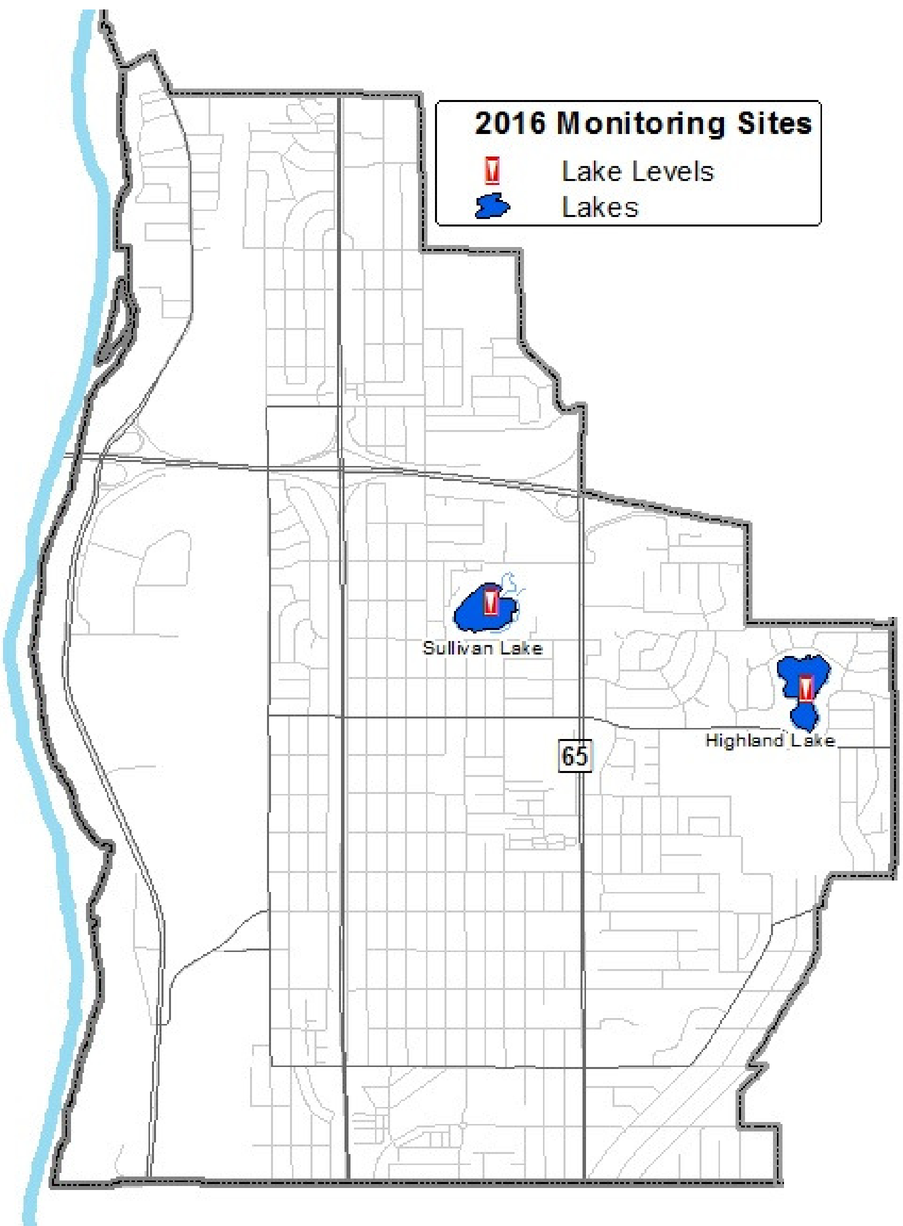


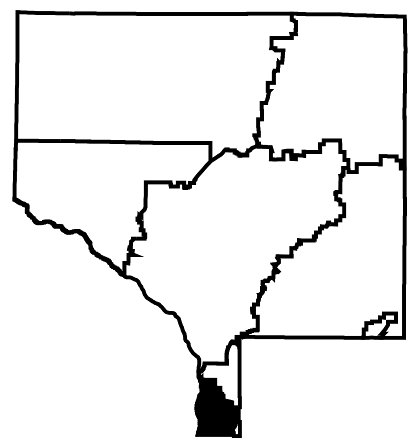
Contact Info: Mississippi Watershed Management Organization
www.mwmo.org
612-465-8780

Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 7
MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

ACD = Anoka Conservation District, MNDNR = Minnesota Department of Natural Resources,
MWMO = Mississippi Watershed Management Organization, ACAP = Anoka County Ag Preserves





Lake Levels

Description: Weekly water level monitoring in lakes. These data, as well as all additional historical data are available on the Minnesota DNR website using the "LakeFinder" feature (www.dnr.mn.us.state\lakefind\index.html).

Purpose: To provide understanding of lake hydrology, including the impact of climate and water budget changes. These data are useful for regulatory, building/development, and lake hydrology manipulation decisions.

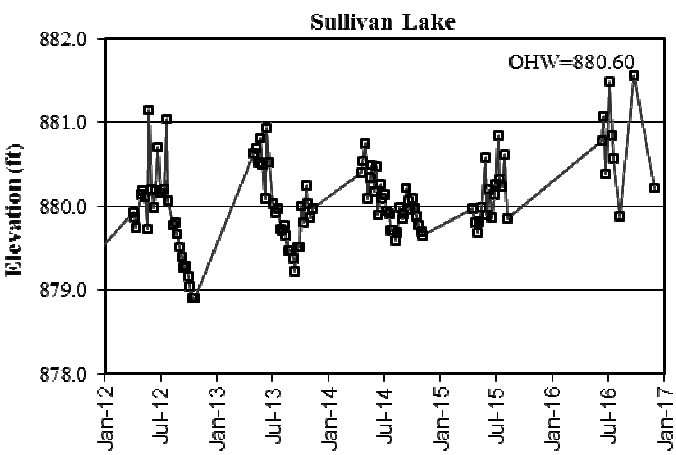
Locations: Sullivan/Sandy Lake

Highland Lake

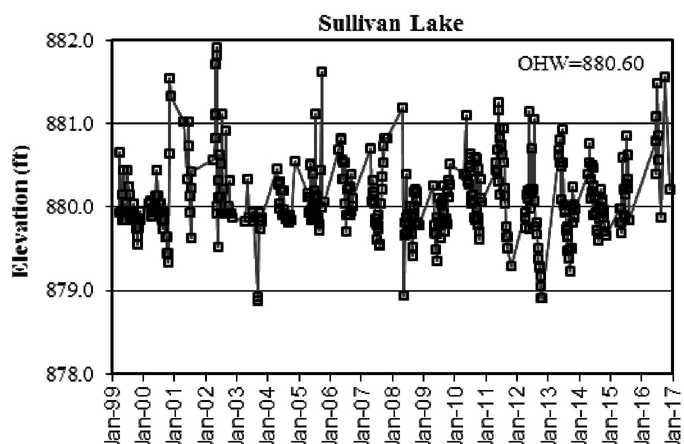
Results: Lake levels were measured 9 times at each lake June through November of 2016. Sullivan Lake water levels fluctuate widely, routinely bouncing by half a foot in response to rainfall, because it receives a large amount of storm water relative to its size, and its outlet releases water in all but the lowest water conditions. Highland Lake fluctuated very little only ranging 0.51 ft. total throughout the season.

Raw lake level data for all sites and all years can be downloaded from the Minnesota DNR website using the "LakeFinder" tool. Ordinary High Water Levels (OHW), the elevation below which a DNR permit is needed to perform work, are listed for each lake on the graph below.

Sullivan/Sandy lake levels last 5 years



Sullivan/Sandy Lake Levels 1999-2016

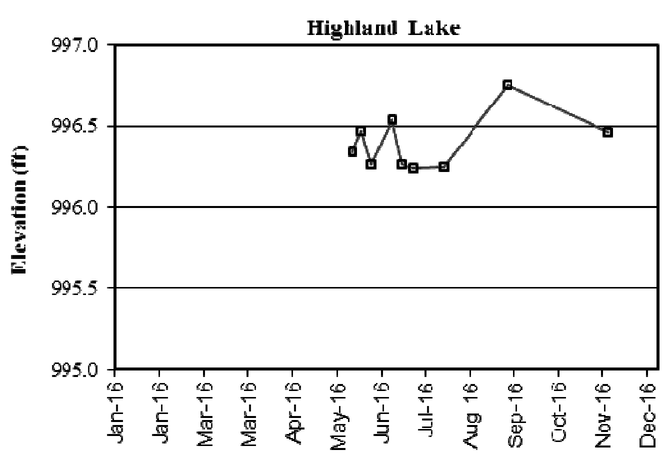


Sullivan/Sandy lake level 5 year summary

Sullivan Lake

Year	Average	Min	Max
2012	879.86	878.91	881.15
2013	880.00	879.23	880.93
2014	880.05	879.60	880.76
2015	880.14	879.69	880.85
2016	880.76	879.88	881.56
5-year	880.06	878.91	881.56

Highland Lake levels 2016



Highland Lake level 2016 summary

Highland Lake

Year	Average	Min	Max
2016	996.40	996.24	996.75

Lake Water Quality

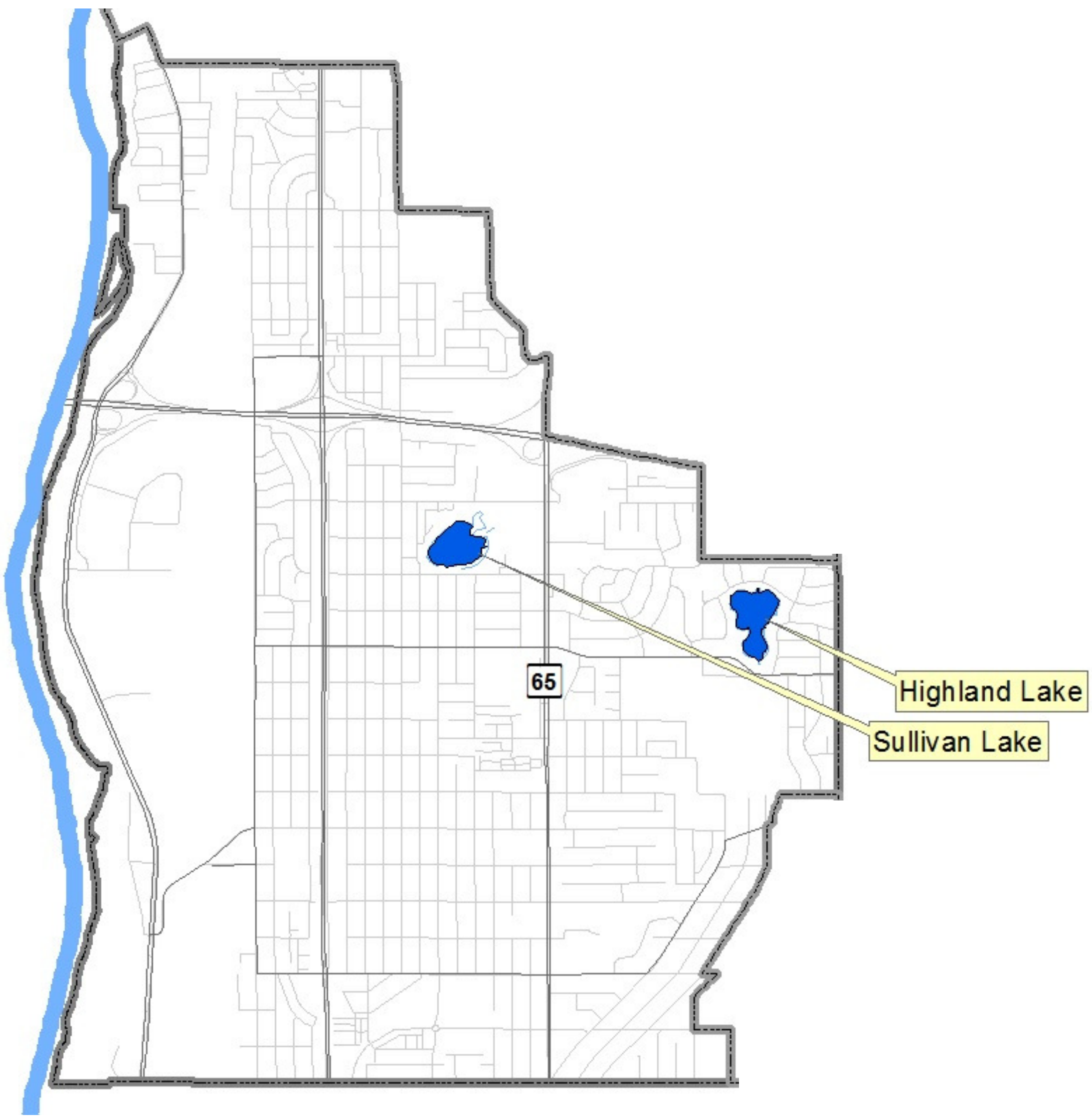
Description: May through September monthly monitoring of the following parameters: total phosphorus, chlorophyll-a, chloride, secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

Purpose: To detect water quality trends and diagnose the cause of changes.

Locations: Sullivan/Sandy Lake

Highland Lake

Results: Detailed data are provided on the following pages, including summaries of historical conditions and trend analysis. Previous years' data are available from the ACD. Refer to Chapter 1 for additional information on interpreting the data and on lake dynamics.



Sullivan/Sandy Lake

City of Columbia Heights, Lake ID # 02-0080

Background

Sullivan Lake, also known as Sandy Lake, is located in south central Anoka County. It has a surface area of 16.8 acres and a maximum depth of 9 feet (2.7 m). A walking trail system/park circumscribes the lake. Adjacent to the trail is a mix of residential, commercial, and retail uses. The walking trail around the lake is used extensively, but the lake itself is used very little for swimming, fishing, or boating because there are few places with clear access to the water. This lake's watershed is highly urbanized, and the lake essentially serves as a flow-through storm water pond. It is connected directly to the curb and gutter storm water system. Because of the heavy influence of storm water on this small lake, it is listed as impaired by the MPCA for both nutrients and biological indicators. Water exiting this lake is discharged to the Mississippi River via storm water conveyances.

Results 2016

Sullivan/Sandy Lake maintains a track record of very poor water quality in 2016 compared to other lakes in this region (NCHF Ecoregion), receiving an overall D letter grade for the fifth consecutive year sampled over the last 13 years. The lake is highly eutrophic, and phosphorus levels are routinely two to three times the threshold for an impaired designation by the MPCA. The lake is unsuitable for swimming during the entire growing season. Both total phosphorus and Chlorophyll-a levels were lower in 2016 than they were when the lake was last sampled in 2013, but both were still very high. Total phosphorus exceeded the shallow lake water quality standard of 60 ug/L in every sample in 2016 with four of five samples more than doubling that standard. Chlorophyll-a also more than doubled the state standard of 20 ug/L in four of five samples in 2016. Past depth profiles indicate that dissolved oxygen is too low for most fish (<4 mg/L) below four feet, and is too low for most aquatic life (<1 mg/L) near the bottom. This is likely due to oxygen consumption by decomposition of expired algae.

Trend Analysis

Fourteen years of water quality data have been collected by the Metropolitan Council (1993-2003) and the Anoka Conservation District (2004, 2005, 2013, & 2016). Water quality is showing a significant downward trend (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,11}=4.43$, $p=0.039$). We examined each of the response variables separately using a one-way ANOVA to gain insight into which might be responsible for the trend. Total phosphorus shows a statistically significant increase ($F_{1,12}=8.08$, $p=0.015$) with Cl-a showing a strong trend upward as well, though not statistically significant.

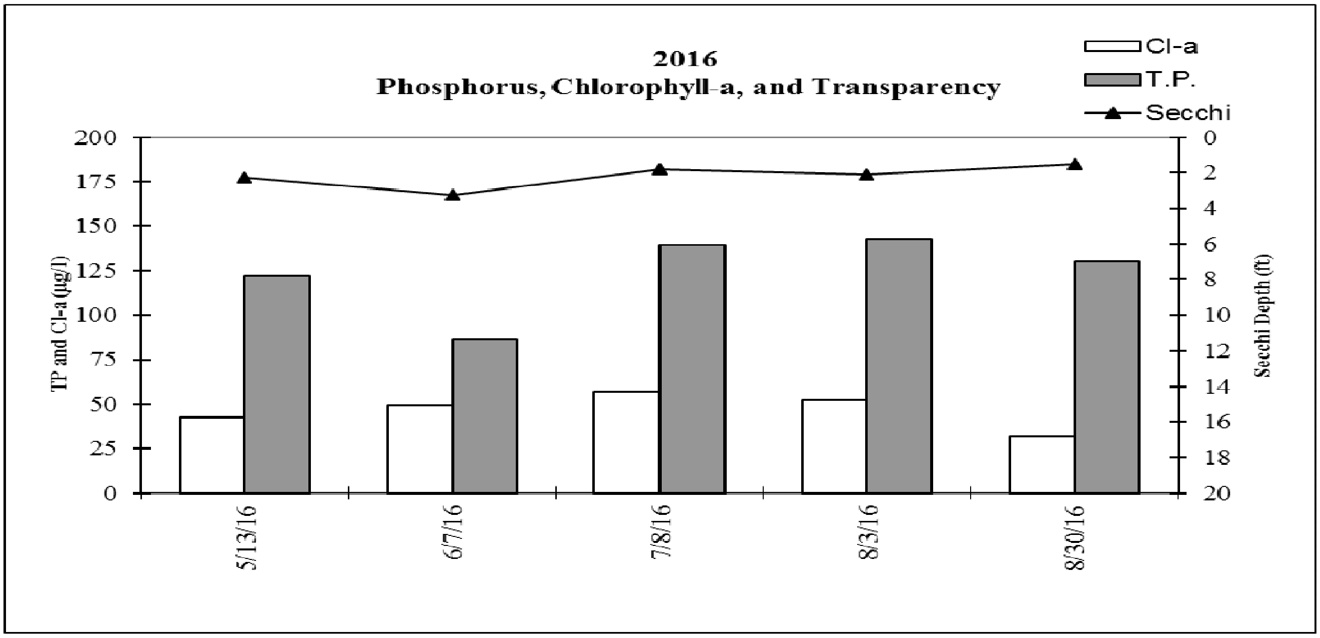
Discussion

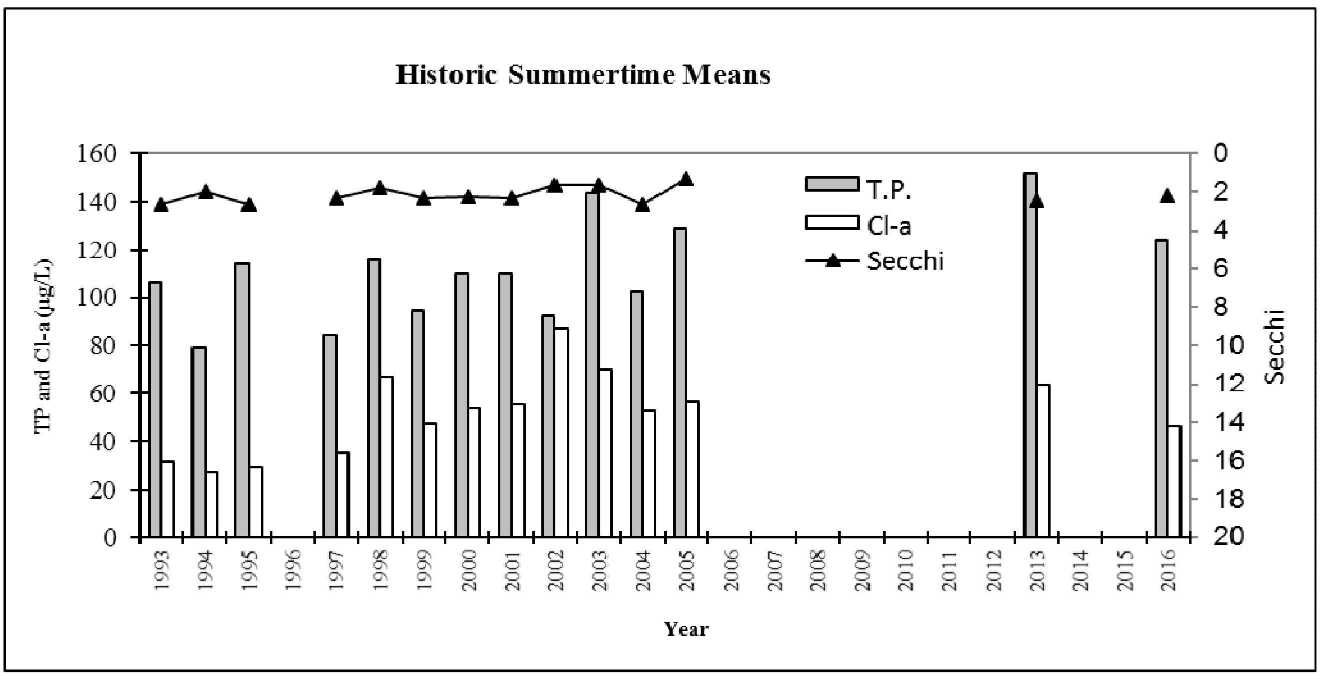
Sullivan Lake likely has poor water quality because of both the quality and quantity of stormwater that it receives. Stormwater from urbanized areas can be high in sediment, nutrients and other pollutants. Improvements to the storm water system that could benefit Sullivan Lake should be explored.

2016 Sullivan/Sandy Lake Water Quality Data

		Date	5/13/2016	6/7/2016	7/8/2016	8/3/2016	8/30/2016			
		Time	9:40	10:00	8:25	9:25	8:45			
	Units	R.L.*	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	7.63	7.97	6.50	9.62	9.30	8.20	6.50	9.62
Conductivity	mS/cm	0.01	0.531	0.590	0.281	0.209	0.143	0.351	0.143	0.590
Turbidity	NTU	1	29	22	38	44	43	35	22	44
D.O.	mg/L	0.01	8.1	10.23	3.28	13.64	10.48	9.15	3.28	13.64
D.O.	%	1	80%	117%	42%	171%	127%	107%	42%	171%
Temp.	°C	0.1	14.2	20.5	23.6	27.2	23.8	21.88	14.23	27.24
Temp.	°F	0.1	57.6	68.9	74.5	81.0	74.8	71.4	57.6	81.0
Salinity	%	0.01	0.3	0.3	0.1	0.1	0.1	0.2	0.1	0.3
Chloride	mg/l	0.1	117.0	117.0	51.4	32.6	15.3	54.1	15.3	117.0
Cl-a	ug/L	0.5	42.7	49.1	57.0	52.0	32.0	46.6	32.0	57.0
T.P.	mg/L	0.010	0.122	0.086	0.139	0.143	0.130	0.124	0.086	0.143
T.P.	ug/L	10	122	86	139	143	130	124	86	143
Secchi	ft	0.1	2.3	3.3	1.8	2.1	1.5	2.2	1.5	3.3
Secchi	m	0.1	0.7	1.0	0.6	0.6	0.5	0.7	0.5	1.0

Sullivan Lake Water Quality Results

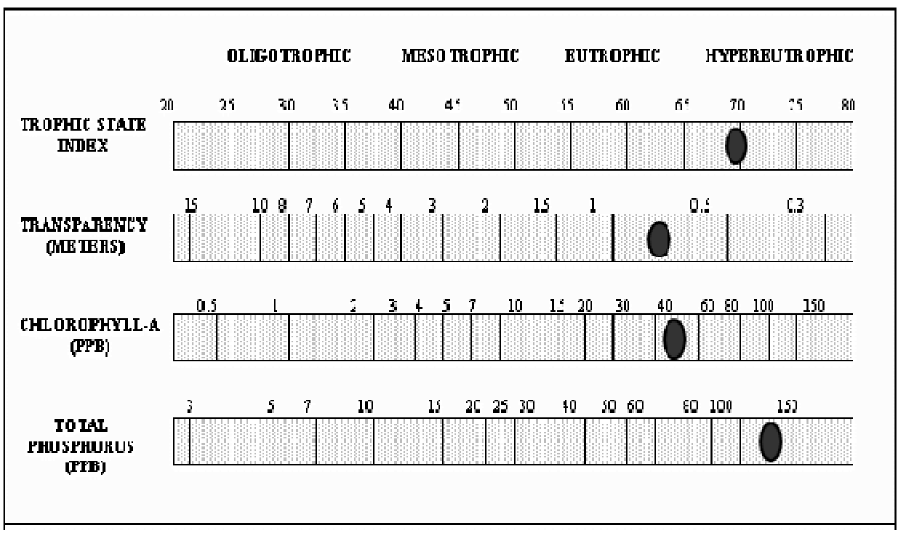




Sullivan Lake Historic Summertime Mean Values

Agency	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	ACD	ACD	ACD	ACD
Year	93	94	95	97	98	99	2000	2001	2002	2003	2004	2005	2013	2016
TP	106.0	79.1	114.0	84.2	115.5	94.4	110.0	110.0	92.4	143.4	102.3	129	151.6	124
Cl-a	31.4	27.2	29.4	35.3	66.8	47.3	53.8	55.2	87.2	70.3	52.6	56.3	64.0	46.6
Secchi (m)	0.80	0.60	0.80	0.70	0.55	0.71	0.69	0.70	0.50	0.50	0.80	0.40	0.7	0.7
Secchi (ft)	2.6	2.0	2.6	2.3	1.8	2.3	2.3	2.3	1.6	1.6	2.6	1.3	2.4	2.2
Carlson's Trophic State Indices														
TSIP	71	67	72	68	73	70	72	72	69	76	71	74	77	74
TSIC	65	63	64	66	72	69	70	70	75	72	70	70	72	68
TSIS	63	67	63	65	69	65	65	65	70	70	63	73	64	65
TSI	66	66	67	66	71	68	69	69	71	73	68	73	71	69
Sullivan Lake Water Quality Report Card														
Year	93	94	95	97	98	99	2000	2001	2002	2003	2004	2005	2013	2016
TP	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Cl-a	C	C	C	C	D	C	D	D	F	D	D	D	D	C
Secchi	D	F	D	D	F	D	D	D	F	F	D	F	D	D
Overall	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**F**	**D**	**D**	**D**	**D**	**D**

Carlson's Trophic State Index



Highland Lake

City of Columbia Heights, Lake ID # 02-0079

Background

Highland Lake is a very shallow lake surrounded by a wooded park in south central Anoka County. Surrounding the park is a highly urbanized residential neighborhood. The lake has a surface area of approximately 14 acres with two small islands in the northeastern corner. The park and trails surrounding the lake are used extensively.

Results 2106

The ACD monitored Highland Lake for the first time in 2016. Prior to 2016, the lake had been monitored through the MPCA citizen volunteer program annually from years 2000-2007. Throughout its monitored history, Highland Lake has had extremely high levels of nutrients and Chlorophyll-a, and additionally suffers from poor water clarity. The MPCA has listed Highland Lake as impaired for nutrients and biological indicators. Highland Lake once again had very poor water quality in 2016 compared to other lakes in this region (NCHF Ecoregion), receiving an overall F grade (the only grade the lake has achieved since 2002). Total phosphorus levels were two to four times the state water quality standard for shallow lakes in the NCHF Ecoregion of 60 ug/L on every sampling event and averaged over triple that standard at 210 ug/L in 2016. Chlorophyll-a exceeded the state standard of 20 ug/L on three of five sampling events with a maximum of 96.1 ug/L and an average of 49.6 ug/L in 2016.

Trend Analysis

Nine years of water quality data have been collected by the MPCA (2000-2007) and the Anoka Conservation District (2016). While this is a pretty small dataset to perform any meaningful statistical analysis on, we did perform a repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, ($F_{2,5}$ = 03.38, p = 0.12) and each of the response variables separately using a one-way ANOVA. While none of these analysis produced a trend of statistical significance, TP levels do appear to be increasing while Cl-a and Secchi depth appear to both be trending downward.

Discussion

Highland Lake, similar to Sullivan Lake, likely has poor water quality because of both the quality and quantity of stormwater that it receives. Stormwater from urbanized areas can be high in sediment, nutrients and other pollutants. Improvements to the storm water system that could benefit Highland Lake should be explored.

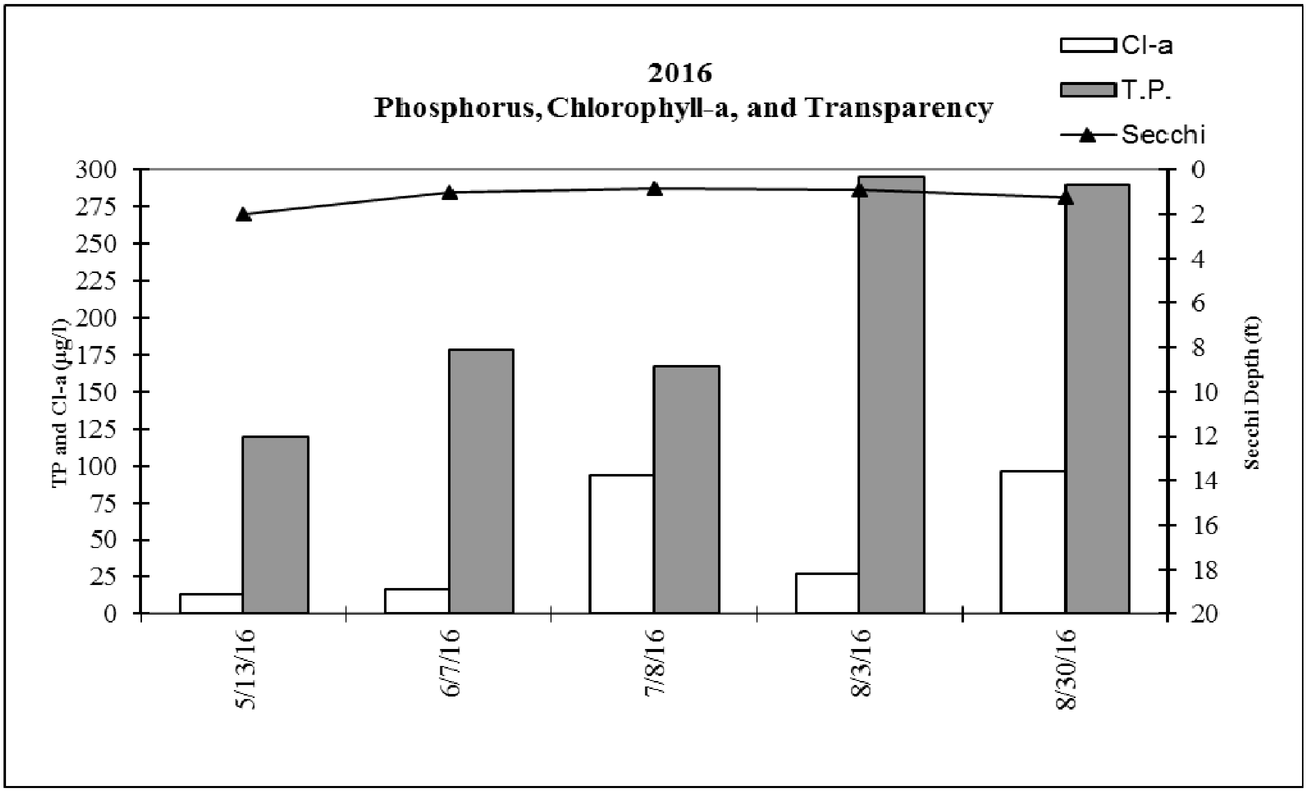
2016 Highland Lake Water Quality Data

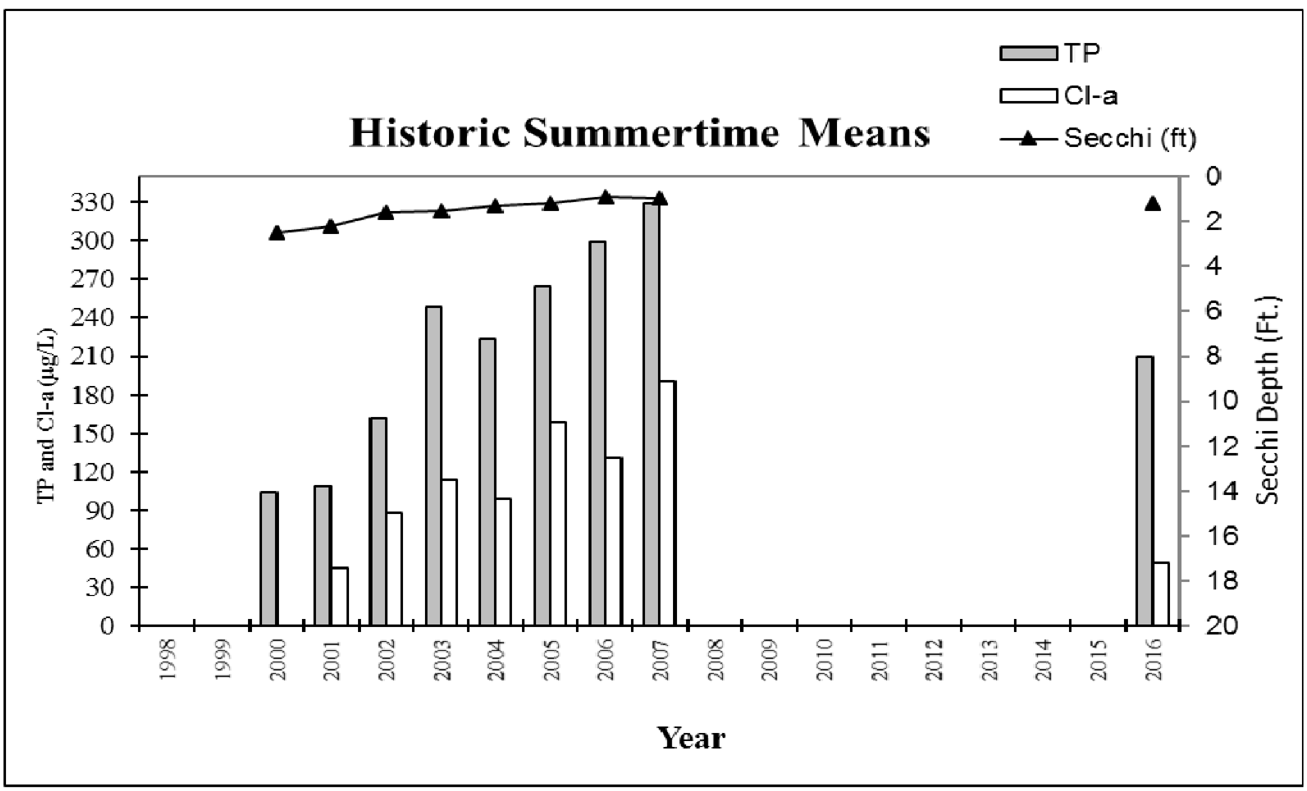
Highland Lake
2016 Water Quality Data

		Date:	5/13/2016	6/7/2016	7/8/2016	8/3/2016	8/30/2016			
		Time:	10:10	10:30	8:50	9:50	9:11			
	Units	R.L.*	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	7.21	7.20	7.21	7.50	6.46	7.12	6.46	7.50
Conductivity	mS/cm	0.01	0.256	0.275	0.199	0.190	0.148	0.214	0.148	0.275
Turbidity	FNRU	1	31.40	49.60	89.30	87.50	59.40	63	31	89
D.O.	mg/l	0.01	9.18	10.82	9.35	9.91	8.63	9.58	8.63	10.82
D.O.	%	1	90%	114%	113%	123%	104%	109%	90%	123%
Temp.	°C	0.1	13.1	18.5	23.2	25.6	23.0	20.7	13.1	25.6
Temp.	°F	0.1	55.6	65.3	73.7	78.0	73.5	69.2	55.6	78.0
Salinity	%	0.01	0.12	0.13	0.10	0.09	0.07	0.10	0.07	0.13
Cl-a	ug/L	0.5	13.5	17.1	94.0	27.3	96.1	49.6	13.5	96.1
T.P.	mg/l	0.010	0.120	0.178	0.167	0.295	0.290	0.210	0.120	0.295
T.P.	ug/l	10	120	178	167	295	290	210.0	120	295
Chloride	mg/L		36.1	35.2	24.7	22.9	13.4	26.5	13	36
Secchi	ft		2.0	1.0	0.8	0.9	1.3	1.2	0.8	2.0
Secchi	m		0.6	0.3	0.3	0.3	0.4	0.4	0.3	0.6

*reporting limit

Highland Lake Water Quality Results





Highland Lake Historic Summertime Mean Values

Agency	MPCA	MPCA	MPCA	MPCA	MPCA	MPCA	MPCA	MPCA	ACD
Year	2000	2001	2002	2003	2004	2005	2006	2007	2016
TP	104	109	162	248	223	264	299	329	210
Cl-a		45.0	88.0	114.0	99.0	159.0	131.0	190.5	49.6
Secchi (n	0.77	0.67	0.48	0.47	0.40	0.36	0.27	0.29	0.4
Secchi (ft	2.5	2.2	1.6	1.5	1.3	1.2	0.9	1.0	1.2

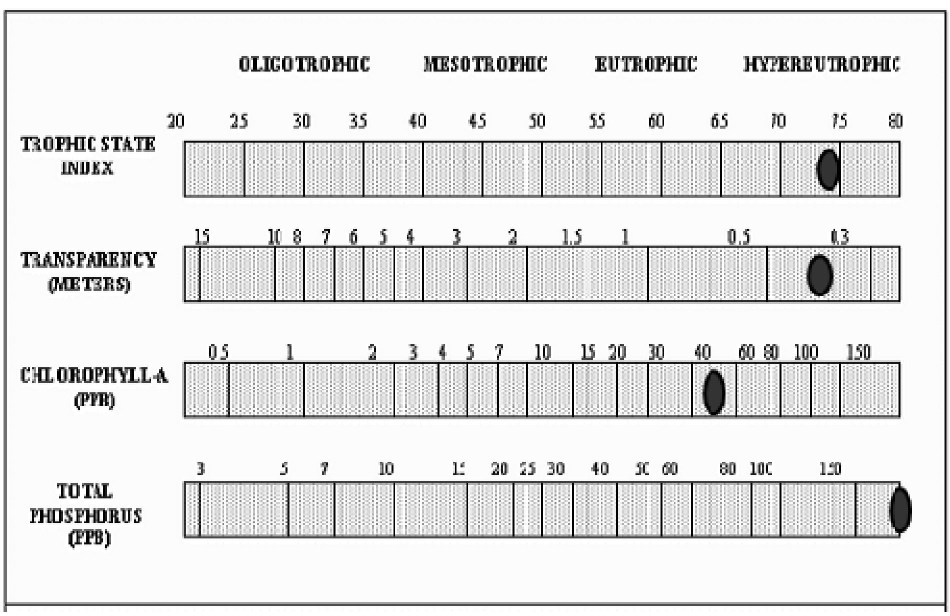
Carlsons Trophic state indices

TSIP	71	72	78	84	82	85	86	88	81
TSIC	na	68	75	77	76	80	78	82	69
TSIS	64	66	71	71	73	75	79	78	73
TSI	67	69	74	77	77	80	81	83	74

Round Lake Water Quality Report Card

Year	2000	2001	2002	2003	2004	2005	2006	2007	2016
TP	D	D	F	F	F	F	F	F	F
Cl-a	na	C	F	F	F	F	F	F	D
Secchi	D	F	F	F	F	F	F	F	F
Overall	**D**	**D**	**F**	**F**	**F**	**F**	**F**	**F**	**F**

Carlson's Trophic State Index



Financial Summary

ACD accounting is organized by program and not by customer. This allows us to track all of the labor, materials and overhead expenses for a program, such as our lake water quality monitoring program. We do not, however, know specifically which expenses are attributed to monitoring which lakes. To enable reporting of expenses for monitoring conducted in a specific watershed, we divide the total program cost by the number of sites monitored to determine an annual cost per site. We then multiply the cost per site by the number of sites monitored for a customer. The process also takes into account equipment that is purchased for monitoring in a specific area.

MWMO 2016 Financial Summary

Mississippi WMO	WMO Asst (no charge)	Lake Level	Lake WQ	Rum River 1W1P	Total
Revenues					
MWMO	0	500	2280	0	2780
State	0	0	0	0	0
Anoka Co. General Services	390	300	91	98	879
Anoka Conservation District	0	0	0	0	0
County Ag Preserves/Projects	0	0	0	0	0
Service Fees	0	0	0	0	0
Regional/Local	0	0	209	0	209
BWSR Cons Delivery	0	0	0	0	0
BWSR Capacity Funds	0	0	0	576	576
BWSR Cost Share TA	0	0	0	0	0
Metro ETA & AWQCP	0	0	0	0	0
Local Water Planning	0	0	0	0	0
TOTAL	390	800	2580	674	4444
Expenses-					
Capital Outlay/Equip	5	9	22	8	44
Personnel Salaries/Benefits	339	696	1639	586	3261
Overhead	25	51	121	43	240
Employee Training	2	4	9	3	18
Vehicle/Mileage	7	15	35	12	69
Rent	12	25	59	21	117
Program Participants	0	0	0	0	0
Program Supplies	0	0	666	0	666
TOTAL	390	800	2550	674	4415

Recommendations

- Investigate storm water conveyances draining to both Highland and Sullivan Lake and determine ways to incrementally improve the quality of water that reaches them. Both of these lakes have extremely poor water quality that has been maintained for many years.