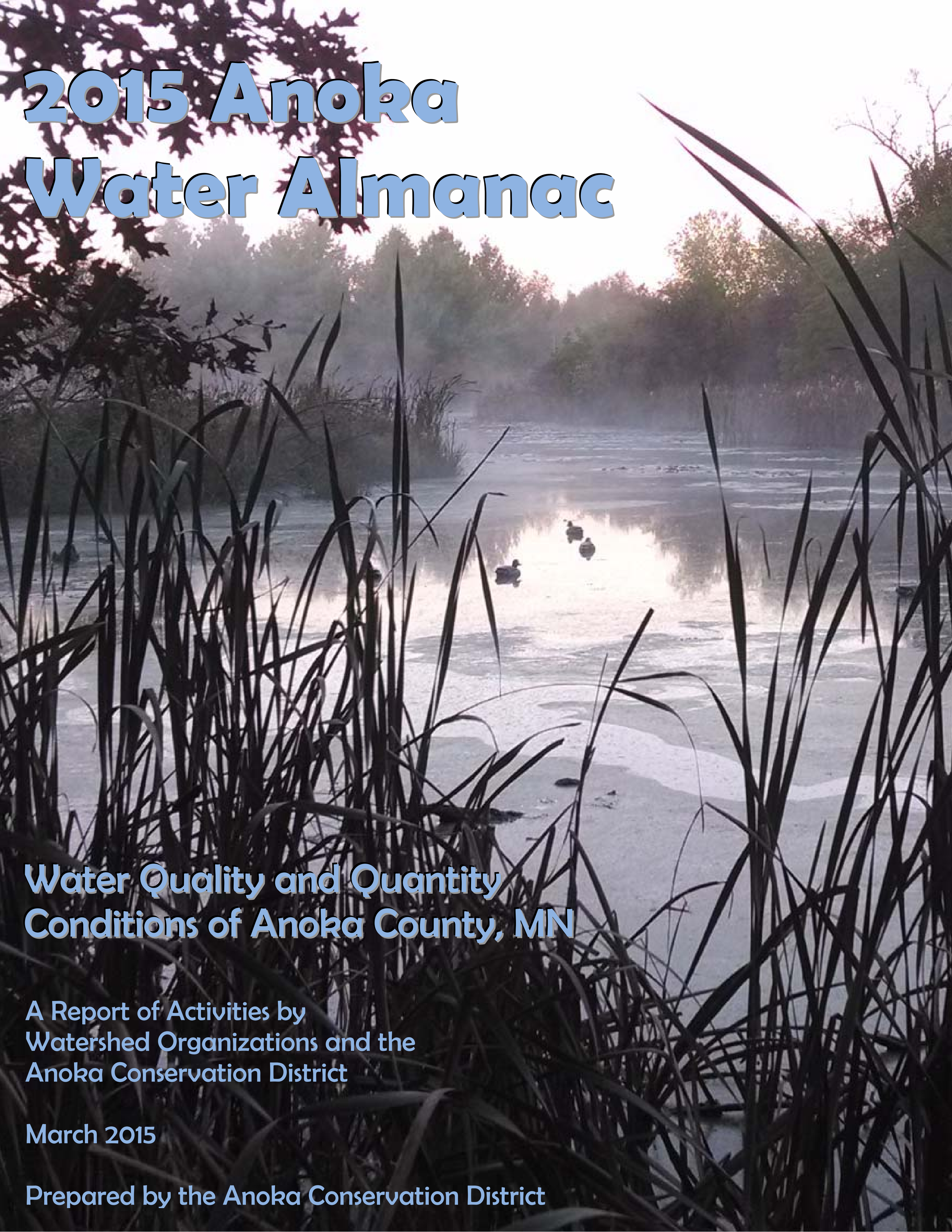


2015 Anoka Water Almanac

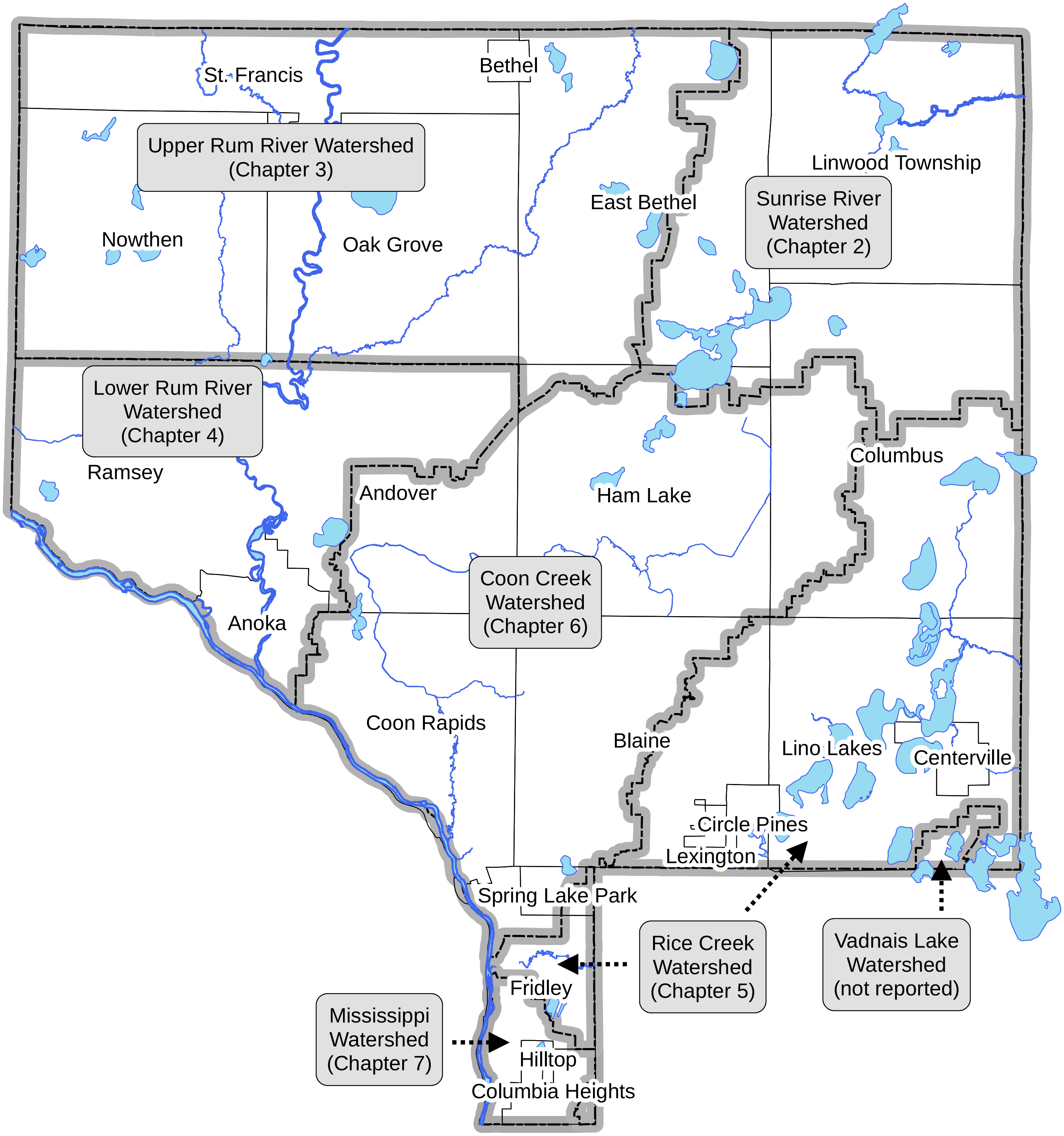
Water Quality and Quantity Conditions of Anoka County, MN

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

March 2015

Prepared by the Anoka Conservation District

Chapter 1 - Primer



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

2015 ANOKA WATER ALMANAC

Water Quality & Quantity Conditions of Anoka County, Minnesota

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

March 2015

Prepared by
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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 hints on interpreting data.

The water resource management and monitoring work reported here include:

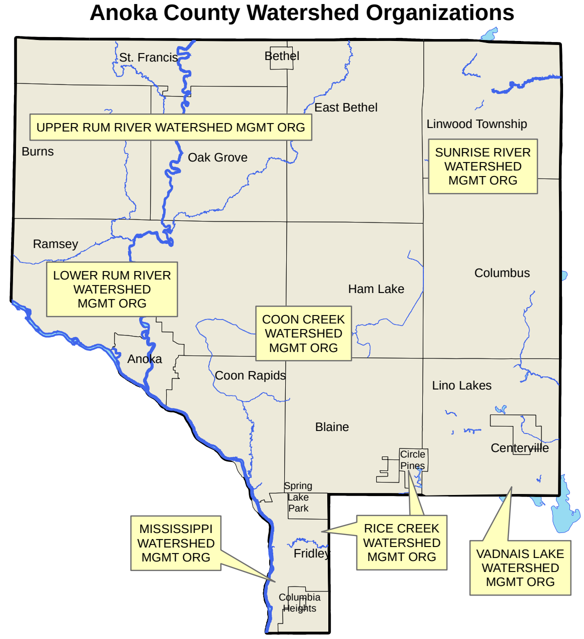
- Monitoring
  - precipitation,
  - lake levels,
  - lake water quality,
  - stream hydrology,
  - stream water quality,
  - stream benthic macroinvertebrates,
  - shallow groundwater levels in wetlands, and
  - deep groundwater in observation wells.
- Water quality improvement projects
  - projects 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 vegetation inventories and 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 2015. 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 2015 is presented in this almanac (although trend and similar analysis also include previous years' data). For results of work completed in years past, readers should refer to previous Water Almanacs. All data collected in 2015 and in years past 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's online precipitation database.

Table of Contents

Anoka County Watershed Organizations

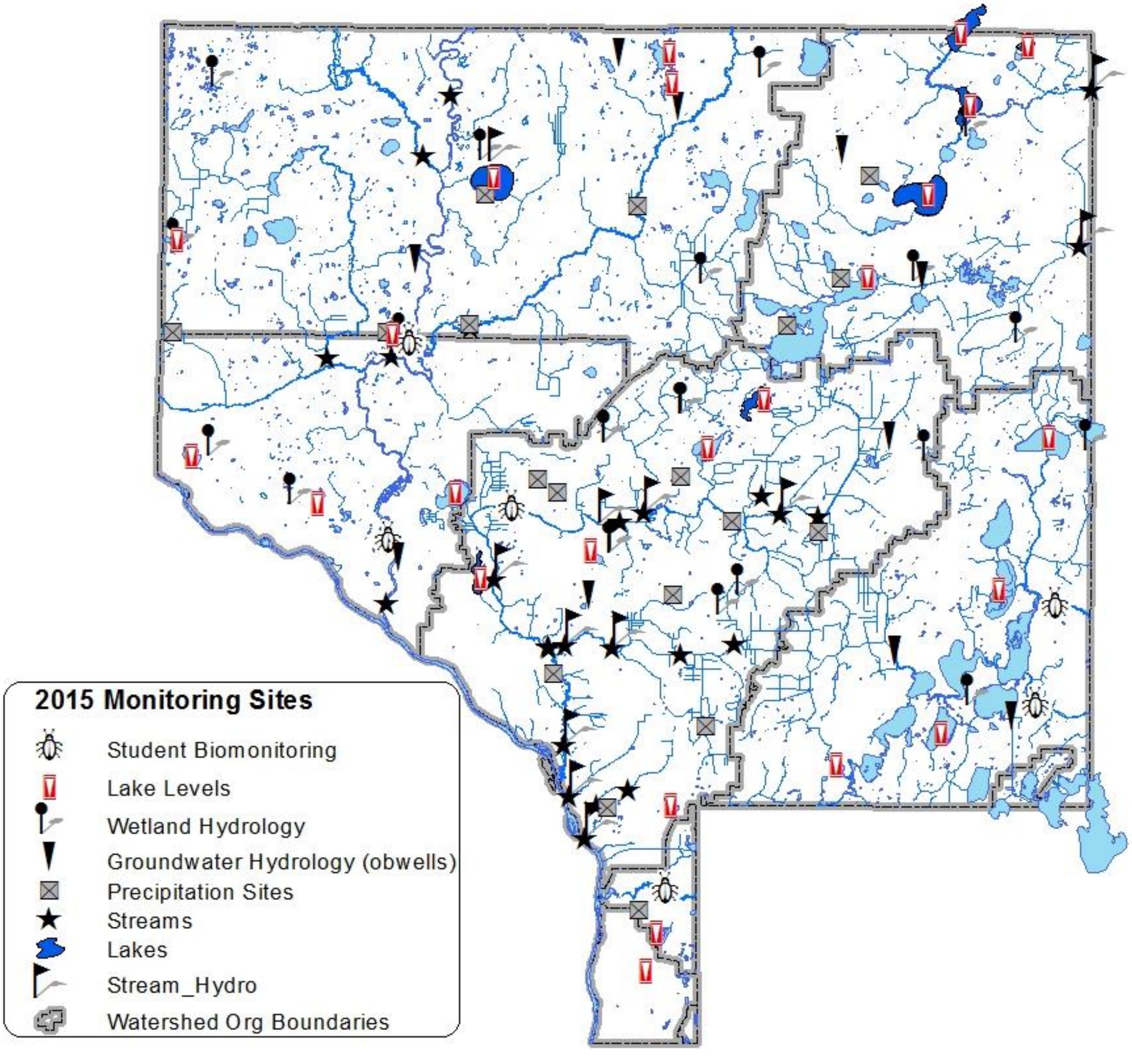


CHAPTER 1: WATER RESOURCE MONITORING PRIMER

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 layperson 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.

2015 Water Monitoring Sites



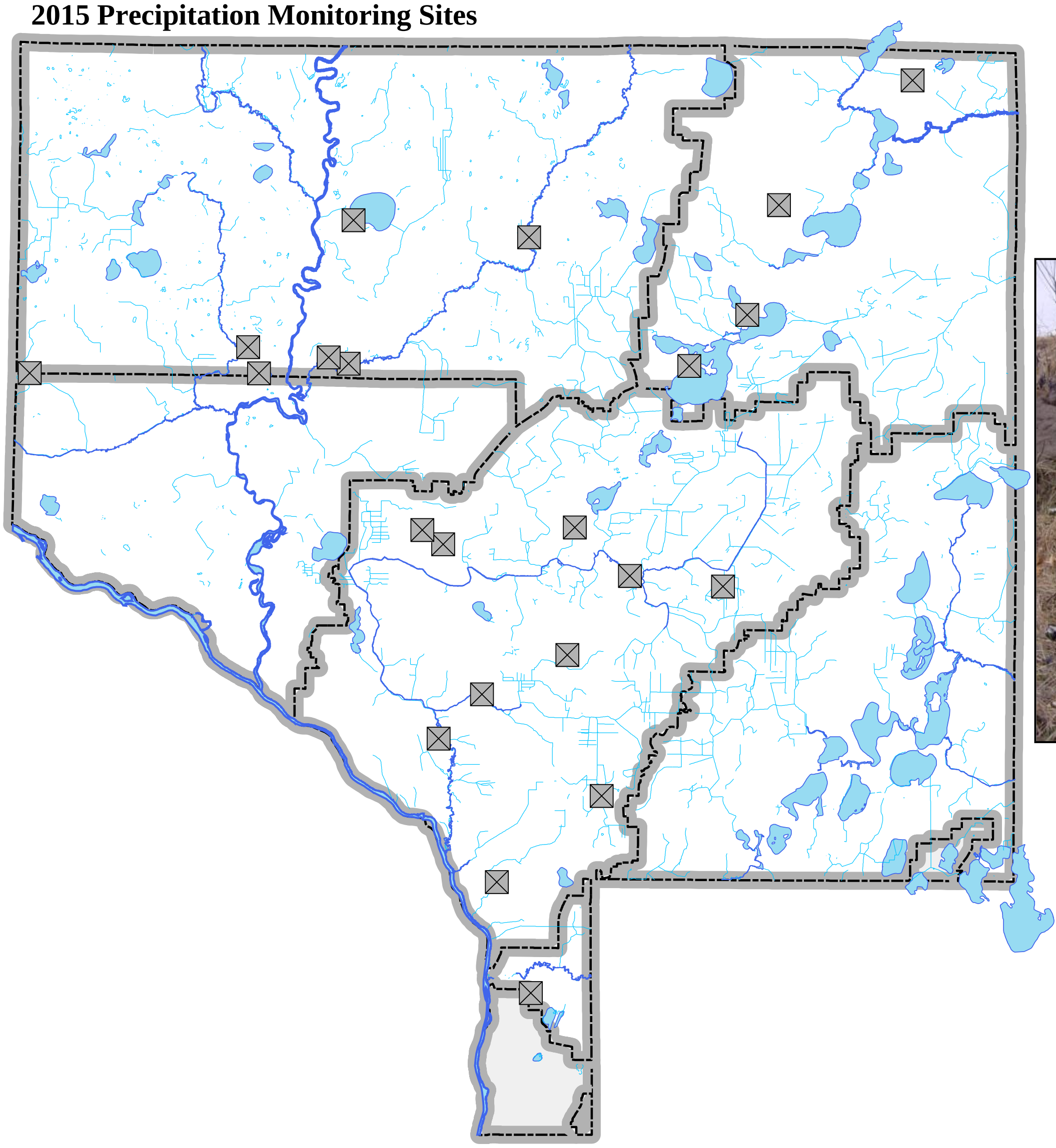
Precipitation

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.

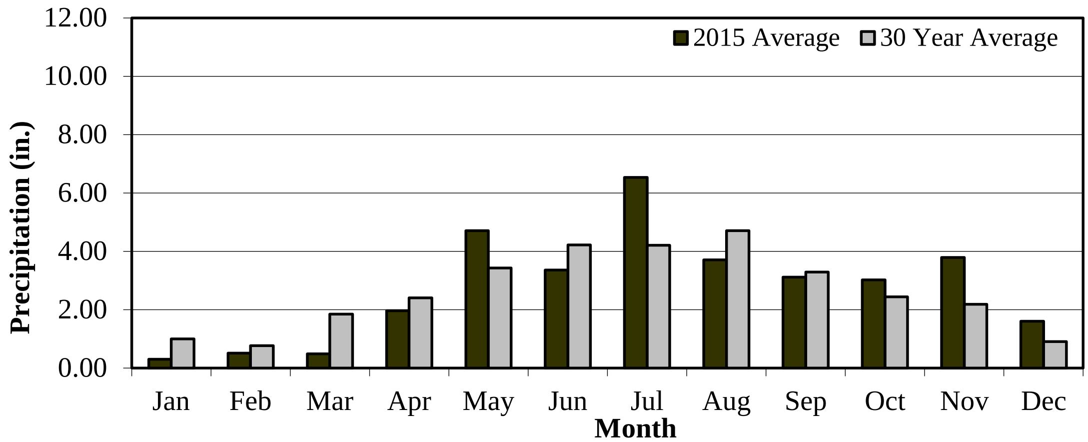
The ACD coordinates a network of 21 rain gauges countywide. Fifteen are monitored by volunteers and six are monitored using datalogging stations operated by the ACD for the Coon Creek Watershed District. The volunteer-operated stations are cylinder-style rain gauges located at the volunteer's home. Total 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. Analyses of antecedent moisture for selected locations are provided in the Coon Creek Watershed chapter.

2015 Precipitation Monitoring Sites



2015 Anoka County Average Monthly Precipitation (average of all sites)



2015 Anoka County Monthly Precipitation at each Monitoring Site

		Month													
Location or Volunteer	**City**	**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			0.24	1.17	5.38	3.25	6.80	4.47	2.65	1.13	3.15		28.24	22.55
Blaine Public Works	Blaine			0.46	2.07	3.32	3.55	7.81	2.50	3.78	2.88	3.80		30.17	20.96
Coon Rapids City Hall	Coon Rapids			0.54	2.08	5.96	5.02	8.01	4.42	5.17	3.02			34.22	28.58
Anoka Cons. District office	Ham Lake			0.44	2.00	4.36	3.41	7.61	2.28	2.75	2.86			25.71	20.41
Waconia Street	Ham Lake			0.46	2.13	5.87	4.14	6.99	2.10	3.03	2.15	3.95		30.82	22.13
Northern Nat. Gas substation	Ham Lake			0.38	1.99	0.48	0.91	1.20	4.10	2.65	2.72	3.68		18.11	9.34
Springbrook Nature Center	Fridley			0.51	1.71	3.41	3.39	6.58	4.06	2.74	3.16	3.64		29.20	20.18
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.31	0.30	0.64	1.96	4.59	3.30	6.94	4.14	2.39	3.25	4.23	1.82	33.87	21.36
J. Rufsvold	Burns				2.72	4.90	4.12	6.39	3.69	3.26	3.70	3.15		31.93	22.36
J. Arzdorf	Blaine			0.35	2.17	5.88	3.71	7.11	4.34	3.05	3.29	3.87		33.77	24.09
P. Arzdorf	East Bethel				2.85	5.12	3.94	6.48	3.65	3.14	3.52			28.70	22.33
A. Mercil	East Bethel	0.24	0.31	0.50	1.96	5.03	3.07	5.96	2.81	2.45	3.58	3.62	1.02	30.55	19.32
K. Ackerman	Fridley	0.30	0.36	0.73	1.88	5.23	3.99	7.13	3.97	4.79	2.72	3.98	1.97	37.05	25.11
B. Myers	Linwood				1.79	4.77	3.07	6.02	4.04	2.91	2.75			25.35	20.81
A. Dalske	Oak Grove	0.32	1.06	0.52	0.93	5.01	2.35	7.12	3.75	1.06				22.12	19.29
ACD Office	Ham Lake				1.93	5.27	3.86	6.15	5.00	3.23	3.50	4.60		33.54	23.51
Y. Lyrenmann	Ramsey				1.91	5.44	1.88	6.64	3.61	3.82	4.15	3.74		31.19	21.39
2015 Average	County-wide	0.29	0.51	0.48	1.96	4.71	3.35	6.53	3.70	3.11	3.02	3.78	1.60	33.04	21.40
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.

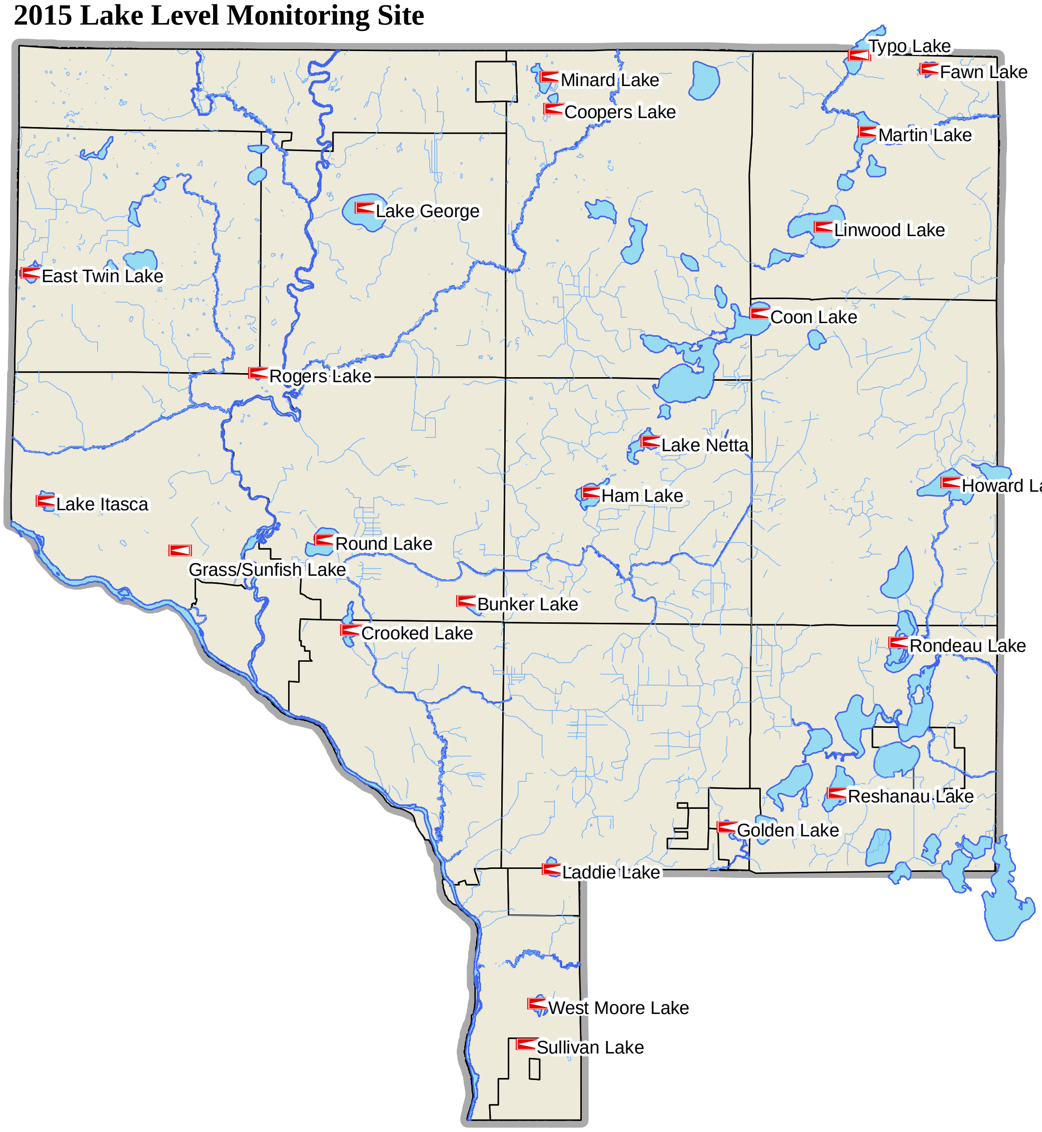
Lake Levels

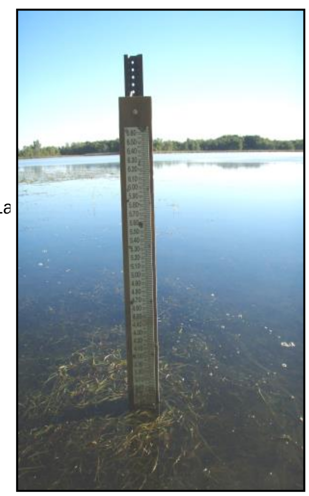
Long-term lake level records are useful for regulatory decision-making, building/development decisions, lake hydrology manipulation decisions, and investigation of possible non-natural impacts on lake levels. ACD coordinates volunteers who monitor water levels on 24 lakes.

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.

2015 Lake Level Monitoring Site





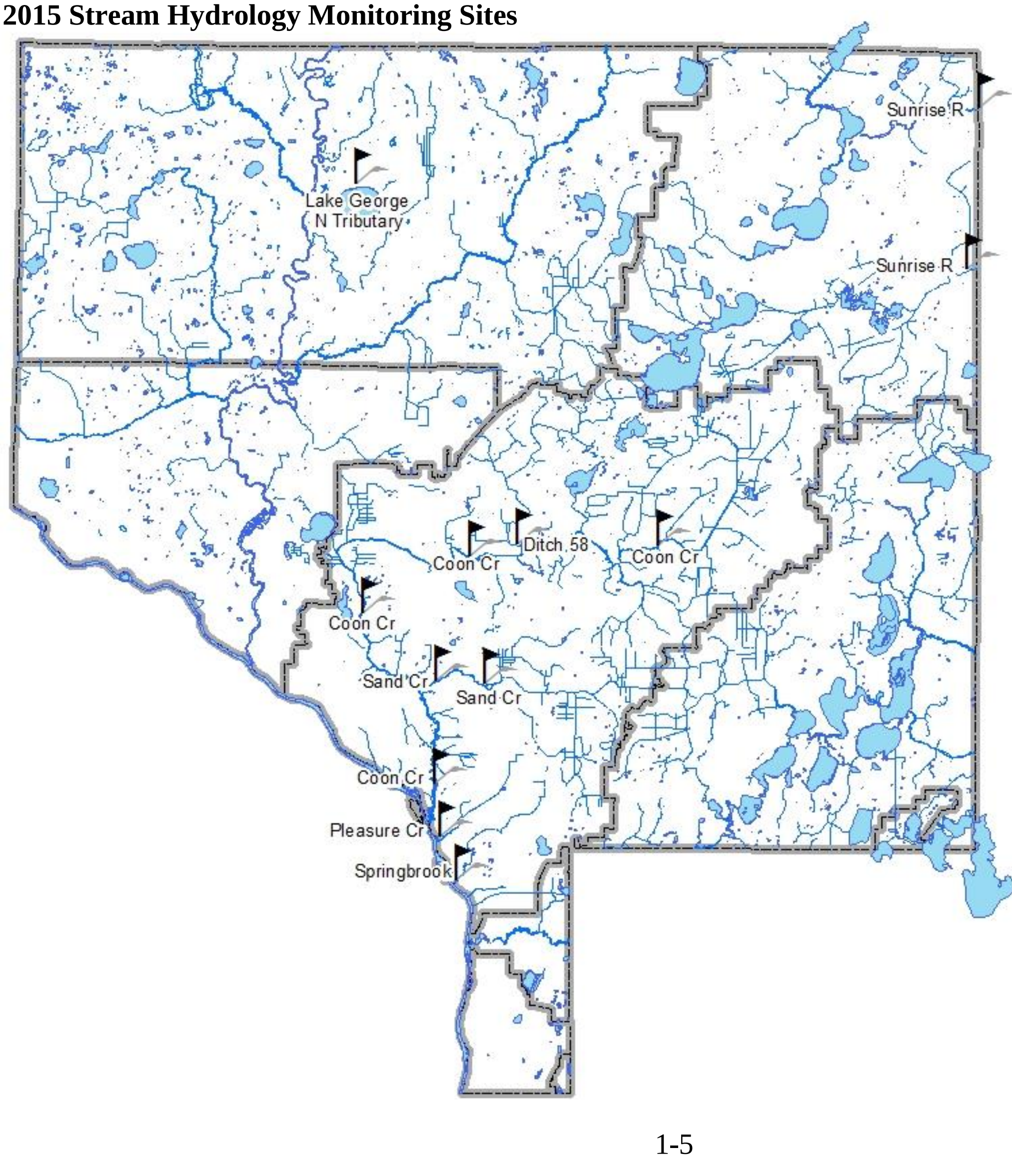
Stream Hydrology

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 10 stream sites in 2015. 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.

2015 Stream Hydrology Monitoring Sites



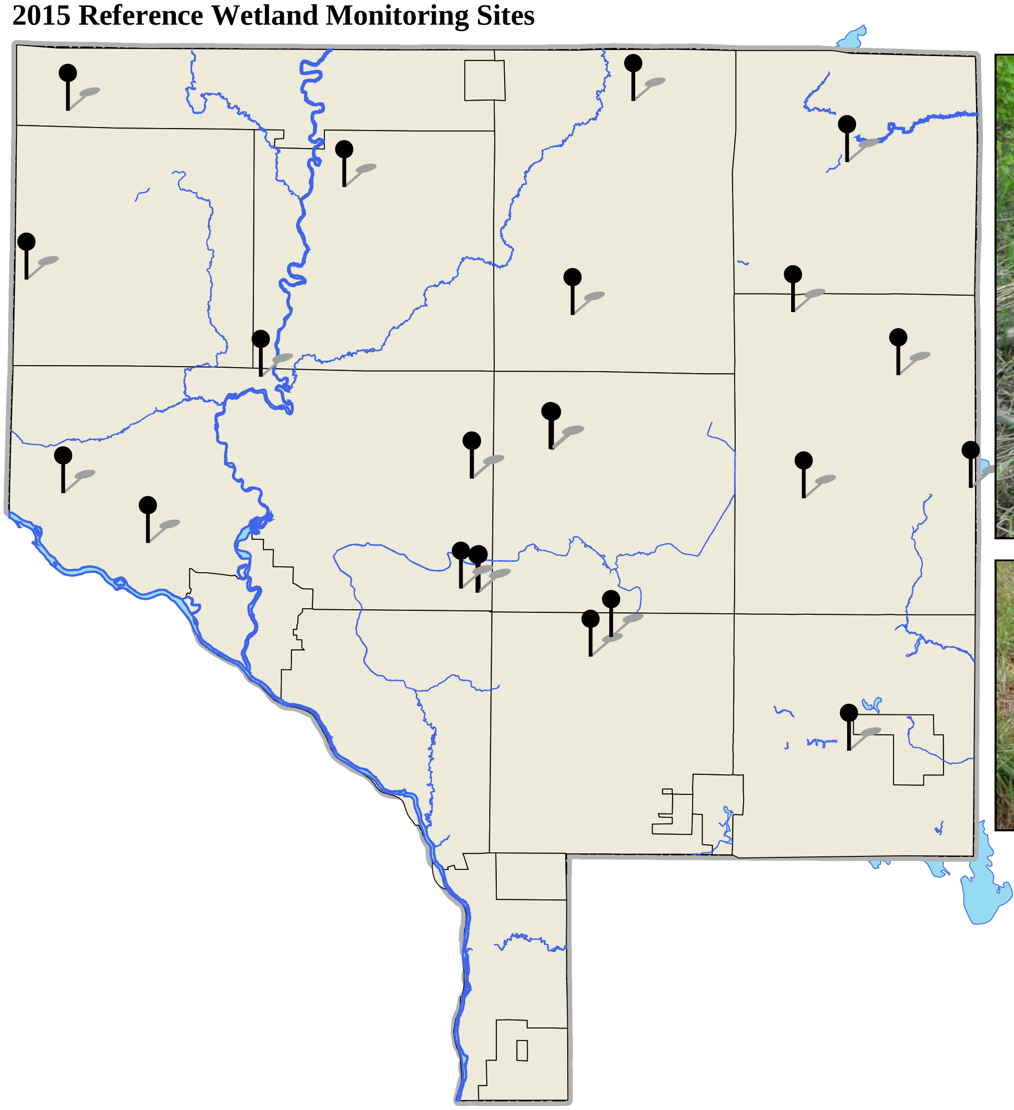
Wetland Hydrology

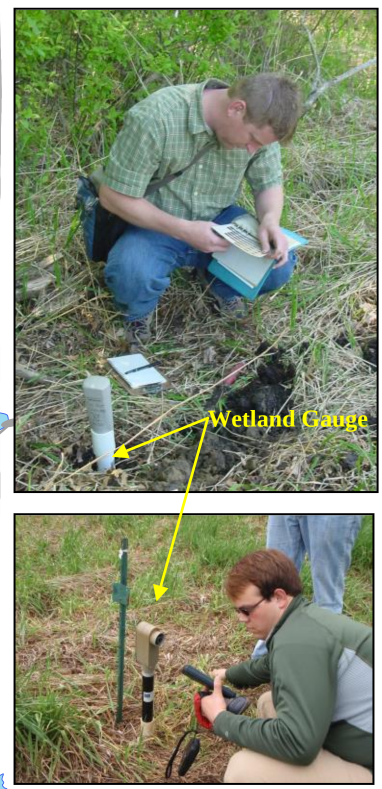
Wetland regulations are often focused upon determining whether an area is, or is not, a wetland. This is difficult at times because most wetlands are not continually wet. In order to facilitate fair, accurate wetland determinations the ACD monitors 18 wetlands throughout the county that serve as a reference 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 down to a depth of 40 inches below grade. 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 some most 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.

2015 Reference Wetland Monitoring Sites



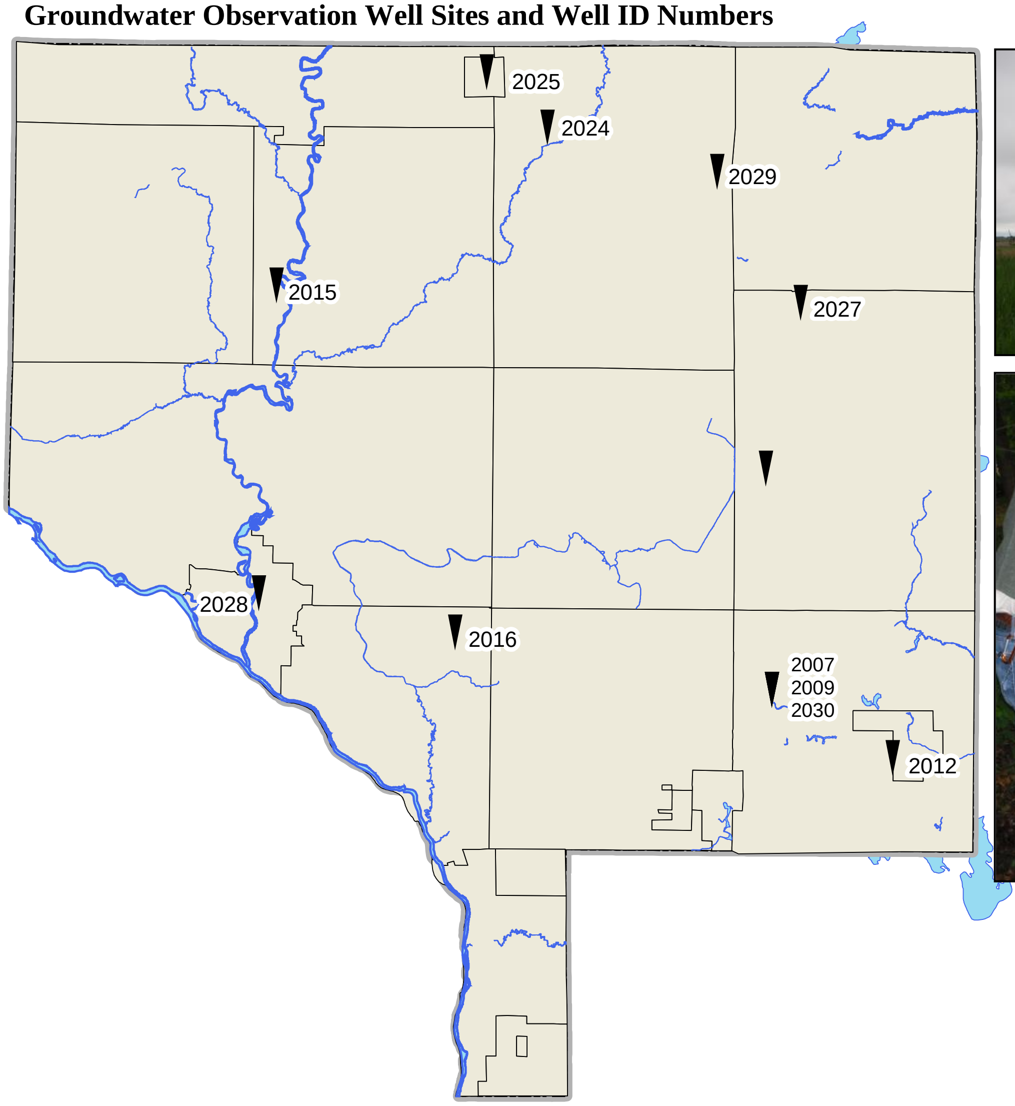


Groundwater Hydrology

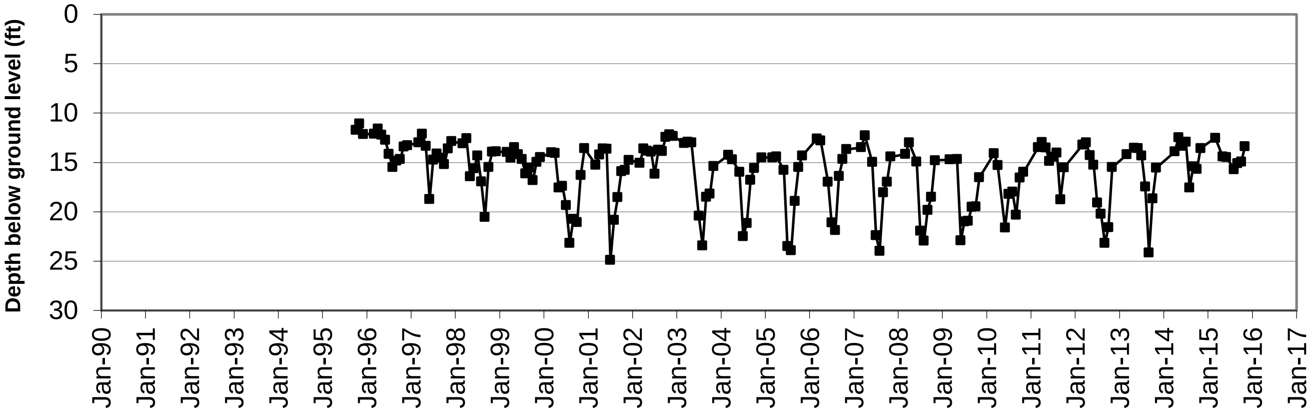
The Minnesota Department of Natural Resources (MN DNR) and ACD are interested in understanding Minnesota's groundwater quantity and flow. The MN DNR maintains a network of groundwater observation wells across the state. The ACD is contracted to take monthly water level readings in wells at 11 sites in 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 groundwater levels for 1990-2015. These results are not presented elsewhere in this report. Raw data can be downloaded from the MN DNR website.

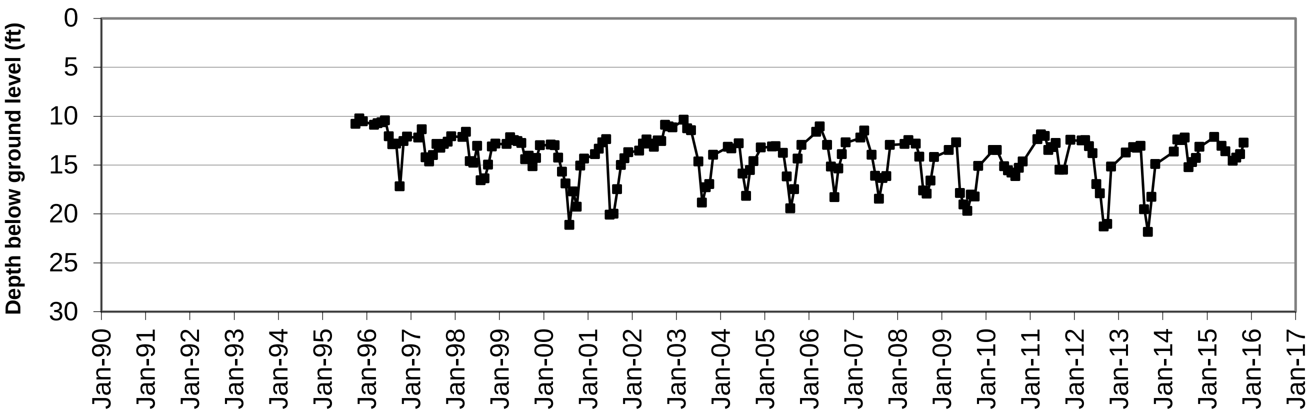
Groundwater Observation Well Sites and Well ID Numbers



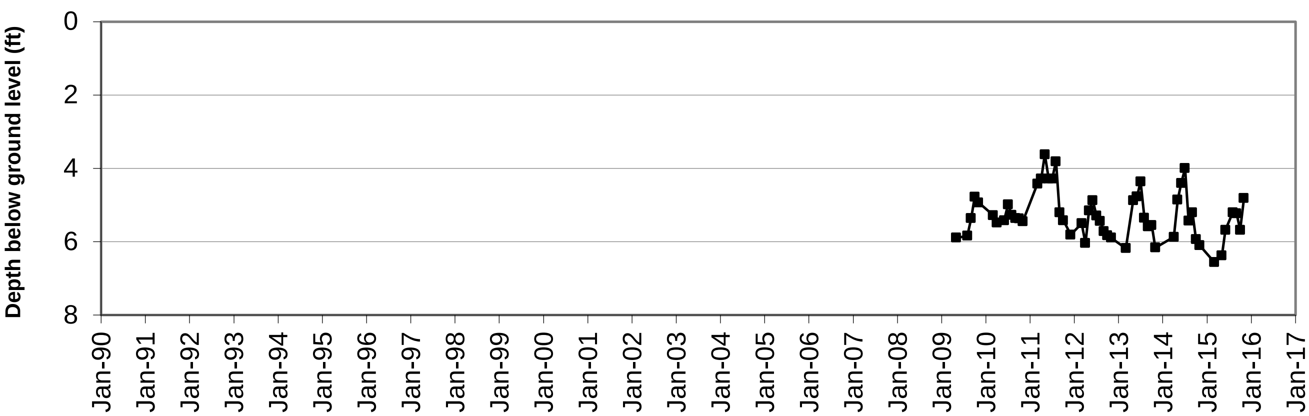
Observation Well #2007 (270 ft deep)—Lino Lakes



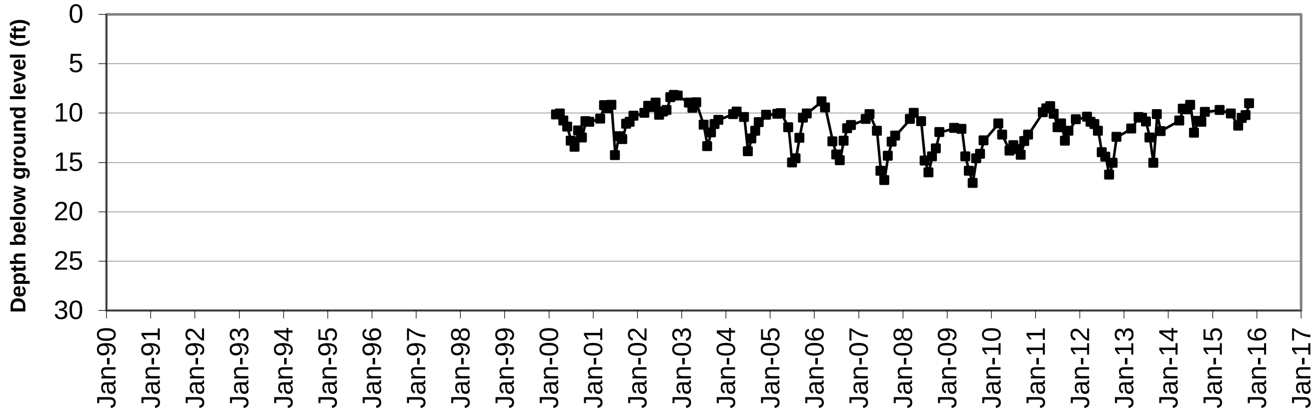
Observation Well #2009 (125 ft deep)—Lino lakes



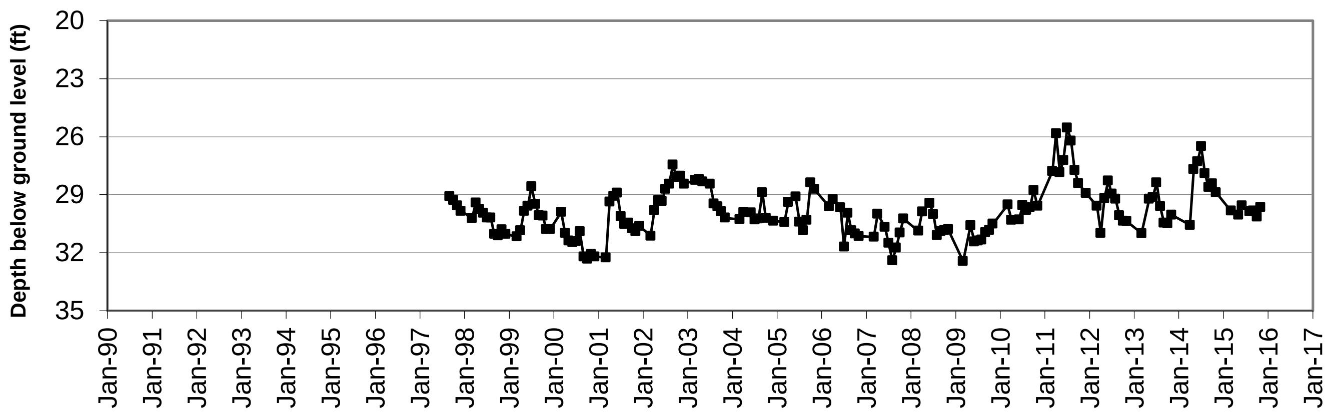
Observation Well #2030 (15 ft deep)—Lino Lakes



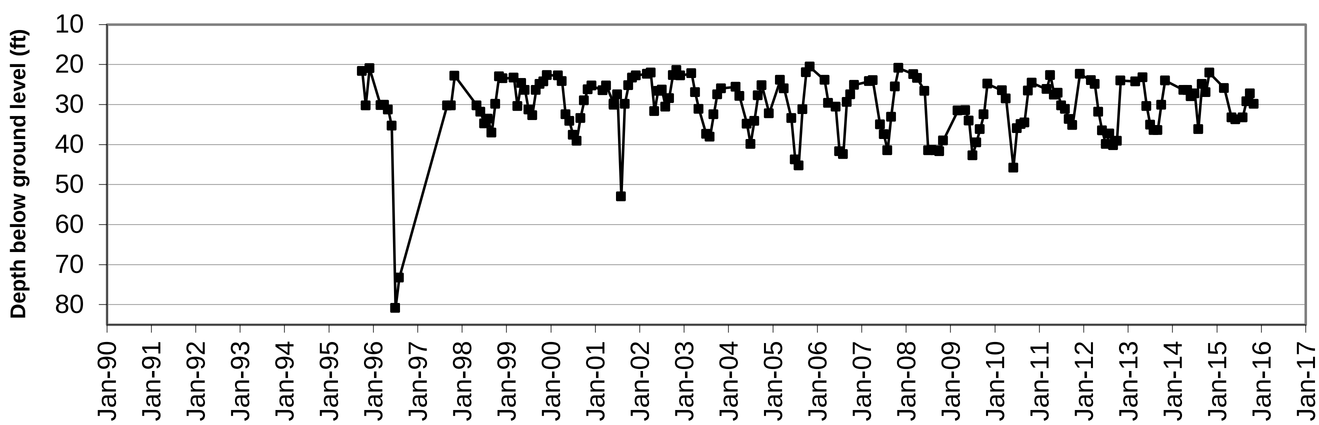
Observation Well #2012 (277 ft deep) – Centerville



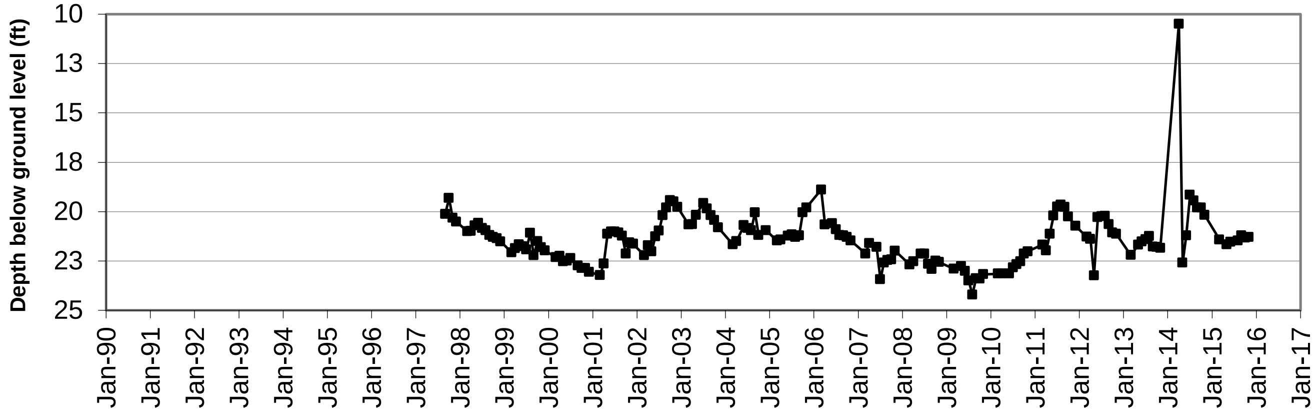
Observation Well #2015 (280 ft deep)—Ramsey



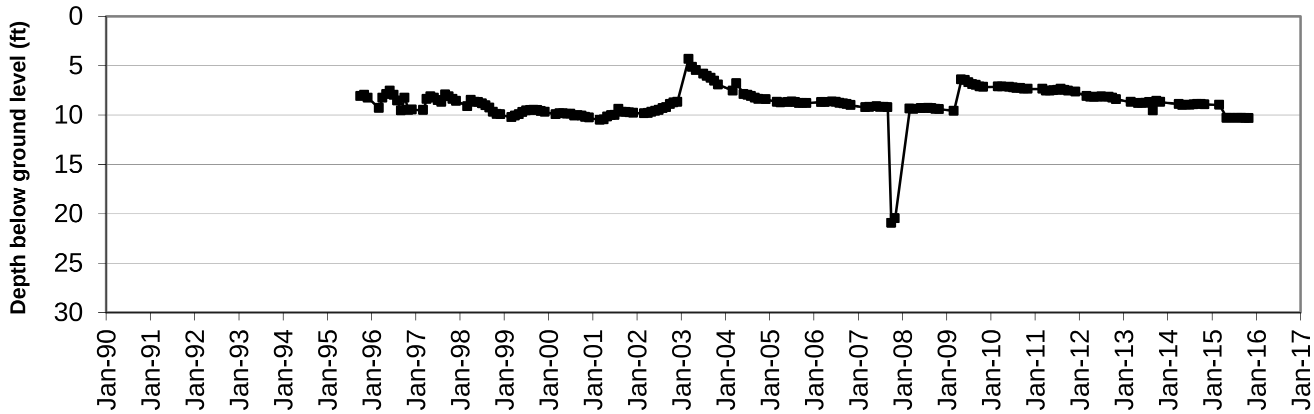
Observation Well #2016 (193 ft deep)—Coon Rapids



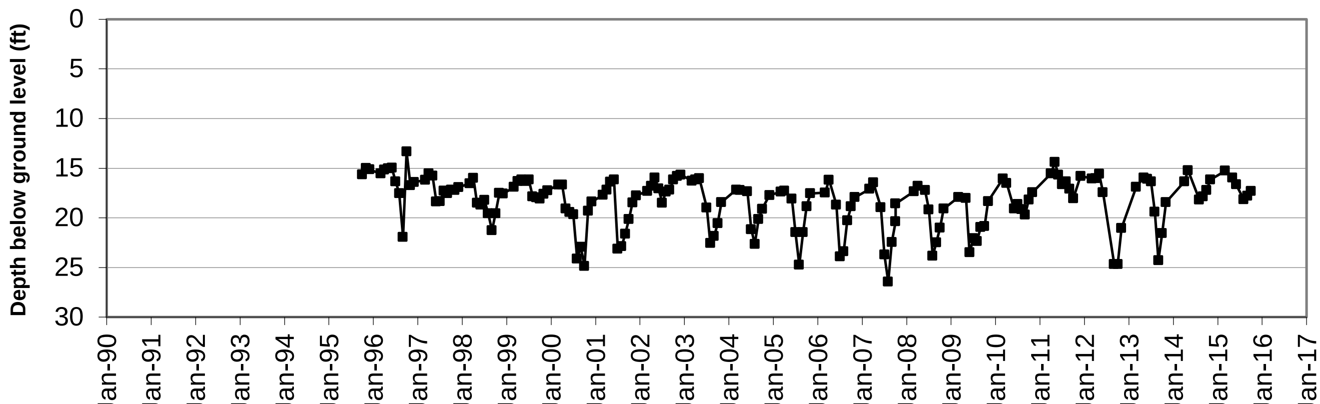
Observation Well #2024 (141 ft deep)—East Bethel



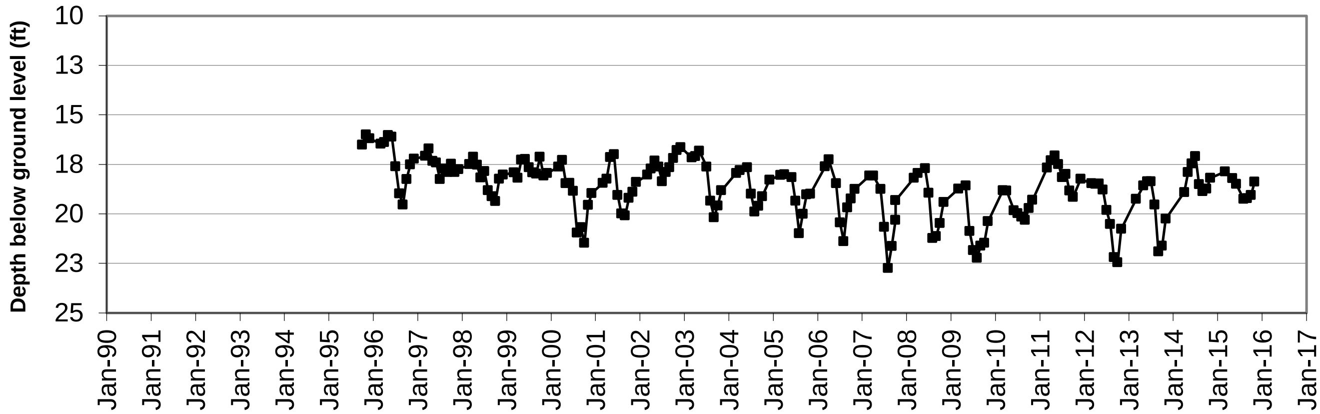
Observation Well #2025 (21 ft deep)—Bethel



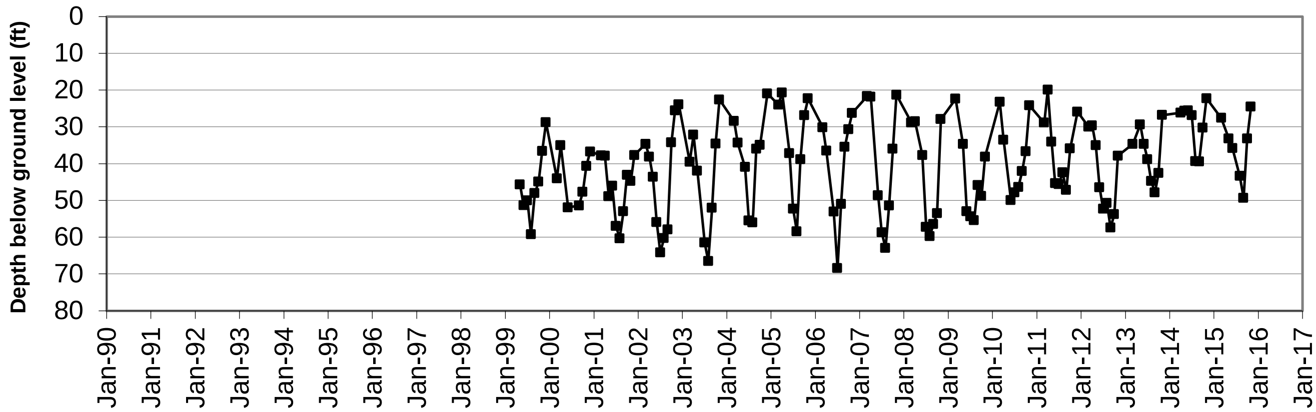
Observation Well #2026 (150 ft deep)— Carlos Avery #4



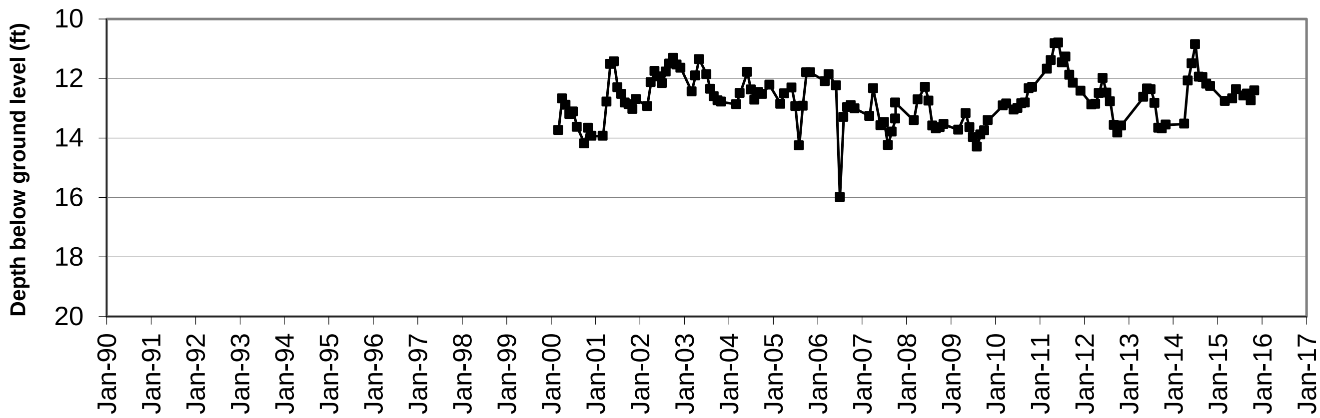
Observation Well #2027 (333 ft deep)— Columbus Twp.



Observation Well #2028 (510 ft deep)—Anoka



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

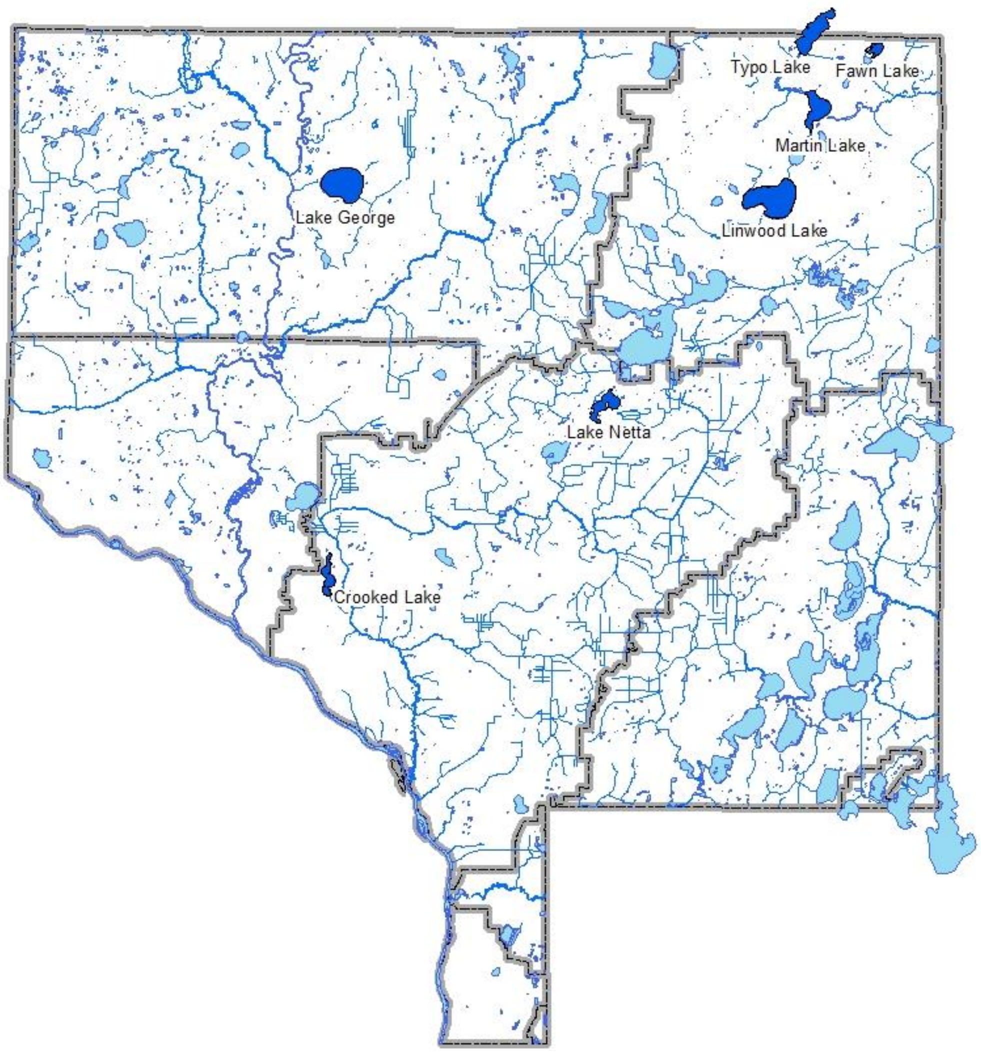


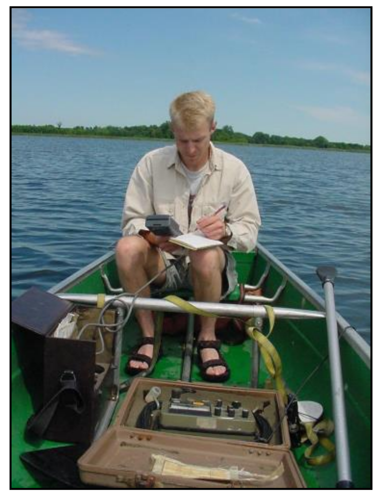
Lake Water Quality

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 prior to the current year, see the summary table on page 16. 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.

2015 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 amount of 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 amount of 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 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 wastes, and storm water 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	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 (25th to 75th 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 the Carlson Trophic State Index?

A- Carlson's Trophic State Index (see figure below) is 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 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.

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.

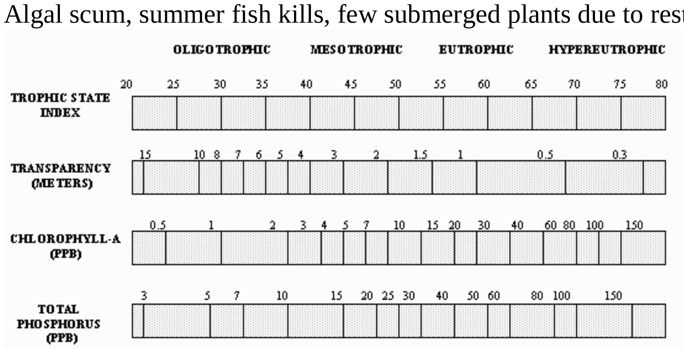
3. Eutrophic- In these lakes, the water is nutrient-rich. Productivity is high for both plants and fish. Abundant plant life, especially algae, results in poorer water clarity and can reduce the dissolved oxygen content when it decays. Algae blooms in the "dog days of summer" are commonplace. Bass and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

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- 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.

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

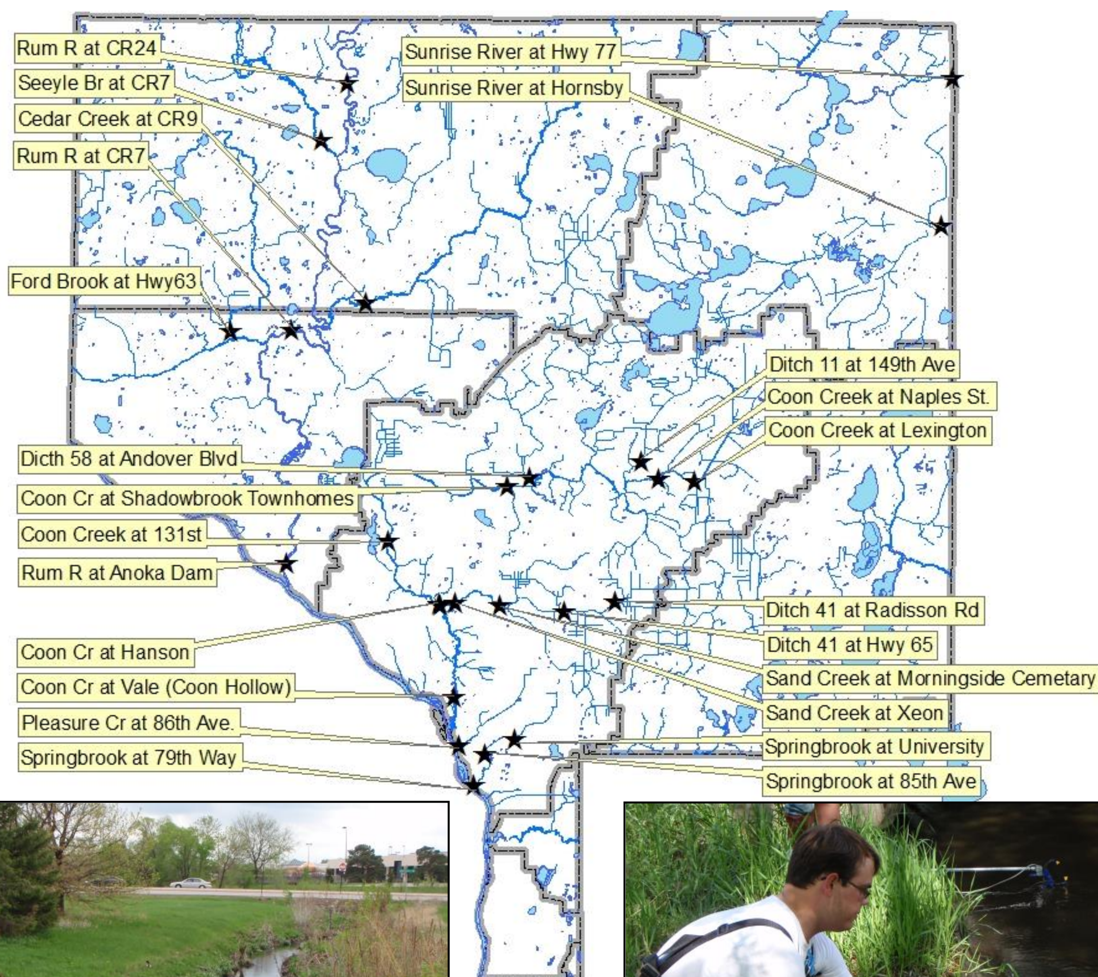
Year→	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cenaiko																	B	A	A	A	B	A	A	A	A	A	A	B	B	B	B	B			
Centerville	C		C					D												C	C		C	C	A										
Coon				C					C					C			C	B	A	B	C	B		C		C		C							
Coon (E. 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	
Coon (W. Bay)																														A		A		B	
Crooked			C		C				C					B	C	B	B	B		B		B	B		B	B		B	B		B	A		A	B
East Twin	B		C						B						B		A	B	A	A		A			A			A		A	A		A		
Fawn								B									A	B	A	A	A	A		A		A		A		A		A			A
George	A	A		A					A					B			A	B	A	A		A			B			B			B		B	B	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		B	A		B	B		A	A	
Highland																			D	C	D	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													B	B	B			C	B	B	B	B	B	B	B			B			B				
Linwood	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
Minard																																	A	A	
East Moore	C	C	C	C	B	C	C							C				C	B	B	C	C	C		C										
West Moore	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
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	
Sandy													D	D	D		D	D	D	D	D	F	D	D	D								D		
Typo													F	F	F		F	F	F	F	F		F		F		F		F			F		D	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 2015 was conducted at Cedar Creek, Seeyle Brook, four Sand Creek sites, eight Coon Creek sites, three Springbrook sites 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.

2015 Chemical Stream Water Quality Monitoring Sites



STREAM WATER QUALITY MONITORING METHODS

Stream water is monitored four times during base flow conditions and four 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);
- Chlorides;
- Sulfate;
- Total hardness;
- Total Suspended Solids;
- 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 were analyzed by the independent laboratory (IRI). Total phosphorus, chlorides, total suspended solids, sulfate, hardness, and any other parameters were analyzed by the independent laboratory (MVTL Labs). Sample bottles were provided by the laboratory, complete with necessary preservatives. Water samples were kept on ice and delivered to the laboratory within 24 hours of collection, with the exception of E. coli samples which were delivered to the laboratory no later than 7 hours after being collected. Stream water level was noted when the sample was 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 amount of dissolved minerals in the stream. Although every stream 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 amount of solid material suspended in the water, due to "muddiness" or algae.

Dissolved Oxygen (DO) - Dissolved oxygen is essential to all aquatic organisms. The lower the DO concentration, the less likely a stream will support a wide range of organisms, including fish.
Sources of dissolved oxygen include the atmosphere, aeration from stream inflow, and submerged plants and algae in the lake creating oxygen through photosynthesis. Dissolved oxygen is consumed by the organisms in the stream and by decomposition within the stream. Large inputs of organic matter (manure, for example) are harmful, in part, because decomposition of these materials can reduce dissolved oxygen to harmfully low levels.

Salinity- Salinity is a measure of dissolved salts in the water. High salinity measurements may be the result of inputs from failing septic systems, spring runoff of road salts, farm field runoff, or others.

Temperature- Fish species and other aquatic life are sensitive to water temperature. Some can only survive in particular temperature ranges. 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.

Total Phosphorus (TP) - Phosphorus is an essential nutrient that stimulates algae growth. A single pound of phosphorus can result in 500 pounds of algal growth. Large amounts of algae reduce water clarity, deplete dissolved oxygen levels algal decomposition which impacts fish populations, and degrade aesthetics for recreation. Ideally, total phosphorus should be below 40 µg/L in lakes and 130 µg/L in streams. Sources of phosphorus include runoff from agricultural land, runoff from lakeshore properties carrying fertilizer and untreated human waste from failing septic systems, pet wastes, and storm water runoff.

Total Suspended Solids (TSS) - This is similar to turbidity, in that it measures the amount of solid material in the water. Turbidity is measured by sending a beam of light through a water sample and measuring how much of it is deflected. In this way it is particularly sensitive to large suspended particles, but not to small particles. Total suspended solids is measured by filtering a water sampling and weighing the filtered material.

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	Method Detection Limit	Reporting Limit	Analysis or Instrument Used
pH	0.01	0.01	Hydrolab Quanta
Conductivity	0.001	0.001	Hydrolab Quanta
Turbidity	0.1	0.1	Hydrolab Quanta
Dissolved Oxygen	0.01	0.01	Hydrolab Quanta
Temperature	0.1	0.1	Hydrolab Quanta
Salinity	0.01	0.01	Hydrolab Quanta
Total Phosphorus	0.3	1.0	EPA 365.4
Total Suspended Solids	5.0	5.0	EPA 160.2
Chloride	0.005	0.01	EPA 325.1
Sulfate		4.0	ASTM D516-02
Hardness		na	2340.B
E. *coli*	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 was 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. 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 were provided by MVTL and included the necessary preservatives.

The hand held Hydrolab Quanta multi-probe used to conduct in-stream monitoring was 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.

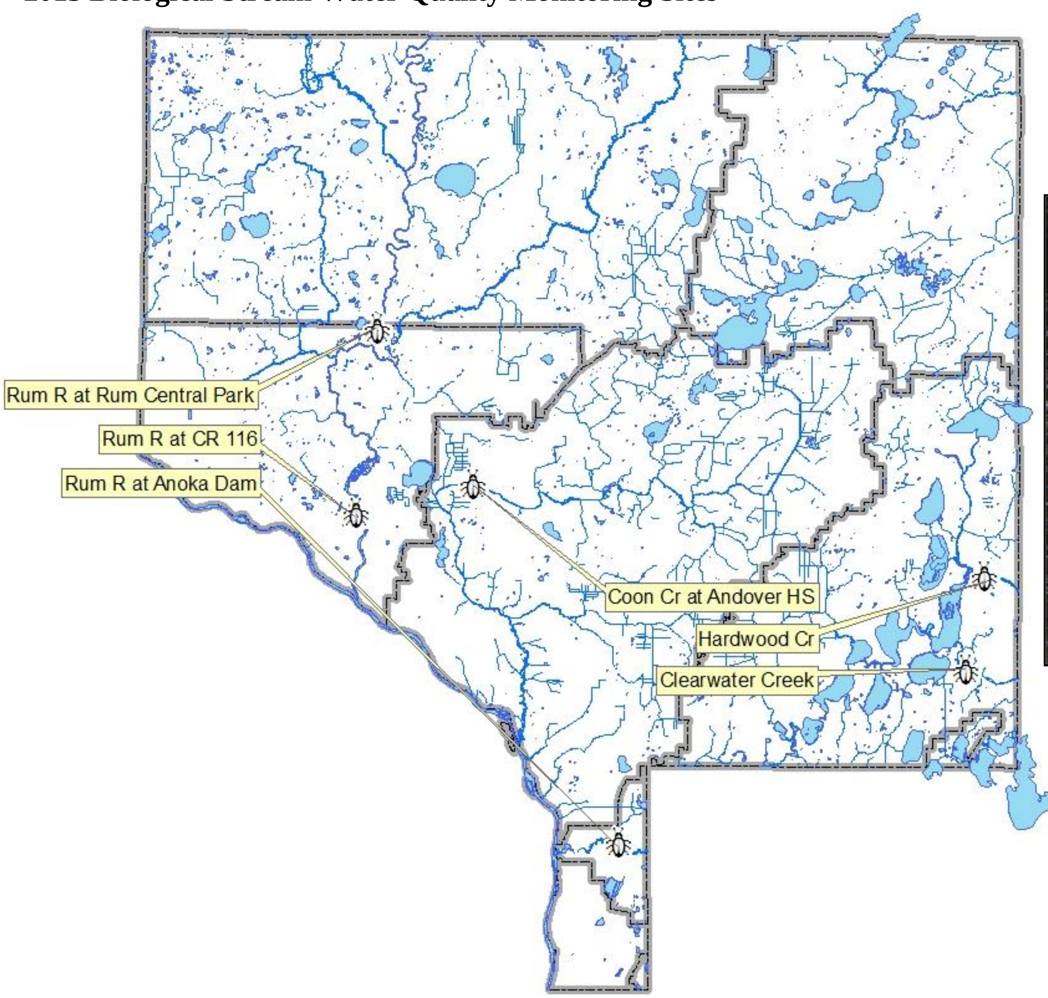
Stream Water Quality – Biological Monitoring

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 2015 there were two 4-H groups as well as approximately 319 students from four high schools who monitored six sites. Since 2000 approximately 4,841 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.

2015 Biological Stream Water Quality Monitoring Sites



Biomonitoring Methods

ACD biomonitoring utilizes 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. 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: Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (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).

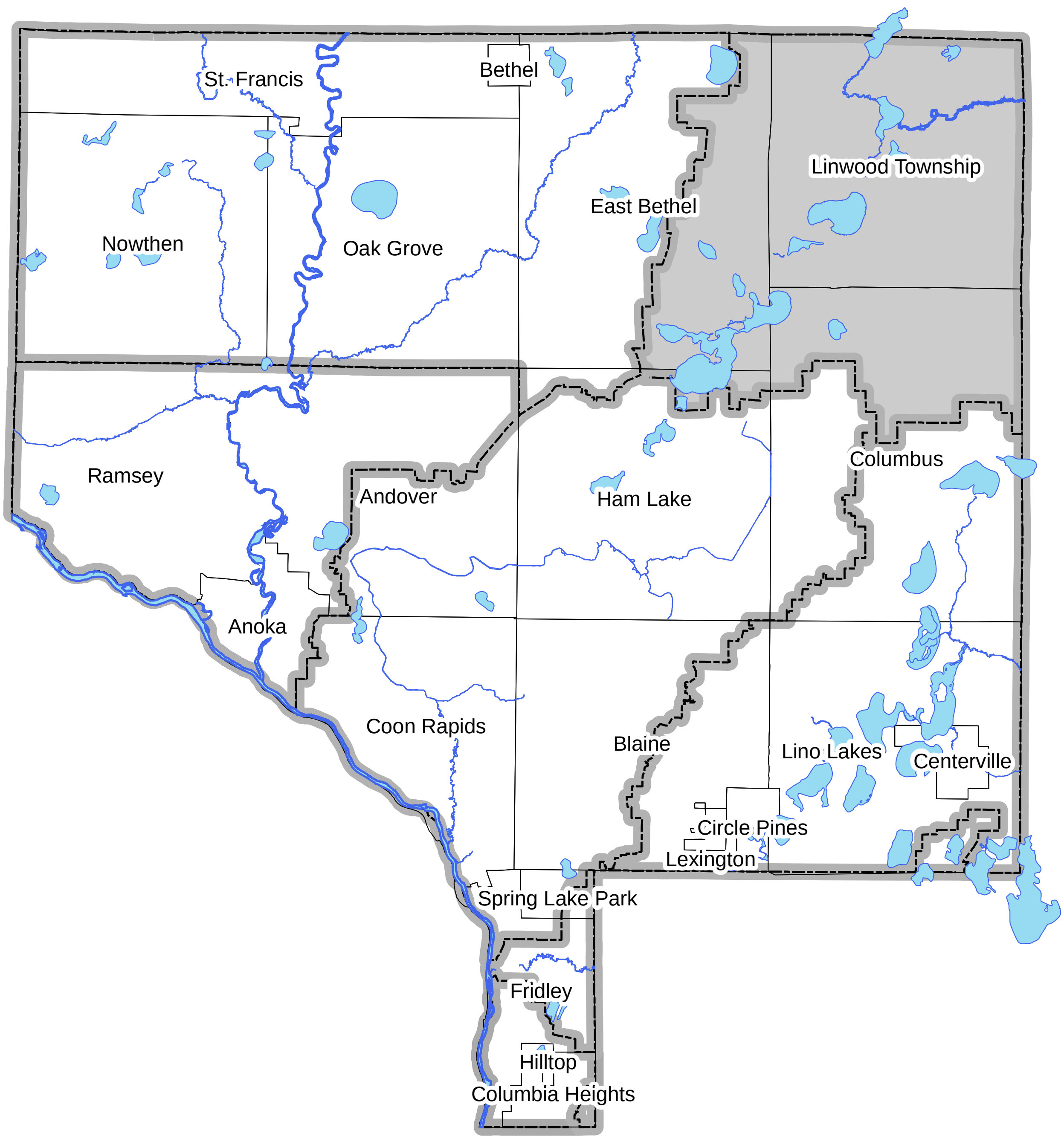
Sites

In 2015, high school classes and a 4-H group, with ACD staff supervision, sampled six sites for benthic macroinvertebrates.

2015 Biomonitoring Sites and Corresponding Monitoring Groups

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

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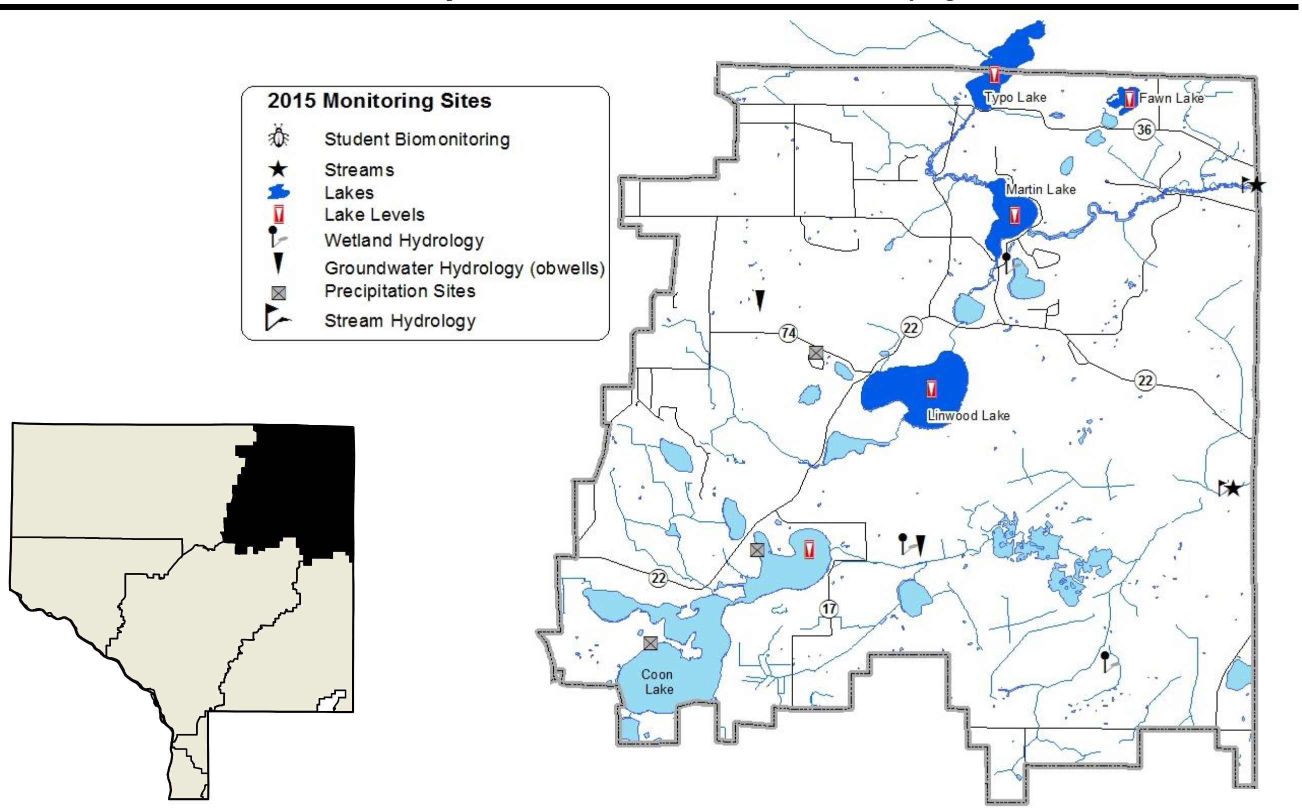
Groundwater Hydrology (obwells)	ACD, MNDNR	See Chapter 1
Precipitation	ACD, volunteers	See Chapter 1

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 are illustrated below, and all historic data are available on the Minnesota DNR website using the "LakeFinder" feature (www.dnr.mn.us.state\lakefind\index.html).

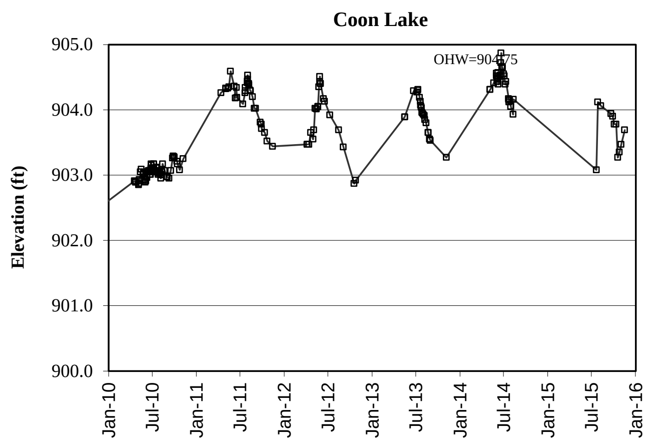
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

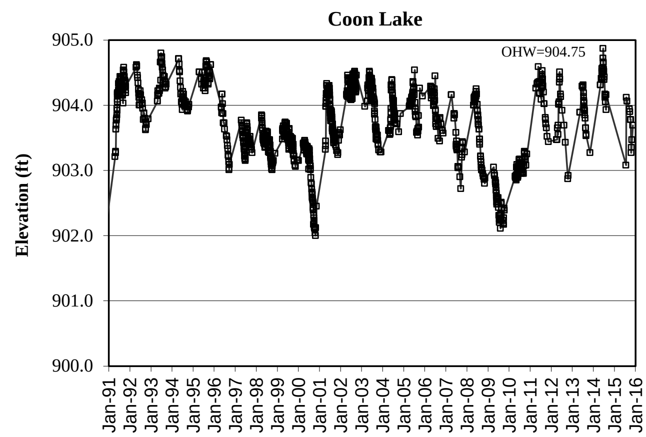
Results: Lake levels were measured by volunteers throughout the 2015 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes had increasing water levels in spring and early summer and then fell later in the year due to less rainfall. Increased rainfall late into fall cause 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.

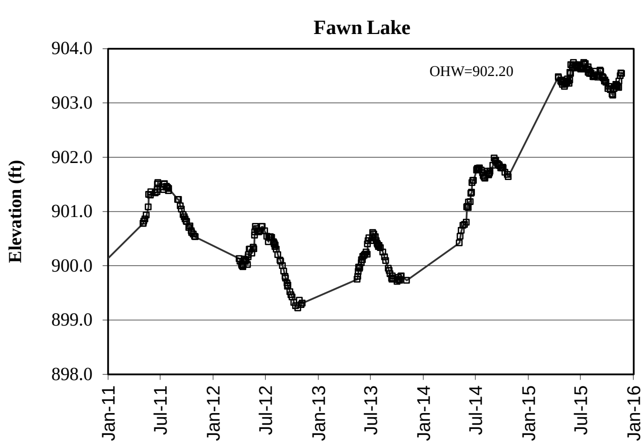
Coon Lake Levels – last 5 years



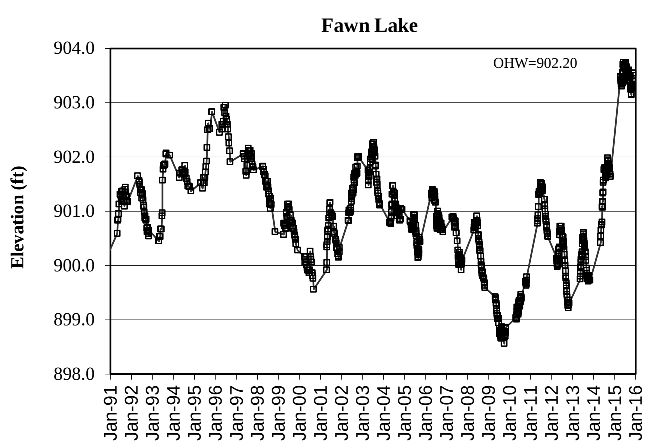
Coon Lake Levels – last 25 years



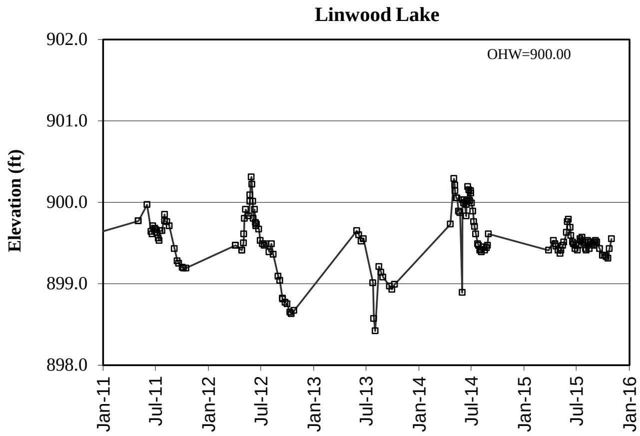
Fawn Lake Levels – last 5 years



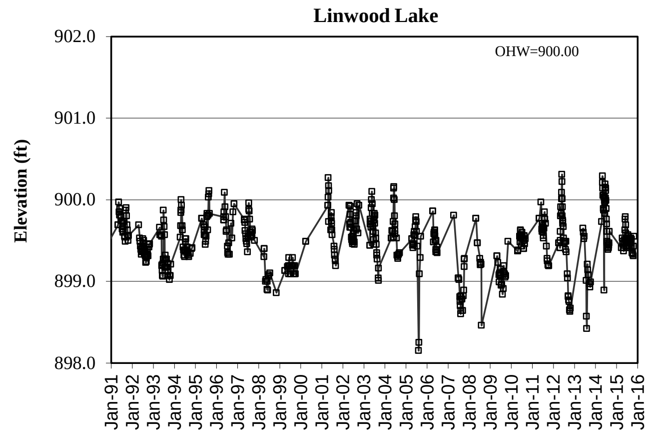
Fawn Lake Levels – last 25 years



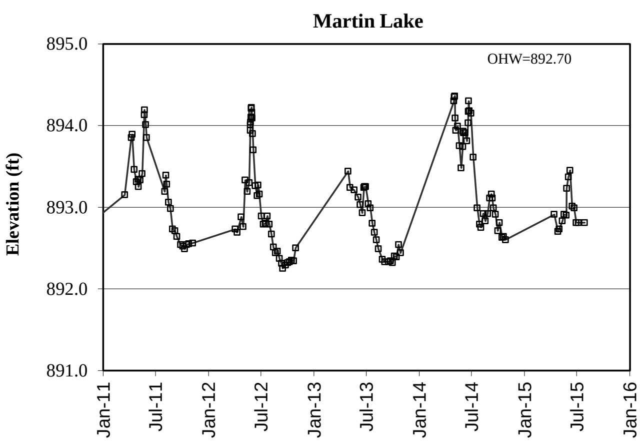
Linwood Lake Levels – last 5 years



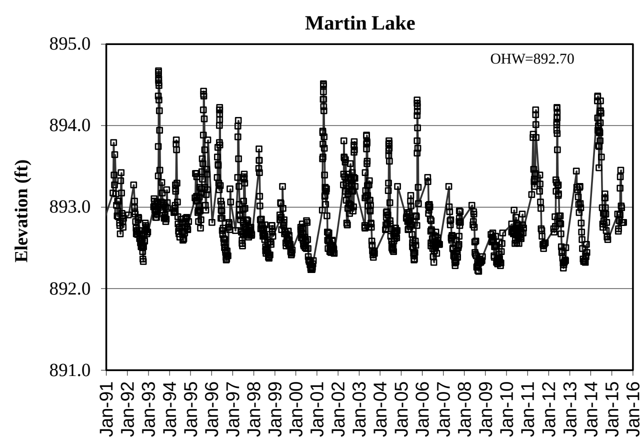
Linwood Lake Levels – last 25 years



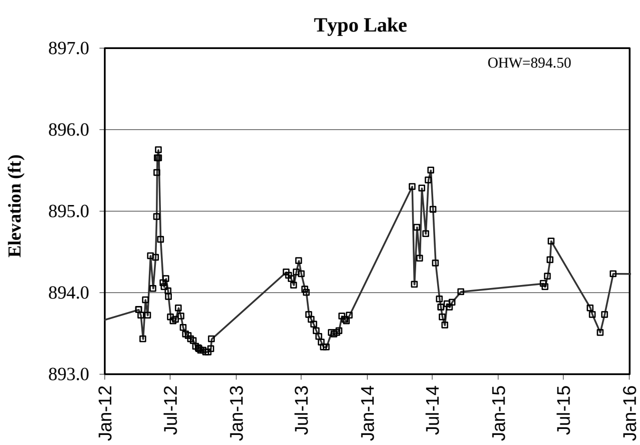
Martin Lake Levels – last 5 years



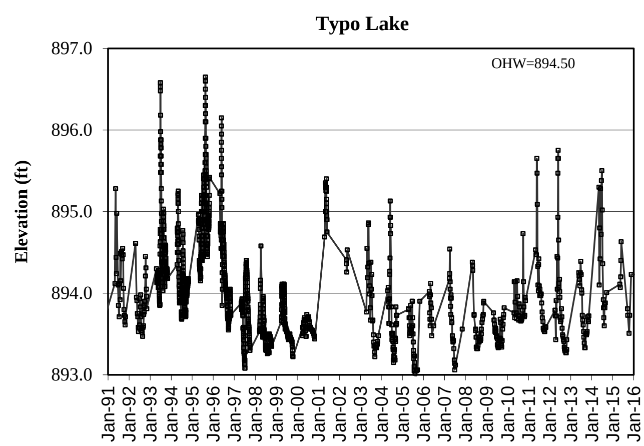
Martin Lake Levels – last 25 years



Typo Lake Levels – last 5 years



Typo Lake Levels – last 25 years



Lake Water Quality

Description: May through September every-other-week 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: Linwood Lake

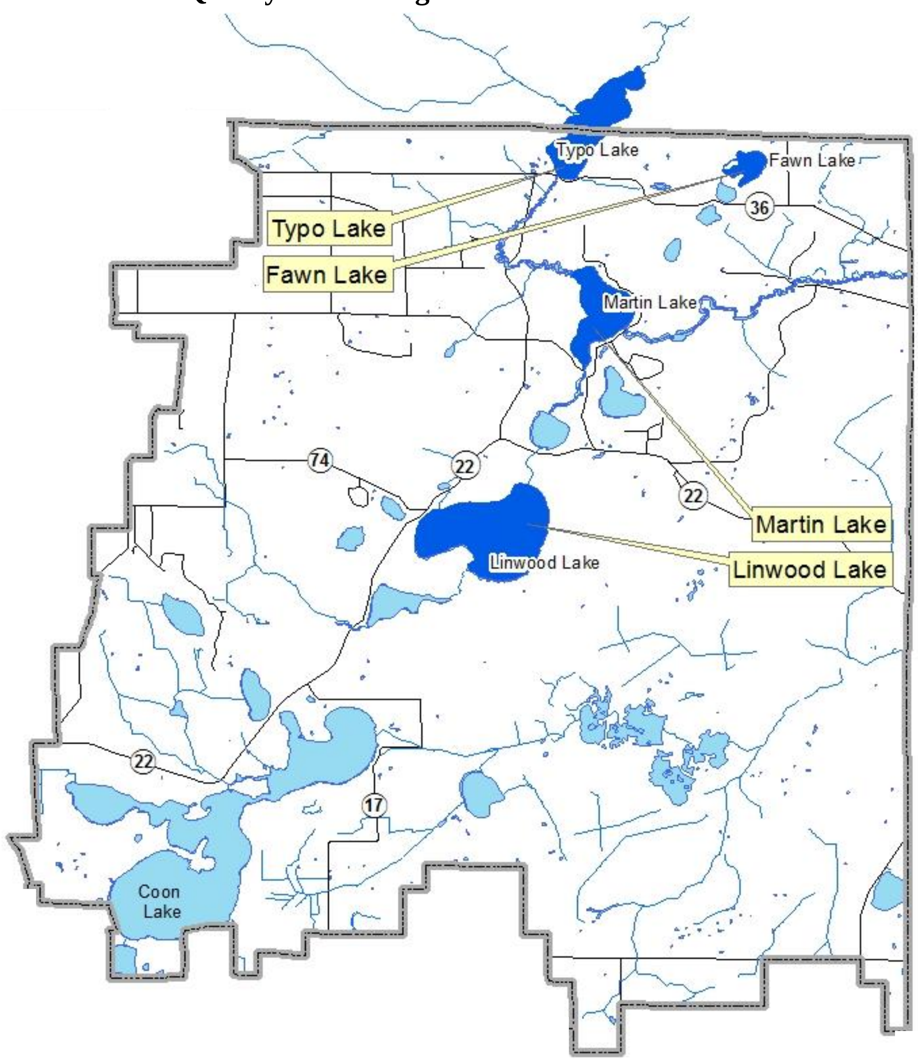
Fawn Lake

Martin Lake

Typo 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 interpreting the data and on lake dynamics.

Sunrise Watershed Lake Water Quality Monitoring Sites



Linwood Lake

Linwood Township, Lake ID # 02-0026

Background

Linwood Lake is located in the northeast portion of Anoka County. It has a surface area of 559 acres and maximum depth of 42 feet (12.8 m). Public access is available on the north side of the lake at Martin-Island-Linwood Regional Park, and includes a boat landing and fishing areas. The lake's shoreline is about 1/3 developed and 2/3 undeveloped. Most of the undeveloped shoreline is on the eastern shore and is part of a regional park. The lake's watershed is primarily vacant with scattered residential.

Linwood Lake is on the Minnesota Pollution Control Agency's 303(d) list of impaired waters for excess nutrients.

2015 Results

In 2015 Linwood Lake had average or slightly below average water quality for this region of the state (NCHF Ecoregion), receiving an overall C grade. The lake is slightly eutrophic. In 2015 total phosphorus averaged 41.0 µg/L, chlorophyll-a averaged 10.5 µg/L, and Secchi transparency averaged 1.2 m. These measurements were within similar range relative to the range observed in other years. ACD staff's subjective observations of the lake's physical characteristics were that there were large suspended algae in mid-May with a more significant algae bloom beginning in July and continuing through September. ACD staff subjectively ranked the lake as having some impairment of swimming in early May and again from mid-June through September.

Trend Analysis

Seventeen years of water quality data have been collected by the Metropolitan Council (1980, '81, '83, '89, '94, '97, 2008) and the ACD (1998-2001, 2003, '05, '07, '09, '12, '15). Water quality has not significantly changed from 1980 to 2015 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,14}=3.38$, $p=0.08$). However, when analyzed individually Cl-a indicates a significant (one-way ANOVA $F_{1,15}=5.34$, $p=0.04$).

Discussion

Linwood Lake is on the Minnesota Pollution Control Agency's (MPCA) list of impaired waters, but it is a borderline case. Linwood Lake was placed on the state impaired waters because summertime average total phosphorus is routinely over the water quality standard of 40 µg/L for deep lakes. The state has since added separate standards for shallow lakes. Linwood does not technically meet the definition of a shallow lake (maximum depth of <15 ft or >80% of the lake shallow enough to support aquatic plants) due to a deep spot. However it is very similar to other shallow lake systems and expectations for water quality should be more in line with shallow lake standards (total phosphorus <60 µg/L, chlorophyll-a <20 µg/L, and Secchi transparency >1m). In the last 10 years Linwood has been substantially lower than the shallow lake phosphorus standard, but it has occasionally exceeded the other two standards. Regardless, water quality improvement is needed.

It is likely that major factors degrading water quality originate from the lake itself and/or its developed shoreline. The primary inlet to Linwood Lake comes from Boot Lake, a scientific and natural area, and it likely has good water quality (though has not been monitored). Threats to Linwood Lake likely include rough fish, failing shoreland septic systems, poor lakeshore lawn care practices, and natural sources such as nutrient-rich lake sediments. High powered boats may be impacting water quality by disturbing sediments because the lake is large enough for these boats to get up to full speed, but is mostly shallow.

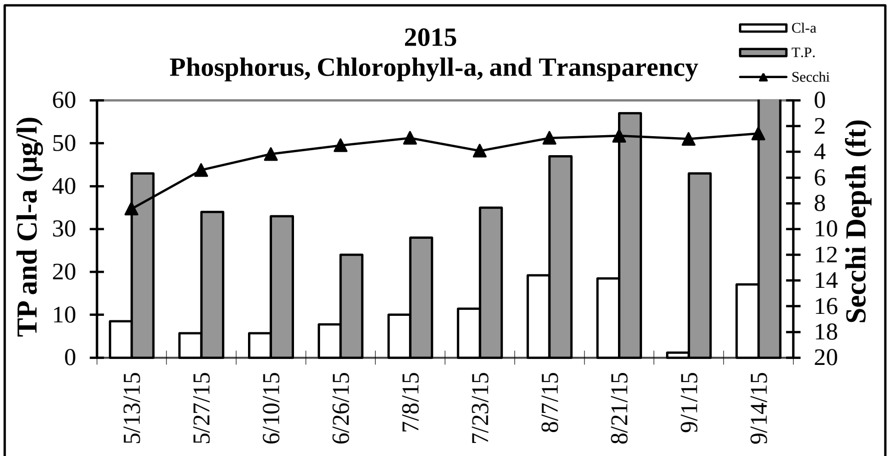
2015 Linwood Lake Water Quality Data

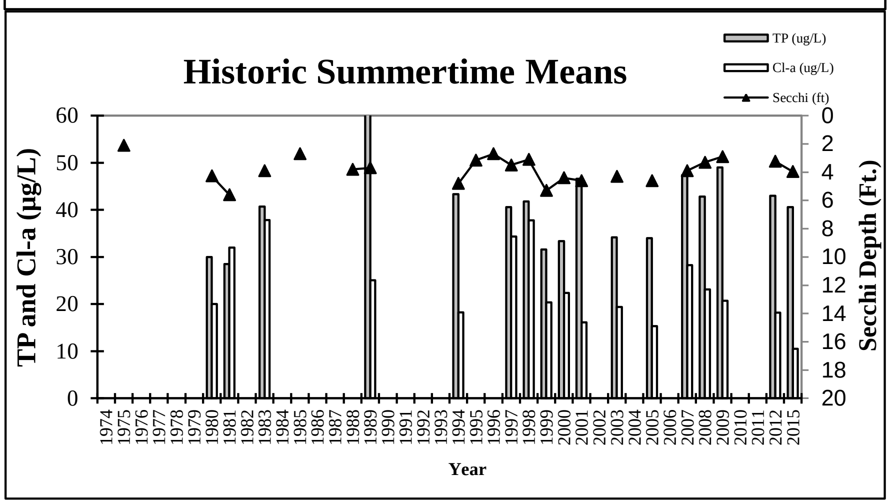
Linwood Lake

2015 Water Quality Data		Date	5/13/2015	5/27/2015	6/10/2015	6/26/2015	7/8/2015	7/23/2015	8/7/2015	8/21/2015	9/1/2015	9/14/2015			
		Time	15:20	13:15	14:25	13:40	13;40	13:04	11:50	13:20	12:45	13:45			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.08	8.17	8.34	8.65	8.48	8.61	8.38	7.65	8.45	8.14	8.30	7.65	8.65
Conductivity	mS/cm	0.01	0.300	0.301	0.302	0.330	0.332	0.281	0.308	0.349	0.287	0.329	0.312	0.281	0.349
Turbidity	FNRU	1	3.6	5.00	8.90	6.70	15.00	11.40	21.60	22.60	19.40	19.20	13	4	23
D.O.	mg/L	0.01	9.25	9.48	8.98	9.50	6.92	9.26	7.51	6.68	10.12	6.72	8.44	6.68	10.12
D.O.	%	1	92%	102%	109%	120%	85%	119%	89%	77%	123%	78%	99%	77%	123%
Temp.	°C	0.1	14.6	17.6	23.2	25.6	24.0	26.3	23.8	21.9	23.3	20.6	22.1	14.6	26.3
Temp.	°F	0.1	58.2	63.7	73.8	78.1	75.2	79.4	74.8	71.4	73.9	69.0	71.8	58.2	79.4
Salinity	%	0.01	0.14	0.14	0.14	0.16	0.16	0.14	0.15	0.17	0.14	0.16	0.15	0.14	0.17
Cl-a	µg/L	1	8.5	5.7	5.7	7.8	10.0	11.4	19.2	18.5	1.2	17.1	10.5	1.2	19.2
T.P.	mg/L	0.005	0.043	0.034	0.033	0.024	0.028	0.035	0.047	0.057	0.043	0.062	0.041	0.024	0.062
T.P.	µg/L	5	43	34	33	24	28	35	47	57	43	62	41	24	62
Secchi	ft	0.1	8.4	5.4	4.2	3.5	2.9	3.9	2.9	2.8	3.0	2.6	4.0	2.6	8.4
Secchi	m	0.10	2.6	1.7	1.3	1.1	0.9	1.2	0.9	0.8	0.9	0.8	1.2	0.8	2.6
Field Observations															
Physical			1	2.0	2.0	2.0	2.0	4.0	2.0	2.0	2.0	2.0	2.1	1.0	4.0
Recreational			1	1.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	1.0	1.3	1.0	2.0

*reporting limit

Linwood Lake Water Quality Results





Linwood Lake Summertime Historic Mean

	CAMP	MC	MC	MC	CAMP	CAMP	MC	MC	CAMP	CAMP	MC	ACD	ACD	ACD	ACD	ACD	ACD	ACD	CAMP	ACD	ACD	ACD
	1975	1980	1981	1983	1985	1988	1989	1994	1995	1996	1997	1998	1999	2000	2001	2003	2005	2007	2008	2009	2012	2015
TP (ug/L)		30.0	28.5	40.7			64.8	43.3			40.6	45.7	48.6	44.4	46.6	34.2	34.0	47.4	42.8	49.0	43.0	41.0
Cl-a (ug/L)		20.0	32.0	37.9			25.1	18.3			34.4	40.0	31.7	31.2	16.1	19.4	15.3	28.3	23.1	20.7	18.2	10.5
Secchi (m)	0.64	1.30	1.70	1.20	0.82	1.17	1.12	1.45	0.96	0.82	1.06	0.94	1.10	1.34	1.4	1.31	1.4	1.19	1.01	0.88	1	1.2
Secchi (ft)	2.1	4.3	5.6	3.9	2.7	3.8	3.7	4.8	3.2	2.7	3.5	3.1	3.6	4.4	4.6	4.3	4.6	3.9	3.3	2.9	3.2	4

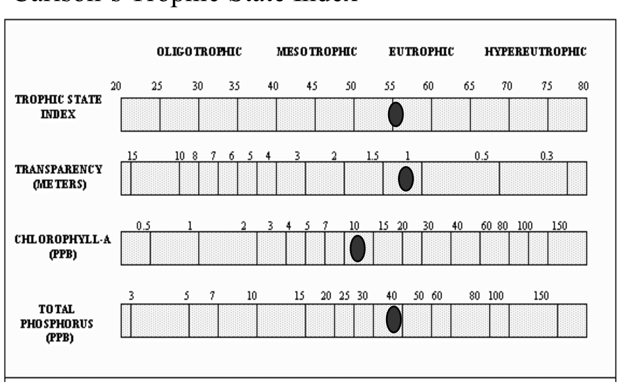
Carlson's Tropic State Indices

TSIP		53	52	58			64	58			58	59	54	54	59	55	55	60	58	60	58	58
TSIC		60	65	66			62	59			65	67	60	61	57	60	57	63	62	60	59	54
TSIS	66	56	52	57	63	58	58	55	61	63	59	61	53	55	56	56	55	57	60	62	60	57
TSI		57	57	60			62	57			61	62	56	57	57	57	56	60	60	61	59	56

Linwood Lake Water Quality Report Card

Year	1975	1980	1981	1983	1985	1988	1989	1994	1995	1996	1997	1998	1999	2000	2001	2003	2005	2007	2008	2009	2012	2015
TP		B	B	C			C	C			C	C	C	C	C	C	C	C	C	C	C	C
Cl-a		B	B	C			C	B			C	C	C	C	B	B	B	C	C	C+	B	B
Secchi	F	C	C	C	D	D	D	C	D	D	D	D	D	C	C	C	C	D	D	D	D	C
Overall		**B**	**B**	**C**			**C**	**C**			**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**

Carlson's Trophic State Index



Fawn Lake

Linwood Township Lake ID # 02-0035

Background

Fawn Lake is located in extreme northeast Anoka County. Fawn Lake has a surface area of 57 acres and a maximum depth of 30 feet (9.1 m). There is no public access to this lake and no boat landing. A neighborhood association has established a small park and swimming beach for the homeowners. Most of the lake is surrounded by private residences, with the densest housing on the southern and western shores. The watershed for this lake is quite small, consisting mostly of the area within less than ¼ mile of the basin.

Fawn is one of the clearest lakes in the county. Groundwater likely feeds this lake to a large extent. Vegetation in the lake is healthy, but not so prolific to be a nuisance, and contributes to high water quality. In 2008 and 2010 an invasive plant species, curly-leaf pondweed, was noticed in a few locations, although it may have been present for some time. It does not appear occur in high densities. Another aquatic invasive species survey was conducted in 2015 by the Anoka Conservation District. Curly-leaf pondweed was still not a nuisance and no new species were identified. Once again a great variety of healthy-native vegetation was identified.

2015 Results

Fawn Lake is classified as mesotrophic and has some of the clearest water in Anoka County. In 2015, Fawn Lake continued its trend of excellent water quality for this region of the state (NCHF Ecoregion) by receiving an overall A grade. Water clarity was high while total phosphorus and chlorophyll *a* were low throughout the 2015 sampling season. Water clarity was 19.4 feet in spring, and averaged 14.5 feet from May through September. The subjective observations of the lake's physical characteristics and recreational suitability by the ACD staff indicated that lake conditions were excellent for swimming and boating throughout the summer.

Trend Analysis

Thirteen years of water quality data have been collected by the Minnesota Pollution Control Agency (1988) and the Anoka Conservation District (between 1997 and 2015). If we examine all years, there is a nearly statistically significant trend of improving water quality (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,10} = 4.49$, $p = 0.04$). It has been concluded that this was driven nearly entirely by poor water quality in the earliest year monitored (1988). If 1988 is excluded, water quality has been consistent among years monitored.

Discussion

This lake's water quality future lies with the actions of the lakeshore homeowners. Because the lake has such a small watershed each lakeshore lot comprises a significant portion of the watershed. Poor practices on a few lots could result in noticeable changes to the lake. Some ways to protect the lake include lakeshore buffers of native vegetation, keeping yard waste out of the lake, and eliminating or minimizing the use of fertilizer. Soil testing on nearby lakes and throughout the metro has found that soil phosphorus fertility is high, and lawns do not benefit from additional phosphorus. Additionally, lakeshore homeowners should refrain from disturbing or removing lake vegetation. One reason is that this lake's exceptionally high water quality is in part due to its healthy plant community. Moreover, curly-leaf pondweed, an invasive only recently noticed in the lake, readily colonizes disturbed areas and can affect both water quality and recreation.

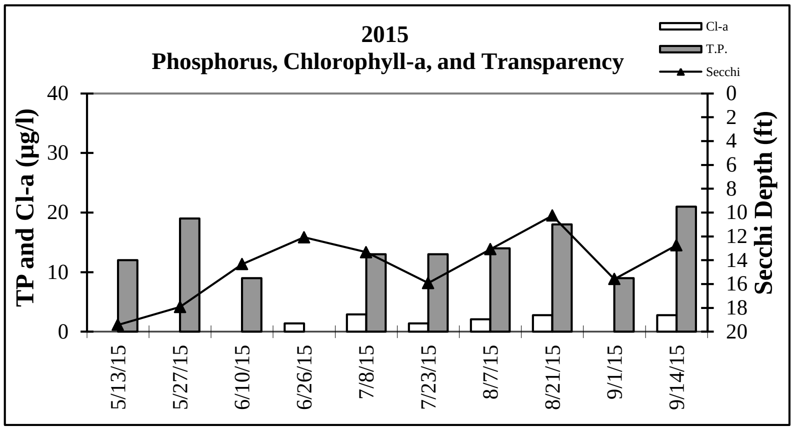
2015 Fawn Lake Water Quality Data

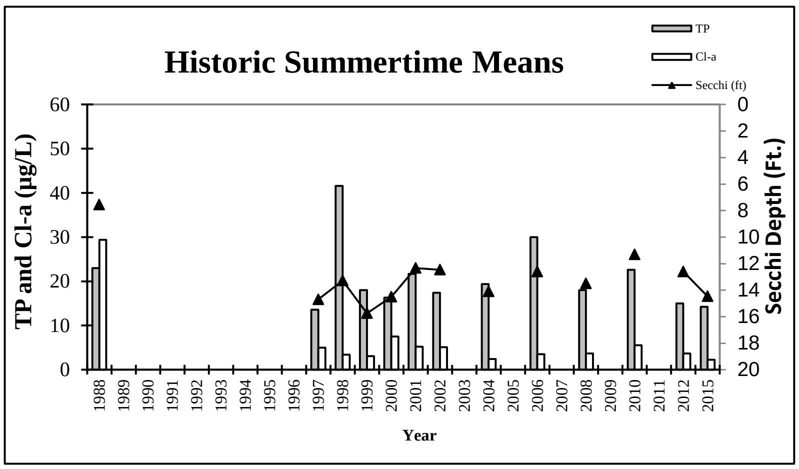
Fawn Lake

2015 Water Quality Data		Date	5/13/2015	5/27/2015	6/10/2015	6/26/2015	7/8/2015	7/23/2015	8/7/2015	8/21/2015	9/1/2015	9/14/2015			
		Time	14:00	12:00	12:30	12:20	12:10	12:20	10:25	12:05	11:35	12:30			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.13	8.47	8.71	8.59	8.52	8.60	8.33	7.70	7.93	8.14	8.31	7.70	8.71
Conductivity	mS/cm	0.01	0.230	0.223	0.214	0.236	0.237	0.195	0.218	0.250	0.217	0.239	0.226	0.195	0.250
Turbidity	FNRU	1.0	0.60	0.00	0.00	0.80	3.20	0.20	5	2	2	0	1	0	5
D.O.	mg/L	0.01	9.98	9.67	9.07	8.70	7.55	8.17	7.56	7.60	8.93	8.42	8.57	7.55	9.98
D.O.	%	1.0	99%	106%	113%	109%	93%	105%	90%	88%	109%	99%	101%	88%	113%
Temp.	°C	0.10	14.5	17.8	24.4	25.4	24.4	26.6	24.4	22.6	23.6	21.1	22.5	14.5	26.6
Temp.	°F	0.10	58.0	64.0	76.0	77.8	76.0	79.9	75.9	72.6	74.5	69.9	72.5	58.0	79.9
Salinity	%	0.01	0.11	0.11	0.10	0.11	0.12	0.10	0.11	0.12	0.10	0.11	0.11	0.10	0.12
Cl-a	µg/L	1.0	<1	<1	<1	1.4	2.9	1.4	2.1	2.8	<1	2.8	2.2	1.4	2.9
T.P.	mg/L	0.005	0.012	0.019	0.009	<0.02	0.013	0.013	0.014	0.018	0.009	0.021	0.014	0.009	0.021
T.P.	µg/L	5	12	19	9	#VALUE!	13	13	14	18	9	21	14	9	21
Secchi	ft	0.1	19.4	17.9	14.3	12.1	13.3	15.9	13.1	10.3	15.6	12.8	14.5	10.3	19.4
Secchi	m	0.1	5.9	5.5	4.4	3.7	4.1	4.9	4.0	3.1	4.7	3.9	4.4	3.1	5.9
Field Observations															
Physical			1.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.5	1.0	2.0
Recreational			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

*Reporting Limit

Fawn Lake Water Quality Results

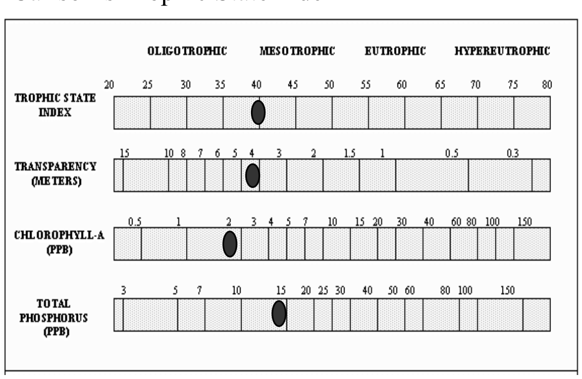




Fawn Lake Historic Summertime Mean Values

Agency	MPCA	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	1988	1997	1998	1999	2000	2001	2002	2004	2006	2008	2010	2012	2015
TP (µg/L)	23.0	13.6	41.6	18.0	16.3	21.7	17.4	19.4	30.0	18.0	22.6	15.0	14.2
Cl-a (µg/L)	29.4	5.0	3.4	3.1	7.5	5.2	5.1	2.4	3.5	3.7	5.6	3.7	2.2
Secchi (m)	2.3	4.5	4.1	4.8	4.4	3.8	3.8	4.3	3.8	4.1	3.5	3.8	4.4
Secchi (ft)	7.5	14.7	13.3	15.7	14.5	12.3	12.5	14.1	12.6	13.5	11.3	12.6	14.5
Carlson's Trophic State Indices													
Year	1988	1997	1998	1999	2000	2001	2002	2004	2006	2008	2010	2012	2015
TSIP	49	42	58	46	44	49	45	47	53	46	49	43	42
TSIC	64	46	43	42	50	47	47	39	43	44	47	43	38
TSIS	48	38	40	37	39	41	41	39	41	40	42	41	39
TSI	54	42	47	42	44	45	44	42	46	43	46	42	40
Fawn Lake Water Quality Report Card													
Year	1988	1997	1998	1999	2000	2001	2002	2004	2006	2008	2010	2012	2015
TP (µg/L)	B	A	C	A	A	A	A	A	B	A	A	A	A
Cl-a (µg/L)	C	A	A	A	A	A	A	A	A	A	A	A	A
Secchi (m)	A	A	A	A	A	A	A	A	A	A	A	A	A
Overall	**B**	**A**	**B**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**

Carlson's Trophic State Index



Typo Lake

Linwood Township, Lake ID # 03-0009

Background

Typo Lake is located in the northeast portion of Anoka County and the southeast portion of 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. Public access is 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.

2015 Results

In 2015 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 worse than the 2014 but is consistent to all previous years monitored. In addition, some of the most important parameters were much better than many of the years observed. In the worst two years of results, total phosphorus averaged 340 (2007) and 353 µg/L(2009), respectively. Total phosphorus in 2015 averaged 201.4 µg/L, which while still very high, but was the second lowest reading since 1997. Chlorophyll-a levels in 2015 (57.5 µg/L) were the second lowest throughout all years monitored. In both 2007 and 2009 a bright white 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. The reason for the especially poor conditions in 2007 and 2009 seems to be drought-induced low water levels. To that same sentiment, it is reasonable to believe that the improvements observed in 2014 may be a result of above average rainfall.

Trend Analysis

Fifteen 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). Water quality has significantly deteriorated from 1993 to 2015 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,12}=5.97$, $p=0.02$). Though, tested individually (one-way ANOVAs on the individual response variables) TP, Cl-a, and Secchi depth show no significant change. The trend toward poorer phosphorus and transparency continue to appear to be strong despite the fact that in 2012, 2014 and 2015 these parameters were slightly better than the previous years monitored.

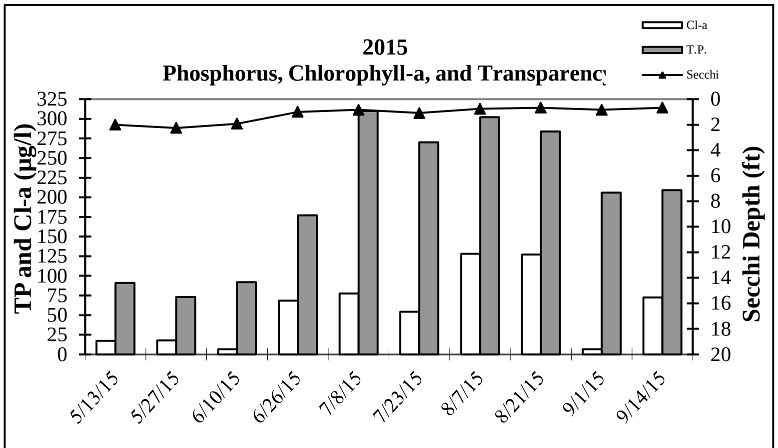
Discussion

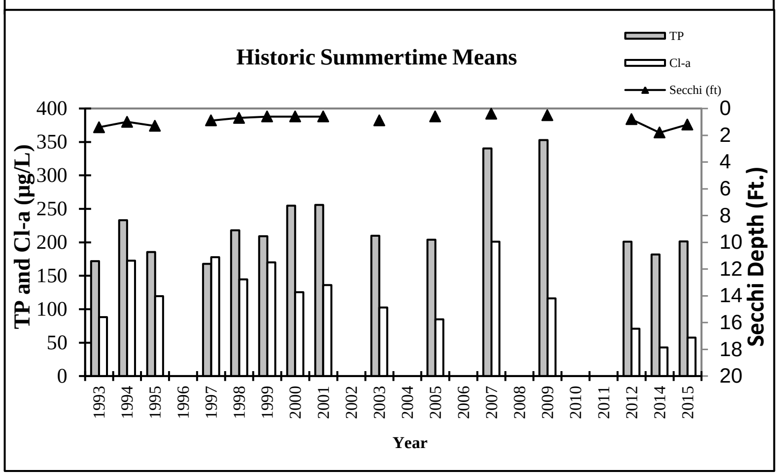
Typo Lake, along with Martin Lake downstream, were the subject of TMDL study by the Anoka Conservation District which was approved by the State and EPA in 2012. This study documented the source of nutrients to the lake, the degree to which each is impacting the lake, and put forward lake rehabilitation strategies. Some factors impacting water quality on Typo Lake include rough fish, high phosphorus inputs from a ditched wetland west of the lake, and lake sediments. A carp barrier project between Martin and Typo lakes has been approved and funded. The first barrier was installed in 2014 with contractors set to install the final three in 2015/2016.

Typo Lake Water Quality Results

Typo Lake		Date	5/13/2015	5/27/2015	6/10/2015	6/26/2015	7/8/2015	7/23/2015	8/7/2015	8/21/2015	9/1/2015	9/14/2015			
2015 Water Quality Data		Time	14:20	12:20	13:00	12:45	12:35	12:45	10:55	11:40	11:55	12:50			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.35	8.48	8.90	8.88	9.15	8.72	8.18	8.53	8.10	8.58	8.59	8.10	9.15
Conductivity	mS/cm	0.01	0.280	0.274	0.257	0.308	0.314	0.259	0.275	0.304	0.250	0.294	0.282	0.250	0.314
Turbidity	FNRU	1	19.50	20.70	37.50	77.90	82.90	104.00	136.00	135.00	126.00	116.00	86	20	136
D.O.	mg/l	0.01	10.05	8.73	11.27	10.95	11.51	8.15	5.77	10.93	8.14	9.96	9.55	5.77	11.51
D.O.	%	1	99%	96%	140%	142%	140%	104%	67%	121%	103%	115%	112%	67%	142%
Temp.	°C	0.1	13.6	18.1	24.4	26.5	23.2	26.8	22.5	20.0	24.4	19.2	21.86	13.60	26.82
Temp.	°F	0.1	56.5	64.5	75.8	79.7	73.8	80.3	72.5	23.7	75.9	66.5	71.4	23.7	80.3
Salinity	%	0.01	0.13	0.13	0.12	0.15	0.15	0.13	0.13	0.14	0.12	0.13	0.1	0.1	0.2
Cl-a	ug/l	0.5	17.1	17.8	6.4	68.4	77.6	54.1	128.0	127.0	6.4	72.6	57.5	6.4	128.0
T.P.	mg/l	0.010	0.091	0.073	0.092	0.177	0.310	0.270	0.302	0.284	0.206	0.209	0.201	0.073	0.310
T.P.	ug/l	10	91	73	92	177	310	270	302	284	206	209	201	73	310
Secchi	ft	0.1	2.0	2.3	1.9	1.0	0.8	1.1	0.8	0.7	0.8	0.7	1.2	0.7	2.3
Secchi	m	0.1	0.6	0.7	0.6	0.3	0.3	0.3	0.2	0.2	0.3	0.2	0.4	0.2	0.7
Field Observations															
Physical			1.0	2.0	3.0	4.0	4.00	4.00	5.0	4.0	2.0	3.0	3.2	1.0	5.0
Recreational			1.0	2.0	2.0	2.0	2.00	1.00	4.0	3.0	2.0	3.0	2.2	1.0	4.0

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
Year	1974	1975	1993	1994	1995	1997	1998	1999	2000	2001	2003	2005	2007	2009	2012	2014	2015
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
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
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
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

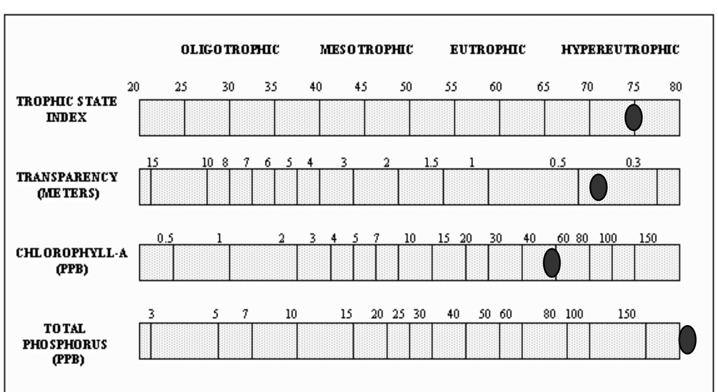
Carlson's Tropic State Indices

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

Typo Lake Water Quality Report Card

Year	1974	1975	1993	1994	1995	1997	1998	1999	2000	2001	2003	2005	2007	2009	2012	2014	2015
TP			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
Secchi	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**

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. Public access is available 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.

2015 Results

In 2015 Martin Lake had poor water quality compared to 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 2015 total phosphorus averaged 92.6 µg/L, slightly above the lake's historical average of 92.1 µg/L and well above the impairment threshold of 60 µg/L. Chlorophyll-a was the second lowest observed in the lakes monitored history at 17.8 µg/L. Average Secchi transparency was only 3.4 feet in 2015 but slightly better than the historical average. 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

Fourteen years of water quality data have been collected by the Minnesota Pollution Control Agency (1983), Metropolitan Council (1998, 2008), and ACD (1997, 1999-2001, 2003, 2005, 2007, 2009, 2012, 2014, 2015). Citizens monitored Secchi transparency 17 other years. Anecdotal notes from DNR fisheries data indicate poor water quality back to at least 1954. A water quality change from 1983 to 2015 is detectable with statistical tests (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,11}$=10.74, p=<0.01). In previous assessments if the oldest year of data (1983) was excluded, there was no longer a statistically significant trend. 2015 is the first year where the exclusion does not change the trend from being statistically significant (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,10}$ =5.82, p=0.021). However, further examination of the data (one-way ANOVAs on the individual response variables) TP, Cl-a, and Secchi depth reveals that no water quality parameter alone has changed significantly, and the direction of their changes is mixed.

Discussion

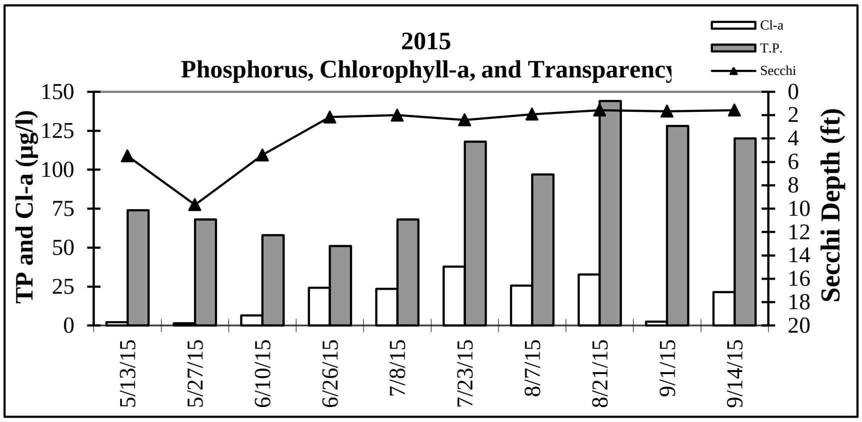
Martin Lake, along with Typo Lake upstream, were the subject of an TMDL study by the Anoka Conservation District that was approved by the State and EPA in 2012. This study documented the source of nutrients to the lake, the degree to which each is impacting the lake, and put forward lake rehabilitation 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. A carp barrier project between Martin and Typo lakes has been approved and funded. The first barrier was installed in 2014 with contractors set to install the final two in 2015/2016.

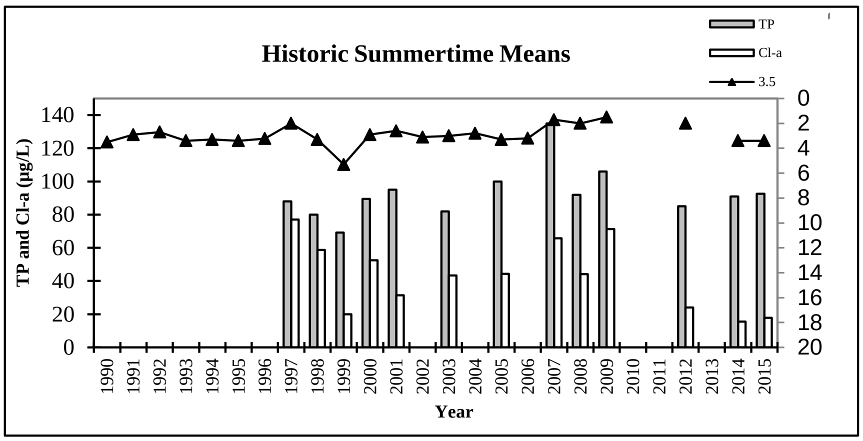
2015 Martin Lake Water Quality Data

Martin Lake
2015 Water Quality Data

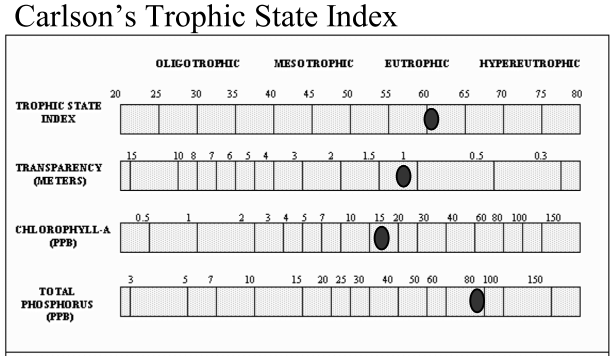
		Date:	5/13/2015	5/27/2015	6/10/2015	6/26/2015	7/8/2015	7/23/2015	8/7/2015	8/21/2015	9/1/2015	9/14/2015			
		Time:	14:50	12:45	13:40	13:10	13:10	13:15	11:15	12:50	12:15	13:15			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	7.78	7.63	8.00	8.46	7.98	8.71	7.83	7.28	8.37	8.28	8.03	7.28	8.71
Conductivity	mS/cm	0.01	0.311	0.312	0.298	0.331	0.348	0.291	0.338	0.370	0.305	0.336	0.324	0.291	0.370
Turbidity	FNRU	1	4.60	0.80	5.60	25.80	23.40	35.80	34.21	51.40	52.70	45.40	27.97	0.80	52.70
D.O.	mg/l	0.01	8.08	7.55	8.67	10.56	6.04	10.39	6.12	5.30	10.96	7.44	8.11	5.30	10.96
D.O.	%	1	81%	81%	107%	128%	73%	132%	73%	60%	130%	85%	95%	60%	132%
Temp.	°C	0.1	15.0	17.3	24.0	25.0	23.4	26.0	23.9	21.5	22.6	20.0	21.9	15.0	26.0
Temp.	°F	0.1	59.0	63.1	75.2	77.0	74.1	78.8	74.9	70.8	72.6	68.0	71.4	59.0	78.8
Salinity	%	0.01	0.15	0.15	0.14	0.16	0.17	0.14	0.16	0.18	0.15	0.16	0.16	0.14	0.18
Cl-a	ug/L	0.5	2.1	1.4	6.4	24.2	23.5	37.7	25.6	32.8	2.5	21.4	17.8	1.4	37.7
T.P.	mg/l	0.010	0.074	0.068	0.058	0.051	0.068	0.118	0.097	0.144	0.128	0.120	0.093	0.051	0.144
T.P.	ug/l	10	74	68	58	51	68	118	97	144	128	120	92.6	51	144
Secchi	ft		5.5	9.7	5.4	2.2	2.0	2.4	1.9	1.6	1.7	1.6	3.4	1.6	9.7
Secchi	m		1.7	2.9	1.7	0.7	0.6	0.7	0.6	0.5	0.5	0.5	1.0	0.5	2.9
Field Observations															
Physical			1.0	2.0	2.0	3.0	3.0	4.0	3.0	3.0	3.0	3.0	2.7	1.0	4.0
Recreational			1.0	1.0	1.0	1.0	1.0	1.0	3.0	2.0	3.0	3.0	1.7	1.0	3.0

Martin Lake Water Quality Results





Carlson's Trophic State Index



Martin Lake Summertime Annual Mean

Agency	CLMP	ACD	MC	ACD	ACD	ACD	CLMP	ACD	CLMP	ACD	ACD	ACD	CAMP	CAMP	ACD	ACD	ACD
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2012	2014	2015
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
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	17.8
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
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

Carlson's Tropic State Indices

TSIP		69	67	64	68	69		68		71		75	69	71	68	69	69
TSIC		73	71	59	67	63		68		68		72	68	73	62	58	59
TSIS	60	67	60	52	63	65	65	62	62	60	60	70	67	73	67	60	60
TSI		70	66	58	66	66		66		66		72	68	72	66	62	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
TP		D	D	C	D	D		D		D		D	D	D	D	D	D
Cl-a		D	D	B	C	C		C		C		D	C	D	C	B	B
Secchi	D	F	D	C	D	D	D	D	D	D	D	F	F	F	F	D	D
Overall		**D**	**D**	**C**	**D**	**D**		**D**		**D**		**D**	**D**	**D**	**D**	**C**	**C**

Aquatic Invasive Vegetation Mapping

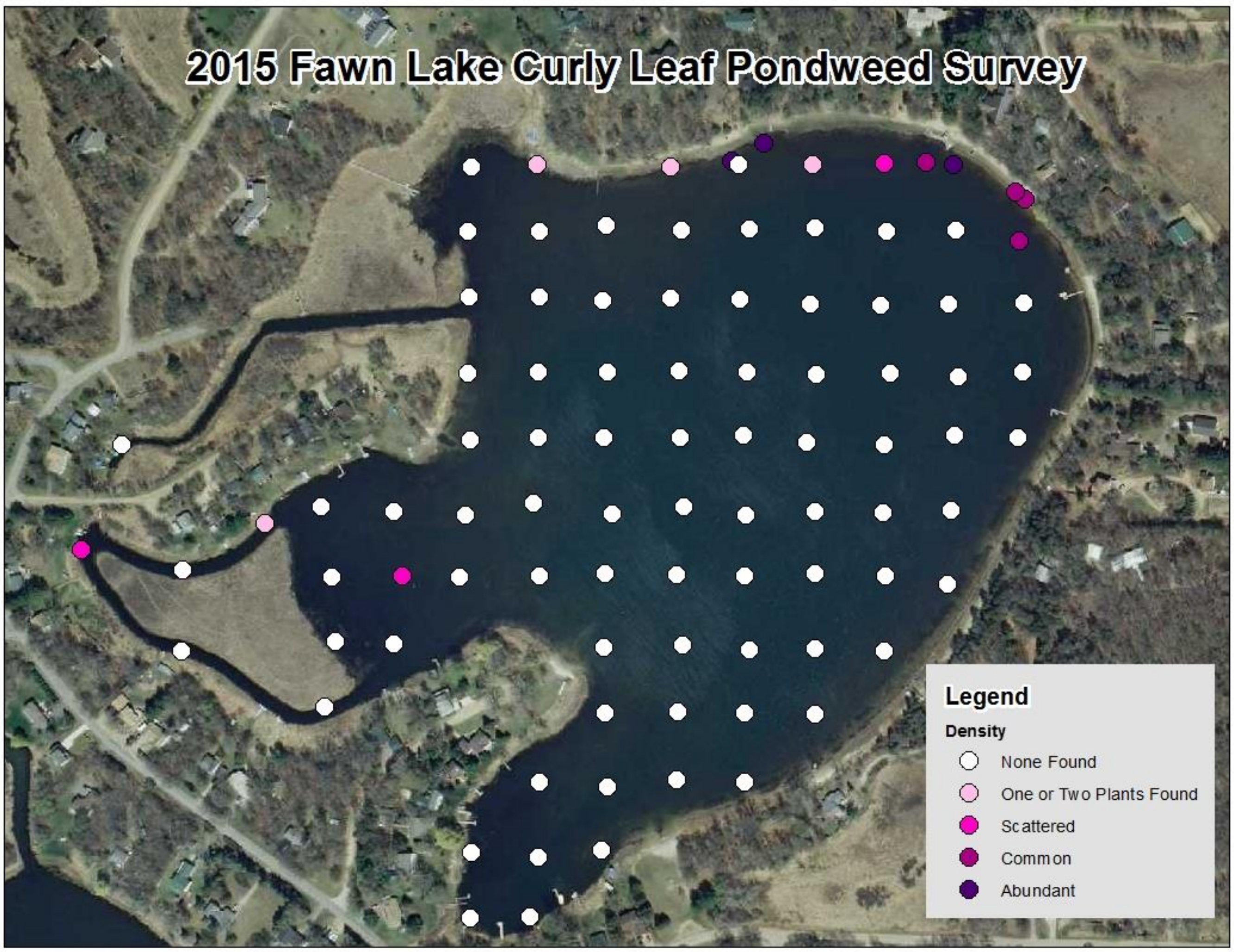
Description: The Anoka Conservation District (ACD) was contracted through the Sunrise River Watershed Management Organization (WMO) to conduct an aquatic invasive vegetation survey.

Purpose: To map out the presence of aquatic invasive vegetation throughout Fawn Lake. Curly-leaf Pondweed is present in Fawn Lake. This survey will provide a sense of the vegetation quality in the lake as well as mark areas of concern which may require further attention in the future. Early detection and rapid response is crucial for minimizing the impacts of invasive species.

LOCATIONS: FAWN LAKE

Results: A map is presented below. These survey points map the areas sampled as well as any areas of interest or concern. Curly-leaf Pondweed is still present but not to nuisance levels. Overall, Fawn Lake contained a large variety of healthy-native vegetation.

2015 Fawn Lake Aquatic Invasive Vegetation Survey



Stream Water Quality

Description: Stream water quality is monitored with grab samples on eight occasions throughout the open water season including immediately following four storms and four times during baseflow. The selected are the farthest downstream limits of the Sunrise River Watershed Management Organization's jurisdictional area. Parameters monitored include water level, pH, conductivity, turbidity, transparency, dissolved oxygen, phosphorus, total suspended solids. This data can be paired with stream hydrology monitoring to do pollutant loading calculations.

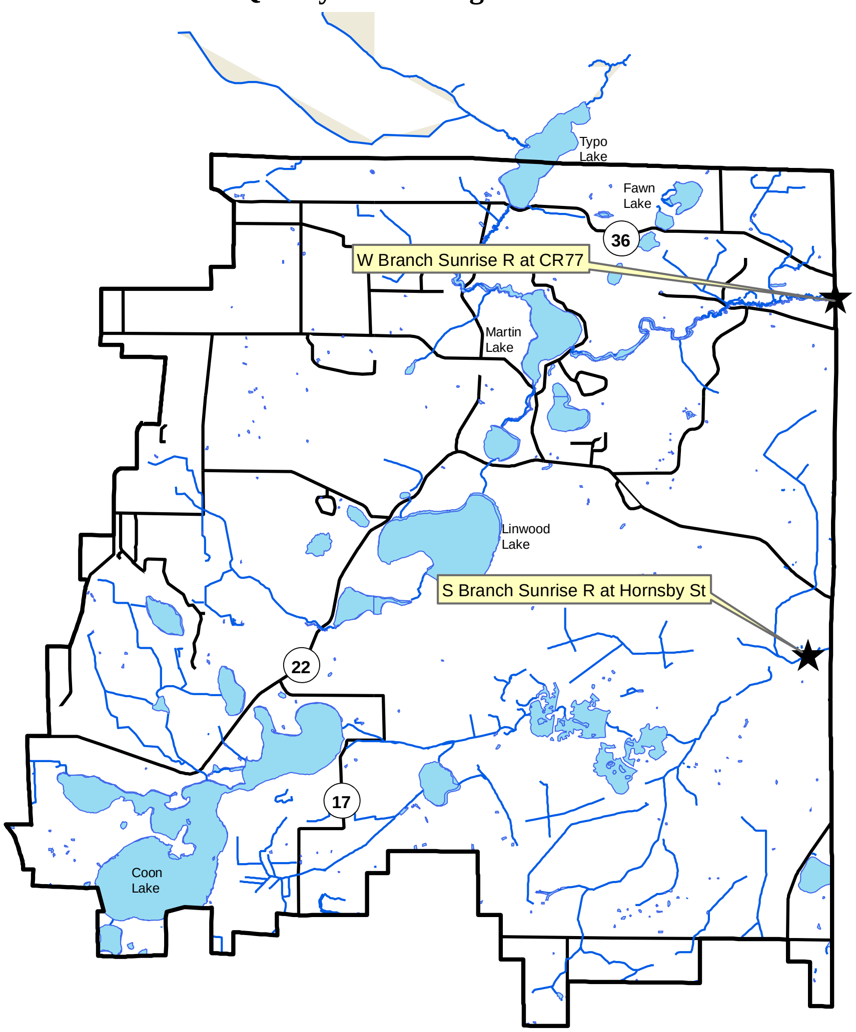
Purpose: To detect water quality trends and problems, and diagnose the source of problems.

Locations: West Branch of Sunrise River at CR 77

South Branch of Sunrise River at Hornsby St

Results: Results are presented on the following pages.

Sunrise Watershed Stream Water Quality Monitoring Sites



WEST BRANCH SUNRISE RIVER

at Co Road 77, Linwood Township

STORET SiteID = S001-424

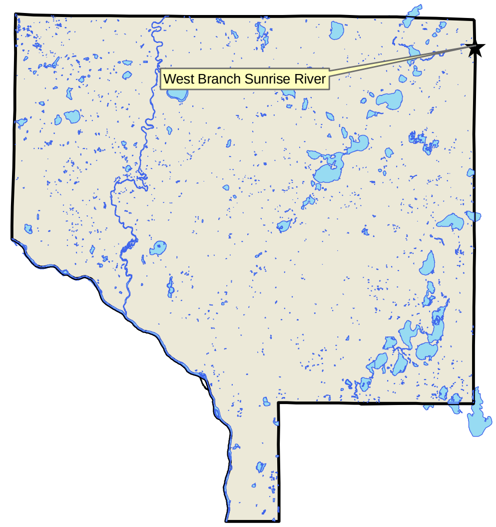
Years Monitored

2001, 2003, 2006, 2012, 2015

Background

This monitoring site is the bottom of this watershed in Anoka County, at the Chisago County border. Upstream, this river drains through Boot, Linwood, Island, Martin, and Typo Lakes. The Sunrise River Watershed Management Organization monitors this site because it is at the bottom of their jurisdictional area. Flows in the West Branch of the Sunrise River are often around 70 cfs, but range from 15 cfs to near 200 cfs.

This segment of the river is listed by the MN Pollution Control Agency as impaired for turbidity and for poor fish and invertebrate communities. A TMDL study was completed in 2013.



Methods

In 2001, 2003, 2006, 2012, and 2015 the West Branch of the Sunrise River ws monitored at County Road 77 (Lyons St). This location is the boundary between Anoka and Chisago Counties. It is also the farthest downstream point within the Sunrise River Watershed Management Organization's jurisdiction.

The river was monitored 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. 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. Water level is monitored continuously in the open water season and a rating curve has been developed to calculate flows from those water level records.

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 in the Sunrise River. While they may be low here, excessive use should be avoided.

- Phosphorus was seen at acceptable levels. This was large decrease from when last monitored in 2012. Even so, when state water quality standards are developed for phosphorus in streams, the West Branch of the Sunrise River may exceed it.

  Management discussion: Management in upstream lakes will help reduce phosphorus in the river.

- Suspended solids and turbidity were well below state water quality standards. There was a large decrease from 2012 results.

  Management discussion: Efforts to reduce suspended material in upstream lakes will help decrease turbidity and suspended solids throughout the Sunrise River.

- pH was within the range considered normal and healthy for streams in this area.
- Dissolved oxygen (DO) was typically within the range considered normal and healthy. Only on one sampling occasion in 2015 did DO drop below 5 mg/L, which was during a storm event.

  Management discussion: Low dissolved oxygen is likely impacting aquatic life and focusing more into this issue would be important to overall stream health.

Results and Discussion

This reach of the West Branch of the Sunrise River has an impaired invertebrate and fish community according to the MPCA. There was one invert sample taken for this determination. The invertebrate monitoring crew sampled overhanging vegetation and macrophytes and did not sample the stream bed. The stream bed is difficult to sample because sediments are deep and unconsolidated. There were two fish samples taken at County Road 77, and another right upstream. The fish visits were scored against a low gradient Index of Biotic Integrity (IBI), which is appropriate for this river. The status of this impairment may change once Minnesota adopts a TALU (tiered aquatic life use) framework when examining water quality standards.

A Total Maximum Daily Load (TMDL) study for this river reach and was completed in 2013. It is part of a larger Sunrise River Watershed Restoration and Protection Project (WRAPP) led by the Chisago Soil and Water Conservation District and MN Pollution Control Agency. Local entities should become involved in this project as it will determine causes of the turbidity and biotic impairments and set forth measures needed to correct them.

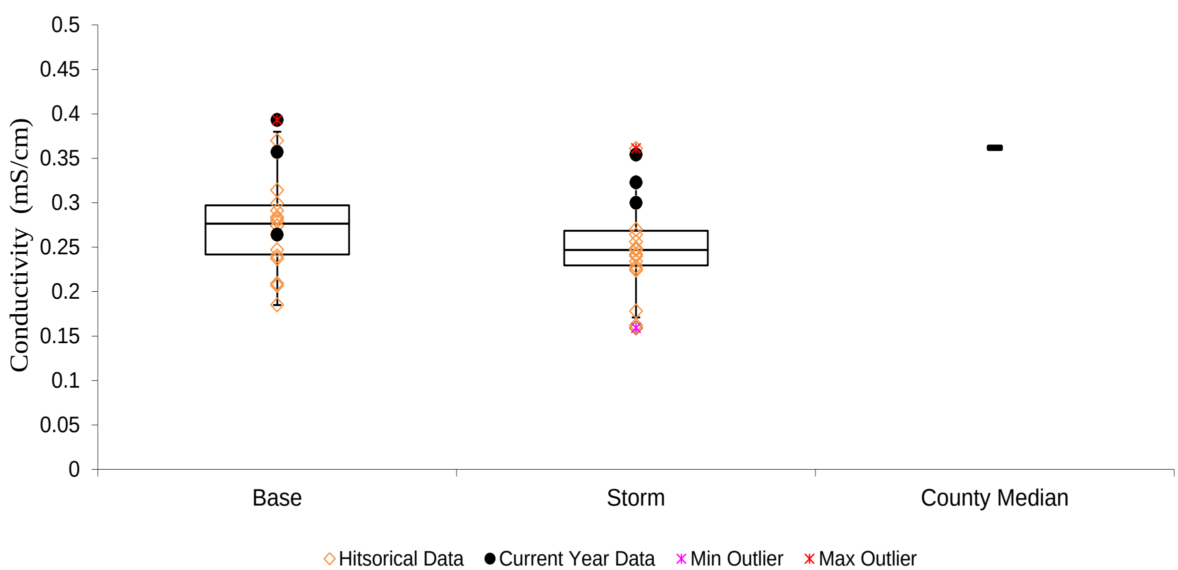
Conductivity and chlorides

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 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 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.

Conductivity was acceptably low in the West Branch of the Sunrise River. Median conductivity across all years was 0.252 mS/cm. 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 too, studied extensively, and the largest cause is road salts that have infiltrated into the shallow aquifer.

Chlorides were not tested in 2015 but 1n 2012 chloride results parallel those found for conductivity. Median chloride levels in the West Branch of the Sunrise River across all years are the same as the median for Anoka County streams of 12 mg/L. The levels observed are much lower than 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 or road deicing salts.

Conductivity during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



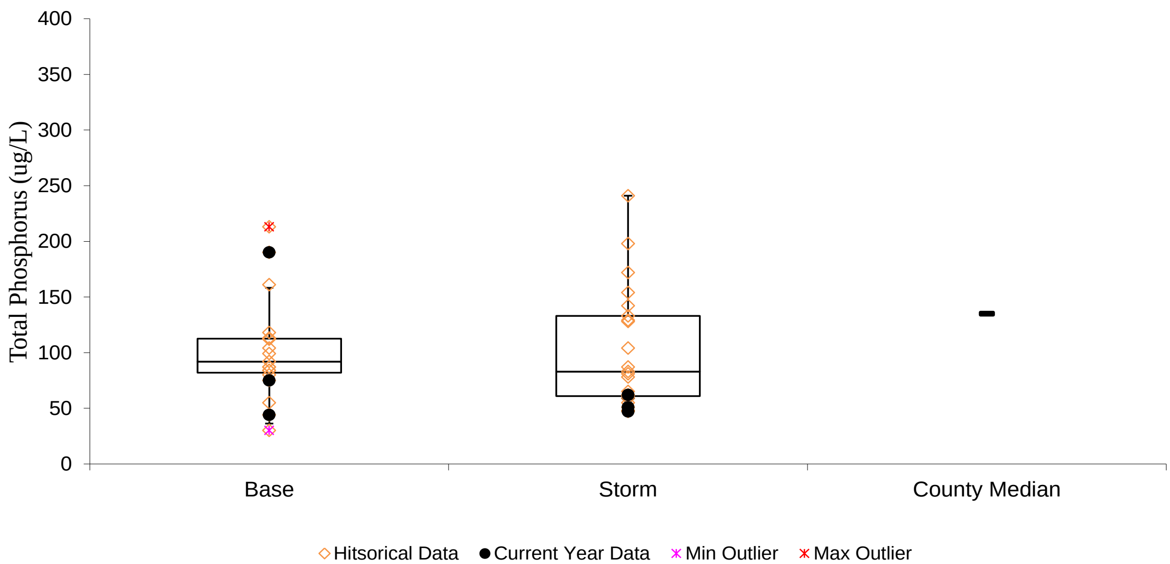
Total Phosphorus

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. Total phosphorus in the West Branch of the Sunrise River is within the acceptable range. The median TP for Anoka County streams is 135 ug/L which is similar to the state water quality standard. The median phosphorus concentration in the West Branch of the Sunrise River across all years was 87.0 ug/L, and in 2015 alone was 63.5 ug/L which was a large decrease from

2012 monitoring results. 7 of 40 samples (17.5%) from all years had TP higher than 150 ug/L and two of these samples were higher than 200 ug/L.

These phosphorus levels are common for the area. In the case of the West Branch of the Sunrise River, phosphorus levels are, at least in part, reflective of conditions of Martin Lake about 3 miles upstream from the sampling site. Martin Lake is impaired for excess phosphorus, with a summertime average of 100 ug/L during the last 10 years. Water quality improvements to Martin Lake will benefit the river downstream. Installation of a carp barrier project between Martin and Typo lakes has begun and improvements to the water quality of the Sunrise River should be seen in the future.

Total phosphorus during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2015 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)

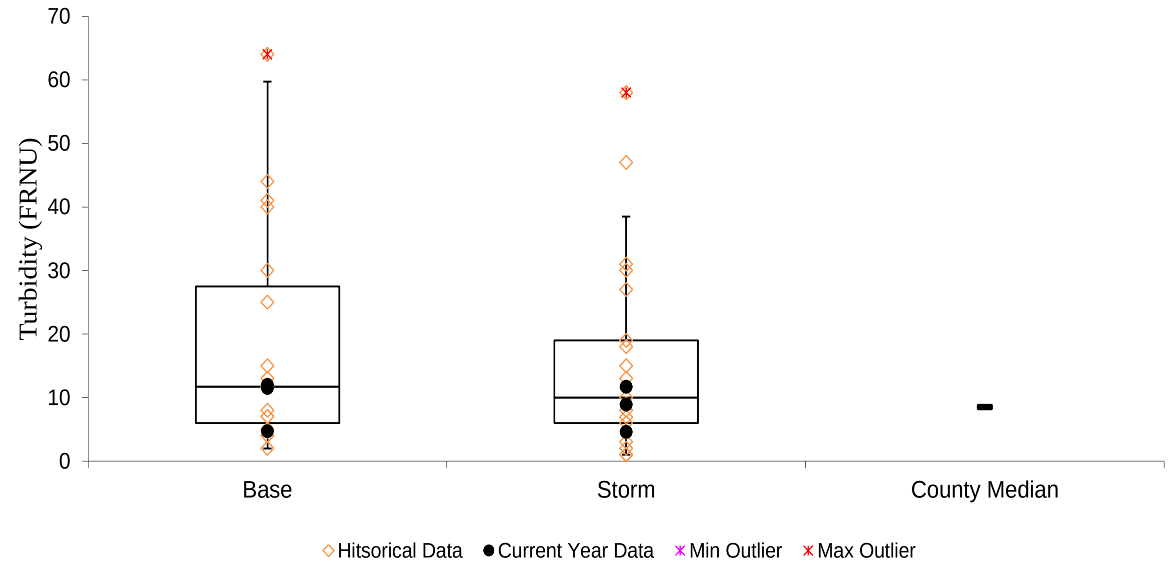
Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by refraction of a light beam passed through a water sample. It is most sensitive to large particles. Total suspended solids is measured by filtering solids from a 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 in and out of the river. 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.

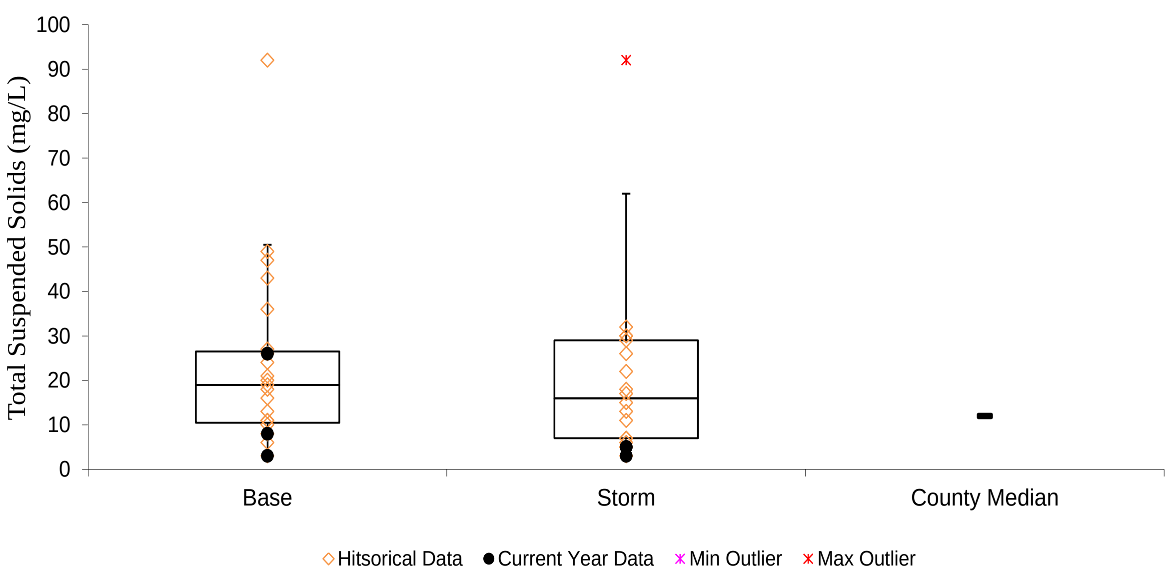
The West Branch of the Sunrise River has been declared as "impaired" for excess turbidity by the MN Pollution Control Agency. Their threshold is 25 NTU turbidity. If a river exceeds this value on three occasions and at least 10% of all sampling events, then it is declared impaired for turbidity. Based on all years of data, the West Branch of the Sunrise River has exceeded 25 NTU turidity on 10 of 40 sampling occassions (25%). But in 2015 all eight samples had turbidity lower than 25 NTU, and the maximum was only 11.7 NTU.

The most obvious source of turbidity is algae from upstream lakes. Three of the four immediately upstream lakes are impaired for excessive nutrients and high algae. They include Linwood, Martin, and Typo Lakes. The river sampling site is just 3 miles downstream from Martin Lake. The intervening area between the lake and sampling site is a wide floodplain fringe and forests with little human impacts that would be expected to add sediment to the river. Therefore, efforts to reduce suspended material in the river should focus on the upstream lakes. It is also worth noting that this section of the river has unconsolidated bottom material which can move around and contribute to turbidity.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 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 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



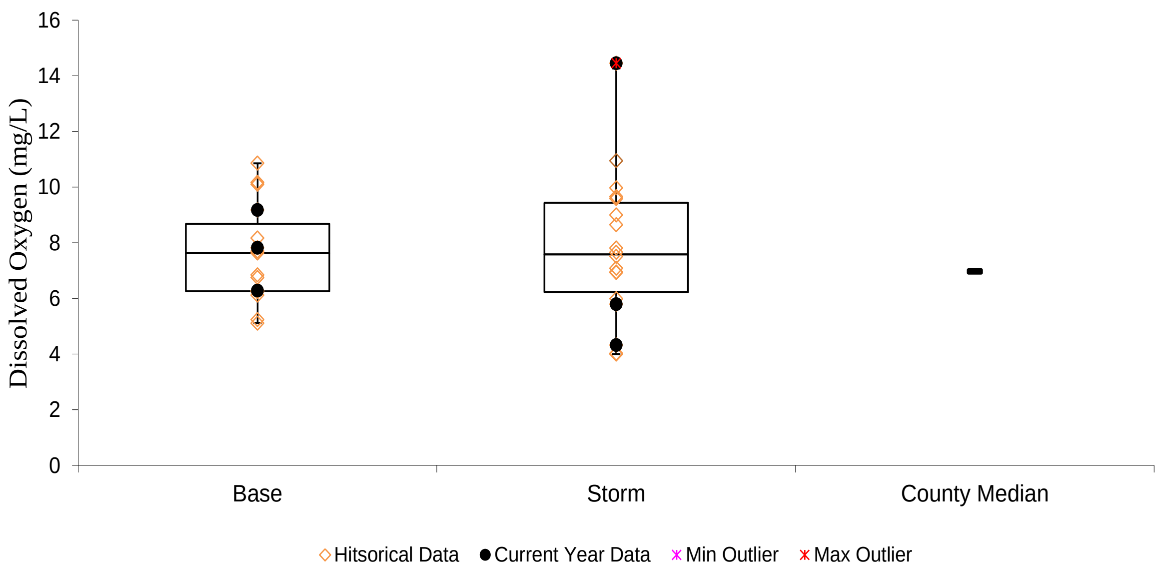
Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below 5 mg/L aquatic life begins to suffer, therefore the state water quality standard is a daily minimum of 5 mg/L. The stream is 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 productions by photosynthesis.

For the West Branch of the Sunrise River there are two datasets to consider. First, spot measurements were taken with the other water quality monitoring described in this report. Dissolved oxygen has been found at less than 5 mg/L on three different occasions. All were during storm events, occurring in 2003, 2012 and 2015. Secondly, MPCA took around-the-clock DO measurements for eight days in 2012. They found DO dipped below 5 mg/L every morning.

The river has been designated as impaired for poor fish and invertebrate communities. Low dissolved oxygen could definitely contribute to or cause this impairment. The Sunrise River TMDL study should provide further diagnosis of the low DO and corrective measures.

Dissolved oxygen results during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

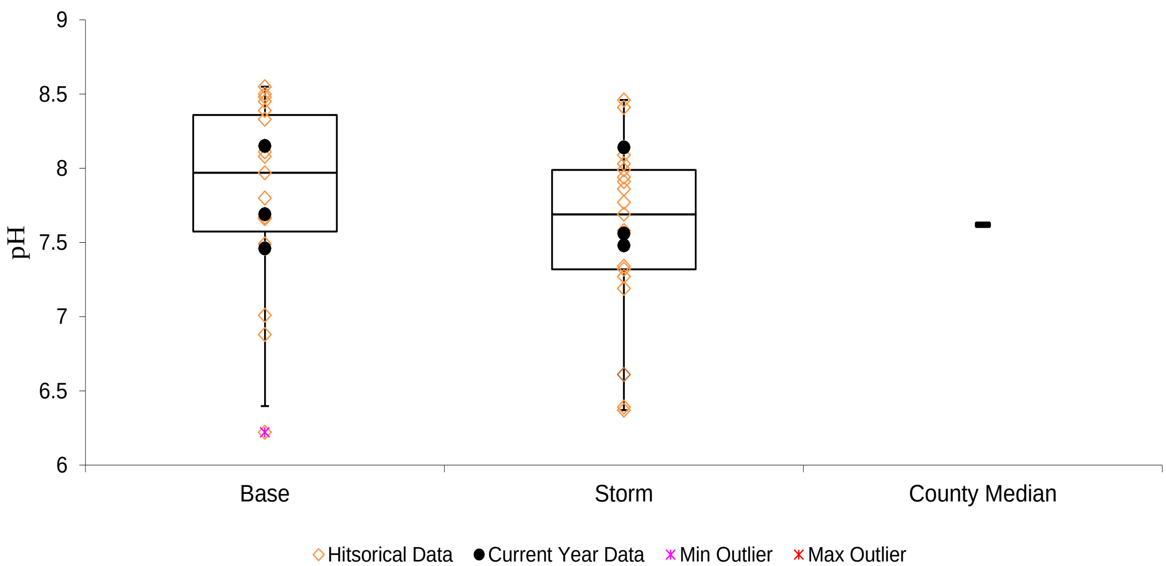


pH

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 West Branch of the Sunrise River is regularly within this range (see figure below). It often has slightly higher pH than other streams because of the impact of algal production in upstream lakes.

It is interesting to note that 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, it's effect on this aquatic system is small.

pH results during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Recommendations

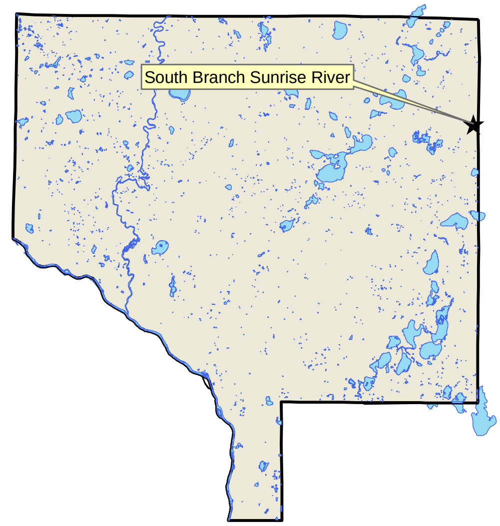
A Total Maximum Daily Load (TMDL) study was completed in 2013 to determine address impairments of this river. The study confirmed turbidity and aquatic life impairments. At this time, it appears that many of the issues in the river are best addressed by water quality improvement projects targeted at upstream lakes, however low dissolved oxygen may be an in-river problem.

Stream Water Quality Monitoring

SOUTH BRANCH SUNRISE RIVER

at Hornsby Street, Linwood Township

STORET SiteID = S005-640



Years Monitored
2012, 2015

Background

This monitoring site is the bottom of this watershed in Anoka County, at the closest accessible point to the Anoka-Chisago County boundary. Upstream, this river drains from Coon Lake and through the Carlos Avery Wildlife Management Area. The Sunrise River Watershed Management Organization monitors this site because it is at the bottom of their jurisdictional area.

2012 was the first year of water quality monitoring at this site. Other monitoring downstream has occurred. Hydrology (stage) monitoring has been done since 2009. No rating curve has been established.

The MN Pollution Control Agency has designated this site as "impaired" due to low dissolved oxygen. A TMDL study was completed in 2013.

Methods

Water Quality was monitored during 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. 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. Water level is monitored continuously in the open water season. A rating curve has not been developed to calculate flows from those water level records.

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Results and Discussion

Summary

Water quality in the South Branch of the Sunrise River has several problems which appear linked. The river has already been designated as "impaired" by the MN Pollution Control Agency for low dissolved oxygen. Our monitoring also found high turbidity and phosphorus during baseflow and periods with low oxygen.

The issues of low oxygen, turbidity, and phosphorus appear to be related. Addressing them in concert may be helpful. The water has a notable reddish color during baseflow, when dissolved oxygen would be expected to be lowest. This color may be due to reduction of iron in soils. Iron in its reduced form is more mobile (hence the reddish water color) and less able to hold phosphorus. High turbidity and phosphorus coincide with low oxygen and baseflow. Low oxygen is likely due to decomposition in upstream wetlands, which might be described as "natural."

On October 23, 2012, when the stream channel held only intermittent pools of water, the water was even more intensely red, turbid, and had extremely high phosphorus. This result is consistent with the theory that iron-rich native soils are an important source of turbidity and phosphorus. It does not appear that watershed practices are to blame.

Summarized water quality results include:

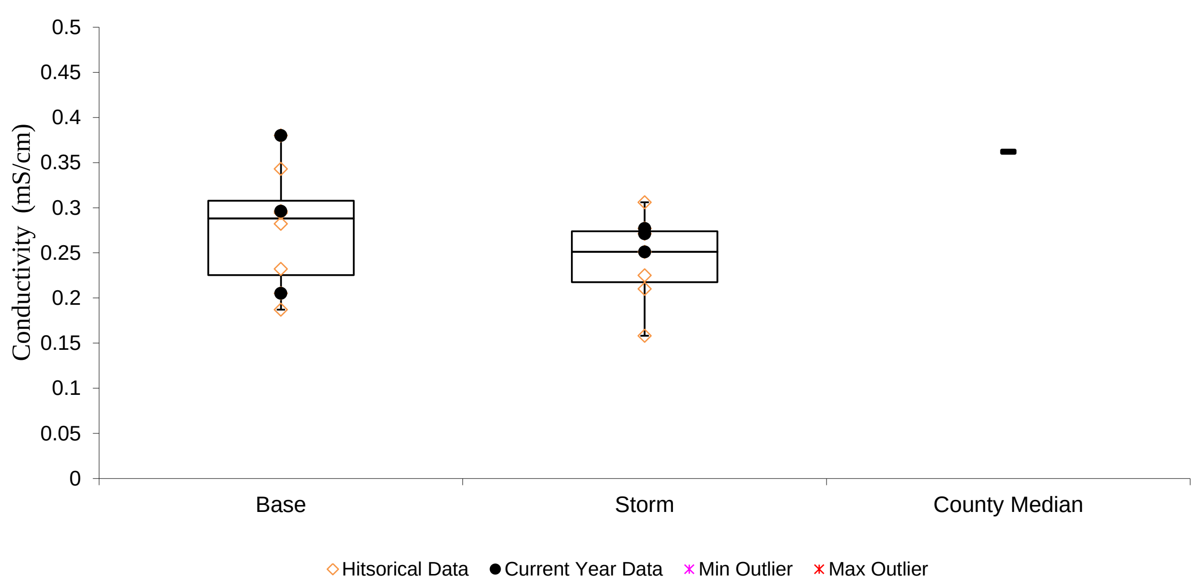
- <u>Dissolved pollutants</u>, as measured by conductivity and chlorides, are low.
- <u>Phosphorus</u> was seen at low levels and was a large decrease from 2012 results. Even so, when state water quality standards are developed for phosphorus in streams, the South Branch of the Sunrise River may exceed it.
- <u>Suspended solids and turbidity</u> were low during baseflow and higher during storm events. Twenty measurements, which we do not yet have, are required determine if it fails to meet state water quality standards. However the data to date suggest the site may fail to meet state standards. In 2015 five out of eight turbidity readings were above the state standard of 25 NTU.
- <u>pH</u> was within the range considered normal and healthy for streams in this area. Interestingly, pH was lower during baseflow than storms. This is the opposite of most streams since rain water is usually more acidic.
- <u>Dissolved oxygen</u> was alarmingly low. Five out of eight reading recorded DO levels below the state standard of 5 mg/L. This river reach is already listed by the State as "impaired" for low dissolved oxygen.

Conductivity and chlorides

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 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 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.

Conductivity is low in the South branch of the Sunrise River. Conductivity was lowest during storms, suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. Higher conductivity during baseflow suggests an impact from road deicing salts that have infiltrated to the shallow groundwater and feed the stream during baseflow.

Conductivity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



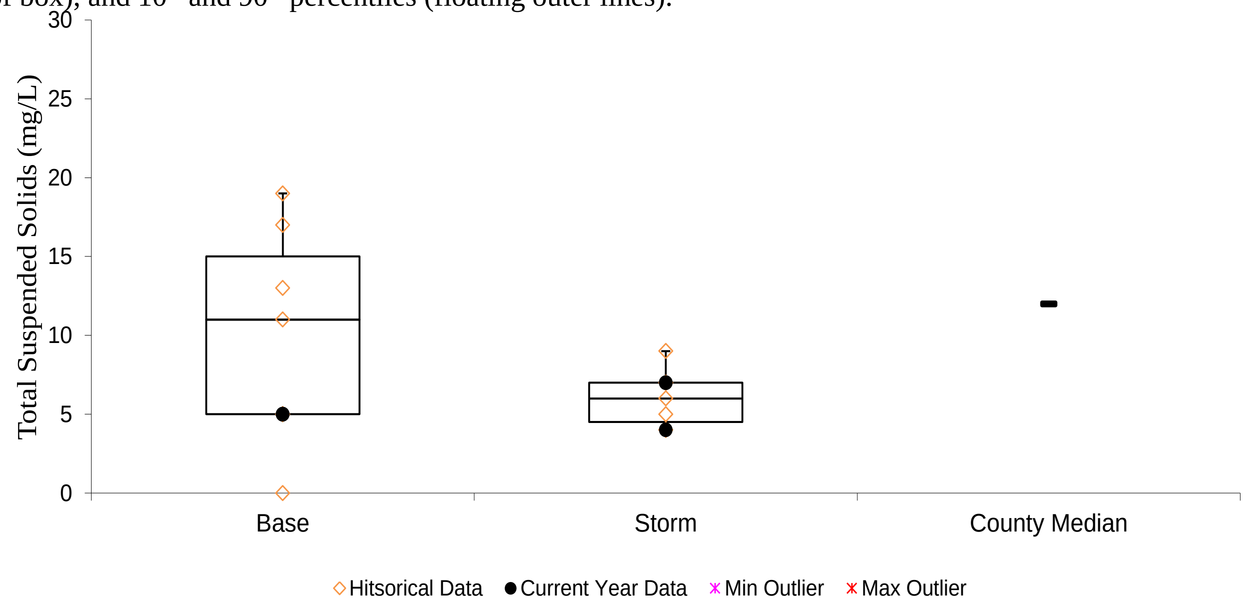
Chlorides were not monitored in 2015 but in 2012 Chlorides were low in the South Branch of the Sunrise River. The levels observed are much lower than the Minnesota Pollution Control Agency's (MPCA) chronic standard for aquatic life of 230 mg/L. This is likely because of low road densities (and therefore deicing salt use) in the watershed. Because of large expanses of public natural areas in the watershed, future increases in chlorides should be minimal.

Total Phosphorus

Total phosphorus (TP) in 2015 was lower during baseflow (average 69.75 ug/L) and higher during storms (average 110.25 ug/L). This is common of most streams, where watershed runoff contributes phosphorus. As described earlier, we've hypothesized that an important source of phosphorus and turbidity in this river is native soils and low oxygen. During baseflow conditions the water is often red, dissolved oxygen is low, and phosphorus is high. When oxygen is low, the iron in soils would become reduced. Reduced iron is more mobile (hence the red color) and less able to hold phosphorus.

A management implication of these findings is that if dissolved oxygen is kept higher, then turbidity and phosphorus should fall as well. However there will likely be challenges achieving higher oxygen. Decomposition within the vast wetlands and pools of the Carlos Avery Wildlife Management Area upstream is likely the cause of low oxygen.

Total phosphorus during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 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.

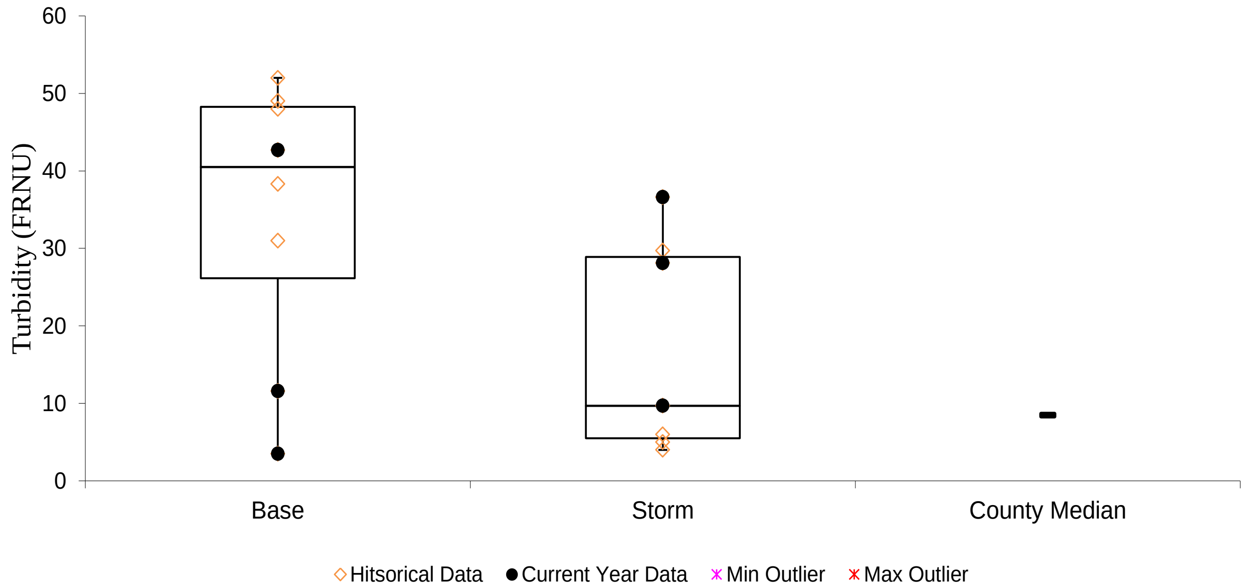
Turbidity and TSS were lower during baseflow, and higher during storms. This was the opposite when last monitored in 2012. During baseflow, average turbidity was 24.02 FNRU, while it was 26.02 FNRU during storms. Average TSS during baseflow was 5 mg/L, and 6.75 mg/L during storms.

The South Branch of the Sunrise River would likely be designated as "impaired" for turbidity if more data existed. The state water quality standard is based on turbidity; TSS can be used as a surrogate if turbidity is not available. The threshold for impairment is at turbidity of 25 FNRU. If 10% and at least 3 of all measurements exceed this value, the river is impaired. At least 20 measurements are required, but only 15 have been taken at this site.

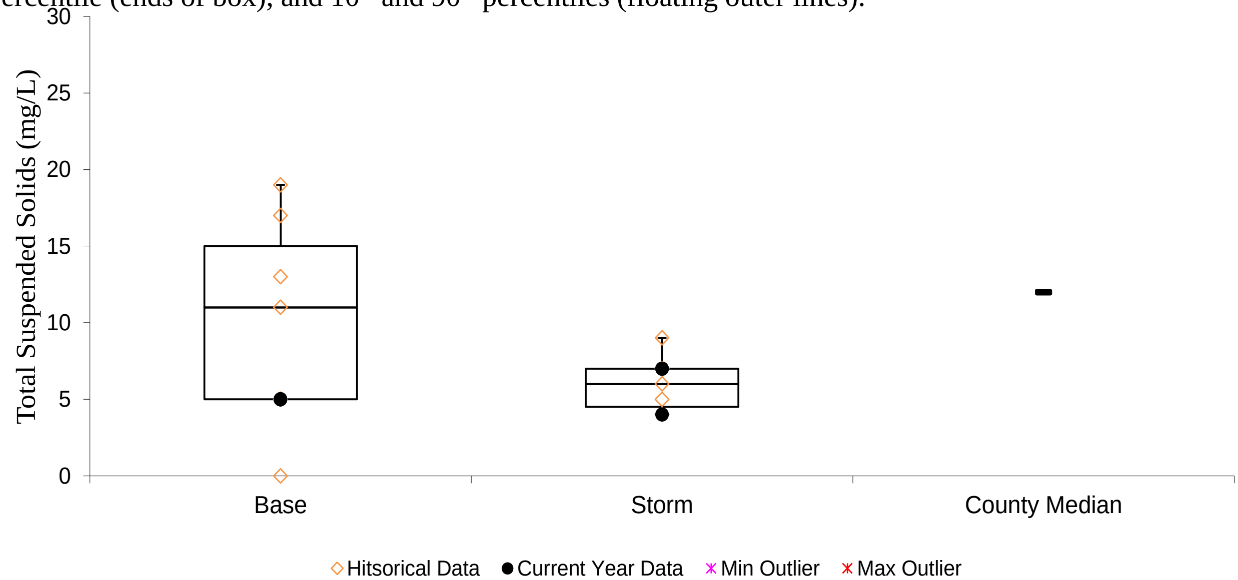
The cause of high turbidity, like high phosphorus, is likely iron-rich native soils in low oxygen conditions. Reduced iron is more mobile. The river is frequently a reddish color during baseflow and low oxygen conditions.

Another cause of turbidity may be the nature of the peat soils through which the river flows. Peat-soils when dried can be susceptible to crumbling easily. Their snow-flake like particles stay suspended in the water column.

Turbidity during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2015 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 2015 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 (DO)

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen 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. The stream is 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 productions by photosynthesis.

The South Branch of the Sunrise River is already designated as "impaired" for low dissolved oxygen. In 2015 only 3 out of eight readings were not below the state standard. The lowest measurements were 1.25 and 2.88 mg/L were found. Another measurement of 3.26 mg/L is concerningly low. We speculate that decomposition in the vast wetlands and pools of the Carlos Avery Wildlife Management Area upstream consumes oxygen and is likely the cause of low oxygen downstream.

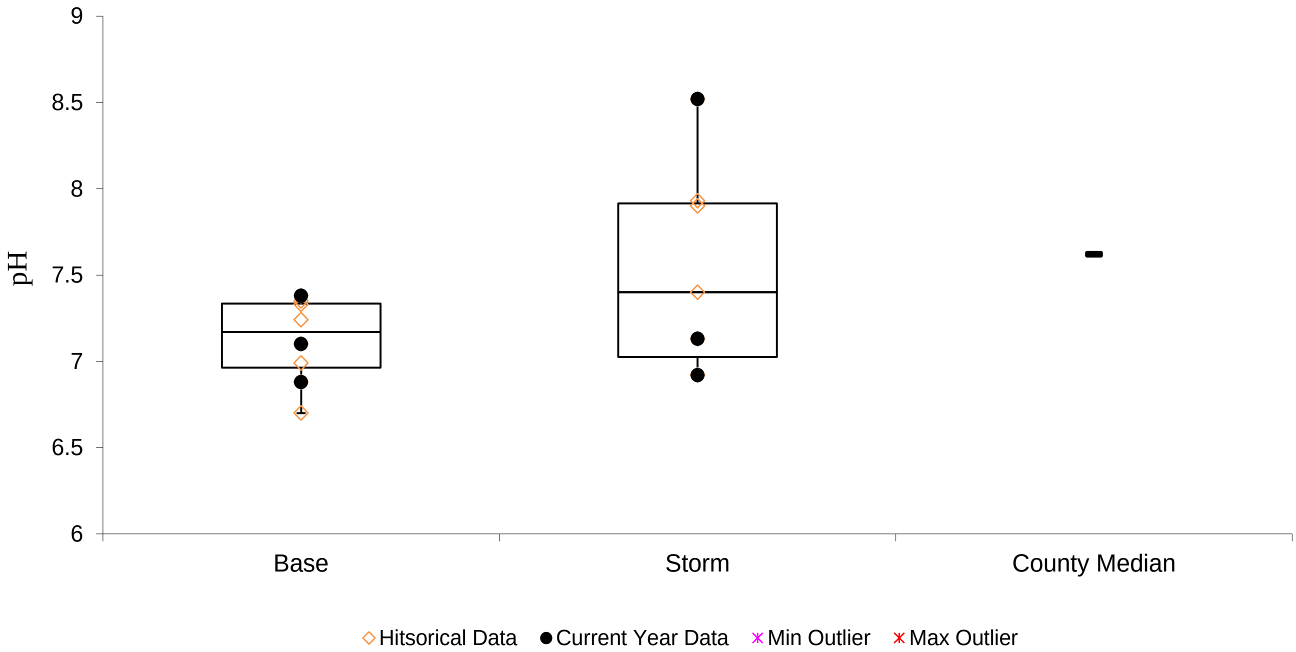
Dissolved oxygen results during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

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.

pH in the South Branch of the Sunrise River is within the acceptable range, however the results between storm and baseflow are the opposite of most streams. In most streams, pH lowers during storms due to the acidity of rainfall. At this river pH was higher during storms. The reason is not known.

pH results during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2015 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) study was completed in 2013 to determine the impairments of this river. While presently this river's impairment is dissolved oxygen, we suggest that a focus should also be around improving turbidity and total phosphorus. These are high as well, and are most likely linked to the low oxygen problem.

Stream Hydrology

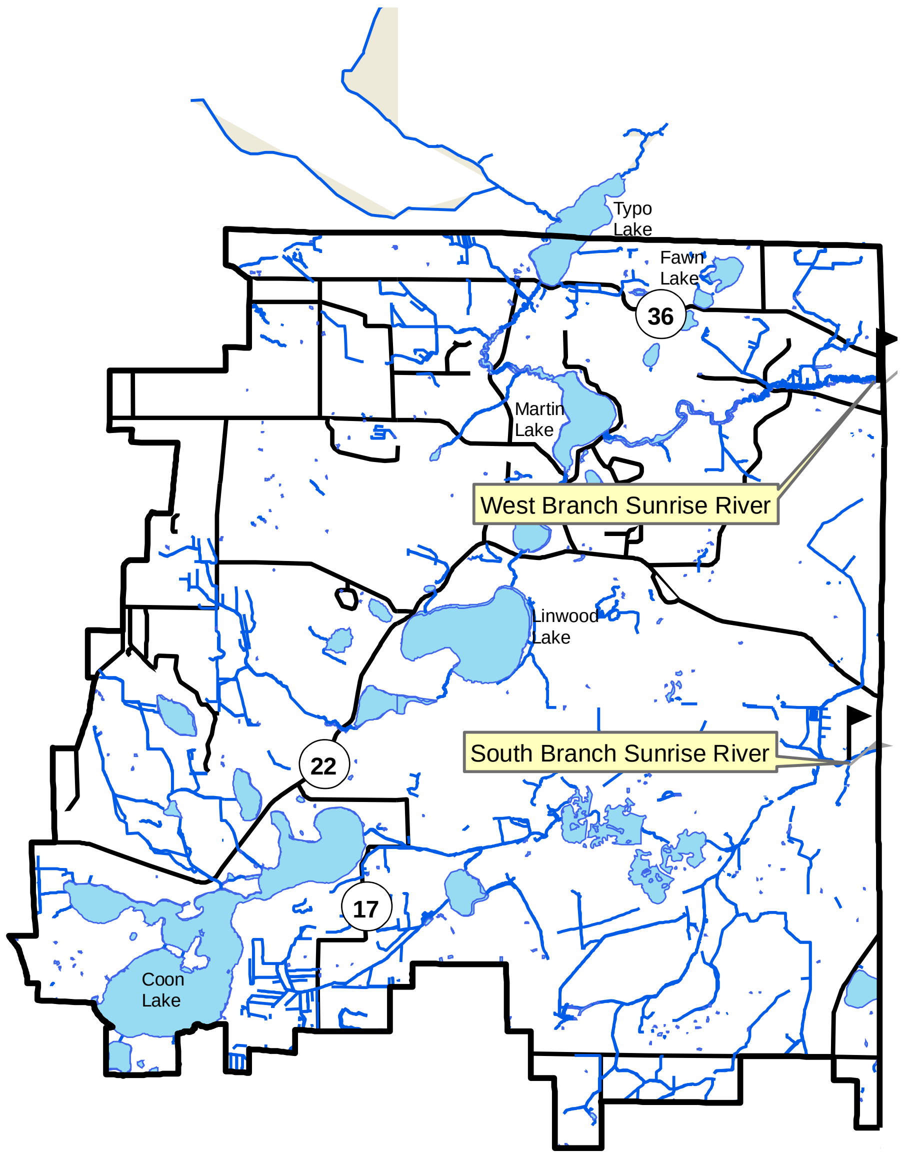
Description: Continuous water level monitoring in streams.

Purpose: To provide understanding of stream hydrology, including the impact of climate, land use or discharge changes. These data are also needed for calculation of pollutant loads and use of computer models for developing management strategies. In the Sunrise River Watershed, the monitoring sites are the outlets of the Sunrise River Watershed Management Organization's jurisdictional area, thereby allowing estimation of flows and pollutant loads leaving the jurisdiction.

Locations: South Branch Sunrise River at Hornsby St NE

West Branch Sunrise River at Co Rd 77

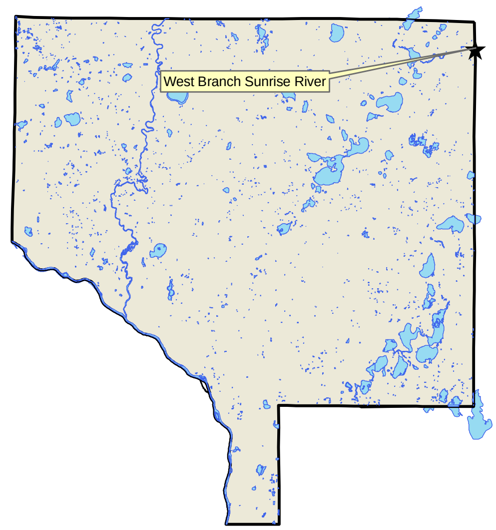
Sunrise Watershed Stream Hydrology Monitoring Sites



Stream Hydrology Monitoring

WEST BRANCH OF SUNRISE RIVER

At Co Rd 77, Linwood Township



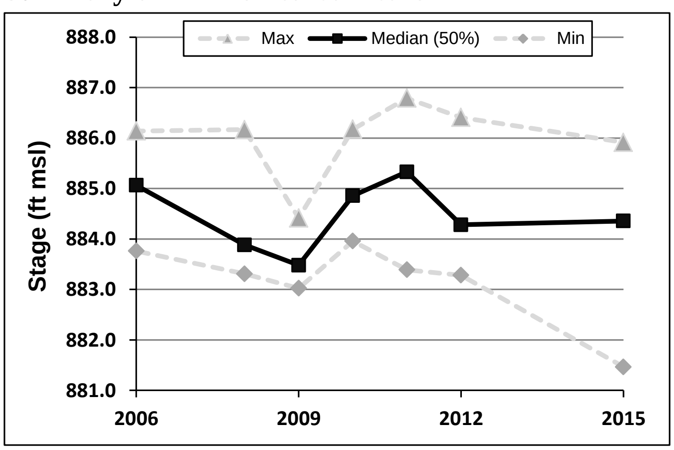
Notes

This monitoring site is the bottom of this watershed in Anoka County, at the Chisago County border. Upstream, this river drains through Linwood, Island, Martin, and Typo Lakes. The Sunrise River Watershed Management Organization monitors this site because it is at the bottom of their jurisdictional area. They have done water quality monitoring at this site and created a rating curve to estimate flow volumes from the water level measurements. In 2008 and 2009 this site was also monitored to collect data for a computer model of the entire Sunrise River watershed being done by the US Army Corps of Engineers, Chisago County, and other partners.

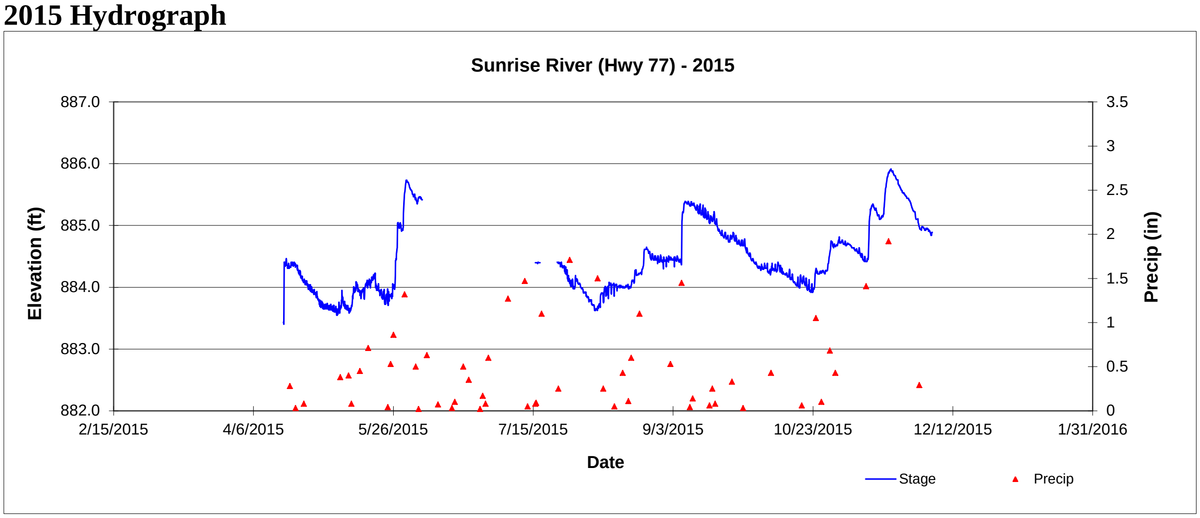
The rating curve to calculate flows (cfs) from stage data is:
Discharge (cfs) = $5.2509(\text{stage}-882.5)^2 + 10.88(\text{stage}-883.5) + 2.699$
$R^2=0.87$

This rating curve was first prepared in 2002. Five additional flow-stage measurements were taken in 2008-09 to keep the equation updated.

Summary of All Monitored Years



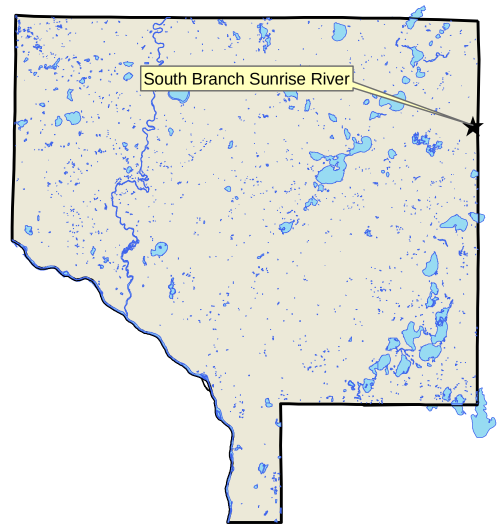
2015 Hydrograph



South Branch of Sunrise River

At Hornsby St, Linwood Township

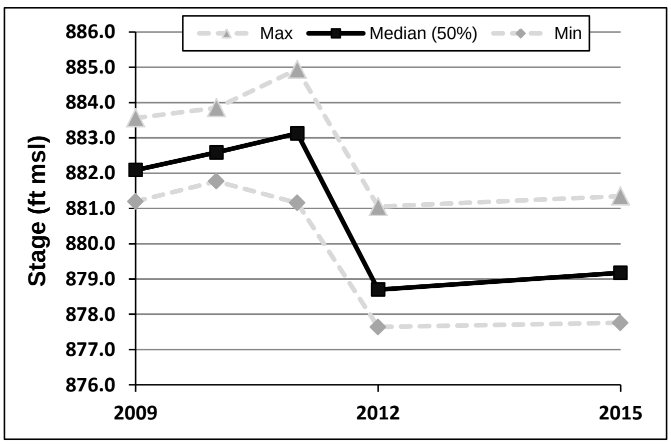
Notes



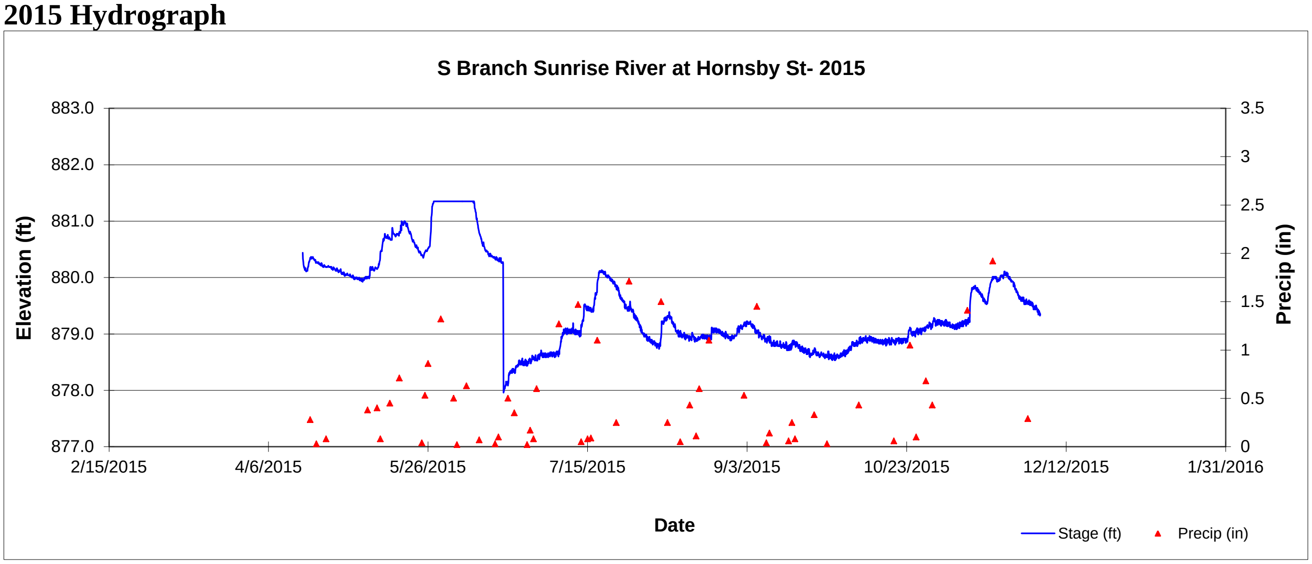
This monitoring site is the bottom of this watershed in Anoka County, at the closest accessible point to the Anoka-Chisago County boundary. Upstream, this river drains from Coon Lake and through the Carlos Avery Wildlife Management Area. The Sunrise River Watershed Management Organization monitors this site because it is at the bottom of their jurisdictional area. This site was first monitored in 2009 to collect data for a computer model of the entire Sunrise River watershed being done by the US Army Corps of Engineers, Chisago County, and other partners. Water quality monitoring has not yet occurred at this site, nor has a rating curve been created to estimate flow volumes from the water level measurements.

No rating curve exists for this site.

Summary of All Monitored Years



2015 Hydrograph



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.

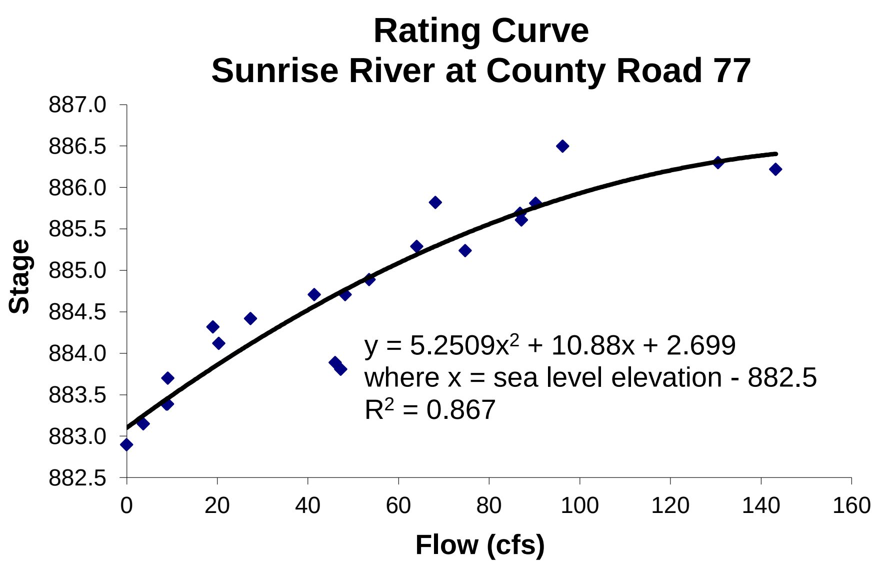
Locations: West Branch Sunrise River at County Road 77

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

South Inlet of Martin Lake at West Martin Lake Drive

Data Creek at Typo Creek Drive

Results: Rating curves were developed for the sites 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, to a depth of 40 inches. County-wide, the ACD maintains a network of 19 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.

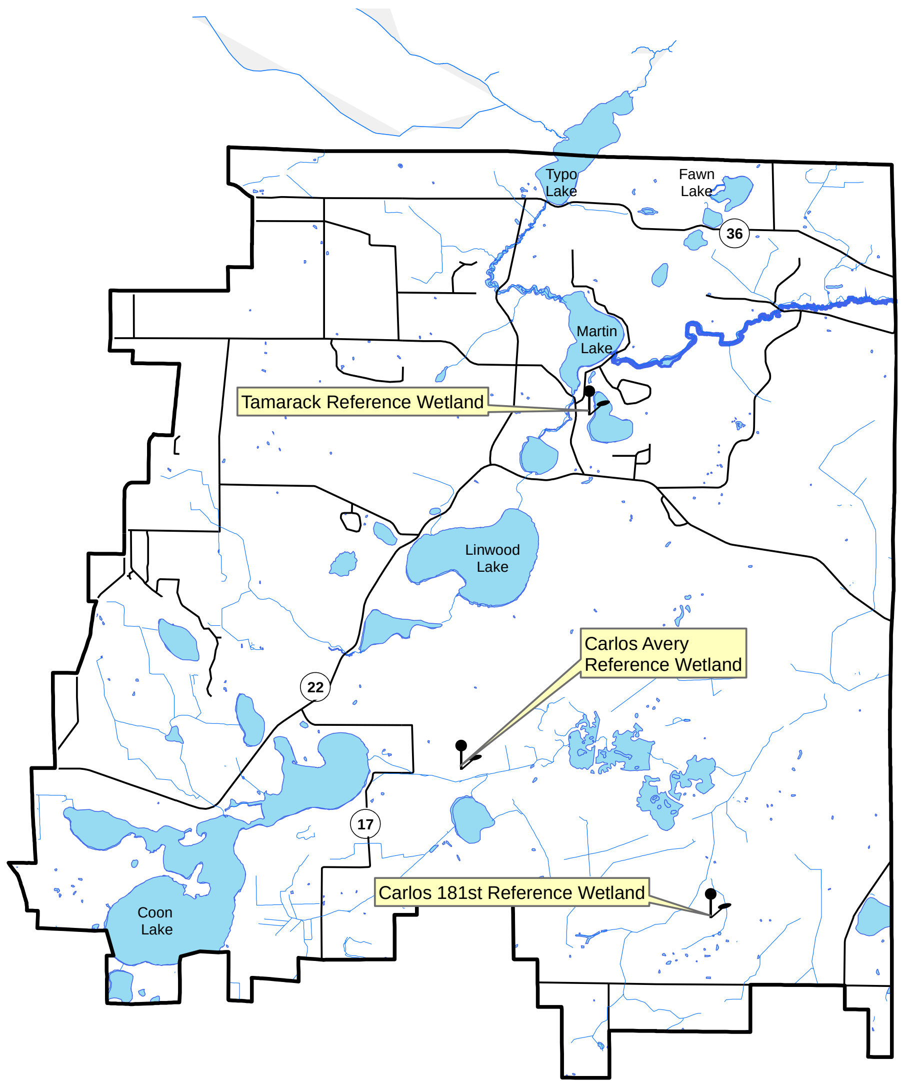
Locations: Carlos Avery Reference Wetland, Carlos Avery Wildlife Management Area, City of Columbus

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

Tamarack Reference Wetland, Linwood Township

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

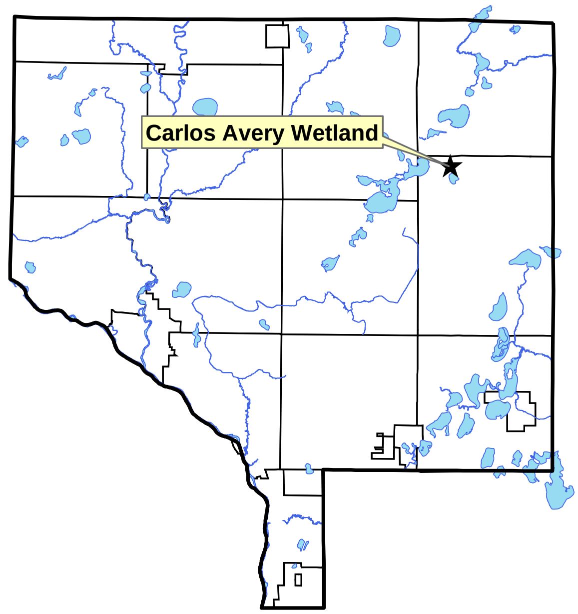
Sunrise Watershed Wetland Hydrology Monitoring Sites



Wetland Hydrology Monitoring

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

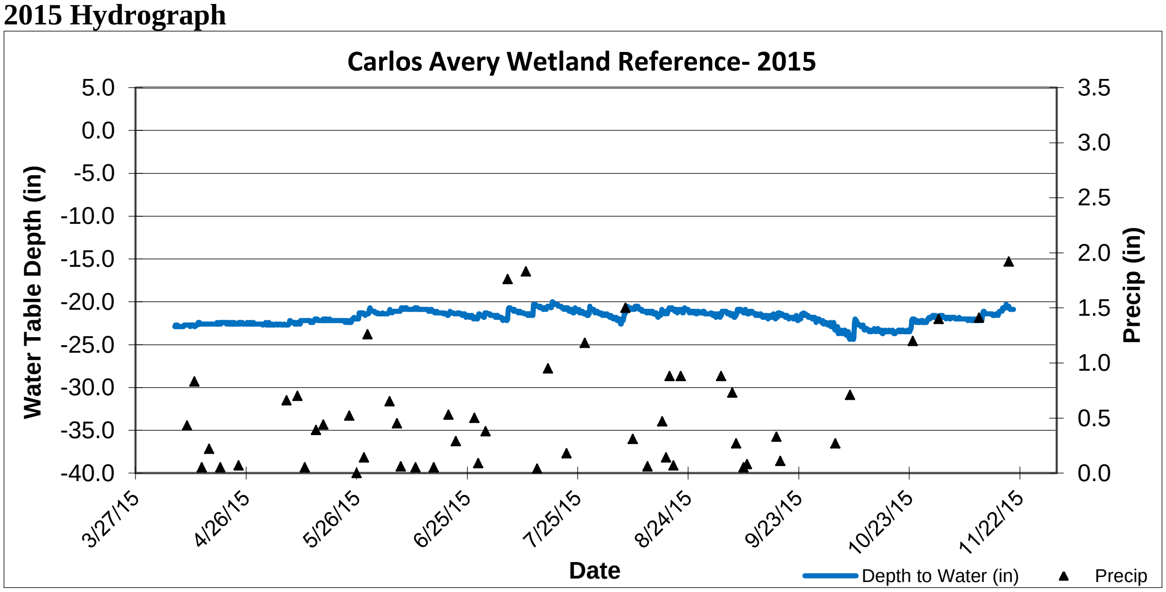
Surrounding Soils: Lino loamy fine sand

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.

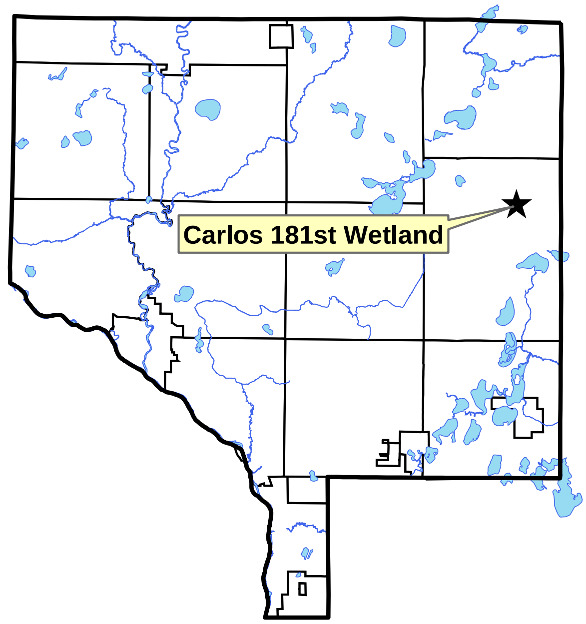
2015 Hydrograph



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

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	-

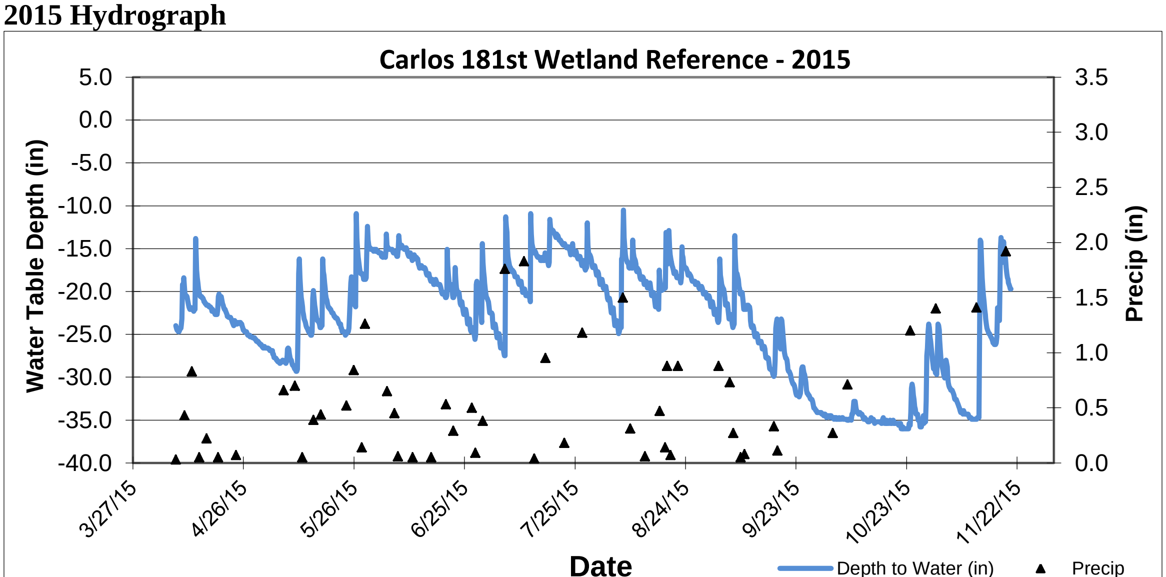
Surrounding Soils: Soderville fine sand

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.

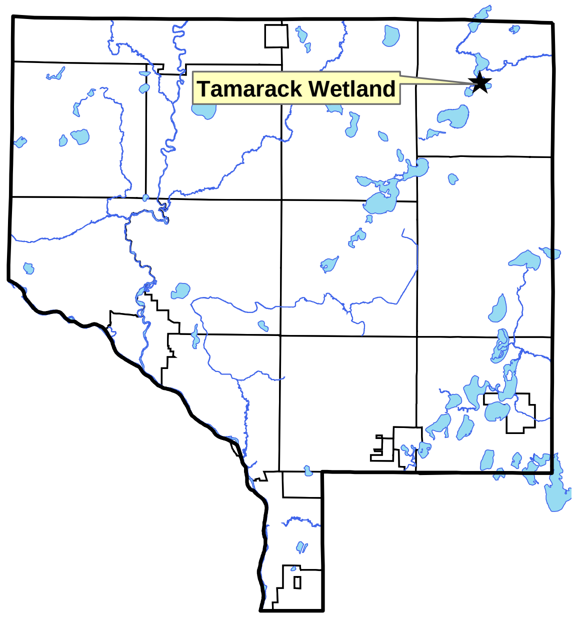
2015 Hydrograph



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

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	-

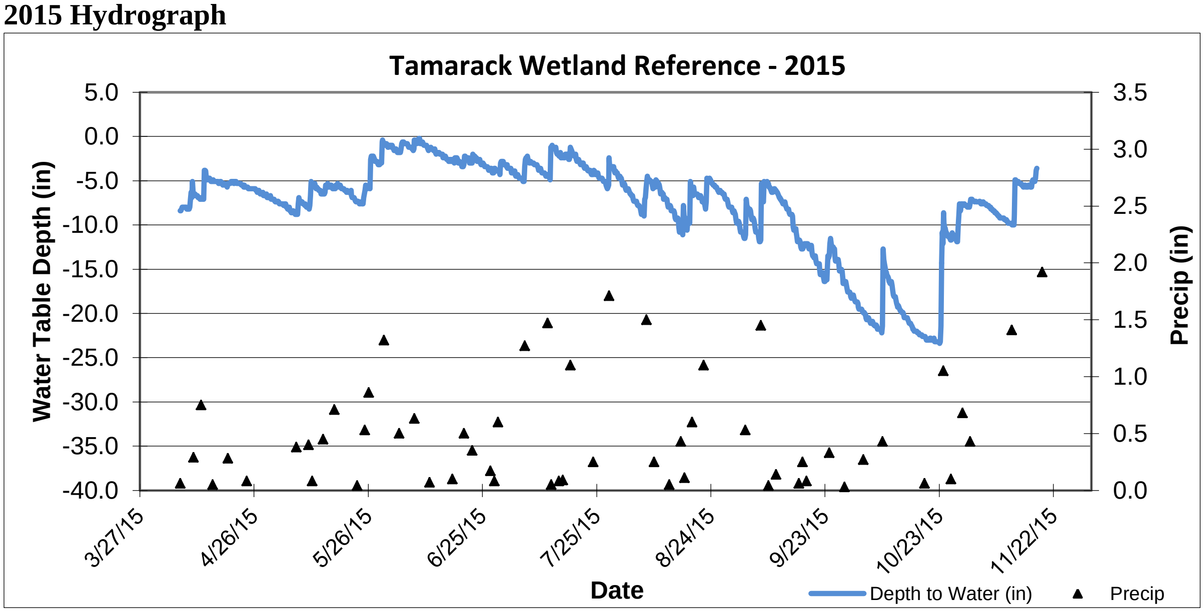
Surrounding Soils: Sartell fine sand

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.

2015 Hydrograph



Well depth was 35 inches, so a reading of –35 indicates water levels were at an unknown depth greater than or equal to 35 inches.

Water Quality Grant Fund

Description: The Sunrise River Watershed Management Organization (SRWMO) offers cost share grants 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. No projects were installed in 2015.

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
Fund Balance		**$7,848.74**

Coon Lake Area Stormwater Retrofits

Description: 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**.** These projects, and two lakeshore restorations planned for 2016, were identified in a 2014 stormwater retrofit analysis study. The projects were funded by a State Clean Water Legacy Grant and local partners.

Purpose: To improve Coon Lake water quality.

Results: Installed two rain gardens and stabilized one stormwater conveyance.

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

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.

Carp Barriers Installation

Description: This project will 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. Even more, 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 2015 three additional barriers were installed at the following locations: Typo Lake outlet, Martin Lakes' north inlet, and Martin Lake outlet. Construction will conclude in early 2016.

Martin Lake south inlet (completed 2014)

Typo Lake outlet (completion in early 2016)

Martin Lake outlet (completion in early 2016)

Martin Lake north inlet (completion in early 2016)

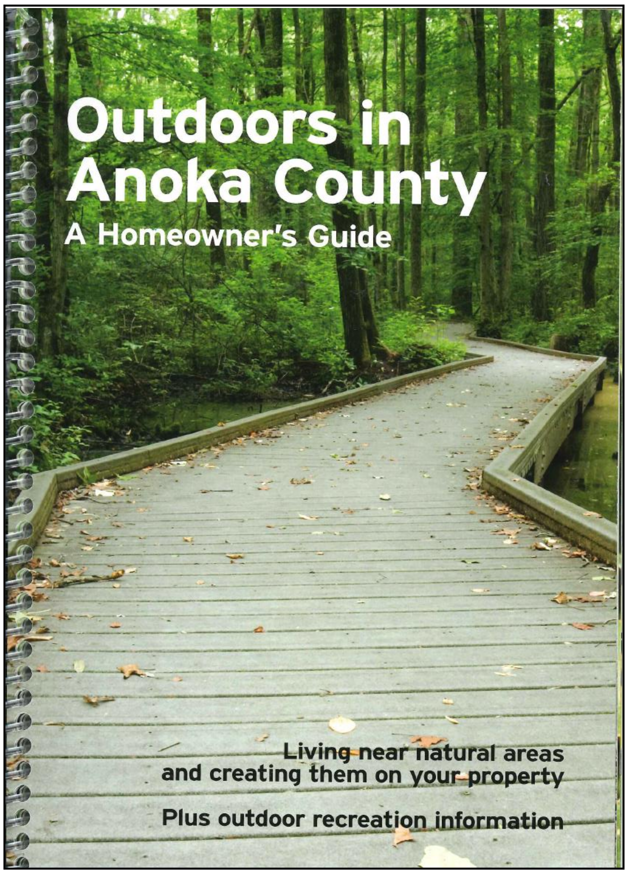
Lakeshore Landscaping Education

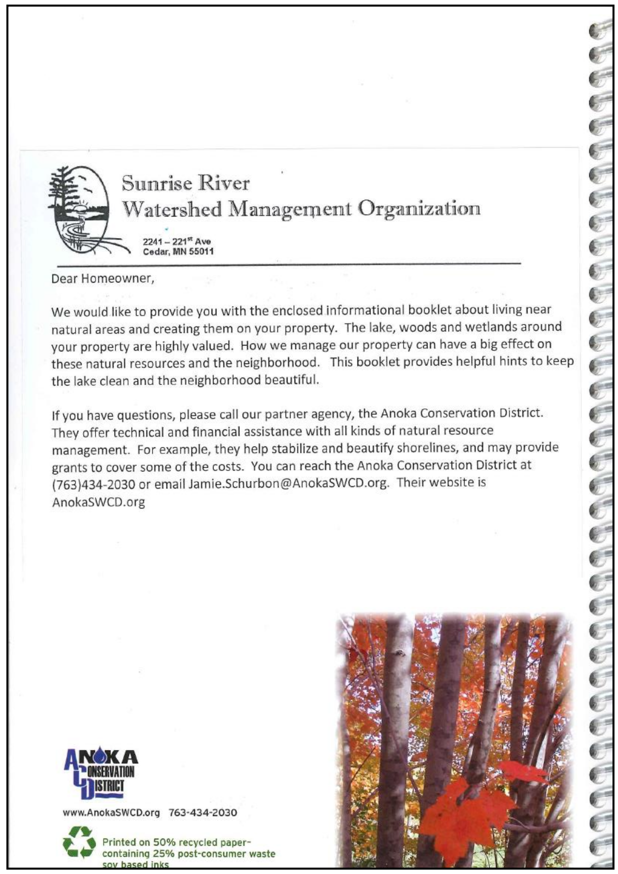
Description: One goal of the Sunrise River WMO is to encourage and facilitate lakeshore restorations with native plants. These projects, usually accomplished by homeowners with assistance from agencies like the SRWMO, are beneficial to overall lake health. By planting native plants at the shoreline runoff into the lake is filtered, and fish and wildlife habitat is substantially improved. To move toward its goal, the SRWMO does regular education and marketing of lakeshore restorations to homeowners.

Purpose: To improve lake water quality and lake health.

Results: In 2015 an informational booklet entitled “Outdoors in Anoka County: A homeowners guide to natural spaces and creating them in your backyard” was distributed to lakeshore homeowners on; Coon, Martin, Typo, Linwood and Fawn Lake. A total of 670 booklets were distributed.

The Anoka Conservation District donated the booklets. A cover letter acknowledging the SRWMO and ACD was provided with each distributed booklet.





Sunrise River Watershed Management Organization
2241 – 221st Ave
Cedar, MN 55011

Dear Homeowner,

We would like to provide you with the enclosed informational booklet about living near natural areas and creating them on your property. The lake, woods and wetlands around your property are highly valued. How we manage our property can have a big effect on these natural resources and the neighborhood. This booklet provides helpful hints to keep the lake clean and the neighborhood beautiful.

If you have questions, please call our partner agency, the Anoka Conservation District. They offer technical and financial assistance with all kinds of natural resource management. For example, they help stabilize and beautify shorelines, and may provide grants to cover some of the costs. You can reach the Anoka Conservation District at (763)434-2030 or email Jamie.Schurbon@AnokaSWCD.org. Their website is AnokaSWCD.org

Anoka Conservation District
www.AnokaSWCD.org 763-434-2030
Printed on 50% recycled paper- containing 25% post-consumer waste soy based inks

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 2015 the SRWMO contracted with the ACD to write the annual newsletter and provide it to member communities for distribution in their newsletters. Topics for annual newsletter were discussed by the SRWMO Board; the Coon Lake Stormwater Retrofits Project was chosen.

SRWMO 2015 Newsletter Article: Coon Lake Projects Installed to Improve Water Quality

Four projects were recently installed to improve water quality in Coon Lake, and two more are scheduled for spring. Two rain gardens, one roadside stabilization and one lakeshore restoration were built this summer. Two more lakeshore stabilizations will be completed in spring 2016. The projects are on lakeshore properties or roads.

All the projects stop erosion or reduce nutrient runoff into the lake. Each rain garden captures road runoff that otherwise would go directly into the lake. The roadside stabilization project at Lincoln Drive corrects an area that regularly washed out into the lake. The lakeshore restorations fix ongoing shoreline erosion and include native plant buffers to filter runoff.

Keeping these pollutants out of the lake will lead to less algae. “Coon Lake is not on the State’s list of impaired waters, but it isn’t that far from it either,” says Jamie Schurbon, Water Resource Specialist at the Anoka Conservation District (ACD). “It is a priority to keep it in good condition.”

In 2014 the ACD identified and ranked projects around the lake that would improve water quality. From that list the most cost effective projects were selected. Landowners were asked to voluntarily work with the conservation district. At the same time, the Sunrise River Watershed Management Organization (WMO) and ACD applied for a State Clean Water Fund grant, which was secured for $74,000.

Major local funding to match the grant came from the Sunrise River Watershed Management Organization, which also helped initiate and guide the projects. Other sources of grant matching dollars included the Coon Lake Improvement District, Coon Lake Improvement Association and Coon Lake Beach Community Center. The Anoka Conservation District is overseeing the projects.

The Sunrise River WMO is a joint powers local unit of government through which East Bethel, Columbus, Ham Lake and Linwood collaborate. For more information about the Sunrise River Watershed Management Organization visit www.SRWMO.org or call Jamie Schurbon at 763-434-2030 ext. 12.

Photos were printed with the article, and are depicted on earlier pages of this report.

SRWMO Website

Description: The Sunrise River Watershed Management Organization (SRWMO) contracted 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.

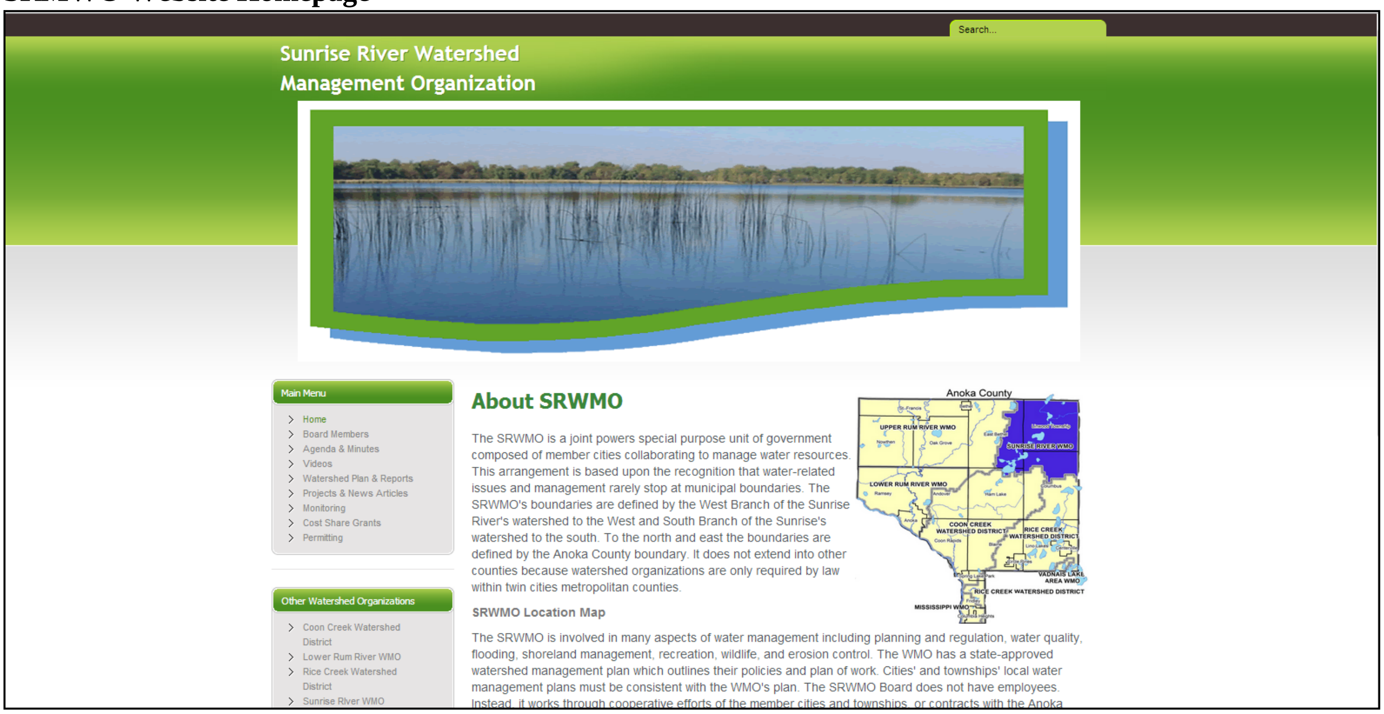
Location: www.SRWMO.org

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

Regular website updates also occurred throughout the year. 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: In 2015 a State Clean Water Legacy Fund grant application was prepared and the grant was awarded. The $73,824 grant will fund a water quality project feasibility study for Ditch 20. Ditch 20 flows into Typo Lake, Martin Lake and the West Branch of the Sunrise River. It has been identified as a high priority area for nutrient reductions to benefit all these waterbodies. The feasibility study will be completed by 2017.

Grant Application Title: **Ditch 20 Wetland Restoration Feasibility Study to Benefit Downstream Water Quality**

Abstract

This feasibility study will produce strategies for wetland restoration and ditch hydrology changes that improve water quality in Typo and Martin Lakes, the Sunrise River and St. Croix River. Our focus is County Ditch 20 (aka Data Cr), which drains >500 acres of wetland. 1849 land surveys show the area as "tamarack swamp." But by 1938 there were no trees, active haying and a network of ditches. Downstream waterbodies were declining. Recently, TMDL studies have found that these ditched wetlands export large amounts of phosphorus and solids.

This project is unique because it targets a pollutant source that is often overlooked but common – ditched wetlands. The Ditch 20 subwatershed has seemingly benign land uses. Yet during storms its phosphorus concentrations were 70% higher than that of neighboring Ditch 13 which is mostly agricultural. As a result, the local watershed plan and TMDLs noted this as a key area for pollutant reduction.

Mechanisms of phosphorus export from ditch 20 were studied over 6 years. Multiple mechanisms are at work, including aerobic decomposition of peat soils, periodic re-wetting, effective drainage of soil water and bank sloughing. These mechanisms can be managed through lateral ditch blocks, water level manipulation, settling basins or other measures.

A feasibility study is needed before construction. We'll use surveying, terrain analysis and hydrologic/hydraulic modeling to evaluate the scope and effects of potential projects. We'll involve landowners early. We'll evaluate the cost/benefit ratio of each project by consolidating primary literature knowledge and applying it, because pollutant models or calculators are not available for this type of project. Finally, we'll prepare designs.

We anticipate designed projects can be installed within 1-3 years after study completion. The watershed management organization plans to budget sufficient funds to match installation grants.

SRWMO 2015 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 a 2015 Sunrise River WMO Annual Report. ACD drafted the report and a cover letter. After SRWMO Board review the final draft was forwarded to BWSR in spring of 2015. 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


2014 Annual Report

Sunrise River Watershed Management Organization

East Bethel – Ham Lake – Linwood - Columbus

April 13, 2015

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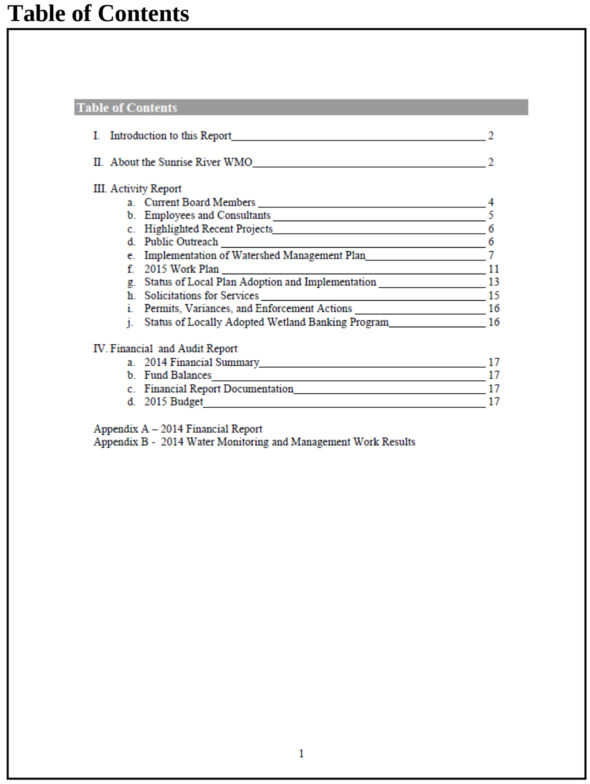
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1

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 2015 a total of 31.5 hours of administrative assistance have occurred as of December 31.

The following tasks were accomplished:

- Reviewed proposed WMO boundary changes with the Rice Creek and Coon Creek Watershed Districts, corresponded with those entities and advised the SRWMO Board.
- Provided the SRWMO Board with information about changes to the Blue Thumb consortium, and advised them against continued membership.
- 2016 budget preparation and related questions from cities.
- Provide a draft records retention schedule for the WMO.
- Assist with preparation of materials for soliciting service bids.
- Discuss the WMO's mission with the Linwood Lake Association, and facilitate discussion with that lake group about weed treatments.
- Occasional inquiries from contractors and developers about any SRWMO permitting requirements.
- Correspond with the City of Ham Lake, per the WMO Board's direction, regarding Joint Powers Agreement changes. Calculated the financial impact of the proposed changes for each member community.
- Assisted the Secretary in handling a public data request.
- Answered Board member questions outside of meetings.
- Assist with meeting packet preparation.
- Assisted with rescheduling one WMO Board meeting.

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.

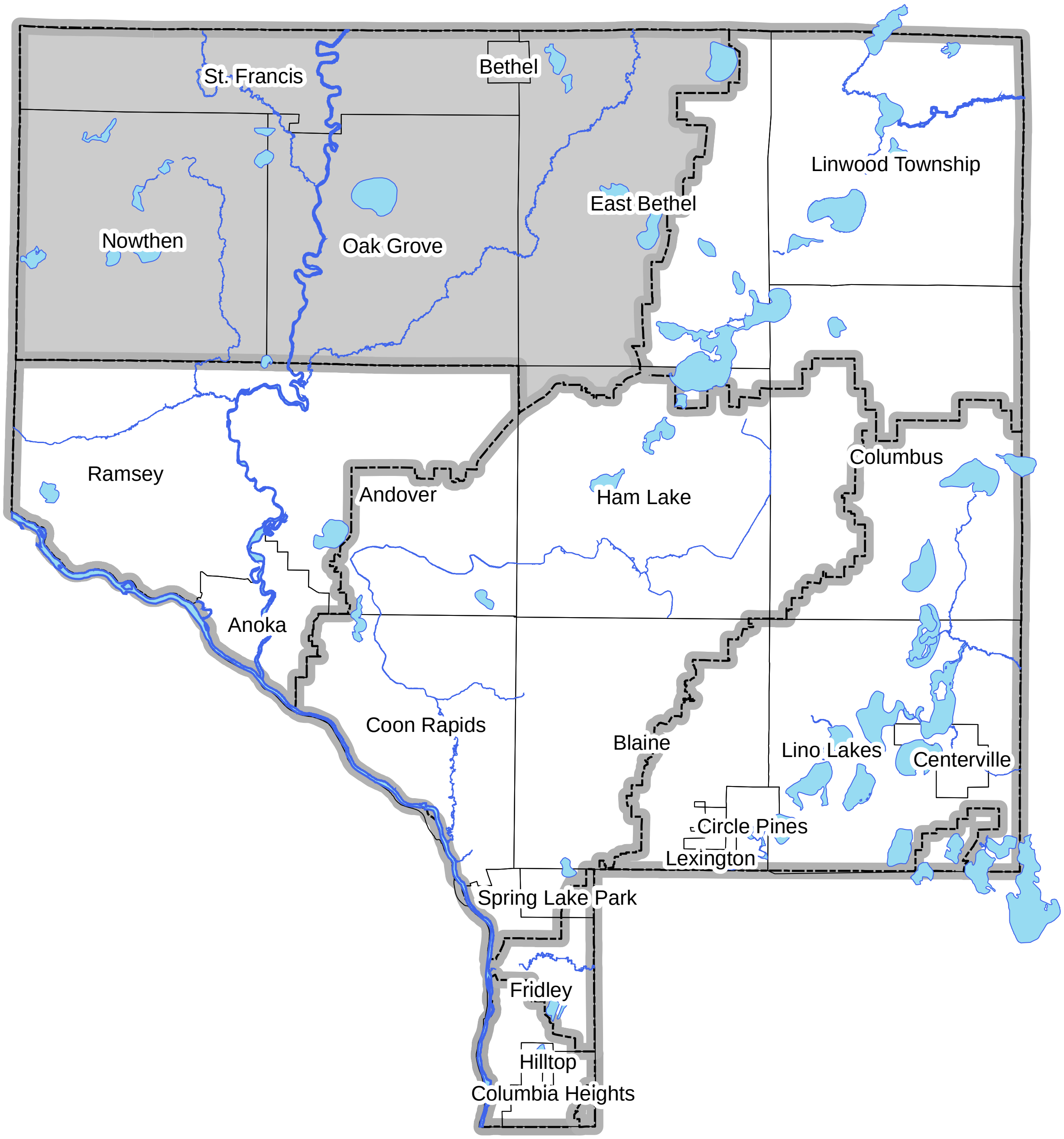
Sunrise River Watershed Financial Summary

Sunrise River Watershed	WMO Asst (no charge)	Volunteer Precip	Reference Wetlands	Ob Well	Lake Level	Lake Water Quality	Stream Level	Stream Water Quality	SRWMO Admin	SRWMO On-Call Admin	WMO Annual Rpts to State	SRWMO Outreach/Promo	WMO Website Maintenance	Martin/Typo Carp Bariers Grant Admin.	Martin/Typo Carp Bariers Project Mgmt.	Coon Lake Retrofit CWF - Admin	Coon Lake Retrofit CWF - Proj. Dev.	Coon Lake Retrofit CWF - Tech./Eng.	Fawn Lake CLP Mapping	Typo Wetlands Feasibility Study	Total
Revenues																					
SRWMO	0	0	1725	0	1250	6500	1250	2800	329	2546	1035	2310	490	0	27149	0	0	21555	675	0	69614
State	0	0	0	320	0	0	0	0	0	0	0	0	0	0	236766	0	0	35894	0	7600	285299
Anoka Conservation District	0	0	88	0	0	0	0	0	0	0	0	0	0	0	0	634	0	0	0	0	721
Anoka Co. General Services	379	0	1176	0	0	0	0	0	0	0	0	0	0	4109	0	0	2311	0	162	613	11447
County Ag Preserves/Projects	0	0	0	0	0	818	0	0	0	0	0	0	0	0	0	0	0	0	0	0	818
Regional/Local	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Service Fees	0	0	46	0	0	960	97	0	0	0	0	0	0	0	5000	0	1410	2190	0	0	9704
BWSR Cons Delivery	0	0	0	0	339	1086	583	0	0	0	0	0	0	0	3742	0	0	0	0	0	5750
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
Local Water Planning	0	664	852	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1516
TOTAL	379	664	3887	320	1589	9365	1930	2800	329	2546	1035	2310	490	4109	272657	634	3721	59639	837	8213	384869
Expenses-																					
Capital Outlay/Equip	3	6	1110	3	14	68	17	14	3	20	3	14	3	35	83	5	32	205	7	71	1760
Personnel Salaries/Benefits	333	584	2378	282	1392	6908	1691	1380	289	2017	267	1432	275	3617	8518	558	3275	20901	737	7230	68666
Overhead	21	37	152	18	89	443	108	88	19	129	17	92	18	232	546	36	210	1339	47	463	4399
Employee Training	2	4	15	2	9	44	11	9	2	13	2	9	2	23	54	4	21	133	5	46	438
Vehicle/Mileage	5	8	34	4	20	99	24	20	4	29	4	21	4	52	122	8	47	301	11	104	987
Rent	14	24	99	12	58	286	70	57	12	84	11	59	11	150	353	23	136	866	31	300	2846
Program Participants	0	0	0	0	0	0	0	0	0	0	0	0	0	0	262980	0	0	35494	0	0	298473
Program Supplies	0	0	99	0	8	1517	9	655	0	0	0	50	0	0	0	0	0	400	0	0	4926
McKay Expenses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	379	664	3887	320	1589	9365	1930	2224	329	2292	303	1676	312	4109	272657	634	3721	59639	837	8213	382495

Recommendations

- **Celebrate and promote the completion of the Martin and Typo Lakes carp barriers project**. Pursued commercial carp harvests to accelerate the benefits of the carp barriers.
- **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 3 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.
- **Support the Ditch 20 (Data Creek) water quality improvement projects feasibility study.** The grant-funded project is led by the Anoka Conservation District but in need of local matching funds. The study will be completed in 2017.

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

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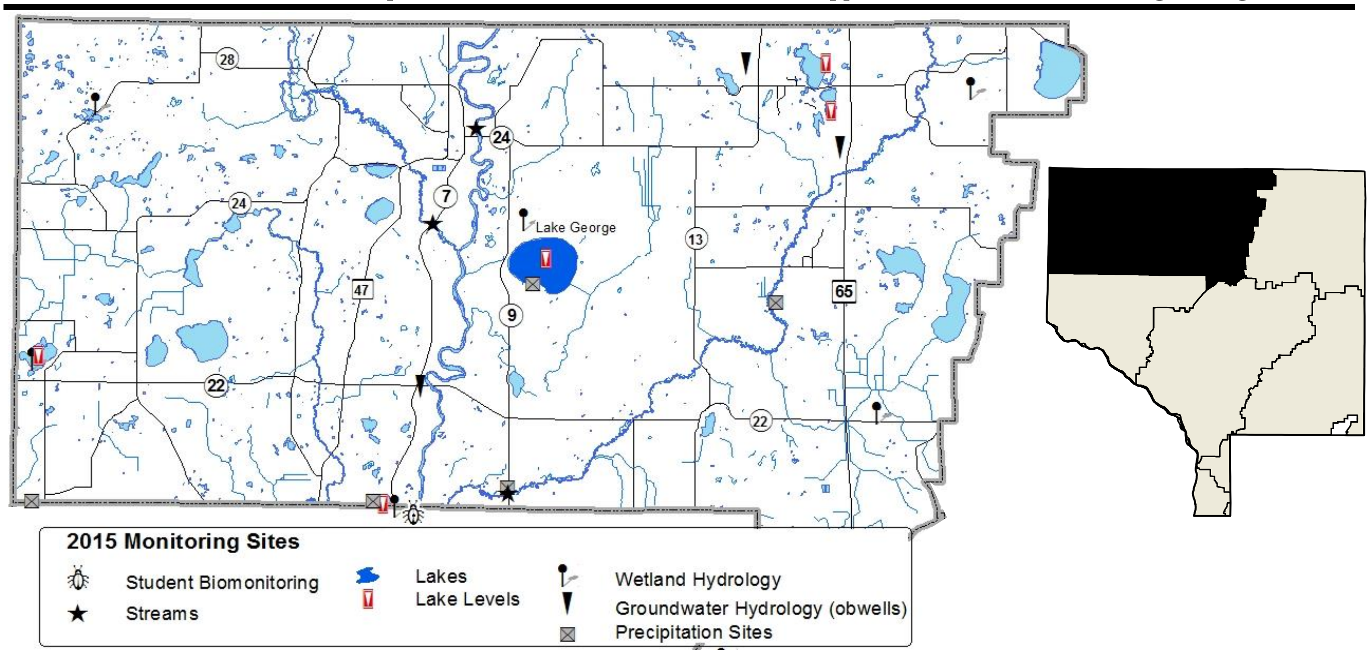
ACAP = Anoka County Ag Preserves, ACD = Anoka Conservation District,
LRRWMO = Lower Rum River Watershed Mgmt. Org, MC = Metropolitan Council
MNDNR = Minnesota Dept. of Natural Resources, URRWMO = Upper Rum River Watershed Mgmt. Org



Lake Levels

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

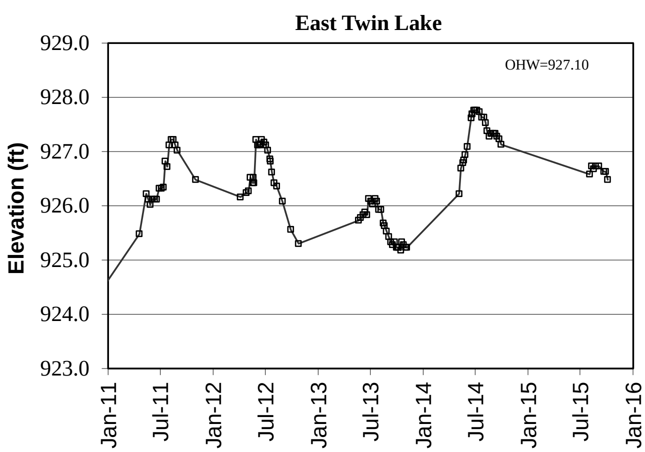
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

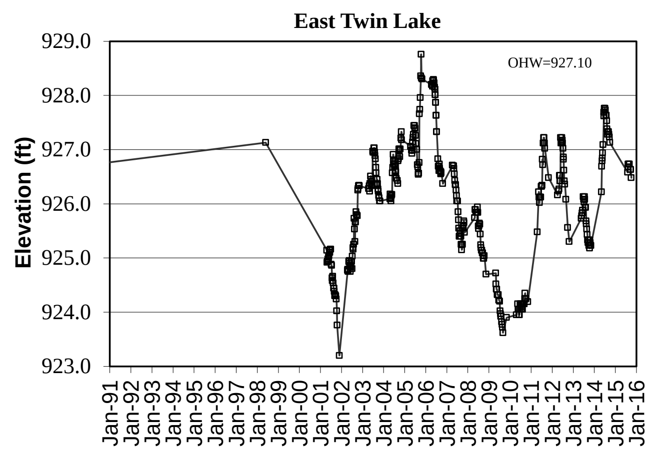
Results: Lake levels were measured by volunteers throughout the 2015 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes had increasing water levels in spring and early summer and dropped steadily by mid-summer. A resurgence of rainfall late 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

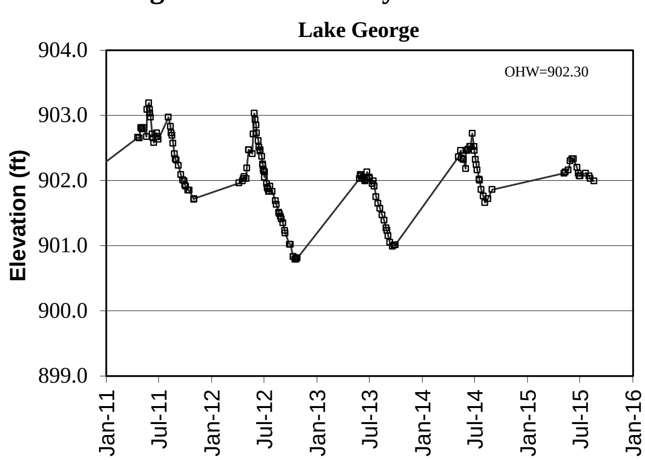


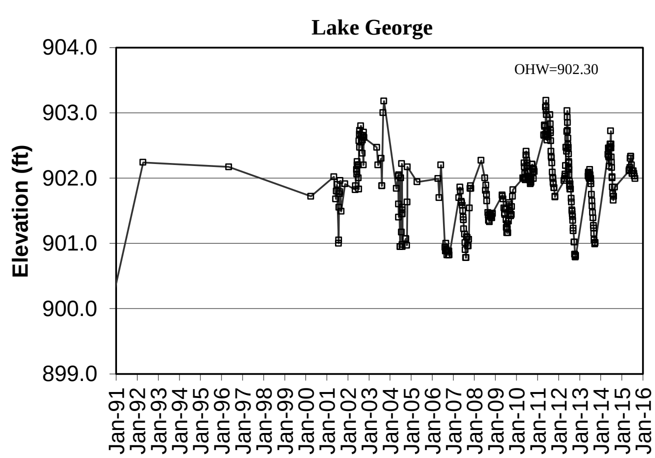
East Twin Lake Levels – last 25 years



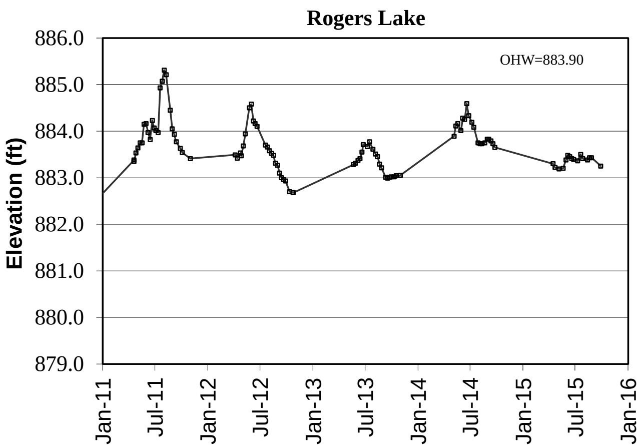
Lake George Levels – last 5 years

Lake George Levels – last 25 years

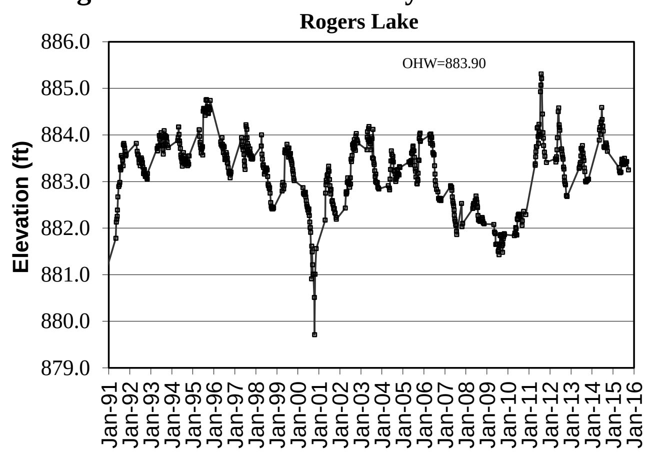




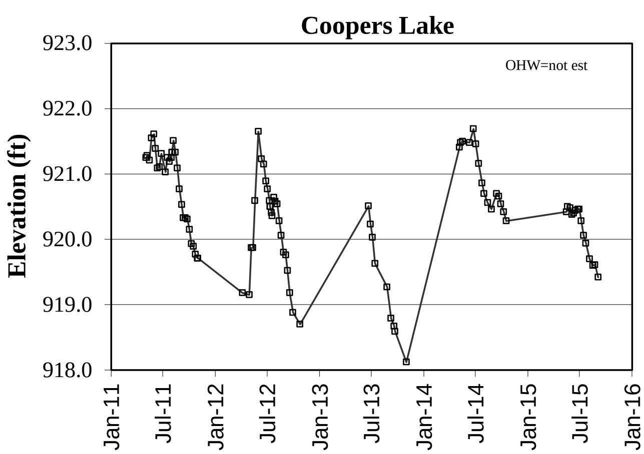
Rogers Lake Levels – last 5 years



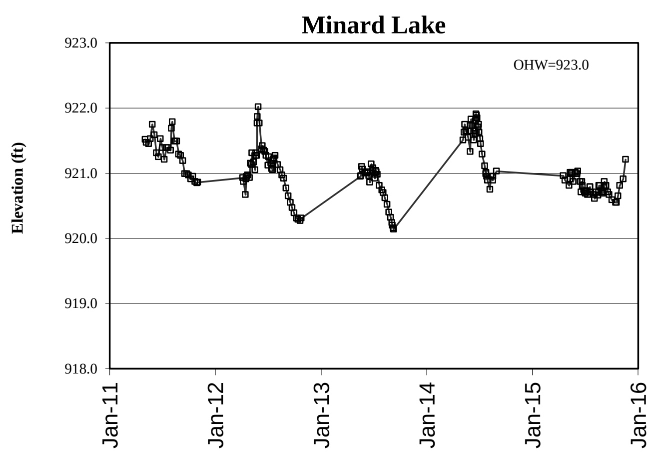
Rogers Lake Levels – last 25 years



Coopers Lake Levels – last 5 years



Minard Lake Levels – last 5 years



Lake Water Quality

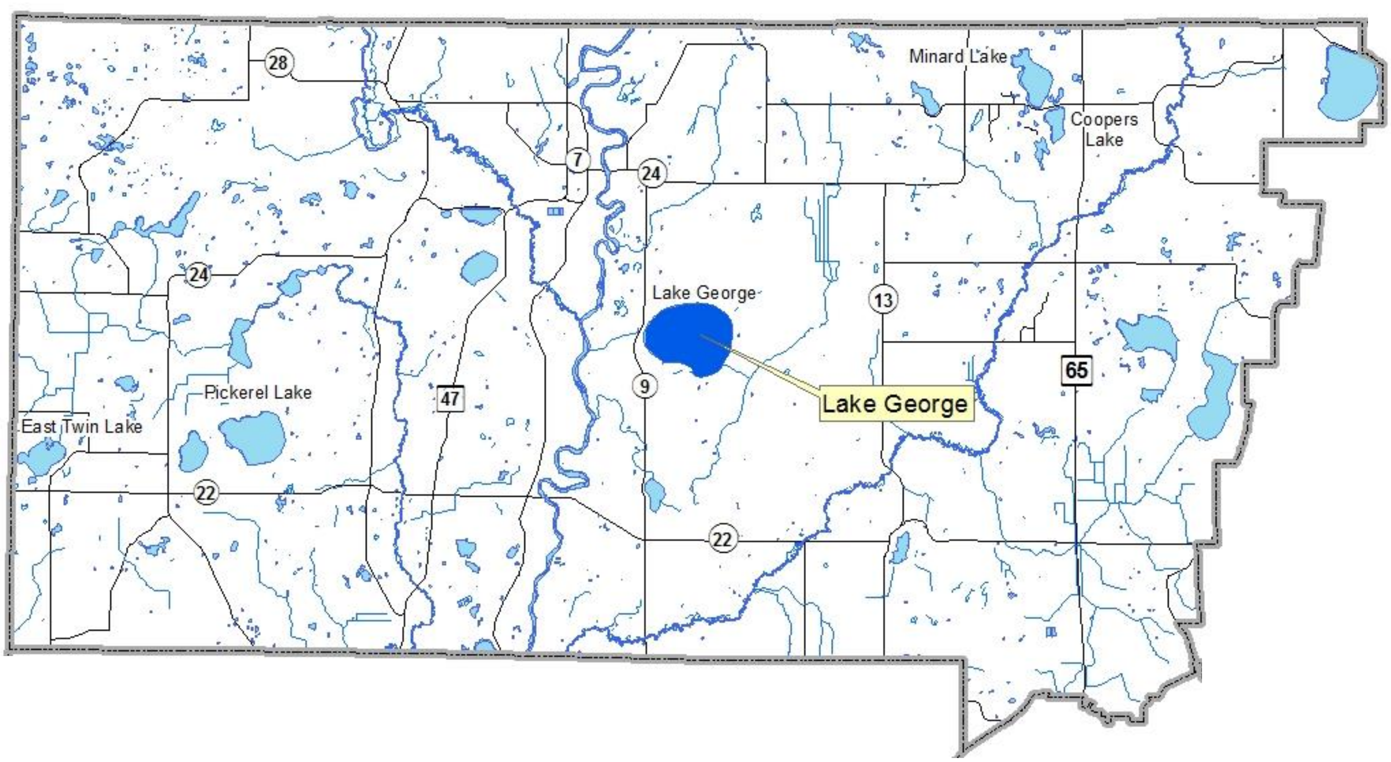
Description: May through September at least once-monthly monitoring of the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

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 improvement district treats both with herbicide.

2015 Results

In 2015 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 22.8 ug/L, lower from the previous year. Secchi transparency was over 12 feet in May, but dropped to as low as 4.0 feet in late-August. Average Secchi transparency was 7.7 feet, a slight improvement from 2014. Chlorophyll-a averaged 4.4 mg/L, which is lower than the total average of all years monitored. Total phosphorous, chlorophyll-a, and transparency were poorest in August.

Trend Analysis

Fifteen years of water quality data have been collected by the Metropolitan Council (between 1980 and '94, 1998 and 2009) and the Anoka Conservation District (1997, 1999, 2000, 2002, 2005, 2008, 2011, 2013, 2014 and 2015). Water quality as a whole has not significantly changed from 1980 to 2015 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,15}$= 0.99, p=0.39). However, when analyzed individually Secchi transparency has significantly decreased (one-way ANOVA $F_{1,16}$= 8.44, p=0.01).

Discussion

Lake George remains one of the clearest of Anoka County Lakes, but its trend toward poorer water quality 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).

In 2015 the Lake George Improvement District and Anoka Conservation District are launching a project 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 and nutrient best management practices. Residential lakeshore restorations are one high priority, 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. A Lake Improvement District was formed to control of 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. The 2014 and 2015 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.

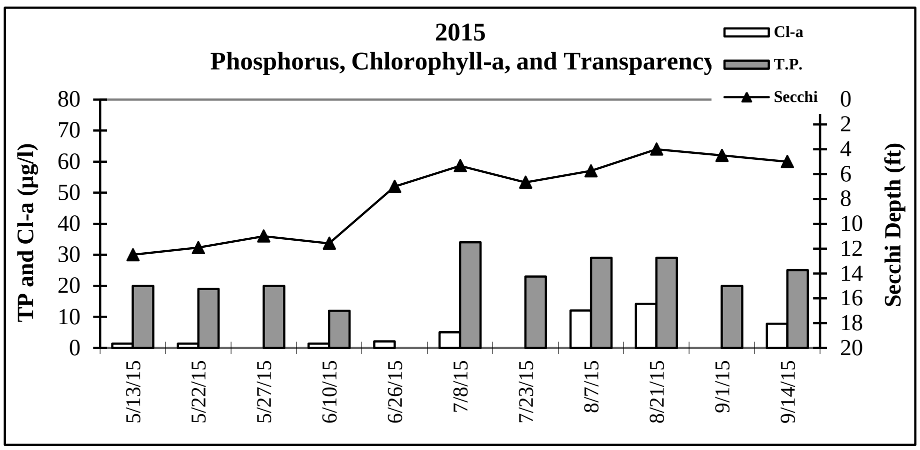
In 2015 the invasive plants were mapped out earlier in the season to allow for earlier treatment, hoping to reduce the chance of water quality impacts (decomposition of larger plants in warmer water). While immediate impacts were not observed in 2015 future monitoring and continued modified herbicide treatments may provide insight.

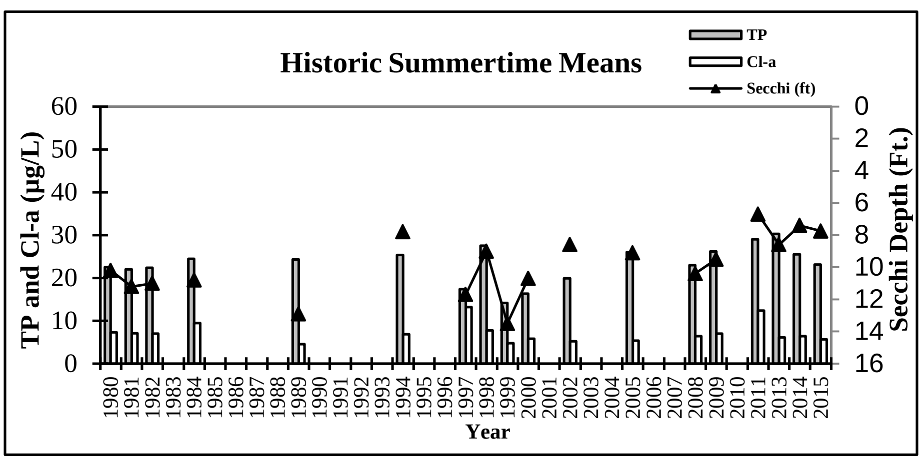
2015 Lake George Water Quality Data

Lake George			5/13/2015	5/22/2015	5/27/2015	6/10/2015	6/26/2015	7/8/2015	7/23/2015	8/7/2015	8/21/2015	9/1/2015	9/14/2015			
2015 Water Quality Data			13:00	11:15	11:00	11:30	11:10	11:10	11:20	9:15	10:35	10:45	11:40			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.04	8.09	8.56	8.65	8.78	8.58	8.66	8.66	8.04	8.26	8.26	8.42	8.04	8.78
Conductivity	mS/cm	0.01	0.228	0.228	0.232	0.233	0.252	0.255	0.219	0.245	0.273	0.236	0.261	0.24	0.219	0.273
Turbidity	NTU	1.00	0.60	1.30	1.50	0.70	2.30	6.20	4.80	12.50	9.40	9.90	7.00	5.11	0.60	12.50
D.O.	mg/L	0.01	10.32	11.2	10.01	8.79	8.67	7.24	8.26	8.07	7.95	9.11	8.78	8.95	7.24	11.20
D.O.	%	1	99.5%	114.1%	106.6%	106.3%	107.4%	88.6%	104.1%	95.8%	90.5%	109.7%	101.0%	102%	89%	114%
Temp.	°C	0.1	14	15	17	23	25	24	26	24	22	23	20	21.18	13.7	25.9
Temp.	°F	0.1	56.7	59.8	62.5	73.7	76.8	75.2	78.7	75.0	71.0	73.3	68.8	70.13	56.7	78.7
Salinity	%	0.01	0.11	0.11	0.11	0.11	0.12	0.12	0.1	0.12	0.13	0.11	0.12	0.11	0.10	0.13
Cl-a	ug/L	0.5	1.4	1.4	1	1.4	2.1	5	1	12.1	14.2	1	7.8	4.40	1.0	14.2
T.P.	mg/L	0.010	0.02	0.019	0.02	0.012	0.02	0.034	0.023	0.029	0.029	0.02	0.025	0.02	0.012	0.034
T.P.	ug/L	10	20	19	20	12	20	34	23	29	29	20	25	22.8	12	34
Secchi	ft	0.1	12.5	11.92	11	11.58	7	5.33	6.67	5.75	4	4.5	5	7.75	4.0	12.5
Secchi	m	0.03	3.81	3.63	3.35	3.53	2.13	1.62	2.03	1.75	1.22	1.37	1.50	2.36	1.2	3.8
Physical			1.0	2.0	2.0	2.0	2.0	2.0	3.0	1.0	1.0	2.0	2.0	1.82	1.0	3.0
Recreational			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	1.09	1.0	2.0

*reporting limit

		2015 Median
pH		8.56
Conductivity	mS/cm	0.236
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





Lake George Summertime Annual Means

Agency	MC	MC	MC	MC	MC	MC	ACD	MC	ACD	ACD	ACD	ACD	ACD	MC	MC	ACD	ACD	ACD
Year	1980	1981	1982	1984	1989	1994	1997	1998	1999	2000	2002	2005	2008	2009	2011	2013	2014	2015
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
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
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
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

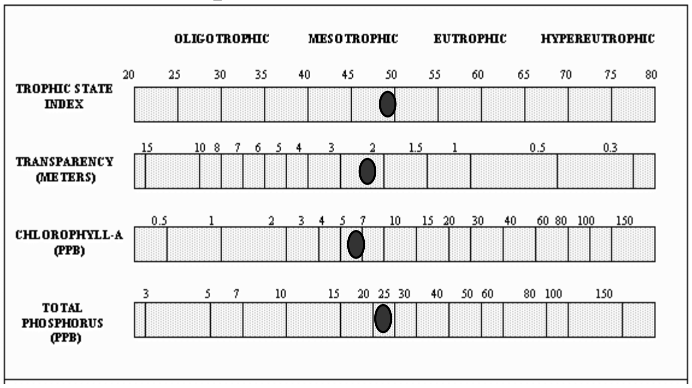
Carlson's Tropic State Indices

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

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
TP	A	A	A	B	B	B	A	B	A	A	A	B	B+	B	B	B	B	A
Cl-a	A	A	A	A	A	A	B	A	A	A	A	A	A	A	B	A	A	A
Secchi	A	A	A	A	A	B	A	B	A	B	B	B	A	B	C	B	B	B
Overall	**A**	**A**	**A**	**A**	**A**	**B**	**A**	**B**	**A**	**A**	**A**	**B**	**A**	**B**	**B**	**B**	**B**	**A**

Carlson’s Trophic State Index



Aquatic Invasive Vegetation Mapping

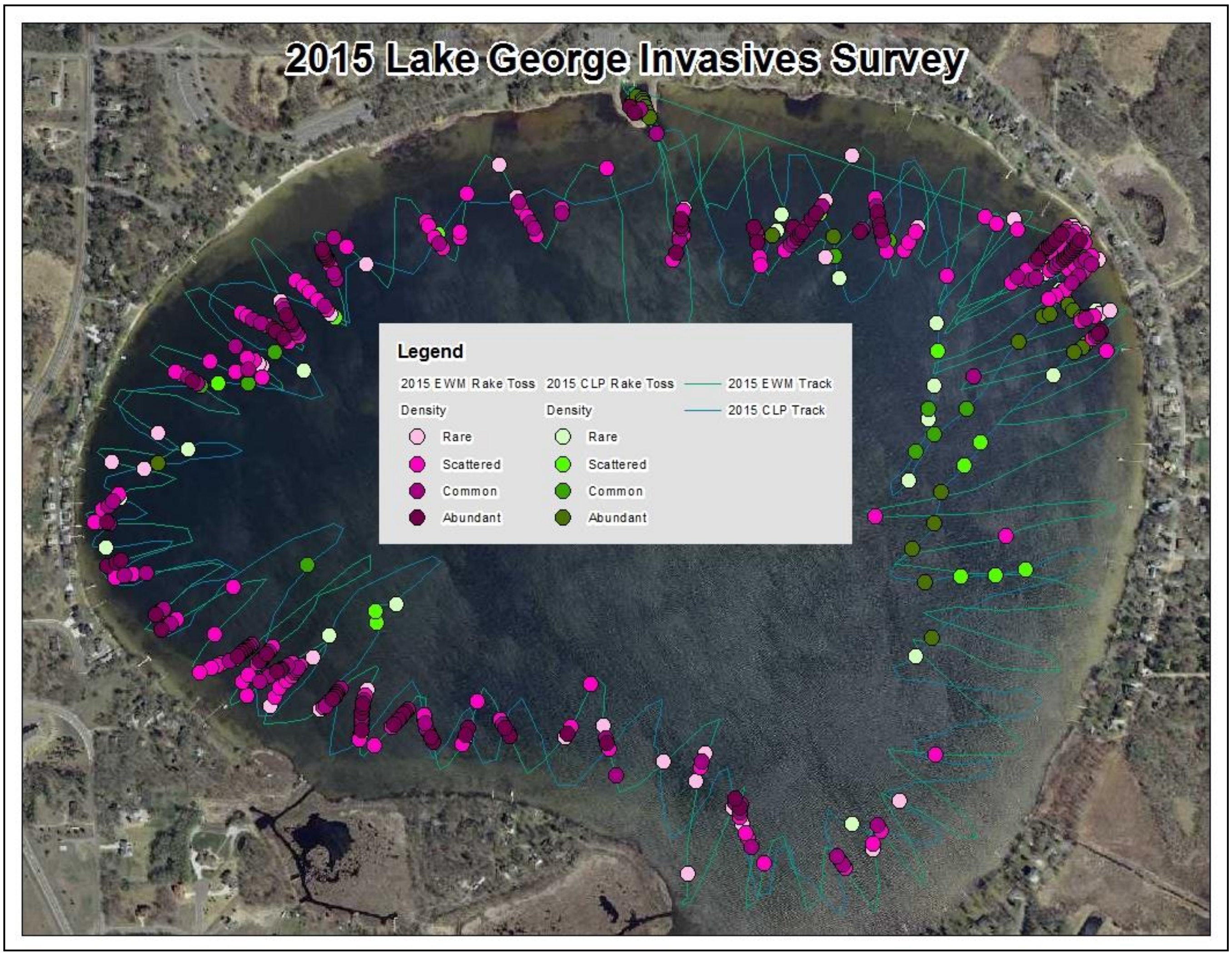
Description: The Anoka Conservation District (ACD) was contracted through the Lake George Lake Improvement District (LID) to conduct an aquatic invasive vegetation delineation.

Purpose: To map out the presence of Curly Leaf Pondweed (CLP) and Eurasian Water Milfoil (EWM) earlier in the season. This would allow for sooner chemical treatment with the goal of eliminating the bounce in nutrients following treatment seen in years past.

Locations: Lake George

Results: A map is presented below. These survey points were reviewed by the MNDNR and herbicide treatments occurred in areas with the greatest density of invasive plants.

2015 Lake George Curly Leaf Pondweed (CLP) and Eurasian Water Milfoil (EWM) Survey



Stream Water Quality - Chemical Monitoring

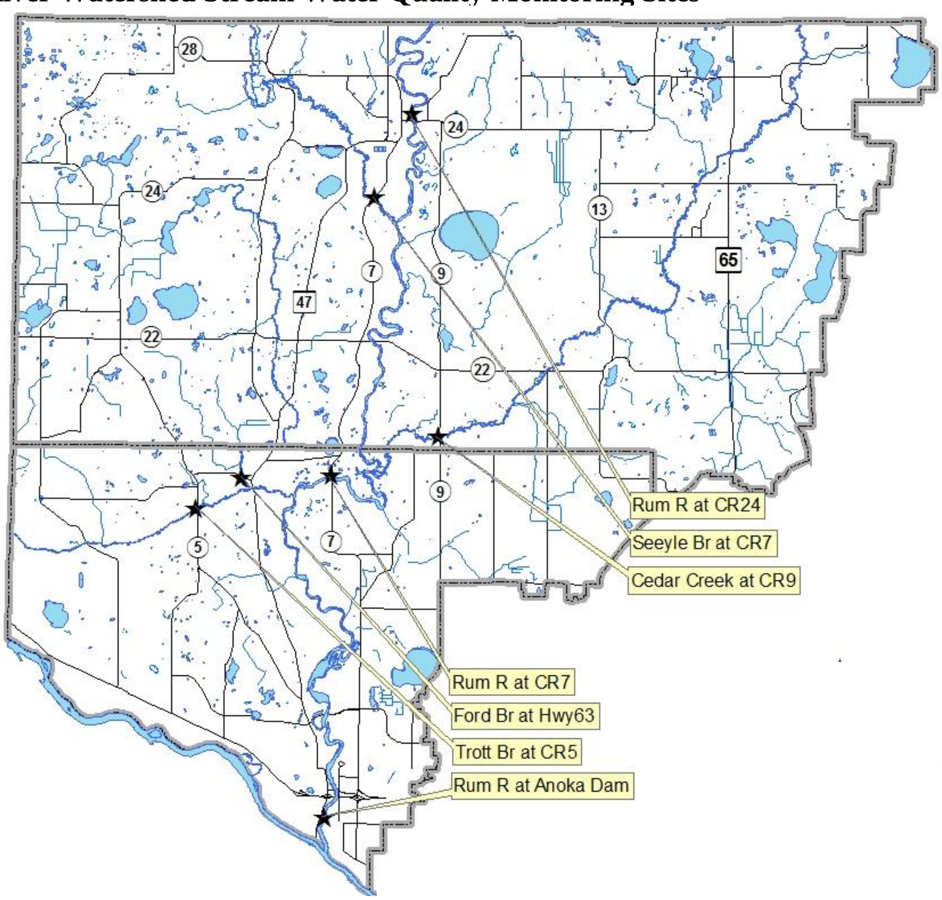
Description: The Rum River and several tributary streams were monitored in 2015. The locations of river monitoring include the approximate top and bottom of the Upper and Lower Rum River Watershed Management Organizations. Tributaries were monitored simultaneous with the Rum River monitoring for greatest 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 of the following parameters: total suspended solids, e. coli, total phosphorus, Secchi tube transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

Purpose: To detect water quality trends and problems, and diagnose the source as well as 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

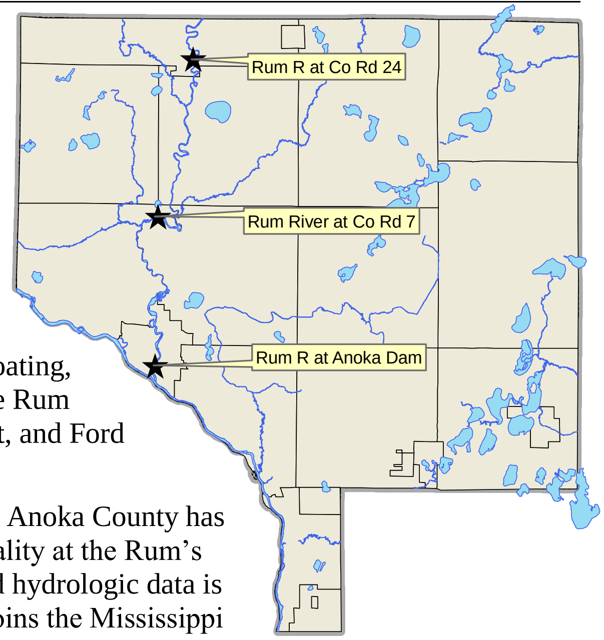
Results: Results are presented on the following pages.

Upper Rum River Watershed 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



Years Monitored

At Co. Rd. 24 –	2004, 2009, 2010, 2011, 2014, 2015
At Co. Rd. 7 –	2004, 2009, 2010, 2011, 2014, 2015
At Anoka Dam –	1996-2011(MC WOMP), 2015

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 been sporadic and sparse. 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, 2010, 2011, 2014, and 2015 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 2015 the river was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were taken; 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 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, total suspended solids. During every sampling 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 2015. 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.

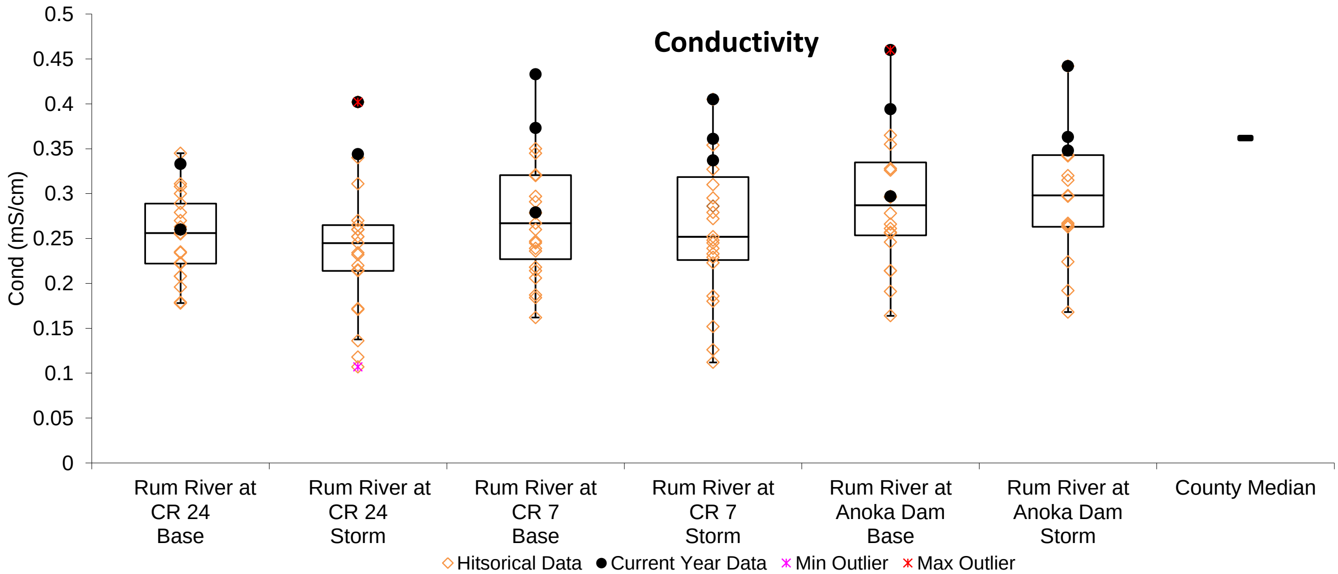
Results and Discussion

On the following pages data are presented and discussed for each parameter. Management recommendations will be included in the 2015 report at the conclusion of this monitoring project. 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 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 2015 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. 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 2015 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 2015 (all conditions) was 0.338 mS/cm, 0.369 and 0.391 mS/cm, respectively. Two of the sites are higher than the median for 34 Anoka County streams of 0.362 mS/cm. The 2015 maximum observed conductivity in the Rum River was 0.46 mS/cm which is the highest on record.

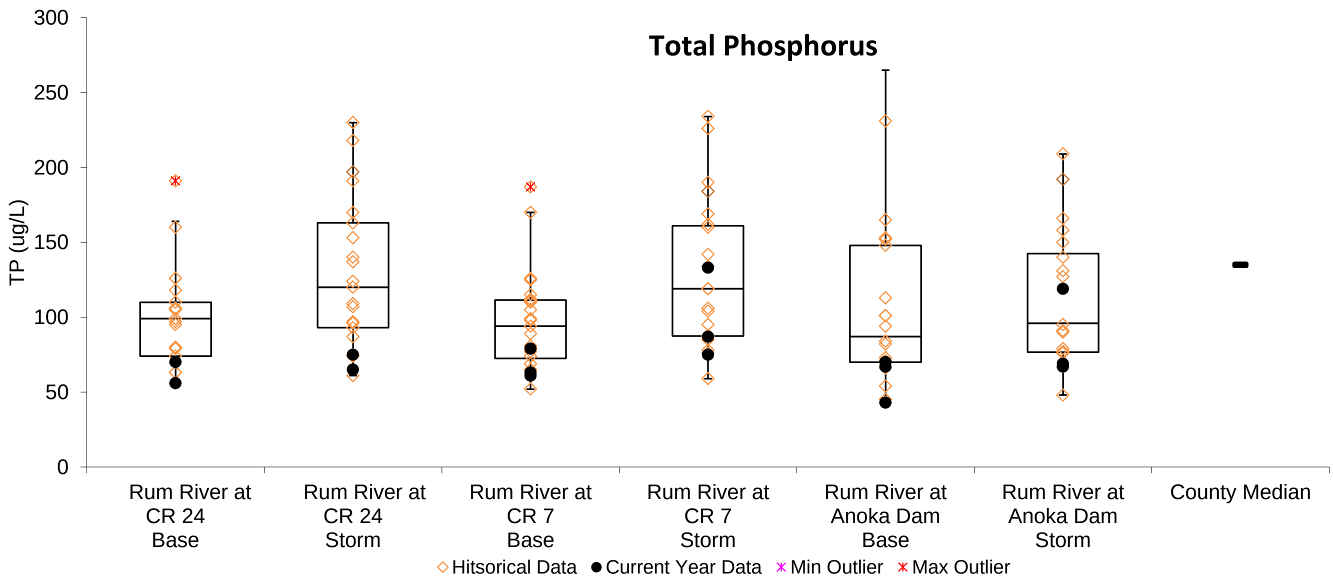
Conductivity was lowest at most sites during storms, suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow conductivity has been observed in most other nearby streams too, studied extensively, and the largest 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 similar to the median for all other monitored 34 Anoka County streams (see figure below). 2015 readings averaged much lower than 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 2015 at the three monitored sites (all conditions) was 67.5, 77 and 69.5 ug/L. These upstream-to-downstream differences are negligible and there is no trend of increasing phosphorus downstream. All sites in 2015 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 133. In all, phosphorus in the Rum River is at acceptable levels but 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 2015 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. In 2015 Suspended solids in the Rum River were 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.

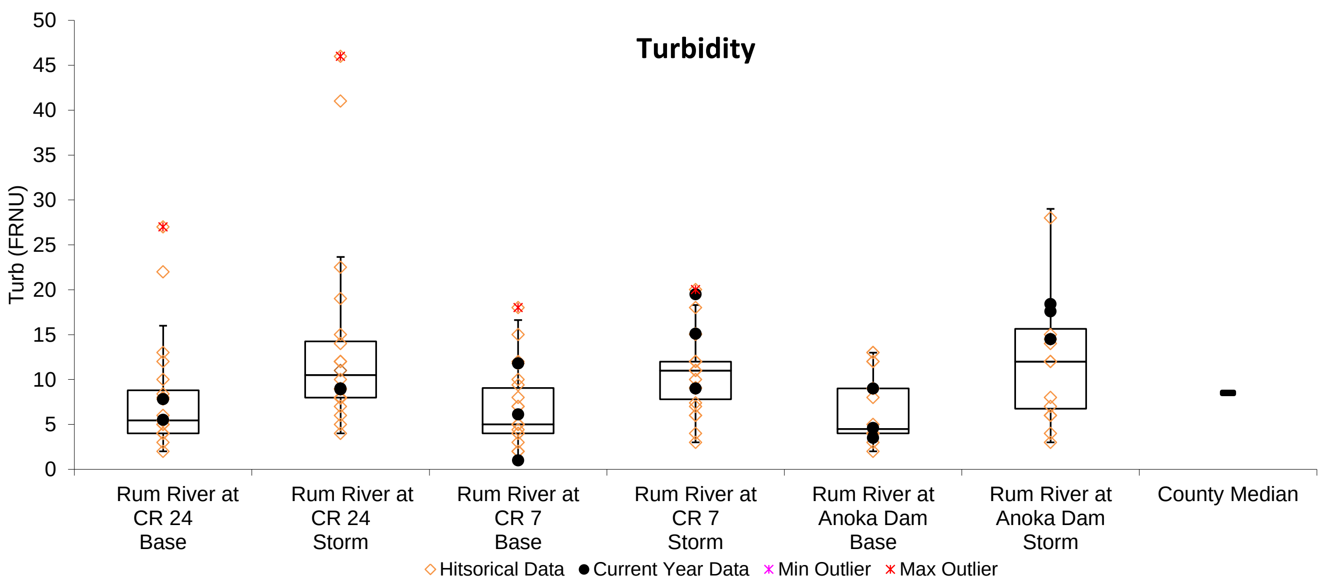
In the Rum River, turbidity was low with increases during storms and a very slight decrease at downstream monitoring sites (see figure below). The median turbidity, in 2015 (all conditions) was 8.35, 10.4 and 9.5 NTU (upstream to downstream), which is similar or higher than the median for Anoka County streams of 8.5 NTU. Turbidity was elevated on a few occasions, especially during storms. In 2015 the maximum observed was 19.5 NTU during a mid-season monitoring event.

TSS in 2015 was similar to 2014 results. The median TSS, in 2015 (all conditions) was 6, 5.5 and 5.5 (upstream to downstream). These are all much lower than the Anoka County stream median for TSS of 12.

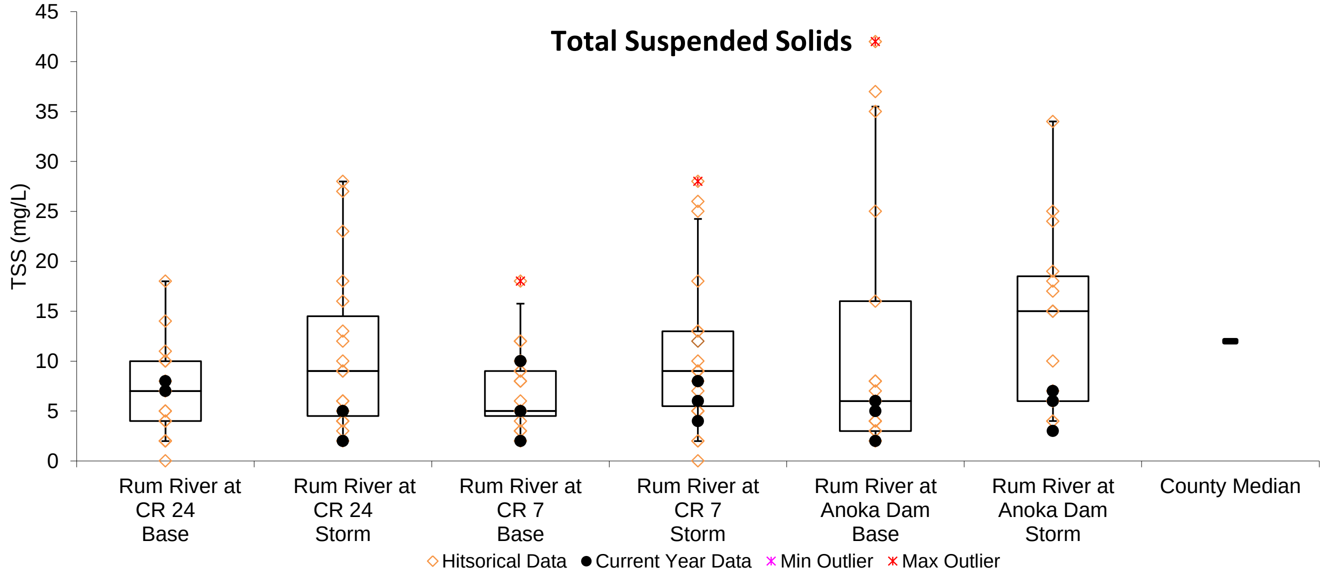
Rigorous stormwater treatment should occur as the Rum River watershed develops, or the collective pollution caused by many small developments will seriously impact the river. Bringing stormwater treatment up to date in older developments is also important.

Differences between TSS and turbidity lend insight into the nature of any problems. TSS showed increases at the downstream monitoring site, while turbidity did not. Turbidity is most sensitive to large particles. Therefore, the downstream increases are likely due to smaller particles. Other pollutants, such as phosphorus and metals, are most highly correlated with smaller particles. These other pollutants can "hitch a ride" on smaller particles because of their greater surface area and, in the case of certain soils, ionic charge. Furthermore, small particles stay suspended in the water column and therefore are more likely to be transported by stream flows and are more difficult to remove with stormwater practices like settling ponds.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



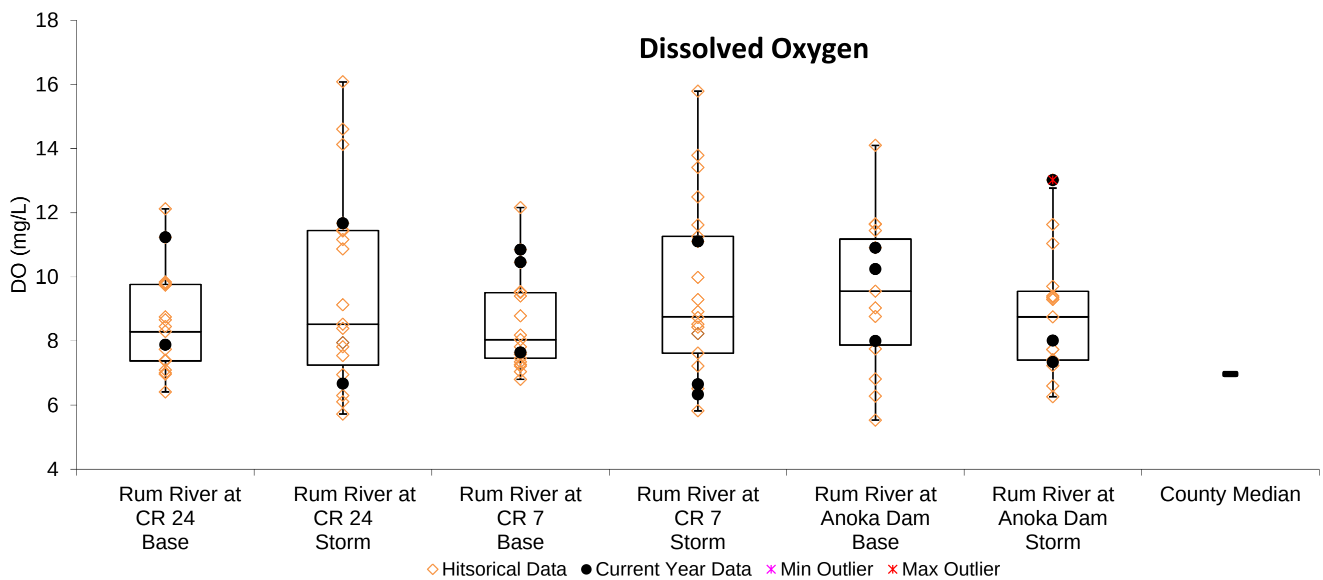
Total suspended solids during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below 5 mg/L aquatic life begins to suffer. In the Rum River dissolved oxygen was always above 5.5 mg/L at all monitoring sites.

Dissolved oxygen during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

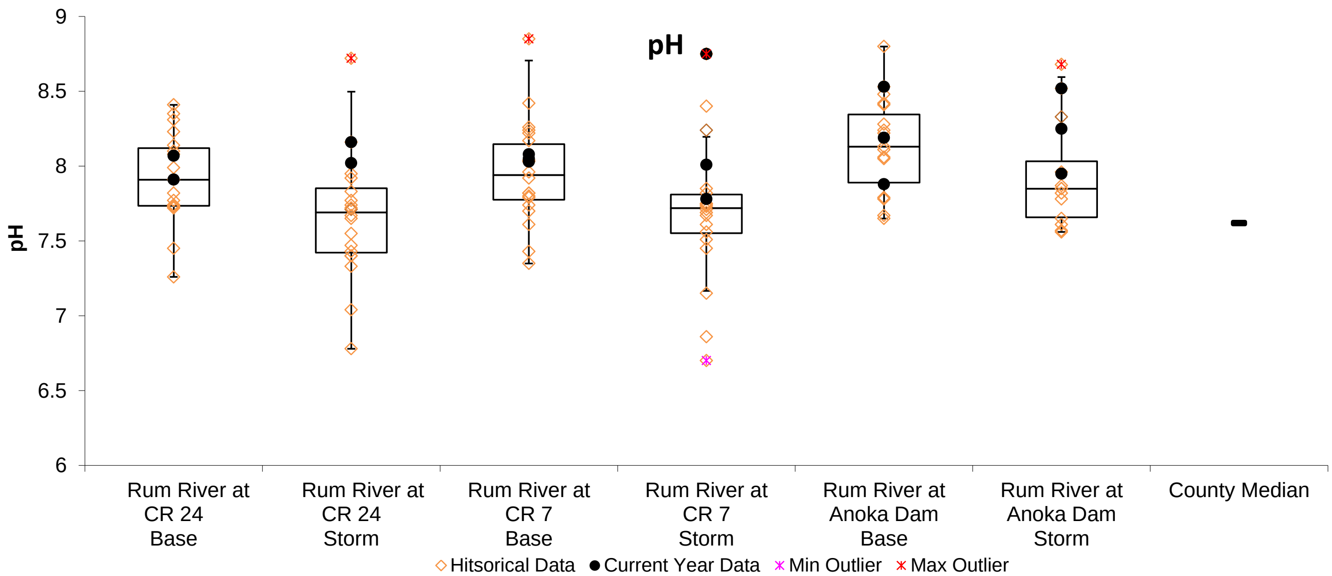


pH

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 (see figure below).

It is interesting to note that pH is 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 2015 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

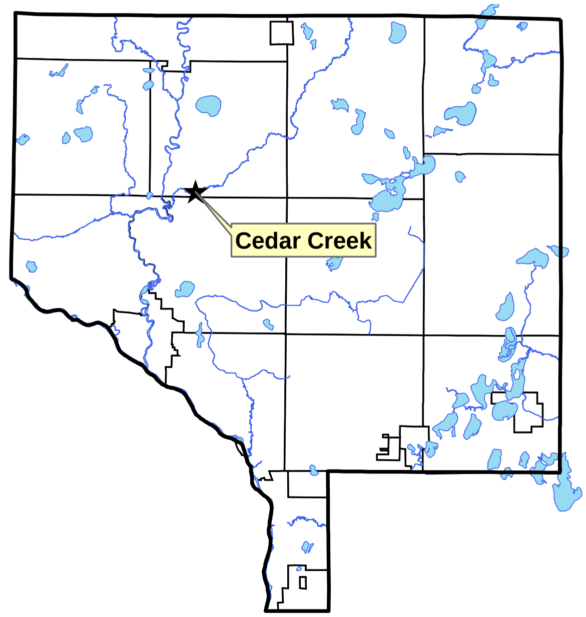


Summary and Recommendations

The Rum River's water quality is very good. It does show a slight increase in suspended solids and conductivity downstream. 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 have the potential to degrade water quality unless carefully sited and managed. 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 and Discussion

This report includes data from 2015. A reason this monitoring is being performed is due to the lack of historical data for the state to determine if the creek is meeting state water quality standards. That assessment process is part of the Rum River Watershed Restoration and Protection Project (WRAPP). 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 0.408 mS/cm Maximum of 0.498 mS/cm and a minimum of 0.328 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 over the proposed MPCA water quality standard of 135 ug/l. Cedar Creek often exceeds the state standard, even during baseflow periods. Phosphorous results in Cedar Creek averaged 209 ug/l (maximum of 324 ug/l and a minimum of 145 ug/l).
- Suspended solids and turbidity both were well above the state standards each sampling event. Total suspended solids averaged 35.8 mg/l (with a maximum of 64.0 mg/l and a minimum of 15 mg/l). Turbidity averaged 25.33 NTU (with a maximum of 41.90 NTU and a minimum of 15.0 NTU).
- pH and dissolved oxygen were within the range considered normal and healthy for streams in this area. However, on one sampling occasions pH exceeded the 6.5-8.5 range. pH averaged 7.83 (maximum of 8.63 and a minimum of 7.21). DO averaged 8.55 mg/l (maximum of 11.55 mg/l and a minimum of 6.46 mg/l).

For a significant number of the results below there are no current state standards. However, this data will be used as a baseline for future assessments of the watershed.

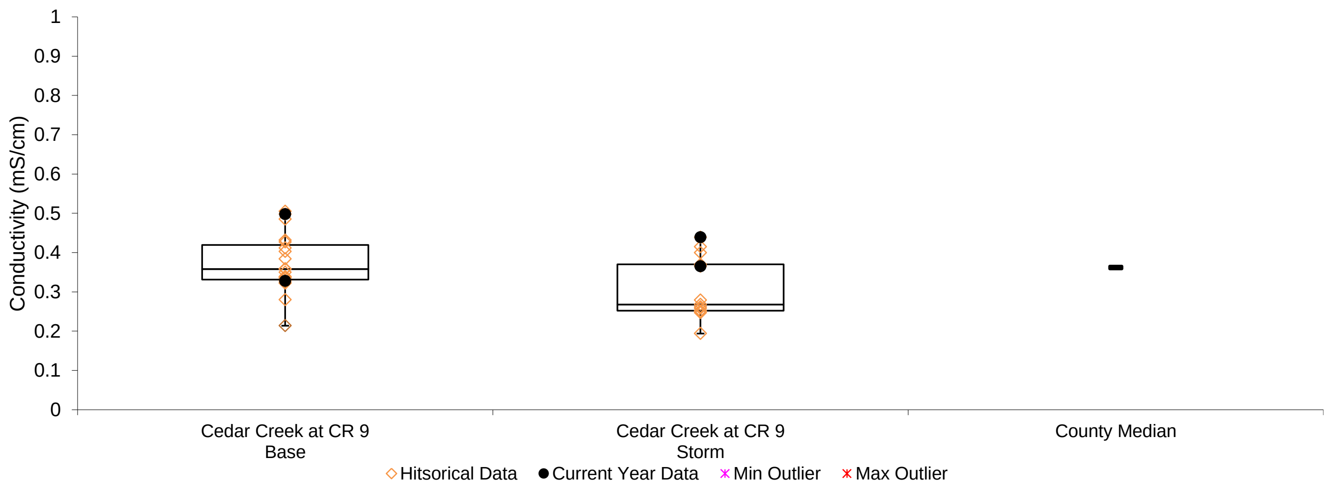
Cedar Creek at CR 9

	Units	R.L.*	3/12/2015 Results	4/13/2015 Results	7/6/2015 Results	7/10/2015 Results	Median	Average	Min	Max
pH		0.1	8.63	7.21	7.61	7.86	7.74	7.81	7.21	8.63
Conductivity	mS/cm	0.01	0.365	0.328	0.439	0.498	0.40	0.406	0.328	0.498
Turbidity	NTU	1	21.0	23.4	41.9	15.0	22.20	24.70	15.00	41.90
D.O.	mg/L	0.01	11.55	8.58	6.46	7.61	8.10	8.46	6.46	11.55
D.O.	%	1	88.7	78.7	74.2	90.1	83.70	83.1	74.2	90.1
Temp.	°C	0.1	3.48	10.34	20.42	22.30	15.38	14.4	3.5	22.3
Salinity	%	0.01	0.17	0.15	0.21	0.24	0.19	0.19	0.15	0.24
T.P.	ug/L	10	158	208	324	145	183.00	204	145	324
TSS	mg/L	2	15	45	64	19	32.00	35.0	15.0	64.0
Secchi-tube	cm		73.00	40.00	39	90	56.50	>90	39	>100
E coli	MPN								0.0	0.0
Appearance										
Recreational										

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 2015 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 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

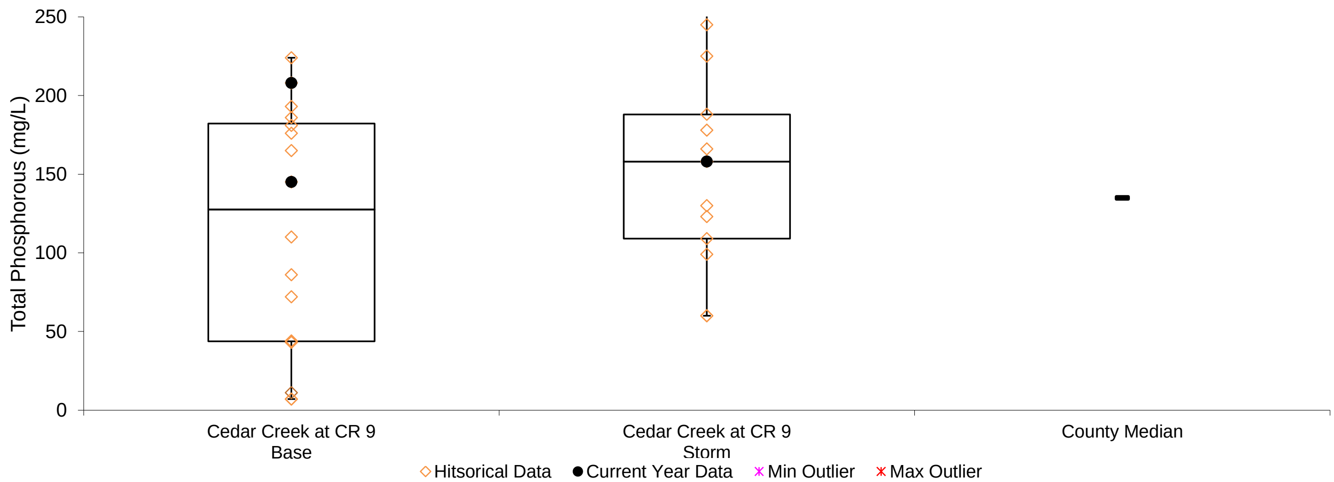


Conductivity is acceptably low in Cedar Creek at CR 9. Median conductivity (all years) is 0.358 mS/cm during baseflow and 0.268 mS/cm during storm events, respectively. Both were lower than the median for Anoka County streams of 0.362 mS/cm. The 2015 maximum observed conductivity in Cedar Creek was 0.505 mS/cm which is the highest on record.

Total Phosphorus

Total phosphorus in Cedar Creek was high and 2015 readings increased from 2014. 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 127.5 ug/L during baseflow and 158 ug/L during storm events. All readings in 2015 had phosphorus concentrations higher 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 324 ug/L. This is the highest reading on record. In all, phosphorus in Cedar Creek is at concerning levels 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 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

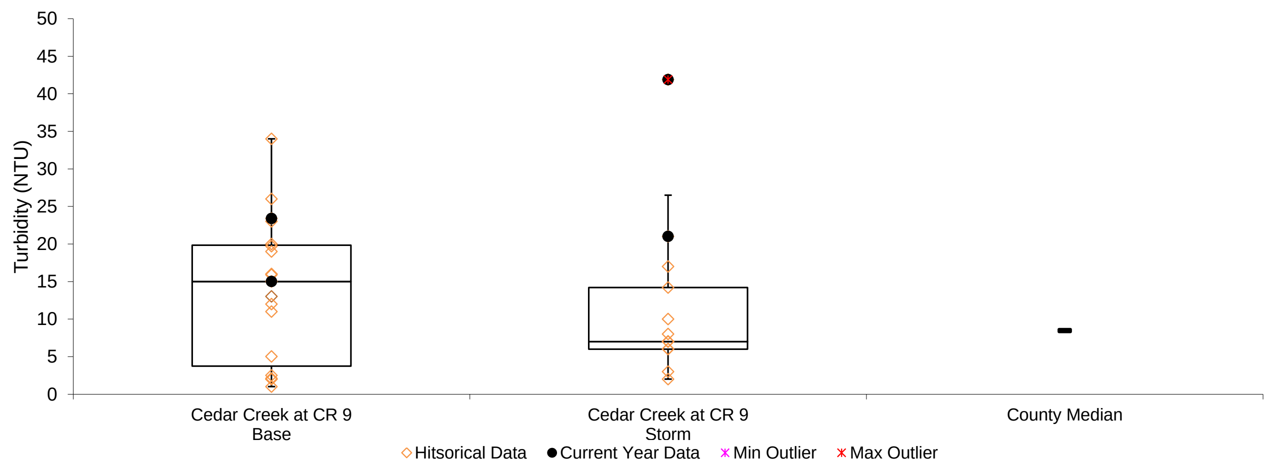


Turbidity and Total Suspended Solids (TSS)

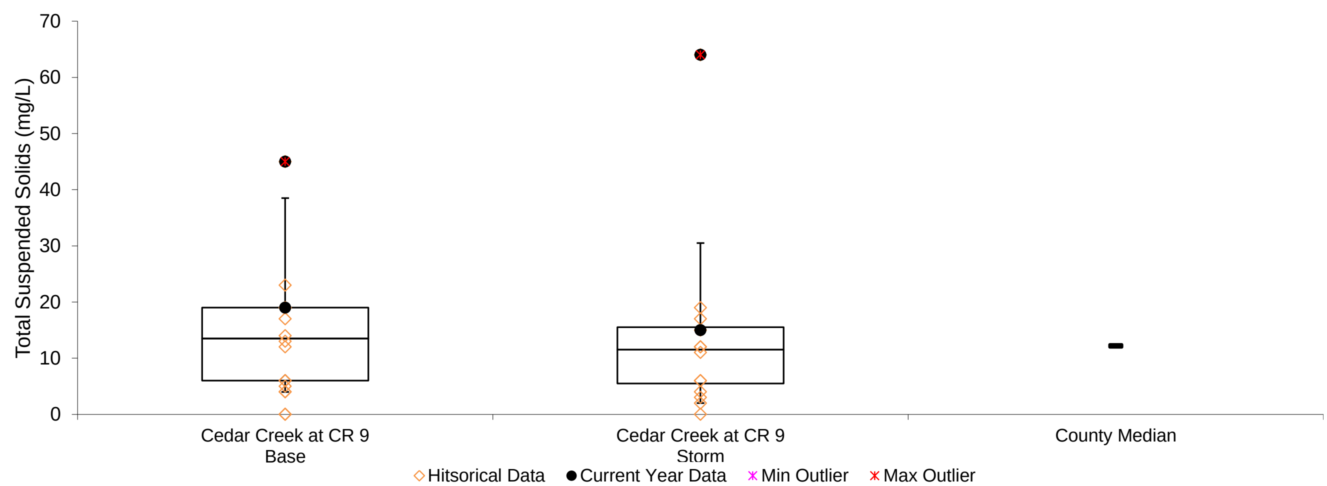
In Cedar Creek, turbidity was low overall with slight increases during storms events. The median turbidity (all years) is 15 NTU during baseflow and only 7 NTU during storm events, which is similar to the median for Anoka County streams of 8.5 FNRU. Turbidity was elevated on a few occasions, especially during storms. In 2015 the maximum observed was 41.5 NTU during a mid-season monitoring event. This is the highest reading on record.

TSS was high throughout 2015 with all readings being above the median for Anoka County streams which is 12 mg/L. In some cases TSS was over 10 times higher in 2015 than 2014. During one storm event an all-time high of 64 mg/L was recorded. Even with high 2015 results median TSS (all years) is 13.5 mg/L during baseflow and 11.5 mg/L during storm events.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



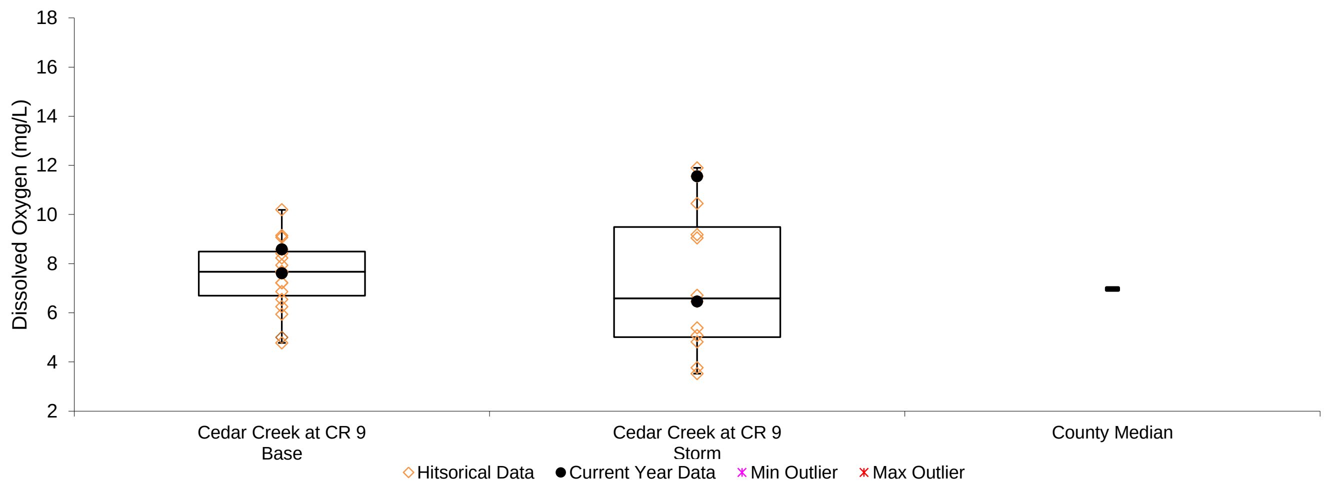
Total Suspended Solids during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below 5 mg/L aquatic life begins to suffer. In 2015 Cedar Creek dissolved oxygen was always above 6.0 mg/L. Median dissolved oxygen of all years of data is 6.7mg/L during baseflow and 5.0 mg/L during storm events.

Dissolved oxygen during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

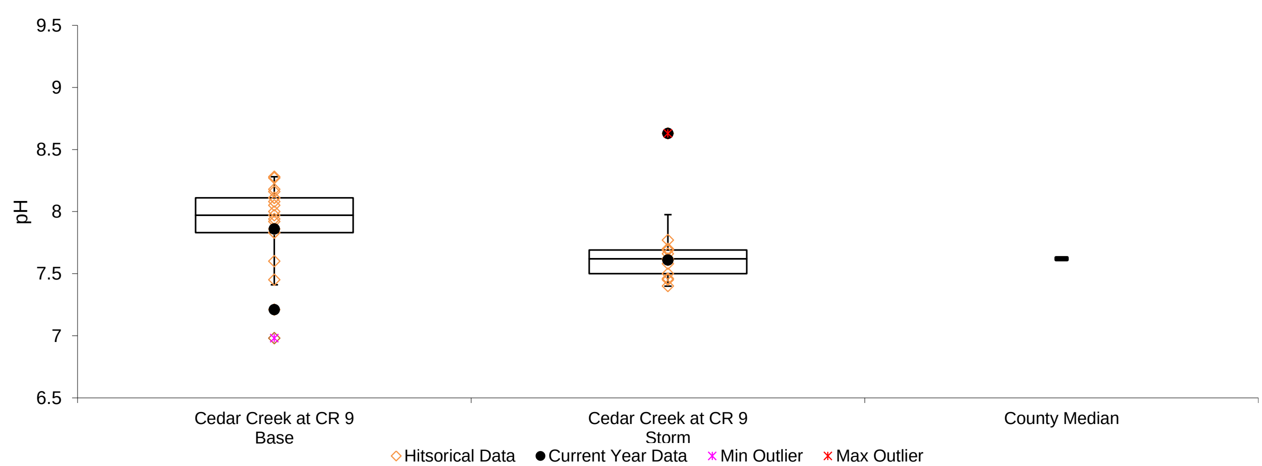


pH

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 is generally within this range (see figure below).

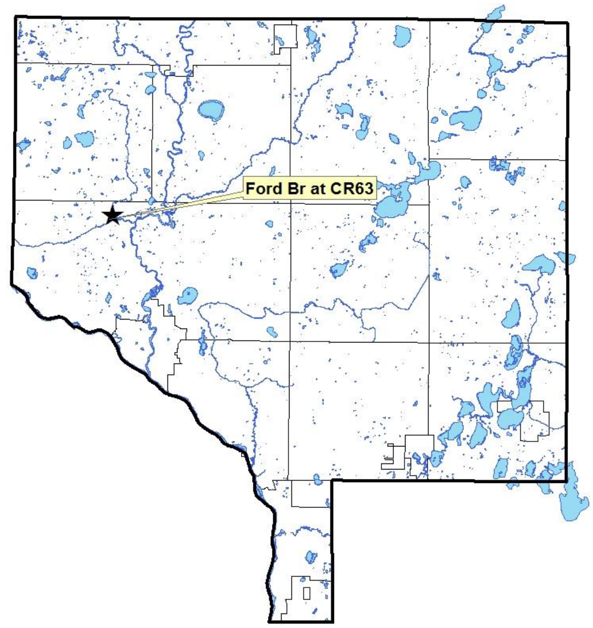
pH is generally lower during storms than during baseflow. This is because the pH of rain is typically lower (more acidic). While acid rain is a longstanding problem, its effect on this aquatic system is small.

pH during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 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 north-western Anoka County and flows south. Ford Brook is a tributary to the Rum River. In north-western Anoka County it flows through the relatively undisturbed 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 grow.

Results and Discussion

This report includes data from 2015. A reason this monitoring is being performed is due to the lack of historical data for the state to determine if the creek is meeting state water quality standards. That assessment process is part of the Rum River Watershed Restoration and Protection Project (WRAPP). The following is a summary of results.

- <u>Dissolved constituents</u>, as measured by conductivity, in Ford Brook were above average when compared to similar Anoka County streams. Conductivity averaged 0.419 mS/cm (maximum of 0.505 mS/cm and a minimum of 0.328 mS/cm).
- <u>Phosphorous</u> averaged above the MPCA water quality standard of 135 ug/l. Ford Brook often exceeds the limit, even during baseflow periods. Phosphorous results in Ford Brook averaged 181 ug/l (maximum of 215ug/l and a minimum of 110 ug/l).
- <u>Suspended solids and turbidity</u> both stayed below the state standards each sampling event. Total suspended solids averaged 22.5 mg/l (maximum of 35.0 mg/l and a minimum of 8.0 mg/l). Turbidity averaged 29.70 NTU (maximum of 49.0 NTU and a minimum of 6.60 NTU). Water flow during the 49.0 NTU reading was extremely fast and turbulent due to abnormal rainfall.
- <u>pH and dissolved oxygen</u> were with the range considered normal and healthy for streams in this area. pH averaged 7.85 (maximum of 8.68 and a minimum of 7.51). DO averaged 8.62 mg/l (maximum of 11.60 mg/l and a minimum of 6.65 mg/l).

For a significant number of the results below there are no current state standards. However, this data will be used as a baseline for future assessments of the watershed.

FordBrook at CR63			3/12/2015	4/13/2015	7/6/2015	7/10/2015				
	Units	R.L.*	Results	Results	Results	Results	Median	Average	Min	Max
pH		0.1	8.68	7.51	7.55	7.64	7.595	7.80	7.51	8.68
Conductivity	mS/cm	0.01	0.328	0.395	0.448	0.505	0.4215	0.420	0.328	0.505
Turbidity	NTU	1	19.4	43.8	49.0	6.6	31.6	30.08	6.60	49.00
D.O.	mg/L	0.01	11.6	8.83	6.65	7.38	8.105	8.51	6.65	11.60
D.O.	%	1	80.4	79	77.3	87.7	79.7	80.8	77.3	87.7
Temp.	°C	0.1	0.2	9.2	21.0	22.5	15.105	13.6	0.2	22.5
Salinity	%	0.01	0.15	0.19	0.12	0.24	0.17	0.17	0.12	0.24
T.P.	ug/L	10	215	198	201	110	199.5	185	110	215
TSS	mg/L	2	13	35	34.0	8	23.5	22.7	8.0	35.0
Secchi-tube	cm		77	38	21	87	57.5	>100	21	87
E coli	MPN									
Appearance										
Recreational										

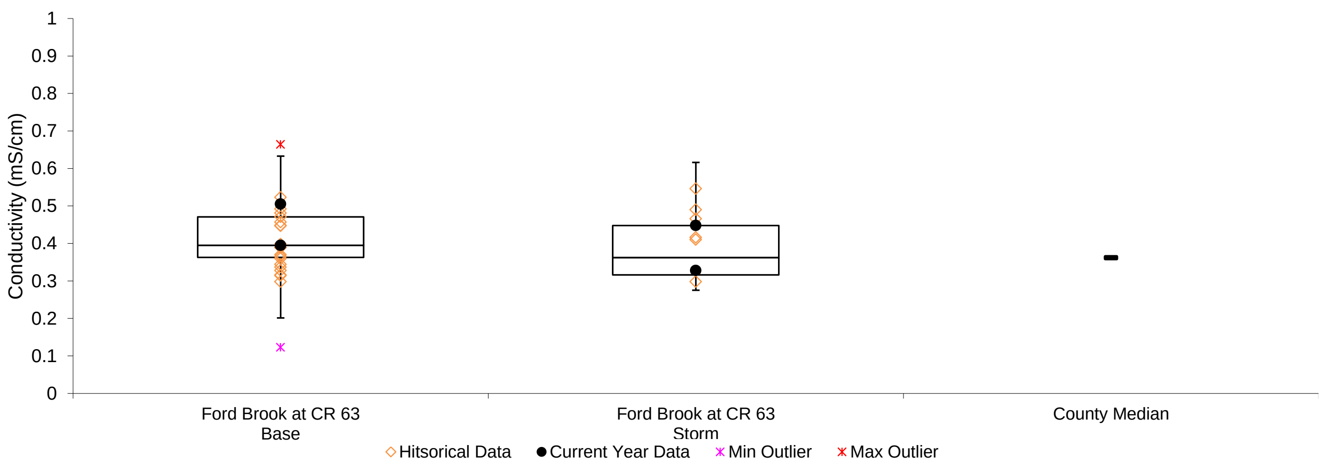
*reporting limit

Conductivity

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

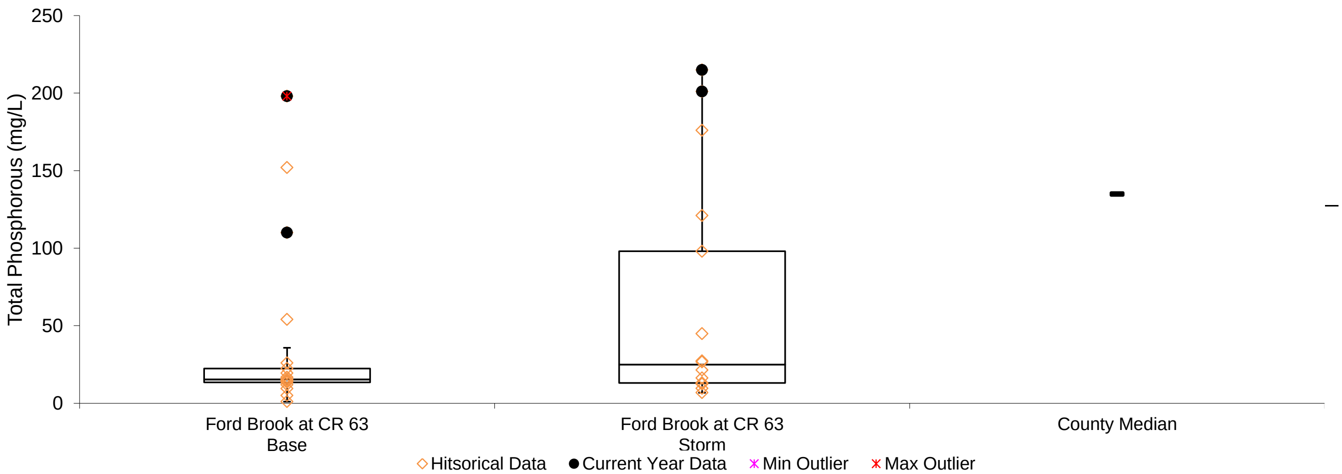
Conductivity at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



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 2015 TP levels in Ford Brook were much higher than the county median and were an increase from past results. TP was higher during storm events then baseflow. Even with high 2015 results, the median TP for Ford Brook (all years) is 15.3 ug/L during baseflow and 24.9 ug/L during storm events. This is substantially lower than the countywide median for streams of 135ug/L, as well as the state water quality standard of 100 ug/L, although 20% of measurements at Ford Brook have been above 100 mg/L.

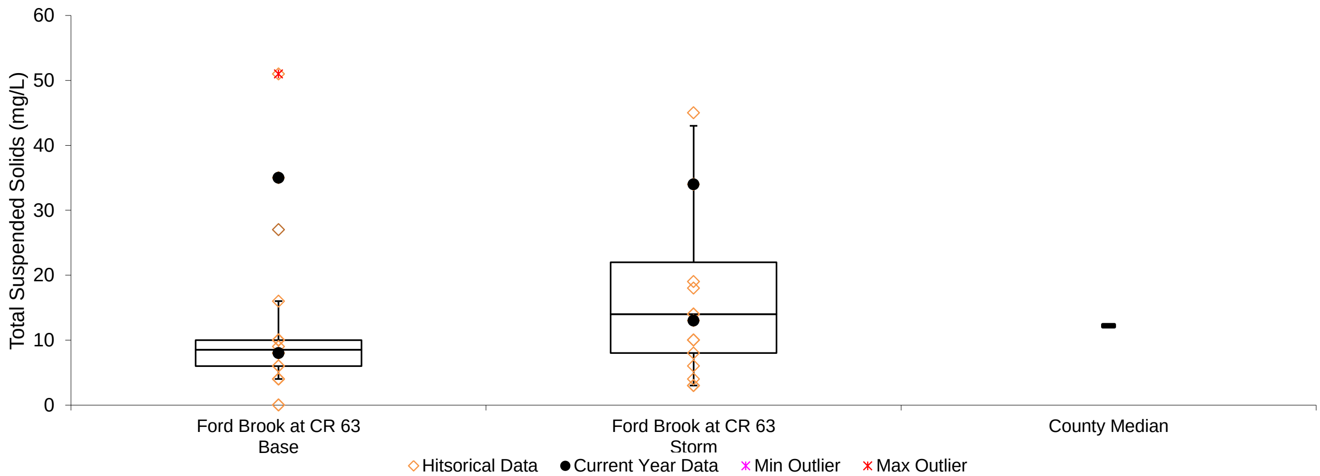
Total Phosphorus at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



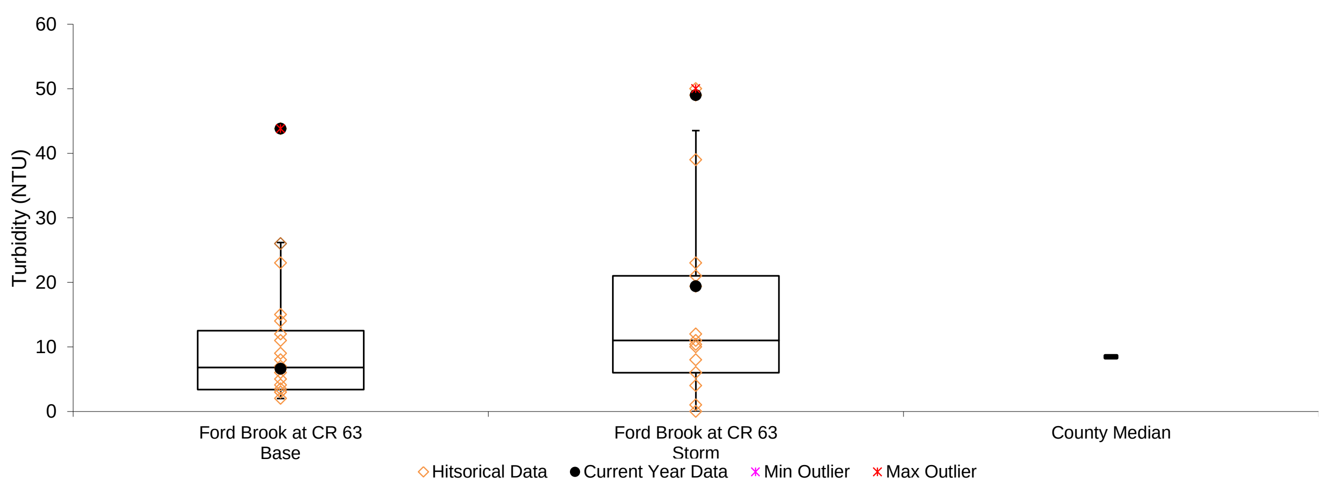
Total Suspended Solids and Turbidity

In Ford Brook both TSS and turbidity were generally low and have been slightly higher during storm events. Median turbidity for Ford Brook (all years, all conditions) was 9 NTU, respectively. This is similar to the countywide median of 8.5 NTU. Only 4 of 33 (12%) measurements at Ford Brook are greater than MPCA's present water quality standard of 25 NTU. Median TSS was 10 mg/L. This is lower than the median for streams county-wide of 12 mg/L. Only 4 of 34 (12%) of TSS measurements exceeded the new water quality standard of 30 mg/L.

Total Suspended Solids at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



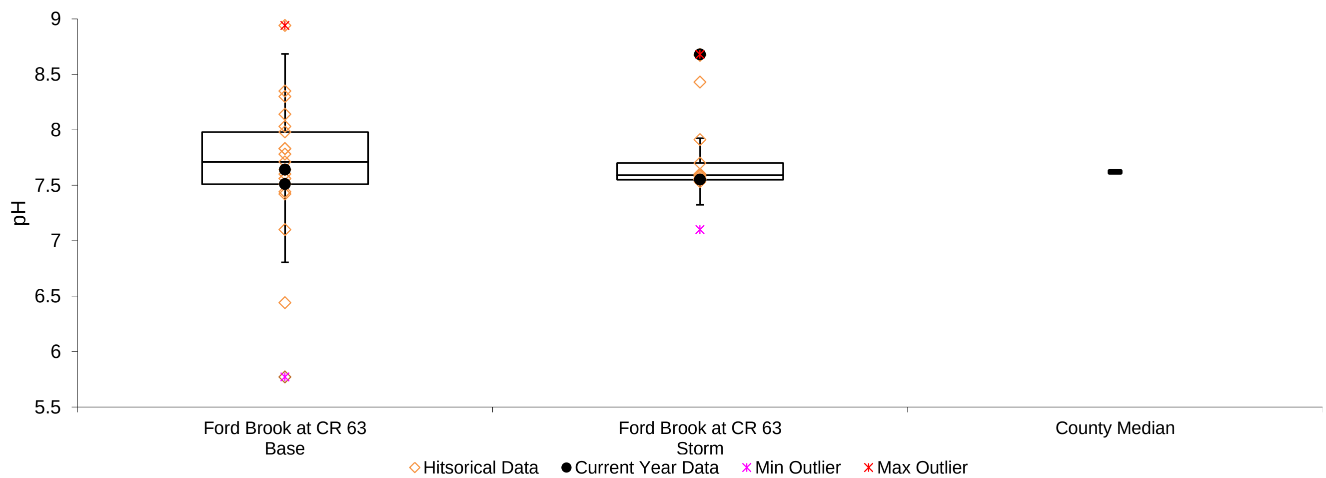
Turbidity at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

pH was generally within the expected range at all sites for 2015. 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 generate concerns. On one monitoring event pH exceeded 8.5. pH was similar during baseflow and storm events.

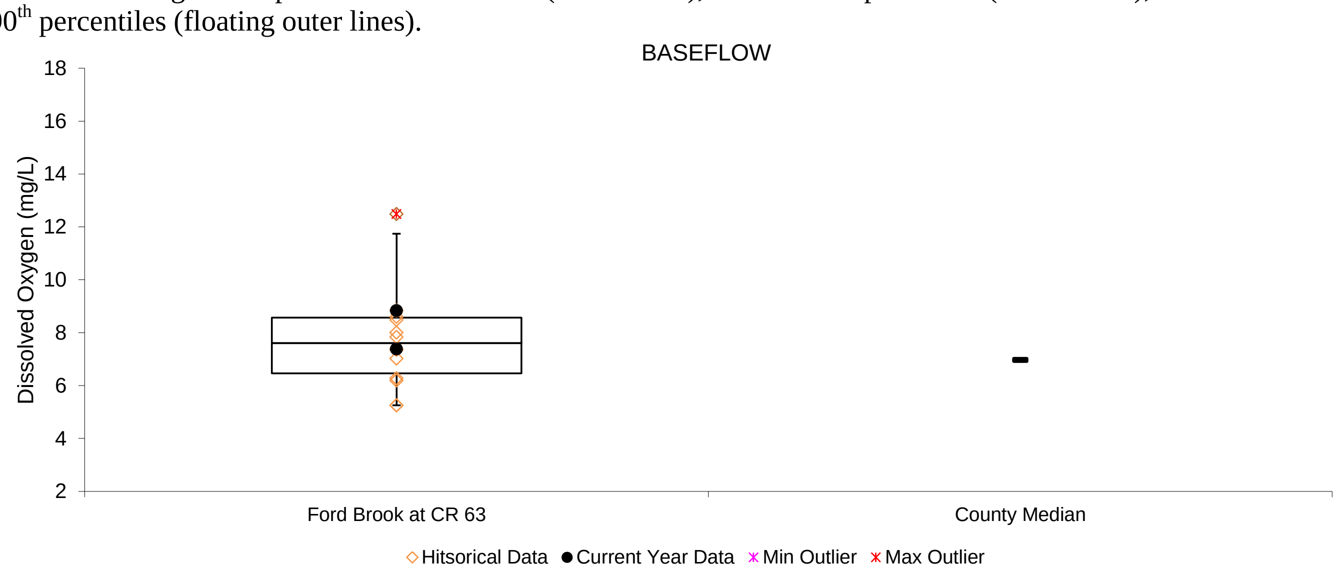
pH at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

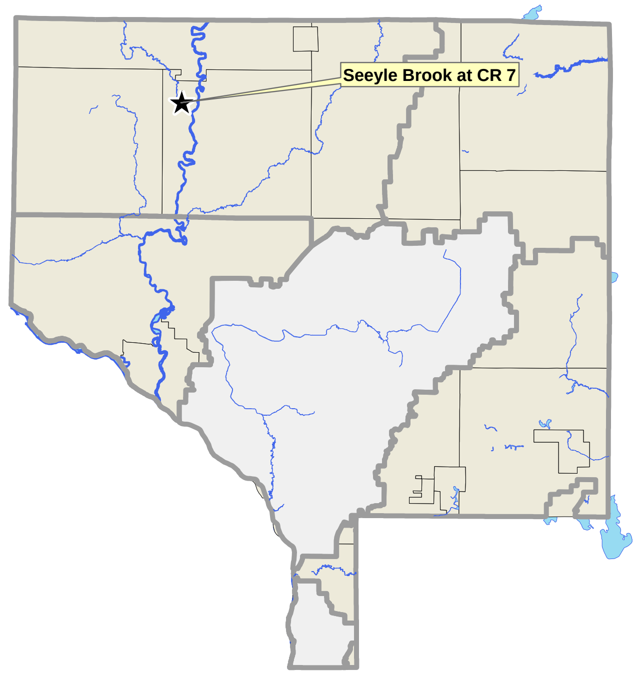
Dissolved oxygen in Ford Brook was within acceptable levels. None of the samples collected have been below the 5 mg/L standard.

Dissolved Oxygen at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



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

This report includes data from 2015. 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 0.396 mS/cm (maximum of 0.534 mS/cm and a minimum of 0.264 mS/cm).
- Phosphorous averaged over the MPCA water quality standard of 135 ug/L. Seelye Brook often exceeds the limit, even during baseflow periods. Phosphorous in Seelye Brook averaged 177 ug/l (maximum of 266 ug/l and a minimum of 117 ug/l).
- Suspended solids and turbidity were higher than the state standards throughout the season. Suspended solids averaged 11.8 mg/l (maximum of 20.0 mg/l and a minimum of 5.0 mg/l). Turbidity averaged 13.88 NTU's (maximum of 18.80 NTU's and a minimum of 4.0 NTU's)
- pH and dissolved oxygen averaged within the range considered normal and healthy for streams in this area. pH averaged 7.85 (maximum of 8.45 and a minimum of 7.44). DO averaged 9.32 mg/l (maximum of 13.53 mg/l and a minimum of 6.61 mg/l).

For a significant number of the results below there are no current state standards. However, this data will be used as a baseline for future assessments of the watershed.

SeelyeBrook at Hwy 7

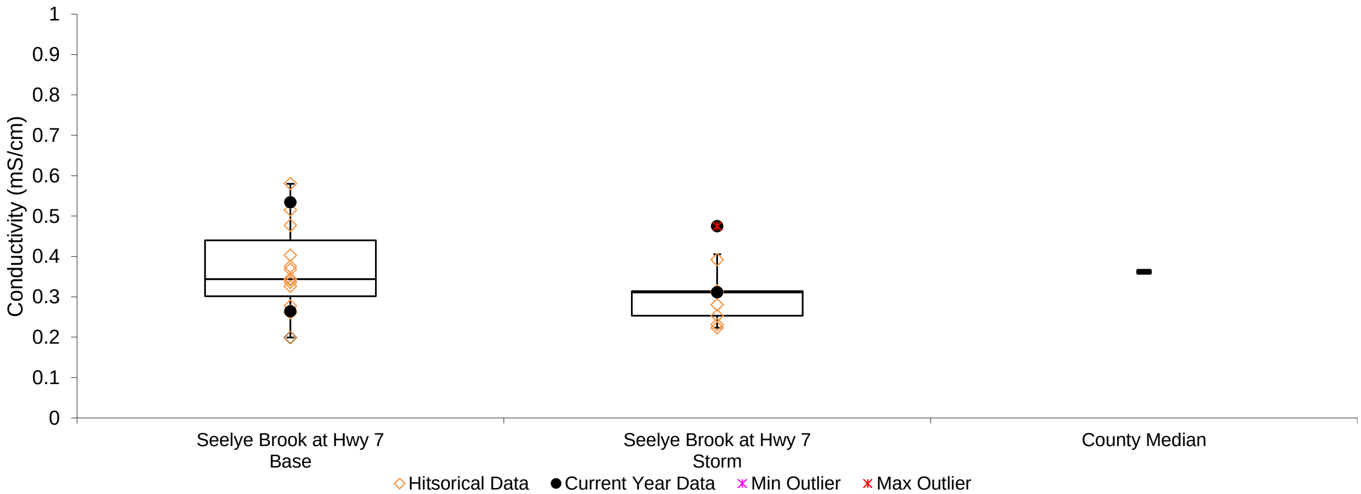
	Units	R.L.*	3/12/2015 Results	4/13/2015 Results	7/6/2015 Results	7/10/2015 Results	Median	Average	Min	Max
pH		0.1	8.45	7.44	7.67	7.82	7.745	7.83	7.44	8.45
Conductivity	mS/cm	0.01	0.311	0.264	0.475	0.534	0.393	0.395	0.264	0.534
Turbidity	NTU	1	18.8	17.5	15.2	4.0	16.35	14.37	4.00	18.80
D.O.	mg/L	0.01	13.53	9.3	6.61	7.82	8.56	9.16	6.61	13.53
D.O.	%	1	93.8	80.6	75.5	90.1	85.35	85.1	75.5	93.8
Temp.	°C	0.1	0.9	9.2	20.1	20.9	14.66	13.2	0.9	20.9
Salinity	%	0.01	0.14	0.13	0.23	0.25	0.185	0.19	0.13	0.25
T.P.	ug/L	10	266	176	149	117	162.5	174	117	266
TSS	mg/L	2	11	20	9.0	7	10	11.4	7.0	20.0
Secchi-tube	cm		64	51	64	>100	64	>100	51	64
E coli	MPN									
Appearance										
Recreational										

*reporting limit

Conductivity

Chlorides were not sampled in 2015 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 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

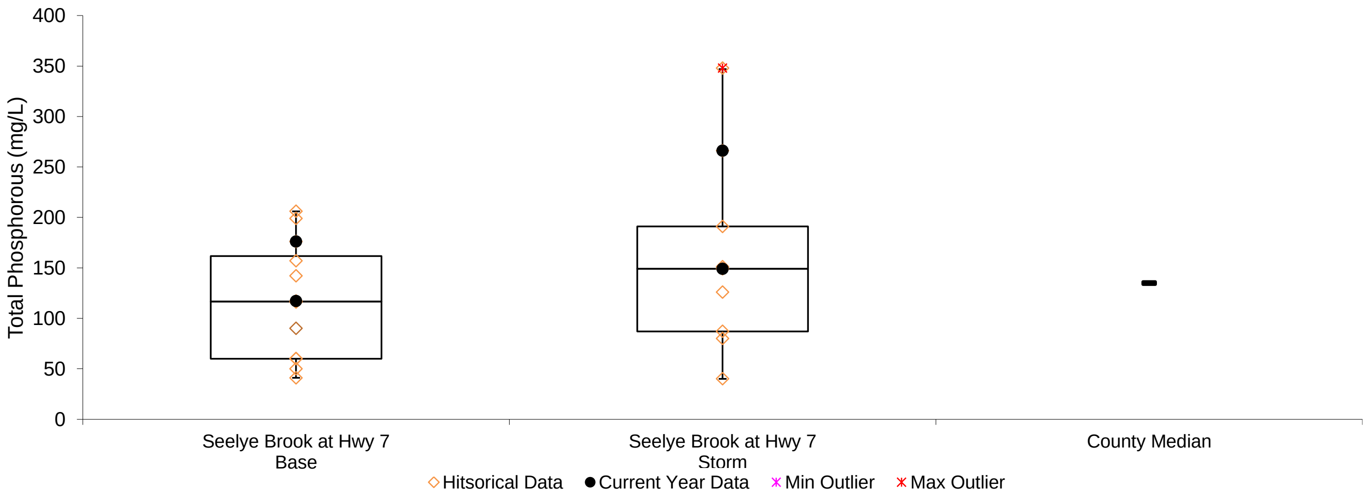


Conductivity is acceptably low in Seelye Brook at Hwy 7. Median conductivity (all years) is 0.301 mS/cm during baseflow and 0.253 mS/cm during storm events, respectively. Both were lower than the median for Anoka County streams of 0.362 mS/cm.

Total Phosphorus

Total phosphorus in Seelye Brook was overall high in 2015 with a slight increase from 2014. 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) was 116.5 ug/L during baseflow and 149 ug/L during storm events. All but one reading in 2015 had phosphorus concentrations higher than the median for Anoka County streams of 135 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 2015 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. In 2015 suspended solids and turbidity increased from 2014.

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.

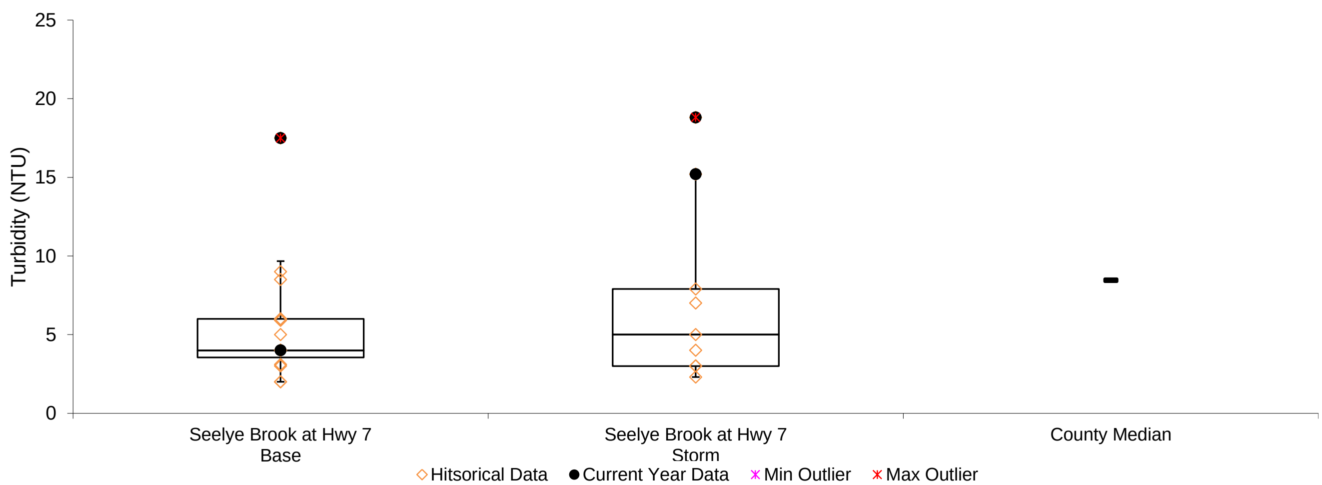
In Seelye Brook, turbidity was much higher in 2015 with slight increases during storms events. The median turbidity (all years) was 4 NTU during baseflow and 5 NTU during storm events, which is lower than the median for Anoka County streams of 8.5 FNRU. Turbidity was elevated on a few occasions. In 2015 the maximum observed was 18.8 NTU during an early-season monitoring event. This was the highest reading ever recorded at this site.

TSS was low throughout 2015 with most readings being below the median for Anoka County streams which is 12.2 mg/L. TSS was much higher than in 2014. During a baseflow sampling an all-time high of 20 mg/L was recorded. Median TSS (all years) was 4.5 mg/L during baseflow and 6.0 mg/L during storm events.

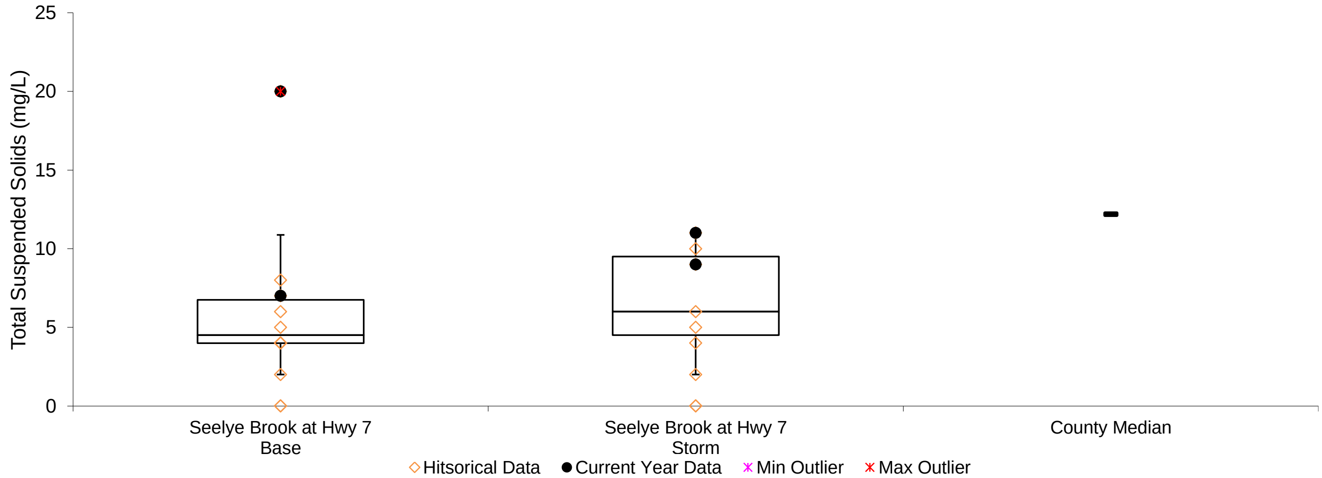
Rigorous stormwater treatment should occur as the Cedar Creek watershed develops, or the collective pollution caused by many small developments will seriously impact the river. Bringing stormwater treatment up to date in older developments is also important.

Differences between TSS and turbidity lend insight into the nature of any problems. TSS showed increases at the downstream monitoring site, while turbidity did not. Turbidity is most sensitive to large particles. Therefore, the downstream increases are likely due to smaller particles. Other pollutants, such as phosphorus and metals, are most highly correlated with smaller particles. These other pollutants can "hitch a ride" on smaller particles because of their greater surface area and, in the case of certain soils, ionic charge. Furthermore, small particles stay suspended in the water column and therefore are more likely to be transported by stream flows and are more difficult to remove with stormwater practices like settling ponds.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



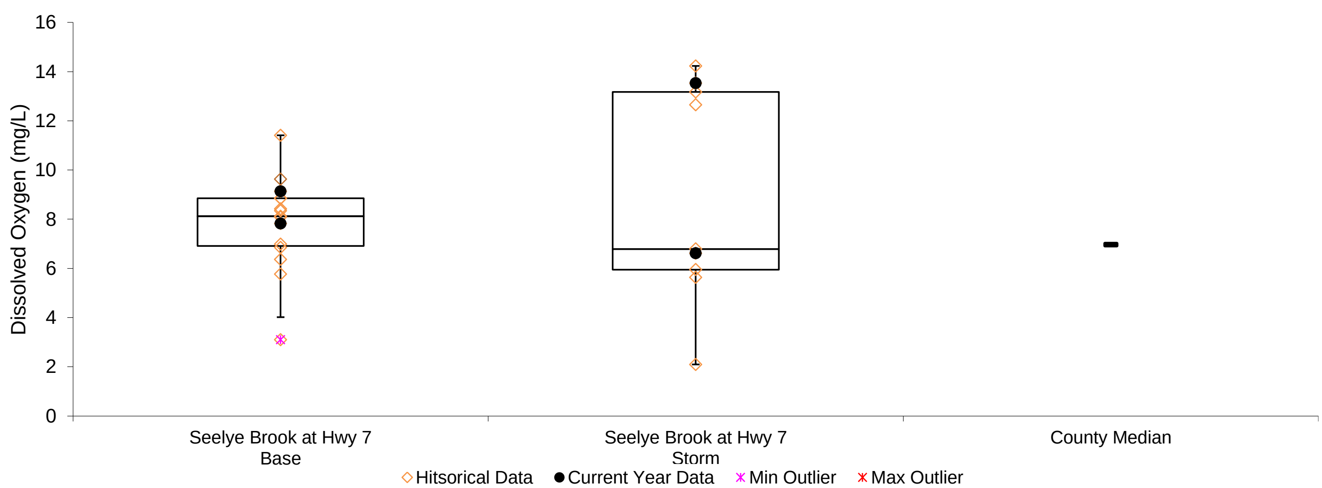
Total Suspended Solids during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below 5 mg/L aquatic life begins to suffer. In 2015 Seelye Brooks dissolved oxygen was always above 6.5 mg/L. Median dissolved oxygen (all years) was 6.91mg/L during baseflow and 5.95 mg/L during storm events.

Dissolved oxygen during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

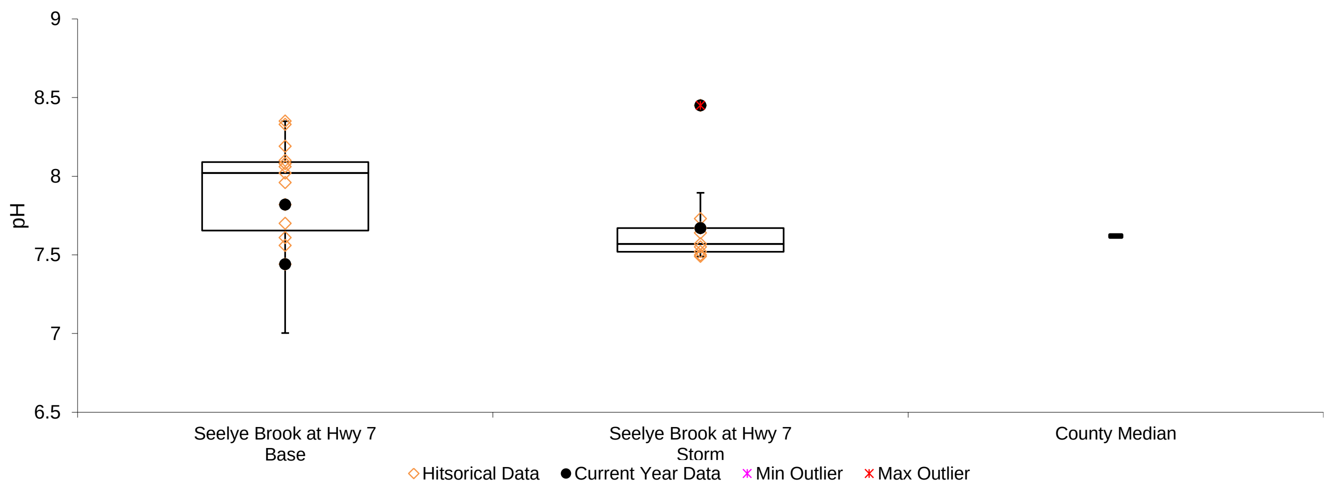


pH

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 is generally within this range (see figure below).

It is interesting to note that pH is 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 2015 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

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 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: Rum River at Hwy 24, Rum River **North County Park, St. Francis**

Rum River at CR 7, Rum River **Central County Park, Oak Grove**

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, 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.

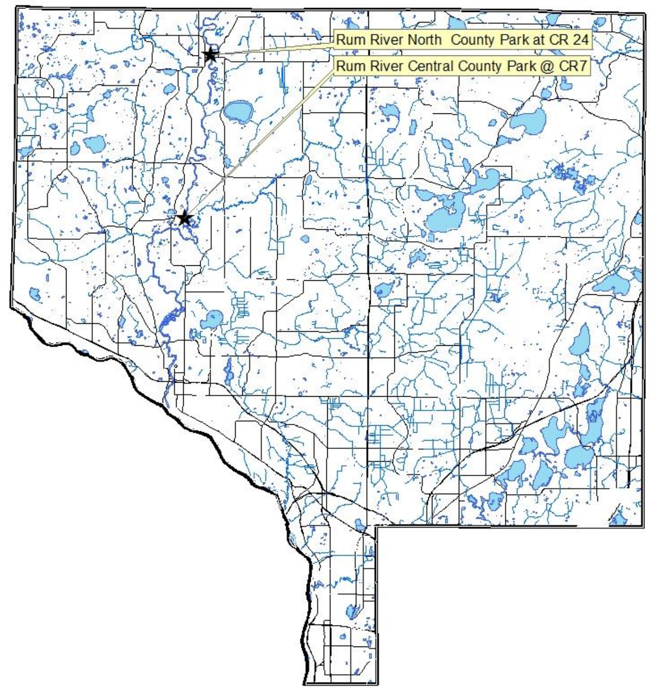
FBI	Stream Quality Evaluation
0.00-3.75	Excellent
3.76-4.25	Very Good
4.26-5.00	Good
5.01-5.75	Fair
5.76-6.50	Fairly Poor
6.51-7.25	Poor
7.26-10.00	Very Poor

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

Biomonitoring

RUM RIVER

at Rum River North County Park, St. Francis



Last Monitored

By St. Francis High School 2014

Monitored Since

2000

Student Involvement

approximately 1,330 since 2000

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. Other than the Mississippi, this is the largest river in the county. In Anoka County the river has both rocky riffles as well as pools and runs with sandy bottoms. The river's condition is generally regarded as excellent. Portions of the Rum in Anoka County have a state "scenic and recreational river" designation.

The sampling site is in Rum River North County Park. This site is typical of the Rum in northern Anoka County, having a rocky bottom with numerous pool and riffle areas.

Results

In 2015 teachers at St. Francis High School decided to not participate in the biomonitoring program. Previous year's results can be observed in the analysis of Rum River Central County Park Data below.

Rum River

Moved to Rum Central Park, Ramsey/Oak Grove

Last Monitored

Anoka County 4-H club in 2015

Monitored Since

2015

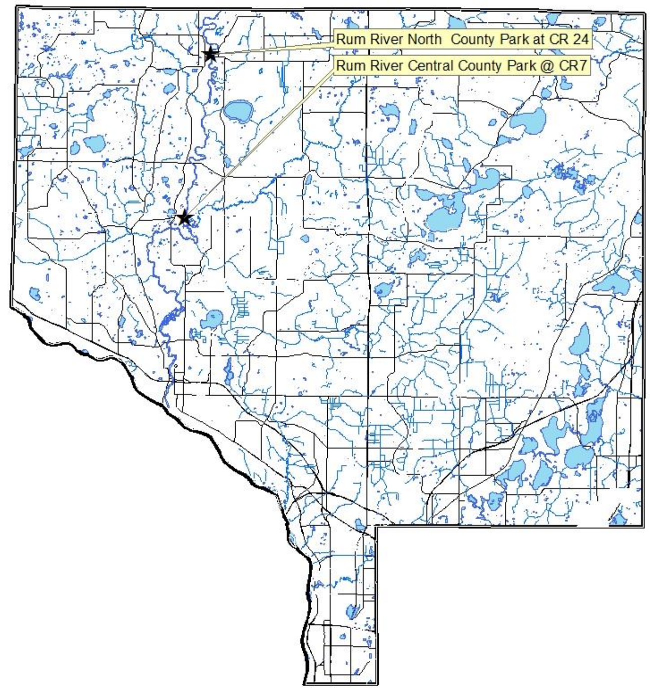
Student Involvement

8 students in 2015

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. Other than the Mississippi, this is the largest river in the county. In Anoka County the river has both rocky riffles as well as pools and runs with sandy bottoms. The river's condition is generally regarded as excellent. Portions of the Rum in Anoka County have a state "scenic and recreational river" designation.

The sampling site is in Rum River Central County Park. This site is typical of the Rum in northern Anoka County, having a rocky bottom with numerous pool and riffle areas.

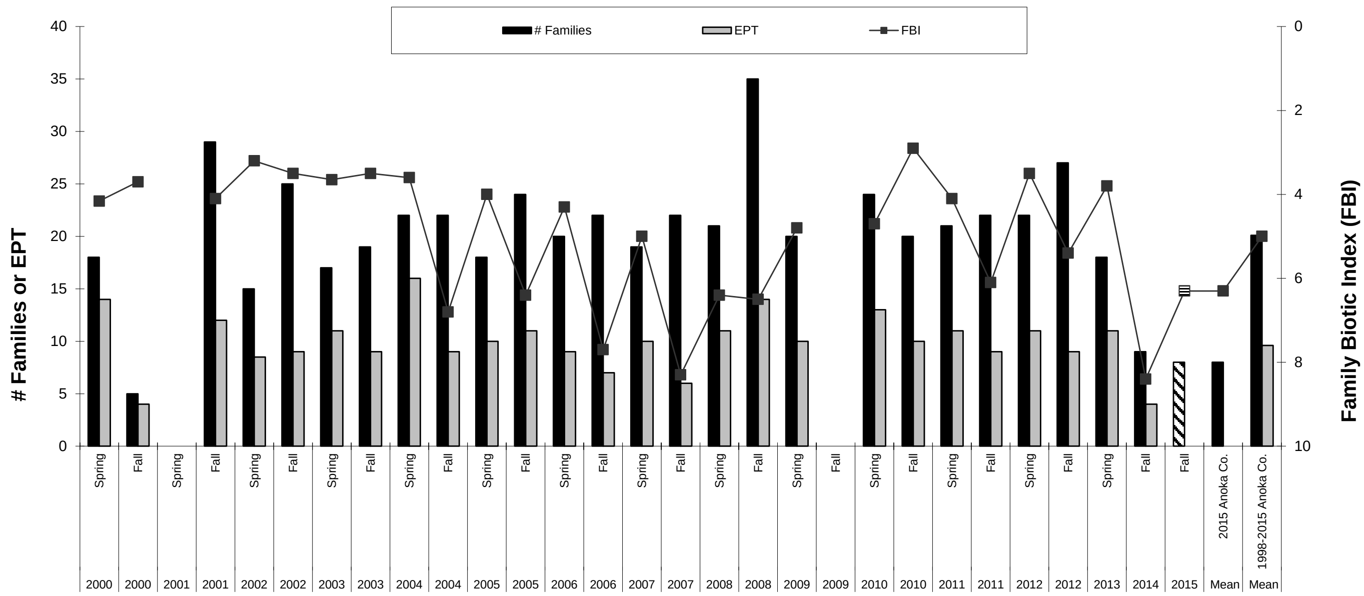


Results

Due to lack of interest from teachers at St. Francis High School in participating in the biomonitoring program, a 4-H club monitored the Rum River at Rum Central Park with Anoka Conservation District (ACD) oversight. The data collected is displayed side by side with the historical data for Rum River North County Park Biological data purely for comparison. If this site continues to be monitored a multi-year site specific analysis will be done. Data collected at Rum Central is not an indication of stream health at Rum River North. Rum Central data is displayed with dashed points for comparison.

Results were similar to those seen at Rum North in 2014 with the exception of EPT families. None were observed. In July 2015, 8 families were found and 0 of them were EPT. This is among the lowest ever observed throughout the monitored area of the Rum River. While this could be concerning, the lack of sample size, historical data, and the habitat at the monitoring location are all likely contributing factors.

Summarized Biomonitoring Results for Rum River at Hwy 24, St. Francis with Rum River at CR 7, Oak Grove displayed with stripes (samplings by St. Francis High School, Crossroads Schools, and an Anoka County 4-H club)



2015 Data collected at Rum Central County Park, Ramsey/Oak Grove

Biomonitoring Data for Rum River at Rum River North County Park, St. Francis (in White) with Rum River at Rum River Central Park, Oak Grove (in Grey)

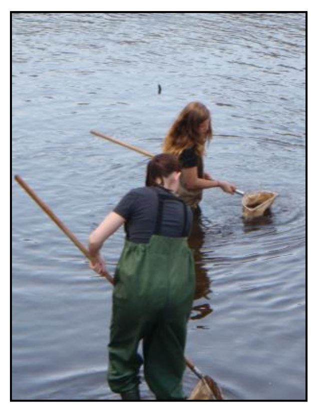
Data presented from the most recent eight years. Contact the ACD to request archived data.

Year	2008	2008	2009	2009	2010	2010	2011	2011	2012	2012	2013	2014	2015	Mean	Mean
Season	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Fall	2015 Anoka Co.	1998-2015 Anoka Co.
FBI	6.40	6.50	4.80	Unusable	4.7	2.9	4.1	6.1	3.5	5.4	3.8	8.4	6.3	6.3	5.0
# Families	21	35	20	Sample	24	20	21	22	22	27	18	9	8	8.0	20.1
EPT	11	14	10		13	10	11	9	11	9	11	4	0	0.0	9.6
Date	27-May	30-Sep	29-Apr	13-Oct	27-Apr	29-Oct	10-Jun	28-Sep	22-May	27-Sep	20-May	24-Oct	22-Jul		
Sampled By	SFHS	SFHS	SFHS	SFHS	SFHS	ACD	ACD	SFHS	SFHS	SFHS	SFHS	SFHS	4-H		
Sampling Method	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH		
Mean # Individuals/Rep.	348	156	267		142	274	418	443	144	333	247.5	219	23		
# Replicates	2	4	2		3	1	1	2	2	1	2	1	1		
Dominant Family	Corixidae	Corixidae	Corixidae		Nemouridae	Leptophlebiidae	baetidae	hydrophilidae	hydropsy	veliidae	Baetiscida	Corixidae	Cambaridae		
% Dominant Family	57.5	61.4	24.3		28.1	39.4	66.3	21.4	36.6	13.8	34.7	86.3	34.8		
% Ephemeroptera	11.9	17.9	18.7		23.9	51.1	81.3	3.6	43.2	34.2	54.1	3.7	0		
% Trichoptera	5.9	6.9	20.2		10.8	6.2	6.0	4.3	41.1	4.2	6.3	0.5	0.0		
% Plecoptera	17.1	2.1	27.7		32.8	26.6	3.8	9.7	5.2	11.1	30.3	2.3	0		

Discussion

Historically, both chemical and biological monitoring indicate the good quality of the Rum River. 2015 observed some of the worst biomonitoring results in recent history. But varying factors should caution any jump to conclusions. One aspect that should be an area of increased observation is that in both 2014 and 2015 the lack of families found as well as the dominant family making up such a high percentage were the key factors in the poor Family Biotic Index observed. Habitat in the Rum River 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. While there does not appear to be any trend, the upper region of the Rum should continue to be observed closely.

Water resource management should be focused upon protecting the Rum's quality. Some steps to protect the Rum River could include:



- Enforce scenic river law building and clear cutting setbacks.
- Retrofit stormwater conveyance systems to provide better water quality treatment, especially in St. Francis and Anoka where older areas have little or no stormwater treatment.
- Education programs to encourage actions by residents that will benefit the river's health.
- Continue water quality monitoring programs.

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

Cedar Creek, Cedar Creek Natural History Area, East Bethel

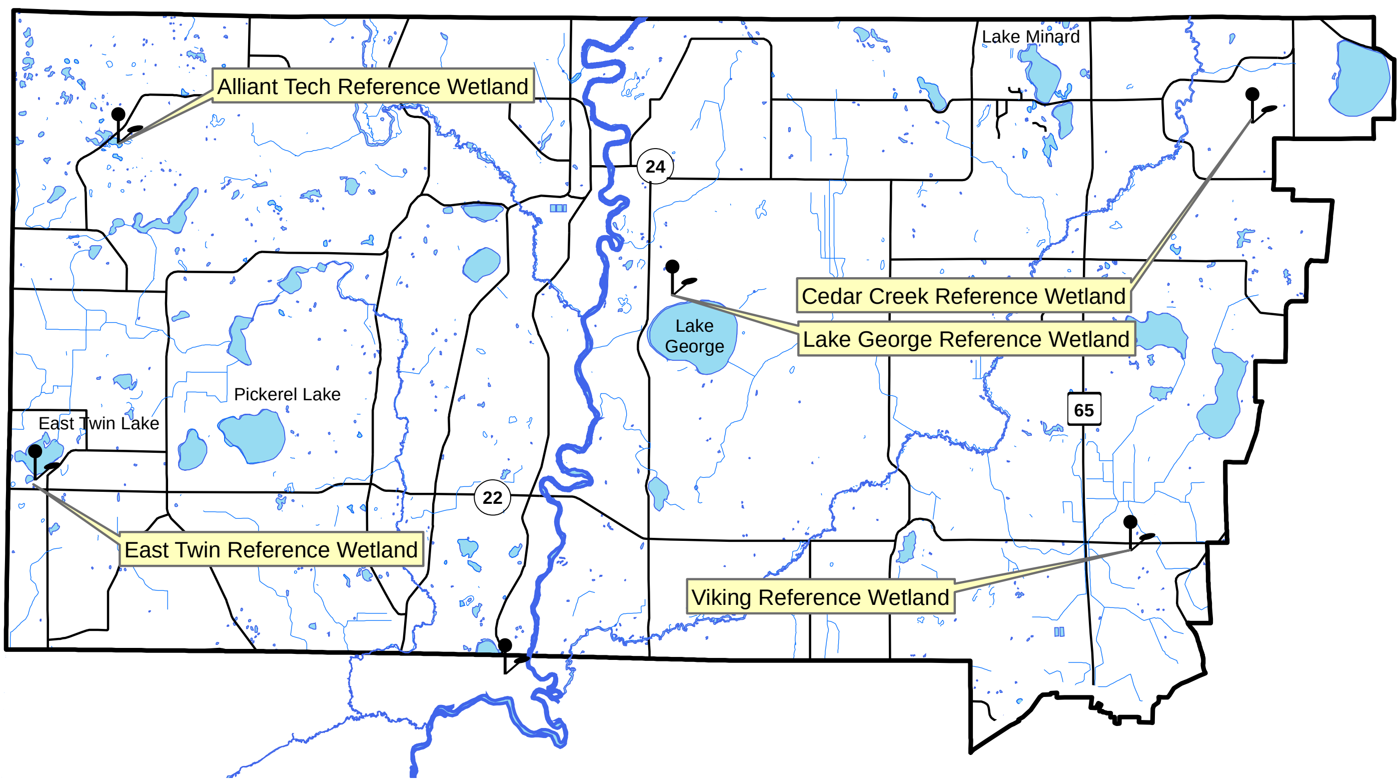
East Twin Reference Wetland, East Twin Township Park, Nowthen

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

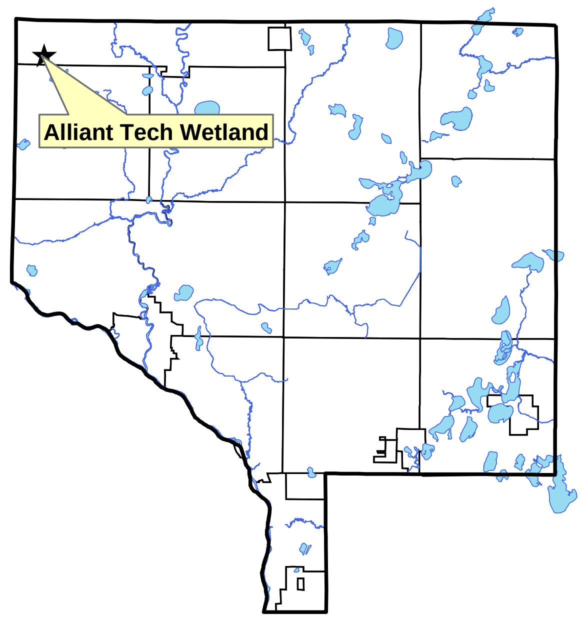
Monitored Since: 2001

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	-

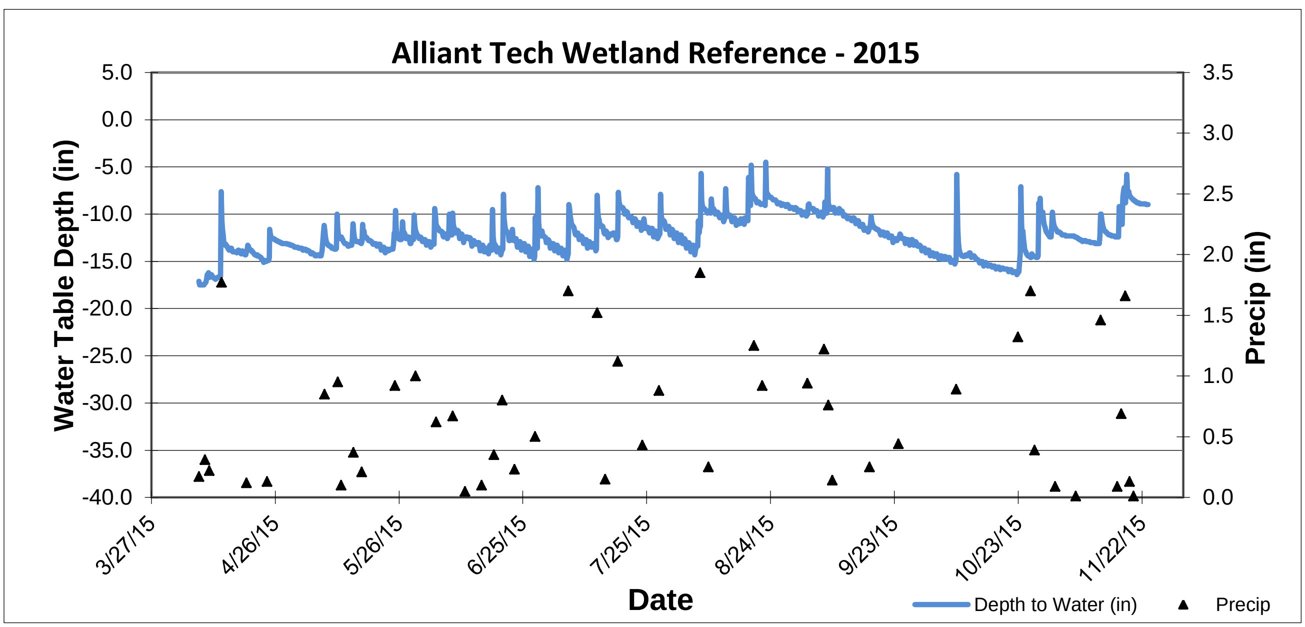
Surrounding Soils: Emmert

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.

2015 Hydrograph

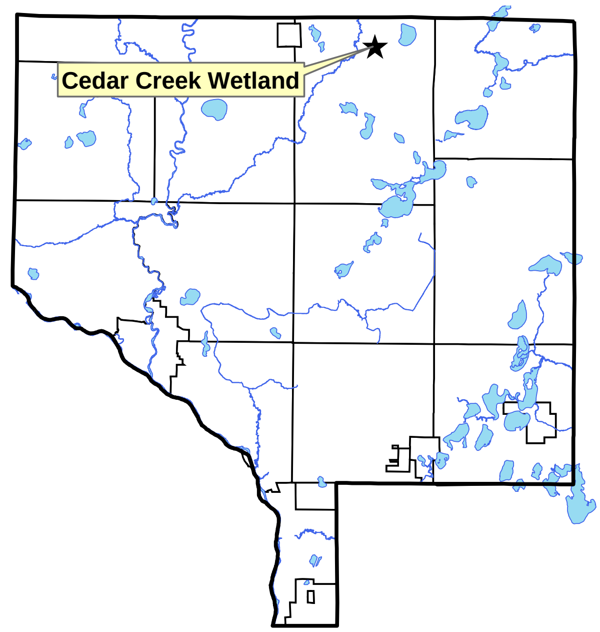


Well depth was 47 inches, so a reading of –47 indicates water levels were at an unknown depth greater than or equal to 47 inches.

Wetland Hydrology Monitoring

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

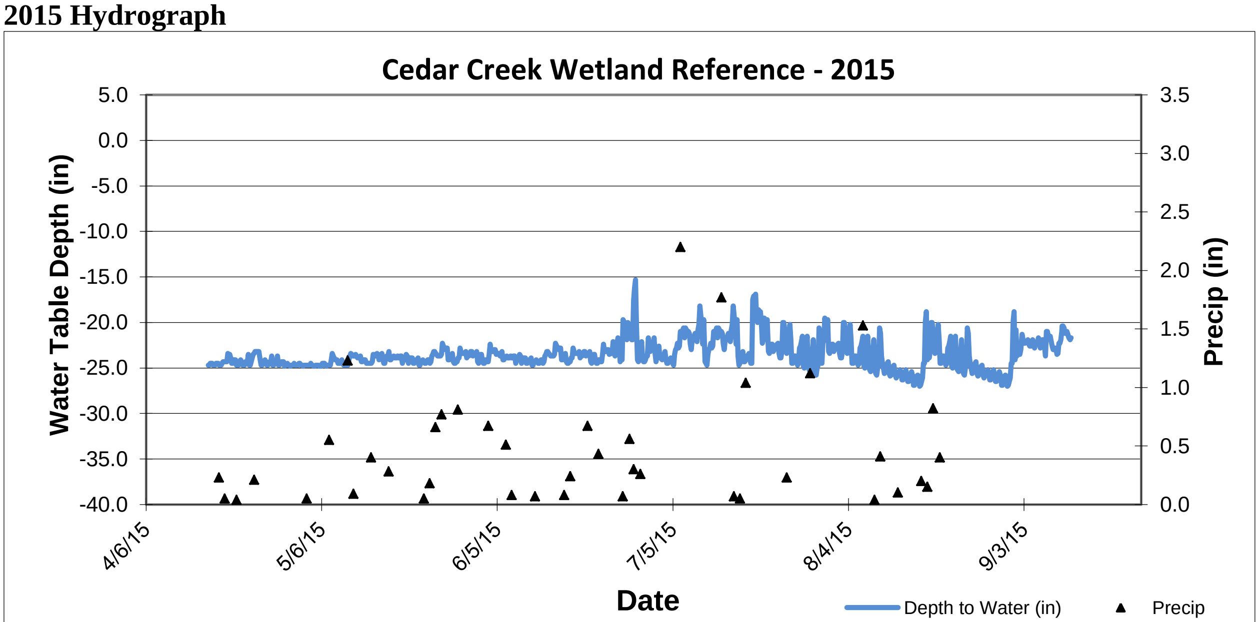
Soils at Well Location: not yet available

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.

2015 Hydrograph

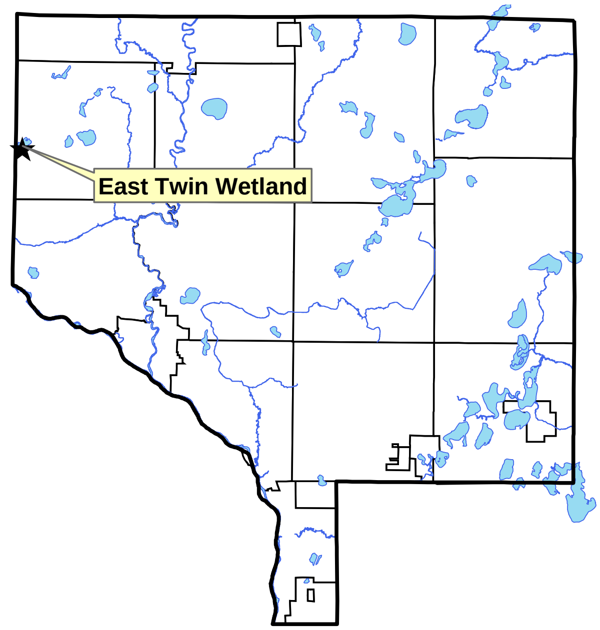


Well depth was 37 inches, so a reading of –37 indicates water levels were at an unknown depth greater than or equal to 37 inches.

Wetland Hydrology Monitoring

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	-

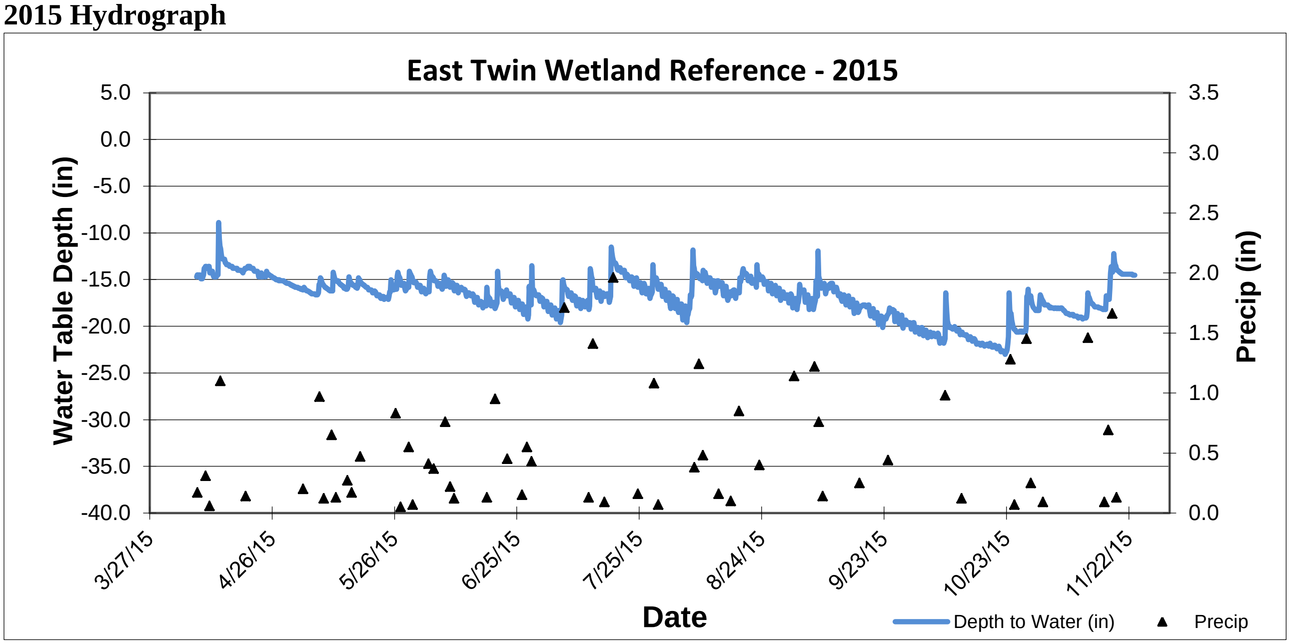
Surrounding Soils: Lake Beach, Growton and Heyder fine sandy loams

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.

2015 Hydrograph

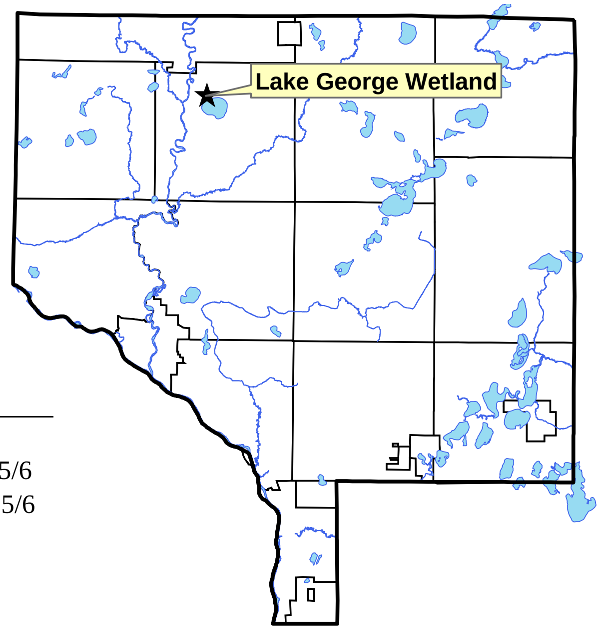


Well depth was 44 inches, so a reading of –44 indicates water levels were at an unknown depth greater than or equal to 44 inches.

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

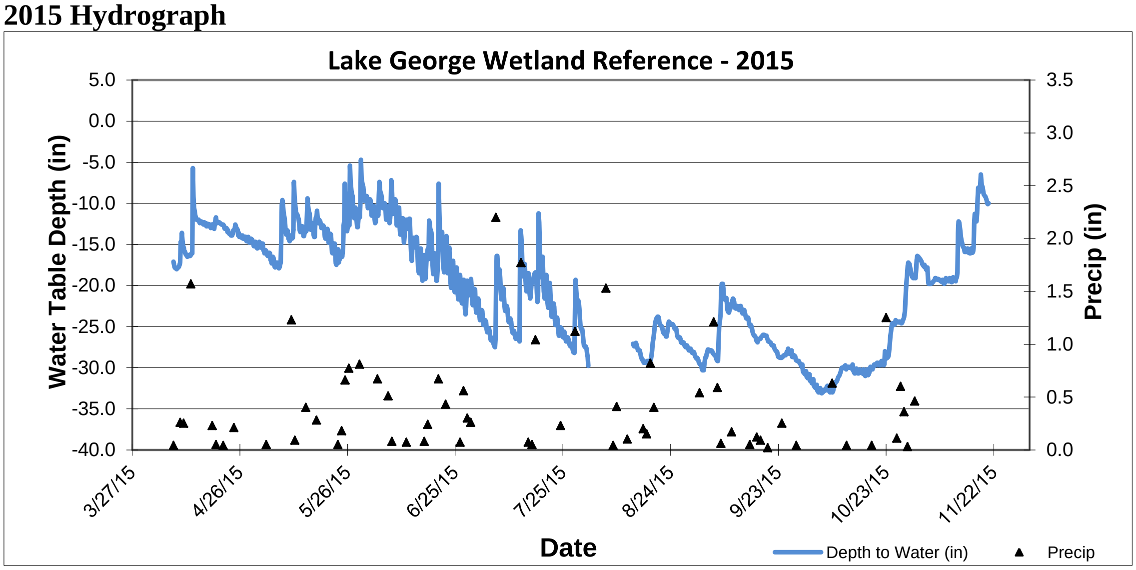
Surrounding Soils: Lino loamy fine sand and Zimmerman fine sand

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.

2015 Hydrograph

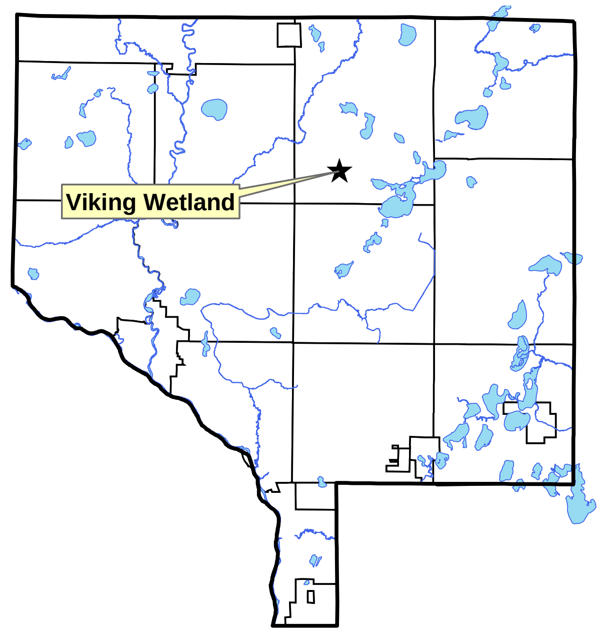


Well depth was 38 inches, so a reading of –38 indicates water levels were at an unknown depth greater than or equal to 38 inches.

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

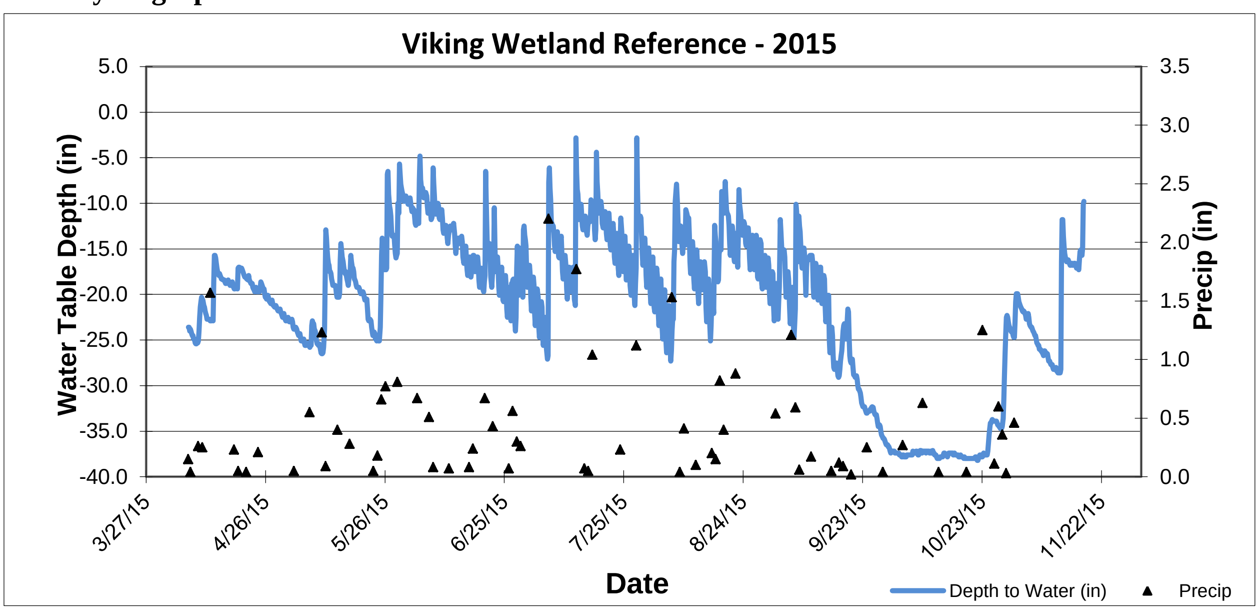
Surrounding Soils: Zimmerman fine sand

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).

2015 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.

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 (see ACD website for full policies). The ACD Board of Supervisors approves any dispersements.

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 provides project consultation and design services at low or no cost, which is highly beneficial for grant applicants. 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
Fund Balance		**$ 1598.67**

Special note: For all funds contributed after 2013, the URRWMO has asked to re-evaluate how these grants are administered. The WMO may choose to administer the funds themselves or with other oversight of the ACD's process.

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.

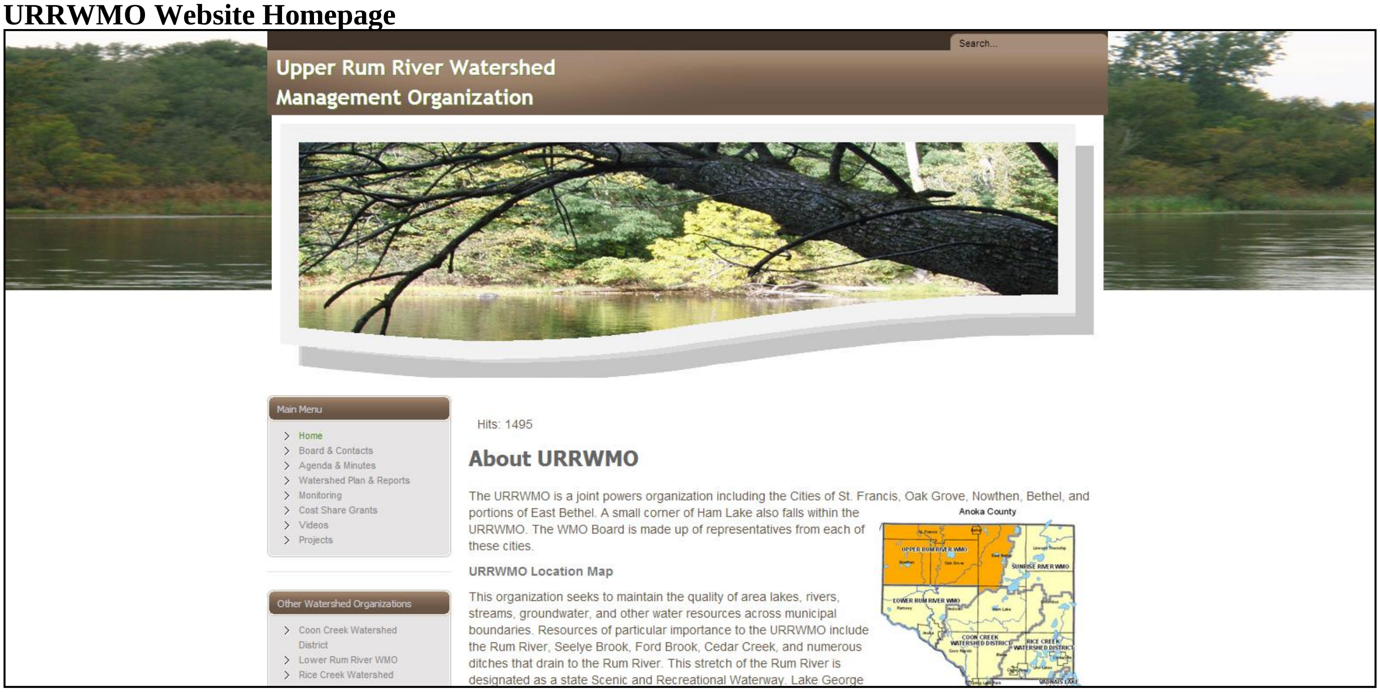
Location: www.URRWMO.org

Results: In 2013 ACD re-launched the URRWMO website.

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.

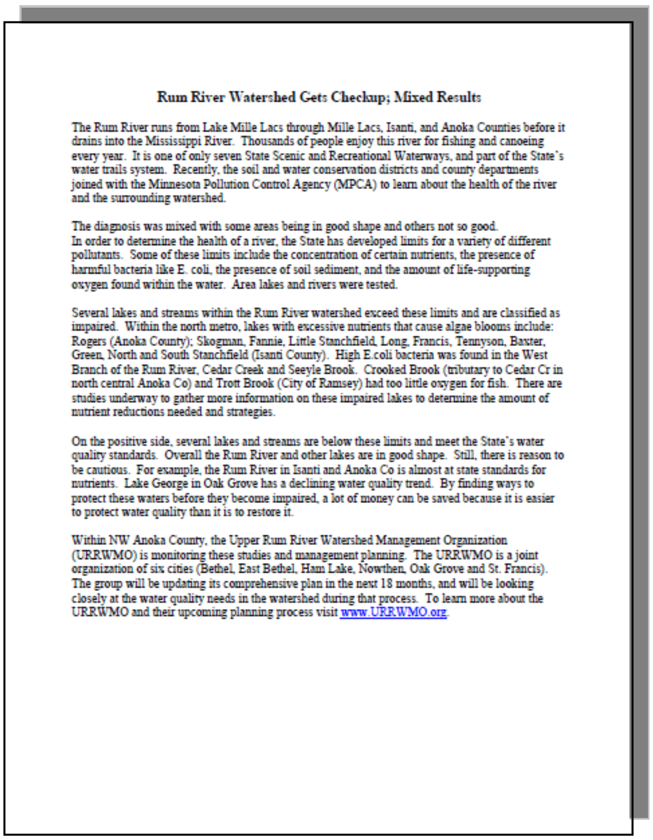
Purpose: To increase public awareness of the URRWMO and its programs as well as receive input.

Locations: Watershed-wide.

Results: The Anoka Conservation District (ACD) assisted the URRWMO by drafting the annual newsletter article. The URRWMO discussed topics to be covered in the article. It was decided that the newsletter article would be the Rum River Watershed Restoration and Protection Project.

ACD staff drafted the newsletter article and sent it to the URRWMO Board for review. The URRWMO Board reviewed and edited the draft article. The finalized article was posted to the URRWMO Website, sent to each member community, as well as to the Independent School District 15 publication, "The Courier."

2015 URRWMO Newsletter Article



Rum River Watershed Gets Checkup; Mixed Results

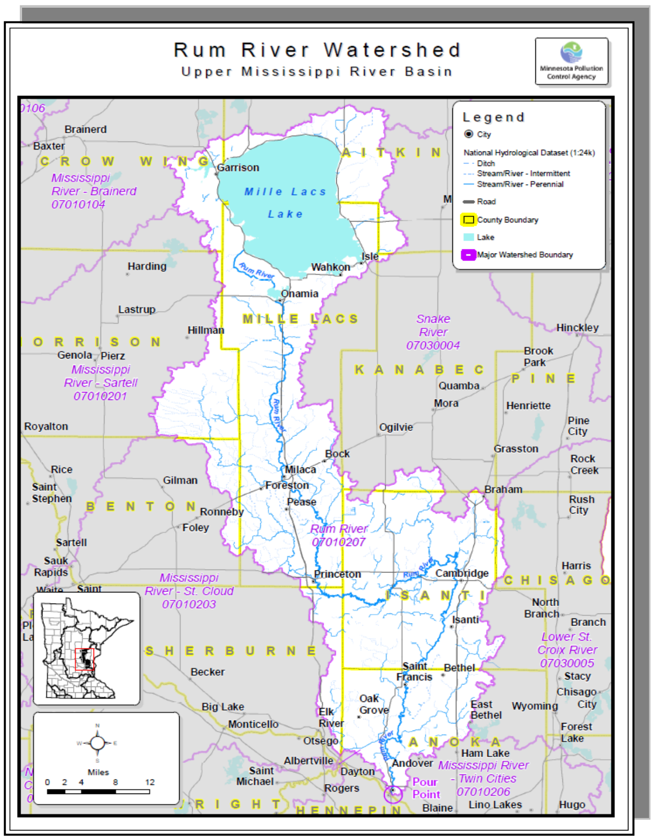
The Rum River runs from Lake Mille Lacs through Mille Lacs, Isanti, and Anoka Counties before it drains into the Mississippi River. Thousands of people enjoy this river for fishing and canoeing every year. It is one of only seven State Scenic and Recreational Waterways, and part of the State's water trails system. Recently, the soil and water conservation districts and county departments joined with the Minnesota Pollution Control Agency (MPCA) to learn about the health of the river and the surrounding watershed.

The diagnosis was mixed with some areas being in good shape and others not so good. In order to determine the health of a river, the State has developed limits for a variety of different pollutants. Some of these limits include the concentration of certain nutrients, the presence of harmful bacteria like E. coli, the presence of soil sediment, and the amount of life-supporting oxygen found within the water. Area lakes and rivers were tested.

Several lakes and streams within the Rum River watershed exceed these limits and are classified as impaired. Within the north metro, lakes with excessive nutrients that cause algae blooms include: Rogers (Anoka County); Skogman, Fannie, Little Stanchfield, Long, Francis, Tennyson, Baxter, Green, North and South Stanchfield (Isanti County). High E.coli bacteria was found in the West Branch of the Rum River, Cedar Creek and Seeyle Brook. Crooked Brook (tributary to Cedar Cr in north central Anoka Co) and Trott Brook (City of Ramsey) had too little oxygen for fish. There are studies underway to gather more information on these impaired lakes to determine the amount of nutrient reductions needed and strategies.

On the positive side, several lakes and streams are below these limits and meet the State's water quality standards. Overall the Rum River and other lakes are in good shape. Still, there is reason to be cautious. For example, the Rum River in Isanti and Anoka Co is almost at state standards for nutrients. Lake George in Oak Grove has a declining water quality trend. By finding ways to protect these waters before they become impaired, a lot of money can be saved because it is easier to protect water quality than it is to restore it.

Within NW Anoka County, the Upper Rum River Watershed Management Organization (URRWMO) is monitoring these studies and management planning. The URRWMO is a joint organization of six cities (Bethel, East Bethel, Ham Lake, Nowthen, Oak Grove and St. Francis). The group will be updating its comprehensive plan in the next 18 months, and will be looking closely at the water quality needs in the watershed during that process. To learn more about the URRWMO and their upcoming planning process visit www.URRWMO.org.



URRWMO 2014 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.

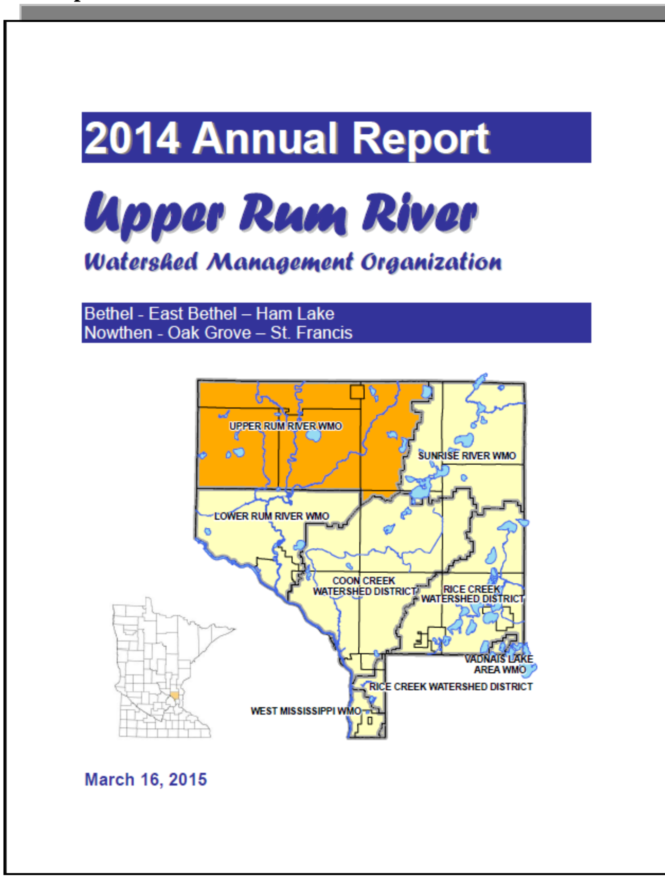
Locations: Watershed-wide

Results: The Anoka Conservation District assisted the URRWMO with preparation of a 2014 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 2015. The report to BWSR and financial report are available on the URRWMO website.

Report to BWR Cover



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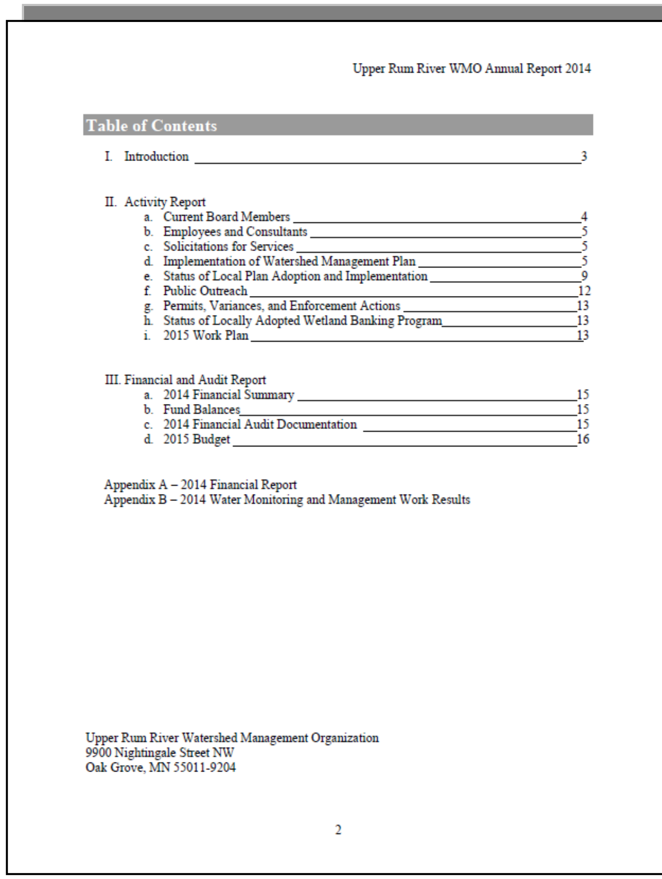

Upper Rum River WMO Annual Report 2014

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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.

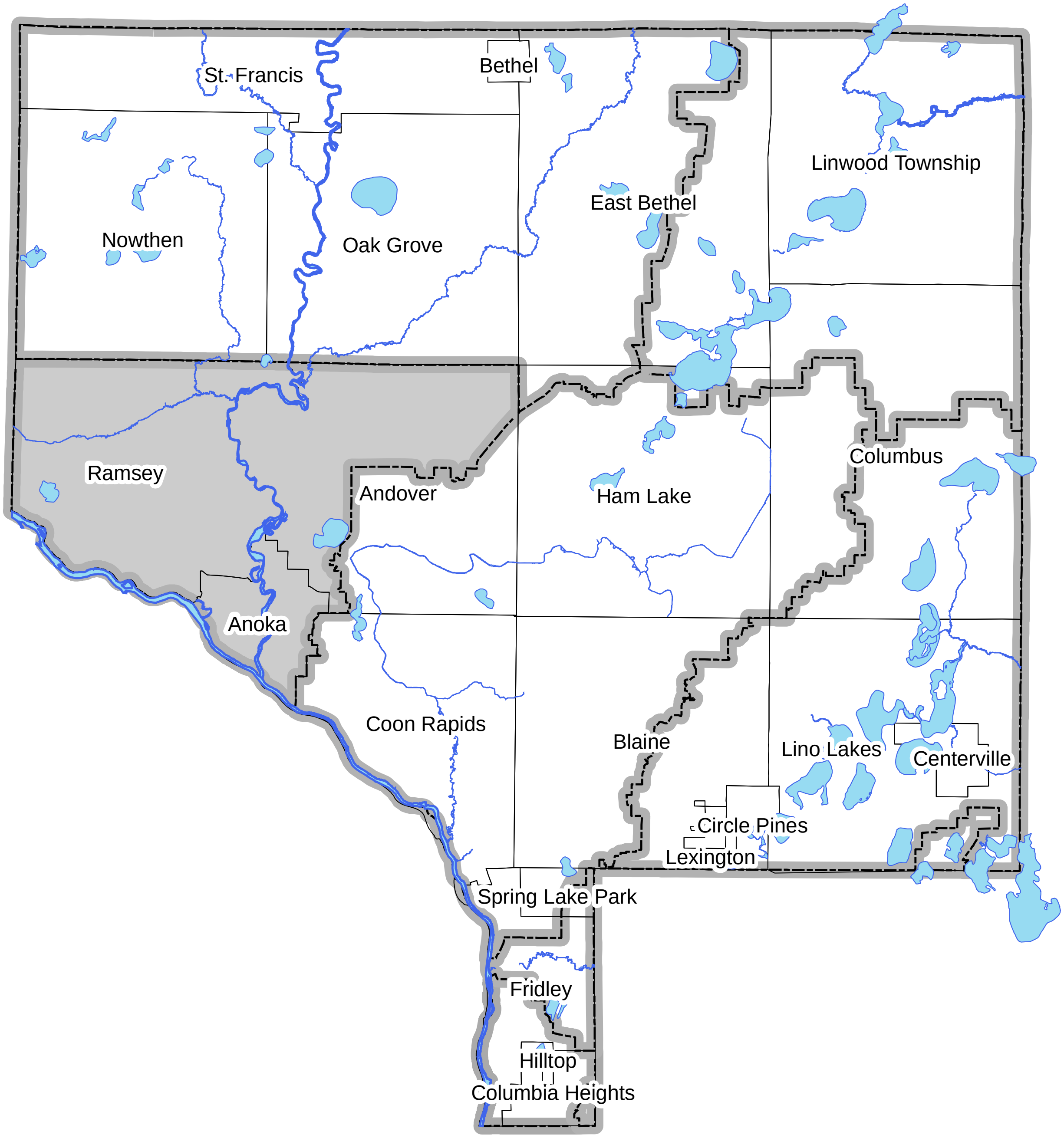
Upper Rum River Watershed Financial Summary

Upper Rum River Watershed	WMO Asst (no charge)	Volunteer Precip	CCWD Precip	Reference Wetlands	Ob Well	Lake Level	Lake Water Quality	Stream Level	Stream Water Quality	Student Biomonitoring	URRWMO Admin	WMO Annual Rpts to State	URRWMO Outreach/Promo	WMO Website Maintenance	URRWMO Planning	BMP Maintenance	Rum River WRAPP	Lake George CLP Mapping	St. Francis SRA (Rum River WRAPP)	Total
Revenues																				
URRWMO	0	0	0	1725	0	1000	0	0	4200	825	798	1000	500	490	0	0	0	0	0	10538
State	0	0	0	0	534	0	0	0	0	0	0	0	0	0	0	0	38373	0	5566	44473
Anoka Conservation District	0	0	0	88	0	0	0	0	0	0	112	0	456	0	276	0	0	0	0	932
Anoka Co. General Services	379	0	0	1176	0	0	0	0	0	0	0	0	0	0	0	2481	853	2257	63	7209
County Ag Preserves/Projects	0	0	0	0	0	0	1003	0	0	384	0	0	0	0	0	0	0	0	0	1387
Regional/Local	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Service Fees	0	0	0	46	0	0	1177	138	0	0	0	0	0	0	0	0	0	1079	0	2441
BWSR Cons Delivery	0	0	0	0	0	271	1331	827	0	46	0	0	0	0	0	0	0	0	0	2476
BWSR Cost Share TA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Local Water Planning	0	996	0	852	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1848
TOTAL	379	996	0	3887	534	1271	3512	965	4200	1255	910	1000	956	490	276	2481	39226	3336	5629	71302
Expenses-																				
Capital Outlay/Equip	3	9	0	1110	5	11	25	8	17	11	8	3	8	3	2	21	52	29	49	1373
Personnel Salaries/Benefits	333	877	0	2378	470	1113	2590	846	1726	1105	801	267	842	275	243	2181	5309	2936	4954	29246
Overhead	21	56	0	152	30	71	166	54	111	71	51	17	54	18	16	140	340	188	317	1873
Employee Training	2	6	0	15	3	7	17	5	11	7	5	2	5	2	2	14	34	19	32	186
Vehicle/Mileage	5	13	0	34	7	16	37	12	25	16	12	4	12	4	3	31	76	42	71	421
Rent	14	36	0	99	19	46	107	35	72	46	33	11	35	11	10	90	220	122	205	1212
Program Participants	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Program Supplies	0	0	0	99	0	7	569	4	819	0	0	0	0	0	0	4	33195	0	0	34696
McKay Expenses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	379	996	0	3887	534	1271	3512	965	2779	1255	910	303	956	312	276	2481	39226	3336	5629	69007

Recommendations

- **Actively participate in the MPCA Rum River WRAPP (Watershed Restoration and Protection Plan).** This WRAPP is an assessment of the entire Rum River watershed. This is an opportunity for the URRWMO to prioritize and coordinate efforts with upstream entities and state agencies.
- **Collaborate on efforts to diagnose declining water quality in Lake George and fix it.** The Lake George Improvement District and 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 is identifying 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 only 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.
- **Correct riverbank erosion issues discovered during the 2010 Rum River survey**. Several locations of severe riverbank erosion were documented, as well as many instances of minor erosion. Offering landowners financial assistance, designs and construction crews is key.
- **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 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

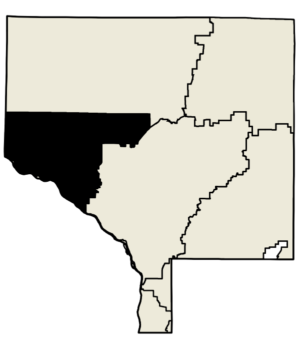


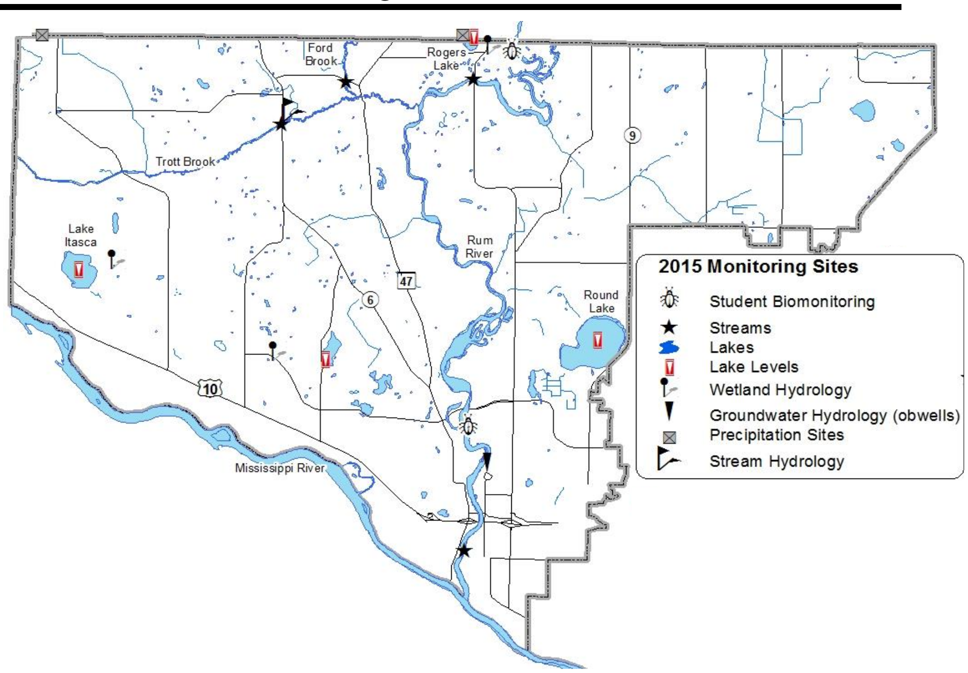
Contact Info: Lower Rum River Watershed Management Organization
www.lrrwmo.org
763-421-8999

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

CHAPTER 4:
LOWER RUM RIVER WATERSHED

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 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).

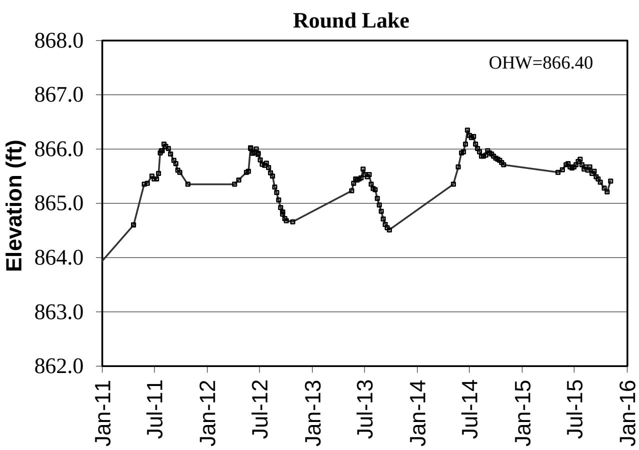
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

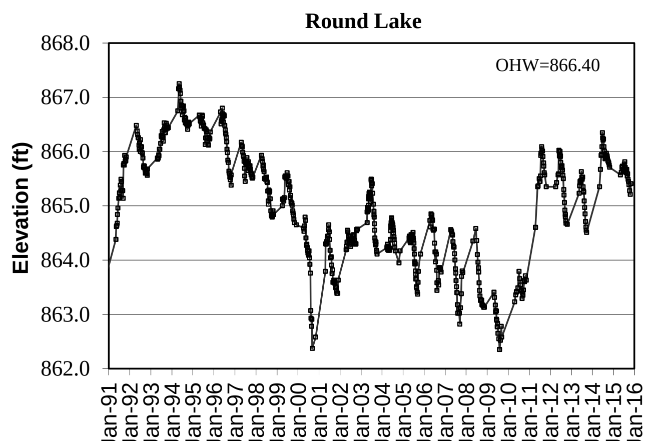
Results: Lake levels were measured by volunteers throughout the 2015 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes had increasing water levels in spring and early summer and then fell later in the year due to less rainfall. Increased rainfall late into fall caused a spike in lake levels at the end of the year. Overall lake levels were lower than in 2014 when 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.

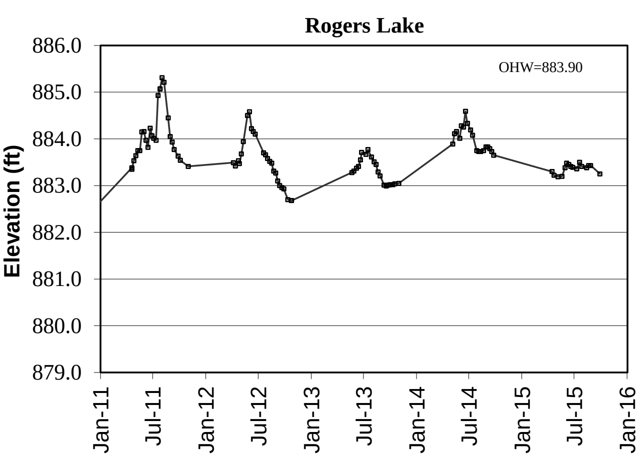
Round Lake Levels – last 5 years



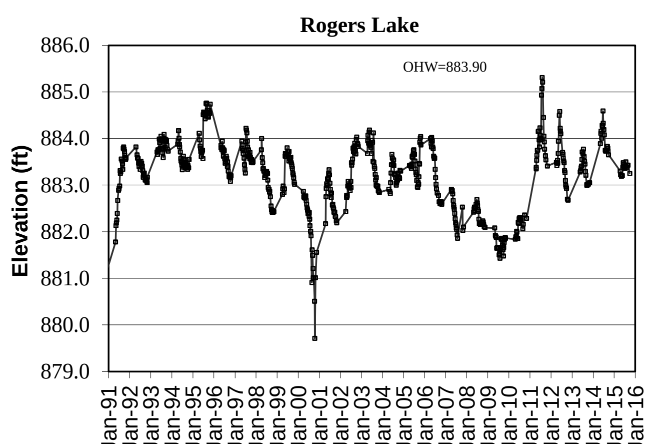
Round Lake Levels – last 25 years



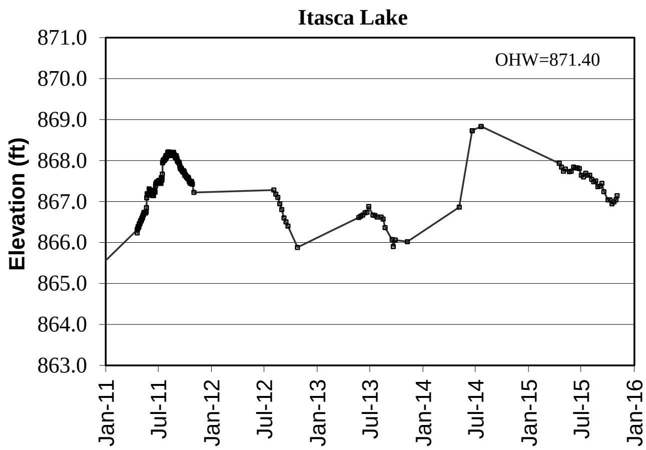
Rogers Lake Levels – last 5 years



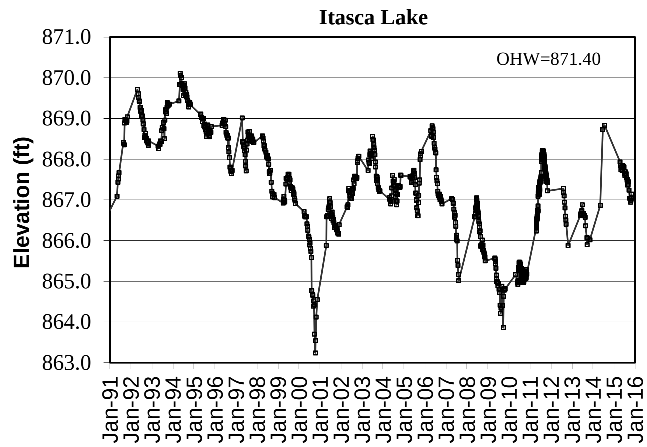
Rogers Lake Levels – last 25 years



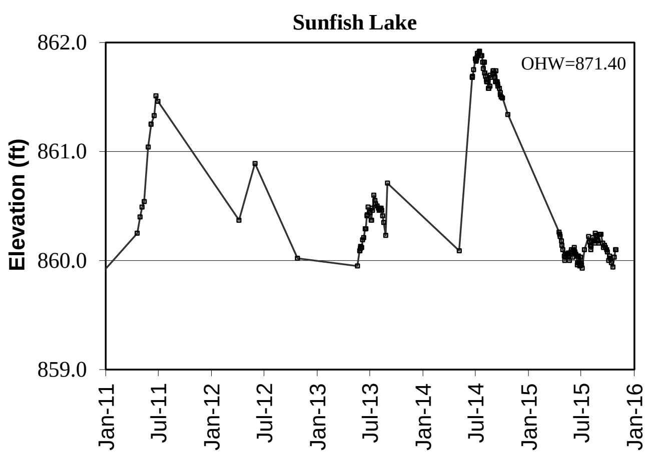
Itasca Lake Levels – last 5 years



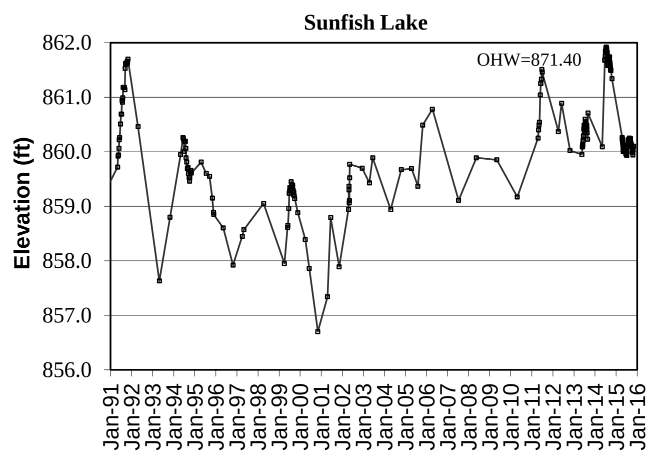
Itasca Lake Levels – last 25 years



Sunfish/Grass Lake Levels – last 5 years



Sunfish/Grass Lake Levels – last 25 years



Stream Water Quality - Chemical Monitoring

Description: In 2015 monitoring events were scheduled May through September for of the following parameters: total suspended solids, e. coli, total phosphorus, Secchi tube transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

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

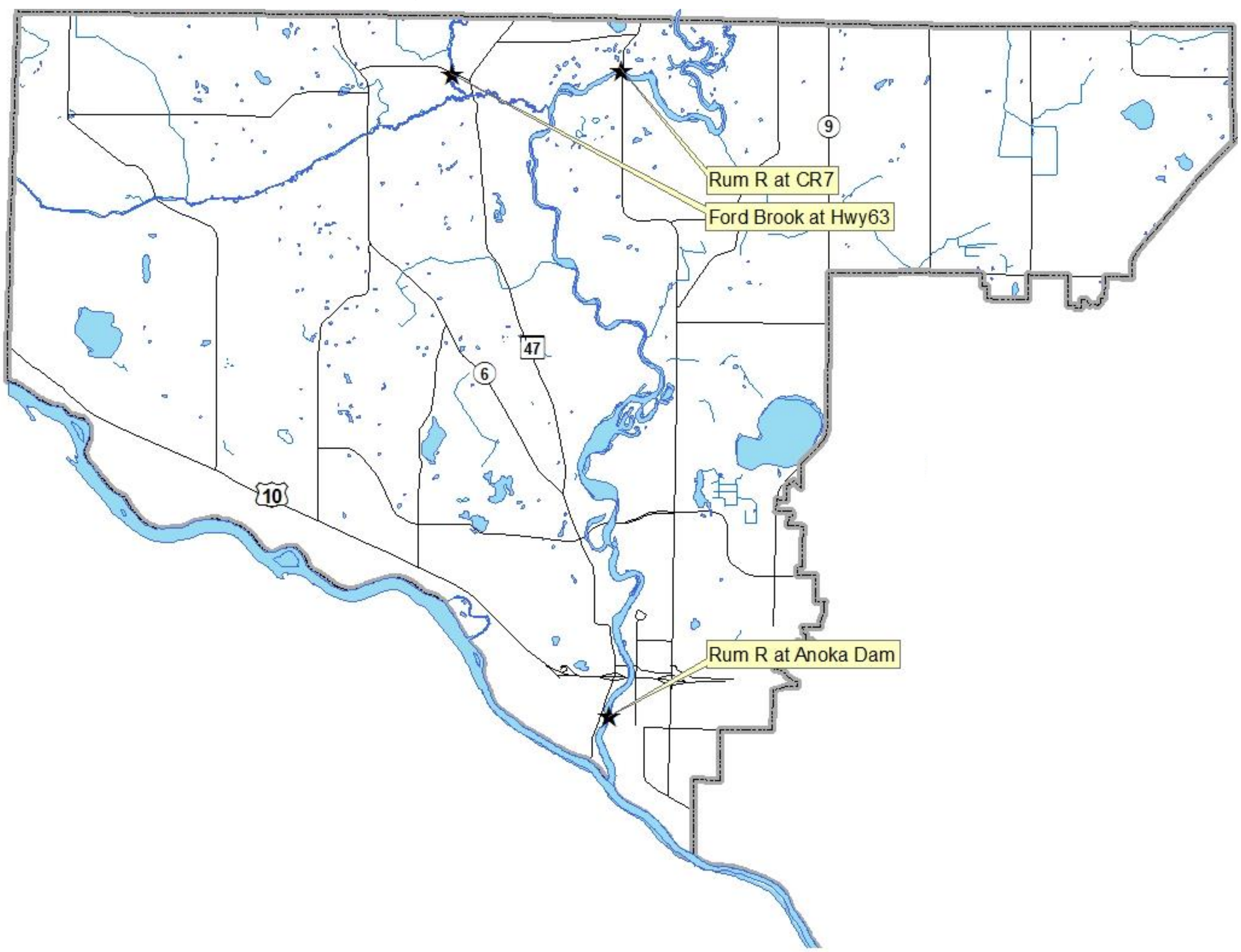
Locations: Ford Brook at Highway 63

Rum River at County Road 7

Rum River at Anoka Dam

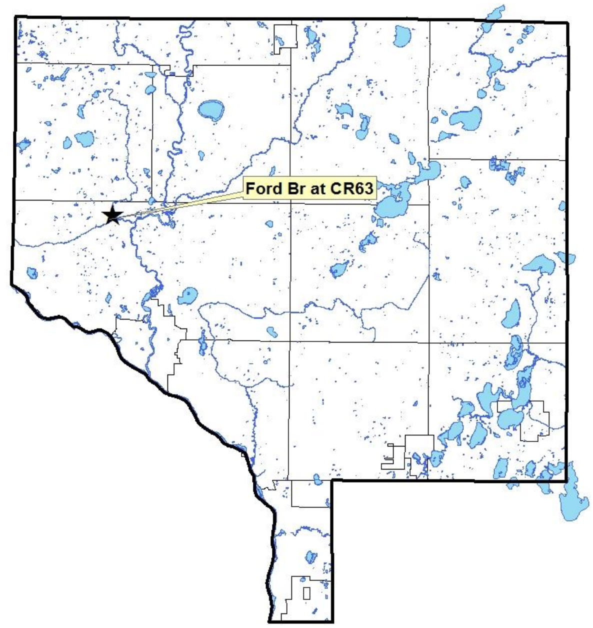
Results: Results are presented on the following pages.

2015 Lower Rum River Monitoring Sites



FORD BROOK

At Co Rd 63, City of Ramsey, MN



Years Monitored

2001, 2003, 2011, 2014, 2015

Background

Ford Brook originates at Goose Lake in north-western Anoka County and flows south. Ford Brook is a tributary to the Rum River. In north-western Anoka County it flows through the relatively undisturbed 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 grow.

Results and Discussion

This report includes data from 2015. Additional monitoring has been done, particularly in 2003 and 2011. The following is a summary of 2015 results.

- Dissolved constituents, as measured by conductivity, in Ford Brook were slightly above average when compared to similar Anoka County streams. Conductivity averaged 0.419 mS/cm (maximum of 0.505 mS/cm and a minimum of 0.328 mS/cm). The median in Anoka County streams is 0.362 mS/cm.
- Phosphorous averaged much higher than proposed MPCA water quality standard of 100 ug/l, during both baseflow and storms. Phosphorous in Ford Brook averaged 181 ug/l (maximum of 215 ug/l and a minimum of 110 ug/l). Median phosphorus concentration in Anoka County streams is 135 ug/L.
- Suspended solids and turbidity were both below state standards each sampling event and averaged well below the standards. Total suspended solids averaged 22.5 mg/l (maximum of 35 mg/l and a minimum of 8 mg/l). Turbidity averaged 29.70 NTU (maximum of 49 NTU and a minimum of 6.6 NTU). Water flow during the 49 NTU reading was extremely fast and turbulent due to abnormal rainfall. Median turbidity in Anoka County streams is 8.5 NTU and total suspended solids averages 12 NTU.
- pH and dissolved oxygen were in the 6.5-8.5 range considered normal and healthy for streams in this area. pH averaged 7.85 (maximum of 8.68 and a minimum of 7.51).
- Dissolved Oxygen levels observed were above the 5 mg/L state standard threshold needed by most aquatic life. DO averaged 8.62 mg/l (maximum of 11.60 mg/l and a minimum of 6.65 mg/l).

FordBrook at CR63			3/12/2015	4/13/2015	7/6/2015	7/10/2015				
	Units	R.L.*	Results	Results	Results	Results		Average	Min	Max
pH		0.1	8.68	7.51	7.55	7.64		7.85	7.51	8.68
Conductivity	mS/cm	0.01	0.328	0.395	0.448	0.505		0.419	0.328	0.505
Turbidity	NTU	1	19.4	43.8	49.0	6.6		29.70	6.60	49.00
D.O.	mg/L	0.01	11.6	8.83	6.65	7.38		8.62	6.65	11.60
D.O.	%	1	80.4	79	77.3	87.7		81.1	77.3	87.7
Temp.	°C	0.1	0.2	9.2	21.0	22.5		13.2	0.2	22.5
Salinity	%	0.01	0.15	0.19	0.12	0.24		0.18	0.12	0.24
T.P.	ug/L	10	215	198	201	110		181	110	215
TSS	mg/L	2	13	35	34.0	8		22.5	8.0	35.0
Secchi-tube	cm		77	38	21	87		>100	21	87
E coli	MPN									
Appearance										
Recreational										

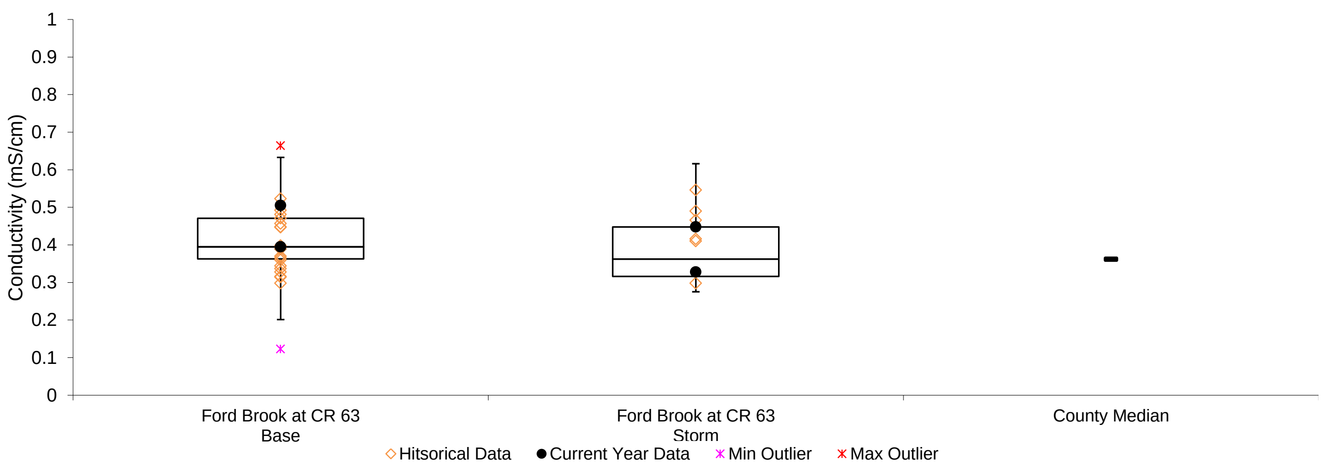
*reporting limit

Conductivity

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 electrical conductivity of the 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; Ford Brook's rural location indicates that sources of high dissolved pollutants are likely naturally occurring.

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

Conductivity at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



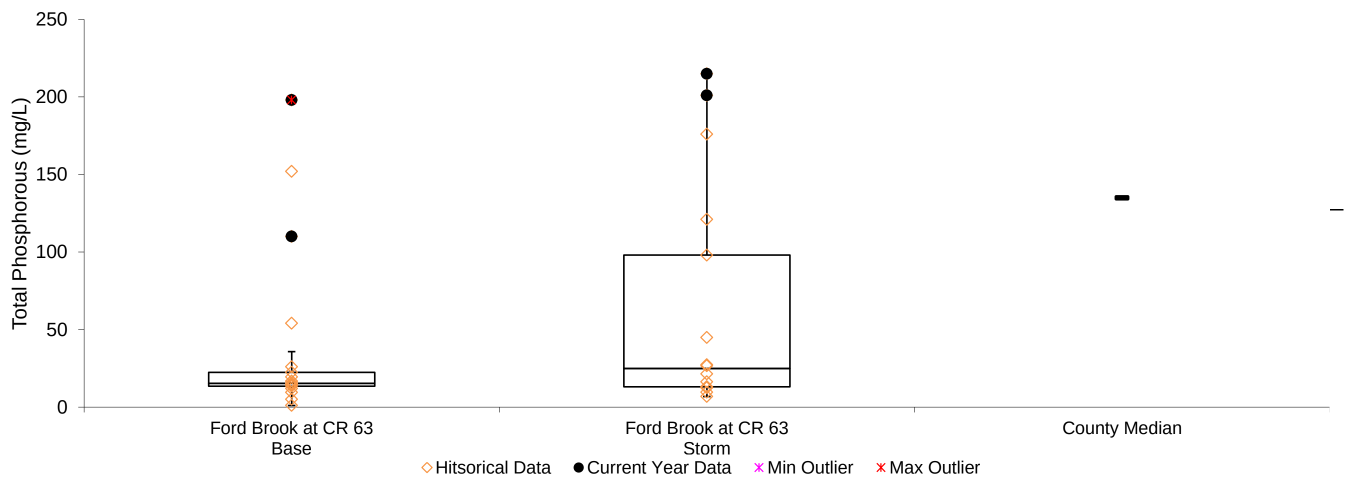
Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algae growth. Total phosphorus in Ford Brook is typically low during baseflow and storm conditions, we have however observed increases during baseflow and storms (see figures below).

In 2015 TP levels in Ford Brook were much higher than the county median and were an increase from 2014 results. TP was higher during storm events than baseflow. The median TP for Ford Brook (all years, all conditions) was only 17.4. This is substantially lower than the countywide median for streams of 135ug/L, as well as the state water quality standard of 100 ug/L, although more recent results have indicated that this may no longer be the case.

The dominant phosphorus sources are likely increases in water volume and changes in land use around Ford Brook. Mobilization of in-stream sediments and agricultural runoff may be an important phosphorus sources. Drained, organic wetland soils may be another source; much of the wetlands Ford Brook runs through no longer hold back water flow.

Total Phosphorus at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2015 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.

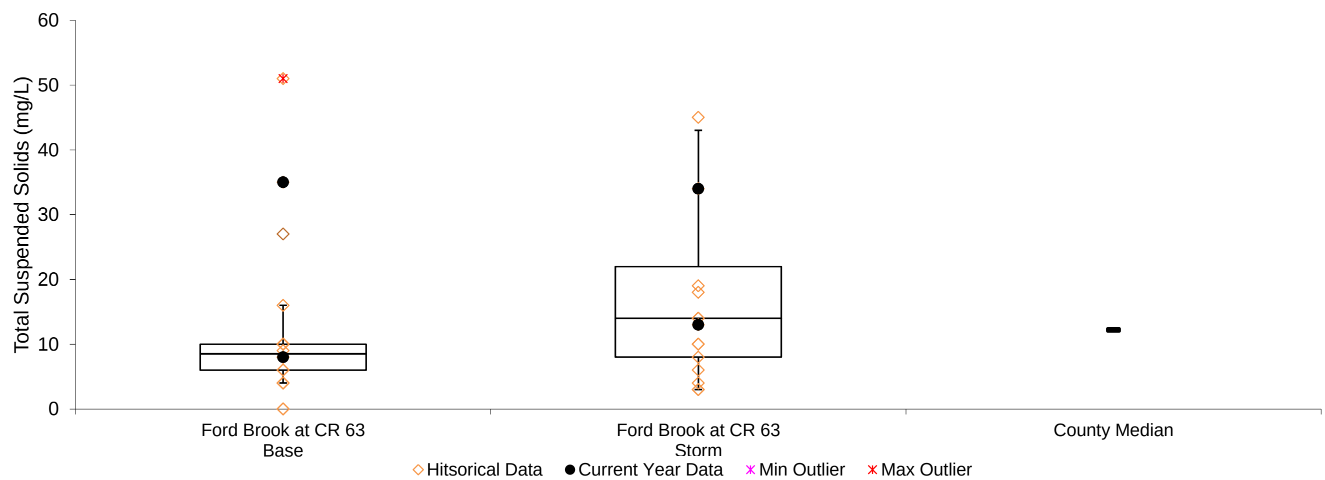
In Ford Brook both TSS and turbidity were generally low and just slightly higher during storm events. Presently the state water quality standard allows turbidity of >25 NTU during no more than 10% of measurements. That standard is being changed to TSS of 30 mg/L. In either case, the stream sometimes exceeds state water quality standards.

Median turbidity for Ford Brook (all years, all conditions) was 9 NTU, respectively. This is similar to the countywide median of 8.5 NTU. Only 4 of 33 (12%) measurements at Ford Brook are greater than MPCA's present water quality standard of 25 NTU. Median TSS was 10 mg/L. This is lower than the median for streams county-wide of 12 mg/L. Only 4 of 34 (12%) of TSS measurements exceeded the new, proposed water quality standard of 30 mg/L.

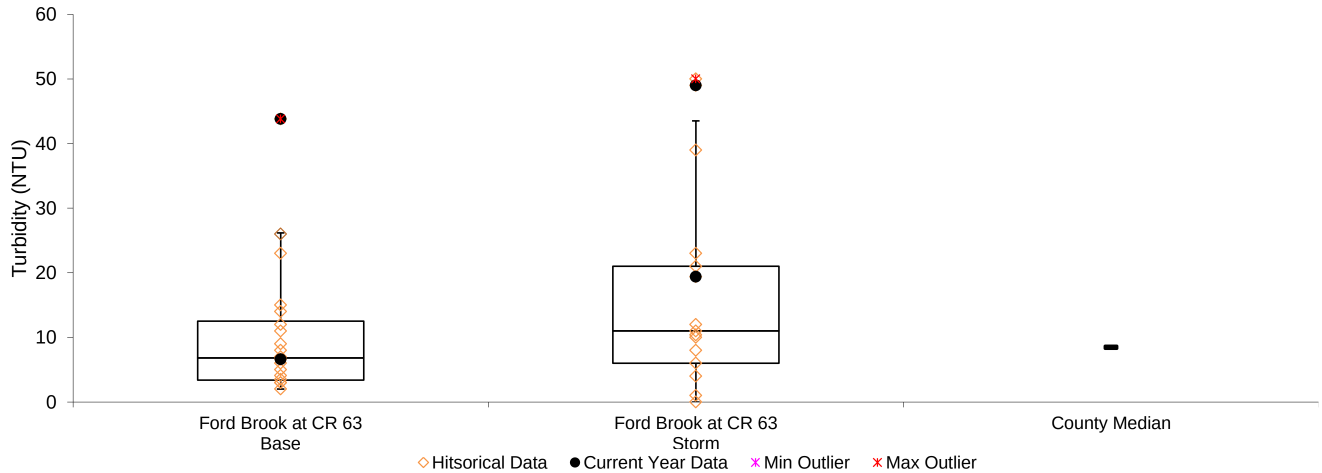
During storms, TSS was often similarly higher at all sites (see figures below). Bank erosion, bedload transport, and stormwater runoff are likely all important sources of suspended solids. Their relative contributions likely differ across the watershed. However given that suspended solids are high throughout 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.

Total Suspended Solids at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



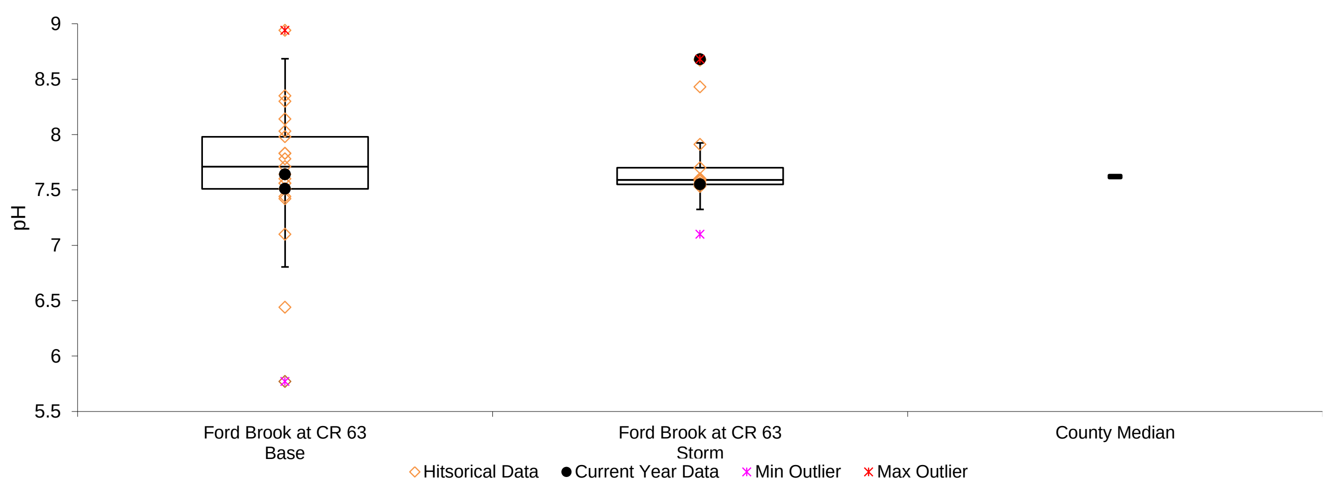
Turbidity at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

pH was generally within the expected range at all sites for 2015. 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. On one monitoring event pH exceeded 8.5. pH was similar during baseflow and storm events. 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.

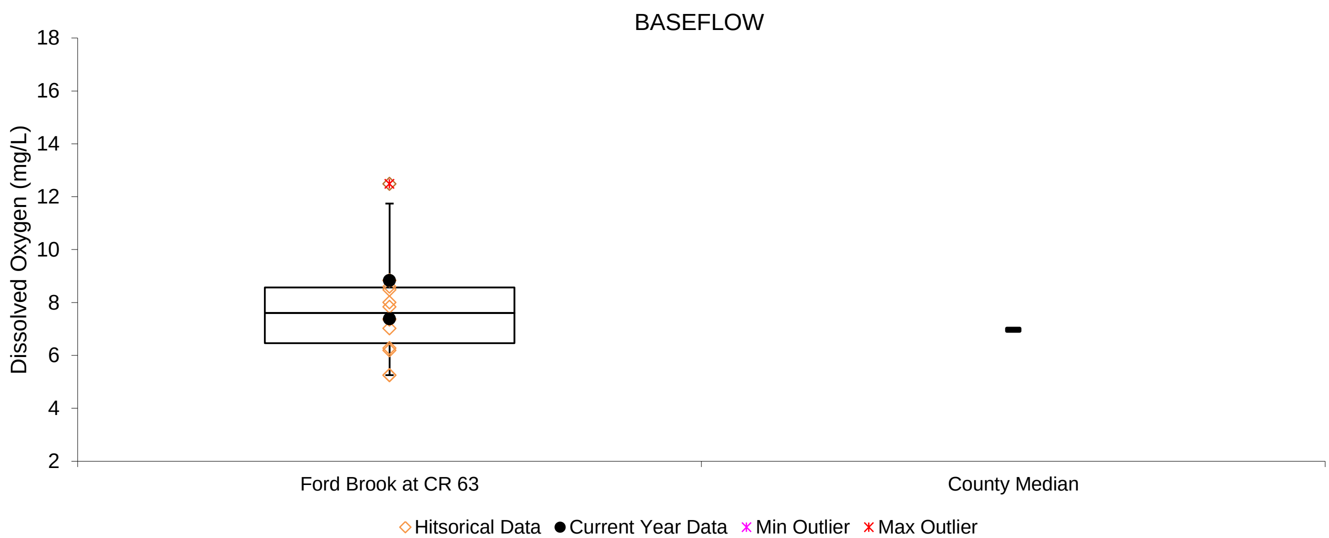
pH at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen in Ford Brook was within acceptable levels in Ford Brok. Of the 29 samples took historically, 0 samples dropped below 5 mg/L. The other sites had no instances of dissolved oxygen below 5 mg/L.   In sum, any dissolved oxygen problems observed appear.

Dissolved Oxygen at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2015 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 - Chemical Monitoring

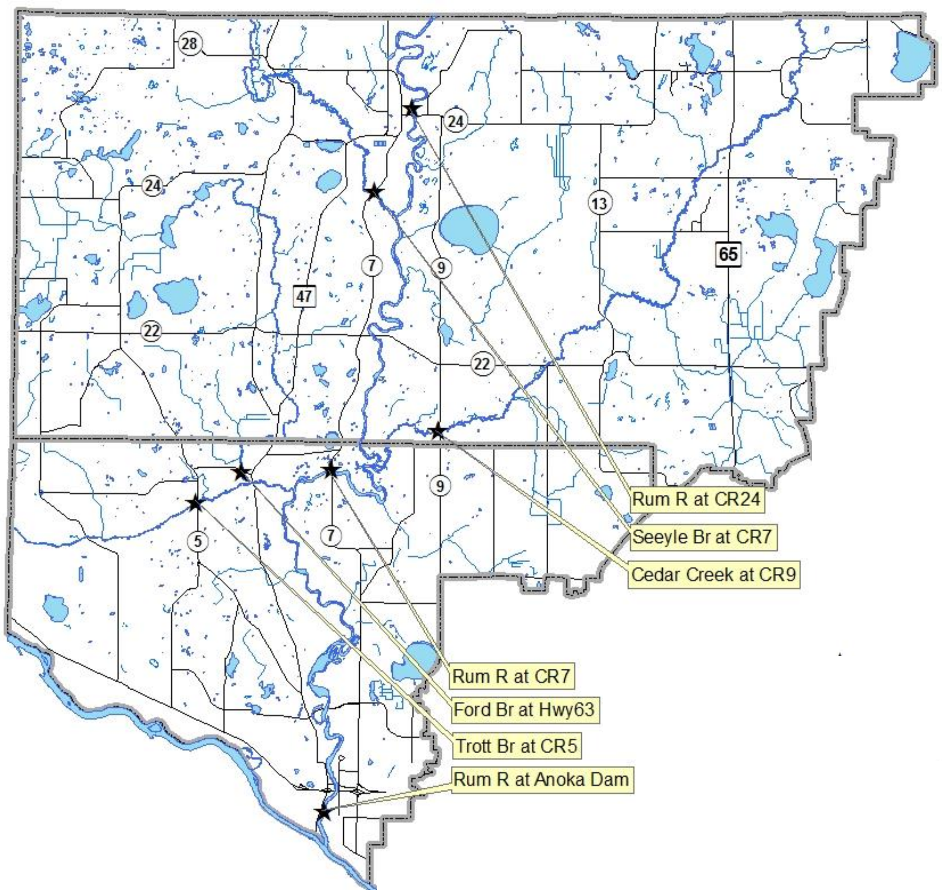
Description: The Rum River and several tributary streams were monitored in 2015. The locations of river monitoring include the approximate top and bottom of the Upper and Lower Rum River Watershed Management Organizations. Tributaries were monitored simultaneous with the Rum River monitoring for greatest 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 of the following parameters: total suspended solids, e. coli, total phosphorus, Secchi tube transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

Purpose: To detect water quality trends and problems, and diagnose the source as well as 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

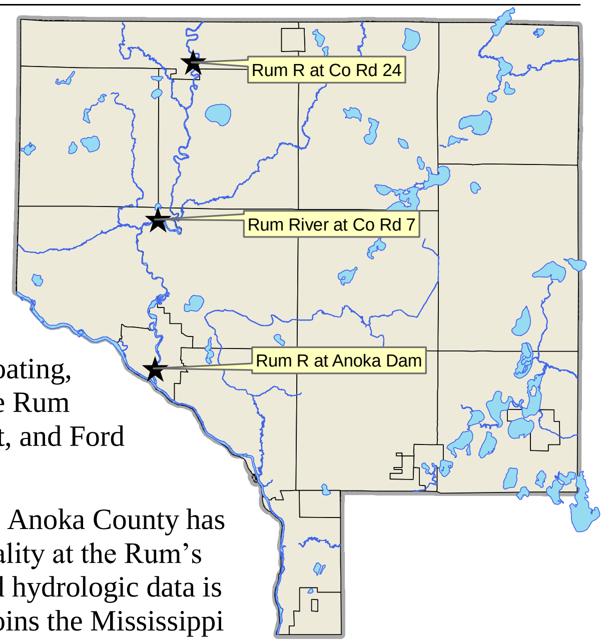
Results: Results are presented on the following pages.

Upper Rum River Watershed 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



Years Monitored

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

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

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

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 been sporadic and sparse. 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, 2010, 2011, 2014, and 2015 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 2015 the river was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were taken; 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 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, total suspended solids. During every sampling 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 2015. 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.

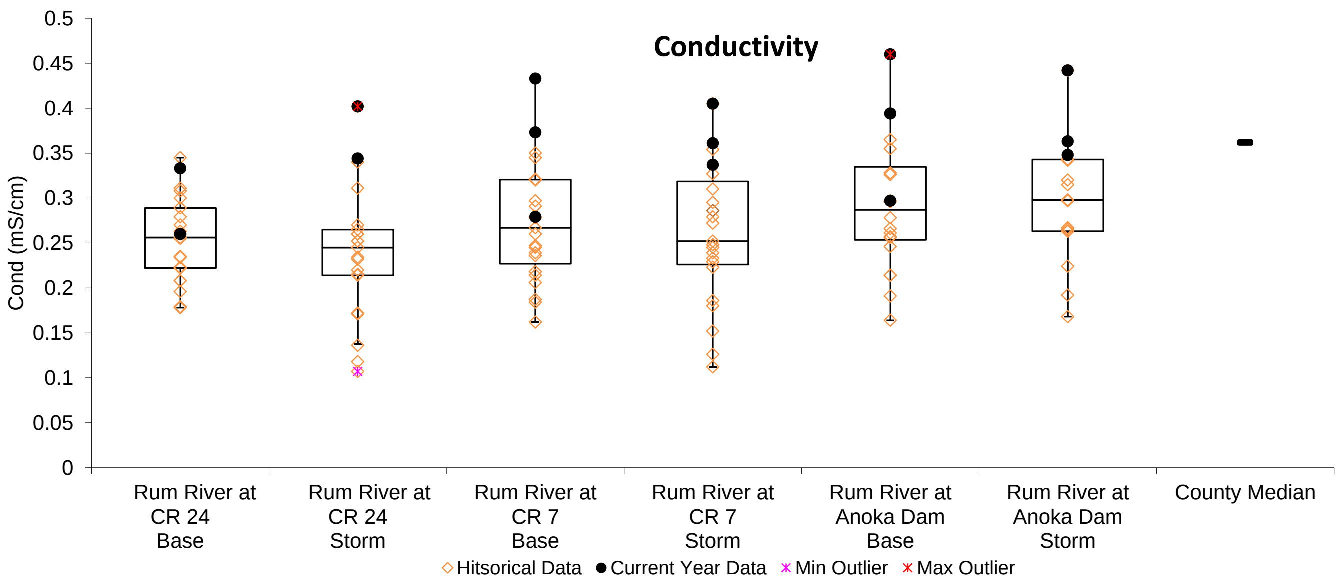
Results and Discussion

On the following pages data are presented and discussed for each parameter. Management recommendations will be included in the 2015 report at the conclusion of this monitoring project. 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 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 2015 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. 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 2015 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 2015 (all conditions) was 0.338 mS/cm, 0.369 and 0.391 mS/cm, respectively. Two of the sites are higher than the median for 34 Anoka County streams of 0.362 mS/cm. The 2015 maximum observed conductivity in the Rum River was 0.46 mS/cm which is the highest on record.

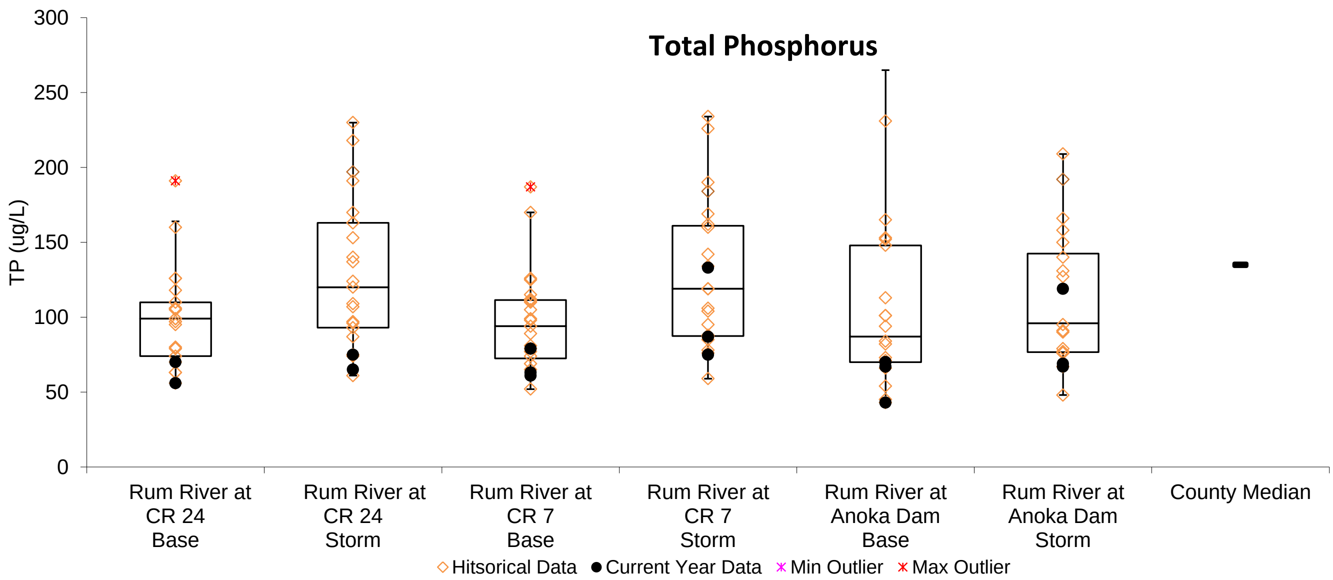
Conductivity was lowest at most sites during storms, suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow conductivity has been observed in most other nearby streams too, studied extensively, and the largest 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 similar to the median for all other monitored 34 Anoka County streams (see figure below). 2015 readings averaged much lower than 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 2015 at the three monitored sites (all conditions) was 67.5, 77 and 69.5 ug/L. These upstream-to-downstream differences are negligible and there is no trend of increasing phosphorus downstream. All sites in 2015 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 133. In all, phosphorus in the Rum River is at acceptable levels but 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 2015 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. In 2015 Suspended solids in the Rum River were 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.

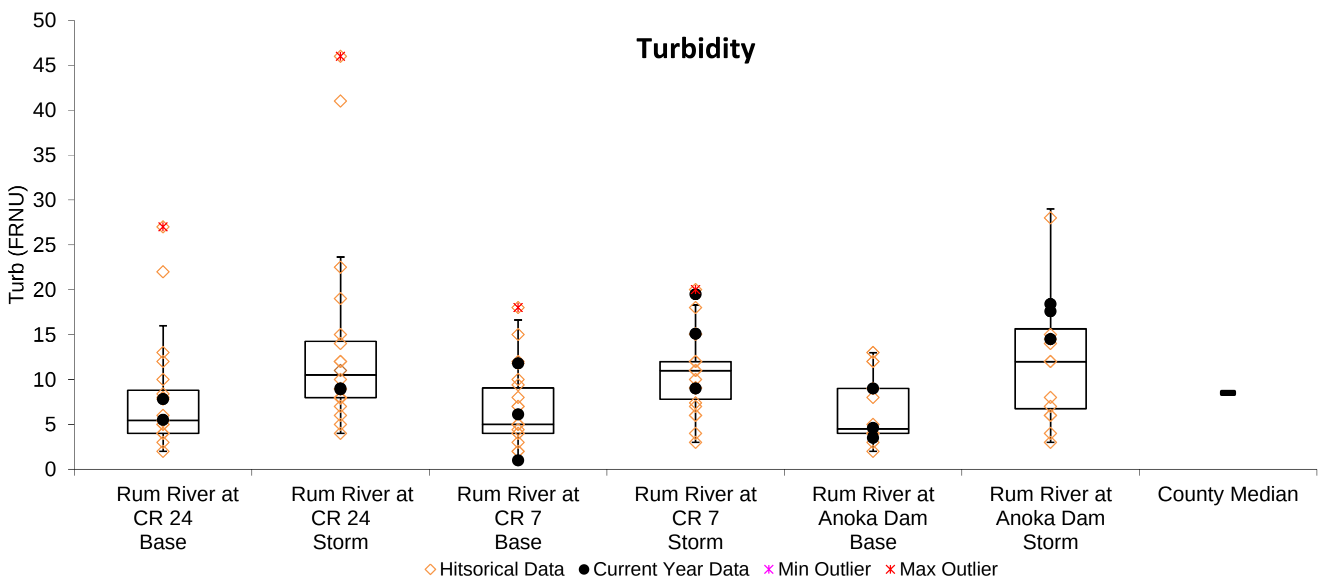
In the Rum River, turbidity was low with increases during storms and a very slight decrease at downstream monitoring sites (see figure below). The median turbidity, in 2015 (all conditions) was 8.35, 10.4 and 9.5 NTU (upstream to downstream), which is similar or higher than the median for Anoka County streams of 8.5 NTU. Turbidity was elevated on a few occasions, especially during storms. In 2015 the maximum observed was 19.5 NTU during a mid-season monitoring event.

TSS in 2015 was similar to 2014 results. The median TSS, in 2015 (all conditions) was 6, 5.5 and 5.5 (upstream to downstream). These are all much lower than the Anoka County stream median for TSS of 12.

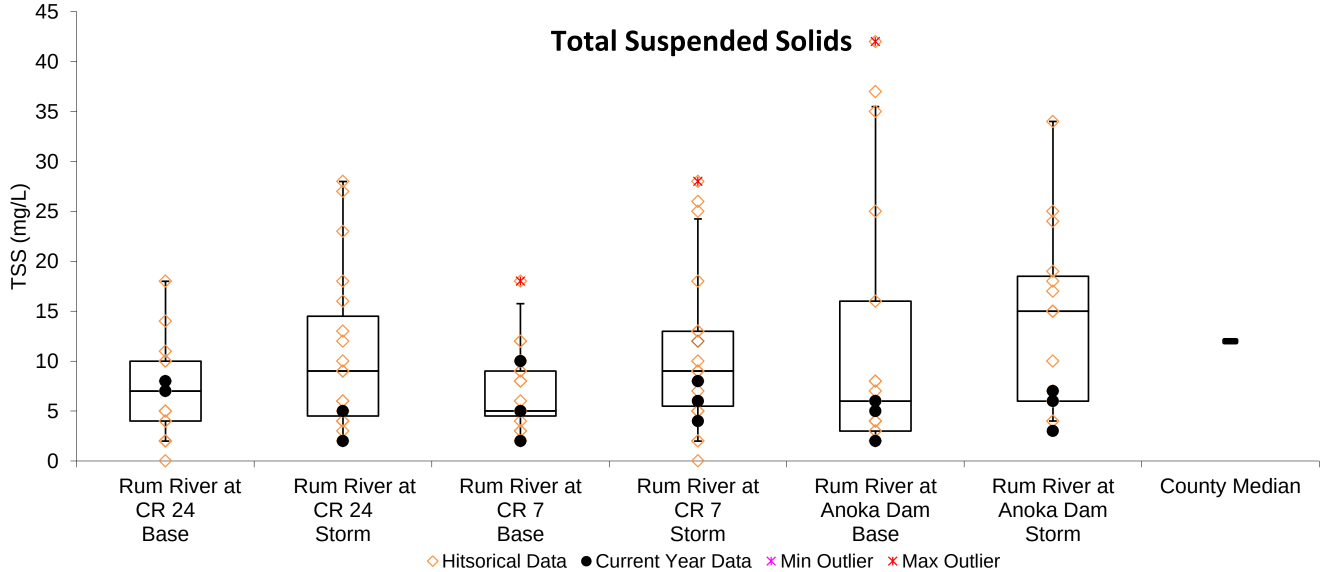
Rigorous stormwater treatment should occur as the Rum River watershed develops, or the collective pollution caused by many small developments will seriously impact the river. Bringing stormwater treatment up to date in older developments is also important.

Differences between TSS and turbidity lend insight into the nature of any problems. TSS showed increases at the downstream monitoring site, while turbidity did not. Turbidity is most sensitive to large particles. Therefore, the downstream increases are likely due to smaller particles. Other pollutants, such as phosphorus and metals, are most highly correlated with smaller particles. These other pollutants can "hitch a ride" on smaller particles because of their greater surface area and, in the case of certain soils, ionic charge. Furthermore, small particles stay suspended in the water column and therefore are more likely to be transported by stream flows and are more difficult to remove with stormwater practices like settling ponds.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



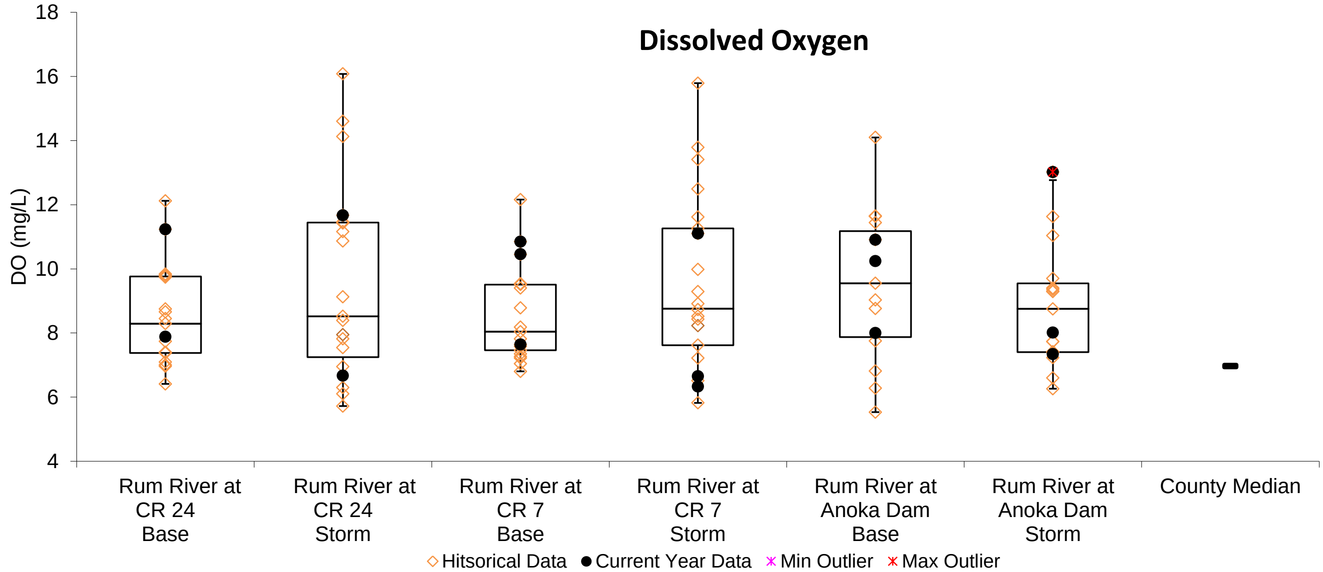
Total suspended solids during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below 5 mg/L aquatic life begins to suffer. In the Rum River dissolved oxygen was always above 5.5 mg/L at all monitoring sites.

Dissolved oxygen during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2015 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

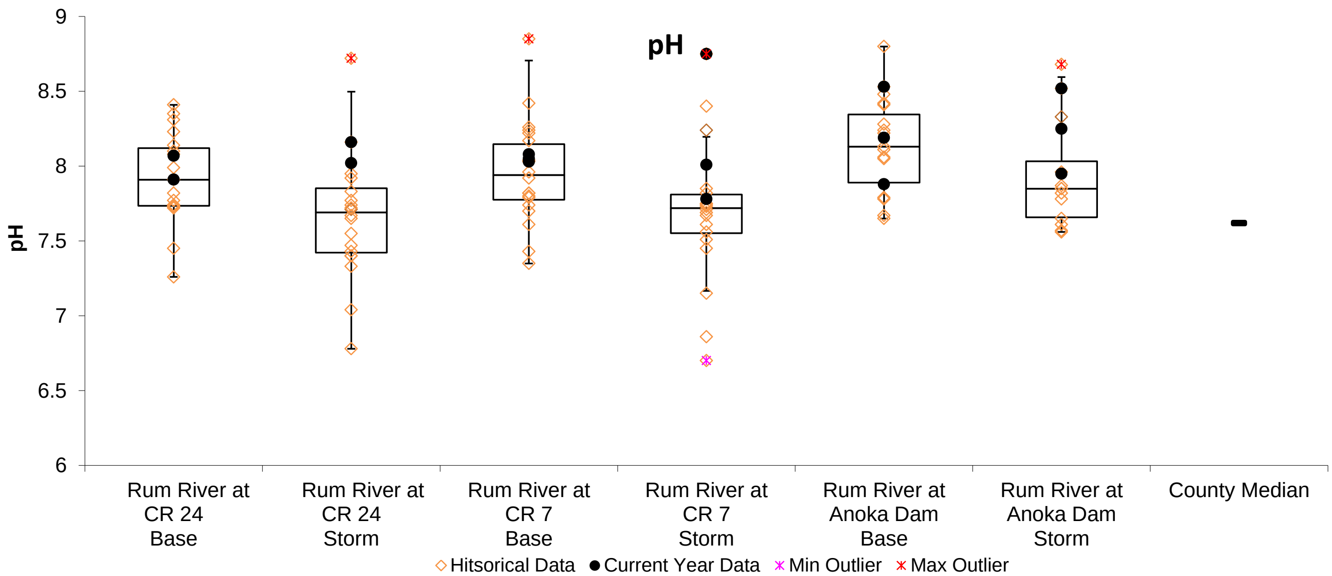


pH

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 (see figure below).

It is interesting to note that pH is 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 2015 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 very good. It does show a slight increase in suspended solids and conductivity downstream. 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 have the potential to degrade water quality unless carefully sited and managed. 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 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 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.

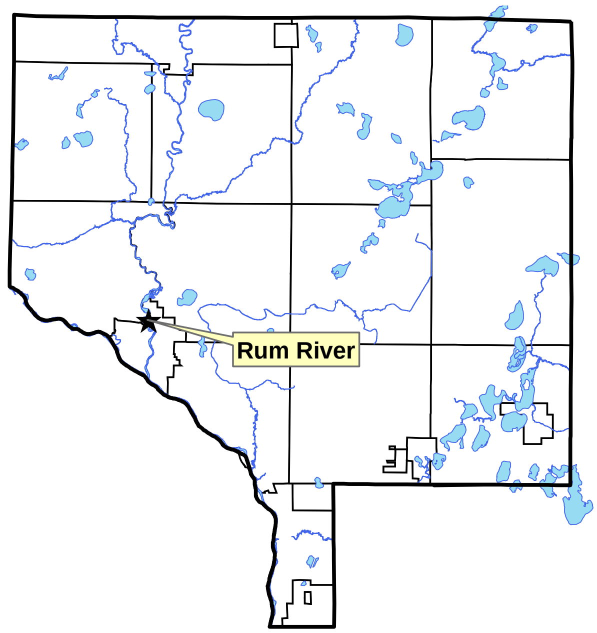
Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

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 2015

Monitored Since

2001

Student Involvement

162 students in 2015, approximately 900 since 2001

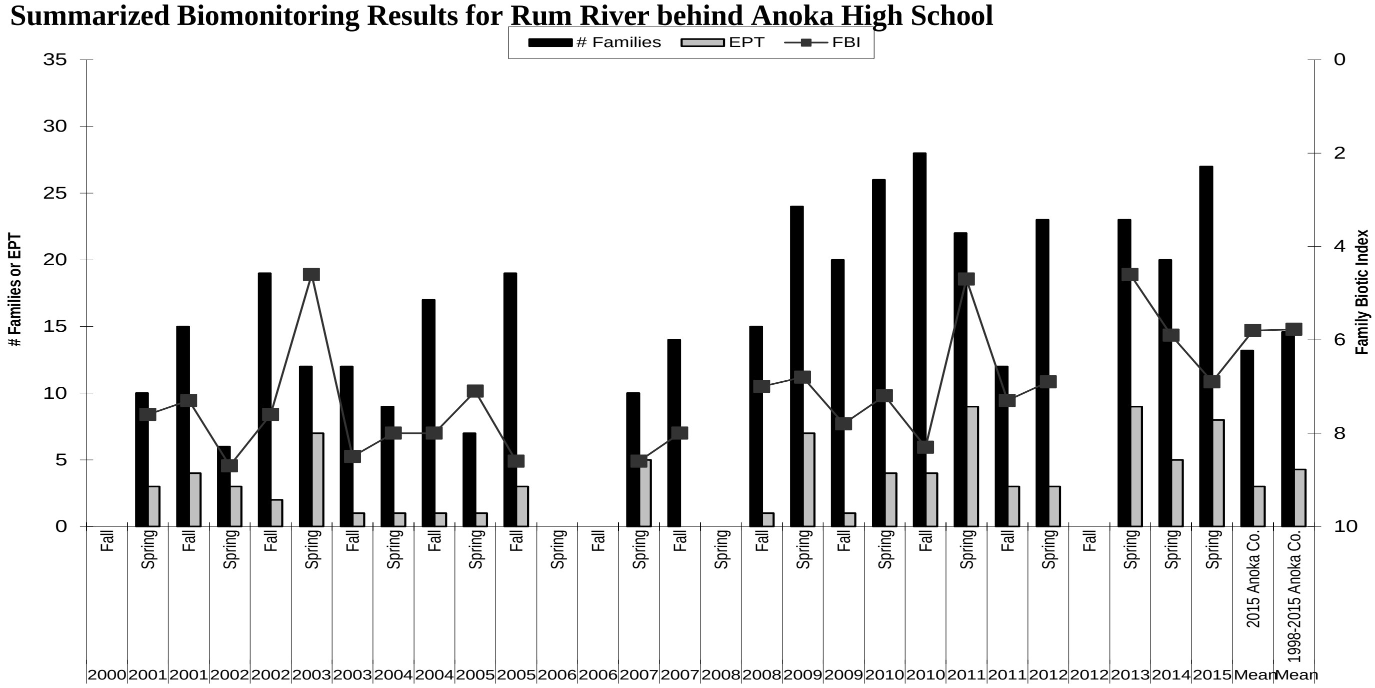
Background

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 2015 with Anoka Conservation District (ACD) oversight. The results for spring 2015 were similar to previous years. More families, 27 in total, were found here than in any other Anoka County stream. This should be expected as most other sites are small streams and this is a larger river. The number of sensitive EPT families (8) and the FBI score (6.9) were the best in Anoka County and above the county averages.

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	2009	2009	2010	2010	2011	2011	2012	2013	2014	Mean	Mean
Season	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Spring	Spring	2014 Anoka Co.	1998-2014 Anoka Co.
FBI	6.80	7.80	7.20	8.30	4.70	7.30	6.90	4.60	5.90	5.8	5.8
# Families	24	20	26	28	22	12	23	23	20	13.2	14.6
EPT	7	1	4	4	9	3	3	9	5	3.0	4.3
Date	8-May	28-Sep	18-May	7-Oct	10-Jun	5-Oct	8-May	14-May	20-May		
sampling by	AHS	AHS	AHS	AHS	ACD	ACD	AHS	AHS	AHS		
sampling method	MH	MH	MH	MH	MH	MH	MH	MH	MH		
Mean # individuals	880	585	443	816	604	188	502	357	350		
# replicates	1	2	1	1	1	1	2	4	4		
Dominant Family	Siphlonuridae	Hyalellidae	Gastropoda	Hyalellidae	baetidae	hyalellidae	silphonuridae	Perlodidae	Siphlonuridae		
% Dominant Family	40.7	39.1	31.8	34.1	57.5	63.3	37.8	42.1	33.4		
% Ephemeroptera	48.2	0.9	8.1	0.9	59.3	11.2	44.9	19.4	57.8		
% Trichoptera	0.1	0	0	0.2	1	0	1.2	0.2	0.1		
% Plecoptera	2.6	0	0.5	0	3.8	0.5	0	42.6	0.5		

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 has a mucky bottom and does not receive good flow. This area is unlikely to be occupied by families which are pollution intolerant. In recent years more sampling occurred in the main channel which has more diverse habitat. This change in sampling likely explains the apparent improvement in the invertebrate community in recent years. In 2014 and 2015 sampling returned to the backwater area, however high water levels likely altered its normal functions.

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 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.

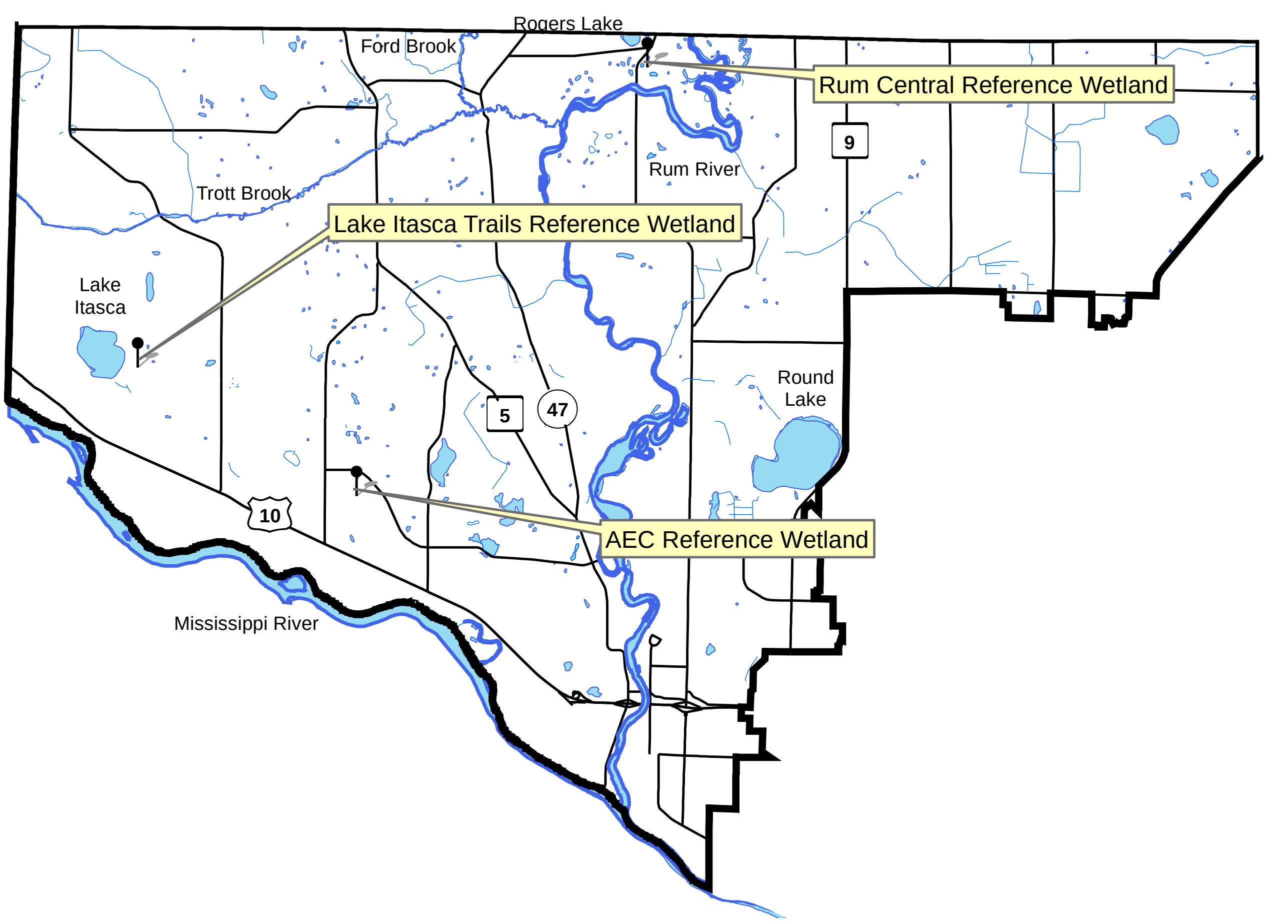
Locations: AEC Reference Wetland, Connexus Energy Property on Bunker Lake Blvd, Ramsey

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

Lake Itasca Trail Reference Wetland, Lake Itasca Park, Ramsey

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

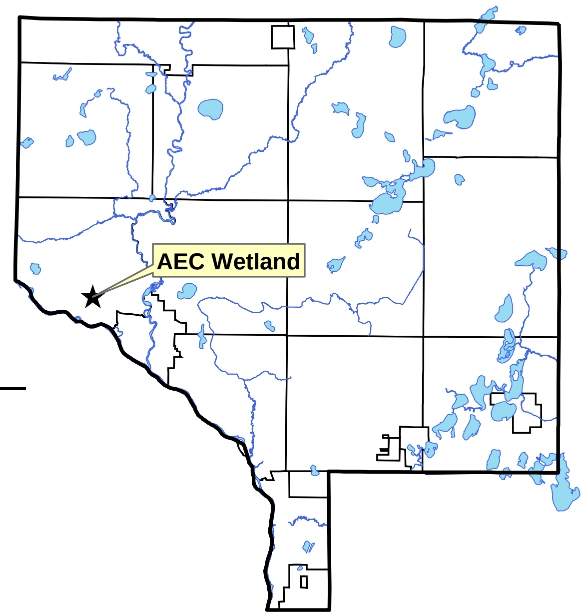
Lower Rum River Watershed Wetland Hydrology Monitoring Sites



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	-

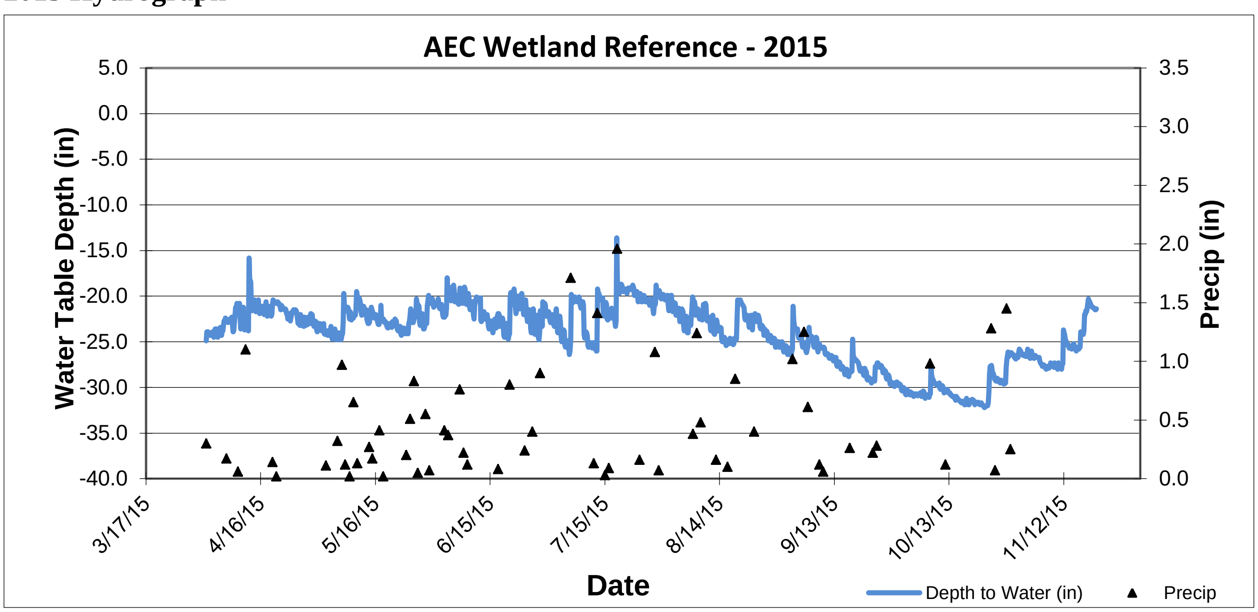
Surrounding Soils: Hubbard coarse sand

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.

2015 Hydrograph

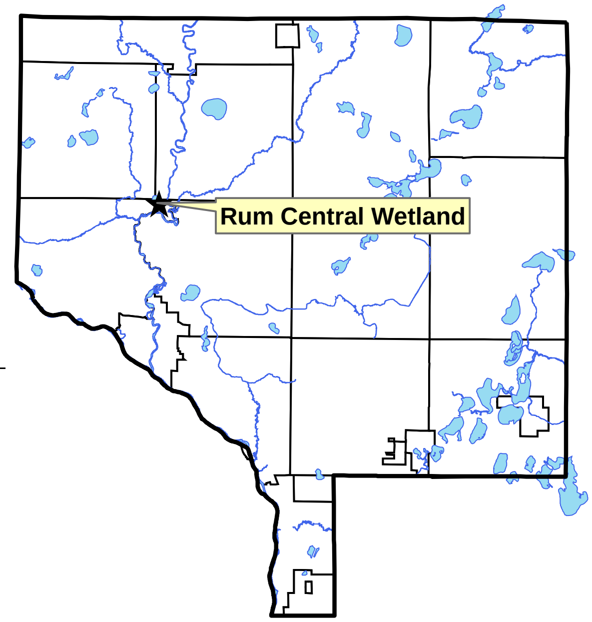


Well depth was 39 inches, so a reading of –39 indicates water levels were at an unknown depth greater than or equal to 39 inches.

Wetland Hydrology Monitoring

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	-

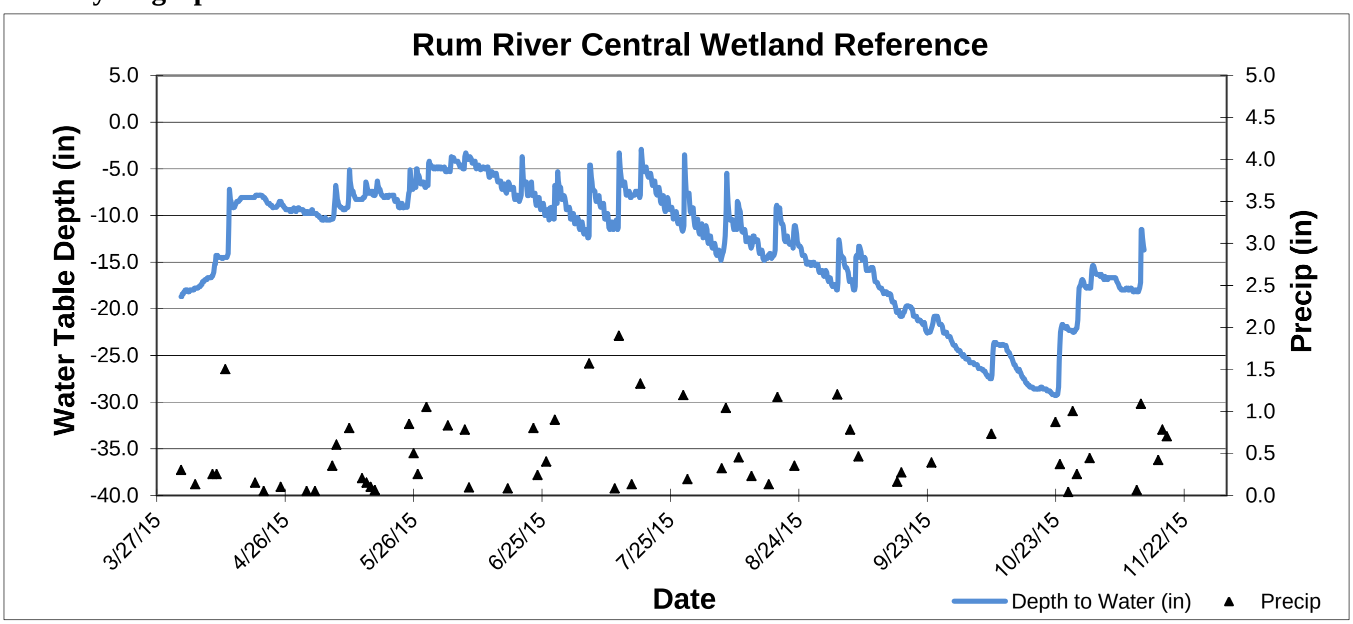
Surrounding Soils: Zimmerman fine sand

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.

2015 Hydrograph

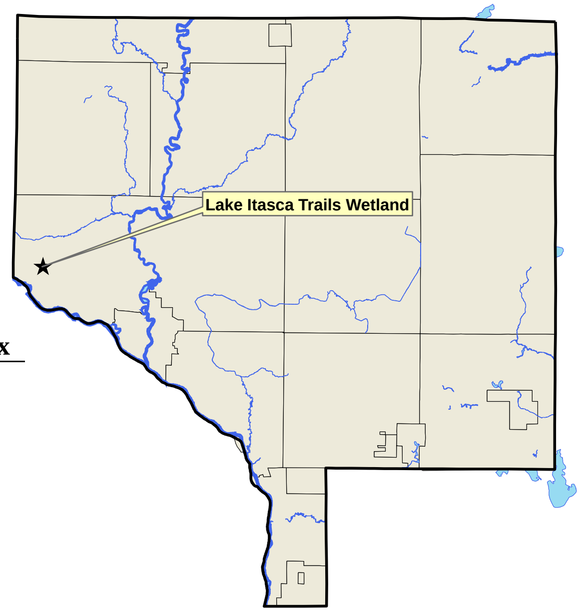


Well depth was 37.7 inches, so a reading of –37.7 indicates water levels were at an unknown depth greater than or equal to 37.7 inches.

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	-

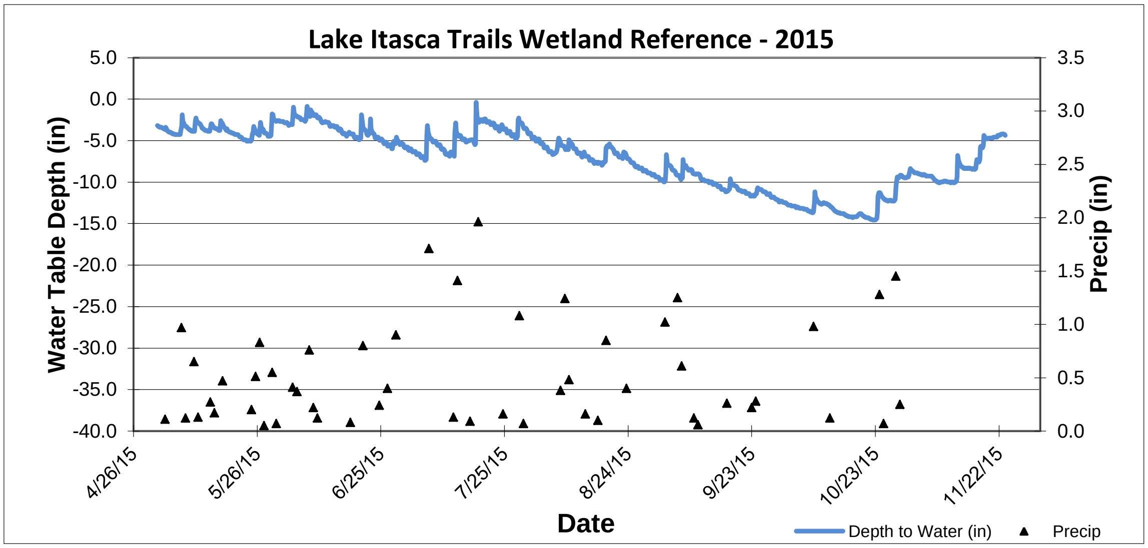
Surrounding Soils: Hubbard coarse sand

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.

2015 Hydrograph



Well depth was 41.4 inches, so a reading of –41.4 indicates water levels were at an unknown depth greater than or equal to 41.4 inches.

Water Quality Grant Fund

Description: The LRRWMO provided 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 was administered by the Anoka Conservation District, which works with landowners on conservation projects. Projects affecting the Rum River were 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.

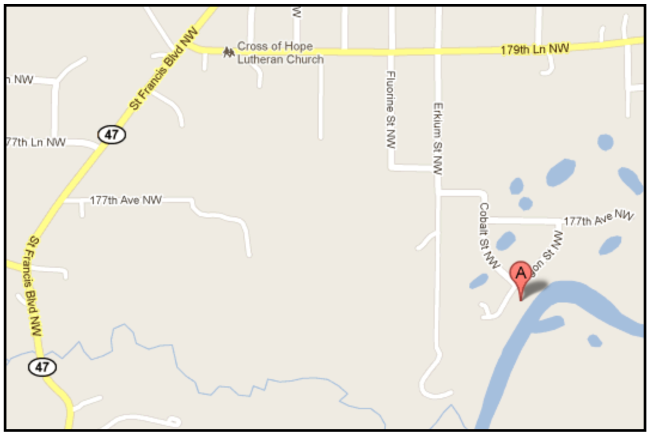
Results: Projects reported in the year they are installed. No projects were installed in 2015.

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
Fund Balance		**$2,516.35**

2015 funded project – Smith Rum Riverbank, City of Ramsey
100 feet of undercut, eroding riverbank was stabilized using a cedar tree revetment. This was phase two of efforts on this property. In 2012, approximately 70 feet of riverbank were stabilized using a cedar tree revetment. A design was completed for the entire 170 feet of riverbank on the property, but a full installation in 2012 was cost prohibitive. The remaining 100 feet of riverbank was stabilized in 2015.

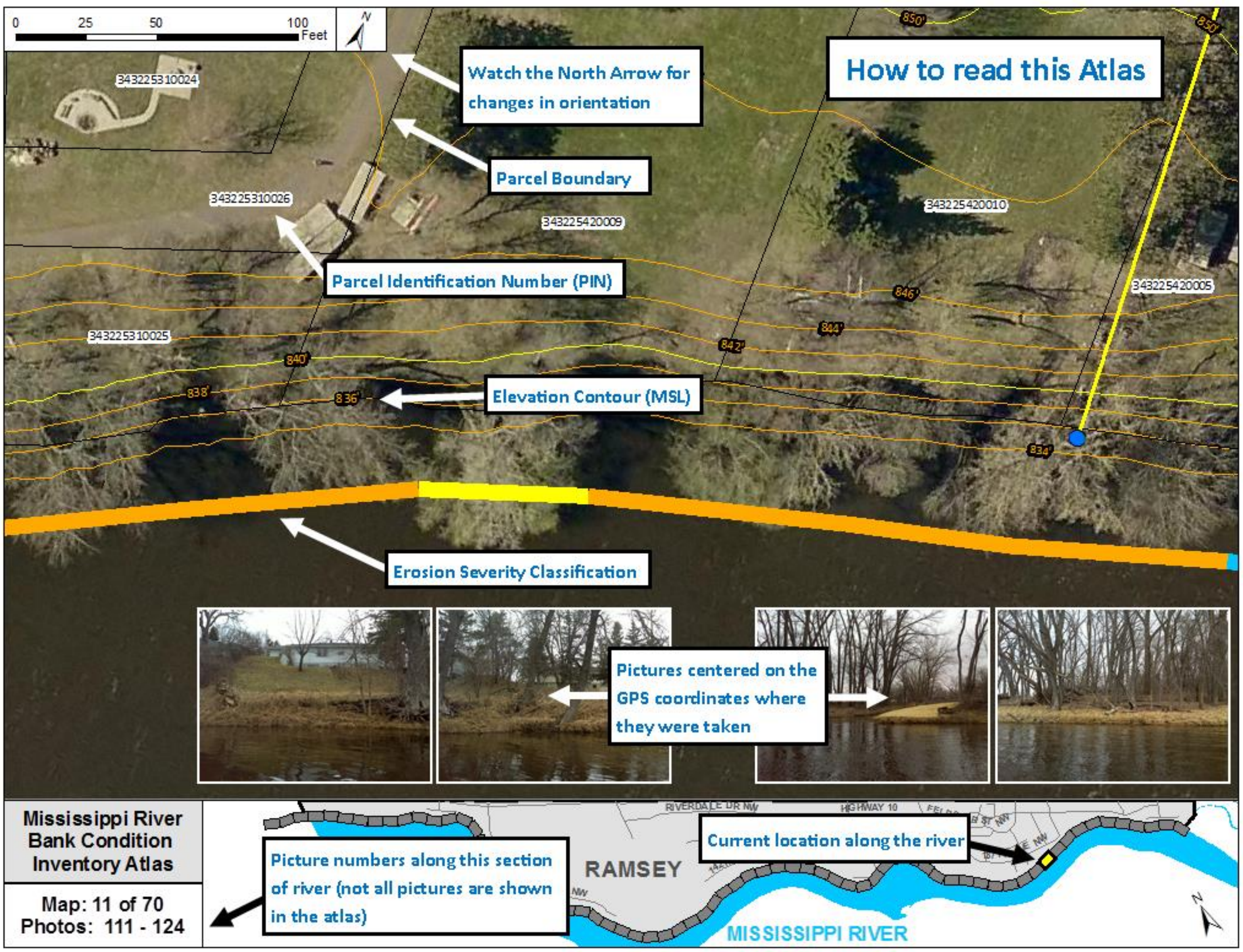
The landowner paid half of the expense of this project; LRRWMO were used to cover the other half. Installation was primarily done by the Minnesota Conservation Corps with oversight from the Anoka Conservation District.



MISSISSIPPI RIVERBANK INVENTORY

Description:	This 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. The inventory will provide the city with a comprehensive record of riverbank condition. This inventory is structured as a report and atlas. The report will provide details on the methodology used to estimate bank erosion severity and provide insight and recommendations on stabilizing severely eroding sections of the riverbank. The atlas will provide a complete record of aerial photographs with corresponding erosions categories as well as key pictures collected during field work.
Location:	City of Ramsey
Purpose:	To gather information about current riverbank conditions in order to better address future concerns.
Results:	Along the 5.8 miles of Mississippi Riverbank in Ramsey, ten stretches of severely eroding riverbank were identified, consisting of 39 properties. If stabilized sediment loading into the river would be reduced by by 5,148 tons per year. Other less severely eroding areas were also documented. A separate report is available.

Example from Mississippi Riverbank Inventory report



Wetland Education Signs & Displays

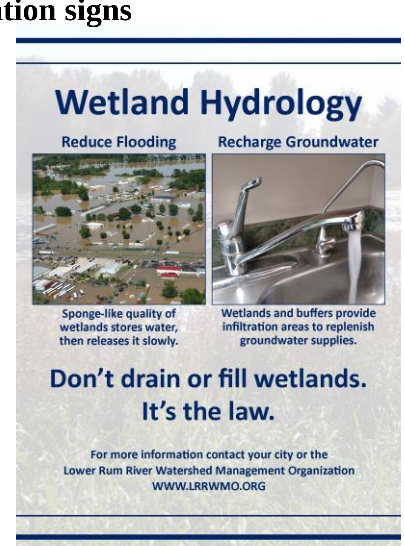
Description: Two separate projects were completed to increase residents' awareness of the values of wetlands, wetland protection laws, and voluntary actions that can be taken to protect wetlands. The projects included trailside signage and a trade-show style display.

Purpose: To increase public awareness of wetland values, boundaries, best management practices and regulations.

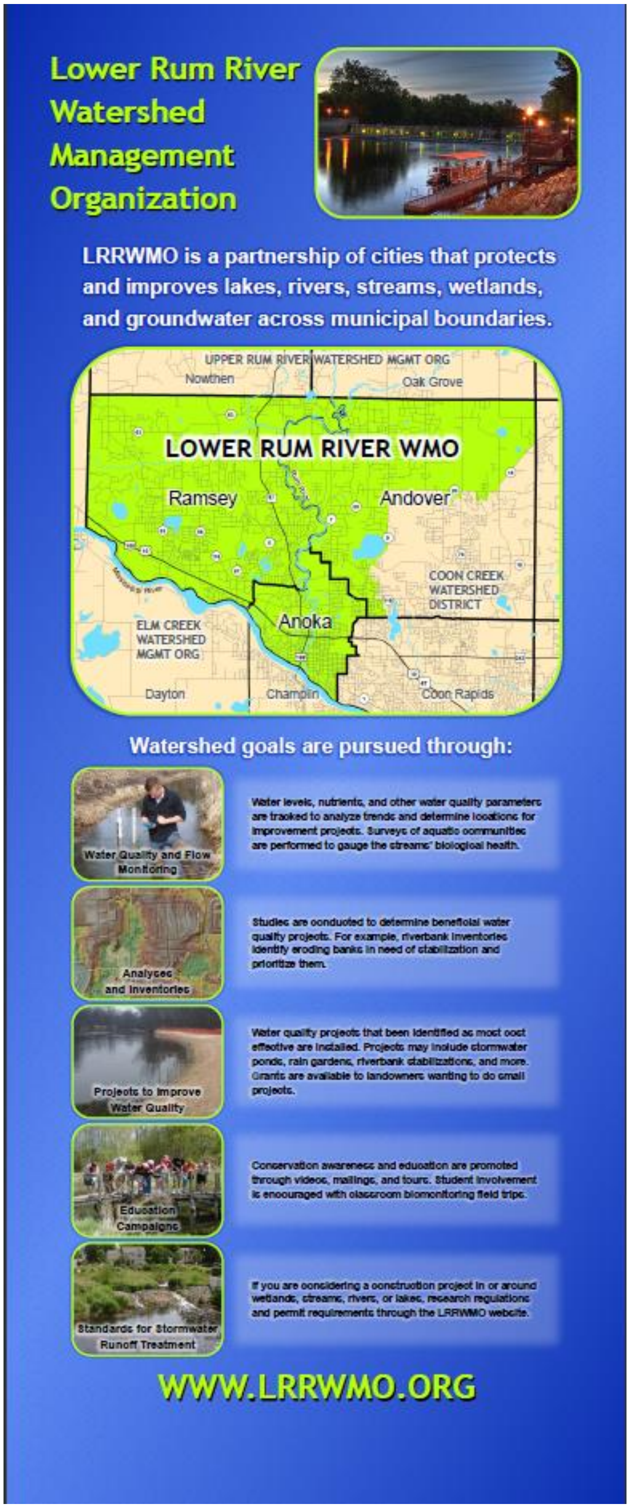
Results: Five signs were designed, printed and will be installed alongside walking trails in the Cities of Ramsey, Anoka and Andover. The signs are shown below and will be installed by city staff in spring 2016.

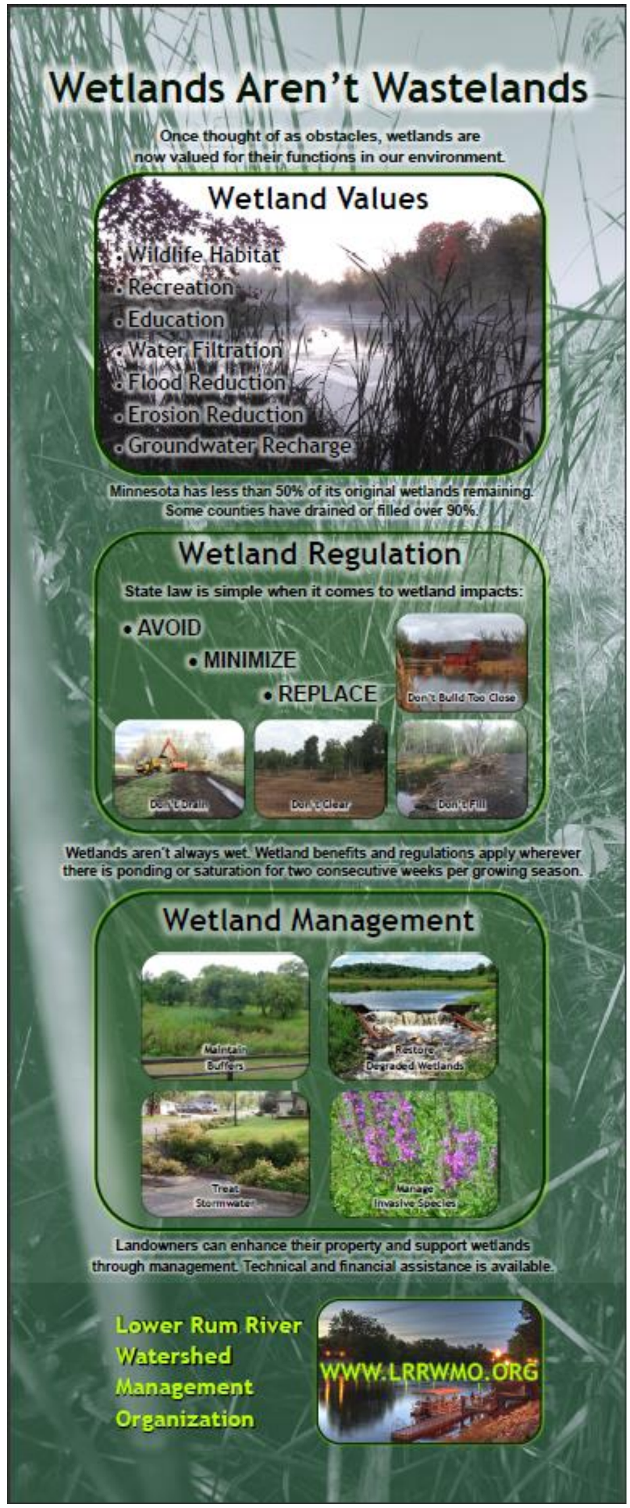
Two trade-show-style displays were designed and printed. One highlighted wetland values and protection. The second display was about the Lower Rum River WMO. Both displays are 33"x80" and will be used by the LRRWMO at local events and other environmental presentations.

Wetland education signs



Displays about Wetlands and the LRRWMO





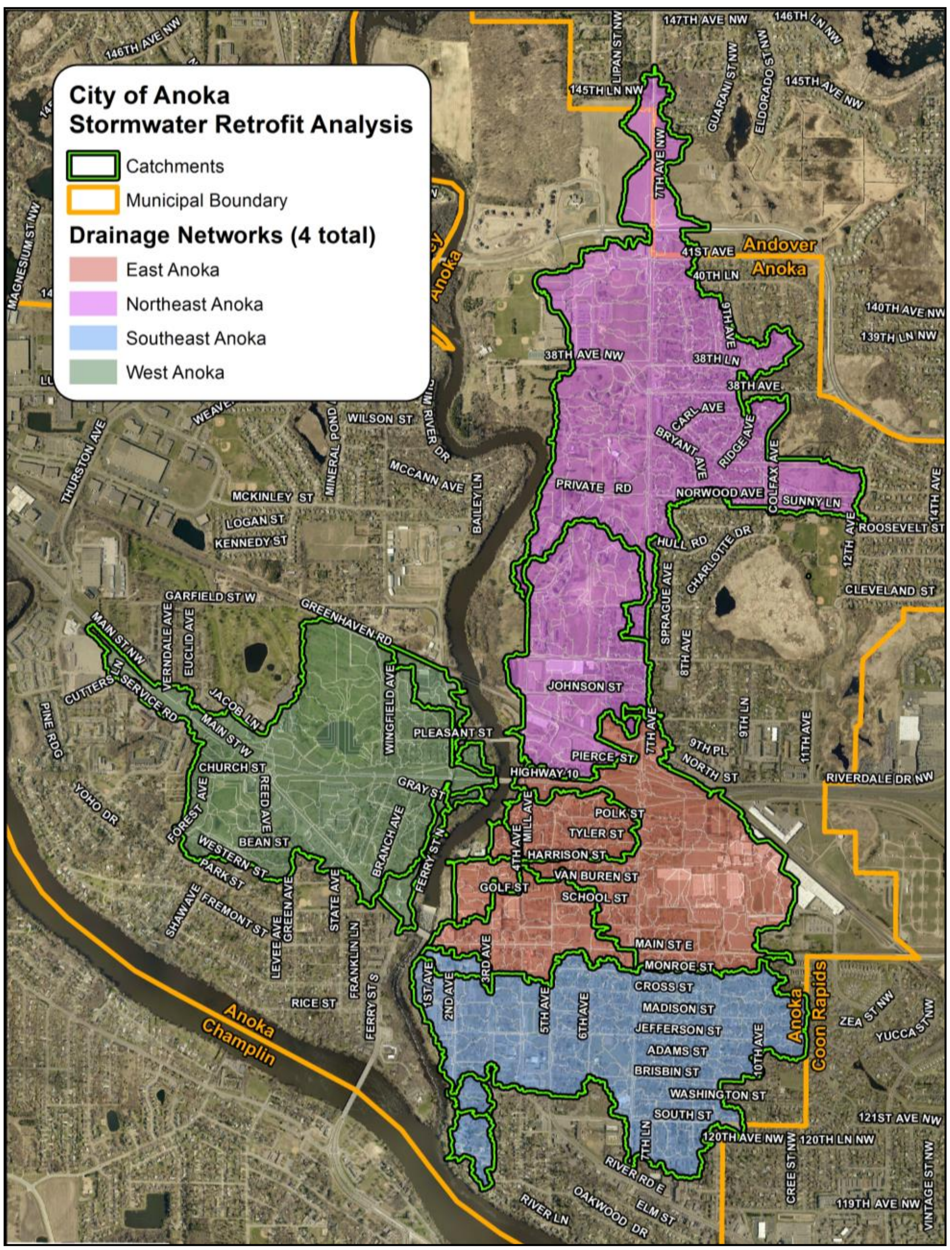
Rum River Stabilizations

Description:	Four riverbank stabilization projects were installed on the Rum River in 2015 in partnership with the Lessard-Sams Outdoor Heritage Council, the Anoka County Parks Department, and Conservation Corps Minnesota. A combination of hard armoring (riprap and Flexamat), regrading, native vegetation, cedar tree revetment, and live willow staking were used to stabilize the severely eroding banks.
Location:	Cedar Creek Conservation Area, Rum River Central Regional Park, near Anoka High School, and a residential property in Ramsey.
Purpose:	To stabilize areas of riverbank with severe erosion and reduce the sediment loading in the Rum River.
Results:	Stabilized a total of 1,150 linear feet of riverbank on the Rum River.

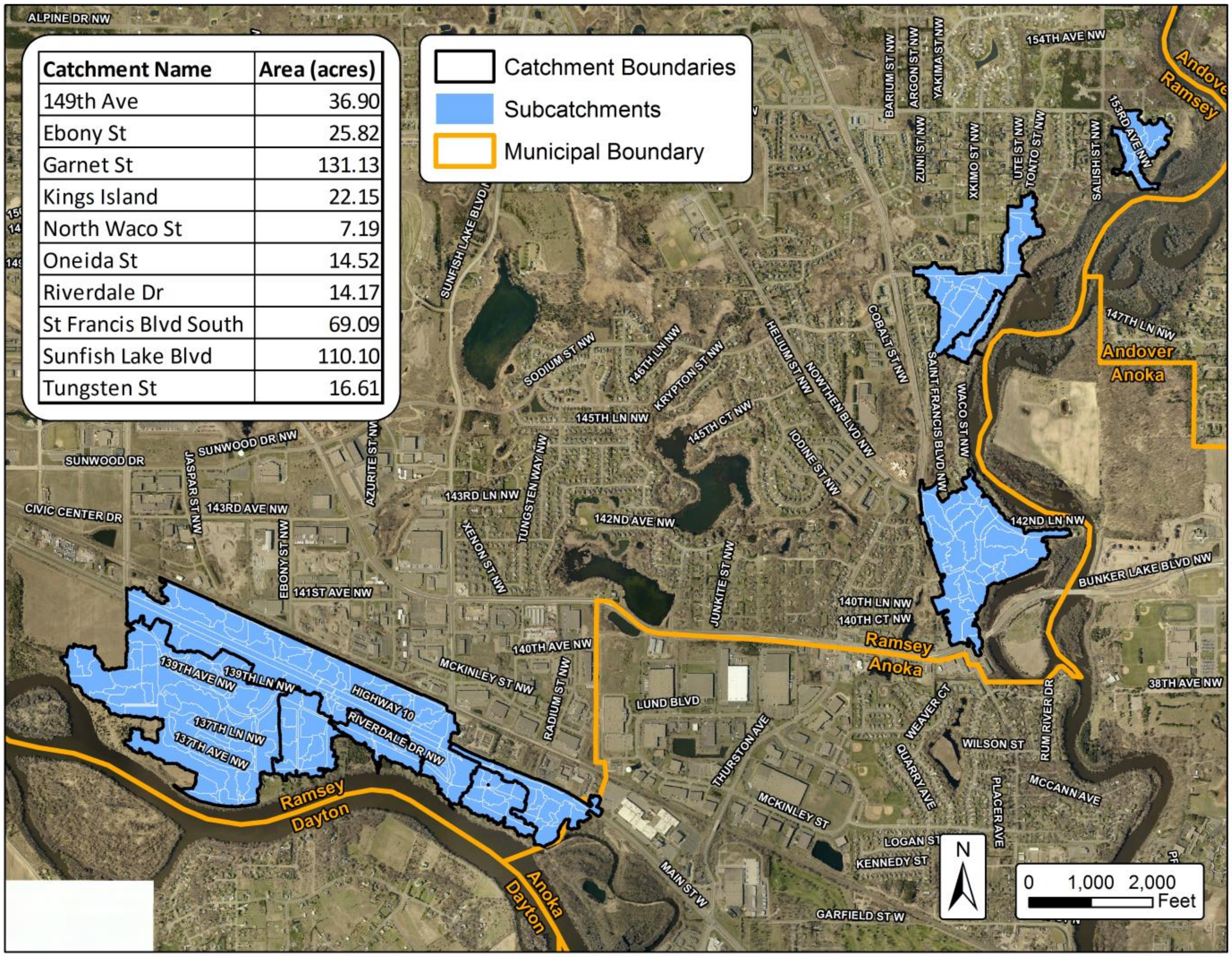
Anoka and Ramsey Stormwater Retrofit Studies

Description:	Studies identify new stormwater treatment opportunities in neighborhoods identified by cities and rank those potential projects by cost effectiveness (amount of pollutant kept out of area rivers per dollar spent). The studies provide sufficient detail for pursuit of funds to install the most cost effective projects. The studies are conducted in areas with little or no stormwater treatment, which are often older neighborhoods.
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 will be completed in 2016. Maps of the study areas are provided below.

City of Anoka Stormwater Retrofit Study Area



City of Ramsey Stormwater Retrofit Study Area



Catchment Name	Area (acres)
149th Ave	36.90
Ebony St	25.82
Garnet St	131.13
Kings Island	22.15
North Waco St	7.19
Oneida St	14.52
Riverdale Dr	14.17
St Francis Blvd South	69.09
Sunfish Lake Blvd	110.10
Tungsten St	16.61

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: The Anoka Conservation District (ACD) drafted two newsletters and sent them to cities for inclusion in their newsletters.

Both 2015 newsletters focused on public education regarding wetlands. One articles included information what homeowners can do to help wetlands on their property. The other focused on wetland regulation and the new "wetland" section on the ACD website.

2015 Newsletter Articles

Be Good To Your Wetland

23% of southwestern Anoka County is water or wetland. Development within our city has wound its way around these wetlands, creating quaint, private neighborhoods. We've protected these ecologically important areas. Now, the condition of these wetlands is in the hands residents, each of whom may own only a small portion.

Each homeowner can do a few simple things to be good to their wetland.

- **Leave an unmowed buffer**. The edge of a wetland is particularly valuable habitat. Leave a 20 foot unmowed strip.
- **Plant natives**. Native plants are those to which native wildlife is adapted. There are several native plant nurseries in our area.
- **Plant for pollinators**. Bees and other pollinators are on the decline. Treat yourself to some color, and treat the pollinators to some habitat by planting native flowers.

The collective actions of homeowners make a difference for wildlife and clean water.

A message from the Lower Rum River Watershed Management Organization www.LRRWMO.org

Wetland Law Made Clearer

Digging ponds, filling in low areas, and removing cattails. All are regulated under complex wetland laws leaving landowners wondering, "can I do that on my property?" A new web tool is available to provide direct answers in one place.

With support from the Lower Rum River Watershed Management, the Anoka Conservation District has added a new "wetlands" section to their website. The website includes a summary of wetland rules, answers to frequently asked questions, a map with permitting contact information and a way to request advice without going through a permitting process.

Three sets of wetland law apply in Minnesota. First is the MN Wetland Conservation Act which applies to all wetlands. Second are DNR rules which apply only to larger, generally open water, "public waters." Third is the Army Corps of Engineers rules which apply to "navigable waters of the US" which can include smaller wetlands that seem "un-navigable" in common language. All apply regardless of whether the property is private or public.

Go to **www.AnokaSWCD.org** and click the "Wetlands" tab before beginning a project in or near low areas. And remember…even an area that is dry today, or even most of the time, may legally be a wetland.

A message from the Lower Rum River Watershed Management Organization www.LRRWMO.org

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.

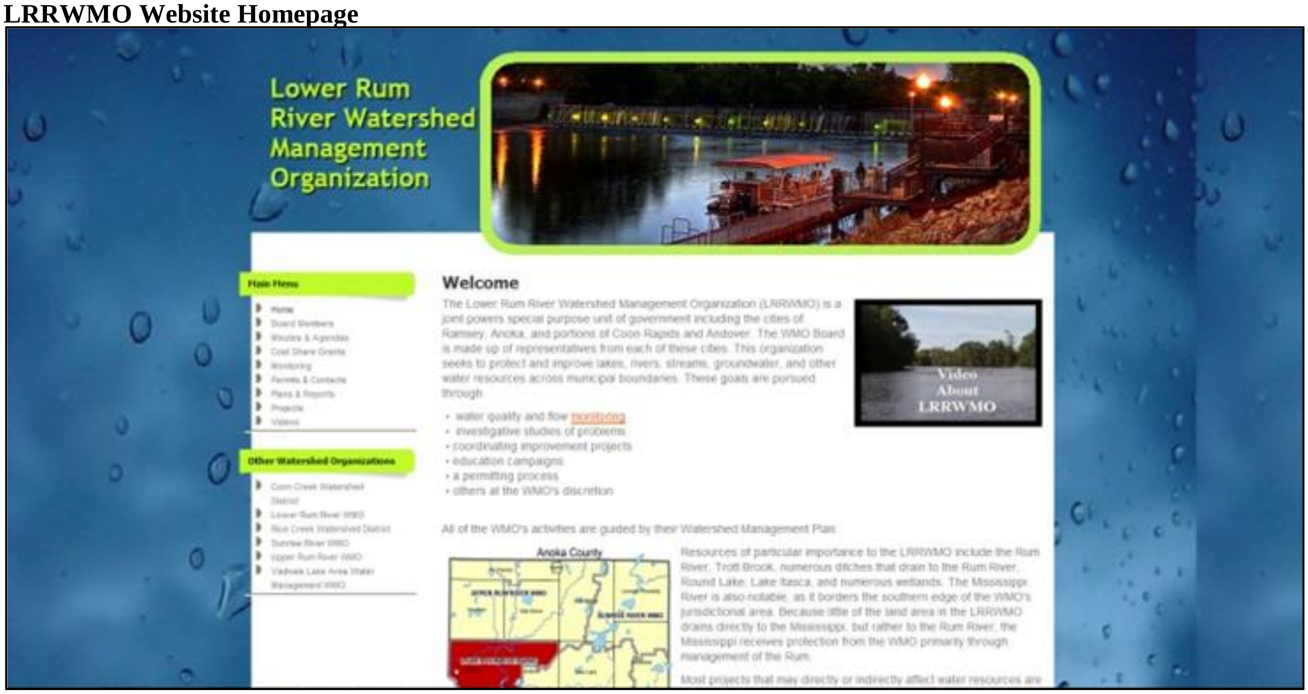
Purpose: To increase awareness of the LRRWMO and its programs. The website also provides tools and information that helps users better understand water resources issues in the area.

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

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.

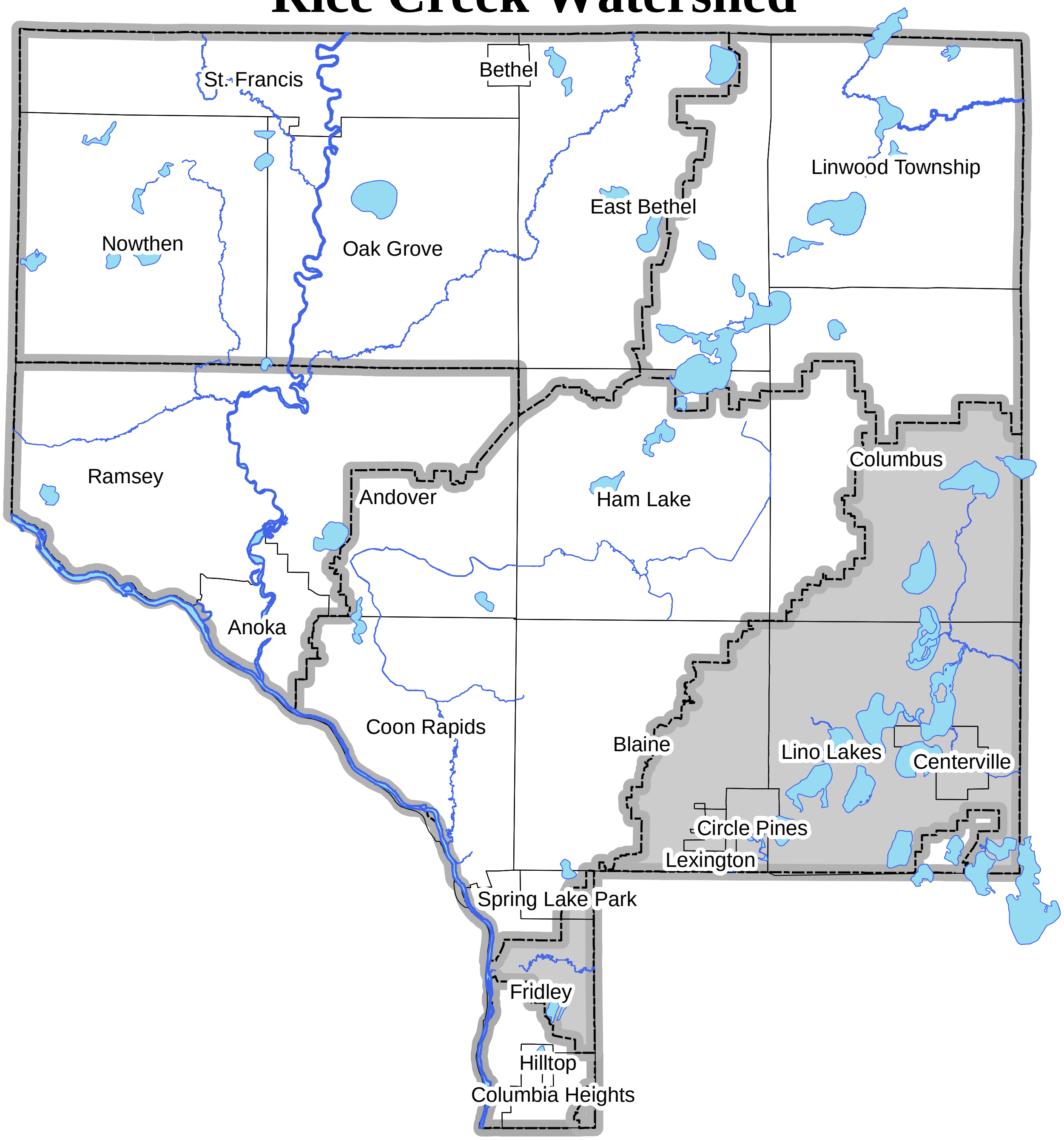
Lower Rum River Watershed Financial Summary

Lower Rum River Watershed	WMO Asst (no charge)	Volunteer Precip	Reference Wetlands	Ob Well	Lake Level	Stream Water Quality	Student Biomonitoring	LRRWMO Admin	City Water Plan Reviews for WMOs	WMO Annual Rpts to State	LRRWMO Outreach/Promo	URRWMO Outreach/Promo	WMO Website Maintenance	Anoka Nat. Pres. Restoration	Rum River Stabilization	BMP Maintenance	Mississippi Riverbank Inventory - Ramsey	Shoreland NRBG	Rum River WRAPP	Anoka SRA (Rum River WRAPP)	Ramsey SRA (Rum River WRAPP)	Project Hours	Total
Revenues																							
LRRWMO	0	0	1725	0	1000	2240	825	0	2000	850	12700	0	585	0	0	0	0	0	0	0	0	534	22459
State	0	0	0	320	0	0	0	0	0	0	0	0	0	0	110000	0	0	0	38373	4289	3486	0	156468
Anoka Conservation District	0	0	88	0	0	0	0	70	331	0	0	0	0	0	0	0	0	0	0	0	0	0	489
Anoka Co. General Services	379	0	1176	0	0	0	0	0	0	0	0	0	0	1567	0	2481	0	0	853	45	61	0	6561
County Ag Preserves/Projects	0	0	0	0	0	0	384	0	0	0	0	0	0	0	69549	0	0	0	0	0	0	9325	79258
Regional/Local	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Service Fees	0	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0	2873	0	0	0	0	3540	6459
BWSR Cons Delivery	0	0	0	0	271	0	46	1153	0	0	0	0	0	0	1363	0	0	0	0	0	0	0	2834
BWSR Cost Share TA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2555	0	0	0	0	0	0	0	2555
Local Water Planning	0	166	852	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1018
TOTAL	379	166	3887	320	1271	2240	1255	1223	2331	850	12700	0	585	1567	183467	2481	2873	0	39226	4334	3547	13398	278100
Expenses-																							
Capital Outlay/Equip	3	1	1110	3	11	10	11	11	20	1	72	0	3	14	163	21	25	0	52	37	31	101	1700
Personnel Salaries/Benefits	333	146	2378	282	1113	1035	1105	1077	2052	134	7365	0	275	1379	16652	2181	2529	0	5309	3815	3122	10354	62635
Overhead	21	9	152	18	71	66	71	69	131	9	472	0	18	88	1067	140	162	0	340	244	200	663	4012
Employee Training	2	1	15	2	7	7	7	7	13	1	47	0	2	9	106	14	16	0	34	24	20	66	399
Vehicle/Mileage	5	2	34	4	16	15	16	15	30	2	106	0	4	20	239	31	36	0	76	55	45	149	901
Rent	14	6	99	12	46	43	46	45	85	6	305	0	11	57	690	90	105	0	220	158	129	429	2596
Program Participants	0	0	0	0	0	0	0	0	0	0	0	0	0	0	122023	0	0	0	0	0	0	1635	123658
Program Supplies	0	0	99	0	7	492	0	0	0	0	649	0	0	0	42526	4	0	0	33195	0	0	0	76970
McKay Expenses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	379	166	3887	320	1271	1668	1255	1223	2331	152	9015	0	312	1567	183467	2481	2873	0	39226	4334	3547	13398	272871

Recommendations

- **Actively participate in the MPCA Rum River WRAPP (Watershed Restoration and Protection Plan) which will conclude in early 2017.** This WRAPP is an assessment of the entire Rum River watershed. This is an opportunity for the LRRWMO to prioritize and coordinate efforts with upstream entities and state agencies. TMDL studies for impaired waters, including Trott Brook, will be completed as part of this project.
- **Engage in the Upper Rum River WMO's watershed plan update** process in 2016.
- **Diagnose low dissolved oxygen in Trott Brook.** Diagnostic monitoring is complete and will be incorporated into the TMDL study for that stream. Local review is advised.
- **Install projects identified in the stormwater retrofitting studies for the Cities of Anoka and Ramsey.** These, which will be completed in 2016, will identify and rank projects that improve stormwater runoff before it is discharged to the Rum or Mississippi Rivers. The projects may be good candidates for State grants.
- **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



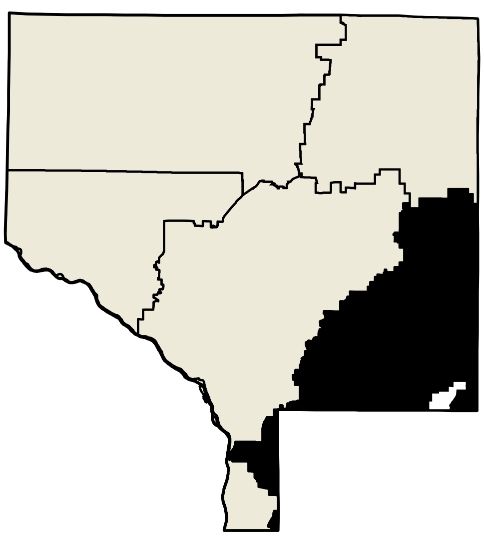
Contact Info: Rice Creek Watershed District
www.ricecreek.org
763-398-3070

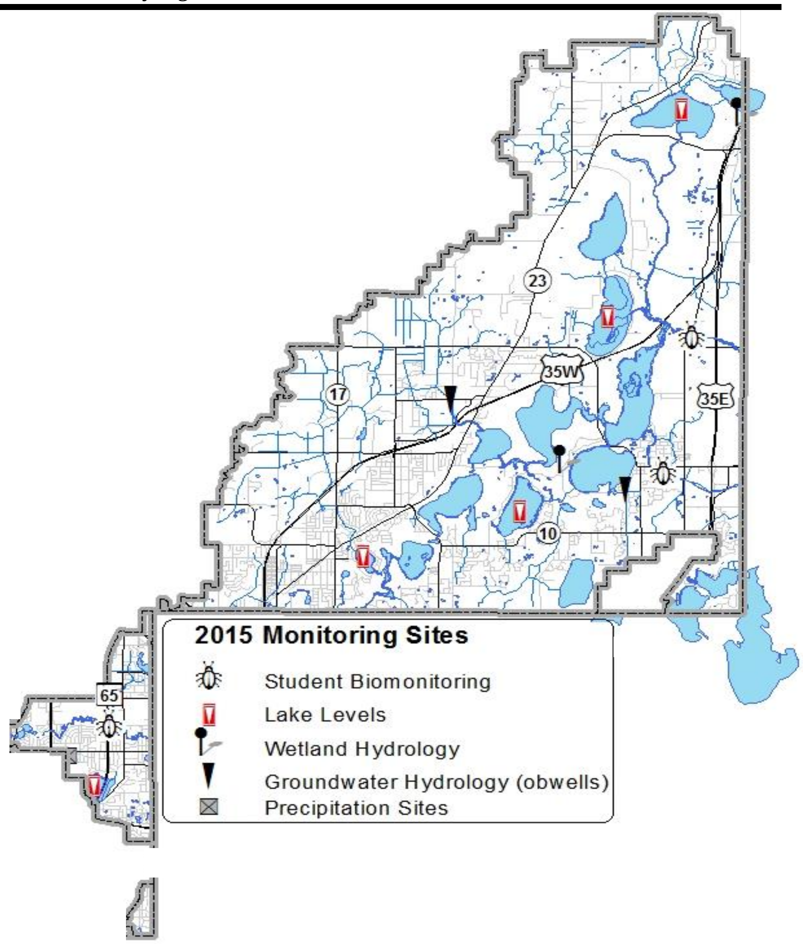
Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

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	5-172
Golden Lake IESF	RCWD, ACD, City of Blaine	5-173
Financial Summary		5-174
Recommendations		5-175
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 since 1990 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

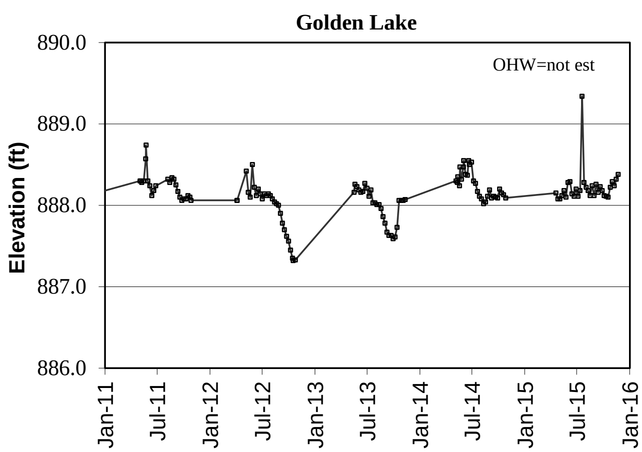
Results: Lake levels were measured by volunteers throughout the 2015 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR.

Lakes had increasing water levels in spring and early summer and began to drop 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.

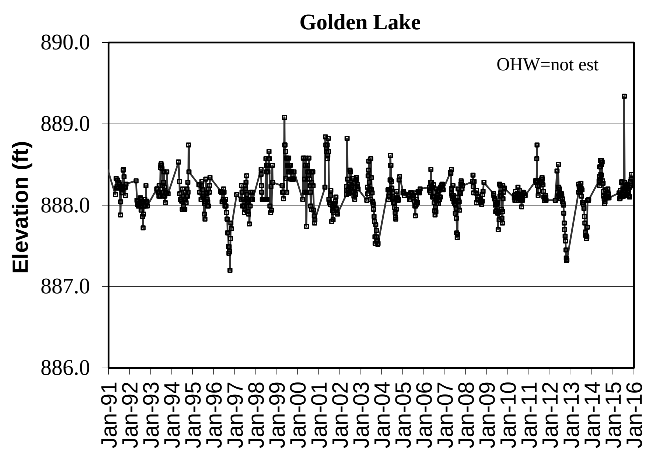
Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is listed for each lake on the corresponding graphs below.

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.

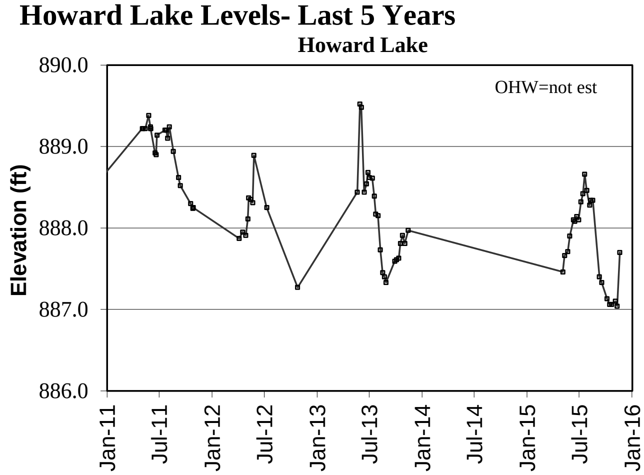
Golden Lake Levels- Last 5 Years



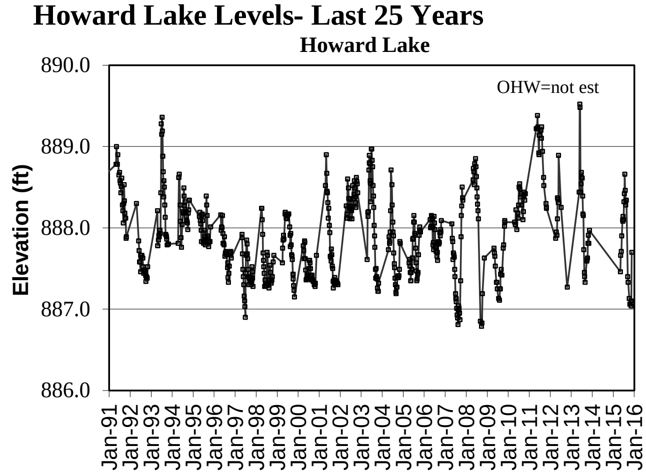
Golden Lake Levels- Last 25 Years



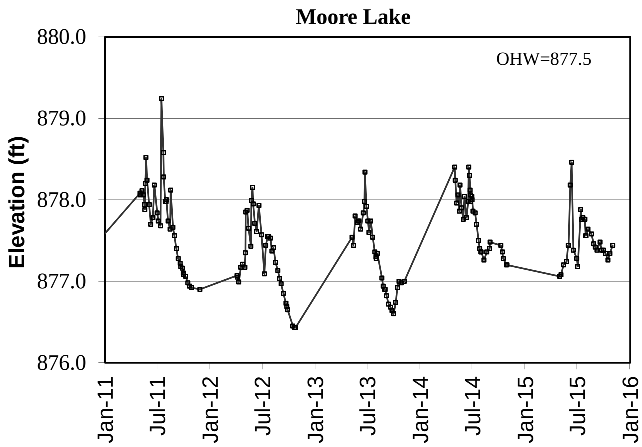
Howard Lake Levels- Last 5 Years



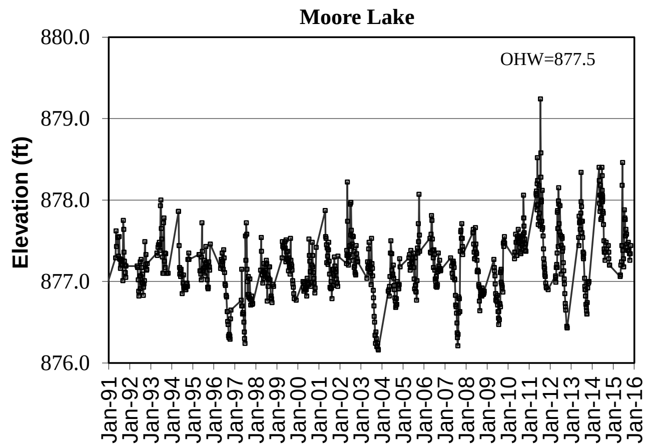
Howard Lake Levels- Last 25 Years



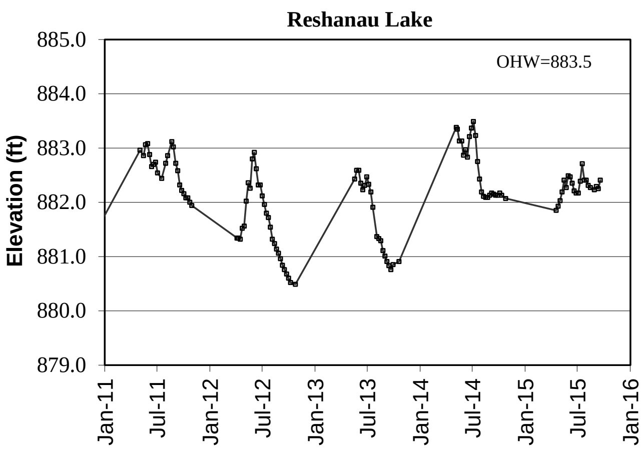
Moore Lake Levels- Last 5 Years



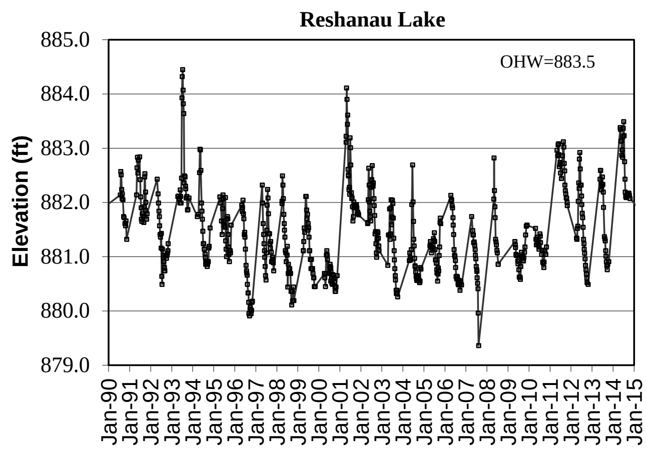
Moore Lake Levels- Last 25 Years



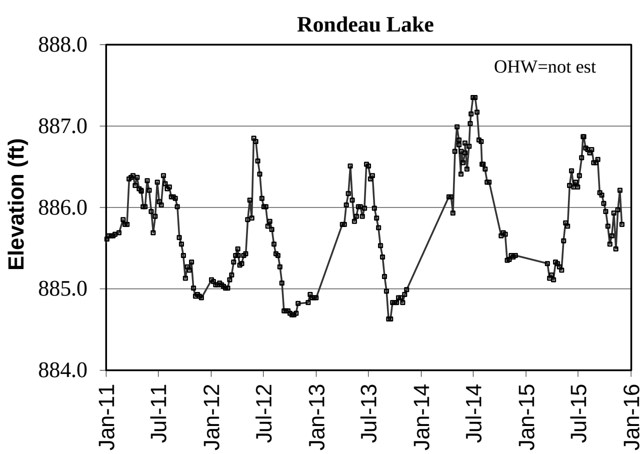
Reshanau Lake Levels- Last 5 Years



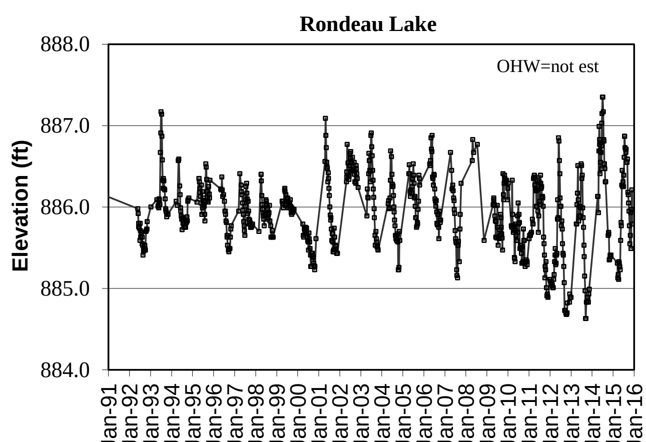
Reshanau Lake Levels- Last 25 Years



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.

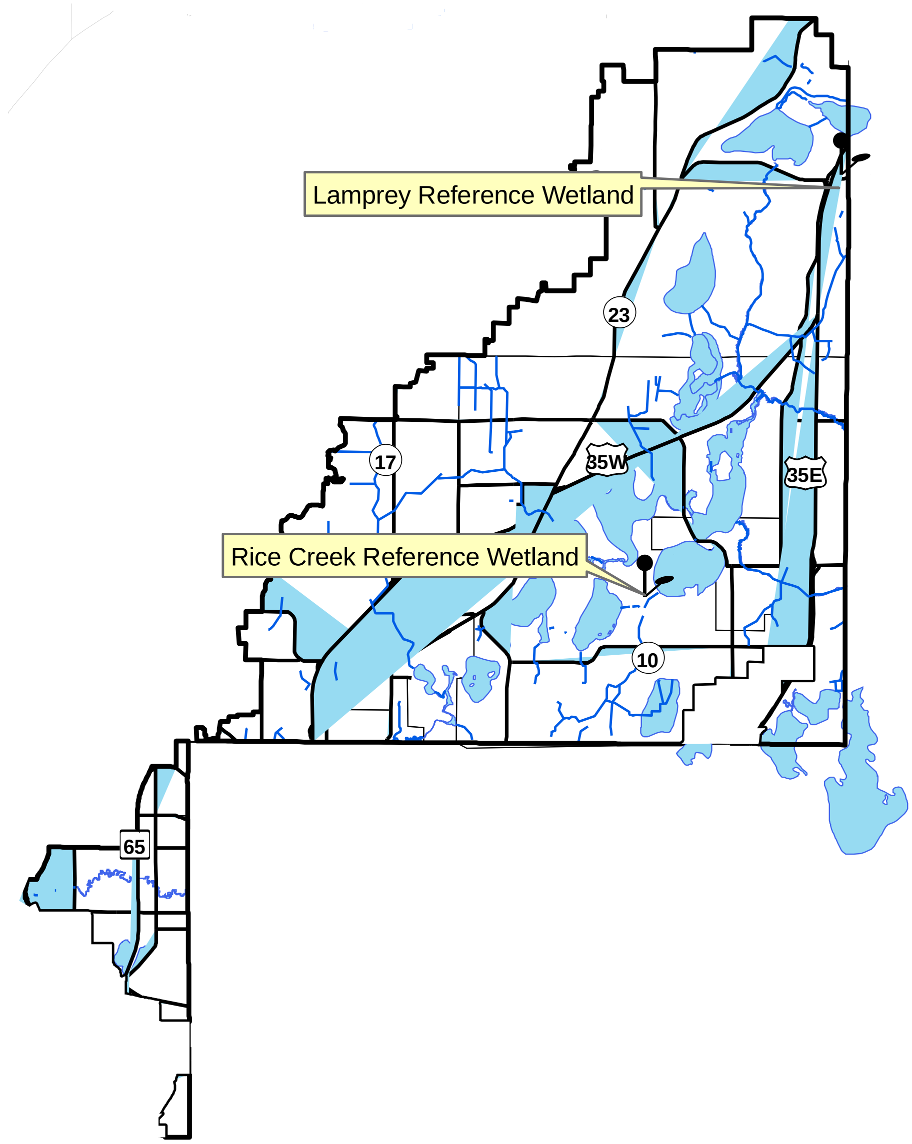
Purpose: To provide an understanding of wetland hydrology, including the impact of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

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.

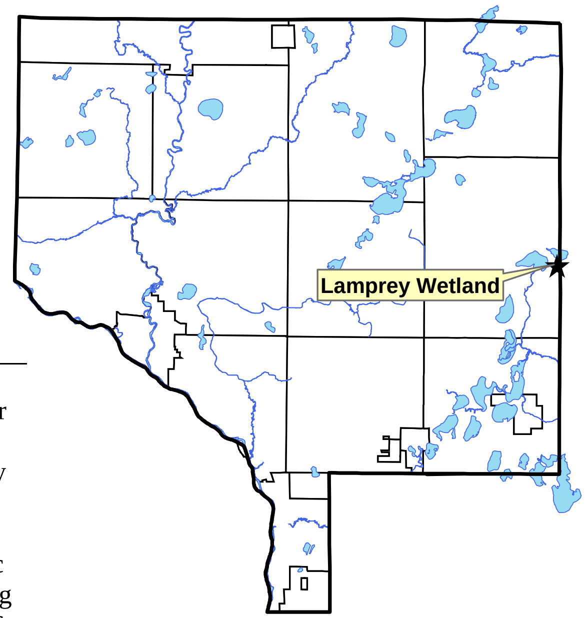
Rice Creek Watershed Wetland Hydrology Monitoring Sites



Wetland Hydrology Monitoring

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

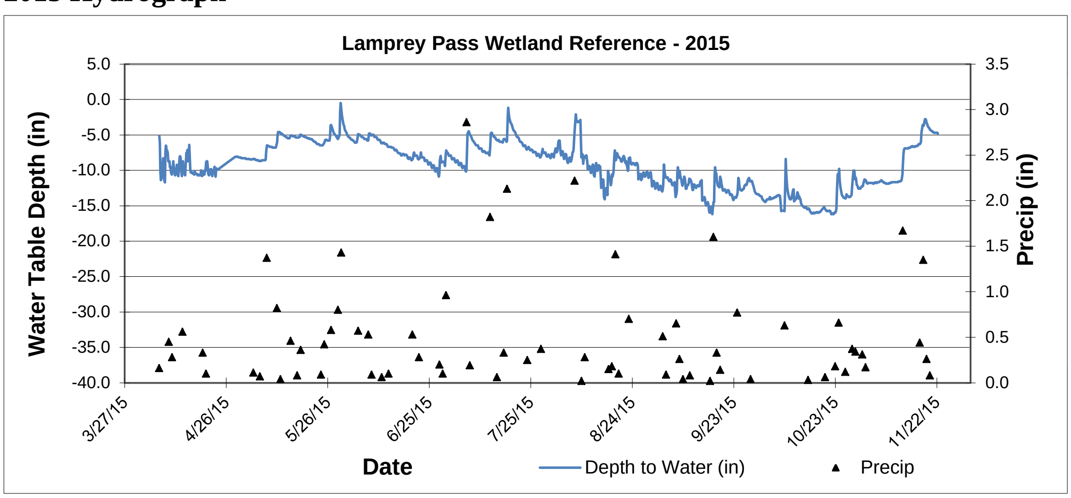
Surrounding Soils: Braham loamy fine sand

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.

2015 Hydrograph



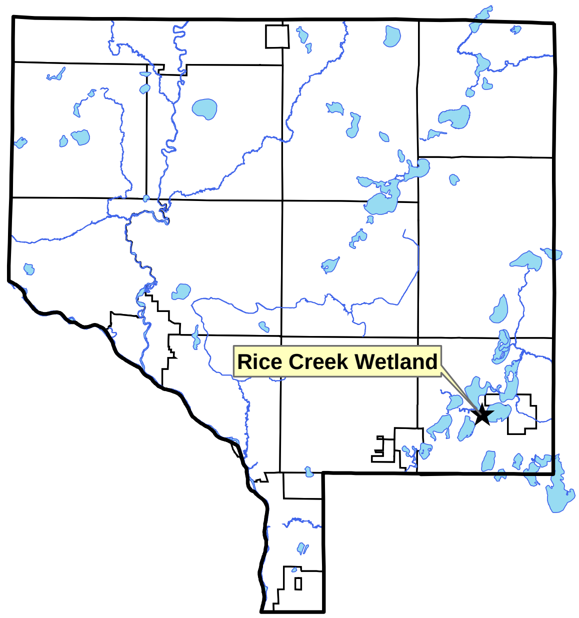
Well depth was 40 inches, so a reading of –43 indicates water levels were at an unknown depth greater than or equal to 43 inches.

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

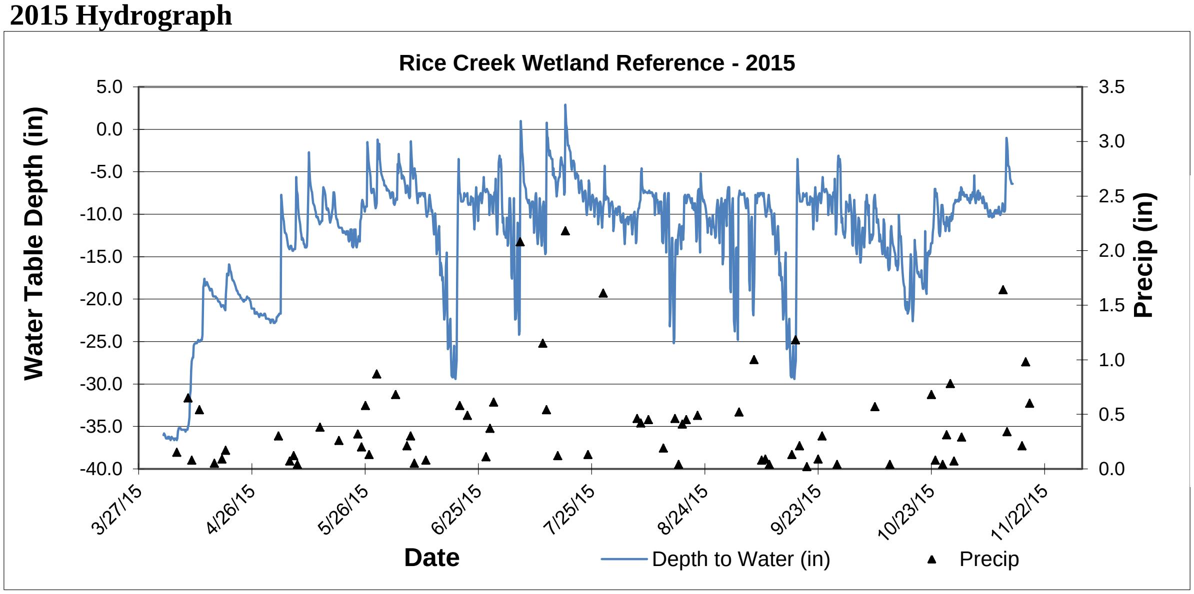
Surrounding Soils: Nessel fine sandy loam and Blomford loamy fine sand

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.

2015 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 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 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.

CLEARWATER CREEK

at Centerville City Hall, Centerville

Last Monitored

By Anoka County 4-H in the fall of 2015

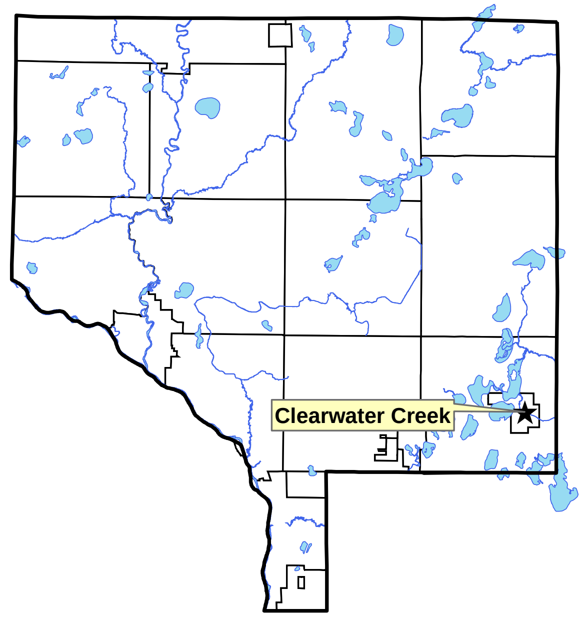
Monitored Since

1999

Student Involvement

8 students in 2015, approximately 637 since 2001

Background

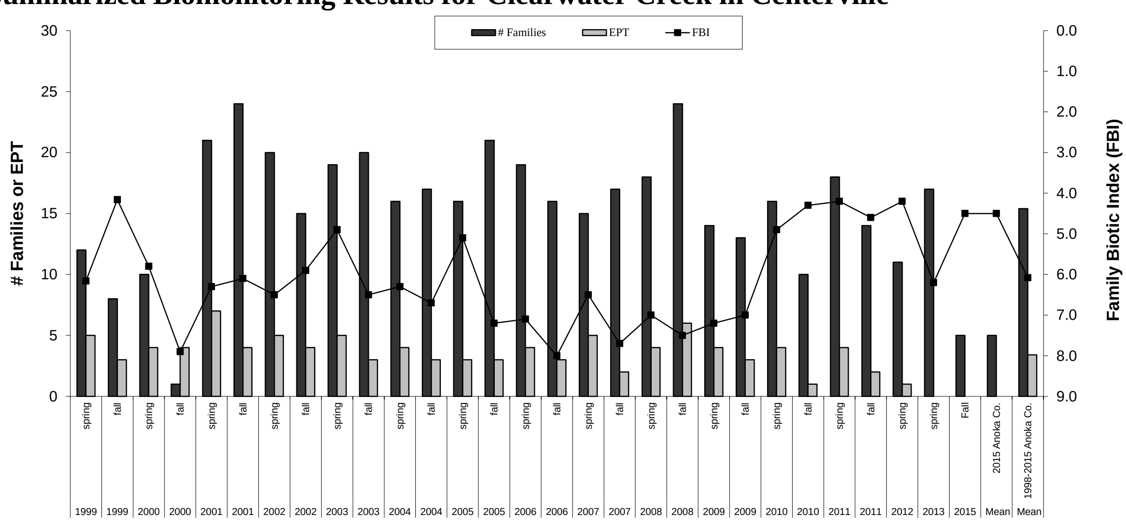


Clearwater Creek originates from Bald Eagle Lake in northwest Ramsey County and flows northwest into Peltier Lake. Land use is an approximately equal mix of residential and vacant/agricultural with some small commercial sites. The land use immediately surrounding the sampling site is entirely residential and developed, however in late summer 2007 a major city reconstruction project began near the stream monitoring site in Centerville, and large areas were graded or disturbed. The stream banks are steep with erosion in spots. The streambed is composed of sand and silt with a few areas of gravel. The stream is 6-12 inches deep at baseflow and approximately 10-15 feet wide.

Results

A 4-H group based out of Anoka County monitored Clearwater Creek in the fall of 2015, with oversight by the Anoka Conservation District (ACD). Overall, this stream has average or slightly below average conditions based upon the invertebrate data, though fluctuations occur. Data from 2010-12 represented an interesting deviation from previous years. A dramatic decrease in the family biotic index (FBI) occurred. The lower FBI value suggests an increase in pollution intolerant species. FBI returned to around the county average in 2013 but decreased again in 2015. The 2013 spike was primarily due to hyalellidae being the dominant species found. While the number of families found increased from 2012, EPT families continued their downward trend and none were found in 2013 or 2015. The number of families observed in 2015 greatly decreased from 2013, but this is most likely due to the low number of participants. Comparison of total number of families and EPT from 2015 with previous years suggests a slight decrease in overall stream health.

Summarized Biomonitoring Results for Clearwater Creek in Centerville



Biomonitoring Data for Clearwater Creek in Centerville

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

Year	2008	2008	2009	2009	2010	2010	2011	2011	2012	2013	2015	Mean	Mean
Season	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	spring	spring	Fall	2015 Anoka Co.	1998-2015 Anoka Co.
FBI	7.00	7.50	7.20	7.00	4.9	4.3	4.2	4.6	4.2	6.2	4.5	4.5	6.1
# Families	18	24	14	13	16	10	18	14	11	17	5	5.0	15.4
EPT	4	6	4	3	4	1	4	2	1	0	0	0.0	3.4
Date	8-May	1-Oct	20-May	9-Oct	14-May	6-Oct	31-May, 6-Jun	12-Oct	17-May	28-May	31-Aug		
Sampled By	CHS	CHS	CHS	CHS	CHS	CHS	CHS & ACD	CHS	CHS	CHS	Anoka 4-H		
Sampling Method	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH		
Mean # Individuals/Rep.	180	450	238	386	664	532	2003	146	273	228	152		
# Replicates	1	1	1	1	1	1	2	1	1	1	1		
Dominant Family	Simuliidae	Corixidae	Hyalellidae	Corixidae	Gammaridae	Gammaridae	Gammaridae	Gammaridae	Gammaridae	Hyalellidae	Gammaridae		
% Dominant Family	27.8	42.3	26.1	53.9	77.7	89.7	93.5	80.1	87.9	34.2	65.7		
% Ephemeroptera	10.6	4.7	28.2	8.5	1.8	0.6	0.6	0.7	2.2	0.0	0.0		
% Trichoptera	2.2	0.7	0.8	2.8	0.6	0.0	0.1	0.7	0.0	0.0	0.0		
% Plecoptera	0.0	0.0	0.0	0.0	0.0	0.0	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.

Parameter	5/5/2008	10/1/2008	5/20/2009	10/9/2009	5/14/2010	10/6/2010	5/31/2011	6/6/2011	10/6/2011	5/17/2012
pH	8	7.65	7.56	7.27	7.23	7.29	7.66	7.88	7.74	7.78
Conductivity (mS/cm)	0.452	0.607	0.699	0.558	0.788	0.701	0.551	0.560	0.551	0.491
Turbidity (NTU)	10	13	4	8	10	21	0	6	16	8
Dissolved Oxygen (mg/L)	11.84	8.74	4.85	9.25	10.31	na	6.32	7.98	1.42	7.58
Salinity (%)	0.01	0.02	0.02	0.02	0.03	0.04		0.02	0.02	0.02
Temperature (°C)	14.3	9.5	16.9	7.6	10.0	12.2	18.6	22.9	17.3	16.7

Discussion

This creek's biological community is probably limited by a combination of habitat, hydrology and water chemistry factors. The portion of the creek that is monitored has been ditched, and is straight with steep banks, no pools or riffles and homogeneous bottom composition. There is a strip of forested land approximately 20-50 feet wide on each side of the stream, but other areas upstream and downstream have less adjacent natural habitat. Flows are generally slow and water levels are low during much of the year, such that the stream sides are seldom submerged to provide habitat. When higher water does occur, it is usually during large storms, and the urbanized subwatershed results in a flashy hydrograph.

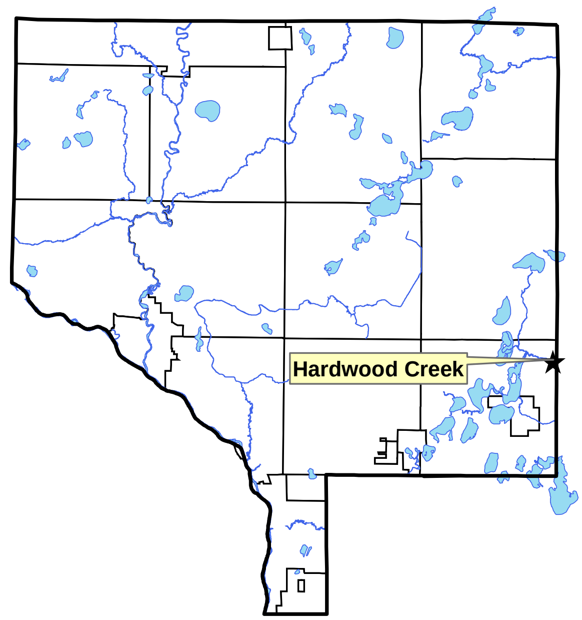
Supplemental water chemistry measurements have highlighted occasions when one or more water quality parameters are substandard, but not necessarily during storms when runoff to the creek would be greatest. For example, a highly turbid condition was noted in October 2004 during a baseflow period when the water was barely moving. Likewise, high conductivity values in 2006-2011 were during low water levels. On October 6, 2011 we found dissolved oxygen of just 1.42 mg/L, much lower than required by most aquatic life.

Overall, this creek seems to provide adequate habitat and water quality for pollution-tolerant invertebrates, but more sensitive varieties are unable to survive. Particularly in more recent years, species evenness has been low. Captures were dominated by Gammaridae, a moderately pollutation-tolerant scud. They accounted for 78%, 90%, 94%, 80% and 88% of the invertebrate community in the spring 2010 through the fall of 2012 samplings, respectively. Gammaridae was less dominant in 2013; however in 2015 Gammaridae made up 66% of all invertebrates observed. Only 5 families were found in 2015 and were in low abundance. Having only 8 participants in 2015 played a large role in the drastic decrease of families found. Collectively, these data indicate a very limited invertebrate community is able to thrive in Clearwater Creek.

Centennial High School students at Clearwater Creek.

HARDWOOD CREEK

see list of monitoring locations below



Last Monitored

By Forest Lake Area Learning Center in fall of 2015

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
2009-15 at Cecelia LaRoux property 600 m W of I-35

Student Involvement

10 students in 2015, approximately 252 since 2001

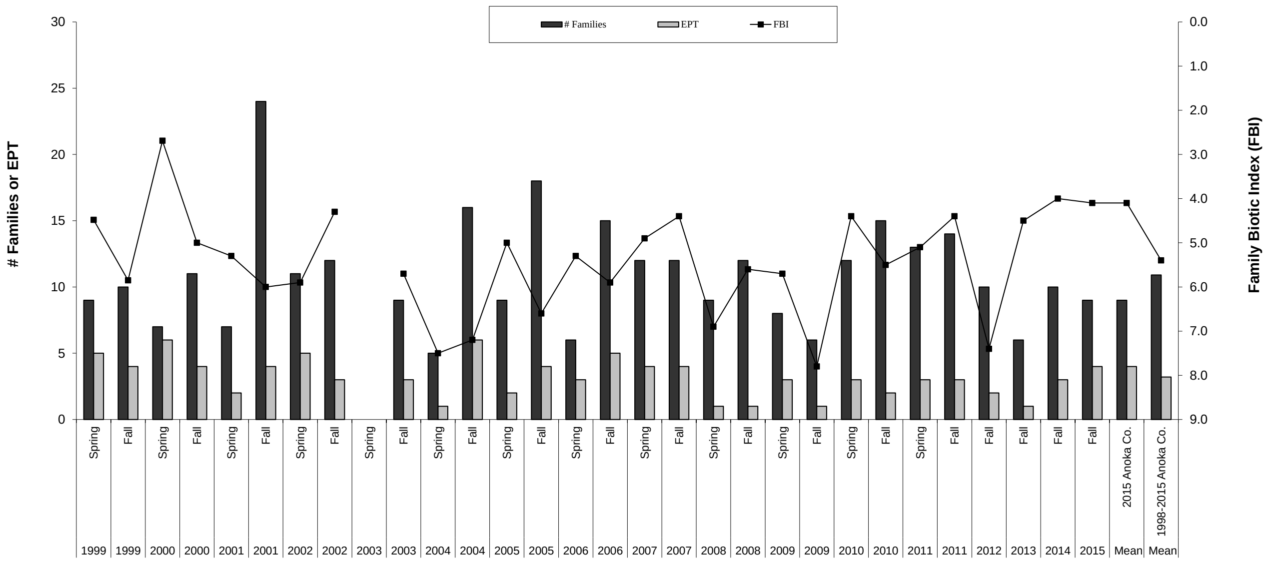
Background

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 2009-14 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 2015, 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 and continued to improve through 2015. EPT also saw an increase in 2015 suggesting improving water quality, although these changes could reflect normal variation. Future monitoring will provide additional insight.

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	2008	2009	2009	2010	2010	2011	2011	2012	2013	2014	2015	Mean	Mean
Season	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Fall	Fall	Fall	Fall	2015 Anoka Co.	1998-2015 Anoka Co.
FBI	5.60	5.70	7.80	4.40	5.50	5.1	4.4	7.4	4.5	4.0	4.1	4.1	5.4
# Families	12	8	6	12	15	13	14	10	6	10	9	9.0	10.9
EPT	1	3	1	3	2	3	3	2	1	3	4	4.0	3.2
Date	8-Oct	19-May	8-Oct	5-May	14-Oct	11-May	5-Oct	11-Oct	10-Oct	10-Oct	8-Oct		
Sampled By	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC	FLALC		
Sampling Method	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH		
Mean # Individuals/Rep.	159	400	391	290	110	237	190	83	87	359	158		
# Replicates	1	1	1	1	1	1	1	1	1	1	1		
Dominant Family	Dystidae	Simuliidae	Corixidae	Baetidae	Gammaridae	Gammaridae	Gammarida	Hyalellidae	Gammaridae	Gammaridae	Gammaridae		
% Dominant Family	57.2	67.3	74.7	68.6	51.8	50.2	62.6	73	87.4	97.2	62.7		
% Ephemeroptera	0.6	19.5	0.3	69	9.1	2.5	16.3	12	3.4	0.8	32.3		
% Trichoptera	0	0.8	0	1.4	0	0.4	1.1	0	0	0.3	0.6		
% Plecoptera	0.0	0.0	0.0	0.0	0.0	0.0	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.

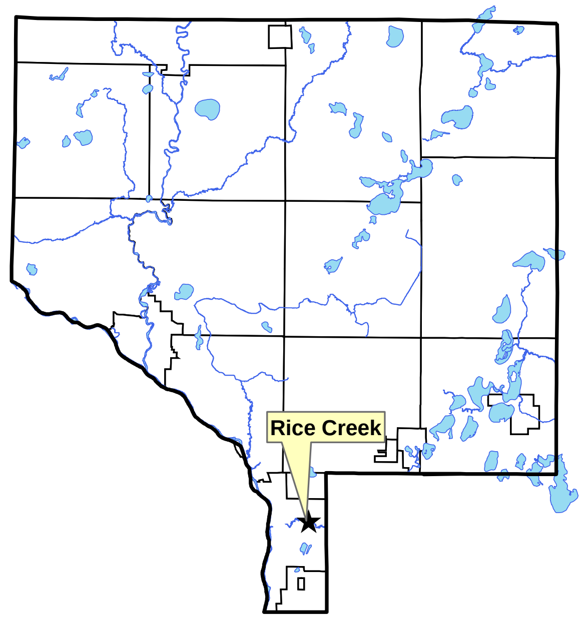
Three sites on this creek have been monitored and provided differing results. The earliest monitoring until 2007 was on the north side of Highway 140 (170th St, W crossing), where habitat was moderate to good and invertebrate communities indicated the best stream health. In spring 2008 it was monitored 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.

Biomonitoring

RICE CREEK

at Hwy 65, Locke Park, Fridley



Last Monitored

By Totino Grace High School in fall 2015

Monitored Since

1999

Student Involvement

78 students in 2015, approximately 1076 since 2001

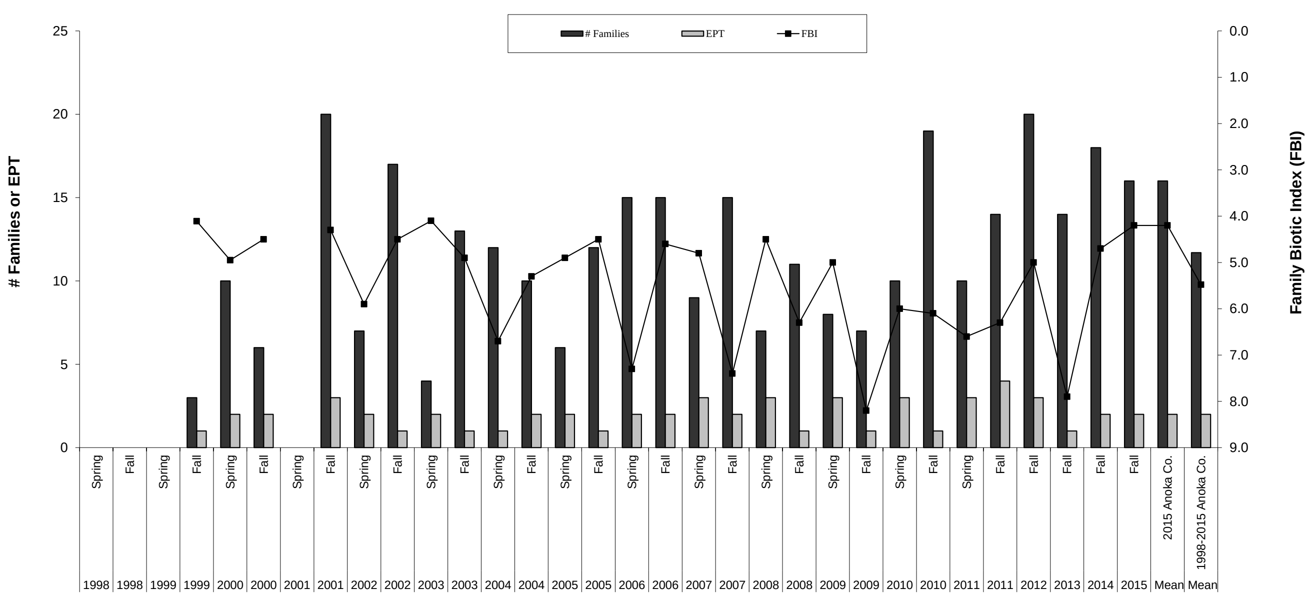
Background

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 2015, facilitated by the Anoka Conservation District (ACD). 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 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 during 2015 monitoring, Hydropsychidae made up 93% of all EPT specimen found.

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	2009	2009	2010	2010	2011	2011	2012	2013	2014	2015	Mean	Mean
Season	Spring	Fall	Spring	Fall	Spring	Fall	Fall	Fall	Fall	Fall	2015 Anoka Co.	1998-2015 Anoka Co.
FBI	5.0	8.2	6	6.1	6.6	6.3	5	7.9	4.7	4.2	4.2	5.5
# Families	8	7	10	19	10	14	20	14	18	16	16.0	11.7
EPT	3	1	3	1	3	4	3	1	2	2	2.0	2.0
Date	11-May	8-Oct	14-May	13-Oct	31-May	7-Oct	5-Oct		16-Oct	13-Oct		
Sampled By	ACD	TGHS	ACD	TGHS	ACD	TGHS	TGHS	TGHS	TGHS	TGHS		
Sampling Method	MH	MH	MH	MH	MH	MH	MH	MH	MH	MH		
# Individuals	148	111	154	132	126	215	248	107	670.5	730		
# Replicates	1	1	1	1	1	1	2	2	2	1		
Dominant Family	Baetidae	Corixidae	Chironomidae	Hydropsychidae	Chronomida	Simulidae	Philopotamidae	Corixidae	Hydropsychidae	Hydropsychidae		
% Dominant Family	50.0	74.8	29.2	31.1	39.7	23.3	38.0	38.0	76.7	92.6		
% Ephemeroptera	50.7	0.0	23.4	0.0	15.9	12.1	10.9	0.0	0.1	0.4		
% Trichoptera	6.8	9.0	3.2	31.1	0.8	14.0	43.1	6.4	76.7	92.6		
% Plecoptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Supplemental Stream Chemistry Readings

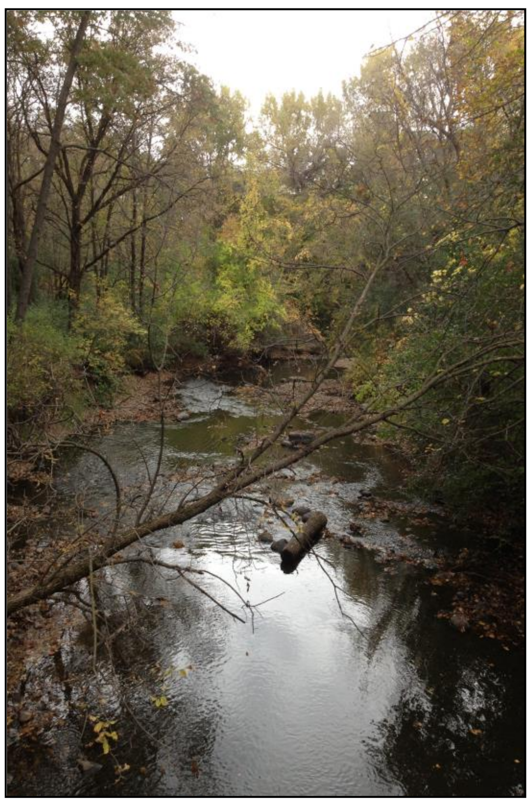
Data presented from the most recent five years. Contact the ACD to request archived data.

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: ACD worked with RCWD to administer the implementation of a cost-share grant program for private landowners. Tasks may include landowner outreach and education, site reviews, project evaluations, BMP design, contractor assistance, construction oversight, long-term project monitoring and other services as needed to ensure a smooth-running program.

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

Results: In 2015 ACD provided assistance for 25 potential projects valued at $8,578.25 and was reimbursed $8,578.25 through the Rice Creek Watershed District.

Project Management Details. The table below provides details on ACD's efforts toward the RCWD BMP cost-share program, which are also presented in the financial summary table at the end of this chapter.

Description	Hours	Rate	Value
Services			
Cost-Share Service Agreement			
Administrative Hours (Specialist)	22.5	$73	$1,642.50
Administrative Hours (Specialist)	1.5	$85	$127.50
Technical Assistance Hours (Specialist)	65	$73	$4,745.00
Technical Assistance Hours (Technician)	32.75	$63	$2,063.25
Total Value of Services Provided			**$8,578.25**

Golden Lake Iron-Enhanced Sand Filter

Description: Golden Lake is on the Minnesota Pollution Control Agency's list of impaired waters for excessive nutrients. Phosphorus is the nutrient of concern. The stormwater pond currently at Centennial Green Park only treats for particulate phosphorus. The iron-enhanced sand filter is a practice specifically designed to remove dissolved phosphorus from water.

Washed sand is uniformly mixed with iron filings so that the end product is 6.5% iron by weight. As water passes through the iron-enhanced sand the dissolved phosphorus chemically binds with the iron. This prevents it from flowing downstream into Golden Lake. The treated water then flows through perforated pipe and discharges into the ditch system.

Partners included the Rice Creek Watershed District, the city of Blaine, and the Anoka Conservation District. Long-term maintenance will be provided by the city of Blaine and routine monitoring will be conducted by the Rice Creek Watershed District.

Location: Centennial Green Park, City of Blaine

Purpose: To improve water quality in Golden Lake.

Results: The IESF was completed in fall of 2015 and will remove 27 pounds of phosphorus annually from entering Golden Lake.

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.

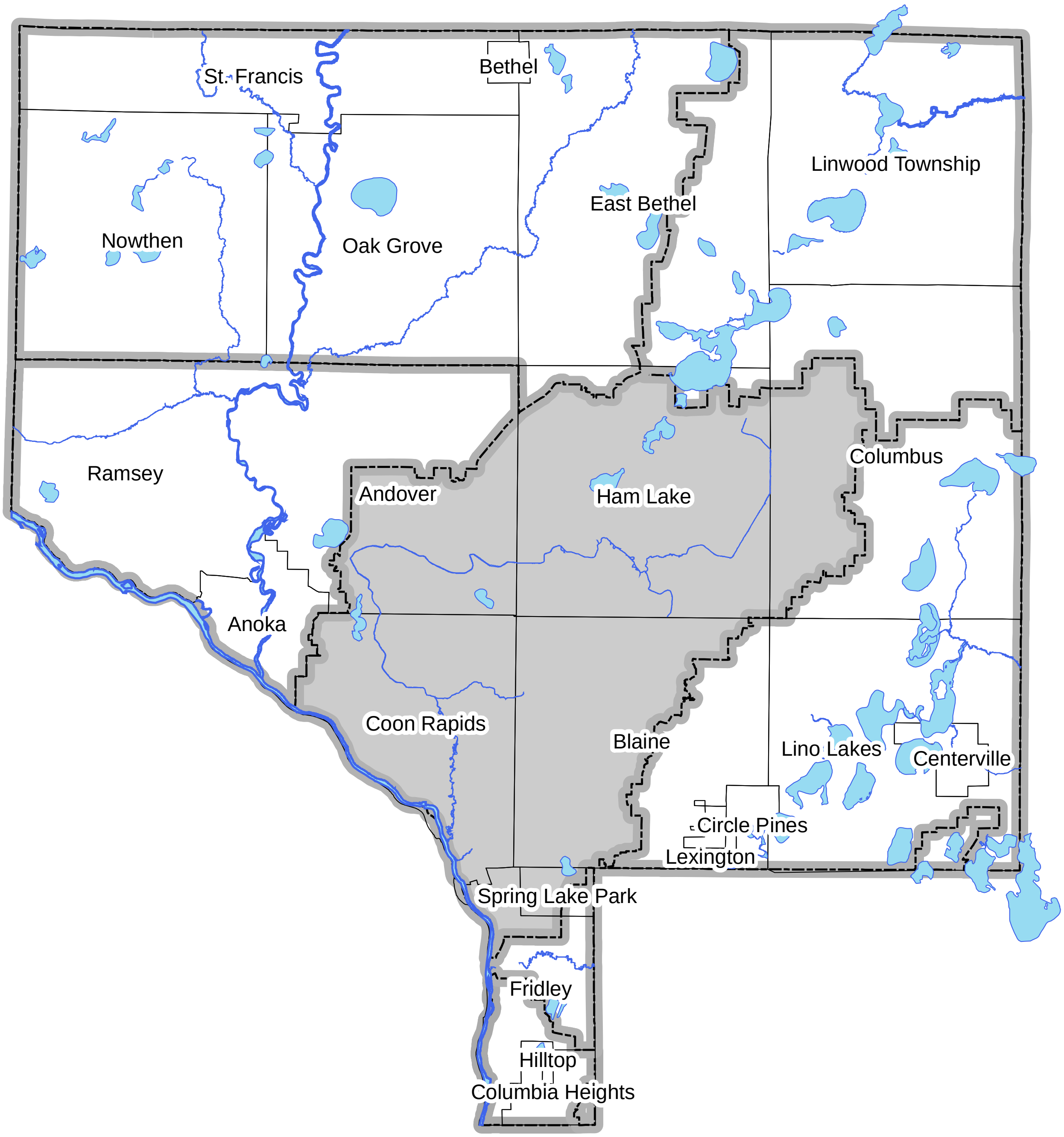
Rice Creek Watershed Financial Summary

Rice Creek Watershed	WMO Asst (no charge)	Volunteer Precip	Reference Wetlands	Ob Well	Lake Level	Student Biomonitoring	RCWD Cost Share Admin	Golden Lake IESF CWF - Admin	Golden Lake IESF CWF - Proj. Dev.	Golden Lake IESF CWF - Tech./Eng.	RCWD Project Hours	Total
Revenues												
RCWD	0	0	1150	0	1250	2475	1491	0	0	36495	0	42861
State	0	0	0	213	0	0	0	0	0	79863	0	80076
Anoka Conservation District	0	0	58	0	0	0	0	0	0	0	0	58
Anoka Co. General Services	379	0	784	0	0	0	0	0	0	0	0	1163
County Ag Preserves/Projects	0	0	0	0	0	1153	0	0	0	0	0	1153
Regional/Local	0	0	0	0	0	0	0	0	0	0	0	0
Other Service Fees	0	0	31	0	0	0	0	0	0	24155	5704	29890
BWSR Cons Delivery	0	0	0	0	339	138	0	1752	146	0	0	2375
BWSR Cost Share TA	0	0	0	0	0	0	0	1112	4512	4116	0	9740
Local Water Planning	0	166	568	0	0	0	0	0	0	0	0	734
TOTAL	379	166	2591	213	1589	3765	1491	2864	4658	144628	5704	168050
Expenses-												
Capital Outlay/Equip	3	1	740	2	14	32	13	25	40	63	49	982
Personnel Salaries/Benefits	333	146	1585	188	1392	3314	1313	2521	4100	6427	5021	26341
Overhead	21	9	102	12	89	212	84	161	263	1357	322	2632
Employee Training	2	1	10	1	9	21	8	16	26	41	32	168
Vehicle/Mileage	5	2	23	3	20	48	19	36	59	92	72	379
Rent	14	6	66	8	58	137	54	104	170	266	208	1092
Program Participants	0	0	0	0	0	0	0	0	0	136381	0	136381
Program Supplies	0	0	66	0	8	0	0	0	0	0	0	74
McKay Expenses	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	379	166	2591	213	1589	3765	1491	2864	4658	144628	5704	168050

Recommendations

- **Continue the biomonitoring program** with area schools. This program provides duel 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 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 IBI's. Hardwood Creek is impaired based on invertebrate data and low dissolved oxygen. In Anoka County Rice Creek does not have this designation, but reaches just upstream are impaired based on invertebrate and fish IBIs. 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

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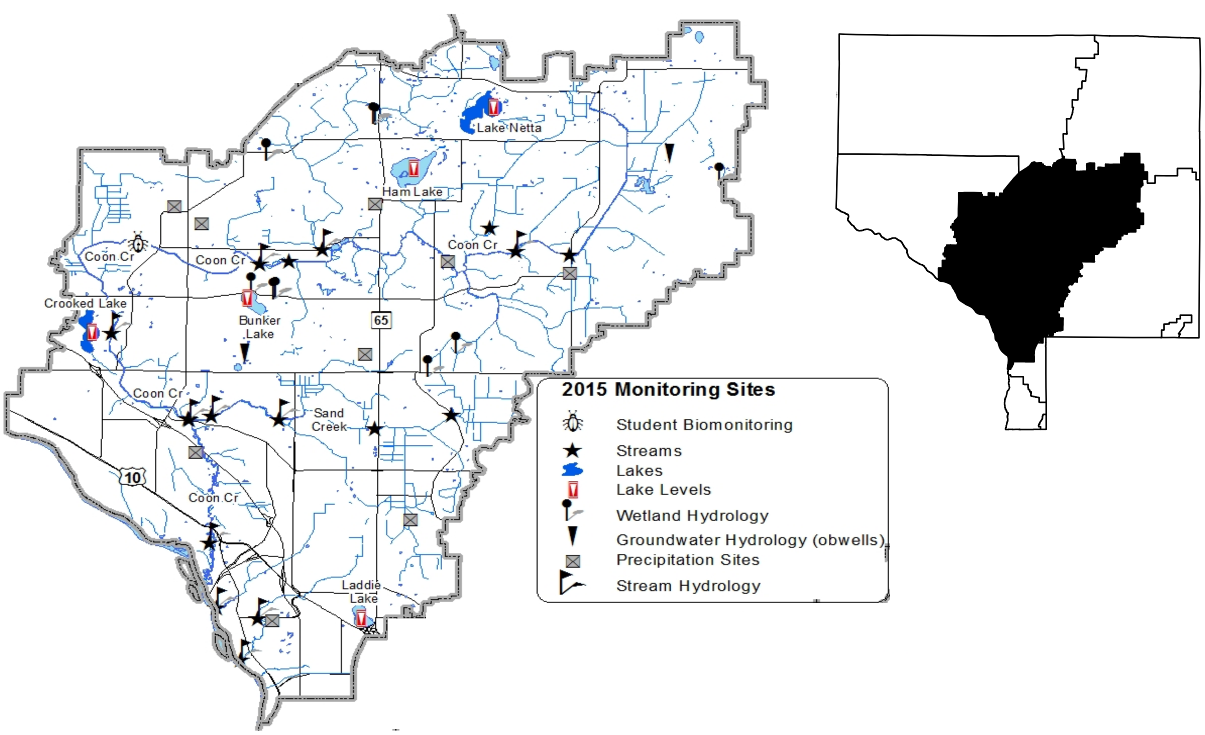
ACAP = Anoka County Ag Preserves, ACD = Anoka Conservation District,
CCWD = Coon Creek Watershed District, MNDNR = MN Dept. of Natural Resources



Summary of Findings

Description:

This is a brief summary of first year monitored sites, any new findings, and notable results in the 2015 monitoring season. Detailed analysis on all individual sites can be found below in the appropriate section of the work results.

Lake Water Quality:

- Crooked Lake received an overall B grade in 2015, which is a decline compared to the A grade received in 2014. This grade is more consistent with overall water quality for the last 15 years where 12 years received B grades. Even though TP increased slightly, chlorophyll-a saw a historical low with an average of 2.6 ug/L. Secchi transparency increased by 0.5 feet from 2014, which makes 2015 the second best year on record at 9.1 feet.
- Lake Netta had above average water quality in 2015. It received an A grade for low concentrations of TP and chlorophyll-a. In 2015 TP had the lowest average on record at 17 ug/L and chlorophyll-a achieved the second lowest average on record at 2.8 ug/L.
- An invasive species survey was conducted in 2015 throughout the littoral zone and high priority areas of Lake Netta and Crooked Lake. No new infestations were observed.

Stream Hydrology:

- Stream levels were monitored for the first time at Coon Creek at 131st Avenue NW in Coon Rapids in 2015. It showed little variation in water levels. Throughout 2015 stream levels spanned 2.64 feet, with a maximum stream level of 856.66 feet and a minimum of 854.02 feet.
- Stream levels were monitored for the first time at Coon Creek at Prairie Road in Coon Rapids in 2015. It seems this site reacts slowly to precipitation in the area. For example in response to a 1.99 inch storm event it took over 36 hours for the stream to rise 1.26 feet. Throughout 2015 stream levels spanned 2.8 feet, with a maximum stream level of 874.42 feet and a minimum of 871.62 feet.
- Sand Creek at Xeon recorded its lowest stream level and lowest maximum stream level in monitoring history. The lower than average precipitation throughout the season most likely played a role in the abnormally low water levels.

Continuous Stream Water Quality Monitoring:

- Hach Hydrolabs and a EXO YSI were deployed for the first time at Coon Creek at 131st Avenue and Coon Creek at Prairie Road in 2016. Equipment was deployed during eight storm events at each site. Throughout the season, results showed overall good water quality at both sites. Further monitoring should be conducted to understand any issues.

Recommendations

- **Encourage the Met Council to install a Watershed Outlet Monitoring Program (WOMP) site on Coon Creek.** Recent conversations with the Met Council have indicated that there is interest and funding to develop new WOMP sites in worthwhile locations. Coon Creek was mentioned as a candidate and the Met Council seemed interested. This could provide years of cost effective in depth data and analysis on Coon Creek.
- **Consider performing new site and updated 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 on 131st and Prairie road monitoring sites should also be considered. 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 this 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. Keep up efforts to replace the Hydrolab MS-5 loggers. Breakdowns have continued at an astounding rate and the service agreement expires in a year.

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.

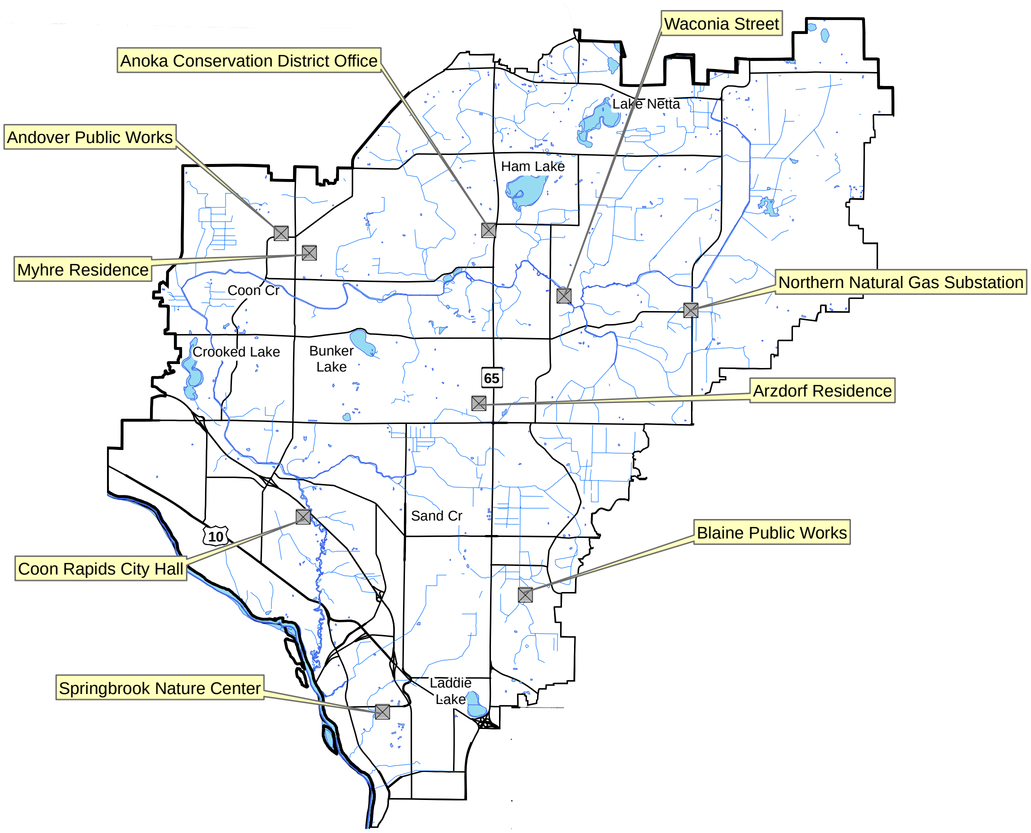
Locations:

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.

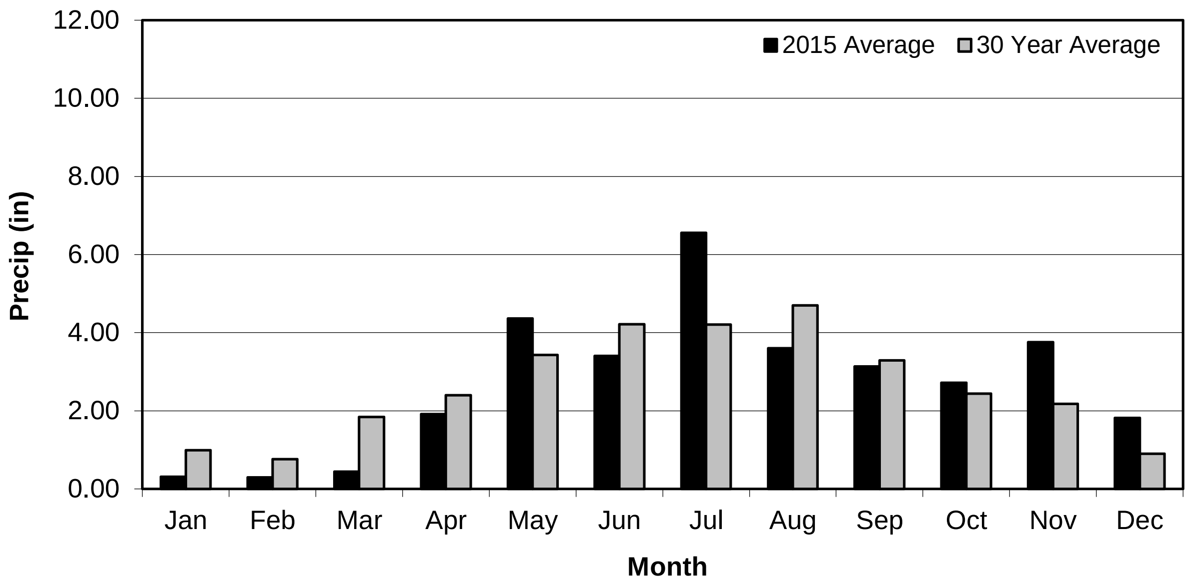
Coon Creek Watershed 2015 Precipitation Monitoring Sites



Coon Creek Watershed 2015 Precipitation Summary Table and Graph

		Month													
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			0.24	1.17	5.38	3.25	6.80	4.47	2.65	1.13	3.15		28.24	22.55
Blaine Public Works	Blaine			0.46	2.07	3.32	3.55	7.81	2.50	3.78	2.88	3.80		30.17	20.96
Coon Rapids City Hall	Coon Rapids			0.54	2.08	5.96	5.02	8.01	4.42	5.17	3.02			34.22	28.58
Anoka Cons. District office	Ham Lake			0.44	2.00	4.36	3.41	7.61	2.28	2.75	2.86			25.71	20.41
Hoffman Sod Farm	Ham Lake			0.46	2.13	5.87	4.14	6.99	2.10	3.03	2.15	3.95		30.82	22.13
Northern Nat. Gas substation	Ham Lake			0.38	1.99	0.48	0.91	1.20	4.10	2.65	2.72	3.68		18.11	9.34
Springbrook Nature Center	Fridley			0.51	1.71	3.41	3.39	6.58	4.06	2.74	3.16	3.64		29.20	20.18
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.31	0.30	0.64	1.96	4.59	3.30	6.94	4.14	2.39	3.25	4.23	1.82	33.87	21.36
J. Arzdorf	Blaine			0.35	2.17	5.88	3.71	7.11	4.34	3.05	3.29	3.87		33.77	24.09
2015 Average	County-wide	0.31	0.30	0.45	1.92	4.36	3.41	6.56	3.60	3.13	2.72	3.76	1.82	28.30	21.07
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



Precipitation Analyses

Description: Two different precipitation analyses were done – 1) 2015 storm analyses and 2) long term precipitation trend analysis.

1.) **2015 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 that was two months or longer were analyzed further. The storm's intensity was tracked throughout the storm and graphed (similar to storm typing, but a type was not assigned). 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 "Ahndover-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
Hoffman Sod Farm	Ham Lake
Waconia Street	Ham Lake
Northern Natural Gas Substation	Ham Lake

*****_Hoffman Sod Farm site relocated to Waconia Street site in April 2013_

Results:

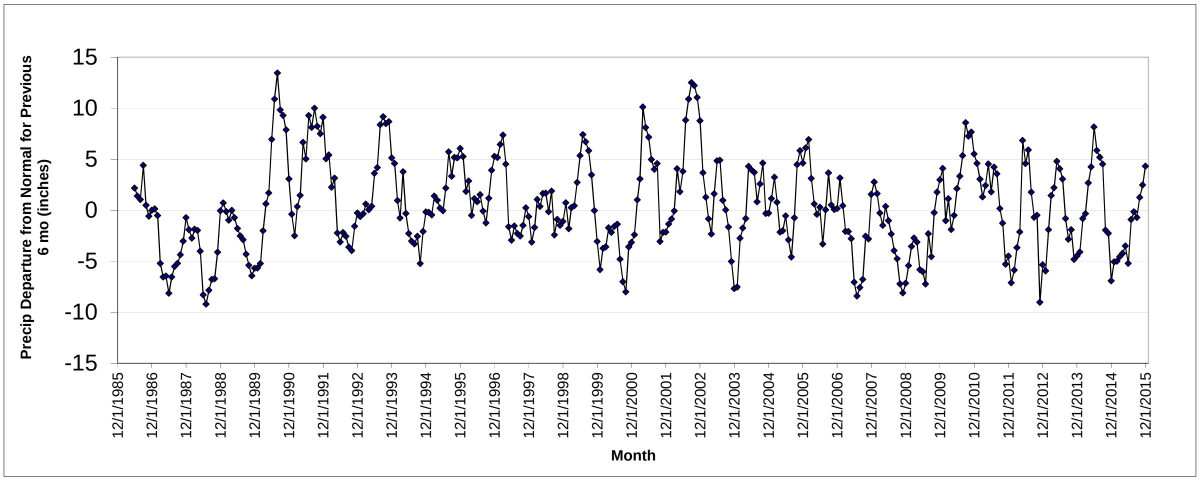
1.) **2015 Storm Analyses:** The results of these analyses were delivered to the Coon Creek Watershed District in digital form and are not reported here due to complexity and lengthiness.

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

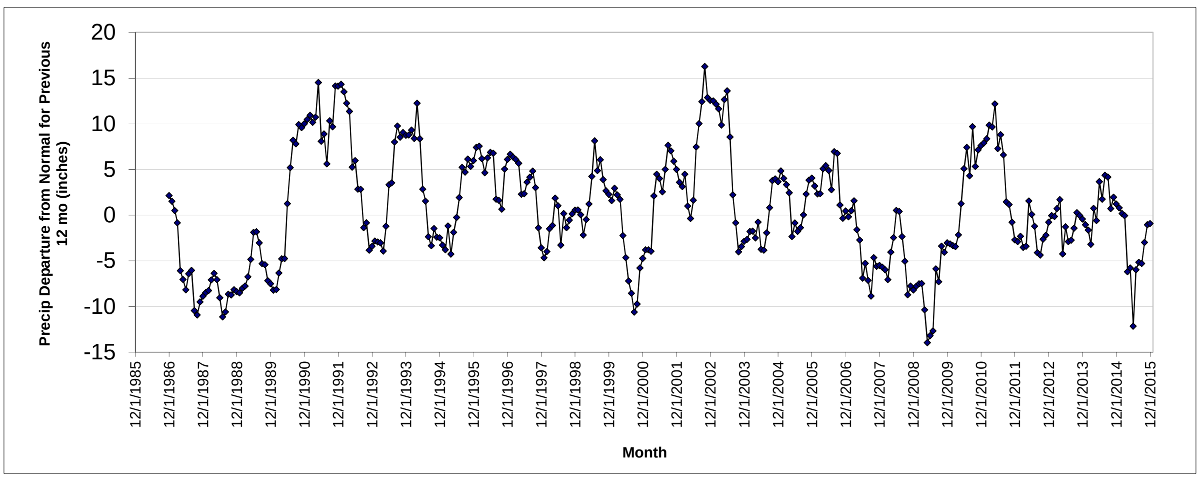
Long Term Precipitation Trends

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.

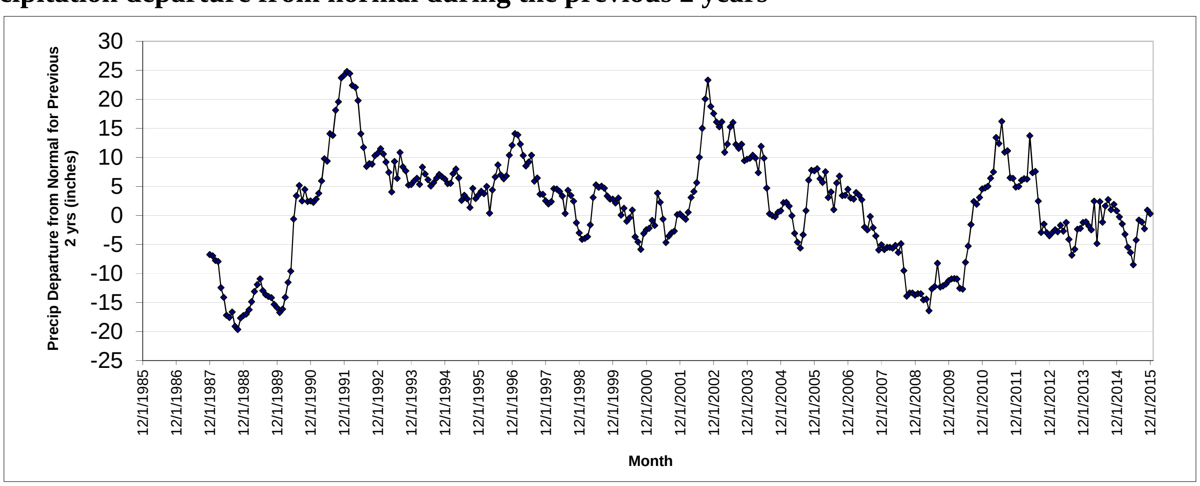
Precipitation departure from normal during the previous 6 months



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:

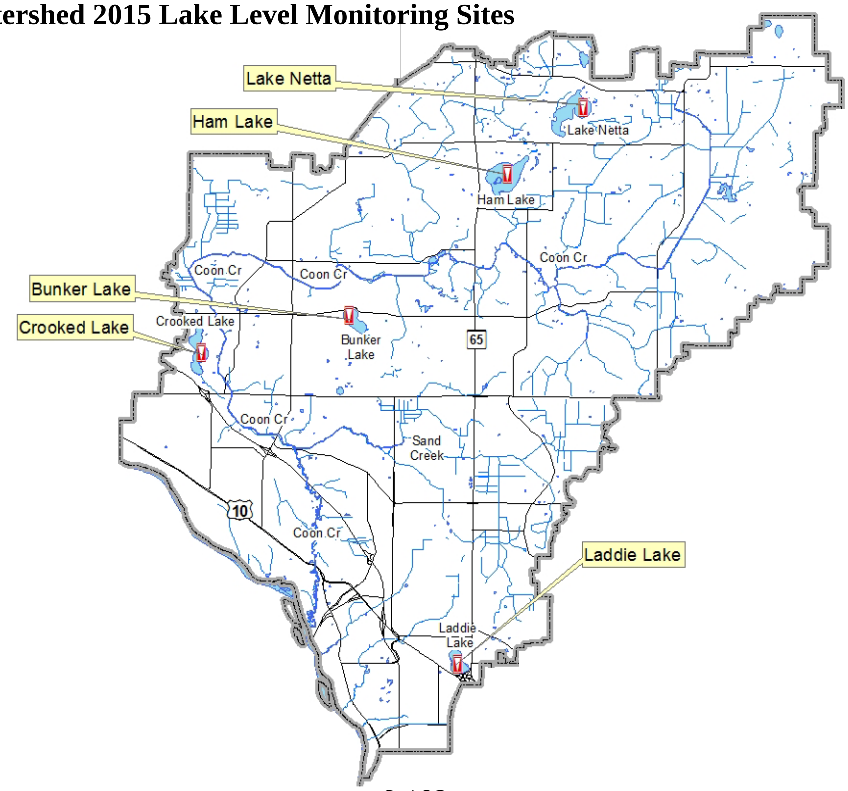
Site	City
Bunker Lake	Andover
Crooked Lake	Andover/Coon Rapids
Ham Lake	Ham Lake
Lake Netta	Ham Lake
Laddie Lake	Blaine

Results: Lake Levels were measured by volunteers 40 times at Crooked Lake, 30 times at Ham Lake, 31 times at Lake Netta, and 45 at Laddie Lake. The level in Bunker Lake was monitored using an electronic gauge, which resulted in 220 days of measurements generated by averaging six readings from each day.

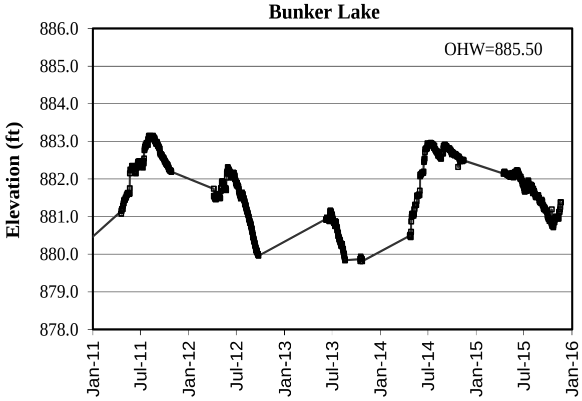
Lakes had increasing water levels in spring and early summer and dropped steadily by mid-summer. A resurgence of rainfall late into fall caused a spike in lake levels at the end of the year. Overall lake levels were lower than in 2014 when very heavy rainfall totals occurred.

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.

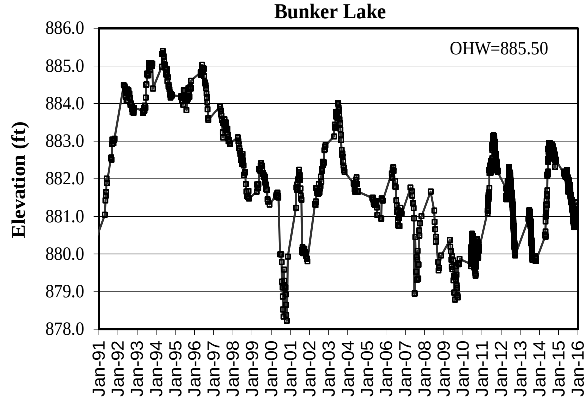
Coon Creek Watershed 2015 Lake Level Monitoring Sites



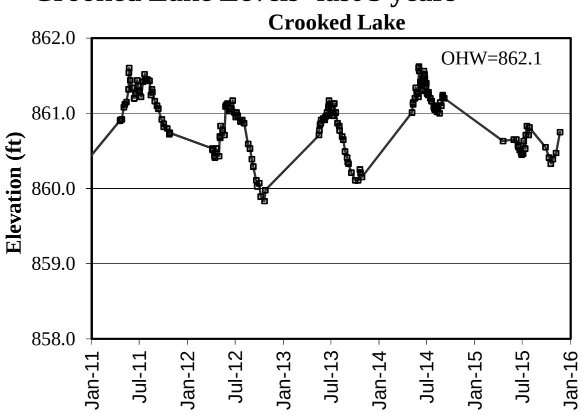
Bunker Lake Levels 2011-2015



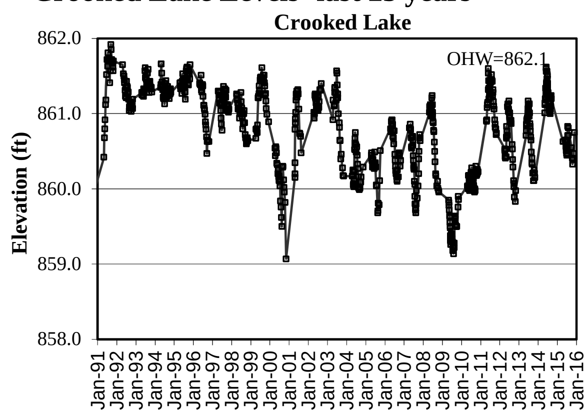
Bunker Lake Levels 1991-2015



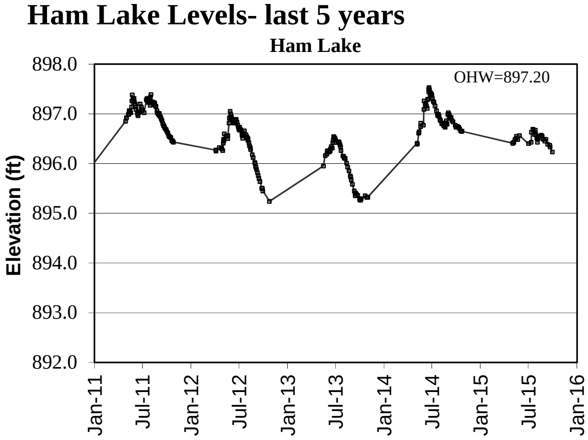
Crooked Lake Levels- last 5 years



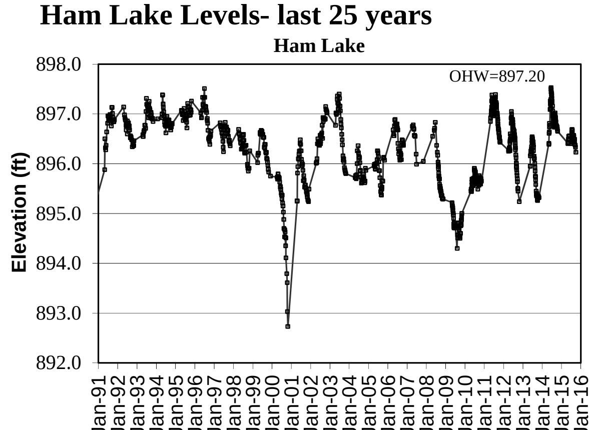
Crooked Lake Levels- last 25 years



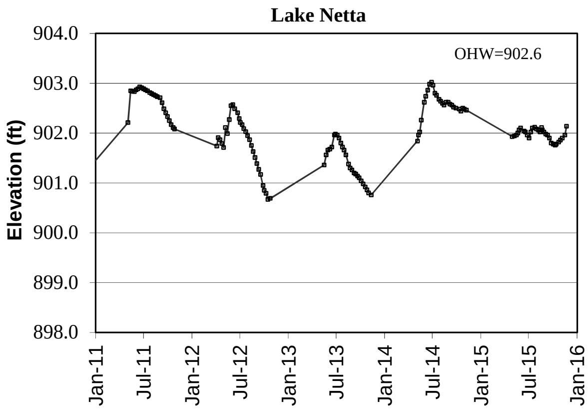
Ham Lake Levels- last 5 years



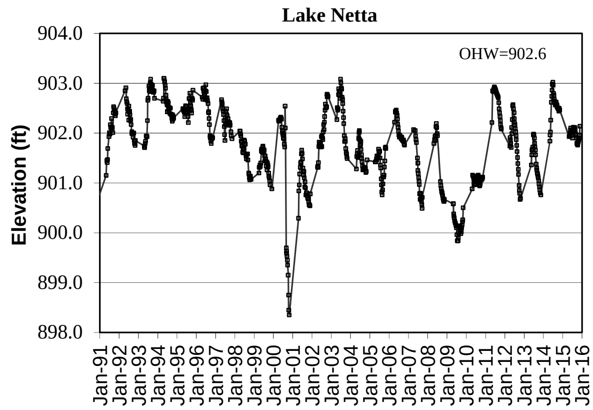
Ham Lake Levels- last 25 years



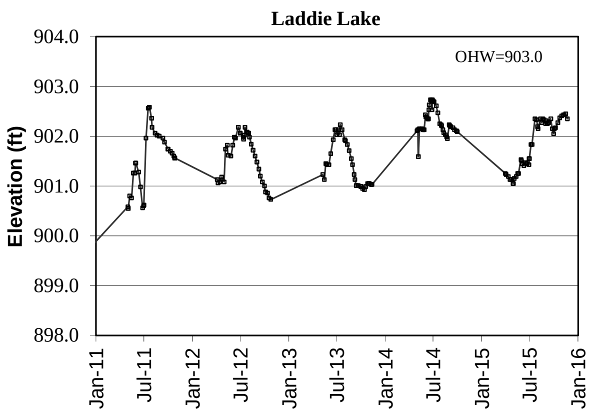
Lake Netta Levels- last 5 years



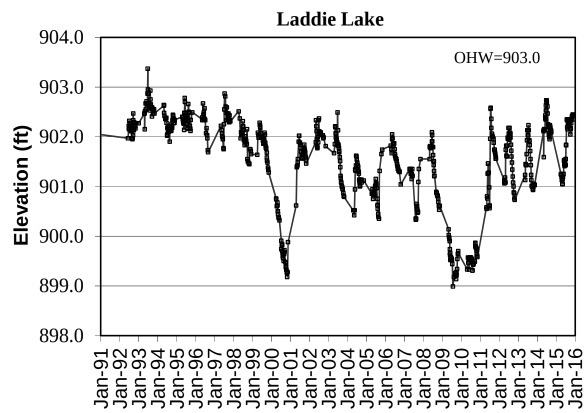
Lake Netta Levels- last 25 years



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	2011	882.40	881.08	883.15
	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
Crooked	2011	861.19	860.72	861.60
	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
Ham	2011	897.00	896.43	897.39
	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

Lake	Year	Average	Min	Max
Netta	2011	902.64	902.08	902.93
	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
Laddie	2011	901.51	900.55	902.58
	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

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.

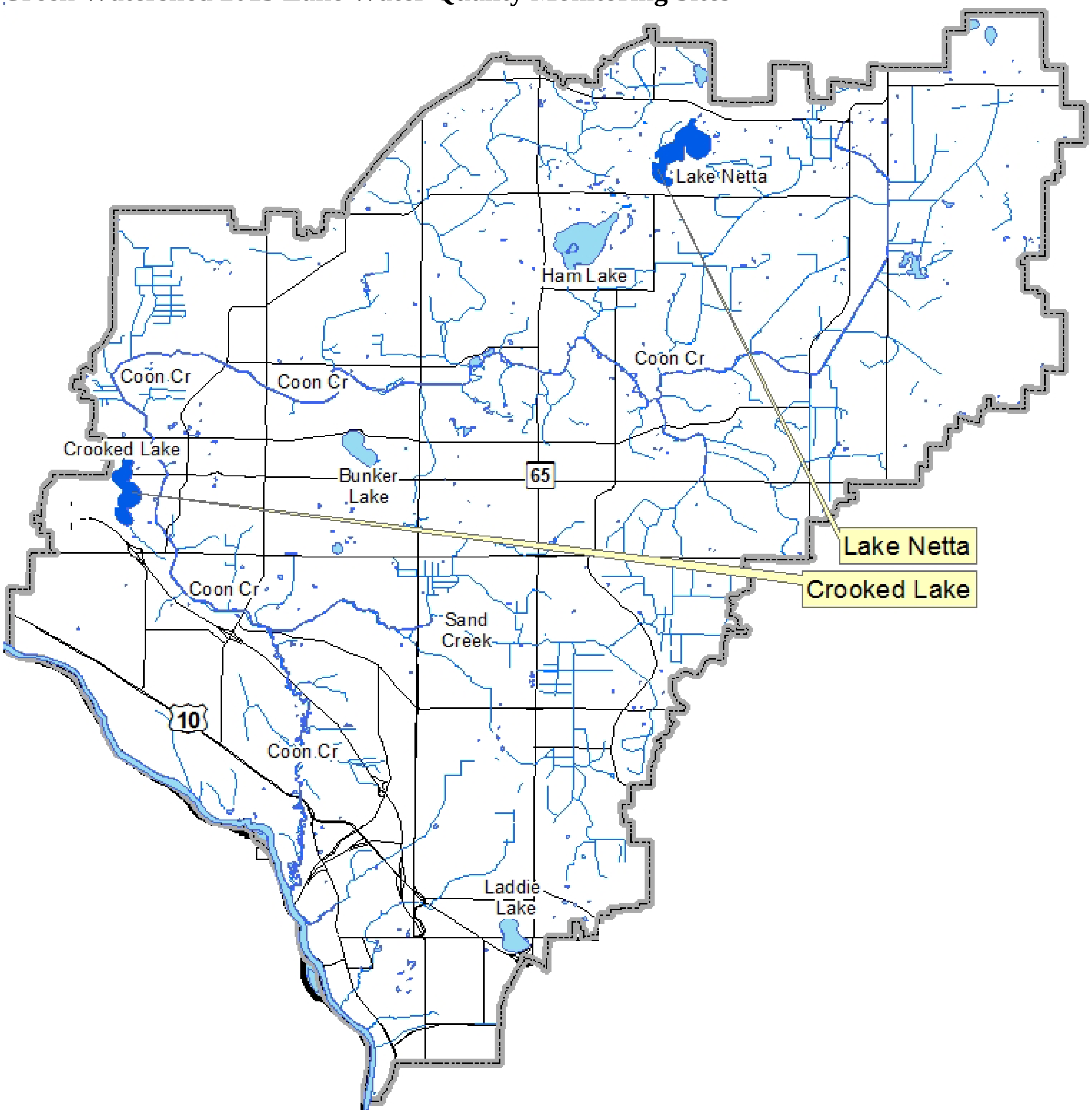
Purpose: To detect water quality trends and diagnose the cause of changes.

Locations:

Site	City
Crooked Lake	Andover/Coon Rapids
Lake Netta	Ham 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 interpreting the data and on lake dynamics.

Coon Creek Watershed 2015 Lake Water Quality Monitoring Sites



CROOKED LAKE
Cities of Andover and Coon Rapids, Lake ID # 02-0084

Background

Crooked Lake is located half in the City of Andover and half in Coon Rapids. It has a surface area of 117.5 acres with a maximum depth of 26 feet (7.9 m). Public access is from two locations, at a boat launch off Bunker Lake Boulevard and at a City of Coon Rapids park on the east side of the lake where a fishing pier is located. The lake is used extensively by recreational boaters and fishers. The 236 acre watershed is developed and primarily comprised of residential land use.

In 1990 Eurasian Water Milfoil (EWM) was discovered in the lake. In 1992 a whole-lake treatment with fluridone was conducted that eradicated nearly all aquatic vegetation. EWM was discovered again in 1996. In 2002 the DNR implemented a low dose of fluridone, which reduced the EWM while having a lesser impact on other vegetation. Spot treatments using triclopyr or 2, 4-D have been conducted since 2010, with 11.5 acres being treated in 2012. EWM is still at nuisance levels in some areas, and may be expanding or becoming denser. In other areas the similar-looking, native, northern milfoil is present. The exotic, invasive plant curly leaf pondweed is also present, but rarely to nuisance levels. This should be continued to be monitored in the future.

2015 Results

In 2015 Crooked Lake had above-average water quality for this region of the state (NCHF Ecoregion). Water quality in Crooked Lake received an overall B grade in 2015, which is a decline compared to the A grade received in 2014. The 2015 grade is more consistent with the overall water quality for the last 15 years where 12 years received overall B grades. This decline was driven by a slight increase in TP to the lake's summertime average (24 µg/L). In contrast, chlorophyll–*a* concentrations averaged 2.6 µg/L, which is lowest on record. In addition, average Secchi transparency increased by 0.5 feet relative to 2014, which makes 2015 the second best year on record at 9.1feet. This is in contrast to water clarity that never averaged near 8 feet until 2009.

Trend Analysis

Nineteen years of water quality data have been collected between 1983 and 2015, with eight additional years of transparency measurements by citizens. Water quality has significantly improved from 1983 to 2015 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,116} = 51.39$, $p < 0.001$). The most dramatic improvements in water quality occurred between 1989 and 1994. However, if only data after 1993 are examined a statistically significant trend of improvement is still found (same analysis, $F_{2,12} = 13.73$, $p = 0.0001$). Examining the trend during this period for each parameter (one-way ANOVA graphs on following page) we find no statistically significant change in phosphorus (although it appears close), but we do observe statistically significant trends toward improvements in chlorophyll-a and transparency.

Discussion

Water quality in Crooked Lake is remarkably good considering its urbanized watershed and intensely manicured shorelines. Noticeable improvements in water quality occurred in both 2012 and 2014 and even with a slight decrease in 2015, water quality remained good overall. The cause of this trend is unknown, but it may be linked to the submerged plant community sequestering nutrients and out-competing algae. Continued efforts to improve stormwater draining to the lake and implement shoreline restorations are encouraged. Invasive aquatic plants continue to be a challenge in Crooked Lake, and EWM seems to be persisting as the primary nuisance, despite continued herbicide treatments. Native plants like the native northern milfoil and coontail are present in some areas, and could heighten resident frustrations about abundant plants hampering recreation. Caution is urged when managing non-native plants to avoid impacting native plants and water quality. The 2009 lake management plan provides direction for protecting water quality and managing plants and should be continued to be referenced.

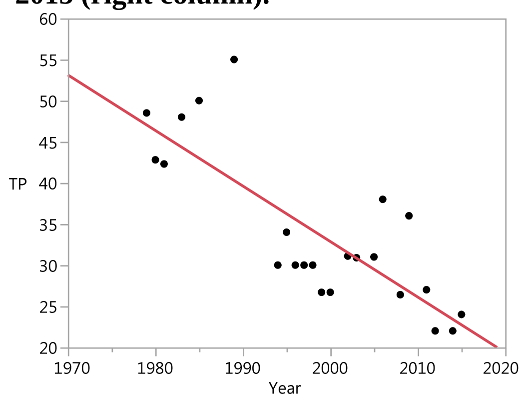
2015 Crooked Lake Water Quality Data

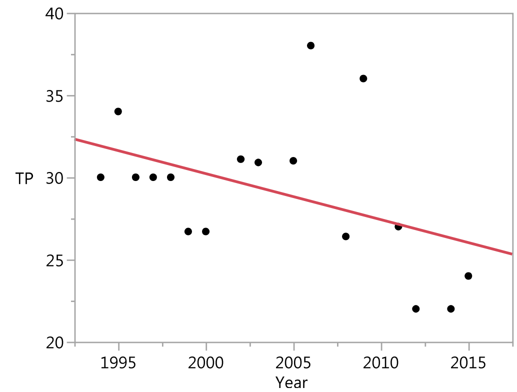
Crooked Lake
2015 Water Quality Data

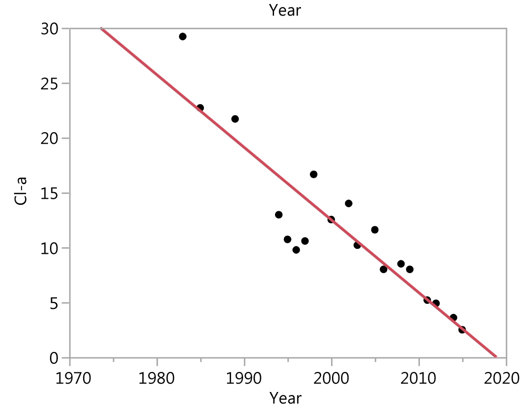
			5/13/2015	5/27/2015	6/10/2015	6/26/2015	7/8/2015	7/23/2015	8/6/2015	8/21/2015	9/11/2015	9/14/2015			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Average	Min	Max	Results	Average	Min	Max
pH		0.1	8.19	8.37	8.52	8.82	8.63	8.6	8.50	7.83	7.89	8.46	8.38	7.83	8.82
Conductivity	mS/cm	0.01	0.527	0.513	0.505	0.537	0.541	0.466	0.528	0.591	0.511	0.57	0.529	0.466	0.591
Turbidity	NTU	1	0.8	0.6	1.3	2.6	2.2	2.2	3	2	3	2.7	2	1	3
D.O.	mg/L	0.01	11.38	11.92	9.33	9.53	7.36	8.13	8.43	7.30	8.62	7.45	8.95	7.30	11.92
D.O.	%	1	114%	129%	115%	120%	90%	103%	103%	85%	103%	87%	105%	85%	129%
Temp.	°C	0.1	15	17	23	25	24	26	25.2	22.5	22.7	21	22.2	14.9	26.2
Temp.	°F	0.1	58.9	63.2	74.3	77.5	75.2	79.1	77.3	72.5	72.8	69.3	72.0	58.9	79.1
Salinity	%	0.01	0.25	0.25	0.24	0.26	0.26	0.22	0.26	0.29	0.25	0.27	0.26	0.22	0.29
Cl-a	ug/L	0.5	4.3	2.8	2.1	1.4	2.8	2.8	2.1	2.8	<1	2.8	2.7	1.4	4.3
T.P.	mg/L	0.010	0.026	0.024	0.023	<.02	0.017	0.017	0.018	0.024	0.041	0.027	0.024	0.017	0.041
T.P.	ug/L	10	26	24	23		17	17	18.0	24.0	41.0	27	24.1	17.0	41.0
Secchi	ft	0.1	8.58	11.83	11.75	8.33	10.08	10.3	7.7	7.5	7.2	8	9.1	7.2	11.8
Secchi	m	0.1	2.62	3.61	3.58	2.54	3.07	3.15	2.3	2.3	2.2	2.44	2.8	2.2	3.6
Physical			1.0	2.0	2.0	3.0	3.0	3.0	1.0	1.0	1.0	1.0	1.8	1.0	2.0
Recreational			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

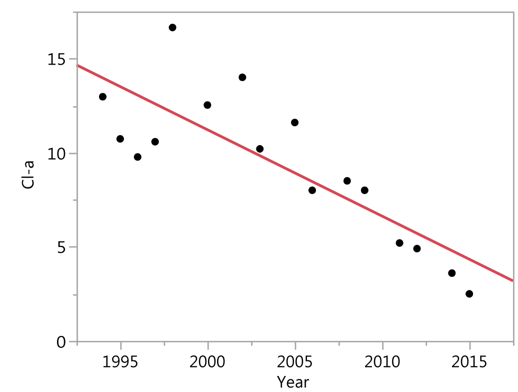
*reporting limit

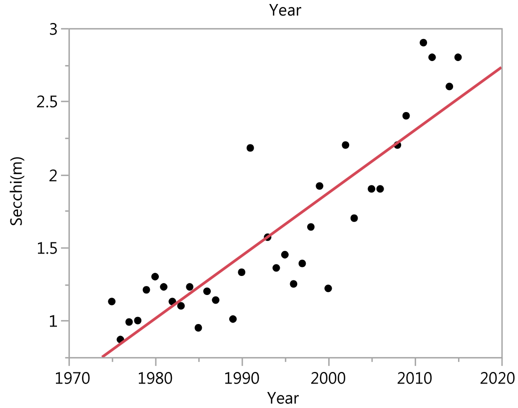
Crooked Lake Water Quality Changes for Each Parameter, All Years (left column) and 1994 – 2015 (right column).

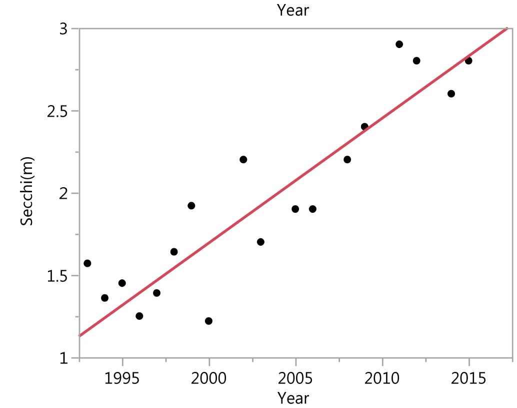




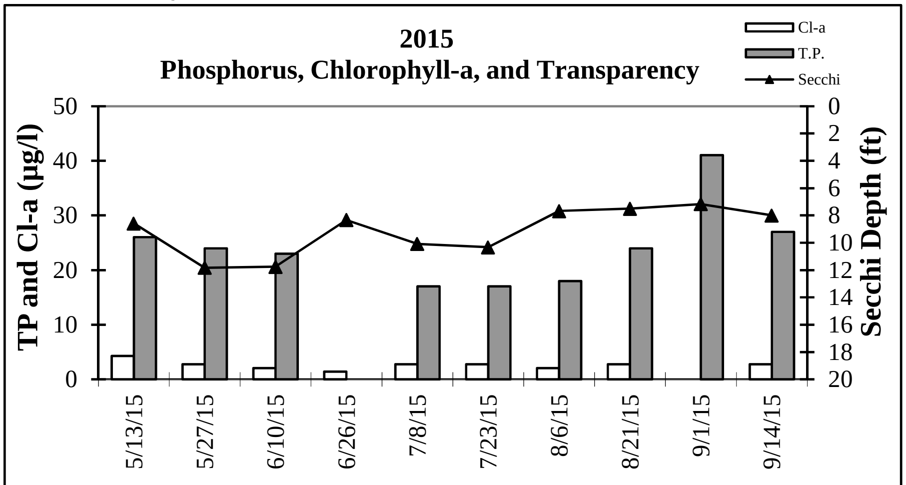


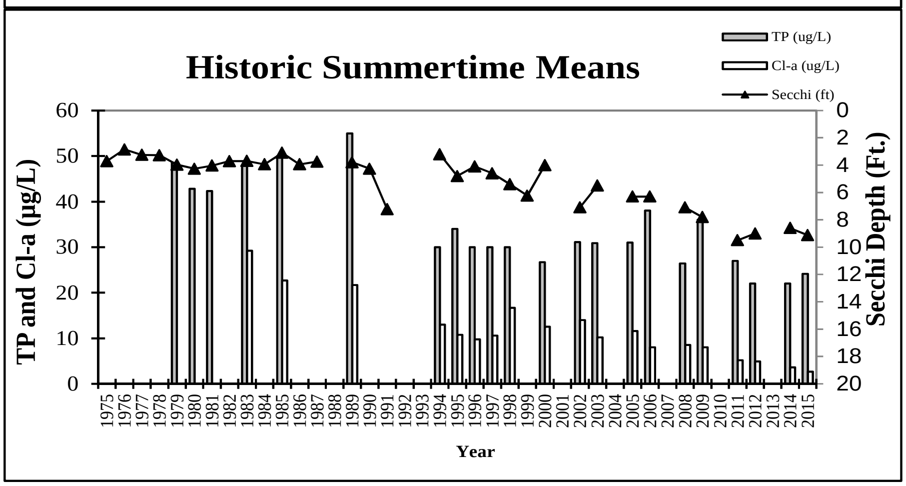






Crooked Lake Water Quality Results





Crooked Lake Historic Summertime Mean Values

Agency	CAMP	CAMP	CAMP	CAMP	CAMP	CAMP	CAMP	CAMP	MC	CAMP	MC	CAMP	CAMP	MC	CAMP	CAMP
Year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1989	1990	1991
TP (ug/L)					48.5	42.8	42.3		48		50			55		
Cl-a (ug/L)									29.2		22.7			21.69		
Secchi (m)	1.13	0.87	0.99	1	1.21	1.3	1.23	1.13	1.12	1.2	0.95	1.2	1.14	1.01	1.3	2.2
Secchi (ft)	3.71	2.85	3.25	3.28	3.97	4.26	4.03	3.71	3.70	3.94	3.10	3.94	3.74	3.80	4.26	7.22
Carlson's Tropic State Indices																
TSIP					60	58	58		60		61			62		
TSIC									64		61			61		
TSIS	58	62	60	60	57	56	57	58	58	57	61	57	58	60	56	49
TSI									61		61			61		
Crooked Lake Water Quality Report Card																
Year	75	76	77	78	79	80	81	82	83	84	85	86	87	89	90	91
TP									C		C			C		
Cl-a									C		C			C		
Seechi	C	D	D	D	C	C	C	D	D		D	C	D	D	C	C
Overall									C		C			C		

Crooked Historic Summertime Mean Values

Agency	MC	MC	MC	MC	MC	CAMP	ACD	ACD	ACD	ACD	ACD	ACD	ACD	ACD			
Year	1994	1995	1996	1997	1998	1999	2000	2002	2003	2005	2006	2008	2009	2011	2012	2014	2015
TP	30.0	34.0	30.0	30.0	30.0		26.7	31.1	30.9	31.0	38.0	26.4	36.0	27.0	22.0	22.0	24.0
Cl-a	13.0	10.7	9.8	10.6	16.7		12.5	14.0	10.2	11.6	8.0	8.5	8.0	5.2	4.9	3.6	2.6
Secchi (m)	1.36	1.45	1.25	1.39	1.64	1.90	1.22	2.20	1.70	1.93	1.90	2.20	2.40	2.90	2.80	2.60	2.80
Secchi (ft)	3.2	4.8	4.1	4.6	5.4	6.2	4.0	7.1	5.5	6.3	6.3	7.1	7.8	9.5	9.0	8.6	9.1
Carlsons trophic state indices																	
TSIP	53	55	53	53	53		52	54	54	54	57	51	56	52	49	49	50
TSIC	56	54	53	54	58		55	56	53	55	51	52	51	47	46	43	40
TSIS	56	55	57	55	53	51	57	49	52	51	51	49	47	45	45	46	45
TSI	55	55	54	54	55		55	53	53	53	53	51	51	48	47	46	45
Crooked Lake Water Quality Report Card																	
Year	94	95	96	97	98	99	2000	2002	2003	2005	2006	2008	2009	2011	2012	2014	2015
TP	B	C	B	B	B		B	B	B	B	C	B	C	B	A	A	B
Cl-a	B	B	A	B	B		B	B	B	B	A	A	A	A	A	A	A
Secchi	C	C	C	C	C	C	C	C	C	C	C	B-	B	B	B	B	B
Overall	**B**	**C**	**B**	**B**	**B**		**B**	**B**	**B**	**B**	**B-**	**B**	**B**	**B**	**A**	**A**	**B**

LAKE NETTA

City of Ham Lake, Lake ID # 02-0053

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.

2015 Results

Lake Netta once again had above-average water quality for this region of the state (NCHF Ecoregion) in 2015. The overall A grade was driven by low concentrations of total phosphorus and chlorophyll-*a* as well as high Secchi transparency. The 2015 average for total phosphorus was the best recorded since monitoring began in 1997 (17 ug/L) and the chlorophyll-*a* average was the second lowest (2.8 ug/L). Other water quality parameters were similar to previous years and indicate the stability of the clear water and healthy submerged vegetation community with this system. An invasive species survey was conducted in 2015 throughout the littoral zone and high priority areas of Lake Netta. No infestations were observed.

Trend Analysis

Thirteen 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), along with Secchi depth measurements by citizens five other years. Lake water quality has fluctuated between "A" and "B" grades, but there is no significant long-term trend of changing lake water quality (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,10} = 2.47$, $p = 0.13$).

Discussion

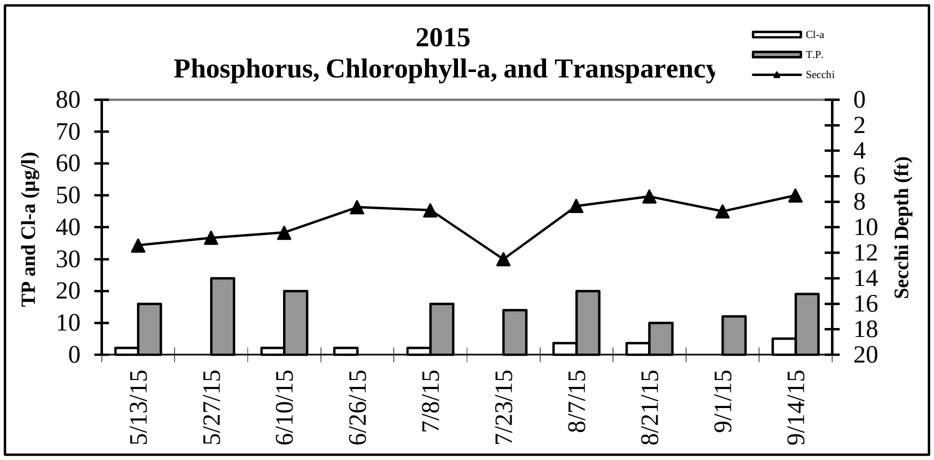
High water quality in Lake Netta has been maintained since 1997, when ACD began regularly monitoring water quality. Good water quality in this lake is in part due to its small watershed receiving little direct runoff and no streams of any consequence entering this lake. Primary production in the lake 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.

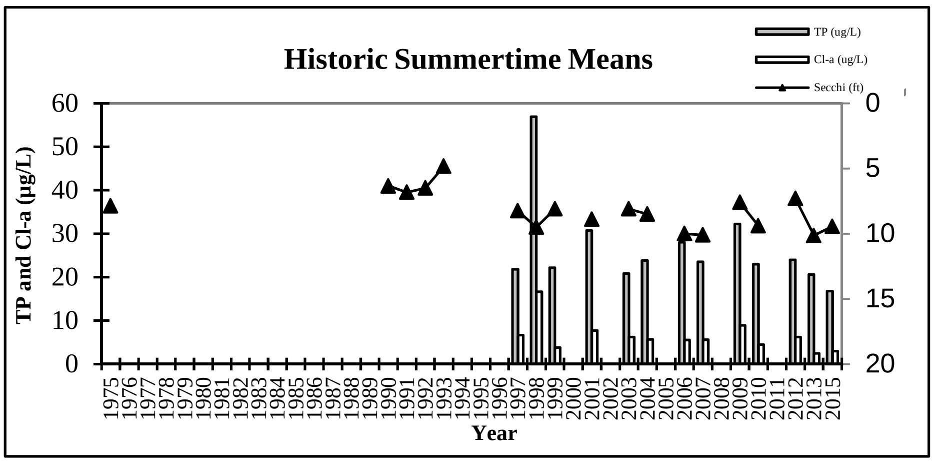
Lake Netta
2015 Water Quality Data

	Units	R.L.*	5/13/2015 Results	5/27/2015 Results	6/10/2015 Results	6/26/2015 Results	7/8/2015 Results	7/23/2015 Results	8/7/2015 Results	8/21/2015 Results	9/1/2015 Results	9/14/2015 Results	Average	Min	Max
pH		0.1	7.79	7.82	8.30	8.19	7.92	7.99	8.00	7.30	7.50	8.05	7.89	7.30	8.30
Conductivity	mS/cm	0.01	0.229	0.229	0.226	0.203	0.237	0.193	0.216	0.243	0.215	0.234	0.223	0.193	0.243
Turbidity	NTU	1	2	0	0	0	3	0	0	0	1	2	1	0	3
D.O.	mg/L	0.01	8.79	8.95	8.59	8.20	7.10	7.22	6.26	7.21	8.22	8.73	7.93	6.26	8.95
D.O.	%	1	88	97	110	103	87	93	74	83	98	101	93	74	110
Temp.	°C	0.1	14.4	18.0	25.5	26.6	24.1	26.5	23.8	21.8	23.2	20.8	22.5	14.4	26.6
Temp.	°F	0.1	58.0	64.3	78.0	79.8	75.3	79.7	74.9	71.2	73.8	69.4	72.4	58.0	79.8
Salinity	%	0.01	0.11	0.11	0.11	0.10	0.11	0.09	0.10	0.12	0.10	0.11	0.11	0.09	0.12
Cl-a	ug/L	0.5	2.1	1.0	2.1	1.3	2.1	1.0	3.6	3.6	1.0	5.0	2.3	1.0	5.0
T.P.	mg/L	0.010	0.016	0.024	0.020	0.020	0.016	0.014	0.020	0.010	0.012	0.019	0.017	0.010	0.024
T.P.	ug/L	10	16	24	20	20	16	14	20	10	12	19	17	10	24
Secchi	ft	0.1	11.4	10.8	10.4	11.3	8.7	12.5	8.3	7.6	8.8	7.5	9.7	7.5	12.5
Secchi	m	0.1	3.5	3.3	3.2	3.4	2.6	3.8	2.5	2.3	2.7	2.3	3.0	2.3	3.8
Physical			1	1	2	1	2	1	2	1	1	1	1.3	1.0	2.0
Recreational			1	1	1	1	1	2	1	1	1	1	1.1	1.0	2.0

*reporting limit

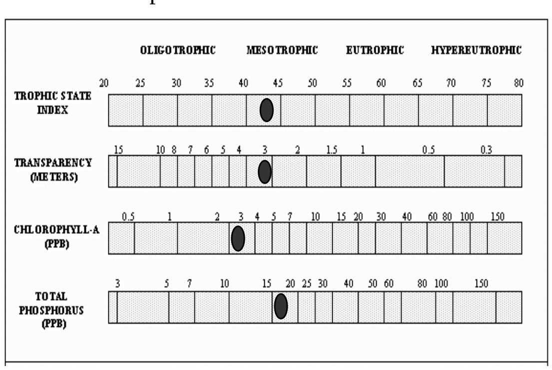
Lake Netta Water Quality Results





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
Year	1975	1990	1991	1992	1993	1997	1998	1999	2001	2003	2004	2006	2007	2009	2010	2012	2013	2015
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
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
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
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
Carlson's Trophic State Index																		
TSIP						49	62	49	54	48	50	52	50	54	49	50	48	45
TSIC						49	58	44	51	48	48	47	48	52	45	48	39	41
TSIS	47	51	49	50	54	47	45	47	46	47	46	44	44	48	45	49	44	44
TSI						48	55	47	50	48	48	48	47	51	46	49	44	43
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
TP (µg/L)						A	C	A	B	A	B+	B	B	C	A-	B+	A	A
Cl-a (µg/L)						A	B	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
Overall						**B**	**B**	**A**	**B**	**A**	**A**	**B+**	**B+**	**B**	**A-**	**B+**	**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.

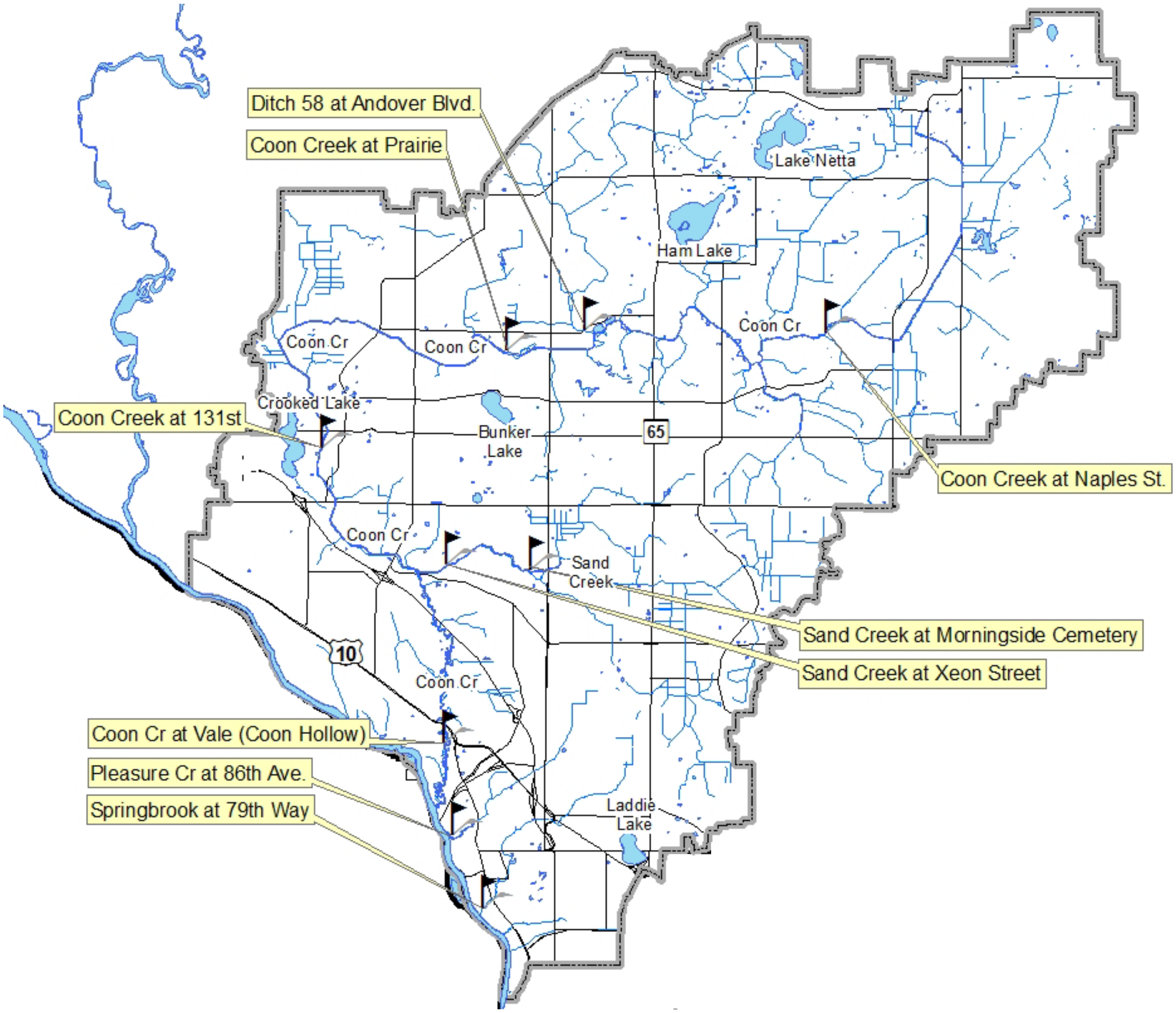
Locations:

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.

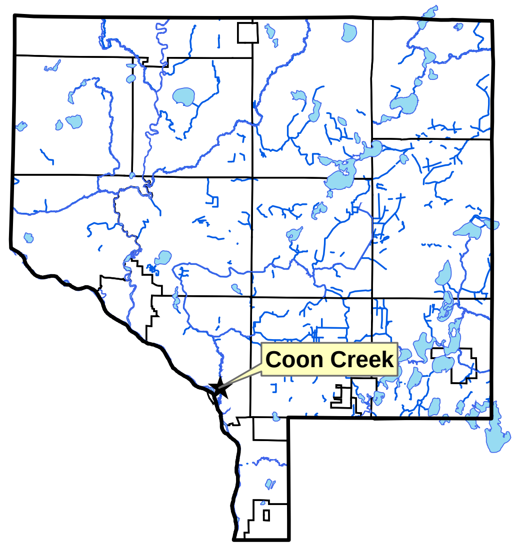
Coon Creek Watershed 2015 Stream Hydrology and Rating Curves Monitoring Sites



COON CREEK

at Coon Creek Hollow, Vale Street, Coon Rapids

Notes



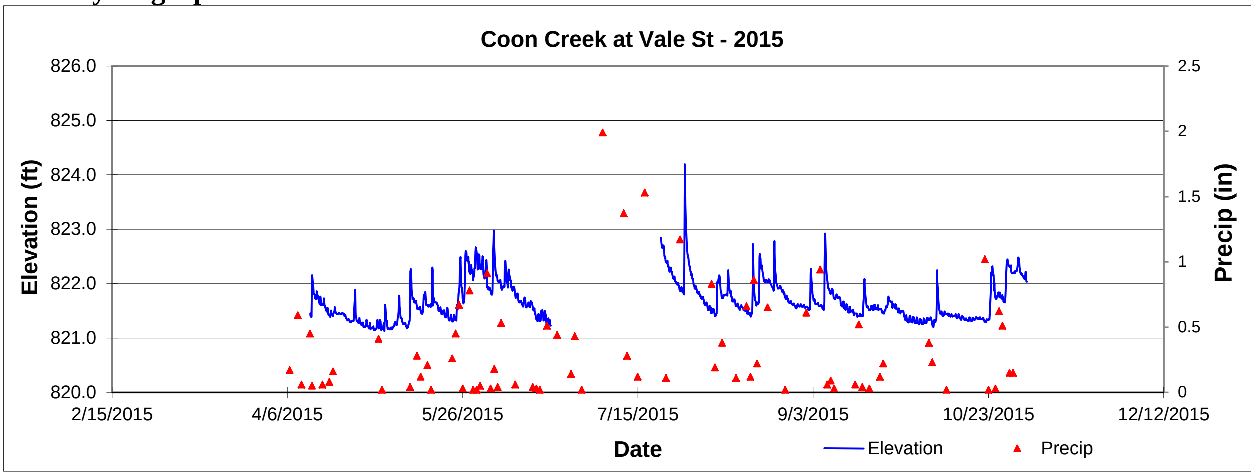
Coon Creek is a major drainage through central Anoka County. This monitoring location is the closest to the outlet to the Mississippi River that is accessible and does not have backwater effects from the Mississippi during high water. Land use in the upstream watershed ranges from rural residential upstream 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 2015 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).

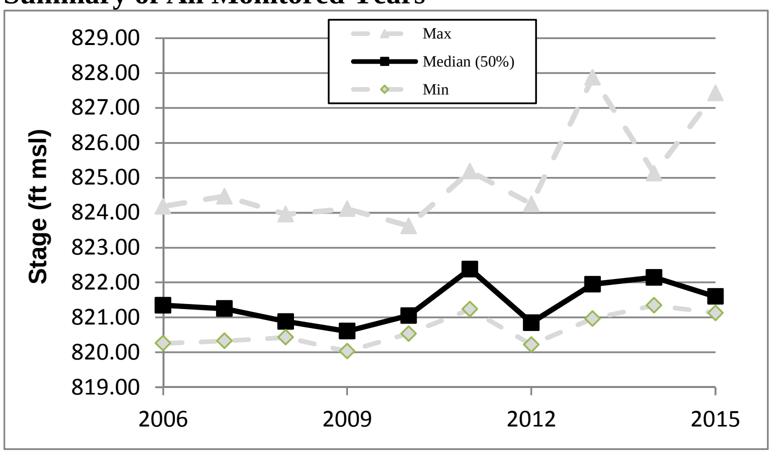
Coon Creek has flashy responses to storms, as displayed in the hydrograph on the next page. Water levels rise quickly in response to precipitation, but return to baseflow conditions more slowly. The quick, intense response to rainfall is runoff from the urbanized downstream watershed near the monitoring 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 2006-2014 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.

The rating curve previously developed for this site and updated in 2010 (most recently reported in the 2011 Water Almanac) has been revised and is presented on the next page. ACD staff discovered an error in the equation that has since been corrected. All past hydrology records that used the equations were also corrected.

2015 Hydrograph



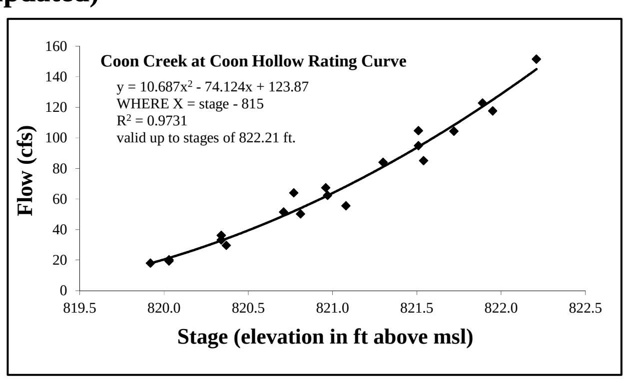
Summary of All Monitored Years



Summary of All Monitored Years

Percentiles	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Min	820.04	820.26	820.33	820.43	820.03	820.54	821.23	820.22	820.97	821.35	821.13
2.5%	820.06	820.42	820.40	820.52	820.12	820.64	821.27	820.28	820.99	821.47	821.19
10.0%	820.19	820.53	820.53	820.57	820.20	820.73	821.31	820.33	821.00	821.51	821.31
25.0%	820.57	820.78	820.73	820.63	820.35	820.85	821.83	820.45	821.20	821.67	821.41
Median (50%)	820.91	821.35	821.25	820.88	820.61	821.05	822.38	820.85	821.95	822.15	821.60
75.0%	821.26	821.78	821.88	821.78	820.93	821.32	822.99	821.28	827.87	823.33	821.91
90.0%	821.77	822.27	822.63	822.26	821.31	821.68	823.70	821.89	827.87	824.38	822.27
97.5%	822.92	822.76	823.21	822.79	822.05	822.33	824.56	823.60	827.87	824.87	822.85
Max	823.26	824.18	824.47	823.96	824.11	823.62	825.18	824.25	827.87	825.13	825.08

Rating Curve (2010 - updated)

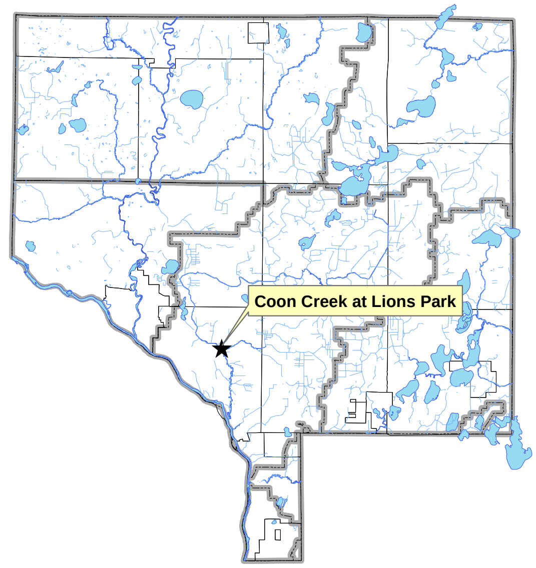


Stream Hydrology Monitoring

Coon Creek

at 131st Avenue NW, Coon Rapids

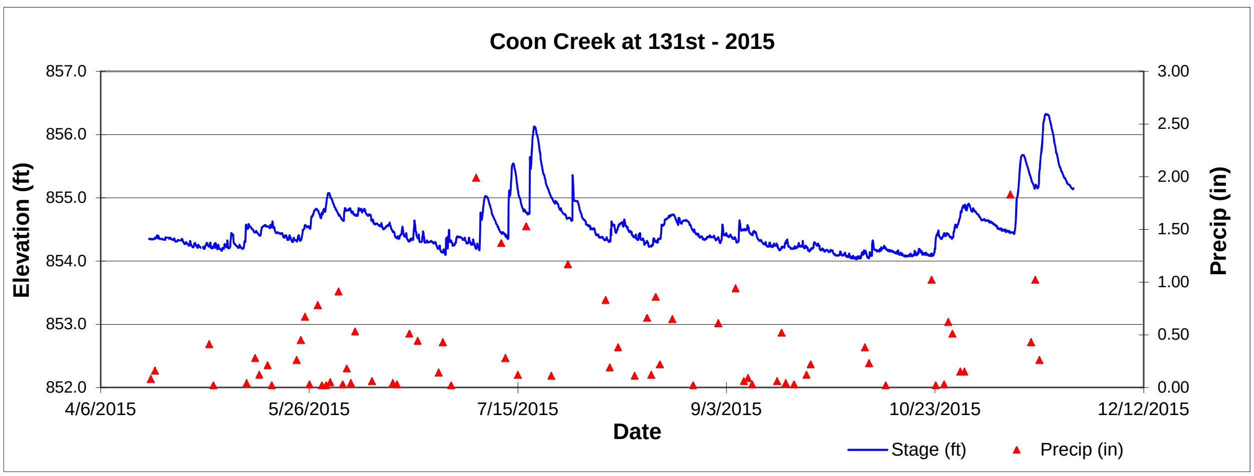
Notes



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 1.02 feet in response to a 1.53 inch storm event. Throughout 2015 stream levels spanned 2.63 feet, with a maximum stream level of 856.66 feet and a minimum of 854.03 feet.

2015 Hydrograph



Summary of All Monitored Years

Percentiles	2015
Min	854.03
2.5%	854.09
10.0%	854.16
25.0%	854.27
Median (50%)	854.41
75.0%	854.68
90.0%	855.03
97.5%	855.79
Max	856.66

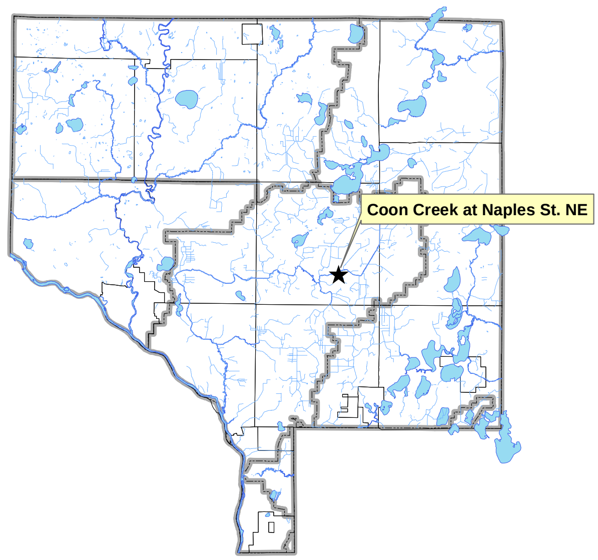
Stream Hydrology Monitoring

COON CREEK

at Prairie Road, Coon Rapids

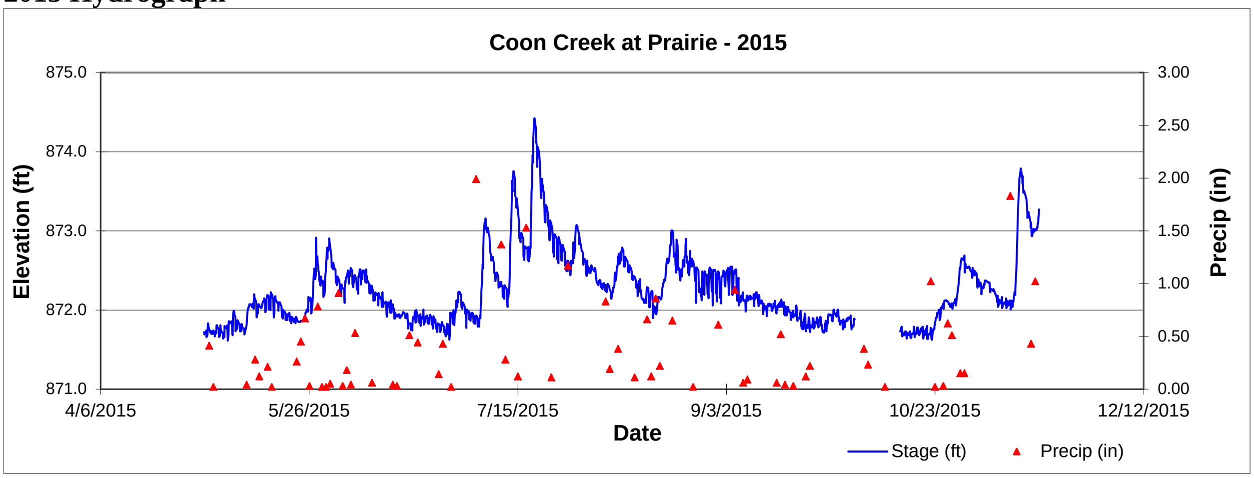
Notes

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. Throughout the season stream level ranged 2.8 feet, having a minimum elevation of 871.62 feet and reaching a maximum elevation of 874.42 feet. This site seems to react slowly to precipitation in the area. For example, in in response to a 1.99 inch storm event on July 5, 2015 it took the stream over 36 hours to rise 1.26 feet. Stream level remained fairly consistent after July due to diminished rainfall. Slight fluctuations late season are attributed to a small resurgence of rain events.

2015 Hydrograph



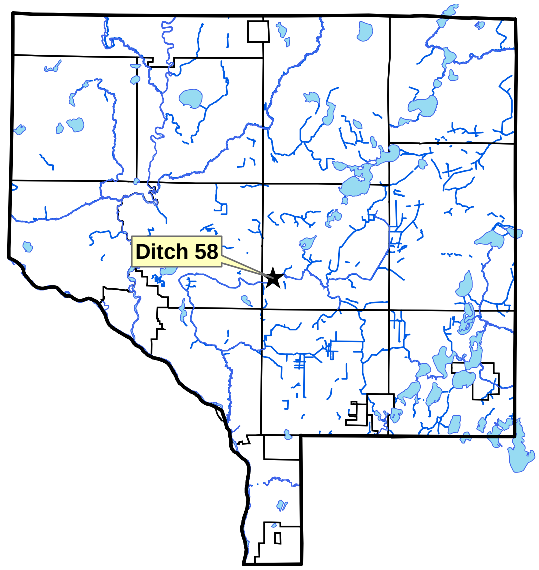
Summary of All Monitored Years

Percentiles	2015
Min	871.62
2.5%	871.70
10.0%	871.78
25.0%	871.92
Median (50%)	872.15
75.0%	872.49
90.0%	872.84
97.5%	873.49
Max	874.42

DITCH 58

at Andover Boulevard, Ham Lake

Notes

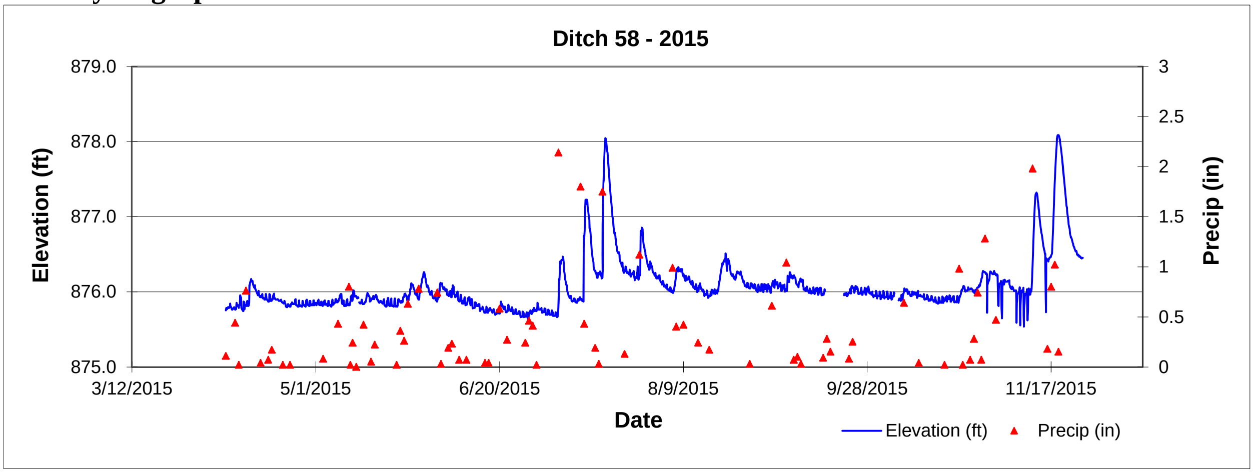


Ditch 58 is a tributary to Coon Creek. Upstream of the monitoring site are 20 miles of ditch, including many small tributaries. Its light bulb-shaped watershed is roughly delimited by Lake Netta to the northeast, Crosstown Boulevard to the northwest and southwest, and highway 65 to the southeast. Watershed 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.

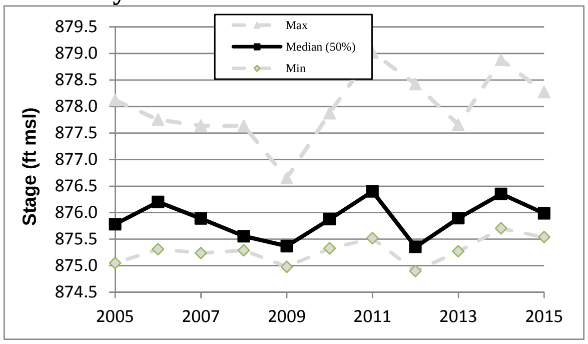
Ditch 58 water levels fluctuated in 2015 substantially less than in 2012 and 2013. These years were unique due to the increased frequency of larger rainfall events. Water levels spanned a range of 2.73 feet which was 1.37 feet less than 2014, but similar to 2013. Ditch 58 remains flashy during rain events. Of particular note was a 0.89 foot increase in water level in 2 hours during a 1.75 inch rain event on July 18, 2015. 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.

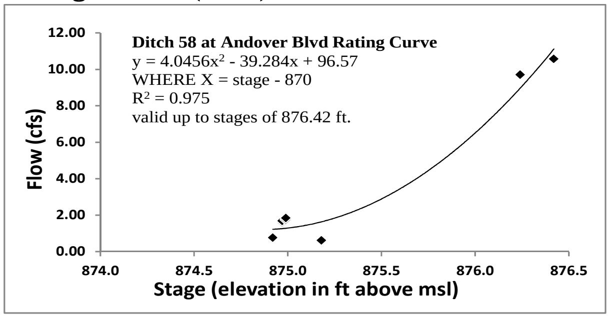
2015 Hydrograph



Summary of All Monitored Years



Ratings Curve (2013)



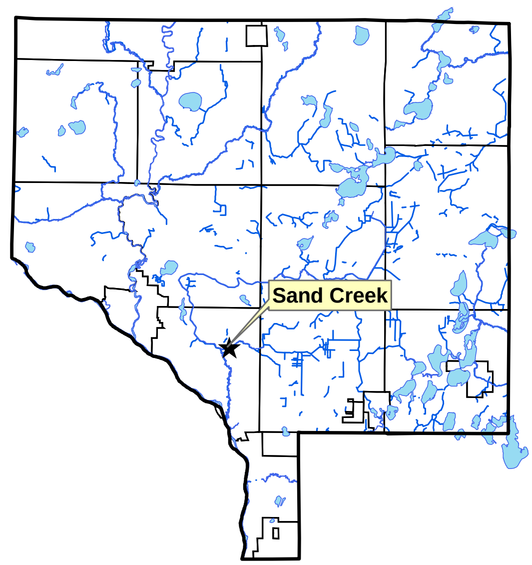
Summary of All Monitored Years

Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
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
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
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
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
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
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
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
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
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

SAND CREEK

at Xeon Street, Coon Rapids

Notes

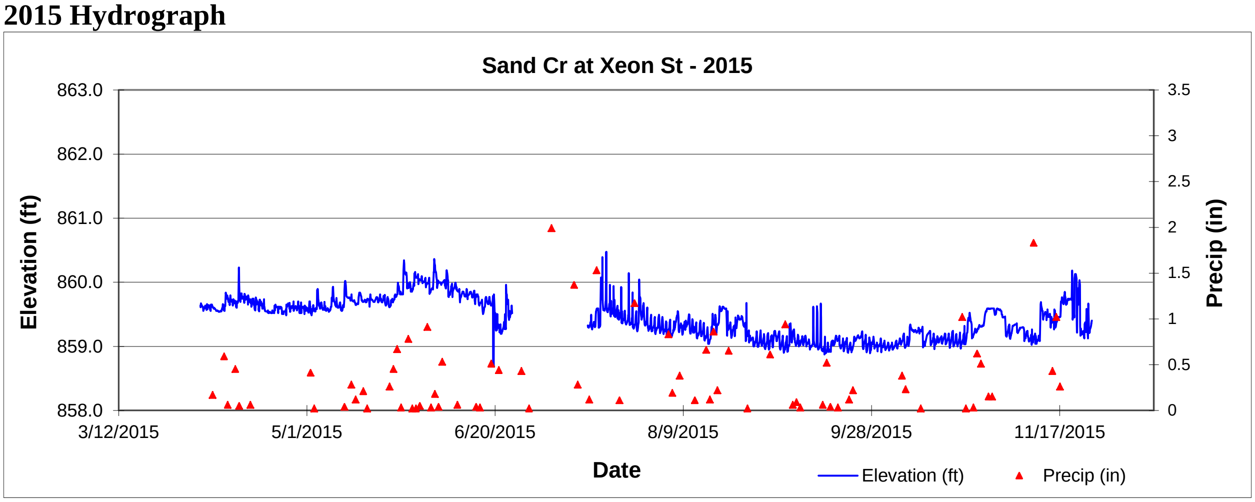


Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial and retail areas throughout northeastern Coon Rapids and western Blaine. The stream is about 15 feet wide and 3 feet deep at the monitoring site during baseflow.

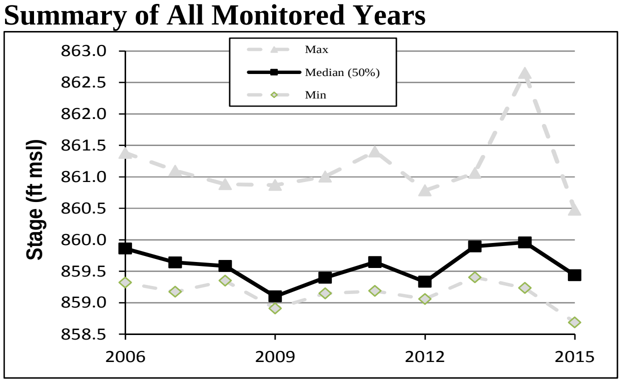
In most years, Sand Creek shows little variation in water levels. Occasionally, large storms cause water level increases of up to two feet, but these are short-lived. For example, in 2011 storms of 1.42 (July 30) and 2.10 (Aug 16) inches caused stream levels to rise 1.49 and 1.17 feet, respectively, 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. The low amounts of precipitation during the beginning of the season most likely played a role in the abnormally low water levels.

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

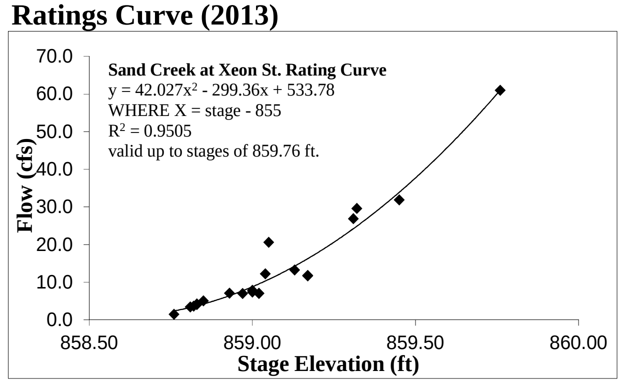
2015 Hydrograph



Summary of All Monitored Years



Ratings Curve (2013)



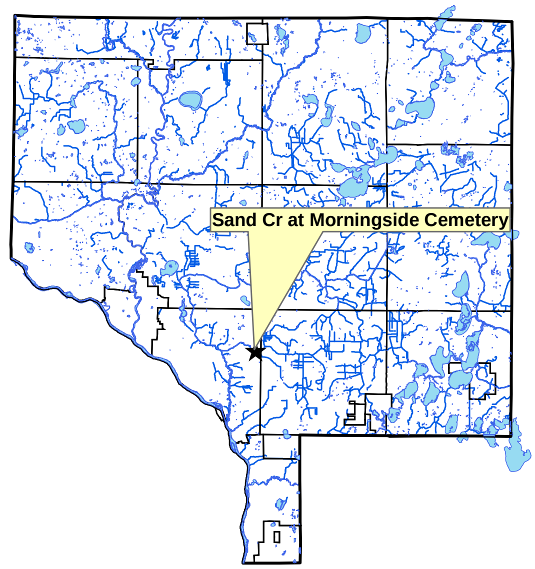
Summary of All Monitored Years

Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
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
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
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
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
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
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
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
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
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

SAND CREEK

at Morningside Cemetery, Coon Rapids

Notes

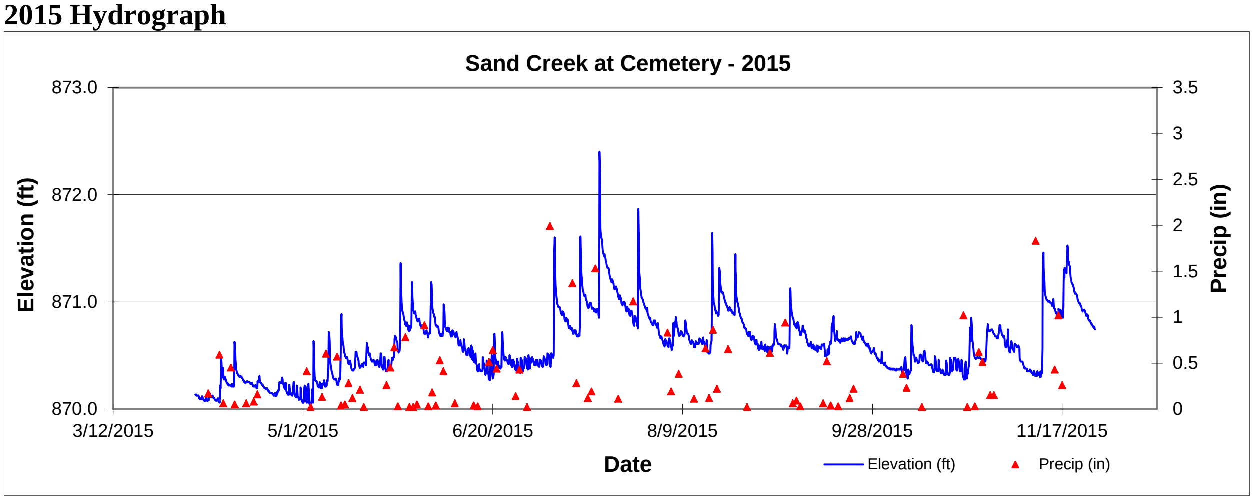


Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial and retail areas throughout northeastern Coon Rapids and western Blaine. The stream is approximately 8 feet wide and 3 feet deep at the monitoring site during baseflow.

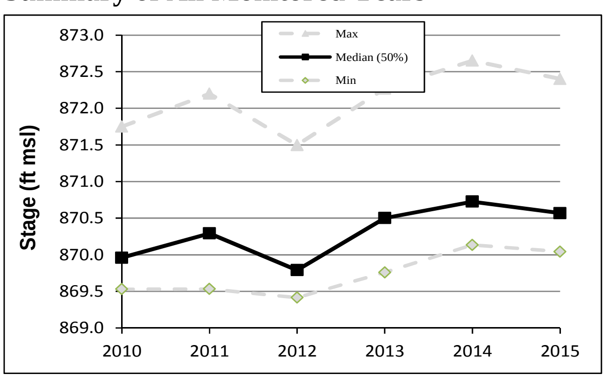
Sand Creek at Morningside Cemetery was monitored for the first time in 2010. The site was added because of its position between the cities of Blaine and Coon Rapids, which provides an estimate of the stormflow contributions from Blaine. In addition, the site is located immediately downstream of the confluence 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 0.61 feet in 4 hours in reaction to a 1.99 rain event on July 5th. 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.

2015 Hydrograph



Summary of All Monitored Years



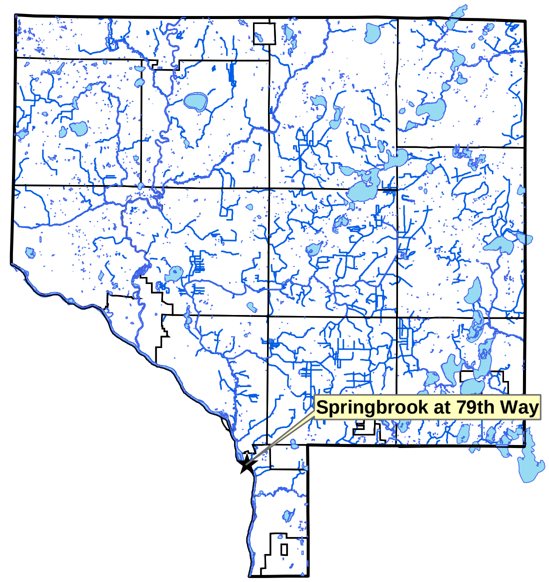
Percentiles	2010	2011	2012	2013	2014	2015
Min	869.53	869.53	869.42	869.76	870.14	870.04
2.5%	869.61	869.59	869.44	869.99	870.19	870.10
10.0%	869.70	869.67	869.47	870.09	870.25	870.24
25.0%	869.79	870.03	869.59	870.19	870.44	870.38
Median (50%)	869.96	870.29	869.79	870.50	870.73	870.57
75.0%	869.96	870.53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

Stream Hydrology Monitoring

SPRINGBROOK

at 79th Way, Fridley

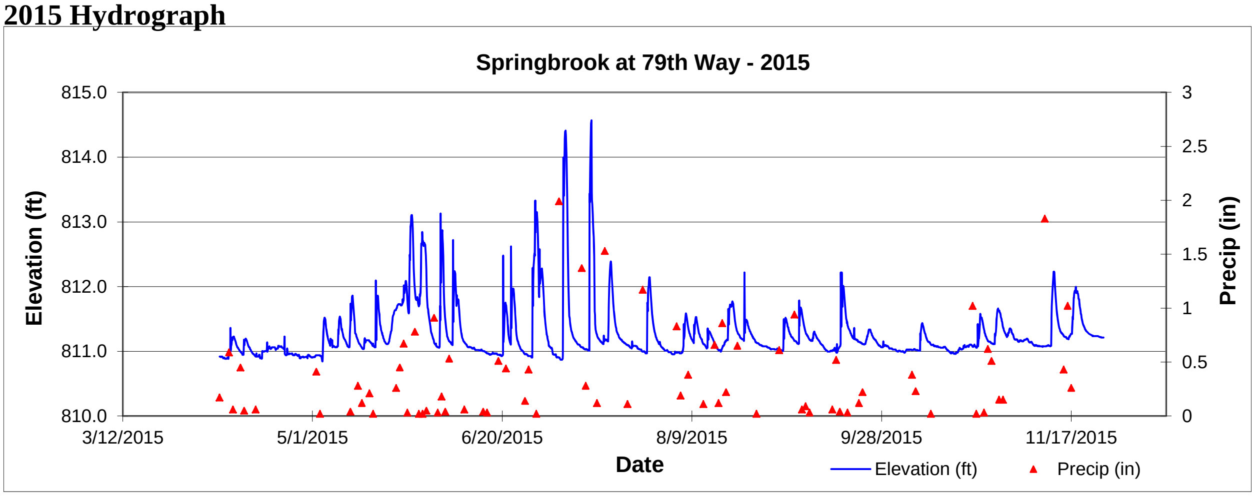
Notes



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 2015 water levels rose 1.65 feet in just 2 hours after a 0.94 inch storm on June 3rd. In 2015 water levels fluctuated 3.72 feet reaching a maximum of 814.57 feet which is 1.32 feet higher than the recorded maximum for 2014. 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.

2015 Hydrograph



Summary of All Monitored Years

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

PLEASURE CREEK

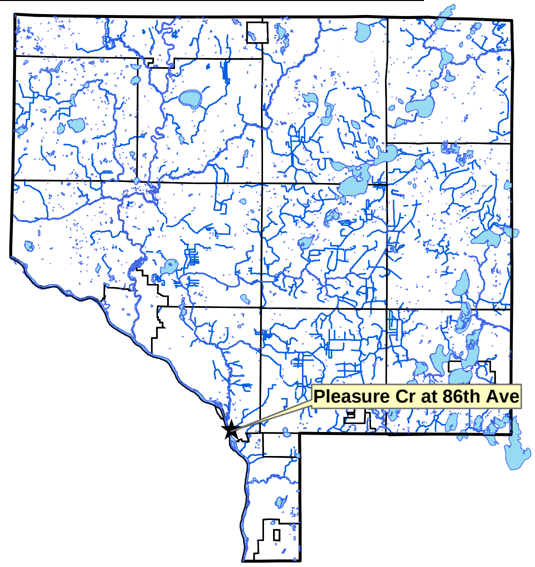
at 86th Ave, Fridley

Notes

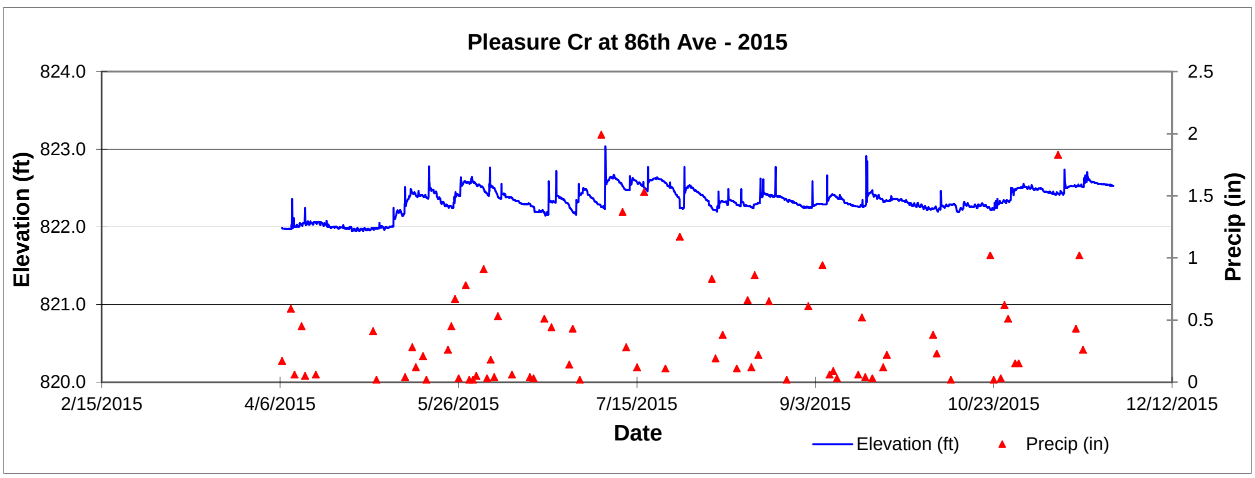
Pleasure Creek flows through the southwestern portion of Blaine and southern Coon Rapids. The watershed is urbanized. The creek is about 8-10 feet wide and 0.5 to 1 foot deep during baseflow. It flows through an interconnected network of stormwater ponds in the upper part of the watershed.

Variations in the water level at Pleasure Creek are seldom more than one foot. 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. Even storms of over two inches the stream response was less than one foot.

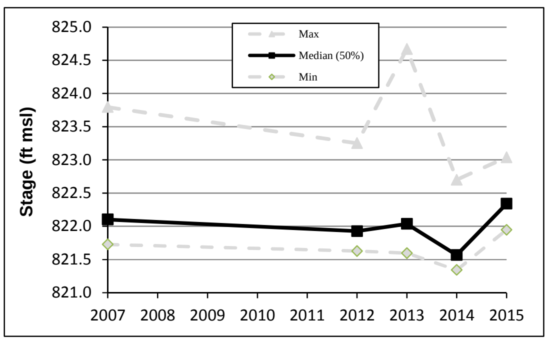
Several manual flow measurements were done in 2013 to inform rating curve development by CCWD's consulting engineer. The engineer plans to use the stream cross section and desktop analysis for rating curve generation.



2015 Hydrograph

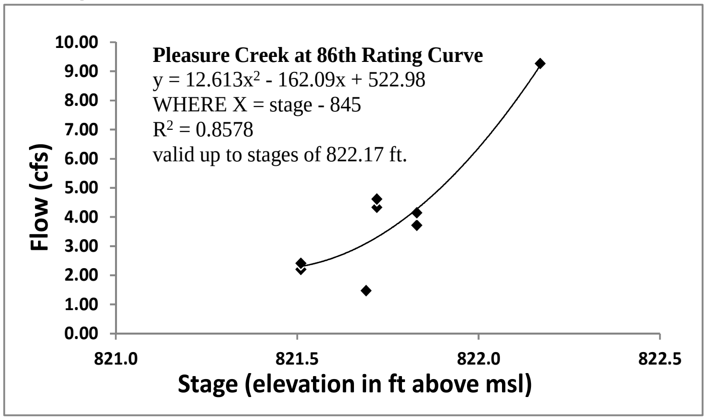


Summary of All Monitored Years



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

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.

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

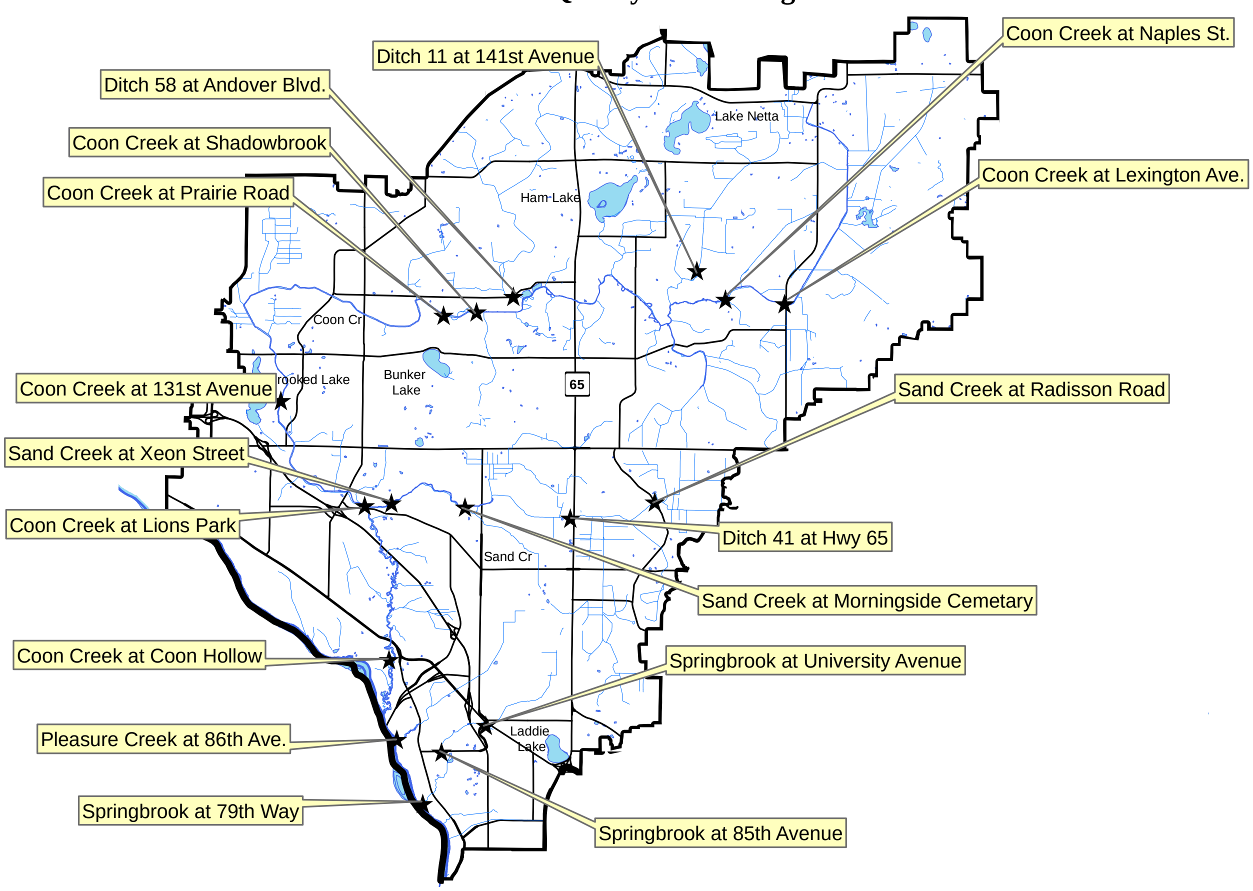
Locations:

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 2015 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 extremes 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 2015 is included.

	Springbrook Cr	Pleasure Cr	Sand Cr	Coon Cr	Median for Anoka Co Streams	State Water Quality Standard
Conductivity (mS/cm)	0.862	0.874	0.751	0.518	0.362	none
Chlorides (mg/L)	159	125	67	40	17	860 - acute 230 - chronic
Turbidity (NTU)	3.75	12	7.5	14.1	8.5	None*
Total Suspended Solids (mg/L)	5	9	6	9.5	12	30*
Total Phosphorus (ug/L)	111	72.0	59.0	121	135	100*
Dissolve Oxygen (mg/L)	7.99	8.22	7.92	8.01	6.97	5
pH	7.80	7.97	7.77	7.69	7.62	6.5-8.5

*Proposed new state water quality standards.

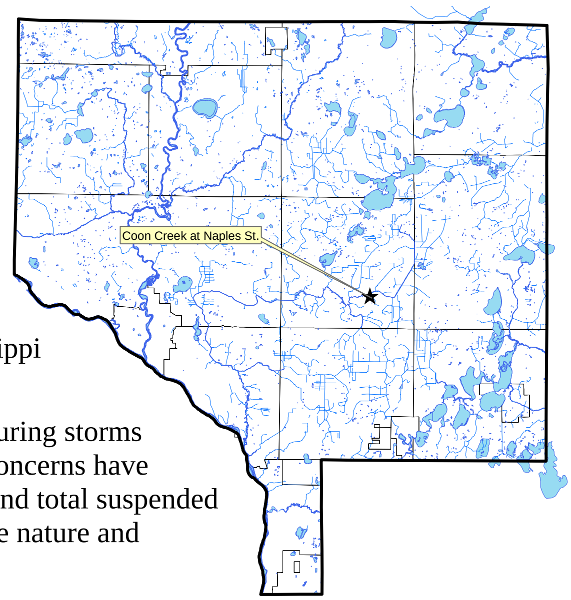
Hydrolab/YSI Continuous Stream Water Quality Monitoring

COON CREEK

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

Years Monitored

Coon Creek at 131st Street, 2015



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 ditch 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, 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 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 first year of continuous stream water quality monitoring at this site.

Coon Creek at 131st Street was monitored immediately before, during, and after storms with a YSI Exo 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 a Measura 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 before, during, and after all YSI monitoring. An RDS Ecotone WM-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 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 0.13 to 1.23 inches. The wide distribution is helpful in discerning the creek's response to different storms.

2015 was the first year of YSI monitoring at this location, only 2015 individual storm results are presented in this report. The individual storm results for other locations of Coon Creek not presented in this report are available upon request from the Anoka Conservation District. Each year the findings of YSI 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.

<u>Turbidity</u>

- 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 couple of 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.

<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 is a likely source of high conductance in stream baseflow year round.

<u>Dissolved Oxygen</u>

- 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 some fish species begin to suffer.
- When stream levels rise, dissolved oxygen often rises as well, but stay low overall.
- 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.

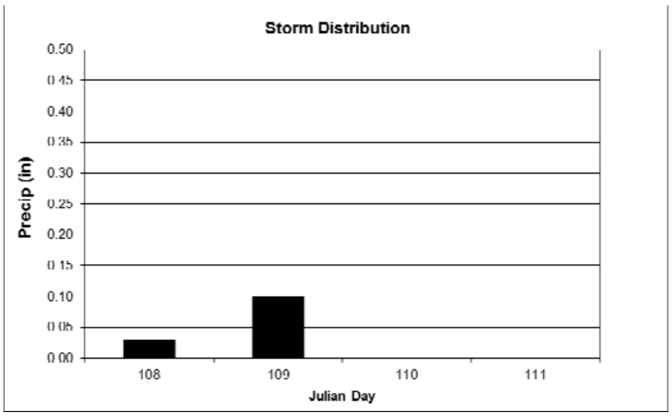
Hydrolab Continuous Monitoring
Storm 1 - 2015

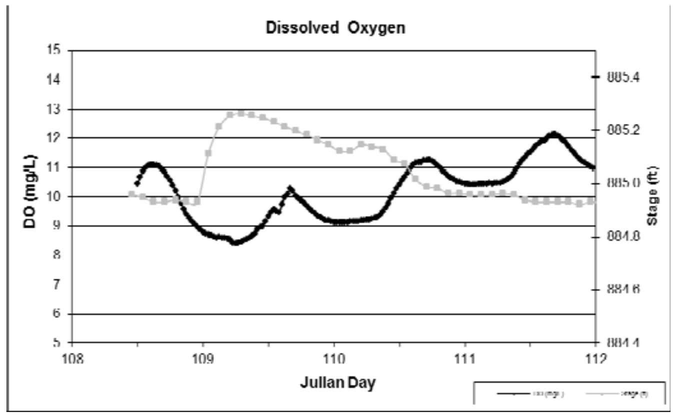
Coon Creek at 131st Street

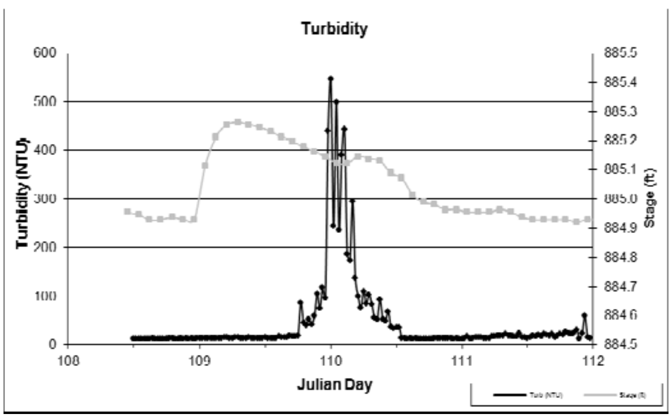
<u>Storm Summary:</u>

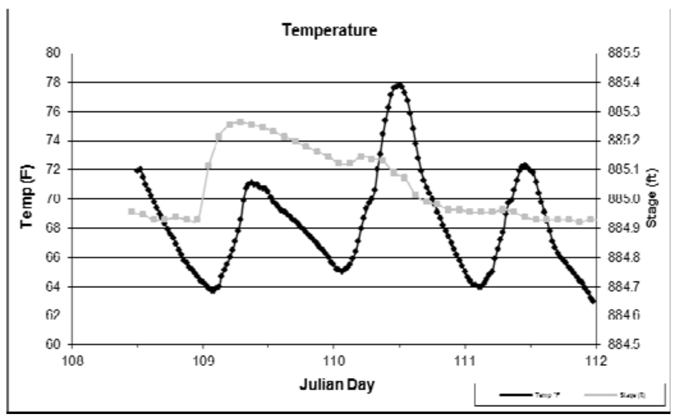
Dates: 18 April 2015 (day 108) to 21 April 2015 (day 111)

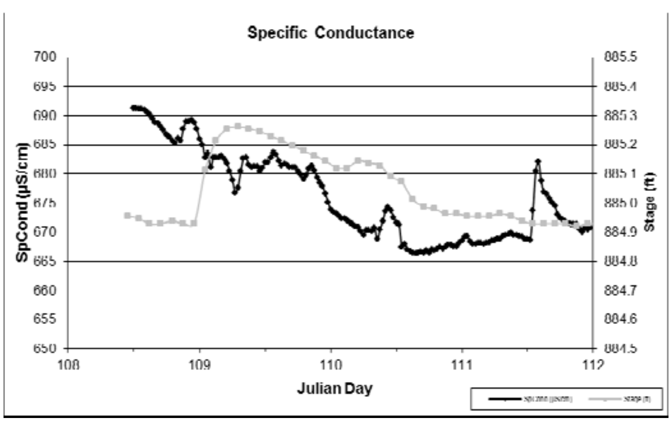
Precipitation: 0.13 inches

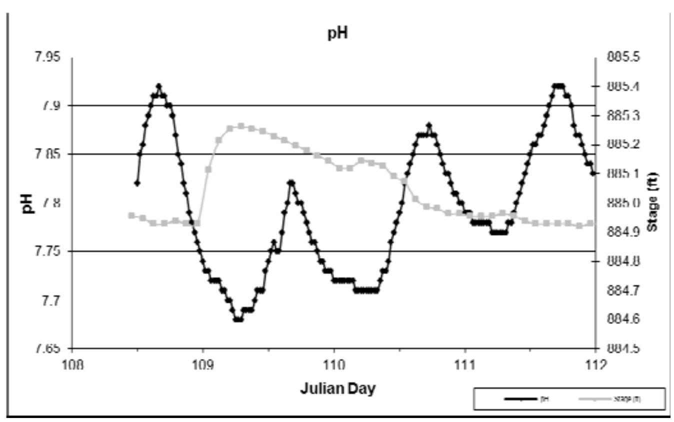












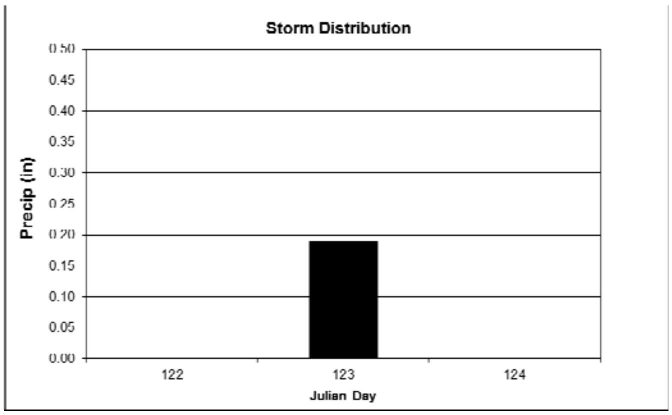
Hydrolab Continuous Monitoring
Storm 2 - 2015

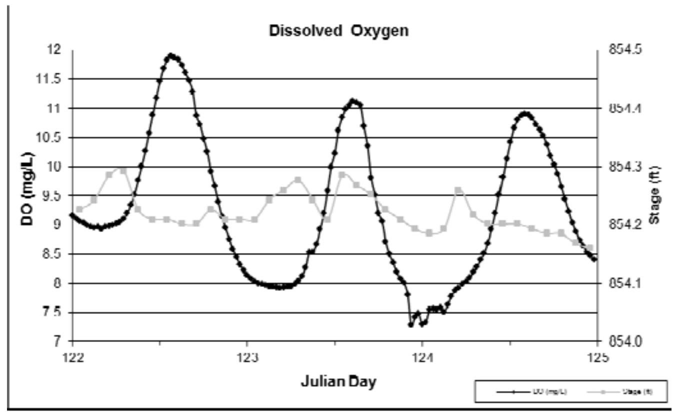
Coon Creek at 131st Street

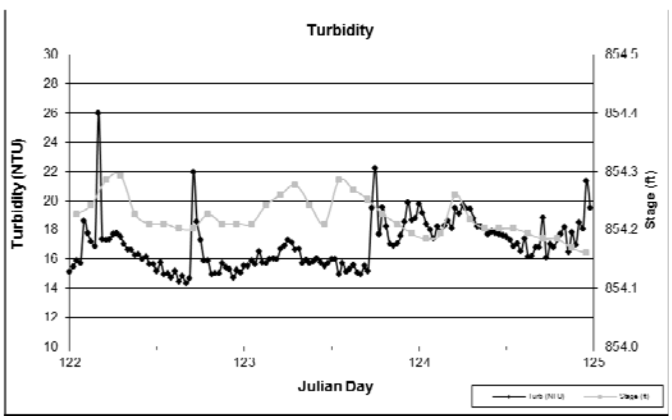
<u>Storm Summary:</u>

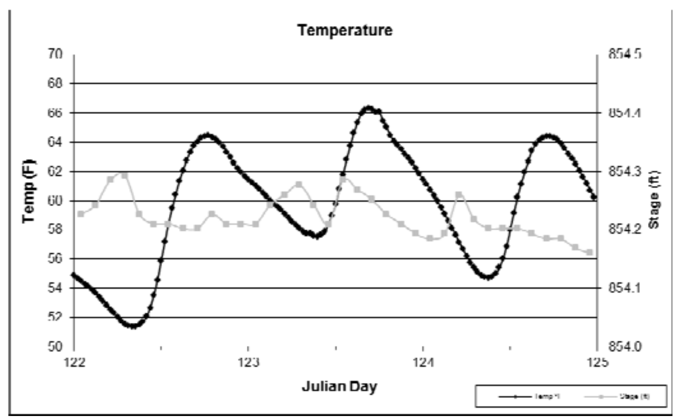
Dates: 2 May 2015 (day 122) to 4 May 2015 (day 124)

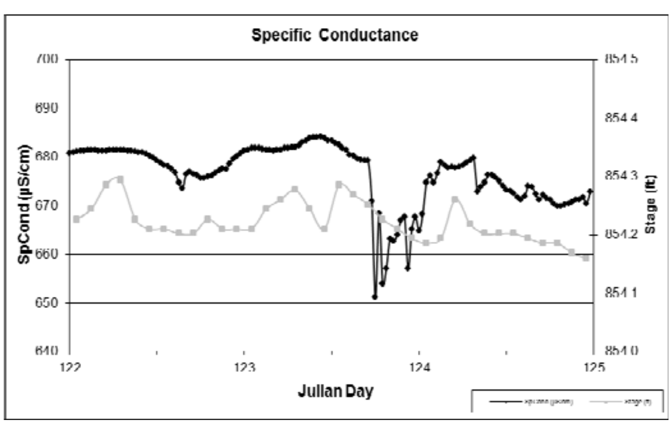
Precipitation: 0.19 inches

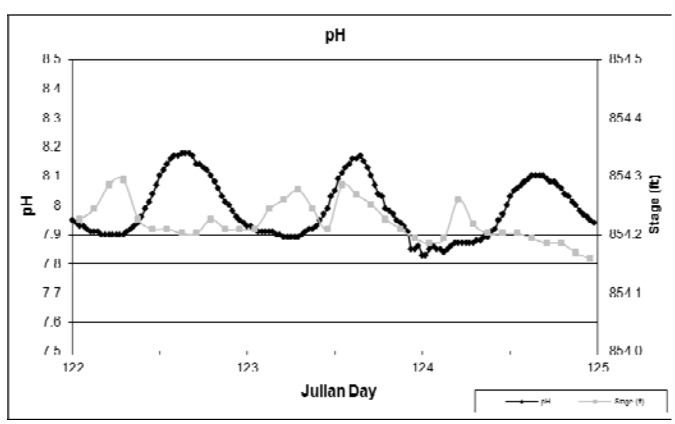






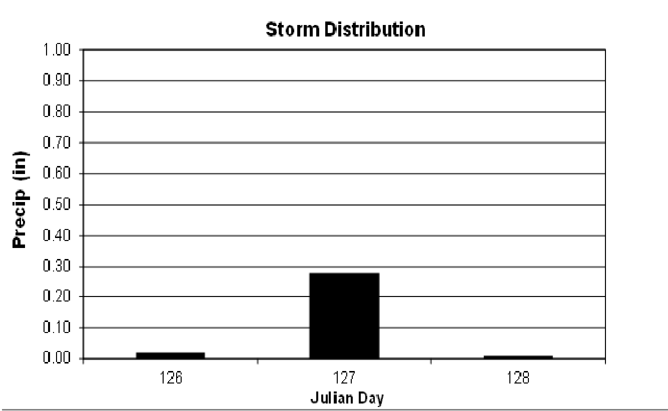


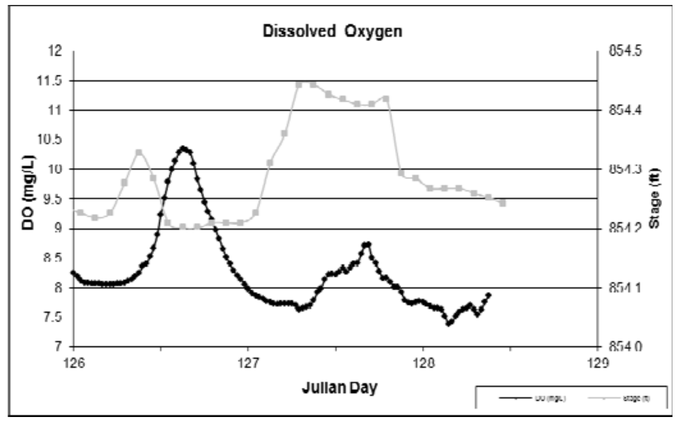


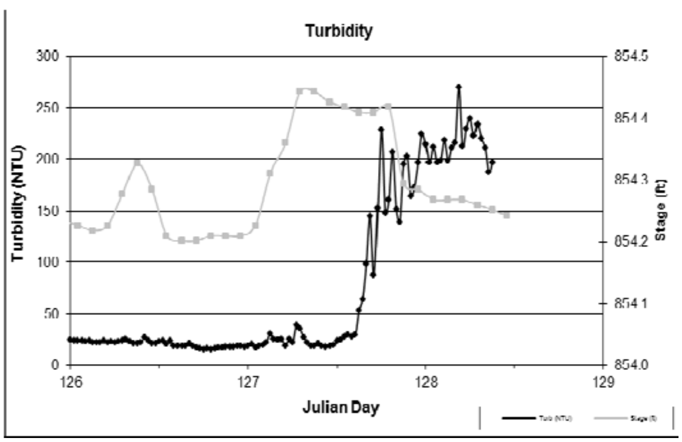


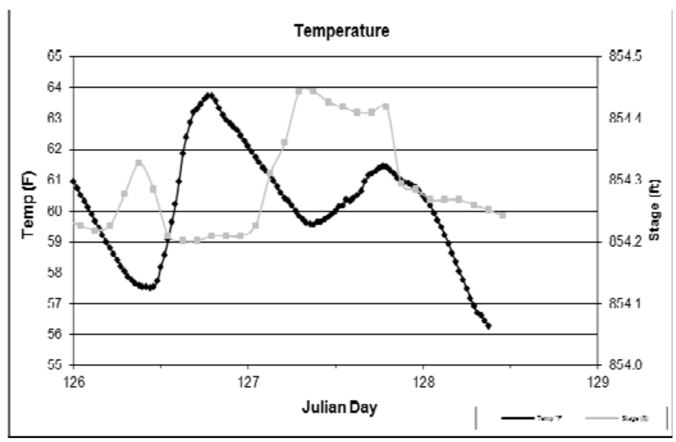
Hydrolab Continuous Monitoring
Storm 3 - 2015

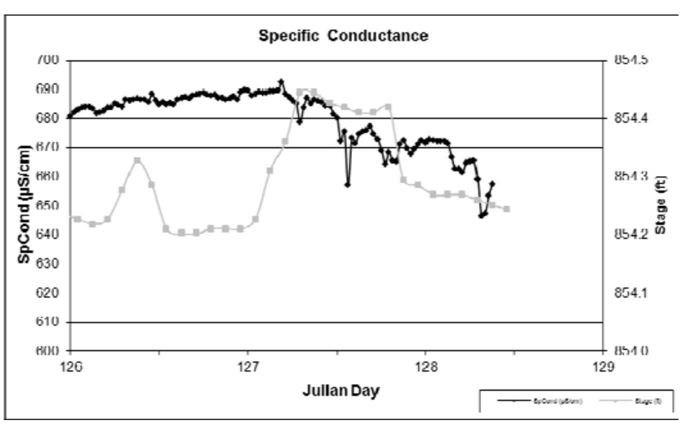
Coon Creek at 131st Street
<u>Storm Summary:</u>
Dates: 6 May 2015 (day 126) to 8 May 2015 (day 128)
Precipitation: 0.31 inches

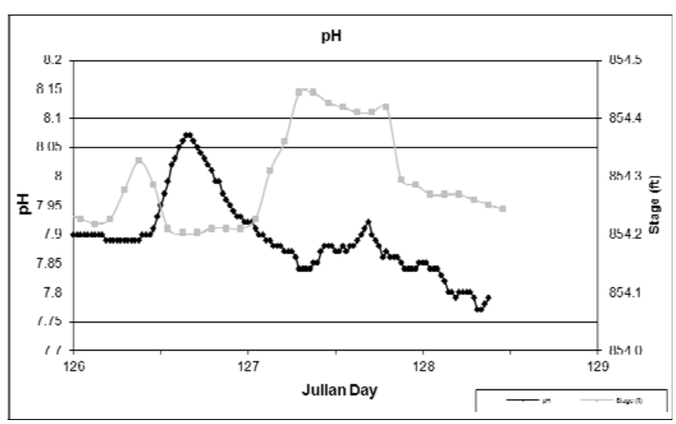












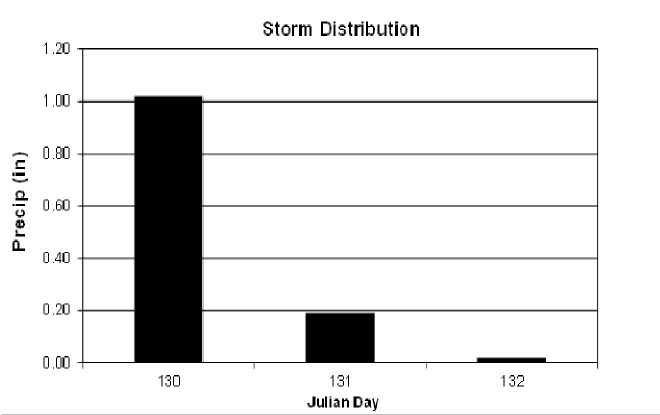
Hydrolab Continuous Monitoring
Storm 4 - 2015

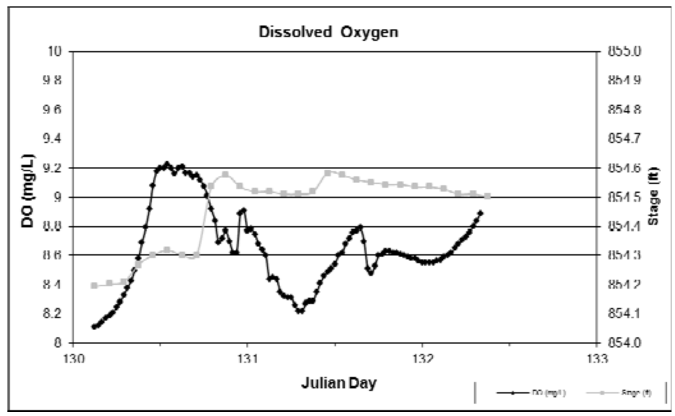
Coon Creek at 131st Street

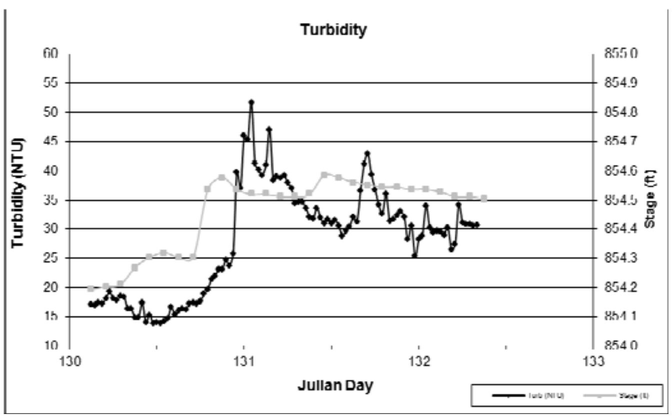
<u>Storm Summary:</u>

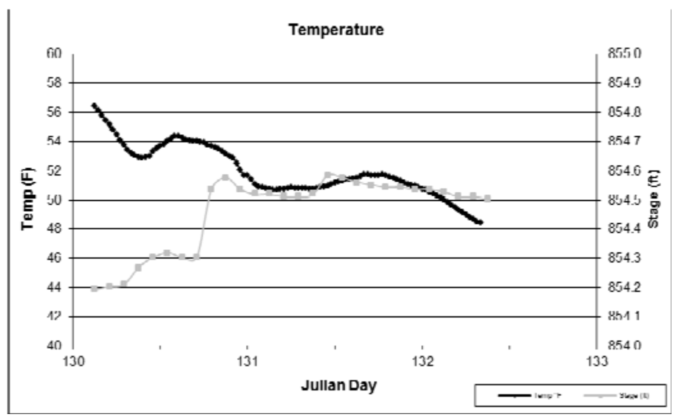
Dates: 10 May 2015 (day 130) to 12 May 2015 (day 132)

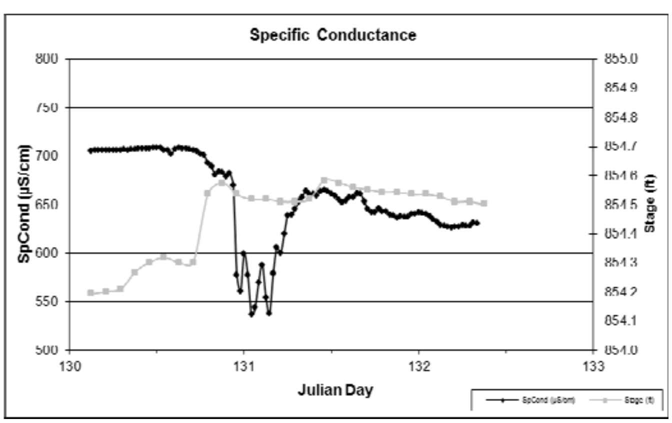
Precipitation: 1.23 inches

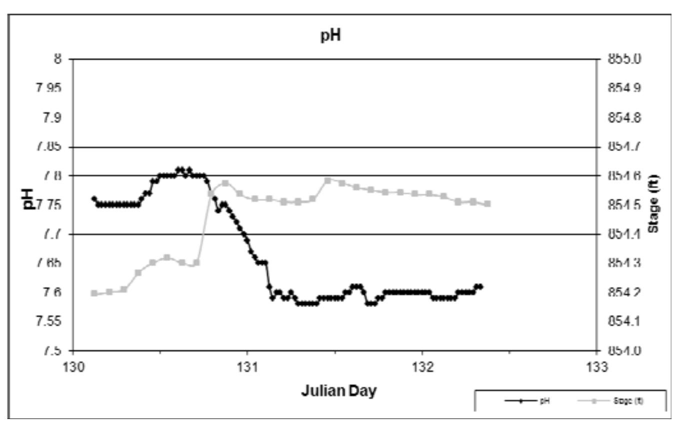






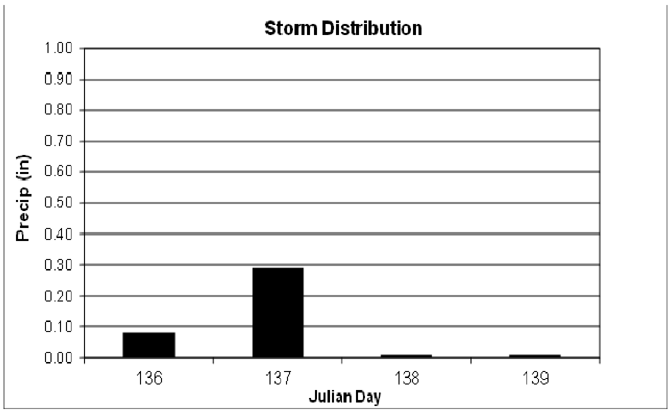


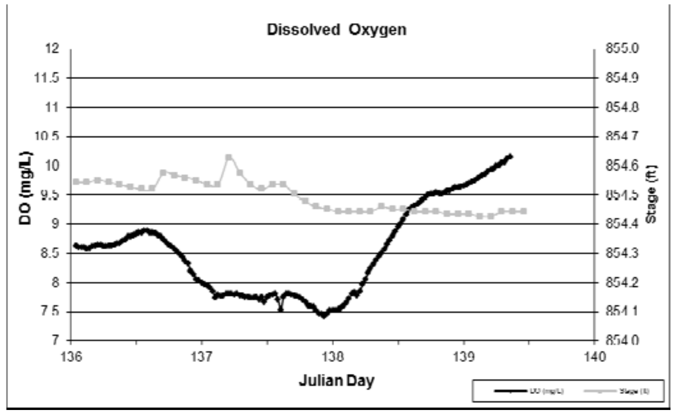


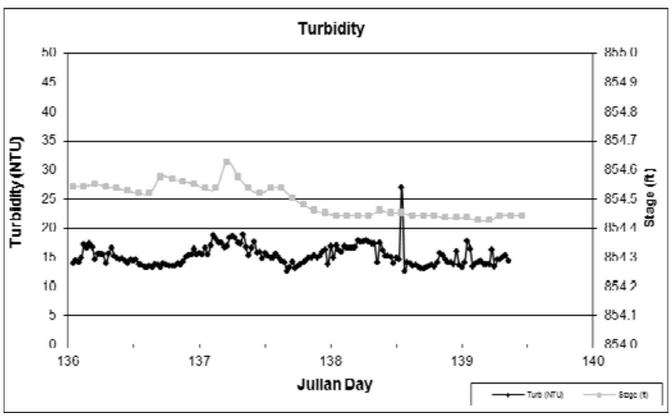


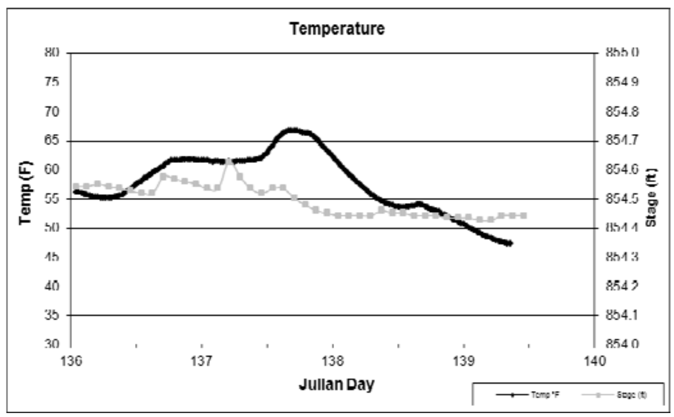
Hydrolab Continuous Monitoring
Storm 5 - 2015

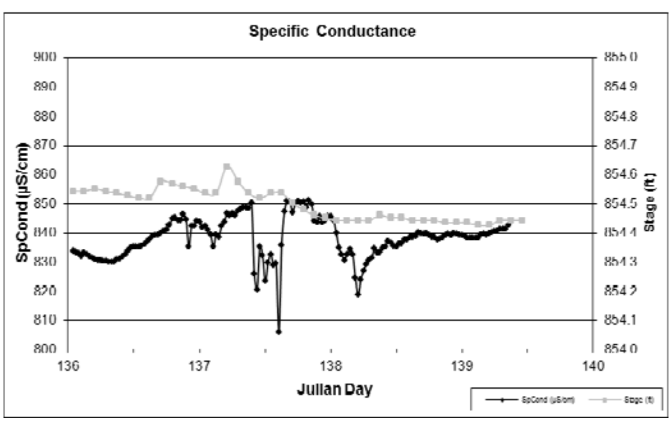
Coon Creek at 131st Street
<u>Storm Summary:</u>
Dates: 16 May 2015 (day 136) to 19 May 2015 (day 139)
Precipitation: 0.39 inches

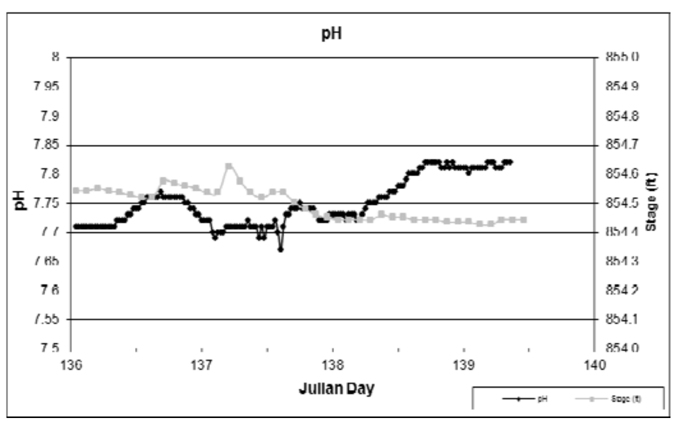










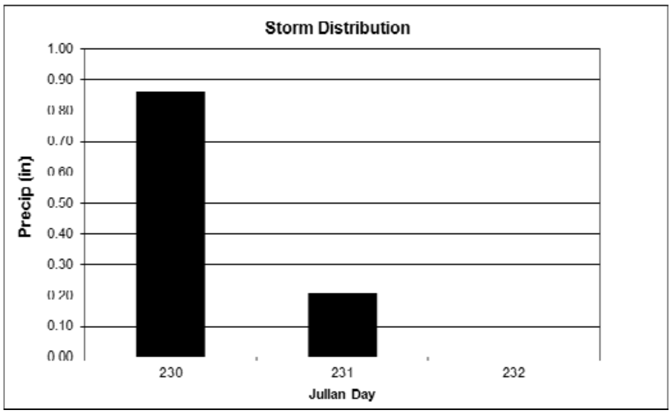


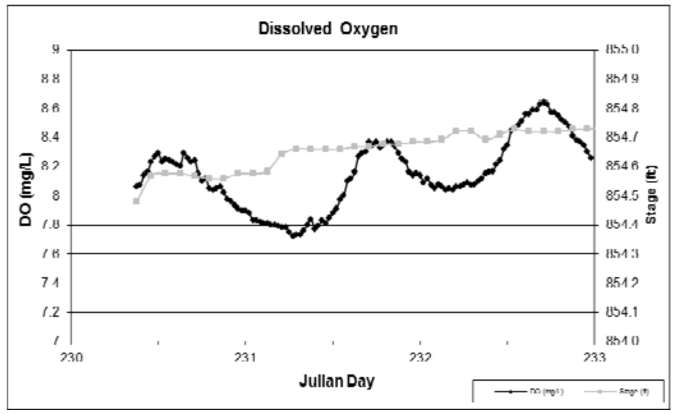
Hydrolab Continuous Monitoring
Storm 6 - 2015

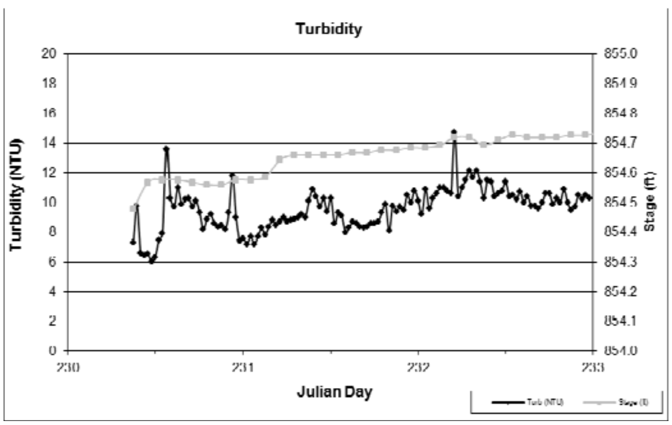
Coon Creek at 131st Street

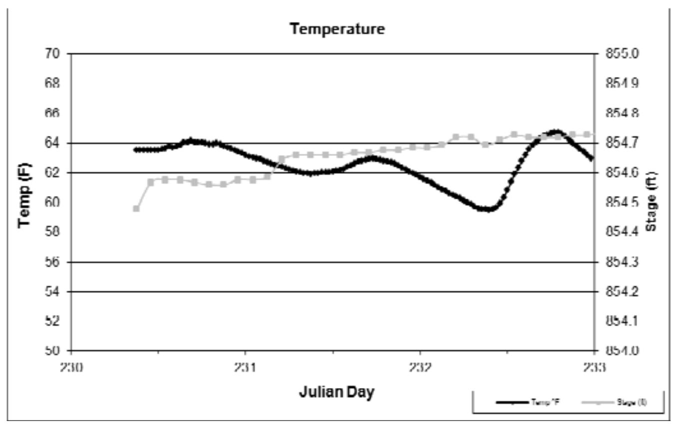
<u>Storm Summary:</u>

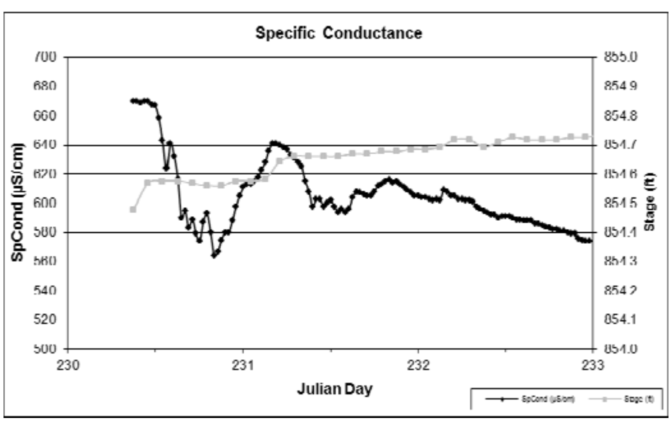
Dates: 18 August 2015 (day 230) to 20 August 2015 (day 232)
Precipitation: 1.07 inches

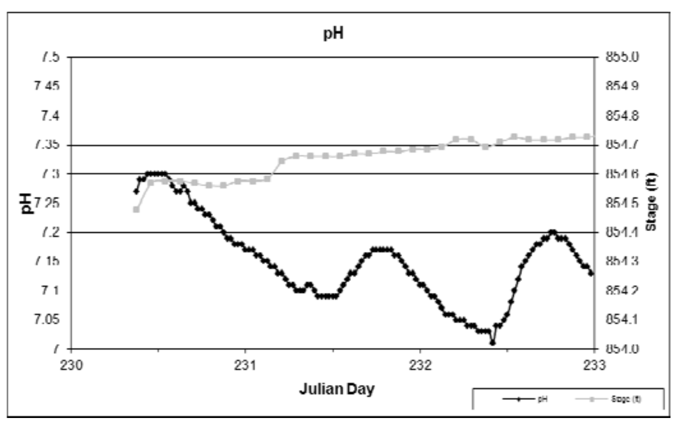






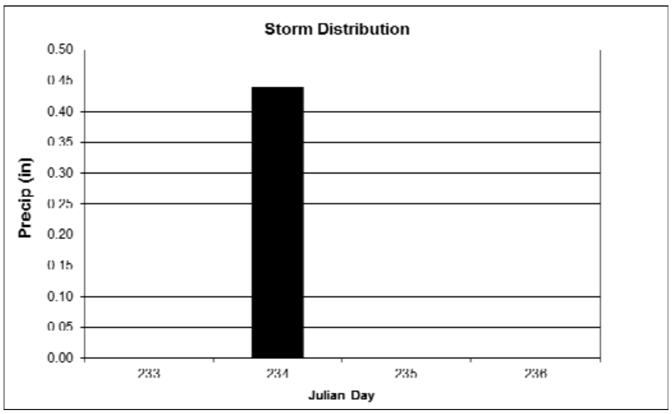


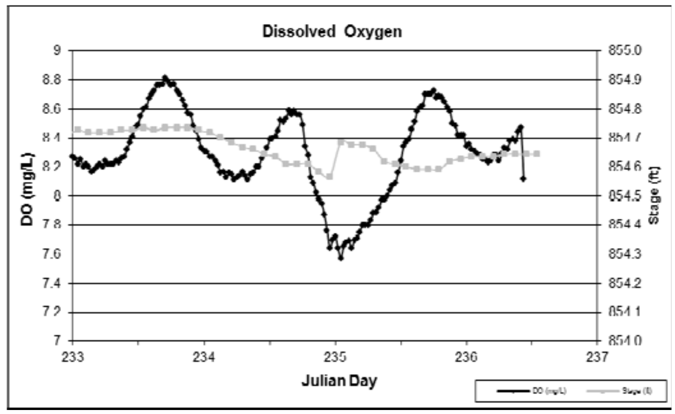


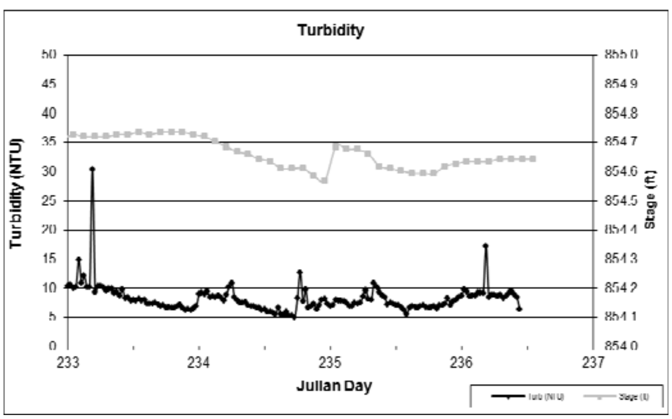


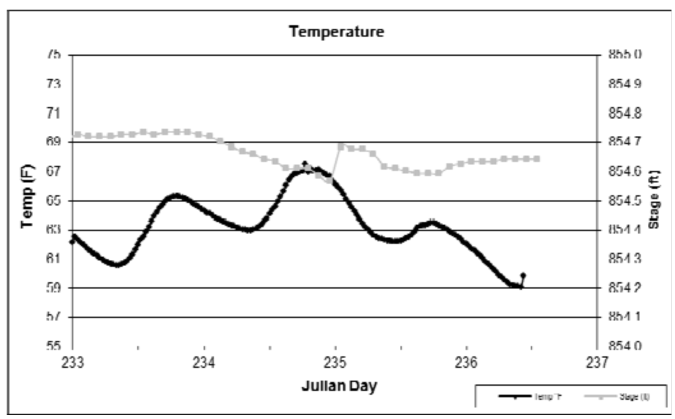
Hydrolab Continuous Monitoring
Storm 7 - 2015

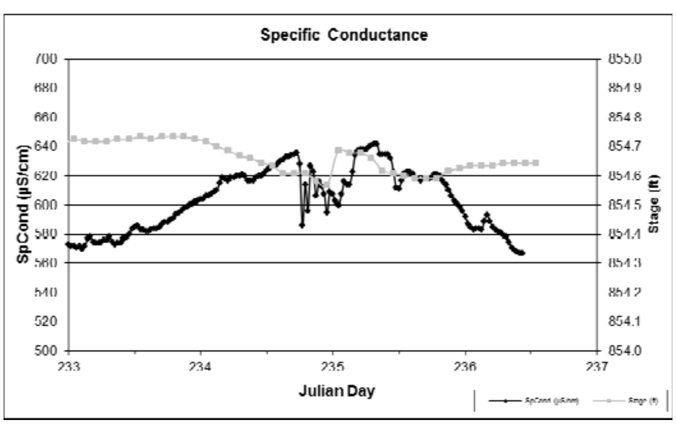
Coon Creek at 131st Street
Storm Summary:
Dates: 21 August 2015 (day 233) to 24 August 2015 (day 236)
Precipitation: 0.44 inches

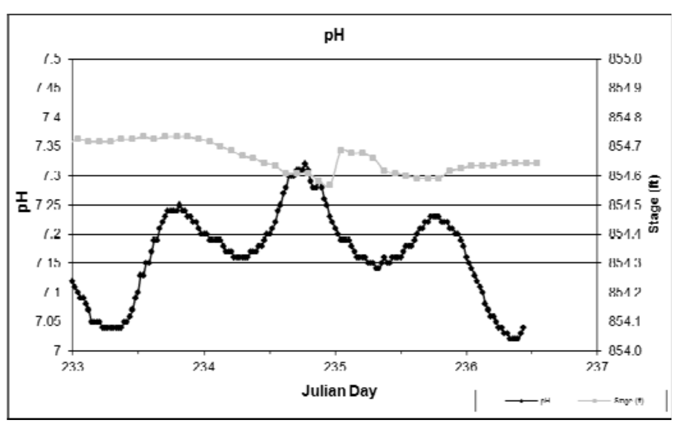






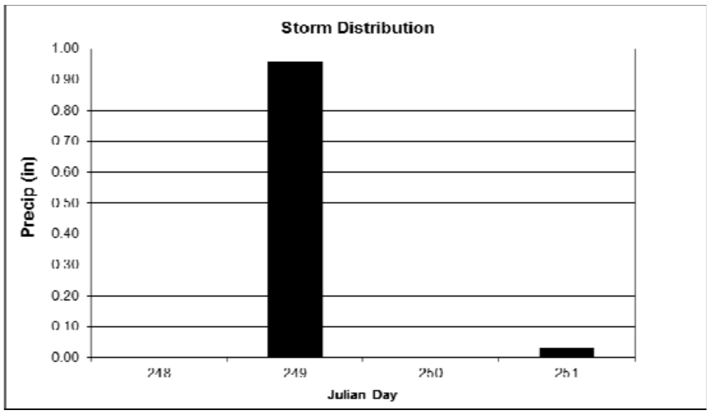


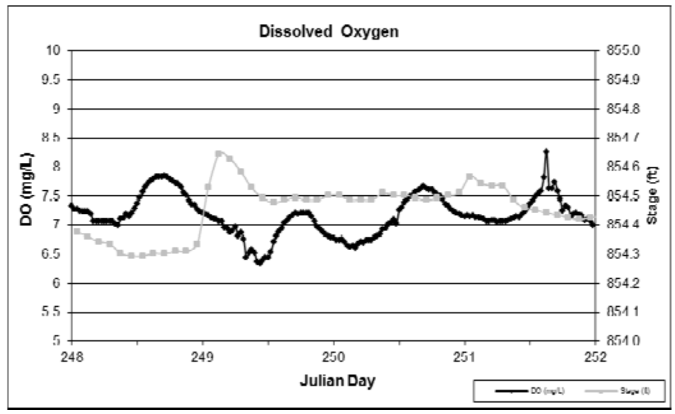


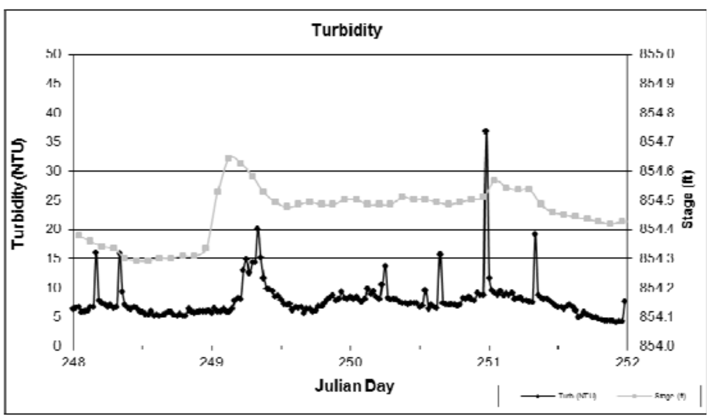


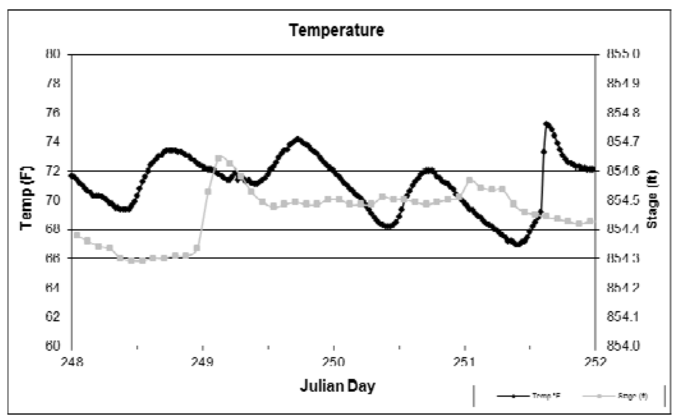
Hydrolab Continuous Monitoring
Storm 8 - 2015

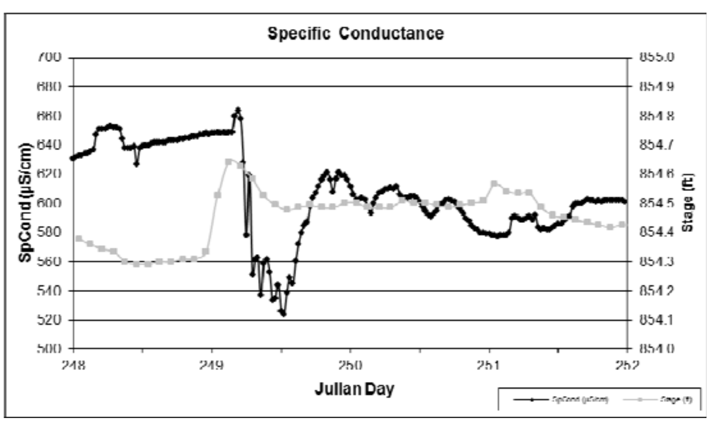
Coon Creek at 131st Street
<u>Storm Summary:</u>
Dates: 5 September 2015 (day 248) to 8 September 2015 (day 251)
Precipitation: 0.99 inches

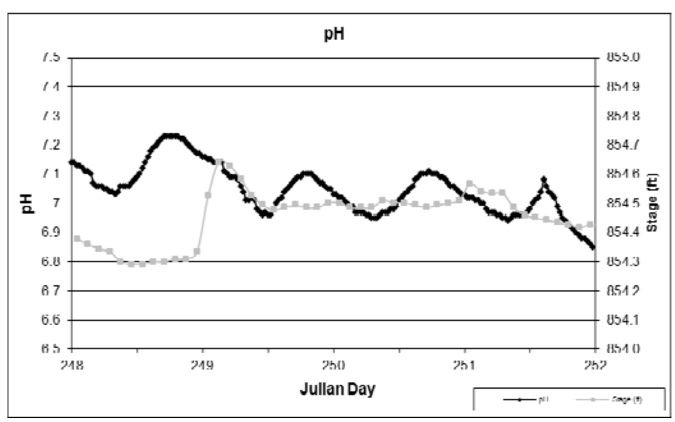












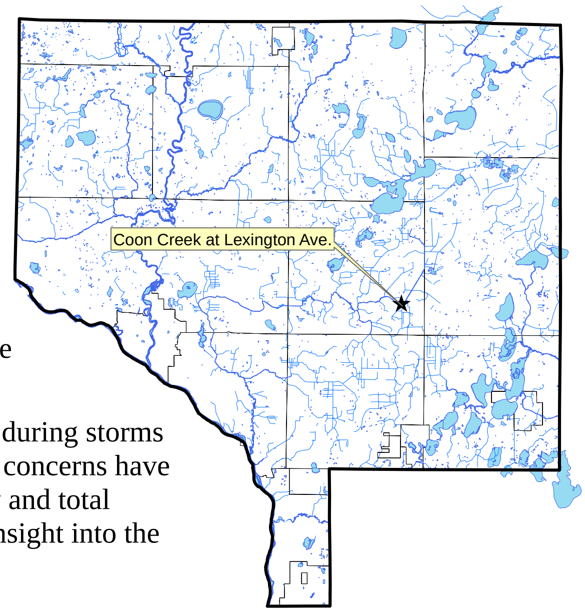
Hydrolab Continuous Stream Water Quality Monitoring

COON CREEK

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

Years Monitored

Coon Creek at Prairie Road 2015



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 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. 2015 was the first year of continuous stream water quality monitoring at this site.

Coon Creek at Prairie Road was monitored immediately before, during, and after storms with a 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 a Measura 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 at a nearby site before, during, and after all Hydrolab monitoring. A Measura WM-40 water level monitoring device recorded water levels every two hours. This stream stage is presented with the water quality data. Coon Creek at Prairie did not have previous stage readings. It would be preferable to present flow, but 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. This data were 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 raged from 0.38 inches to 1.87 inches. The distribution is helpful in displaying the creek's response to storms of varying intensity.

The discussion below incorporates results from all years of Hydrolab monitoring, but only 2015 individual storm results are presented in this report. The individual storm results for previous years are in that year's Anoka Water Almanac, or are available upon request from the Anoka Conservation District. Each year the findings of Hydrolab 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.

<u>Turbidity</u>

- A brief turbidity spike is 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.
- Because turbidity does not closely follow stream stage, bed load is not the primary driver of high turbidity.

<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 oxygen concentrations in Coon Creek fluctuated in and out of the healthy, desirable range.
- Dissolved oxygen fell below 5 mg/L only during several of the storm events recorded.
- 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

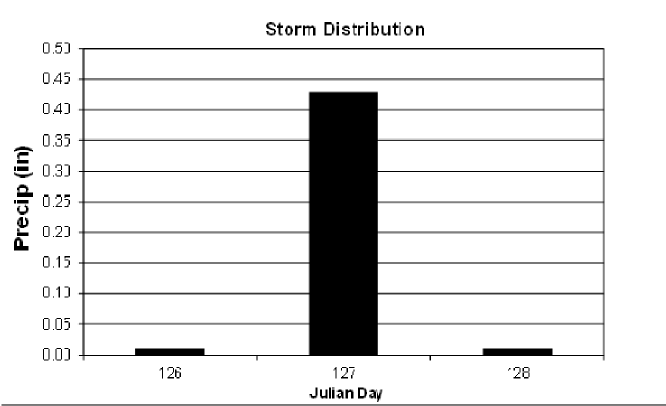
- Water temperature is generally not considered a concern in Coon Creek because there are no trout or other temperature sensitive resources.
- Cycles of day warming and night cooling are apparent in the data.

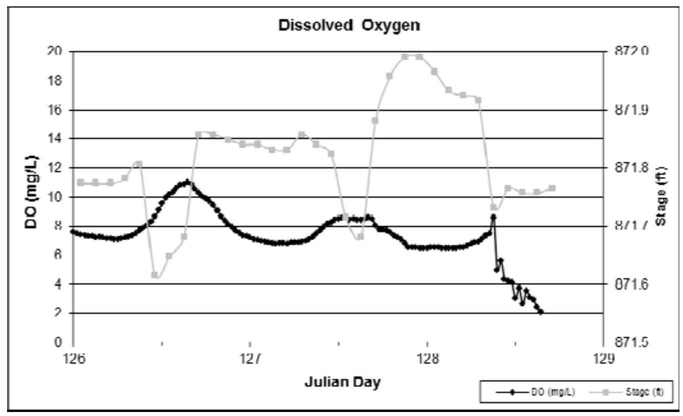
pH

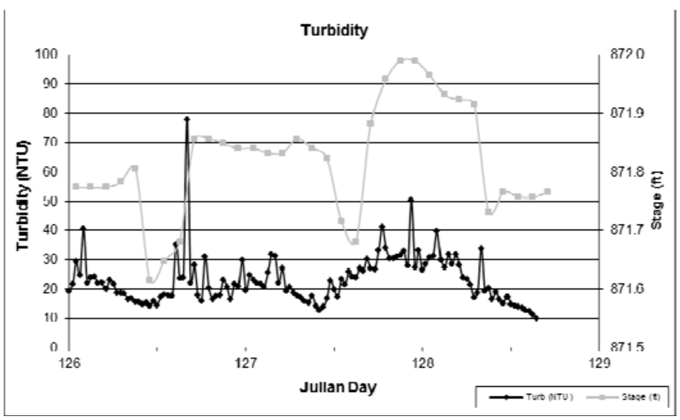
- pH is inversely related to water level in Coon Creek. When water level rises, pH declines. This is because rainwater has a lower pH than that of local shallow groundwater.
- pH stayed within the desired range of 6.5 to 8.5 that is specified in state water quality standards.
- pH fluctuates diurnally indicating that photosynthesis and respiration of excessive aquatic plants is likely the driving force in poor dissolved oxygen levels.

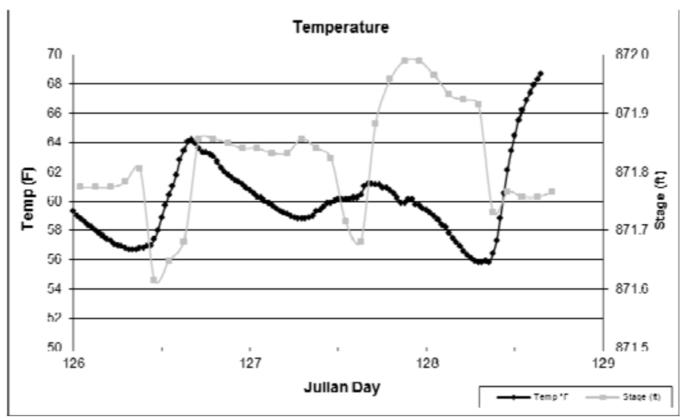
Hydrolab Continuous Monitoring
Storm 1 - 2015

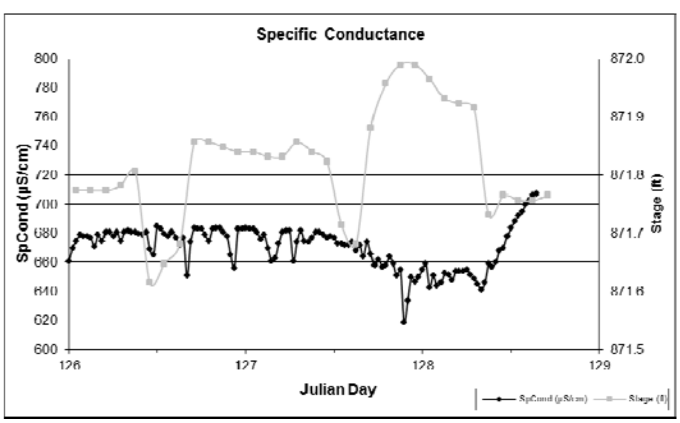
Coon Creek at Prairie Road
<u>Storm Summary:</u>
Dates: 6 May 2015 (day 126) to 8 May 2015 (day 128)
Precipitation: 0.45 inches

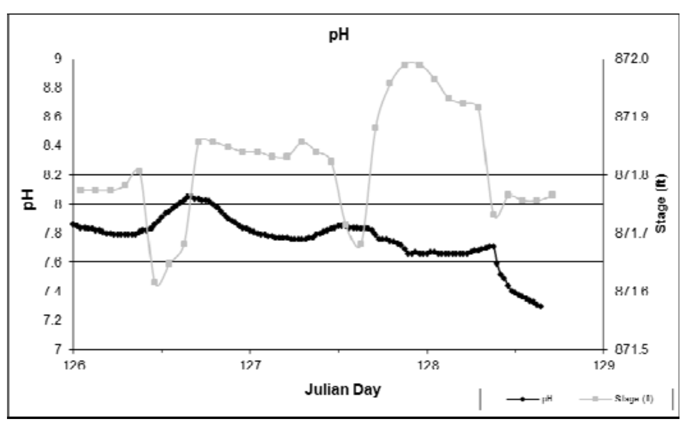






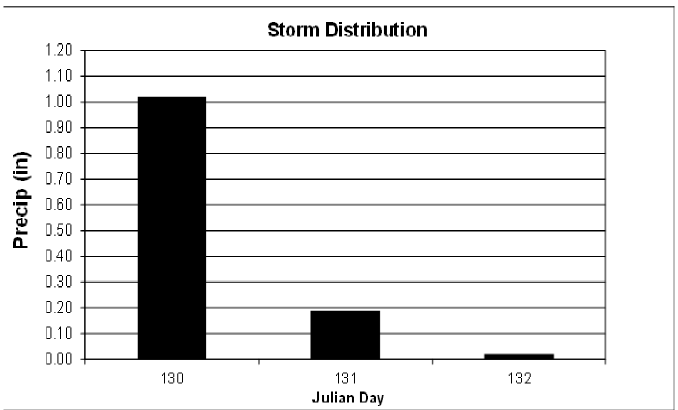


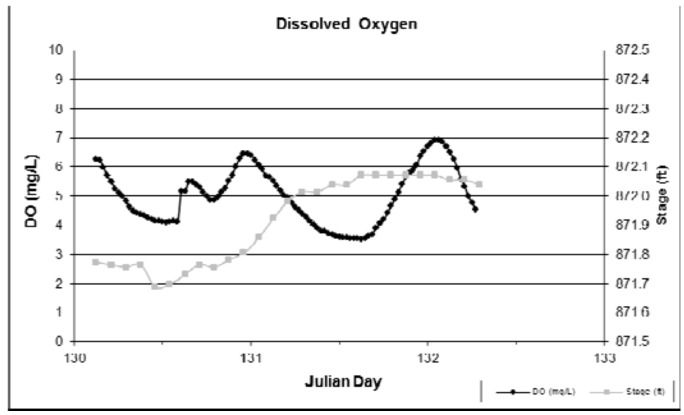


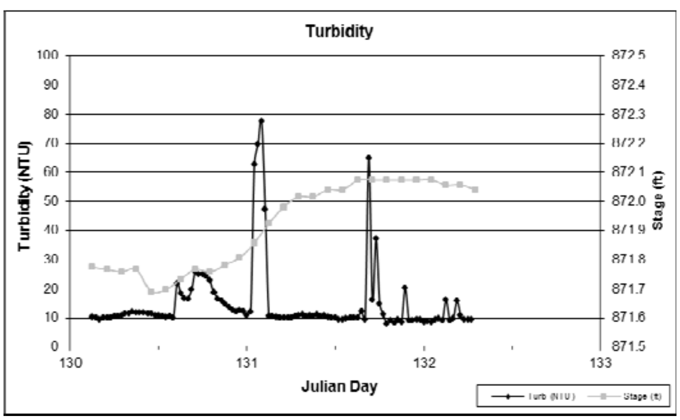


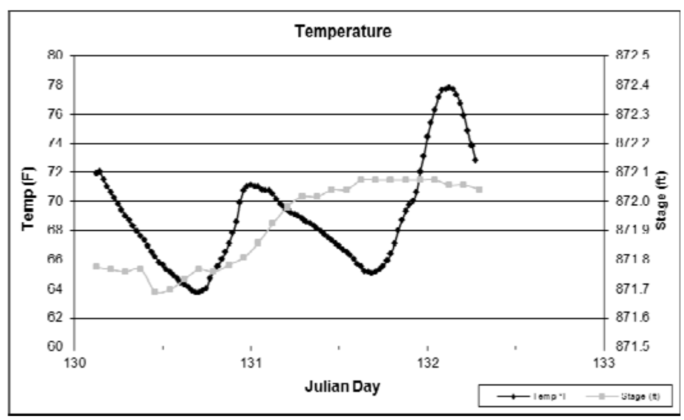
Hydrolab Continuous Monitoring
Storm 2 - 2015

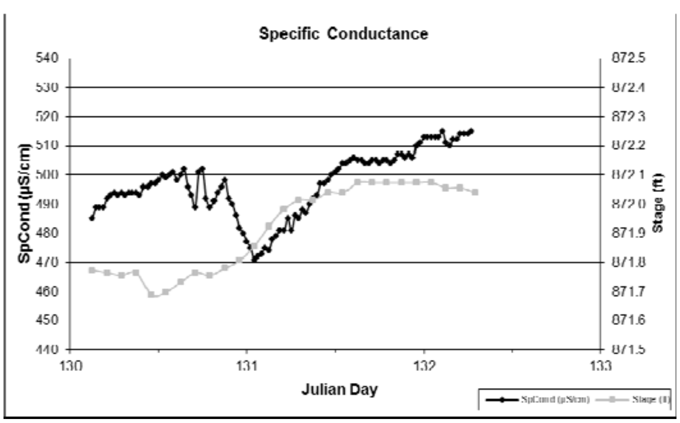
Coon Creek at Prairie Road
<u>**Storm Summary:**</u>
Dates: 10 May 2015 (day 130) to 12 May 2015 (day 132)
Precipitation: 1.23 inches

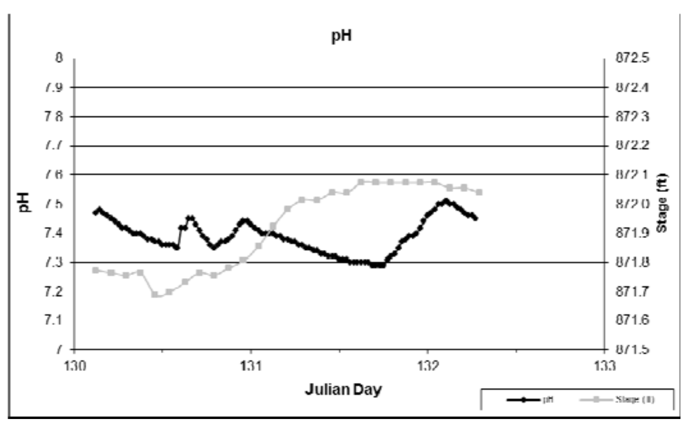












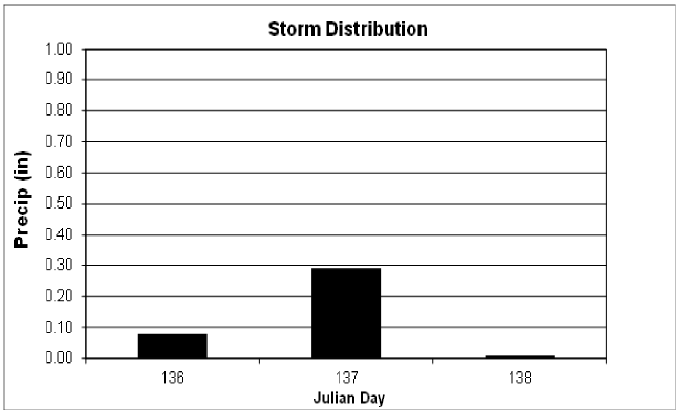
Hydrolab Continuous Monitoring

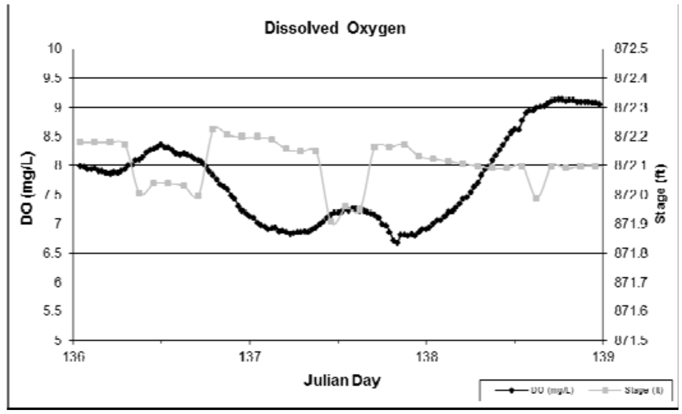
Storm 3 - 2015

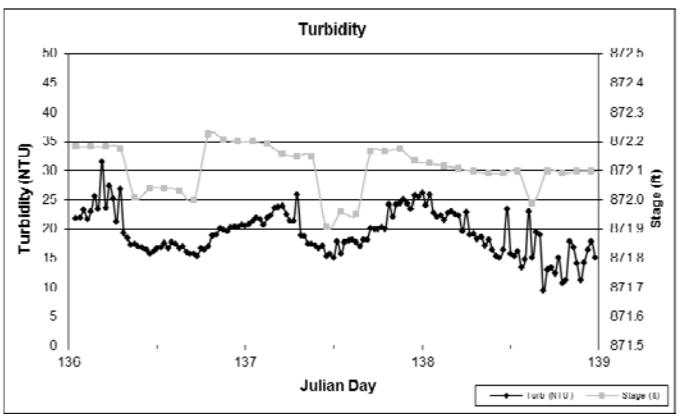
Coon Creek at Prairie Road

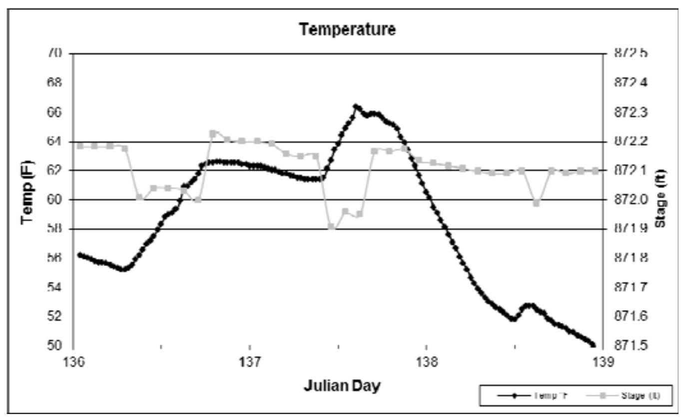
<u>Storm Summary:</u>

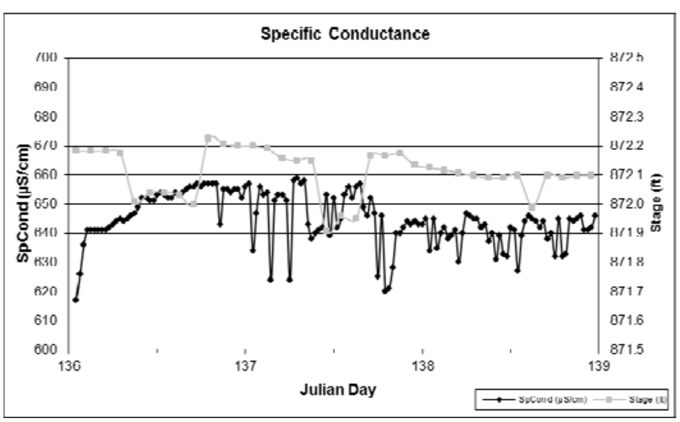
Dates: 16 May 2015 (day 136) to 18 May 2015 (day 138)
Precipitation: 0.38 inches

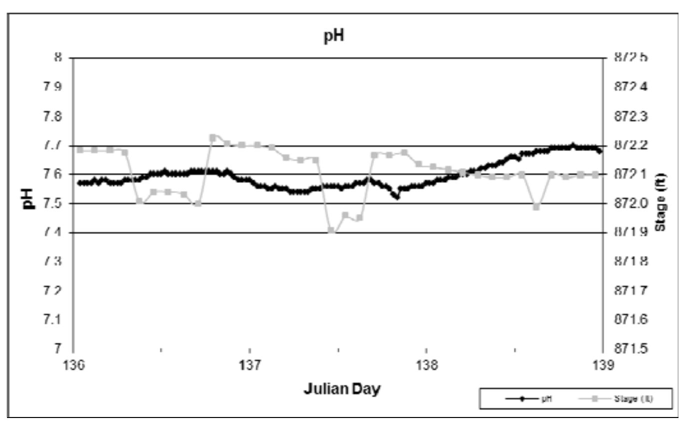












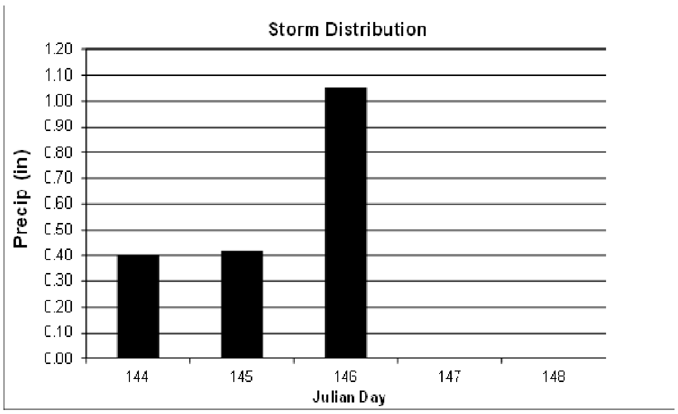
Hydrolab Continuous Monitoring Storm 4 - 2015

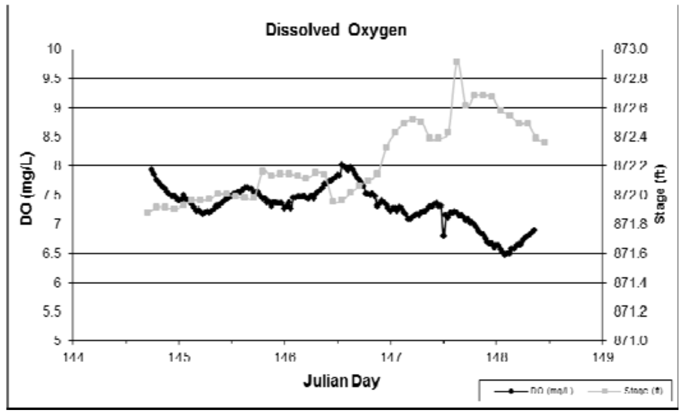
Coon Creek at Prairie Road

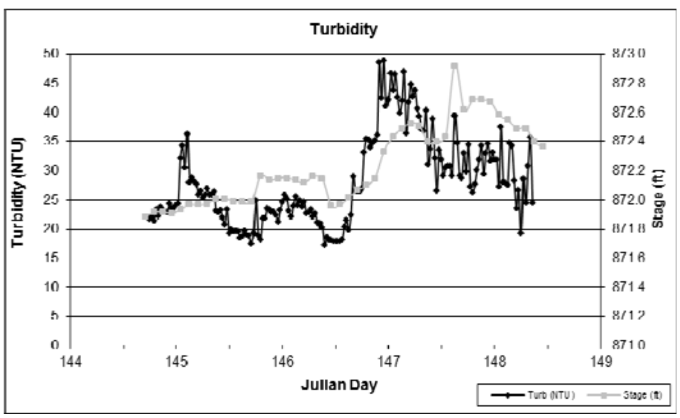
<u>Storm Summary:</u>

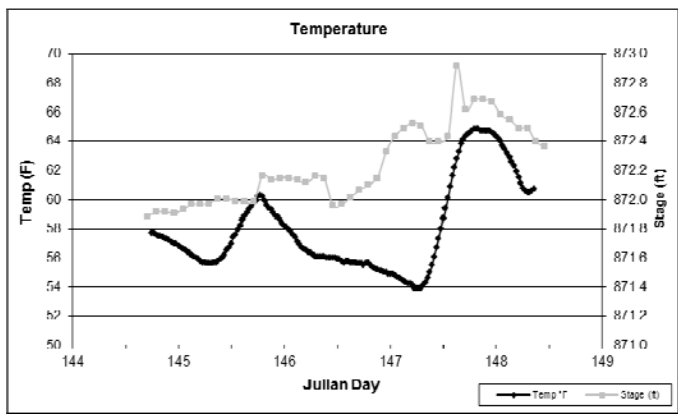
Dates: 24 May 2015 (day 144) to 28 May 2015 (day 148)

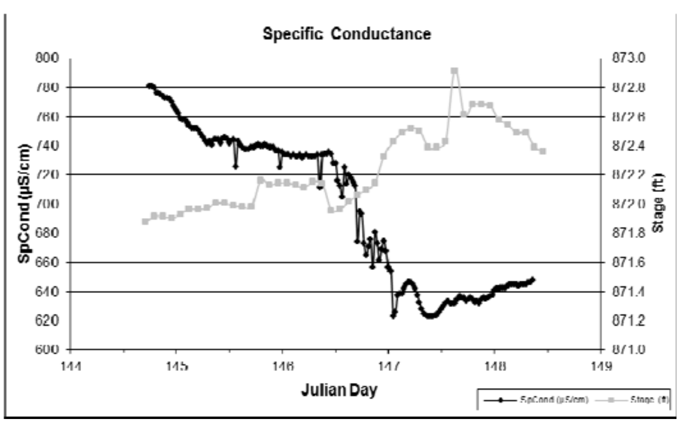
Precipitation: 1.87 inches

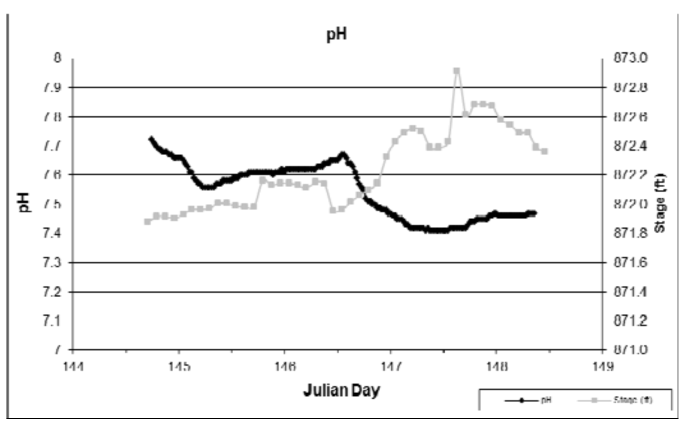






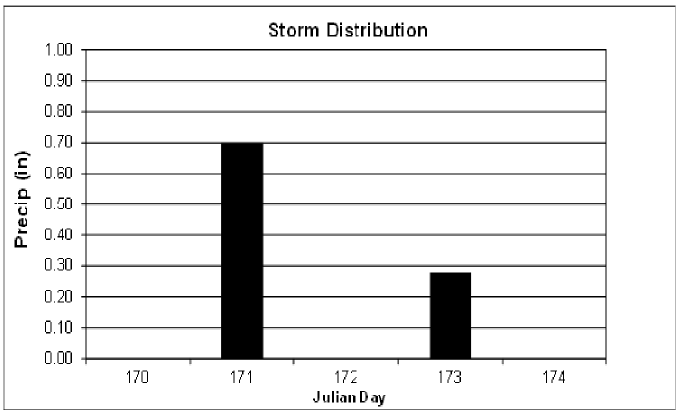


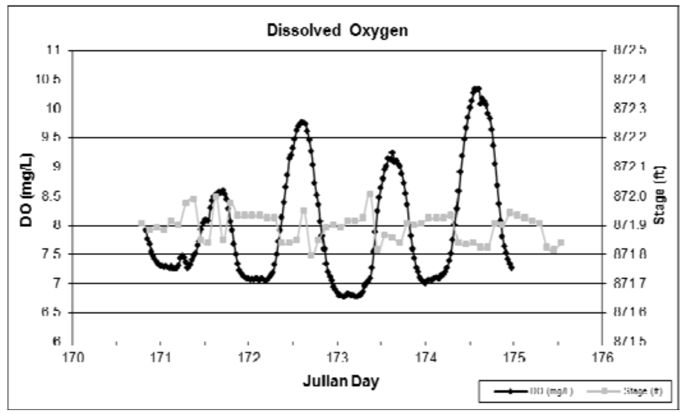


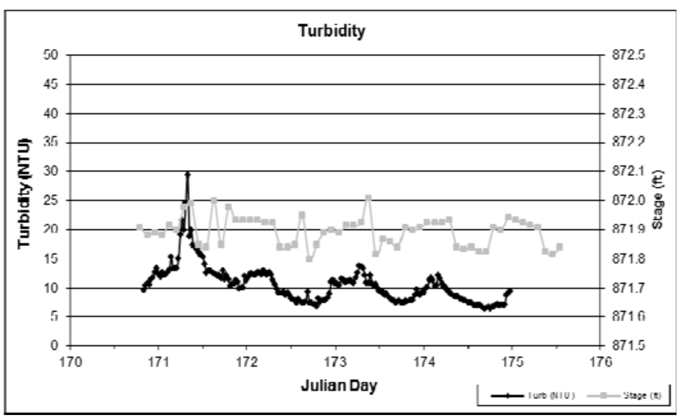


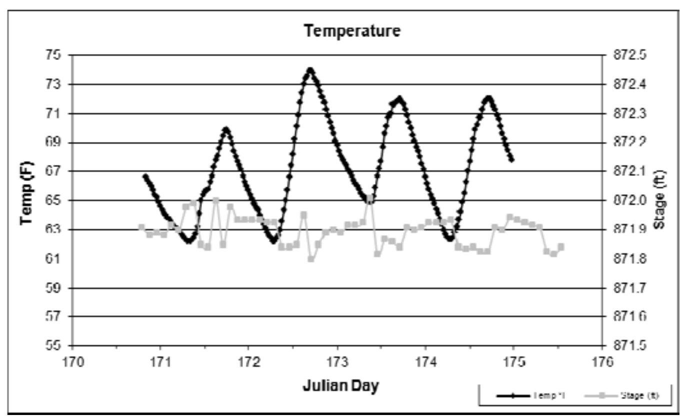
Hydrolab Continuous Monitoring
Storm 5 - 2015

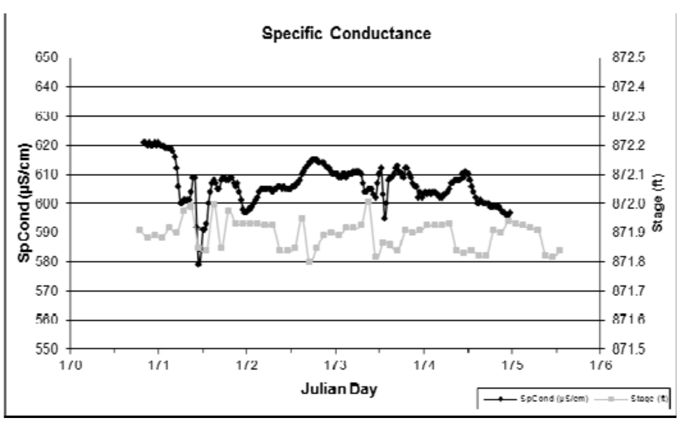
Coon Creek at Prairie Road
<u>Storm Summary:</u>
Dates: 19 June 2015 (day 170) to 23 June 2015 (day 174)
Precipitation: 0.98 inches

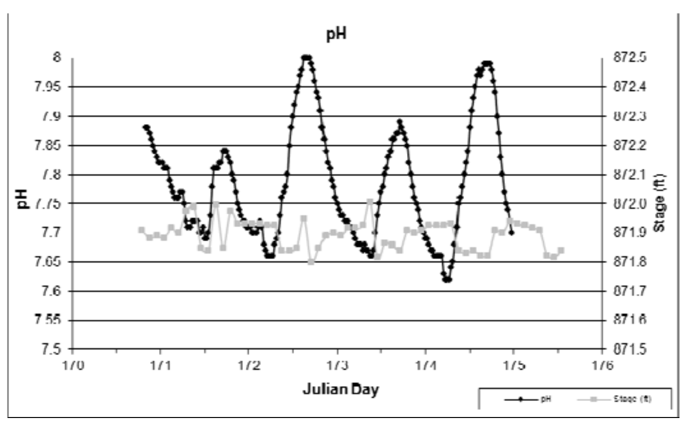












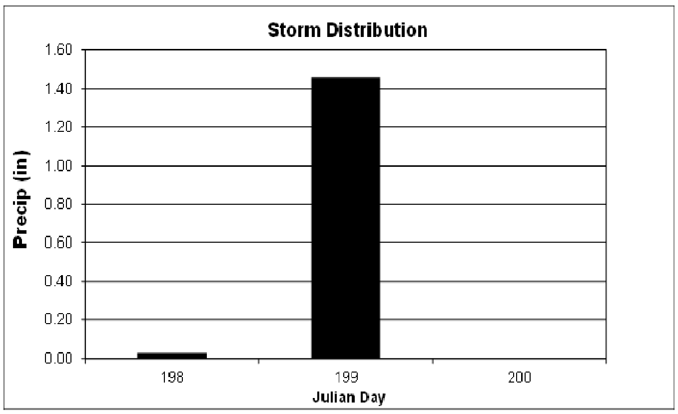
Hydrolab Continuous Monitoring
Storm 6 - 2015

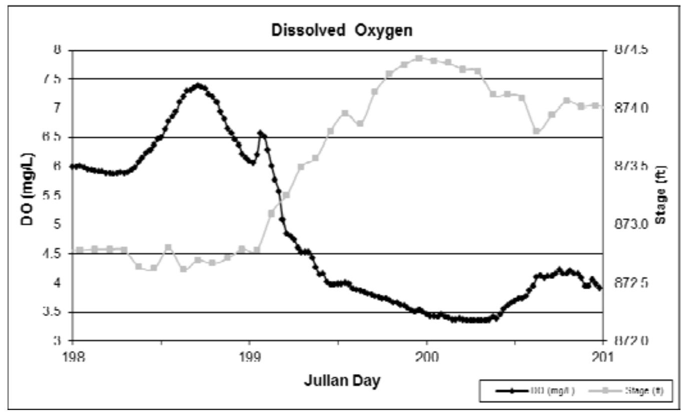
Coon Creek at Prairie Road

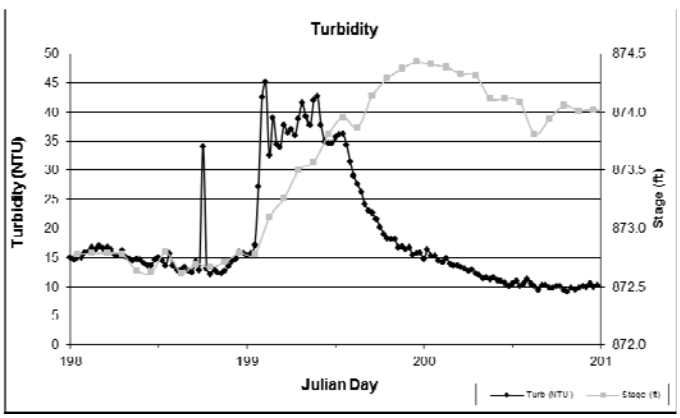
<u>Storm Summary:</u>

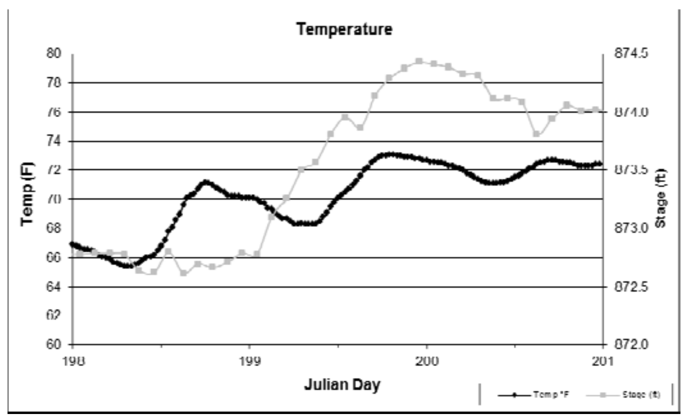
Dates: 17 July 2015 (day 198) to 19 July 2015 (day 200)

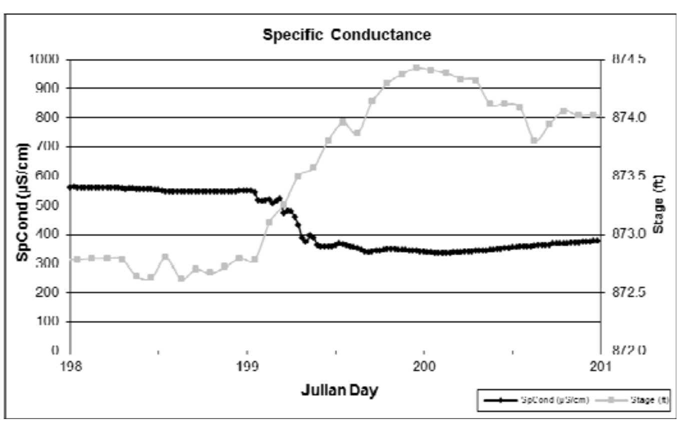
Precipitation: 1.49 inches

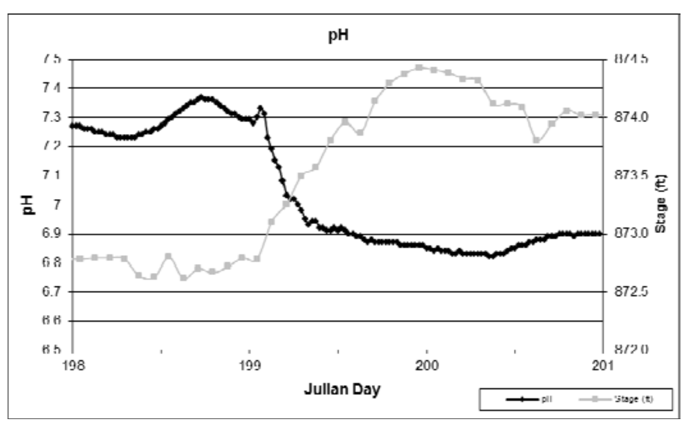






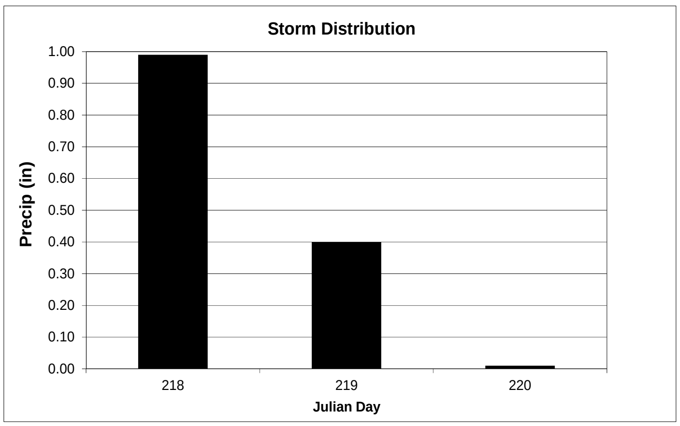


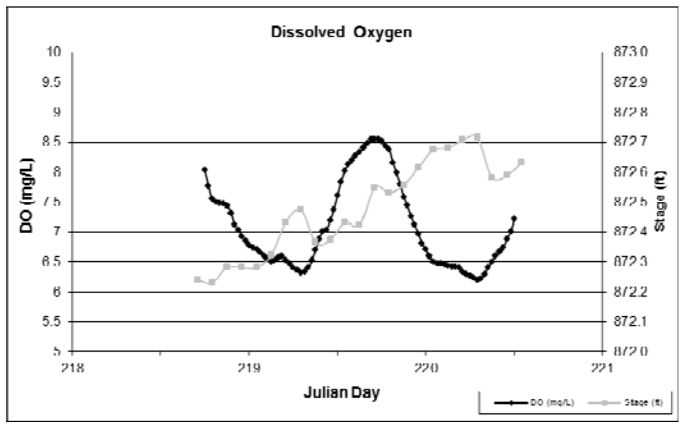


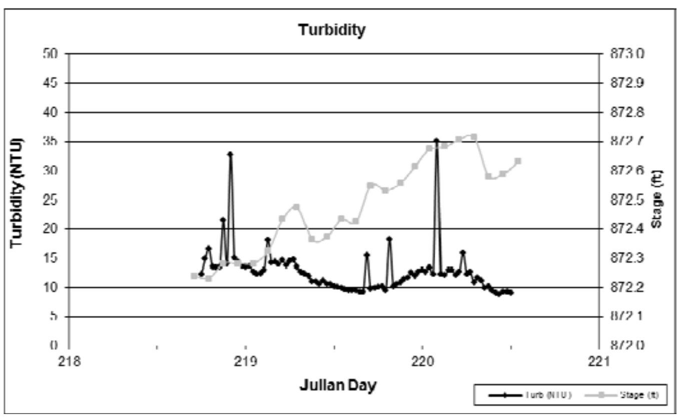


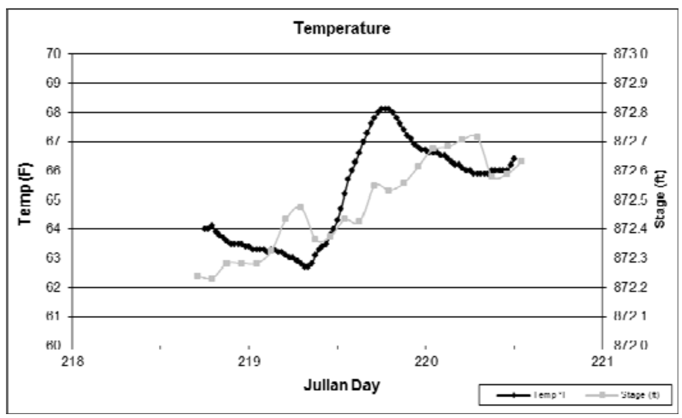
Hydrolab Continuous Monitoring
Storm 7 - 2015

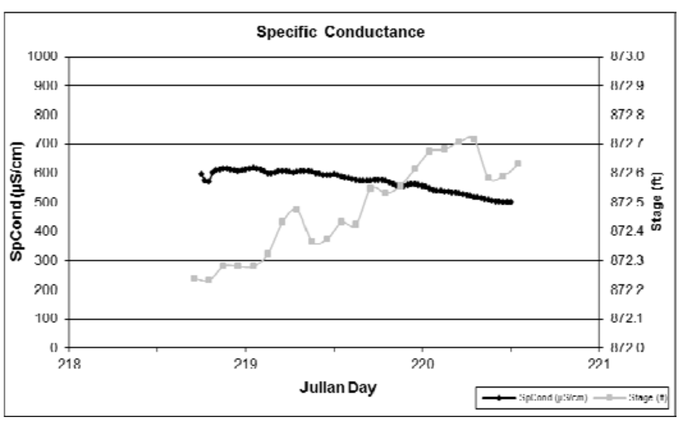
Coon Creek at Prairie Road
<u>Storm Summary:</u>
Dates: 6 August 2015 (day 218) to 8 August 2015 (day 220)
Precipitation: 1.39 inches

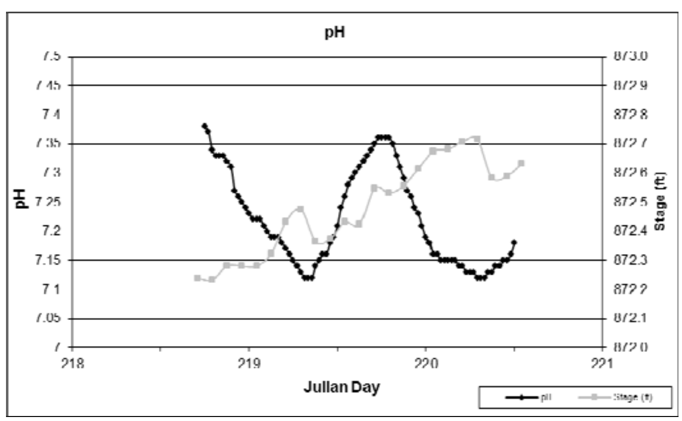










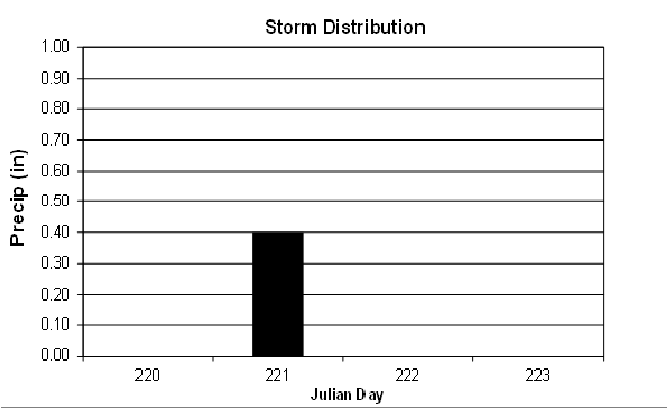


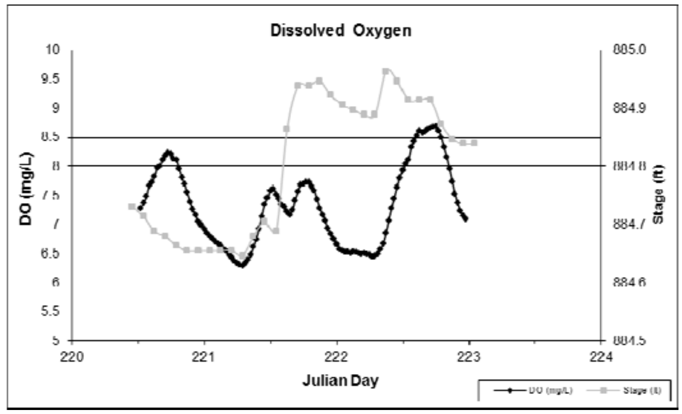
Hydrolab Continuous Monitoring
Storm 8 - 2015

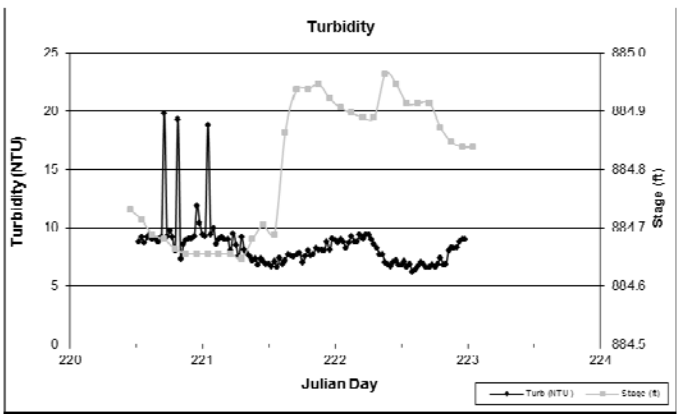
Coon Creek at Prairie Road

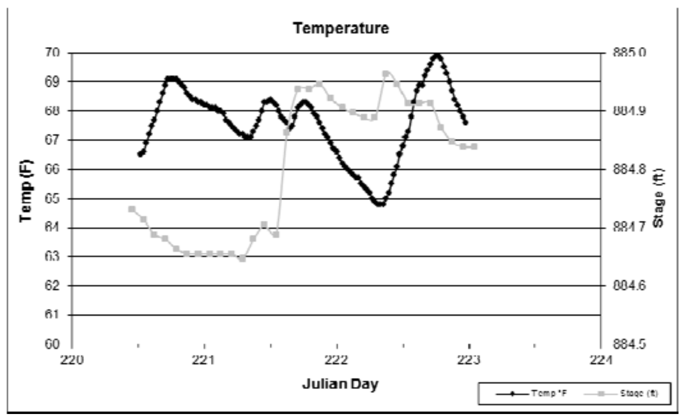
Storm Summary:

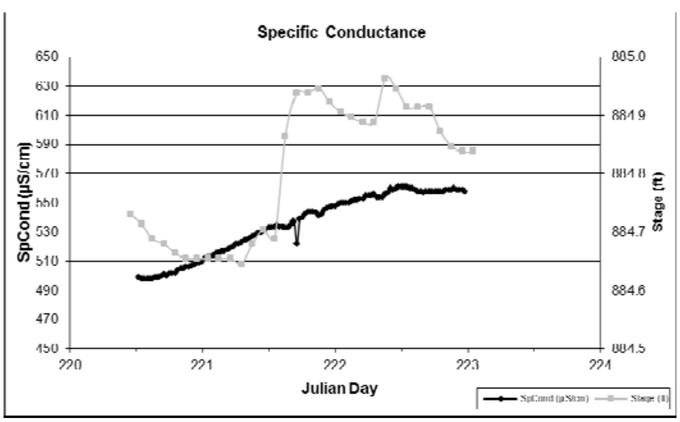
Dates: 8 August 2015 (day 220) to 10 August 2015 (day 222)
Precipitation: 0.41 inches

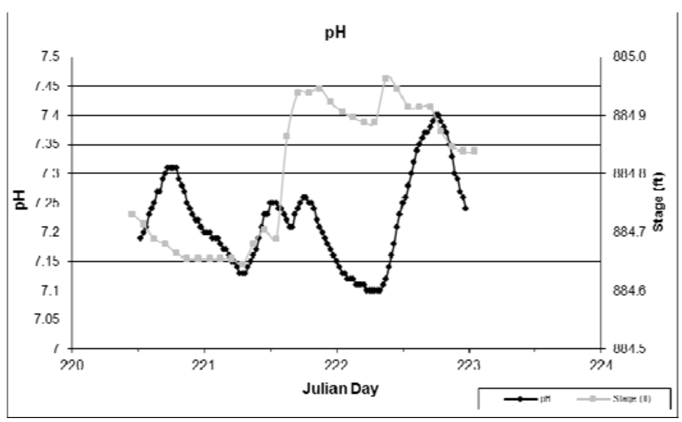












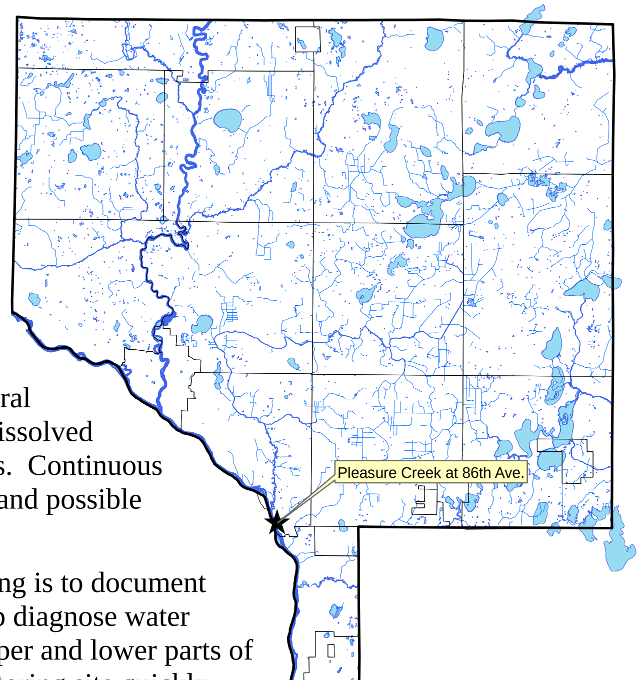
Hydrolab Continuous Stream Water Quality Monitoring

PLEASURE CREEK

Pleasure Creek at 86th, Coon Rapids   STORET SiteID = S003-993

Years Monitored

Pleasure Creek at 86th Avenue   2013, 2014, 2015



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.

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 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 a storm. This should help diagnose water quality problems and analyze differences in runoff from upper and lower parts of the watershed. Runoff from 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 would occur during high flow. This site has been used for past monitoring efforts.

Hydrolab MS5 casing (taller) and a Measura 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 a 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 Hydrolab 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 before, during, and after all Hydrolab monitoring. A Measura WM-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, which is approximately 2 miles northeast 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 0.34 to 1.53 inches. The wide distribution is helpful in discerning the creek's response to different events.

The discussion below incorporates results from 2015 Hydrolab monitoring. 2013 was the first season of Hydrolab 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.

<u>Turbidity</u>

- 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 or less. 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 900+ 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 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 fish species begin to suffer.
- When stream levels rise, dissolved oxygen often drops, but 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 is commonly above the desired range of 6.5 to 8.5 that is specified in state water quality standards.

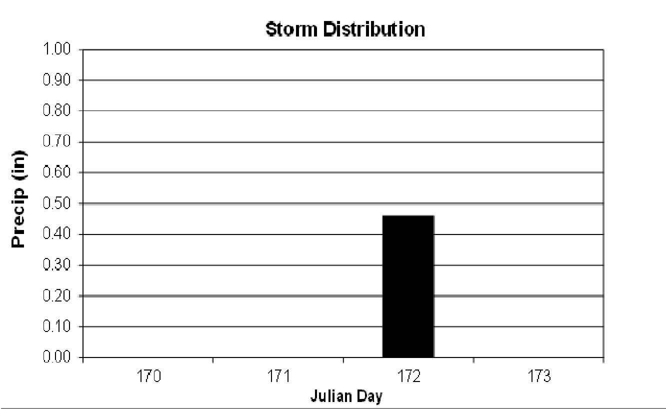
Hydrolab Continuous Monitoring
Storm 1 - 2015

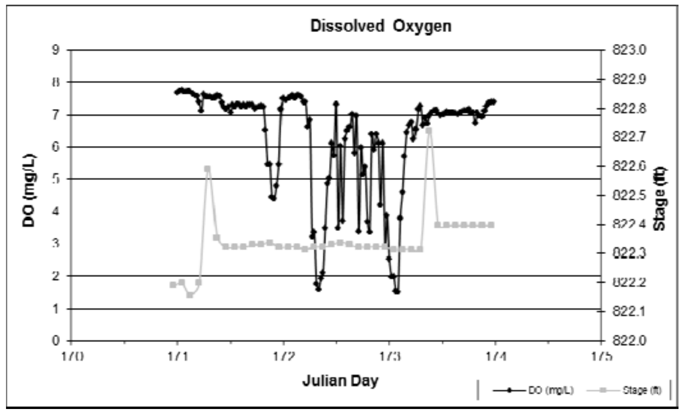
Pleasure Creek at 86th Ave

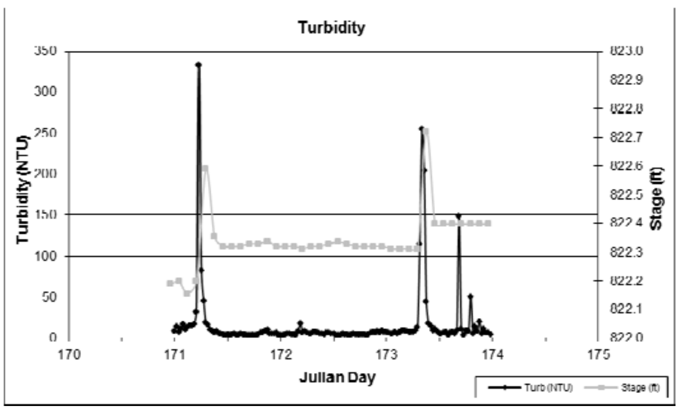
<u>Storm Summary:</u>

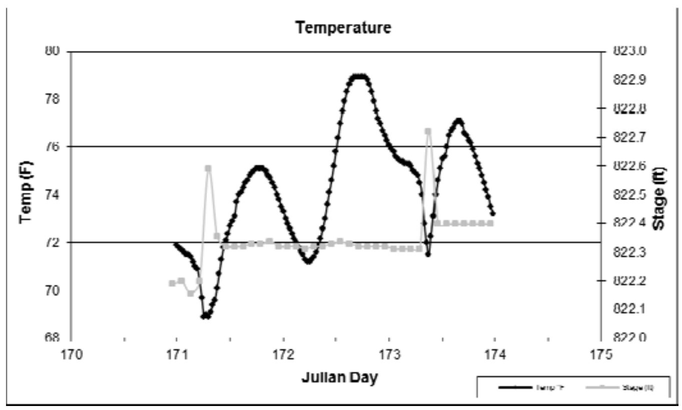
Dates: 20 June 2015 (day 171) to 22 June 2015 (day 173)

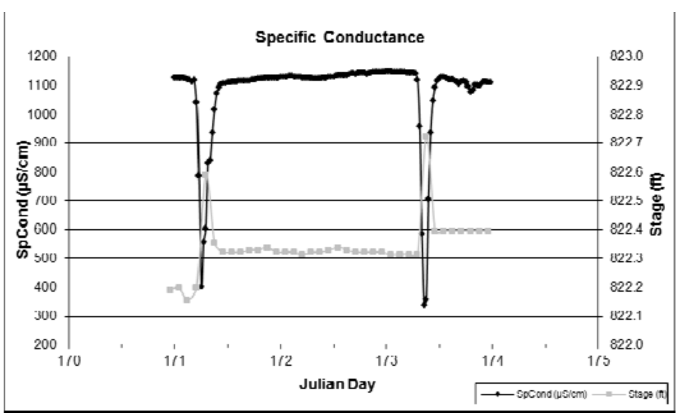
Precipitation: 0.44 inches

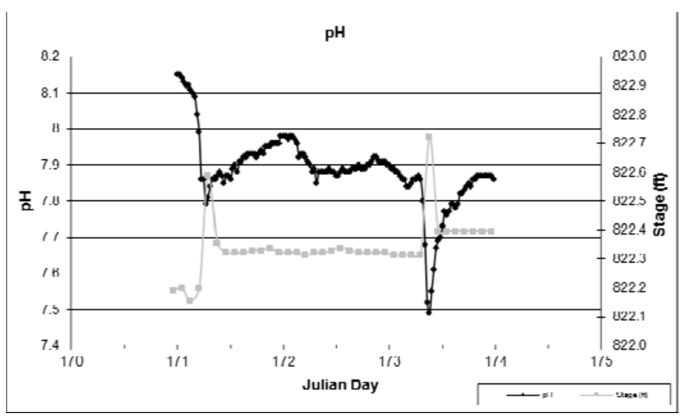












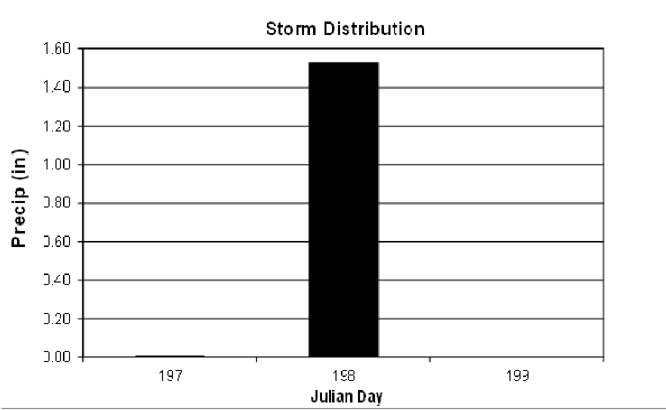
Hydrolab Continuous Monitoring
Storm 2 - 2015

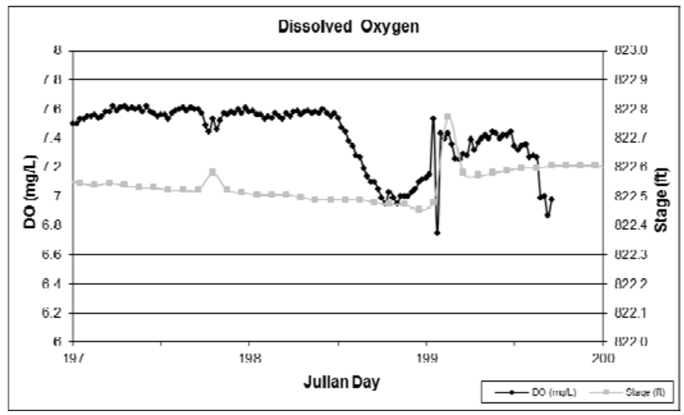
Pleasure Creek at 86th Ave

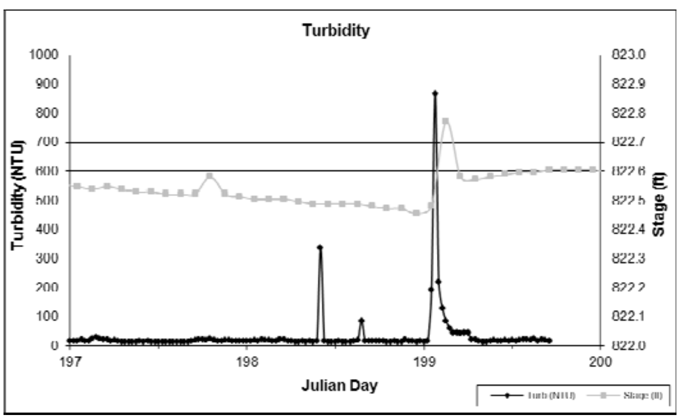
<u>Storm Summary:</u>

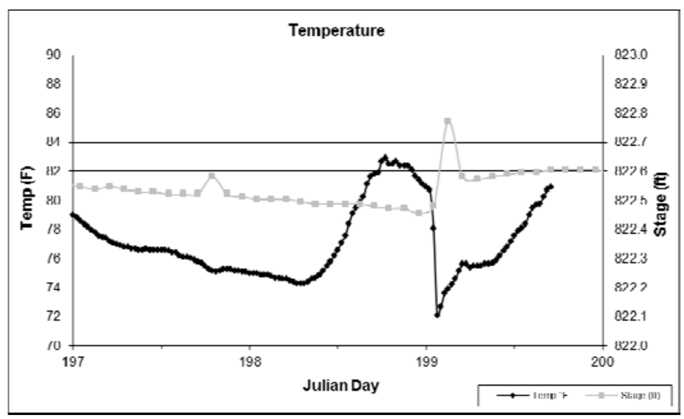
Dates: 16 July 2015 (day 197) to 18 July 2015 (day 199)

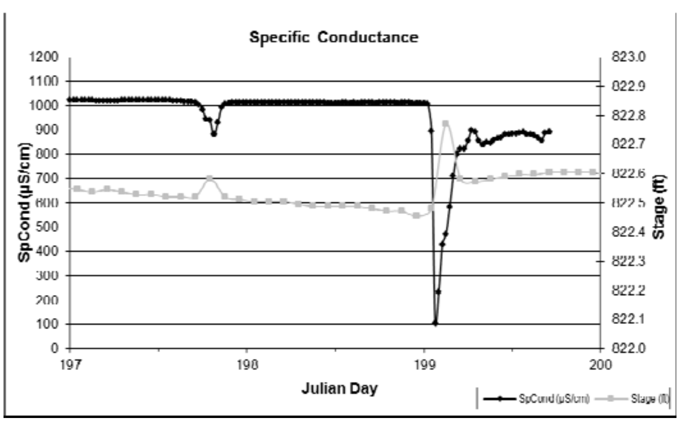
Precipitation: 1.53 inches

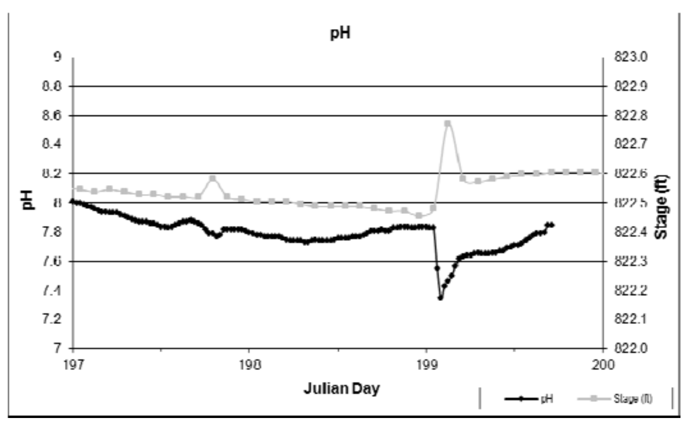






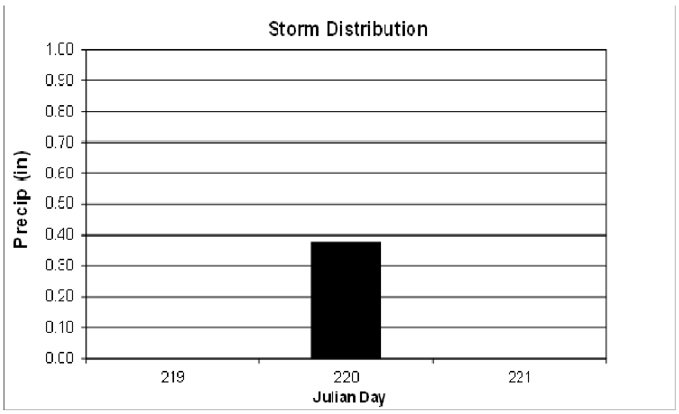


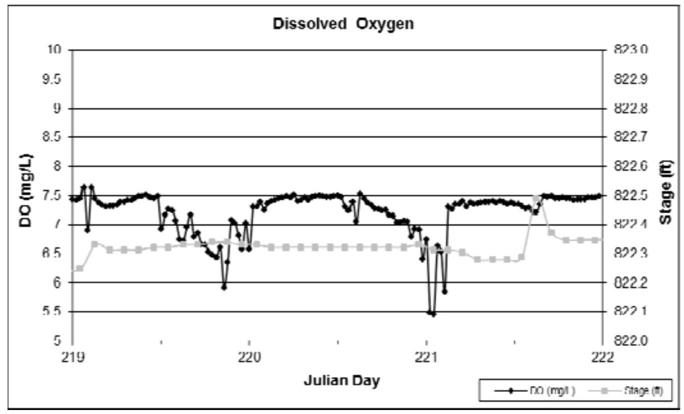


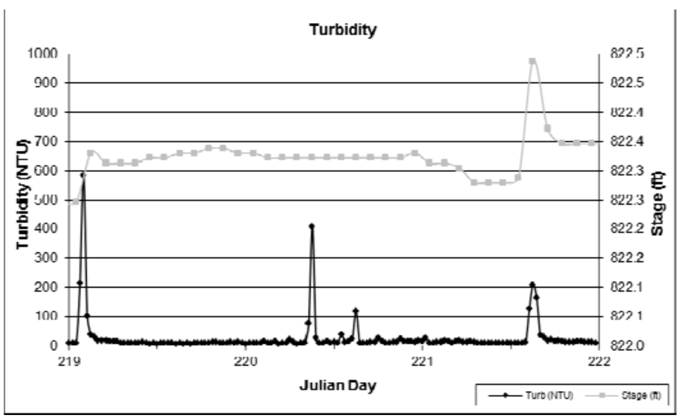


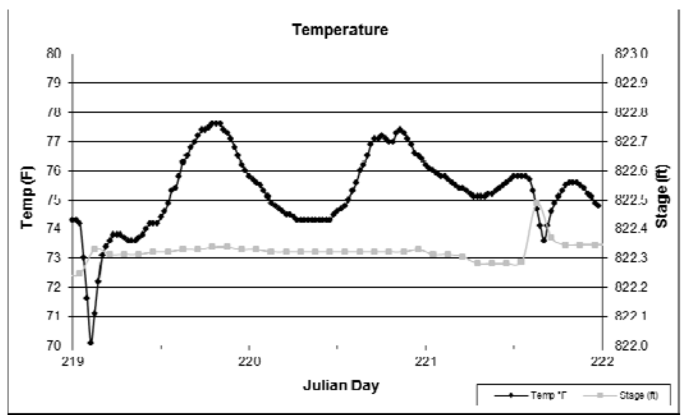
Hydrolab Continuous Monitoring
Storm 3 - 2015

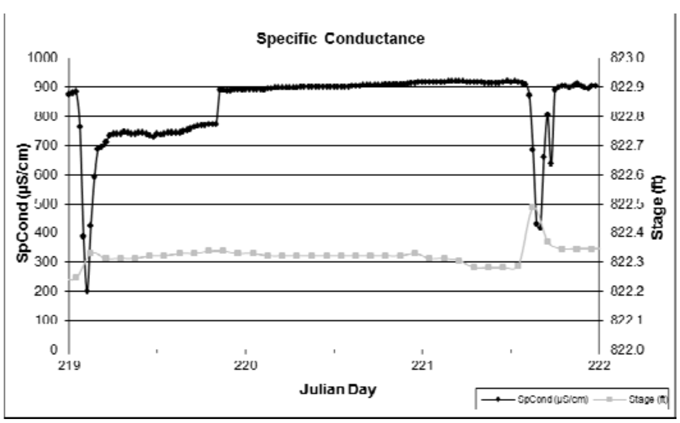
Pleasure Creek at 86th Ave
<u>Storm Summary:</u>
Dates: 7 August 2015 (day 219) to 9 August 2015 (day 221)
Precipitation: 0.38 inches

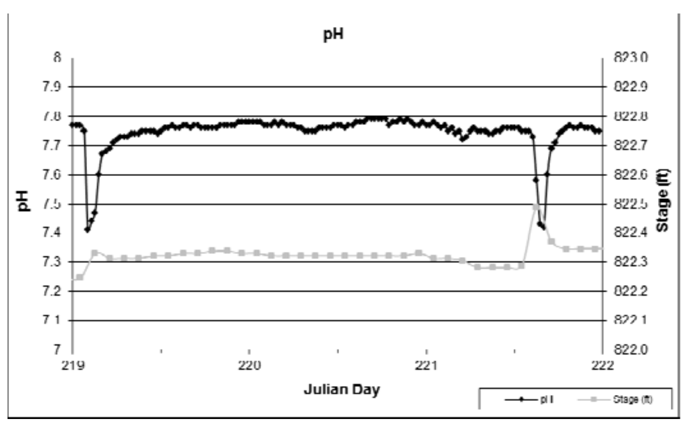












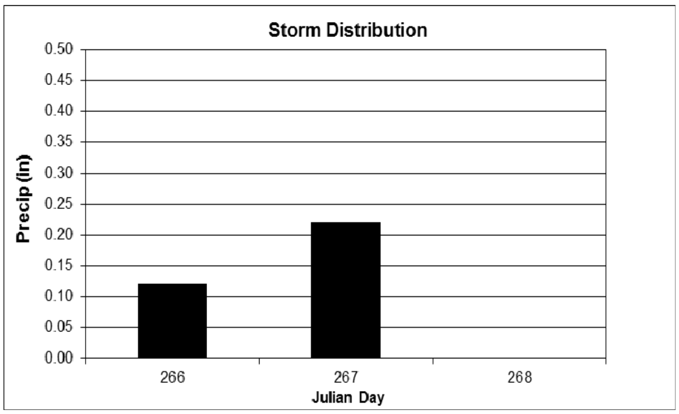
Hydrolab Continuous Monitoring
Storm 4 - 2015

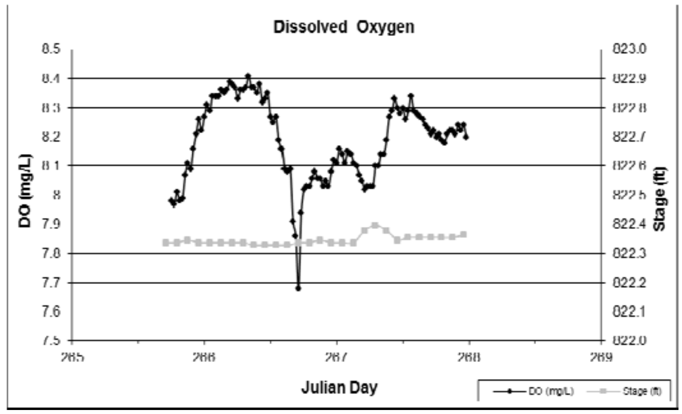
Pleasure Creek at 86th Ave

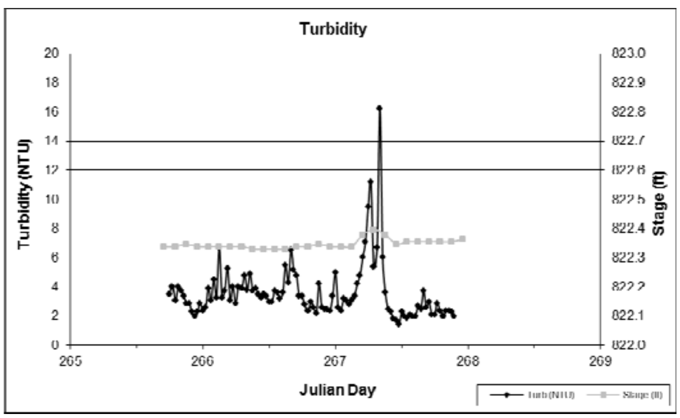
Storm Summary:

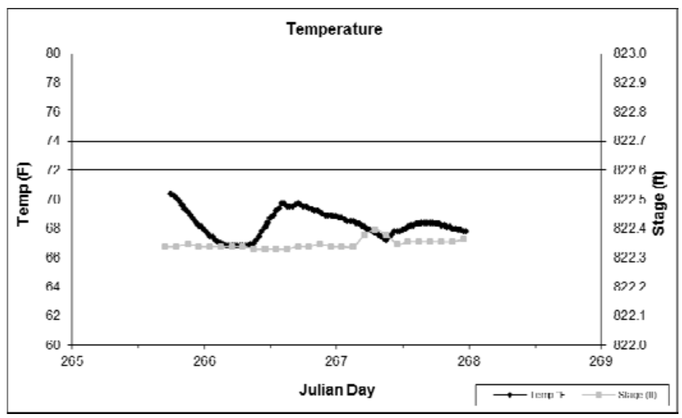
Dates: 22 September 2015 (day 265) to 24 September 2015 (day 267)

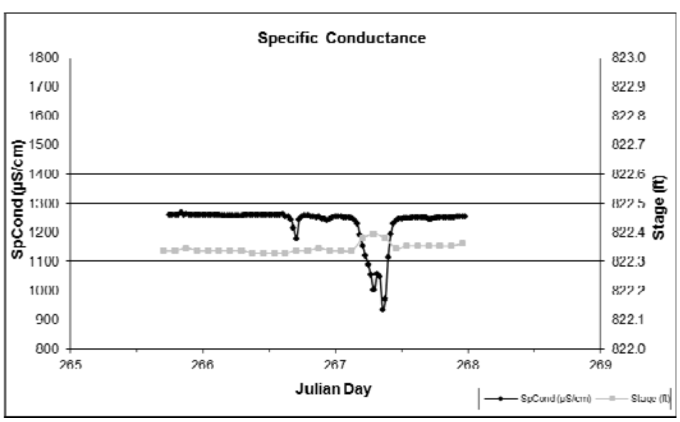
Precipitation: 0.34 inches

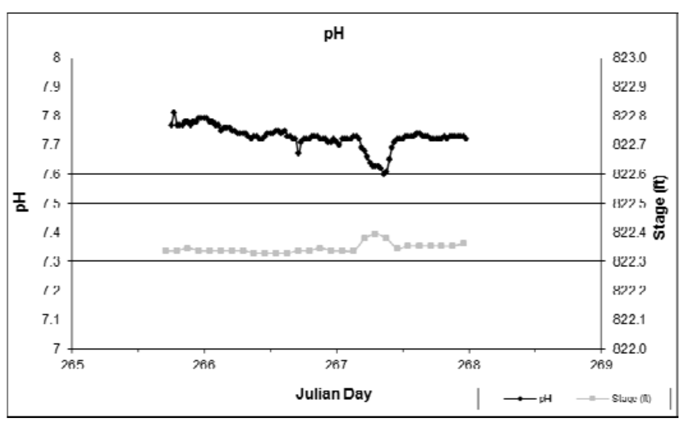












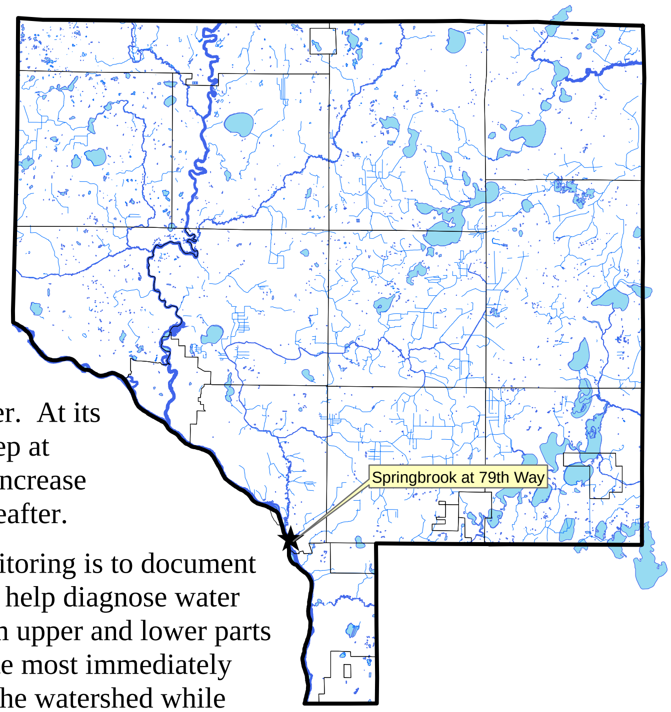
Hydrolab Continuous Stream Water Quality Monitoring

SPRINGBROOK

Springbrook at 79th, Coon Rapids   STORET SiteID = S003-993

Years Monitored

Springbrook at 79th Way   2013, 2014, 2015



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 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

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 limited due to backwater influences from the Mississippi River can occur 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 a 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 a Measura continuous water level monitoring device I Springbrook Creek.

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. 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 before, during, and after all Hydrolab monitoring. A Measura 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, which is approximately 2 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 0.44 to 1.09 inches. The wide distribution is helpful in discerning the creek's response to different events.

The discussion below incorporates results from 2015 Hydrolab monitoring. 2013 was the first season of Hydrolab 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.

Turbidity

- For most storms there is a brief, large turbidity spike during or immediately following rainfall. For small rain events less than 0.1 the change in stream turbidity was minimal or unnoticeable. For larger storms turbidity immediately rose sharply through stream water levels changed only modestly. Turbidity typically retreated to lower levels within hours or less. 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 250+ 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.

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 concentrations in Springbrook stayed well within the healthy, desirable range.
- Dissolved oxygen stayed above 5 mg/L, the state water quality standard, in all events monitored. Below this level some fish species begin to suffer.
- When stream levels rise, dissolved oxygen often drops to low levels.

Temperature

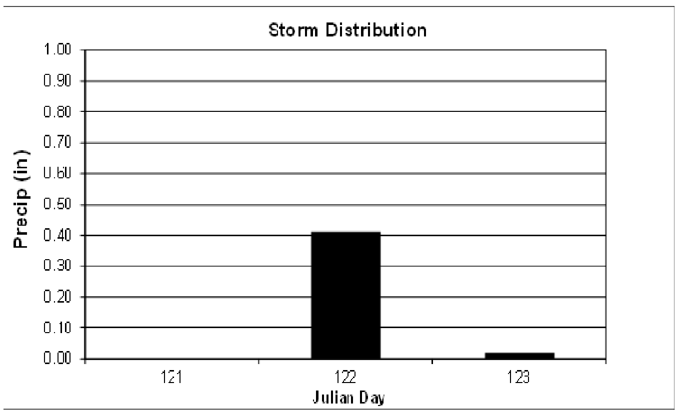
- Water temperature is generally not considered a concern in Springbrook Creek because there is no trout or other temperature sensitive resource.
- Cycles of day warming and night cooling are apparent in the data.

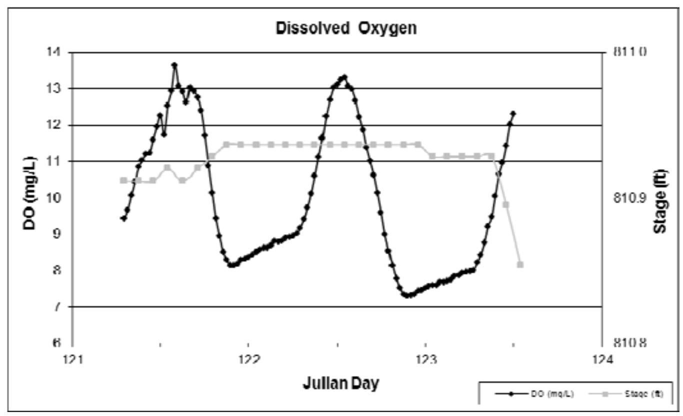
pH

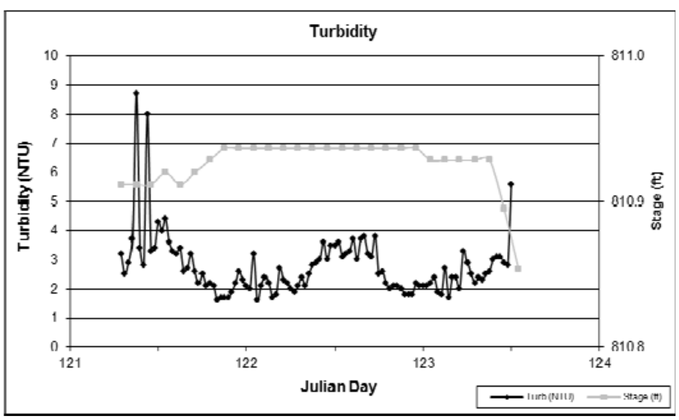
- pH is inversely related to water level in Springbrook Creek. When water level rises, pH declines. This is because rainwater has a lower pH than that of local shallow groundwater.
- pH was in the desired range of 6.5 to 8.5 that is specified in state water quality standards.

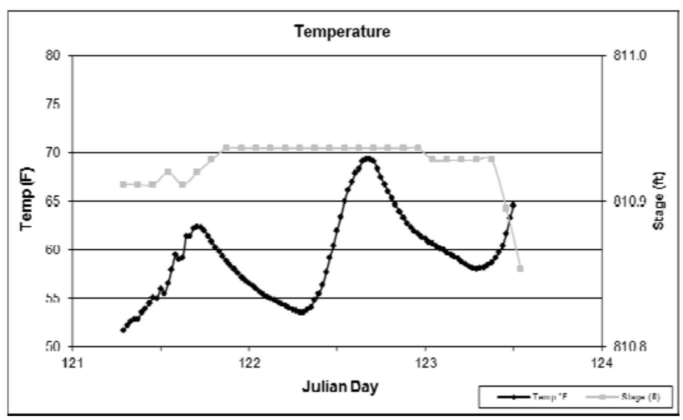
Hydrolab Continuous Monitoring
Storm 1 - 2015

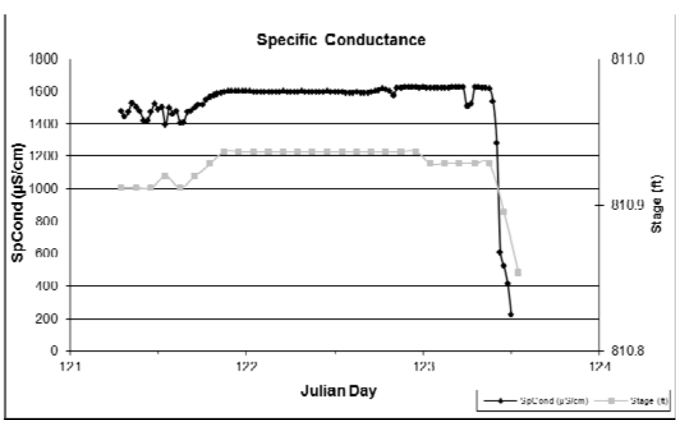
Springbrook at 79th Way
<u>Storm Summary:</u>
Dates: 1 May 2015 (day 121) to 3 May 2015 (day 123)
Precipitation: 0.44 inches

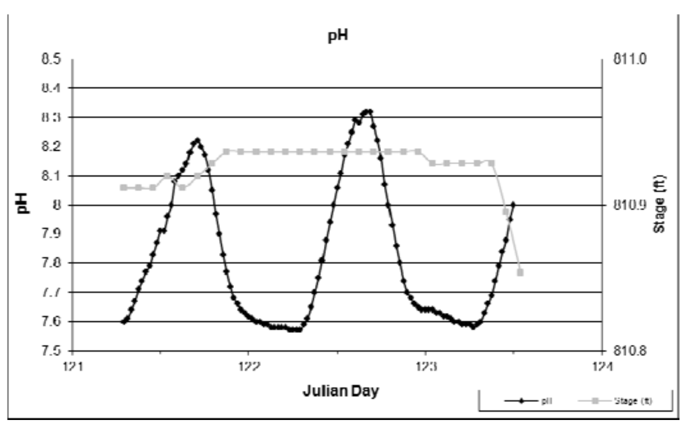












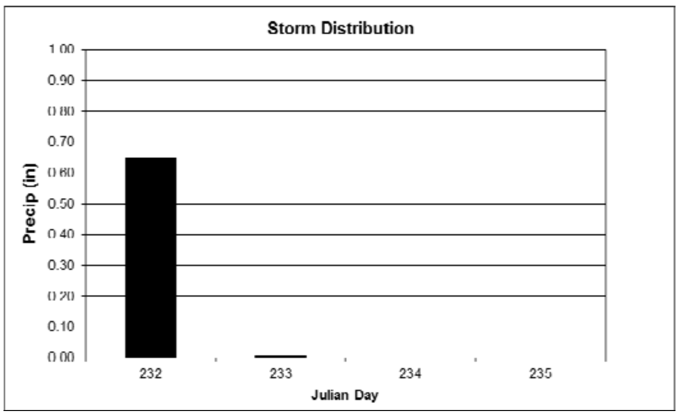
Hydrolab Continuous Monitoring
Storm 2 - 2015

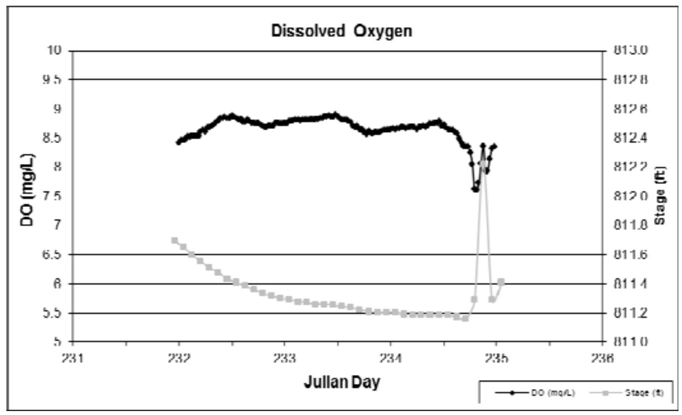
Springbrook at 79th Way

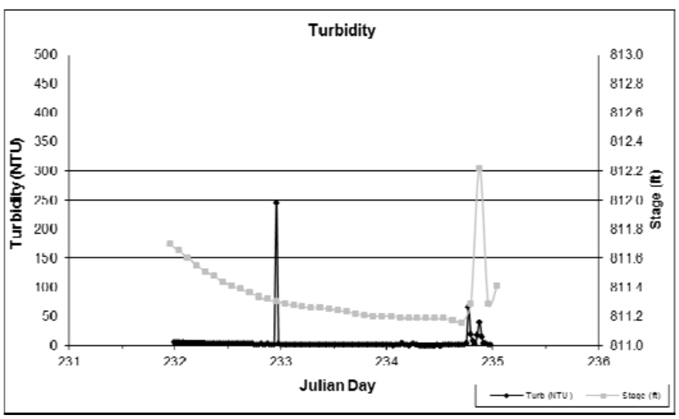
<u>Storm Summary:</u>

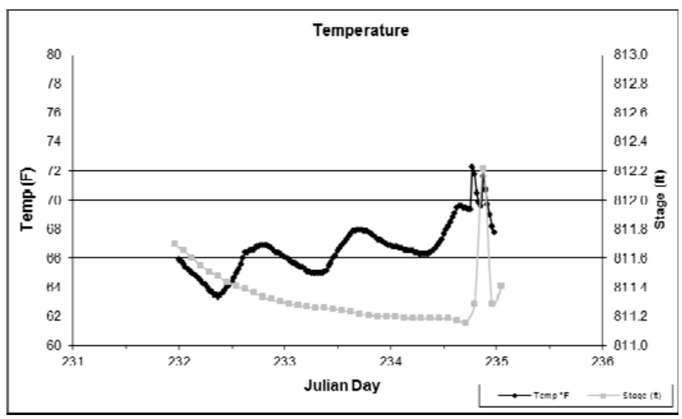
Dates: 20 August 2015 (day 232) to 23 August 2015 (day 235)

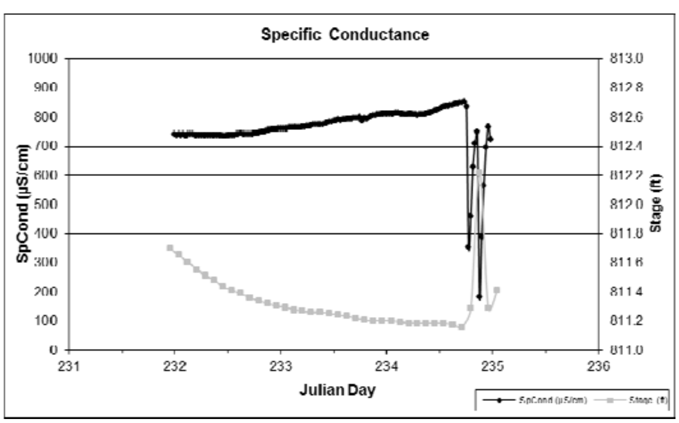
Precipitation: 0.66 inches

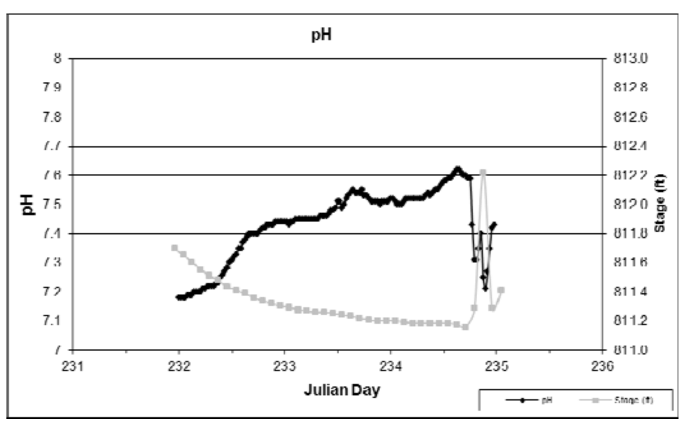












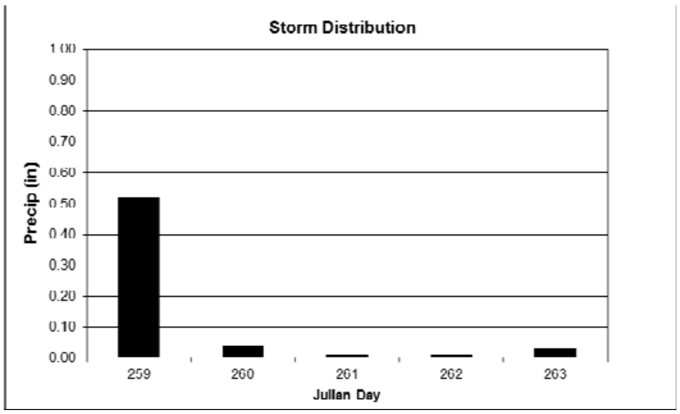
Hydrolab Continuous Monitoring
Storm 3 - 2015

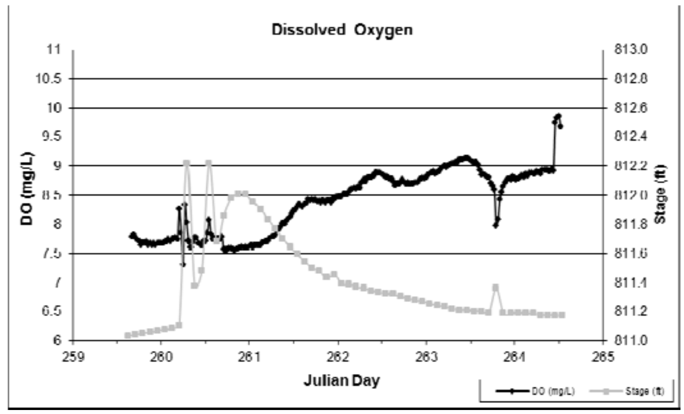
Springbrook at 79th Way

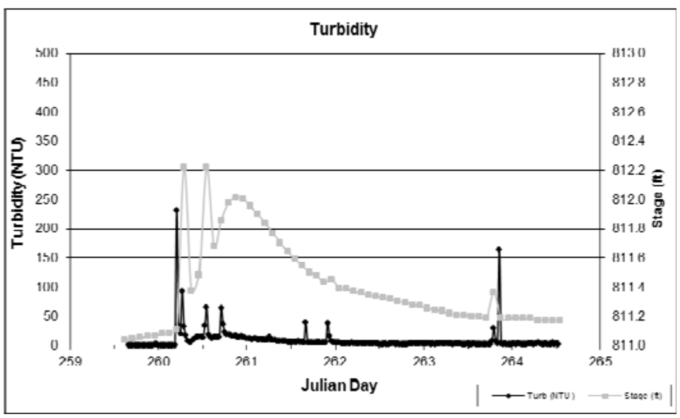
Storm Summary:

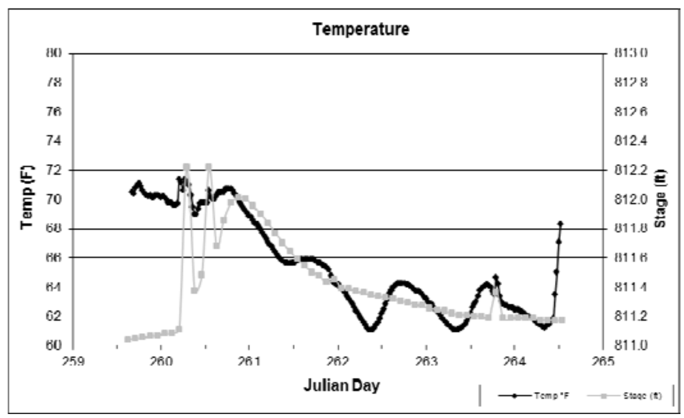
Dates: 16 September 2015 (day 259) to 21 September 2015 (day 265)

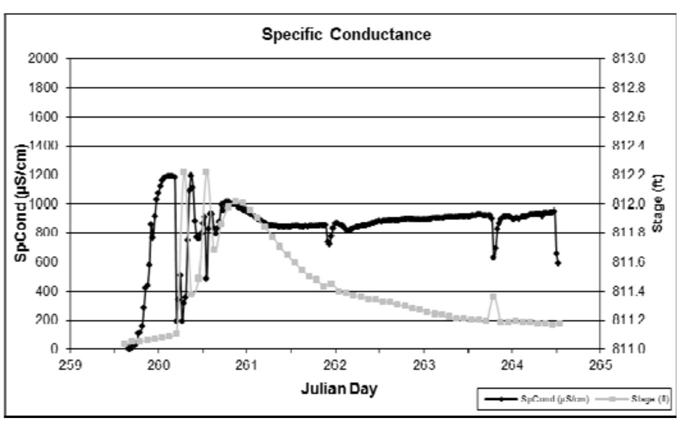
Precipitation: 0.61 inches

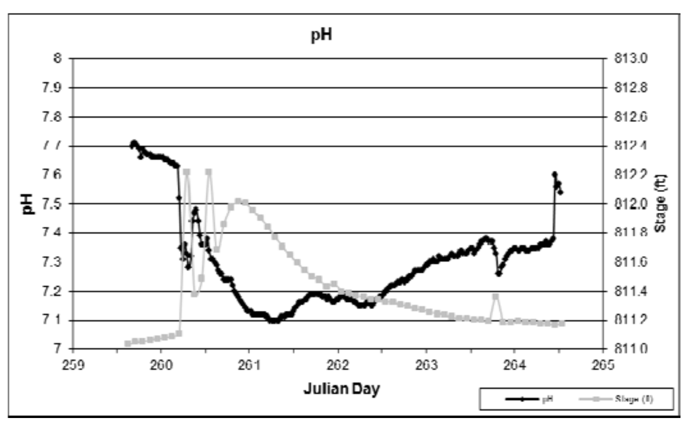












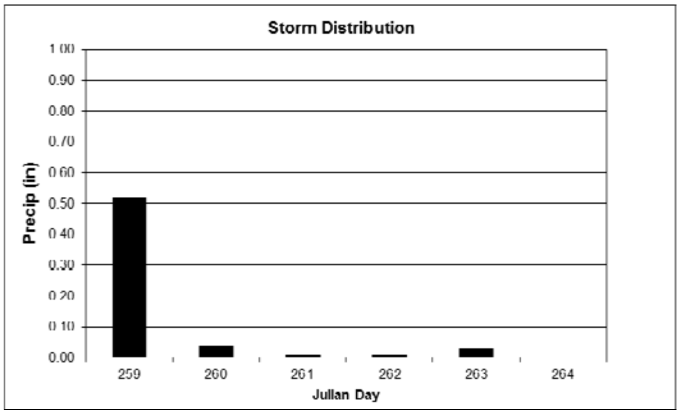
Hydrolab Continuous Monitoring
Storm 4 - 2015

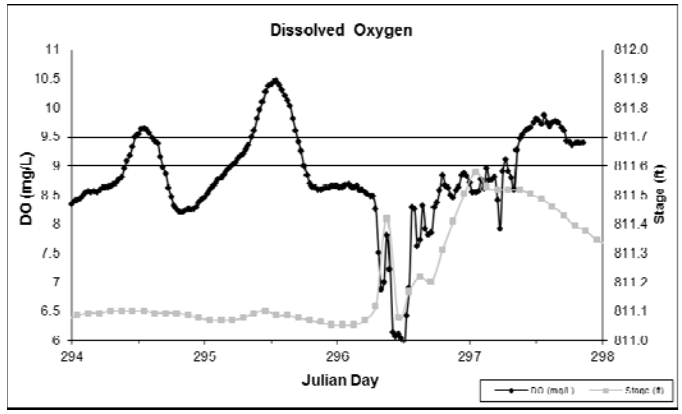
Springbrook at 79th Way

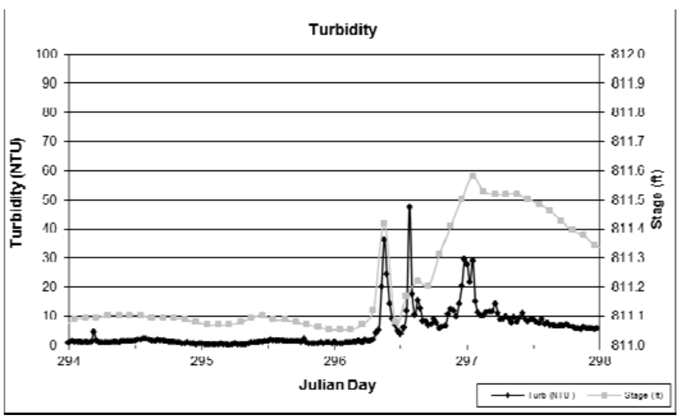
<u>Storm Summary:</u>

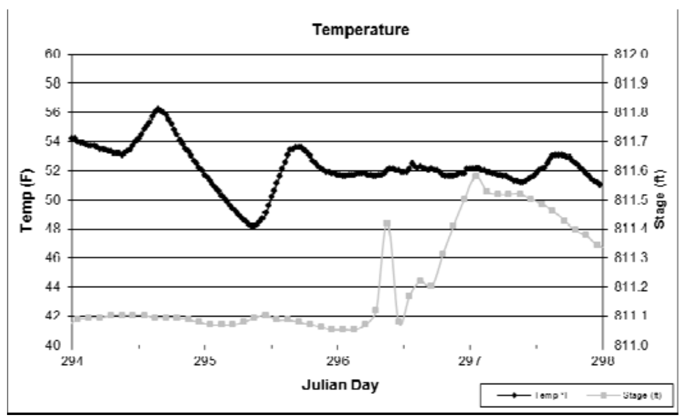
Dates: 21 October 2015 (day 294) to 24 October 2015 (day 297)

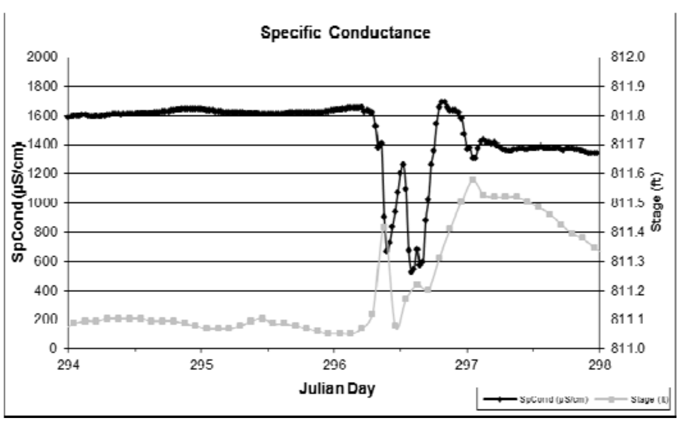
Precipitation: 1.09 inches

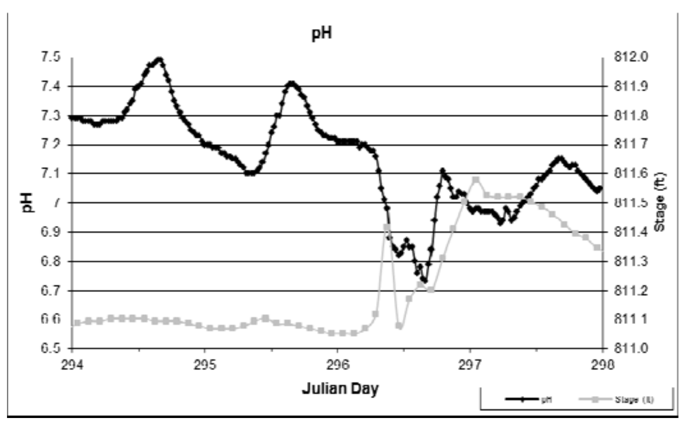












Stream Water Quality Monitoring

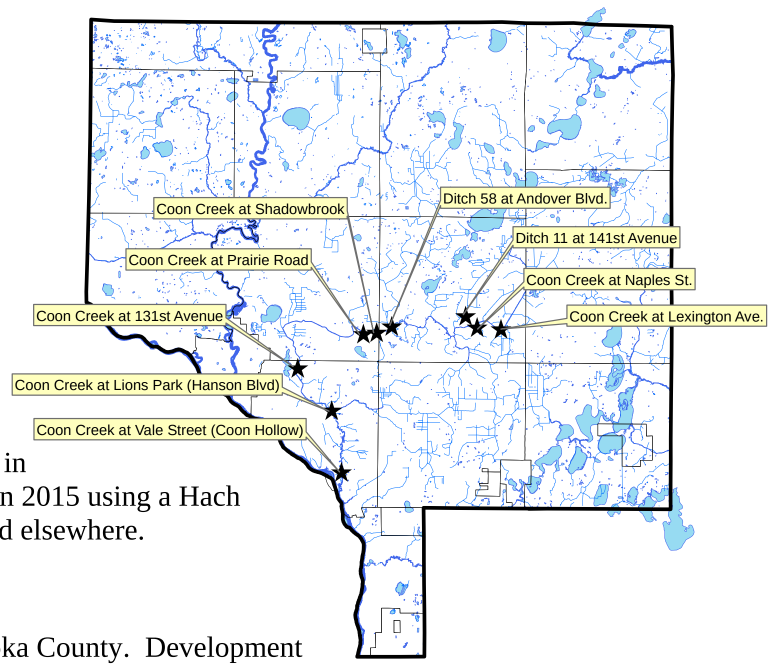
COON CREEK

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	2013-2015
Ditch 11 at 149st Ave	2013-2015
Coon Cr at Naples St	2012-2015
Ditch 58 at Andover Blvd	2013-2015
Coon Cr at Shadowbrook Townhomes	2007-2015
Coon Cr at 131st Ave	2010-2015
Coon Cr at Lions Park (Hanson Blvd)	2007-2015
Coon Cr at Vale St	2005-2015

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 in 2015 using a Hach Hydrolab and EXO YSI 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, as well as photo-documentation of water appearance. 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 a data-logging electronic gauge at various sites and data can 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. 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 generally higher 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.

  Management discussion: Phosphorus needs to be reduced in both the upper and lower watershed, though the sources are likely different.

- 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. 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 important in 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 probably 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 important in Coon Creek because much of it is ditched, and ditches generally have unstable sides, and because native soils are highly erodible. 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 were within the range considered normal and healthy for streams in this area. All measurements were in the desired range of 6.5-8.5.
- 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 used. It measures electrical conductivity of the 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 noteworthy that Coon Creek is upstream from the drinking water intakes on the Mississippi River for the Twin Cities.

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 (all sites, all conditions) was 0.621 mS/cm compared to the countywide median of 0.362 mS/cm.

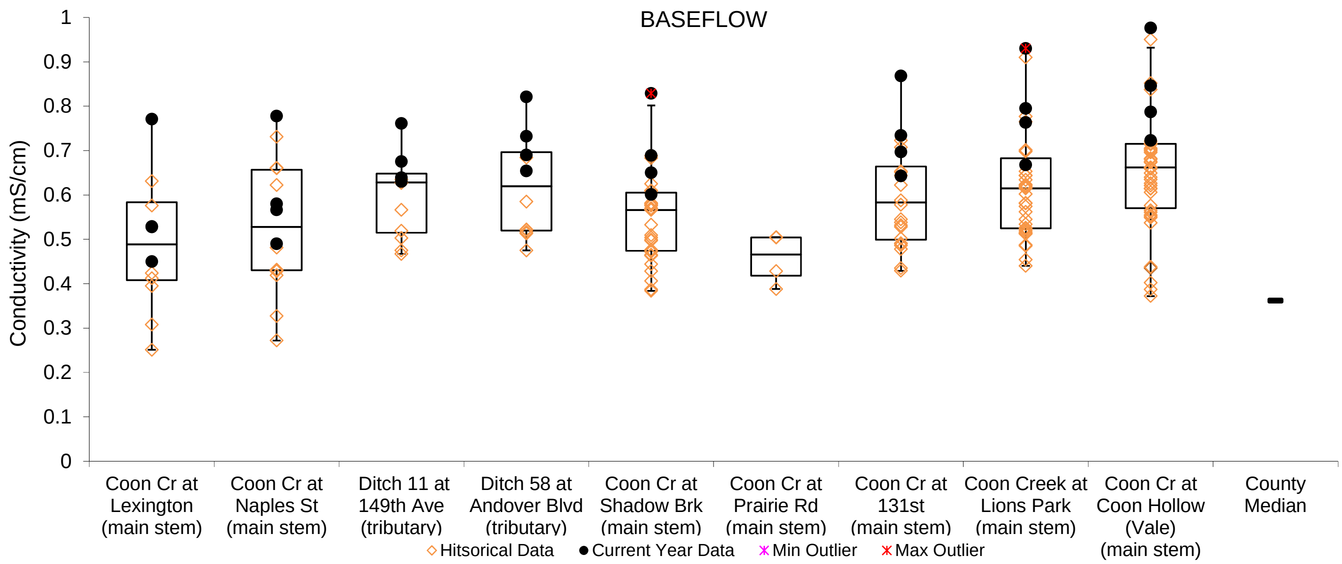
Dissolved pollutants were higher in downstream reaches of Coon Creek, where there is more impervious area (see figures below). Median conductivity (all years) increased gradually from upstream (0.489 mS/cm) to downstream (0.662 mS/cm) during baseflow. Median conductivity (all years) for storm events showed moderate to no difference between upstream and downstream conductivity ranging from 0.394 to 0.457 mS/cm.

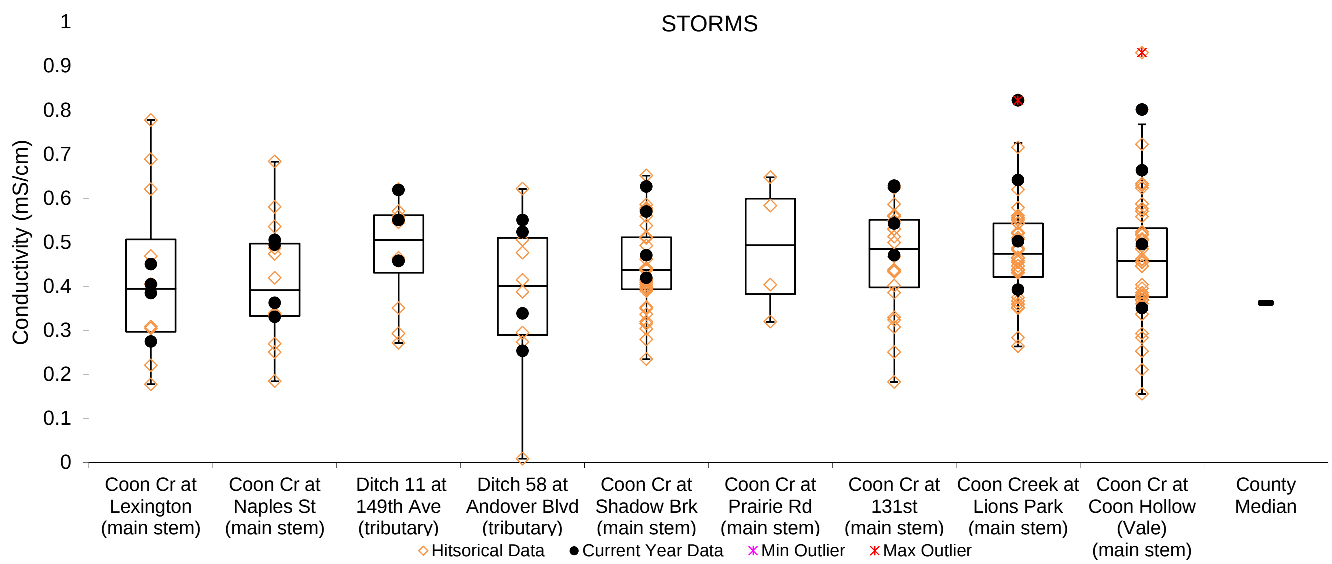
This lends some insight into the pollutant sources. If dissolved pollutants were only elevated during storms, stormwater runoff would be suspected as the primary contributor. If dissolved pollutants were highest during baseflow, pollution of the shallow groundwater which feeds the stream during baseflow 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 all years through 2015. Chlorides not monitored in 2013-2015.

	Conductivity (mS/cm)	Chlorides (mg/L)	State Standard	N
Baseflow	0.662	62	Conductivity – none	43
Storms	0.457	40	Chlorides 860 mg/L acute, 230 mg/L chronic	44
All	0.561	52		87
Occasions > state standard				0

Conductivity at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2015 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 consistently 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 2015, eight Coon Creek watershed sites were monitored (two are tributaries).

Baseflow TP was low. In 2015, during baseflow, the eight monitoring sites had median TP of 34.5, 51, 114, 52.5, 59, 68.5, 75.5, and 77 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 16 of 40 measurements at the Vale Street site have been above100 ug/L. There was little variability among baseflow samples.

TP was higher at upstream sites than downstream during storms. Median storm TP, upstream to downstream, in 2015 were 162, 217.5, 395, 168.5, 186.5, 173.5, 134, and 129 ug/L, respectively.

TP at all downstream sites regularly exceeded the state standard of100 ug/L. At Vale Street only three of 44 TP measurements during storms have been lower than100 ug/L. The maximum observed was 672ug/L.

In addition to monitoring sites on the main stem of Coon Creek, two tributaries were also monitored in 2013-2015 Ditch 11 and Ditch 58. Median TP for both baseflow and storms were generally higher than those observed on the main stem of the creek. In 2015 median TP for baseflow was 114 and 52.5 ug/L, respectively. Median TP during storm events in 2015 was 544 and 317.5 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 may be an important phosphorus source, and stormwater runoff to a lesser degree. Drained, organic wetland soils may be another source; many ditch tributaries exist. Downstream parts of the watershed are fully developed and some were 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.

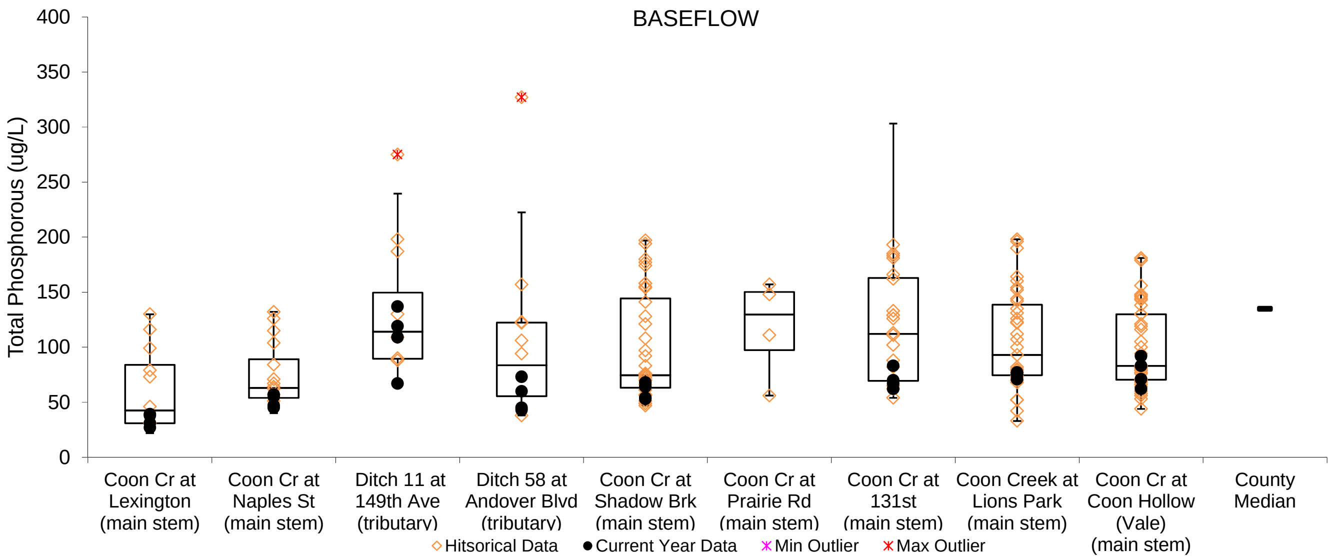
Phosphorus reduction needs to occur throughout the watershed. The highest priority should be addressing phosphorus from urban stormwater runoff in the lower portion of the watershed. This is the area with the highest TP. Also, this is the area with the highest levels of other pollutants, such as total suspended solids. Improvements to stormwater treatment in this area could address multiple problems.

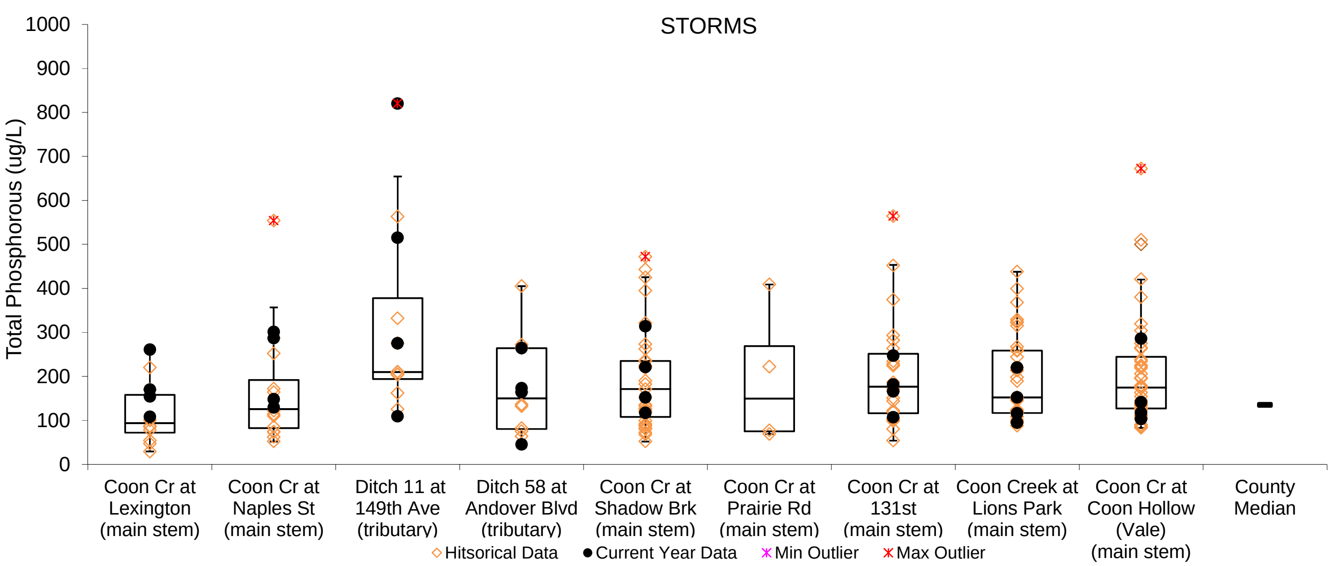
Median total phosphorus in Coon Creek. Data is from Vale St for all years through 2015.

	Total Phosphorus (ug/L)	State Standard*	N
Baseflow	83	100	43
Storms	174.5		44
All	128		87
Occasions > state standard			57 (41 storms, 16 baseflow)

*New state standards are under development. The standard listed is the likely new threshold.

Total Phosphorus at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2015 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 sometimes exceeds state water quality standard.

During baseflow turbidity and TSS were reasonably low and showed slight upstream to downstream increase. Median turbidity (all sites, all years) during baseflow from upstream to downstream were 5.75, 9.15, 2.1, 6.85, 8.75, 9.15, 12, 10.7, and 12 NTU, respectively. This is similar to the countywide median of 8.5 NTU. Median TSS (all sites, all years) during baseflow from upstream to downstream were 3, 5, 5, 3, 6, 4.5, 6.5, 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 43 (2%) of 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 approximately 1.5 to 6.8 times higher than during baseflow (comparison is among site medians). Median TSS during storms (all sites, all years) were 8.5, 10, 9, 6, 13, 30.5, 19, 21, and 34 mg/L from upstream to downstream. Median turbidity during storms (all sites, all years) were 13.8, 19.9, 13.55, 20.1, 18, 15, 34.5, 28.5, and 31.45 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.

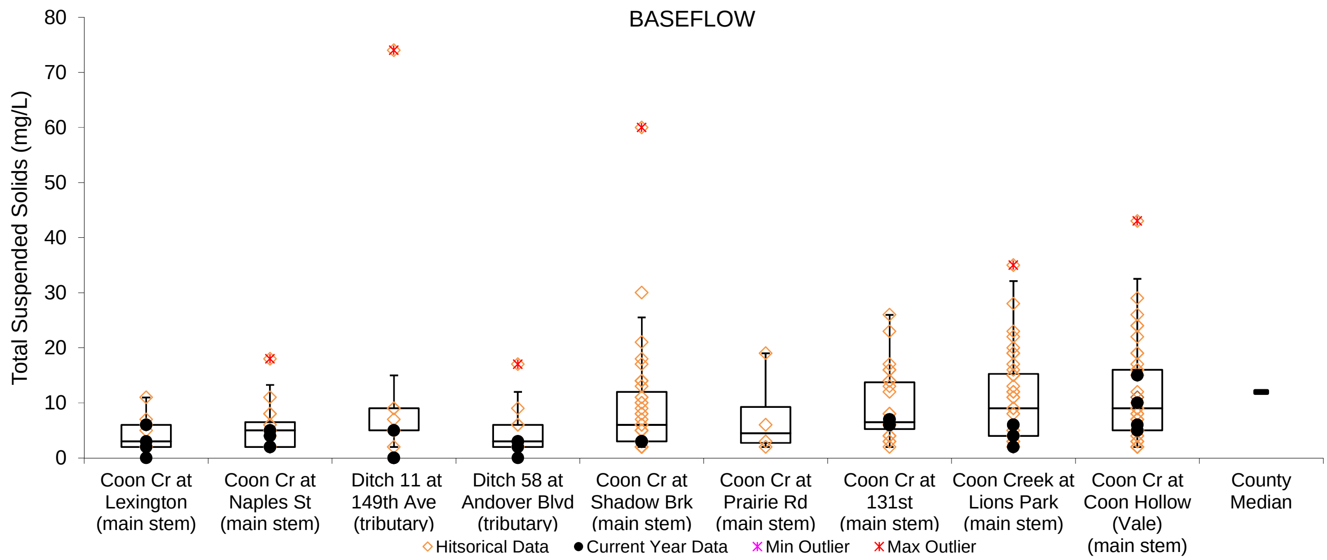
Research should be done to determine the extent to which bed load transport of sediment is contributing to high turbidity and TSS. Presently, it appears that it has the potential to be important. High suspended solids in the upper watershed, where land uses are rural residential and sod fields is surprising, 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.

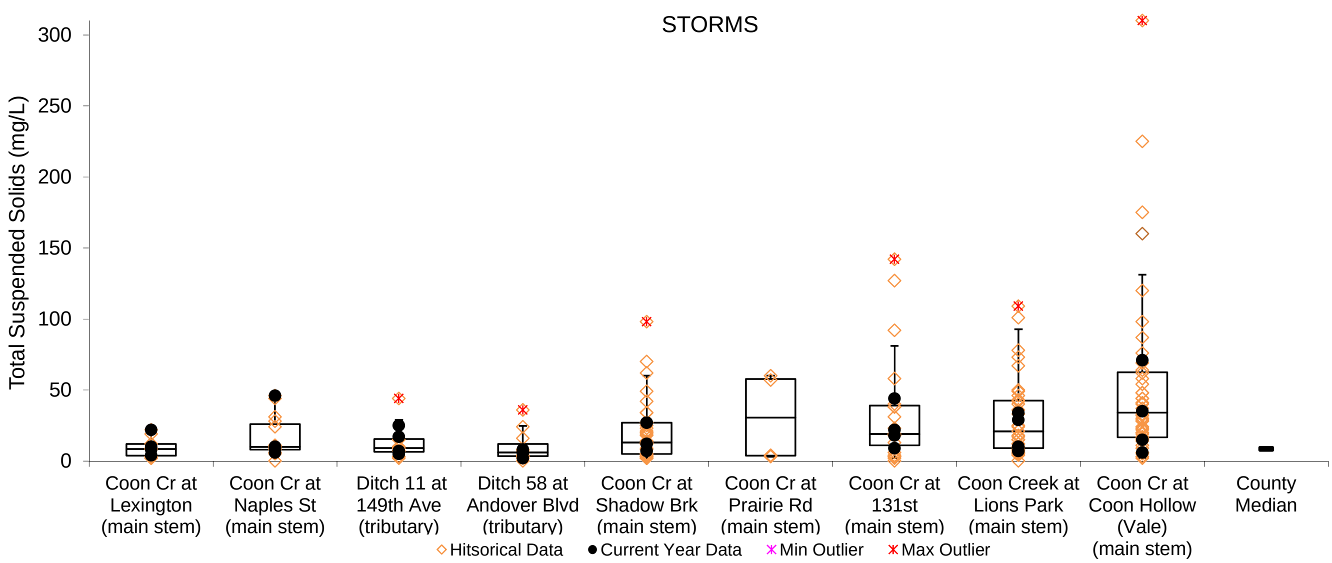
Median turbidity and suspended solids in Coon Creek. Data is from Vale St for all years through 2015.

	Turbidity (NTU)	Total Suspended Solids (mg/L)	State Standard*	N
Baseflow	12	9	30 mg/L TSS	43
Storms	31.5	34		44
All	20	16		87
Occasions > new state TSS standard				25

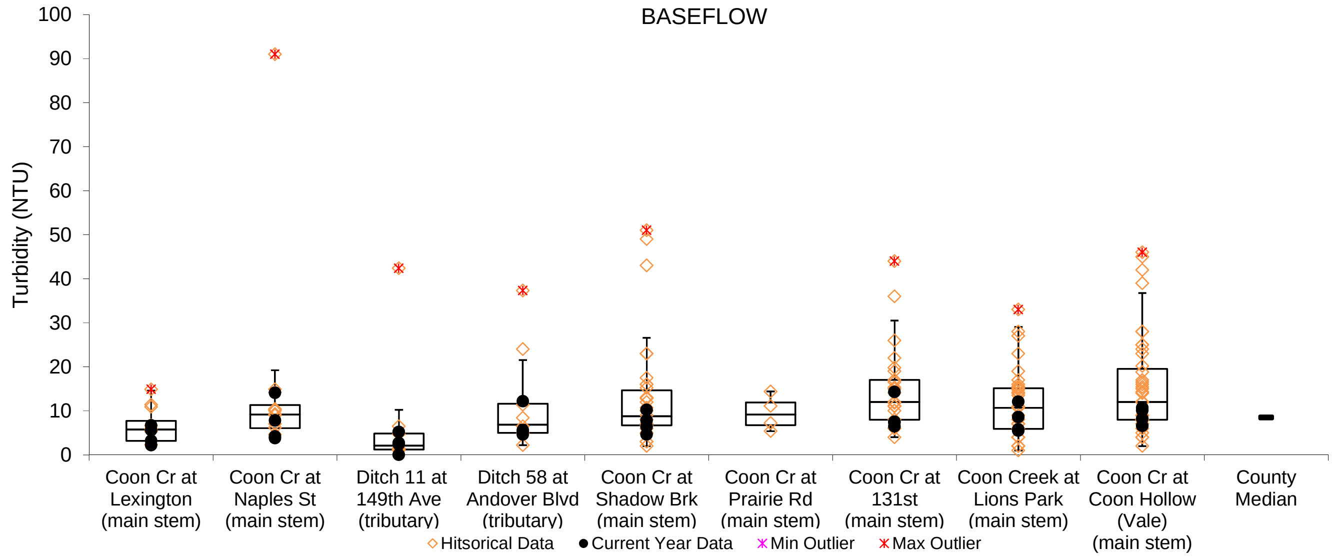
*New state standards are under development. The standard listed is the likely new threshold.

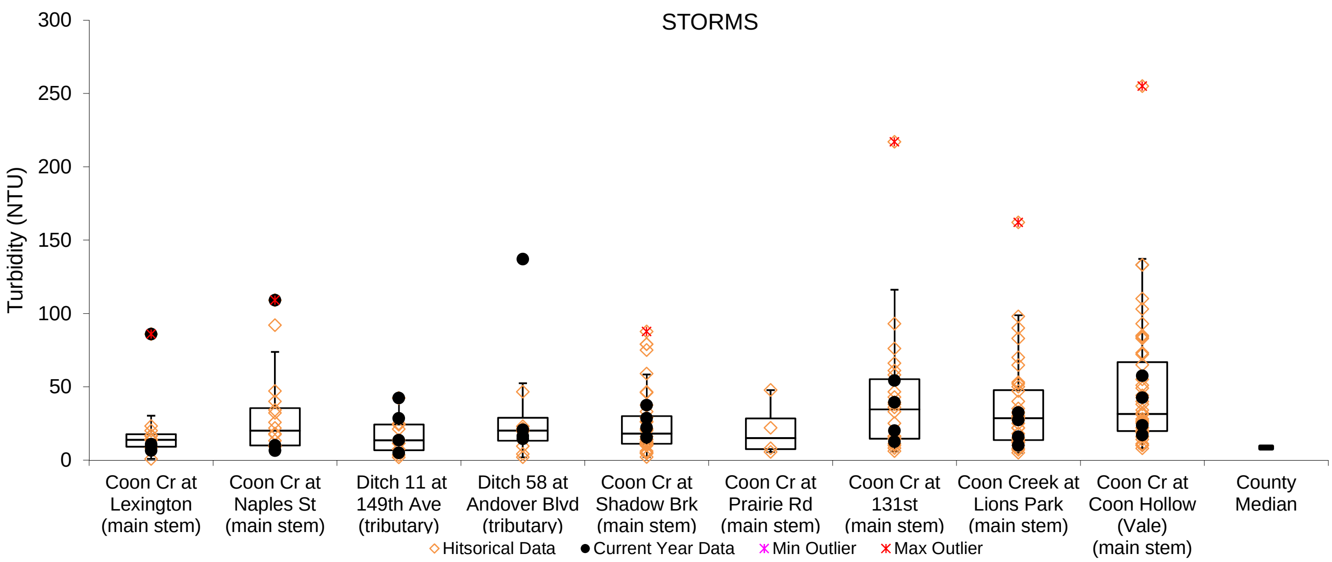
Total Suspended Solids at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





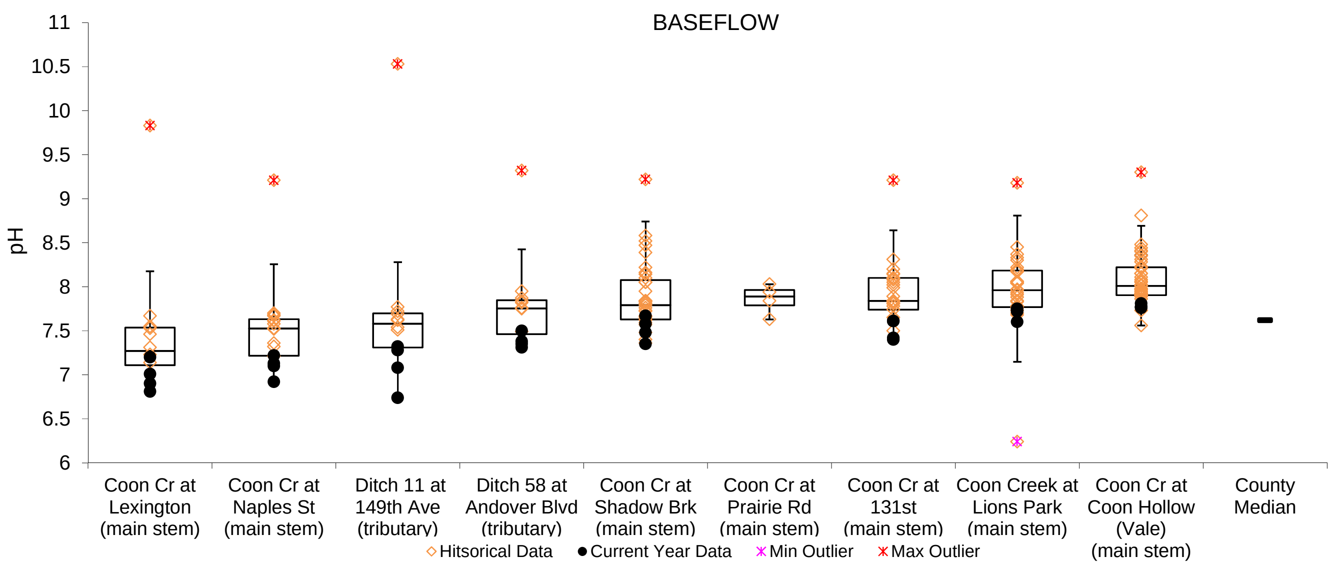
pH

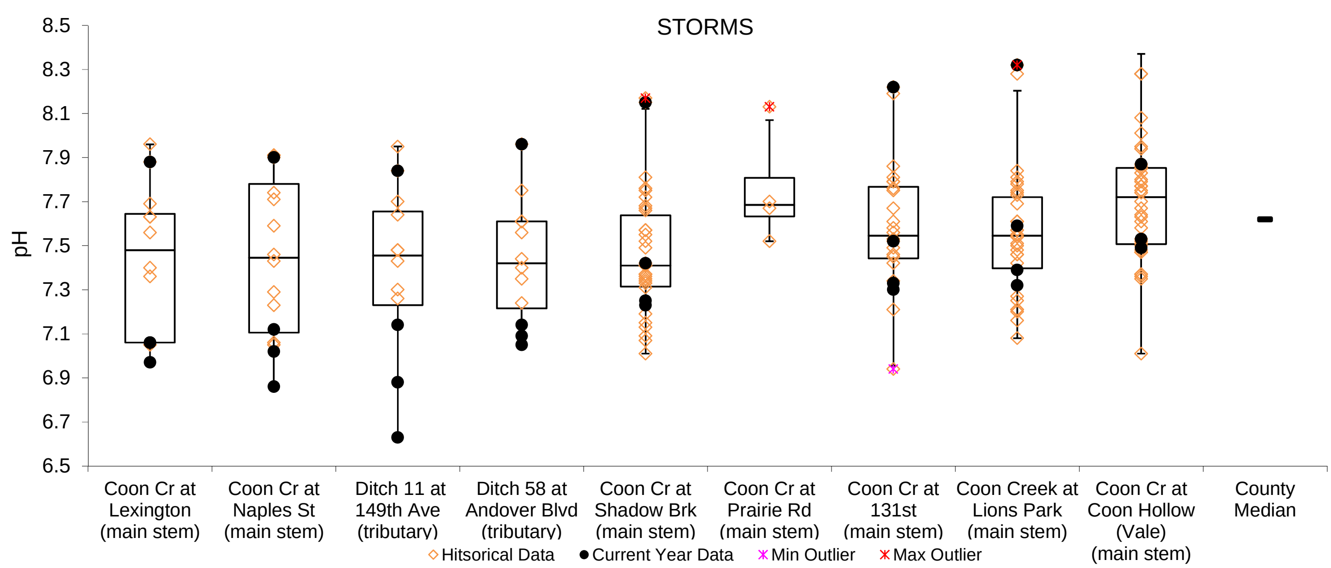
pH was within the expected range at all sites for 2015. pH is expected to be between 6.5 and 8.5 according to MPCA water quality standards. While occasional readings outside of this range have occurred in previous years, they were not large departures that generate concerns. pH was notably lower during 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 2015.

	pH	State Standard	N
Baseflow	8.01	6.5-8.5	43
Storms	7.72		40
All	7.89		83
Occasions outside state standard			12, all sites

pH at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





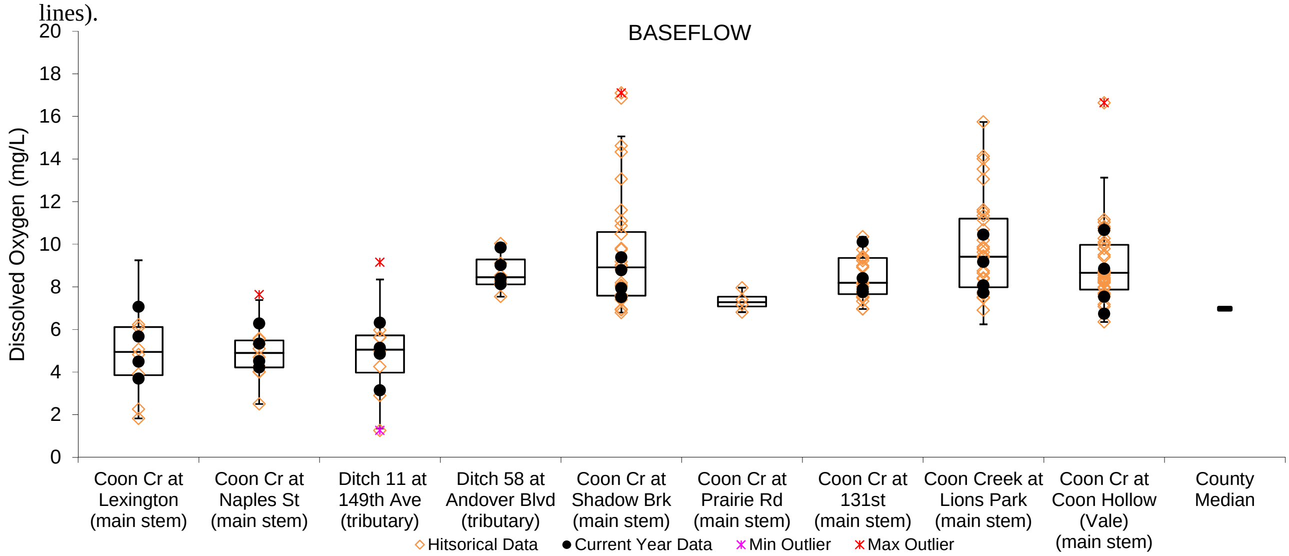
Dissolved Oxygen

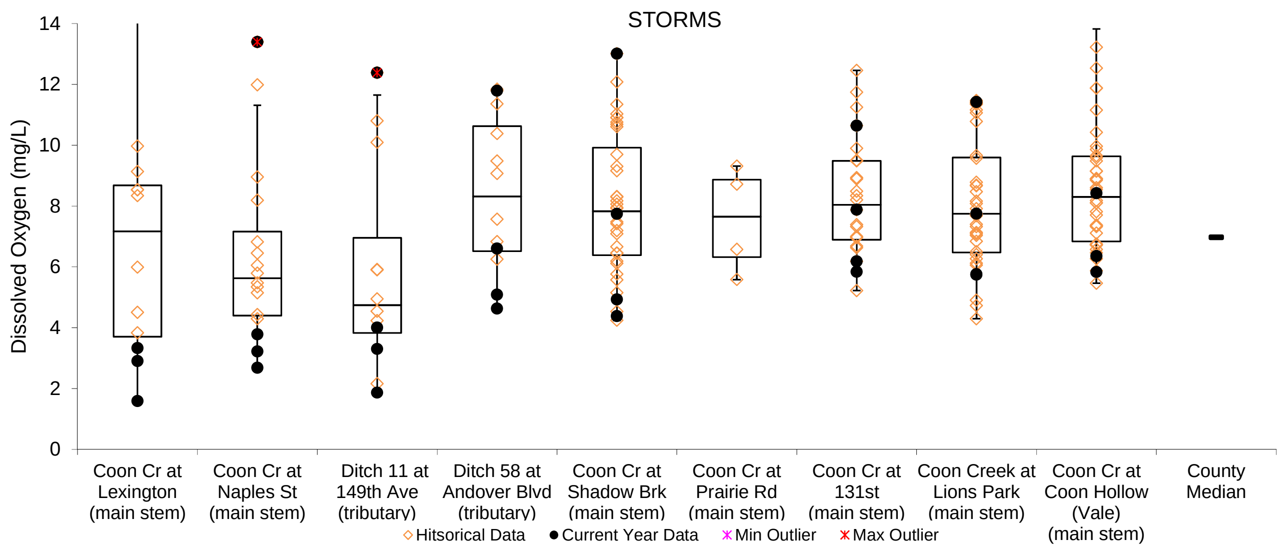
Dissolved oxygen was poor in most of the upstream stream sites (i.e. <5 mg/L). Of the 64 samples took in 2015, 18 samples dropped below 5 mg/L. These low readings all occurred in the upstream sites of Coon Creek. The other sites had no instances of dissolved oxygen below 5 mg/L. In sum, any dissolved oxygen problems observed appear to be in the upper reaches of the Coon Creek system.

Median dissolved oxygen in Coon Creek. Data is from Vale St for all years through 2015.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.65	5 mg/L daily minimum	40
Storms	8.3		42
All	8.57		82
Occasions <5 mg/L			3 at Lions Park, 4 at Shadowbrook Townhomes, 12 at Naples St, 11 at Lexington, 13 at Ditch 11 tributary, 1 at Ditch 58

Dissolved oxygen at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2015 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 testable 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 examination of the data.

During baseflow E. *coli* was acceptably low in the lower Coon Creek system but has higher in the bottom of the watershed (at Shadowbrook townhomes and below). Median E. *coli* for all years during baseflow from upstream to downstream were 34, 60, (75, 64.5 tributaries), 100, 113, 145, 169, and 187 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.

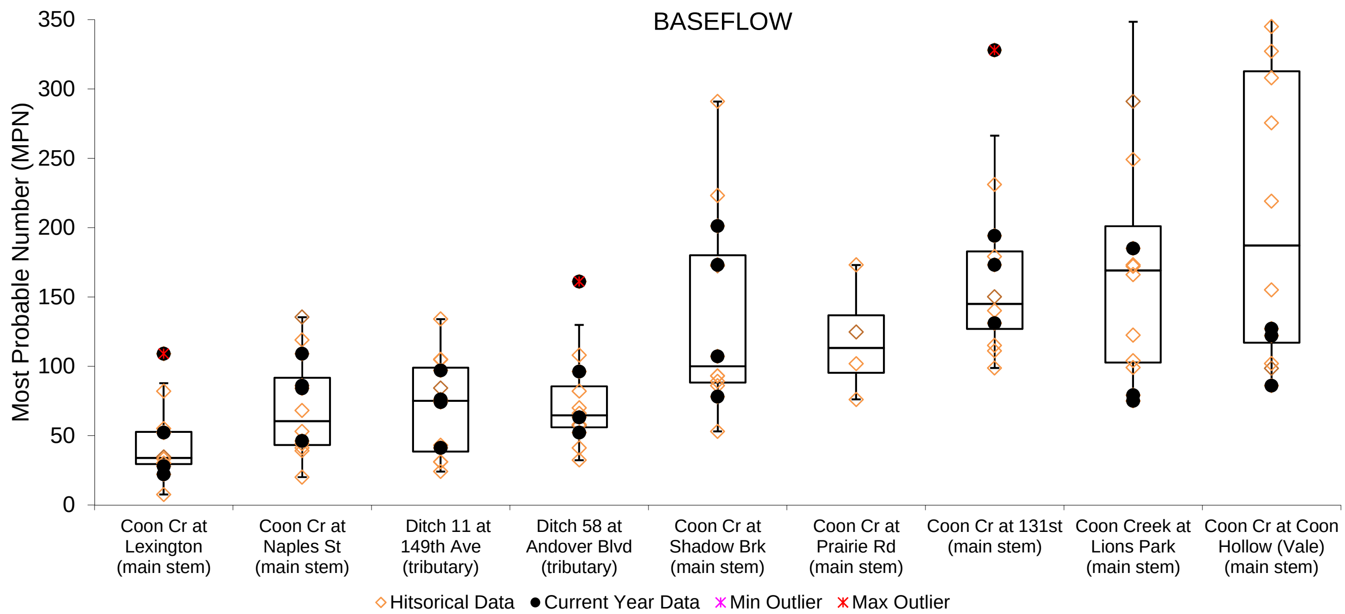
During storms E. coli was significantly higher and variable (notice the difference in Y axis scales in the graphs below). Median E. coli for all years during storms from upstream to downstream were 232, 360, (234, 339 tributaries), 495, 796, 368, 521, and 668 MPN, respectively. A large part of this variability might be explained by the intensity of the storm, phenology of the storm and when the storm the sampling was done.

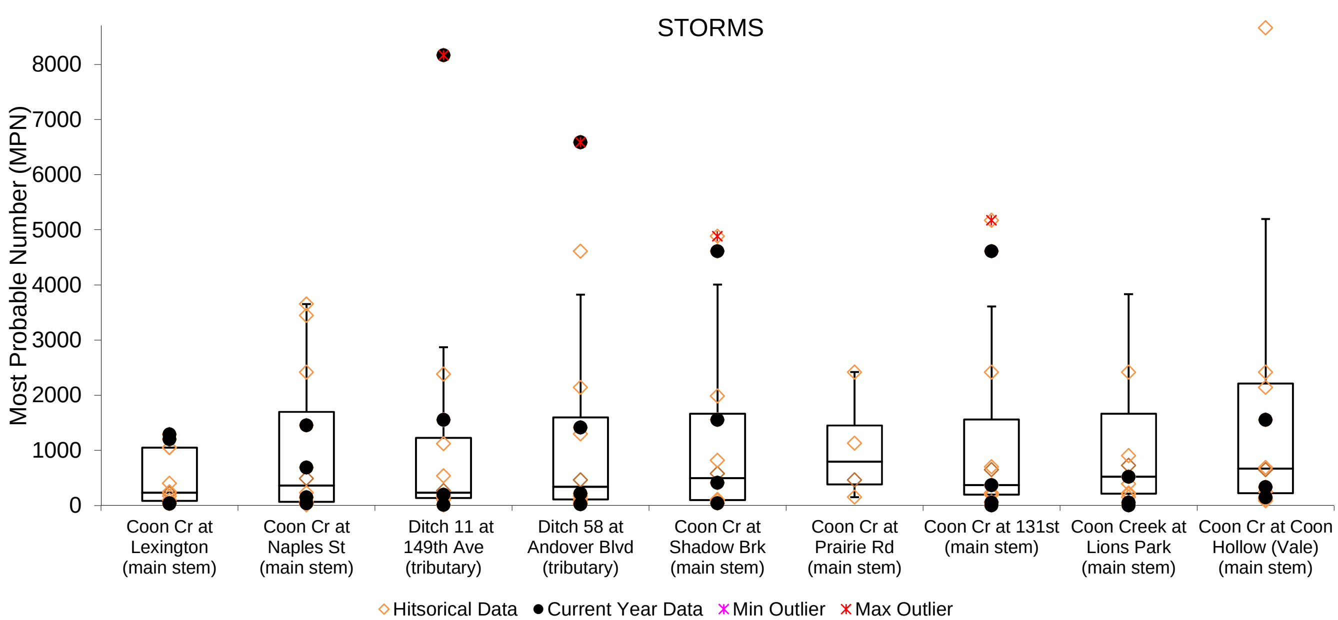
Though the frequency requirements were not met, bacteria levels during storms grossly exceed the 126 MPN state water quality standard on most occasions (75% of samples taken). Coon Creek clearly exceeded the standard of 10% of monitoring events in a month above 1260 MPN. It is notable, however, that two storm events accounted for 81% of the samples that exceeded the 1260 MPN standard.

Median E. *coli* in Coon Creek. Data is from All Sites from 2013-2015.

	E. *coli* (MPN)	**State Standard**	**N**
Baseflow	98.6	Monthly Geometric Mean >126	100
Storms	407		100
All	146.5		200
Occasions >126 MPN **Occasions >1260 MPN**		Monthly 10% average >1260	31 baseflow, 75 storm 0 baseflow, 31 storm

E. *coli* at Coon Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



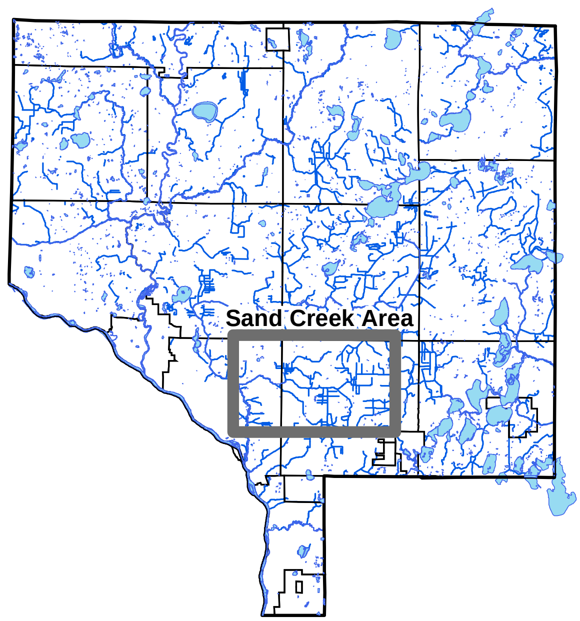


SAND CREEK SYSTEM

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	2010-2015
Sand Cr (Ditch 41) at Highway 65	2009-2015
Sand Cr at Happy Acres Park	2009
Ditch 60 at Happy Acres Park	2009
Sand Cr at University Avenue	2008-2015
Ditch 39 at University Avenue	2009
Sand Cr at Morningside Cemetery	2010-2015
Sand Cr at Xeon Street	2007-2015



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 older development. 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.

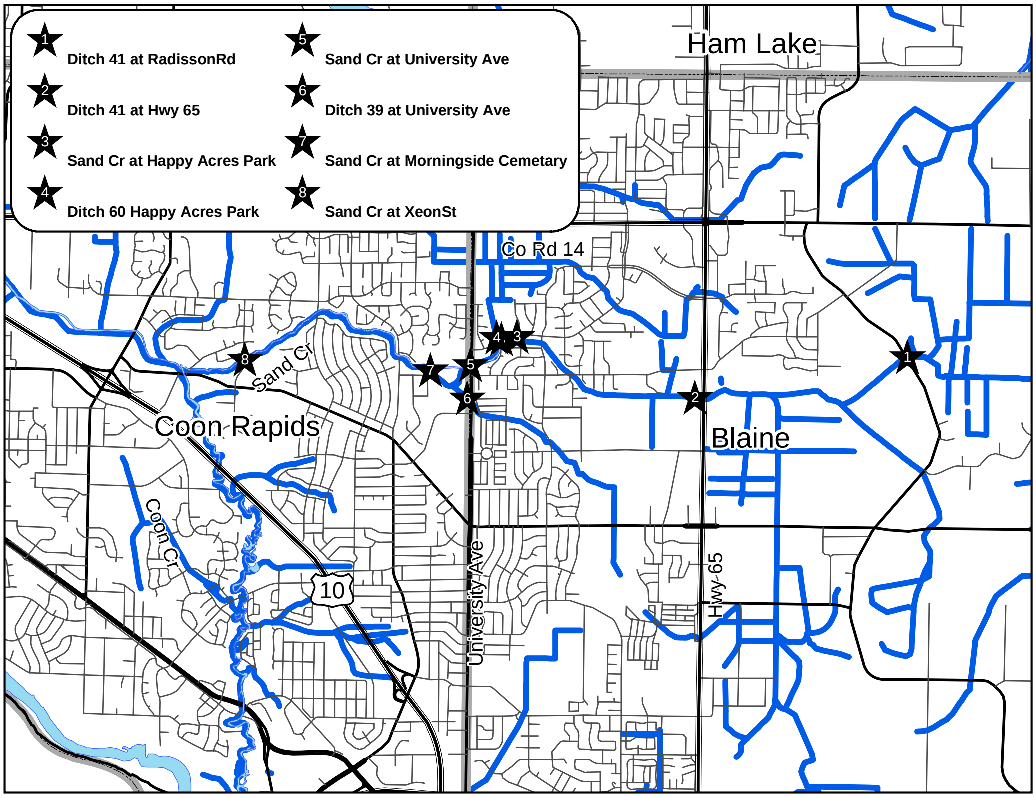
Methods

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, as well as photo-documentation of water appearance. 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 a datalogging electronic gauge 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 monitoring at all sites. We focus upon 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, especially 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 2015. 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 violate the state standard of 100 ug/L. 19% of Sand Creek samples violated that standard in 2015. Most of these exceedances were during storms. Phosphorus increases modestly during storms. Phosphorus does not increase noticeably from upstream to downstream in Sand Creek. Phosphorus in Sand Creek is lower than 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 at lowering storm-related phosphorus in Sand Creek. Achieving state water quality standards 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 it is so close to water quality standards, 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 already 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.

  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 used. 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 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 more than two times greater than the median for all Anoka County streams (0.862 mS/cm compared to 0.362 mS/cm).

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 salt-containing chemicals are 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.

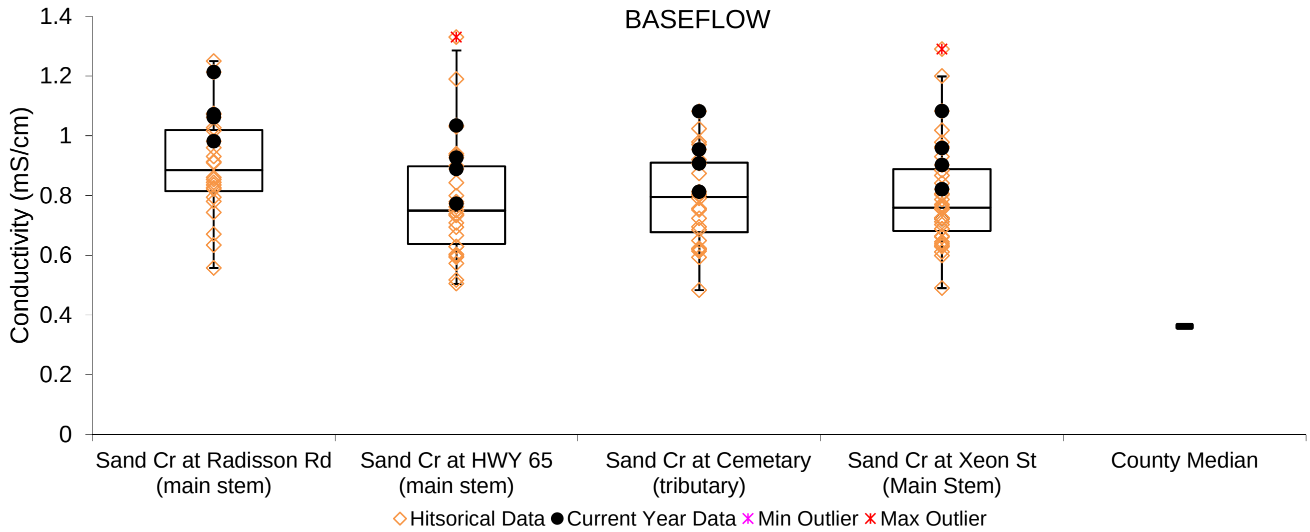
Dissolved pollutants were slightly lower during storms than during baseflow (see figures below). Dissolved pollutants can easily infiltrate into the shallow groundwater that feeds streams during baseflow. If this has occurred, dissolved pollutants will be high during baseflow. If road runoff was the primary dissolved pollutant source, then readings would be highest during storms. The median conductivity from all Sand Creek sites during baseflow was higher than during storms in 2015 (0.956 vs 0.783 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.

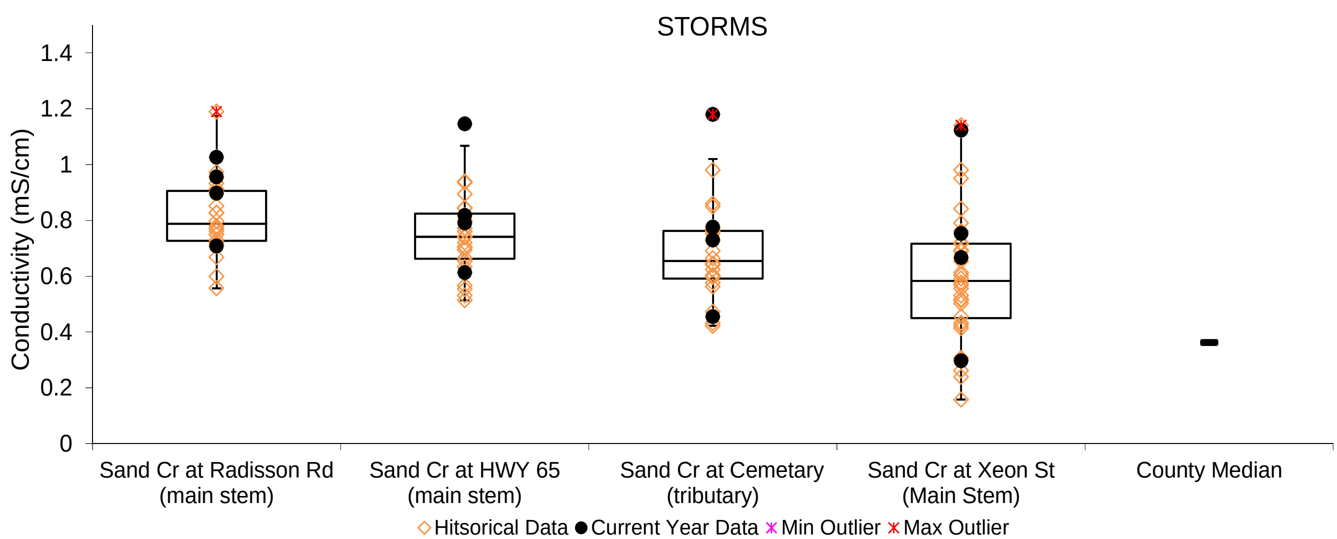
Sand Creek degrades Coon Creek with dissolved pollutants. Both creeks were monitored just before they join. Across all years monitored, Sand Creek's median conductivity was 23% higher than Coon Creek (0.751 vs 0.518 mS/cm). Sand Creek's median chlorides when last monitored were 42% higher than Coon Creek (74 vs 52 mg/L).

Median conductivity and chlorides in Sand Creek. Data is from Xeon St for all years through 2015.

	Conductivity (mS/cm)	Chlorides (mg/L)	State Standard	N
Baseflow	0.682	75	Conductivity – none Chlorides 860 mg/L acute, 230 mg/L chronic	36
Storms	0.583	63		36
All	0.691	72		72
Occasions > state standard				0

Conductivity at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2015 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 (all sites, all years) was 54 ug/L during baseflow and 67 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).

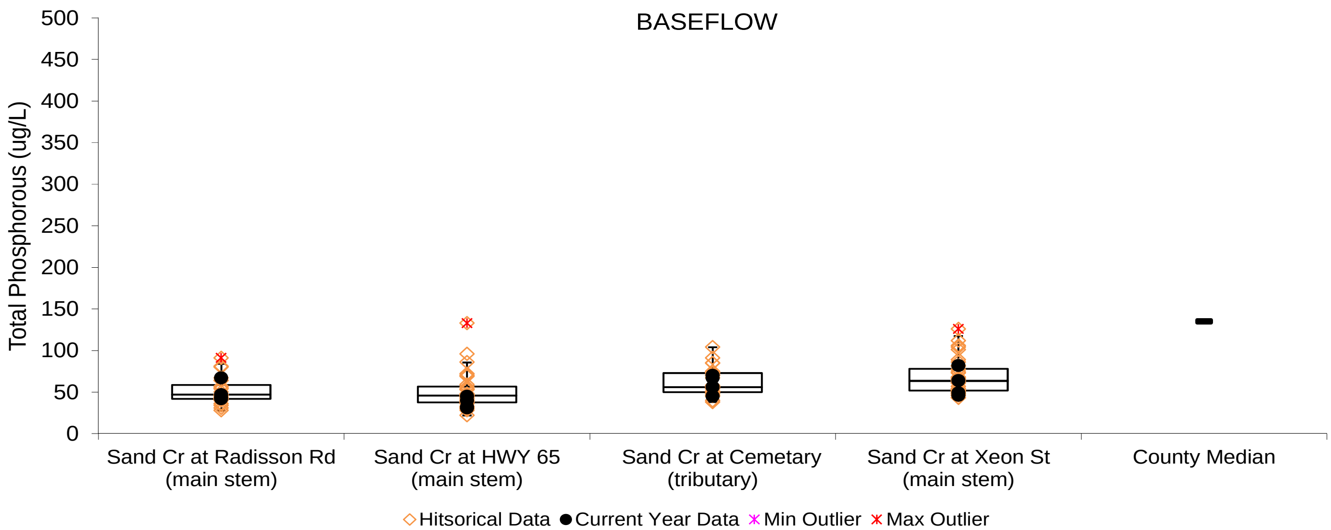
Nonetheless, Sand Creek will likely be found to be in violation (impaired) for excess phosphorus. While the median phosphorus level is below100 ug/L, the stream at Xeon Street exceeds that level in 27% of samples. Most of these exceedances (14 of 19) occur during storms. Retrofitting stormwater treatment 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.

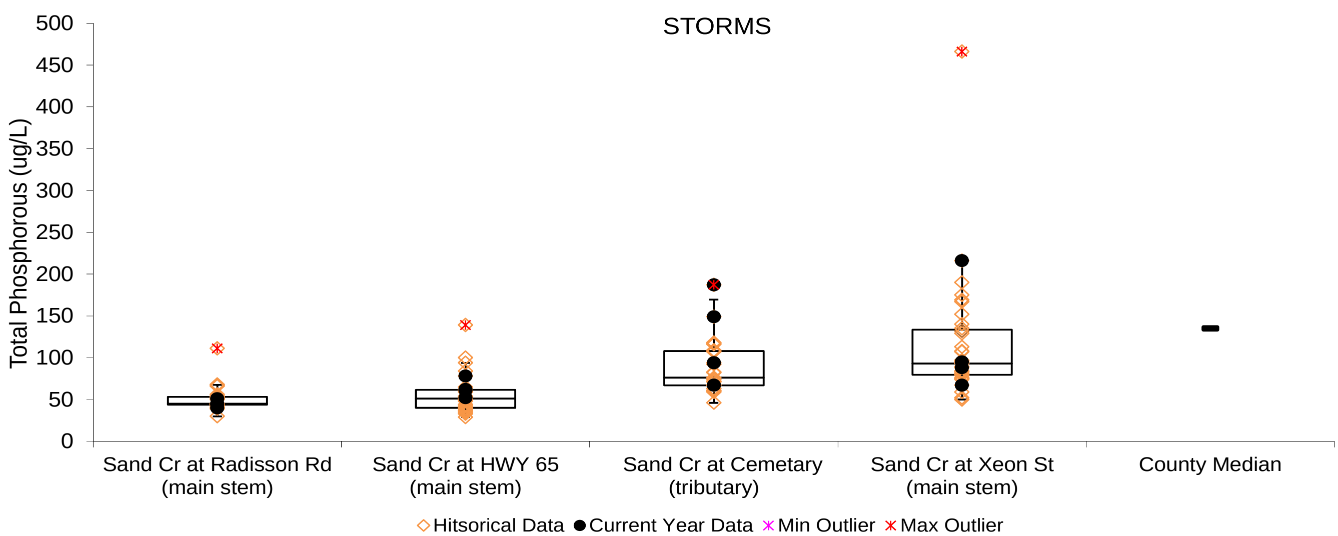
Median total phosphorus in Sand Creek. Data is from Xeon St for all years through 2015.

	Total Phosphorus (ug/L)	**State Standard***	**N**
Baseflow	63.5	100	36
Storms	93		35
All	79		71
Occasions > state standard			14 during storms, 5 baseflow

*New state standards are under development. The standard listed is the likely new threshold.

Total phosphorus at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2015 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 5.5 mg/L, but 12.5 mg/L during storms. Both are low compared to the state water quality standard of 30 mg/L, but that standard was exceeded in 6 samples (11%). This may or may not constitute a violation of state water quality standards for the stream overall – it will be a borderline case.

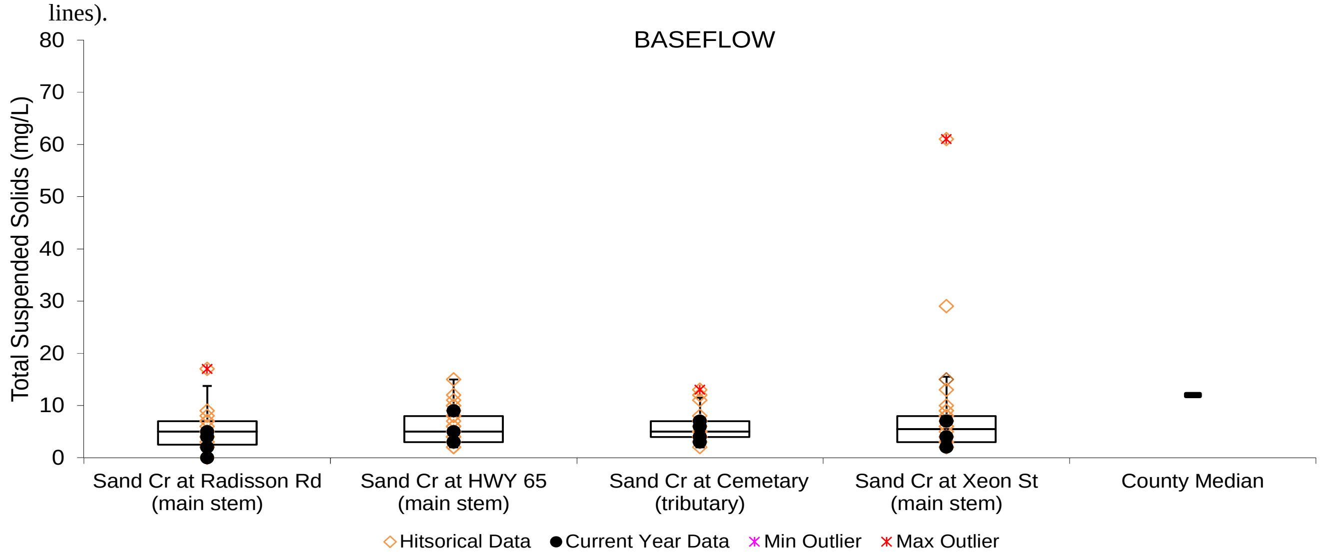
Because it is so close to water quality standards, and because it flows into Coon Creek which has high suspended solids, efforts should be made to lower these pollutants in Sand Creek. The Coon Creek Watershed District is already installing projects toward this end.   Projects in the lower watershed are most needed. While there are some instances of higher turbidity in the upper watershed, this is related to algal production in upstream lakes.

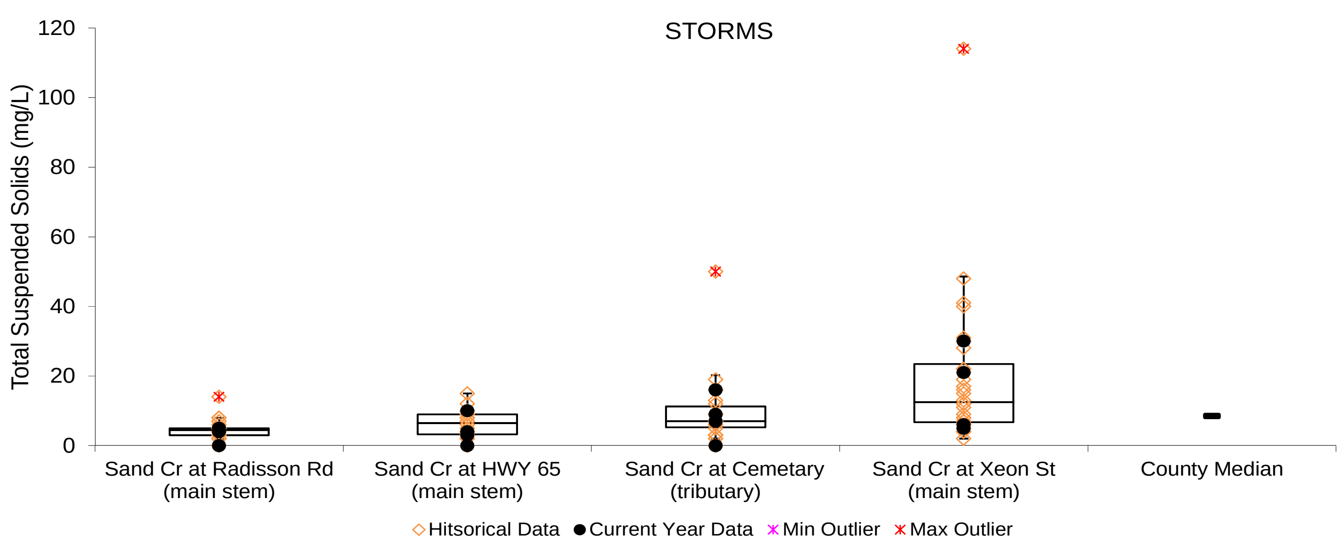
Median turbidity and suspended solids in Sand Creek. Data is from Xeon St for all years through 2015.

	Turbidity (FNRU)	Total Suspended Solids (mg/L)	State Standard*	N
Baseflow	5.0	5.5	30 mg/L TSS	35
Storms	12.0	12.5		36
All	8.0	7.0		71
Occasions > new state TSS standard				5 during storms, 1 baseflow

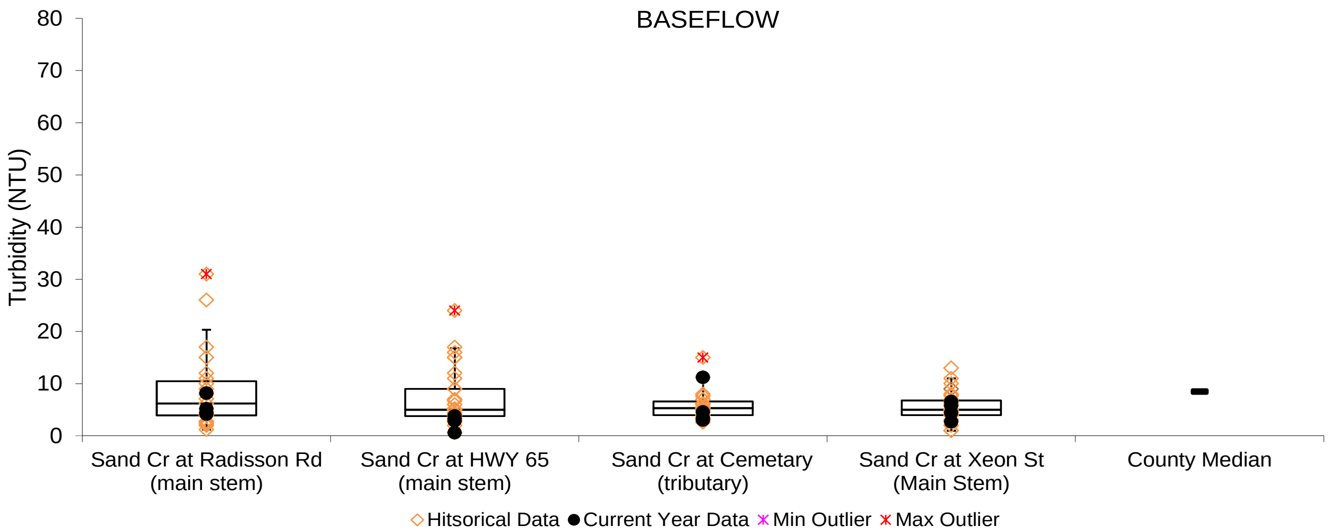
*New state standards are under development. The standard listed is the likely new threshold.

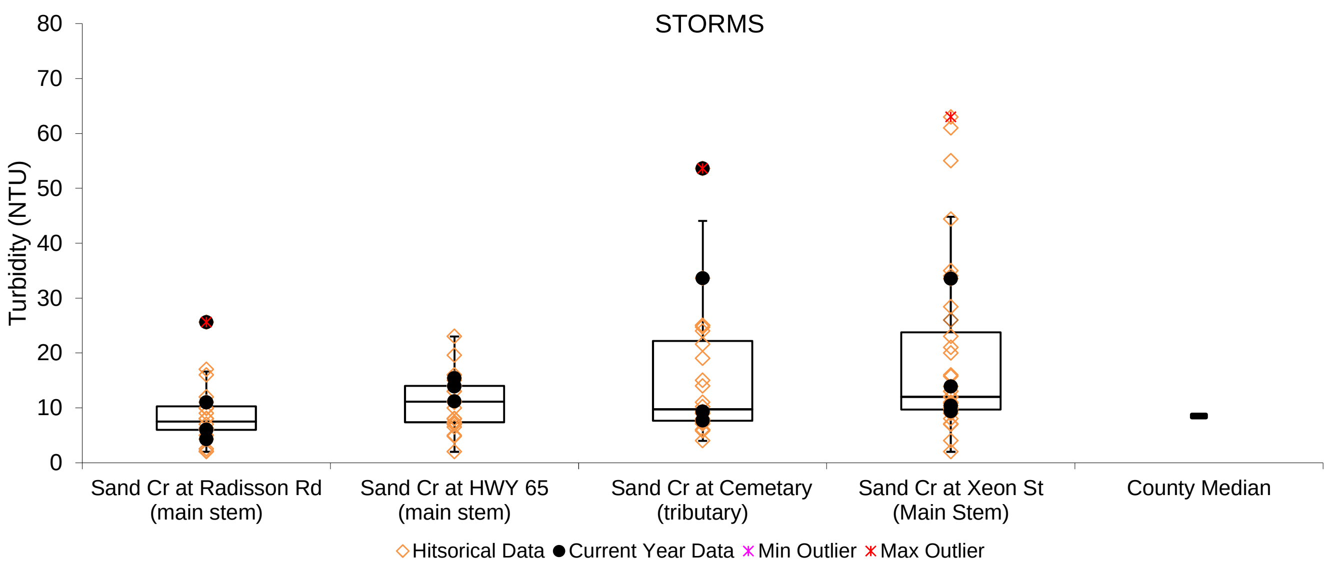
Total suspended solids at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





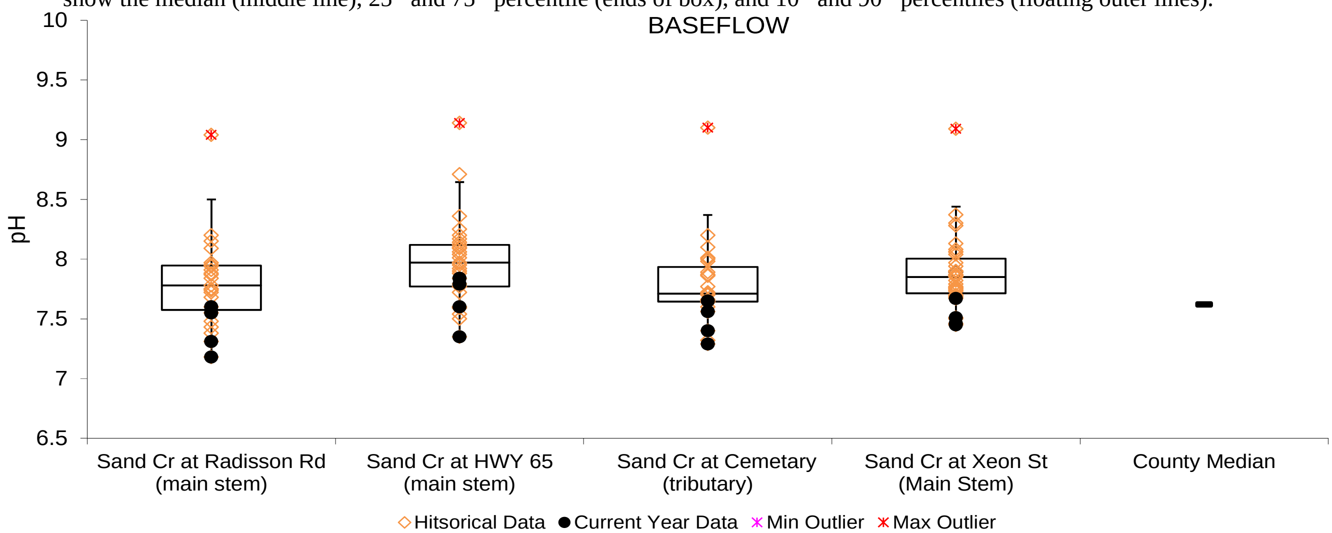
pH

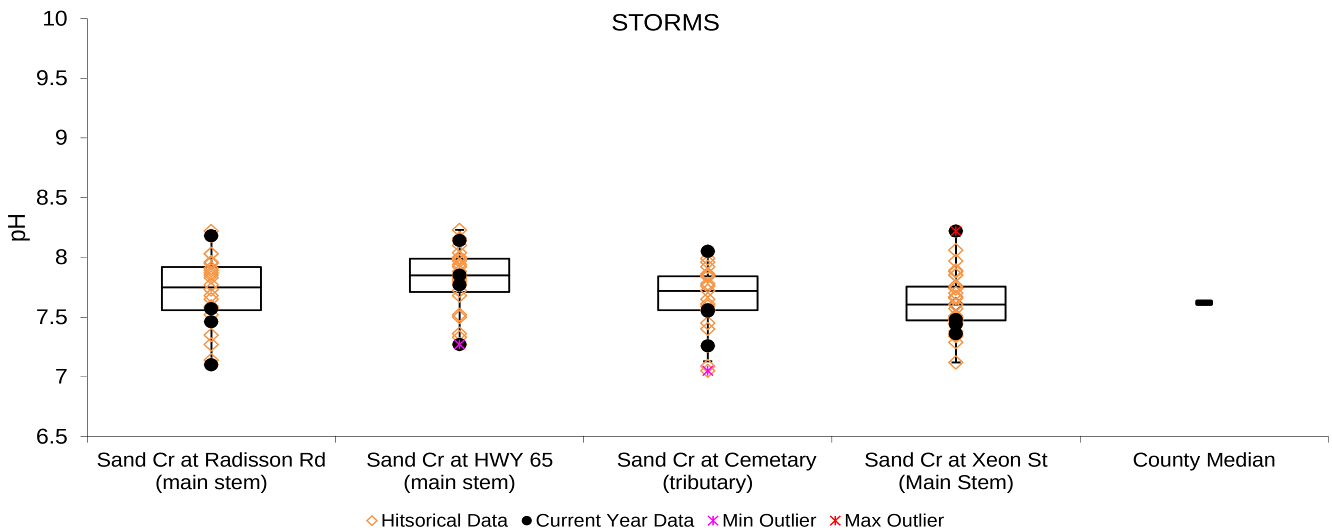
Sand Creek pH for 2015 was within the expected range at all sites and during all conditions (see figures below), ranging from 7.1 to 8.22. The median was 7.55. The Minnesota Pollution Control Agency water quality standards set an expectation for pH between 6.5 and 8.5. At all sites pH was lower during storms because rainwater has a lower pH.

Median pH in Sand Creek. Data is from Xeon St for all years through 2015.

	pH	State Standard	N
Baseflow	7.85	6.5-8.5	35
Storms	7.61		34
All	7.74		69
Occasions outside state standard			2

pH at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2015 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

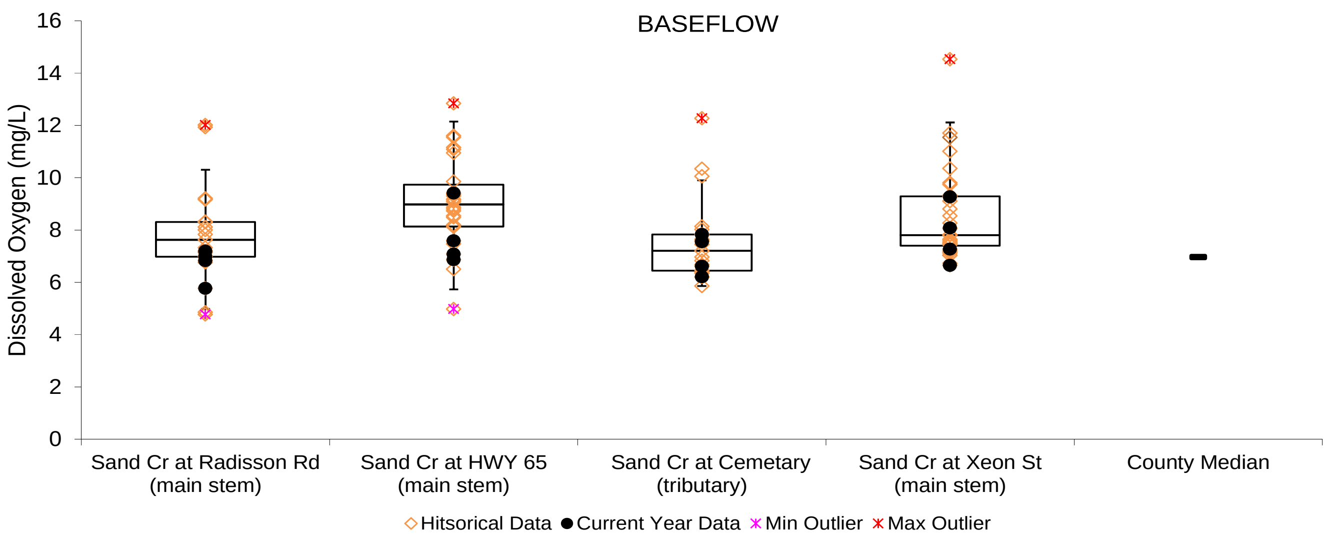
Dissolved oxygen (DO) essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO is below 5 mg/L. Low DO can be a symptom of organic pollution, the decomposition of which reduces oxygen.

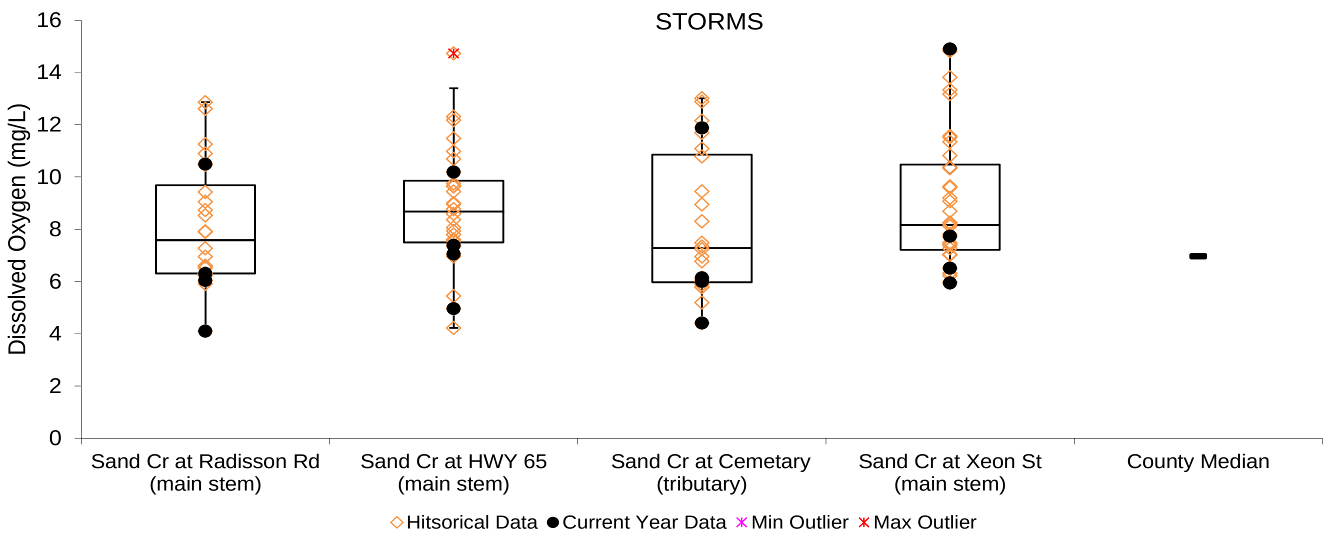
Dissolved oxygen in Sand Creek was within the acceptable level (>5 mg/L) on 97.3% of the site visits (see table figure below). On eight occasions of all the years monitored DO dropped below 5 mg/L. Two were during storms and five during baseflow, suggesting the issue is not flow-dependent. Overall, we do not have concerns about dissolved oxygen levels in Sand Creek.

Median dissolved oxygen in Sand Creek. Data is from Xeon St for all years through 2015.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	7.80	5 mg/L daily minimum	32
Storms	8.16		36
All	7.93		68
Occasions <5 mg/L			0 at Xeon St., 8 at other sites

Dissolved Oxygen at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2015 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 testable 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 examination of the data.

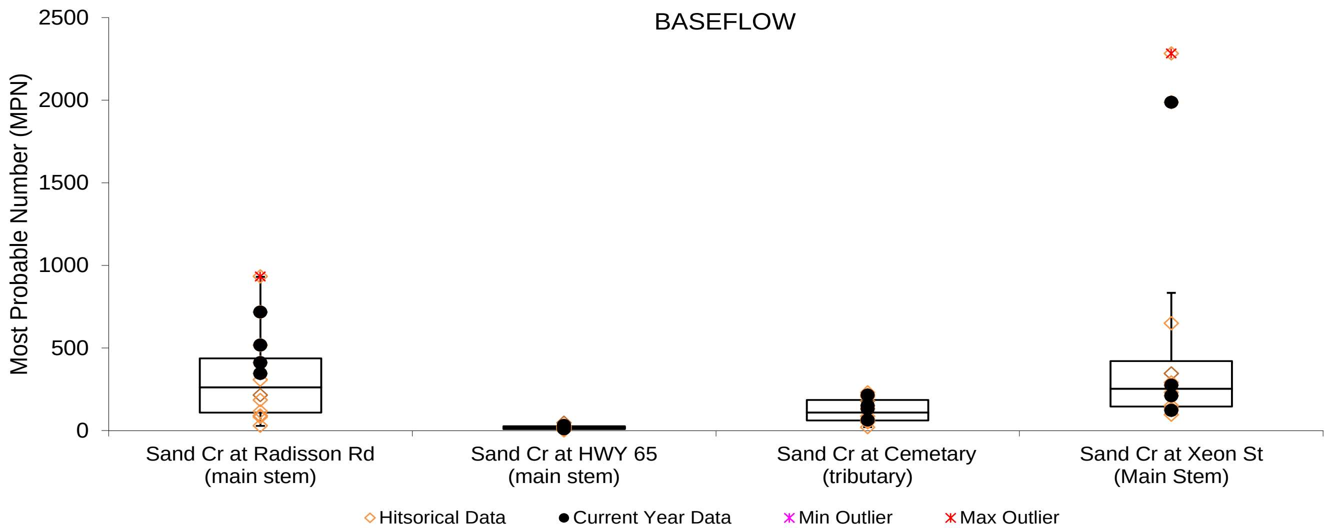
2015 E. *coli* levels were much higher than 2014. During baseflow E. *coli* was moderate and showed slight upstream to downstream increase after highway 65. Median E. *coli* during baseflow for all years from upstream to downstream were 260.95, 18, 109, and 253 MPN, respectively. Other than Sand Creek at Highway 65, E. *coli* levels during baseflow exceeded 126 MPN on a regular basis in 2015.

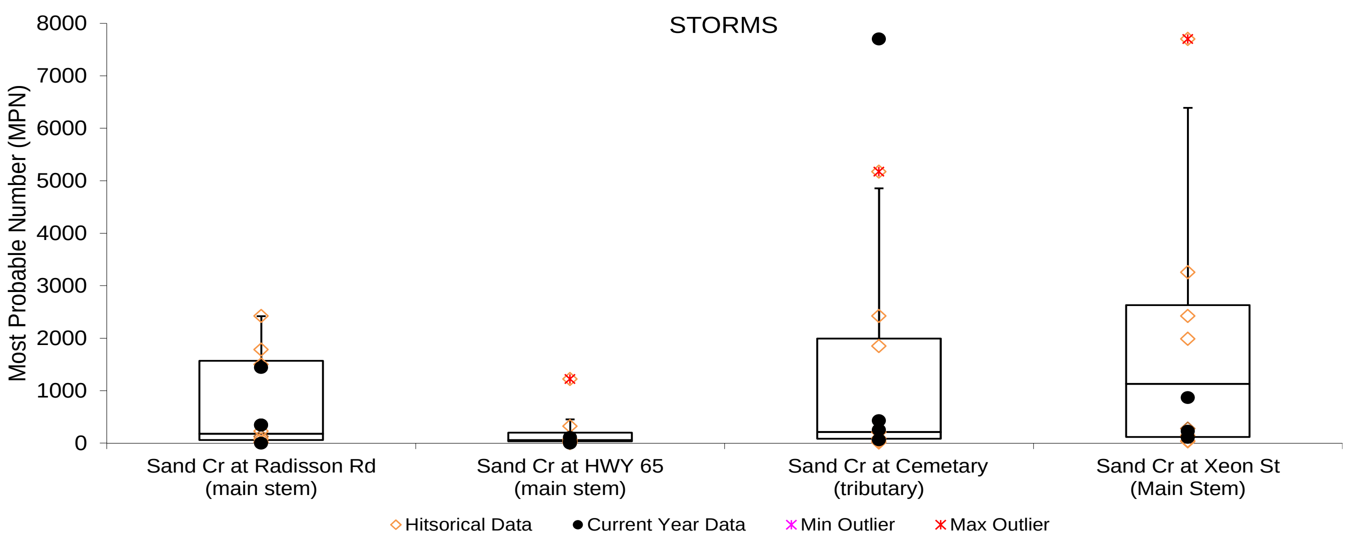
During storms E. coli was significantly higher and more variable, and there was modest increase from upstream to downstream after Highway 65. Median E. *coli* during storms for all years from upstream to downstream were 345, 48.2, 230 and 570.75 MPN, respectively. E. *coli* levels during storms in 2015 exceed the 126 MPN on over half of the occasions (56% of samples taken).

Median E. *coli* in Sand Creek. Data is from All Sites for all years through 2015.

	E. *coli* (MPN)	**State Standard**	**N**
Baseflow	127	Monthly Geometric Mean >126	48
Storms	210		48
All	140.7		96
Occasions >126 MPN		Monthly 10% average >1260	24 baseflow, 27 storm
Occasions >1260 MPN			2 baseflow, 14 storm

E. *coli* at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating lines).



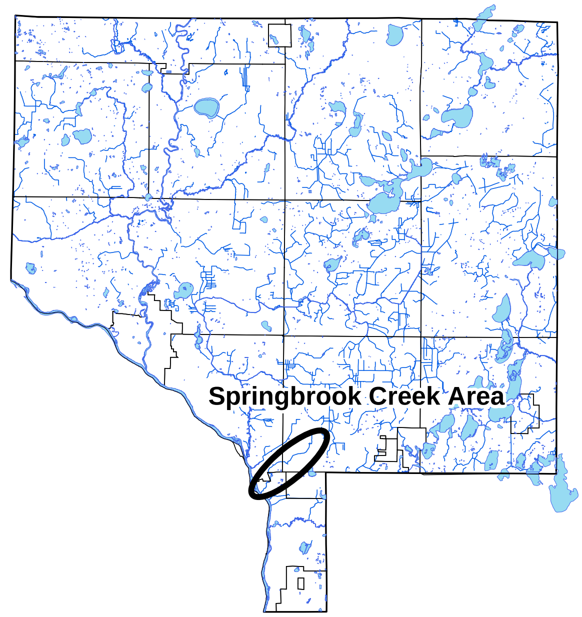


SPRINGBROOK CREEK

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 2013-2015
Springbrook at 85th Avenue 2013-2015
Springbrook at 79th Way 2012-2015



Other sites around the Springbrook Nature Center were monitored a few occasions in the early 2000's 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 2000's 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 project several projects to better treat stormwater and rehabilitate the Nature Center impoundment were initiated. Water 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 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 other impairments, the data to date suggest that other impairment designations are 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 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, total suspended solids. During every sampling the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using a datalogging electronic gauge.

Results and Discussion

Springbrook 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. Chlorides, phosphorus, and suspended solids all approach or exceed State standards at least occasionally.

Following is a parameter-by-parameter summary, including a management discussion:

- <u>Dissolved pollutants</u>, as measured by conductivity and chlorides, are higher in Springbrook than any other Anoka County stream except nearby Pleasure Creek, which is similar. Conductivity reached four times greater than the median for Anoka County streams, while chlorides were nine times greater. Both were elevated during storms and baseflow, but consistently higher concentrations were during storms. On one of eight 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.

- <u>Phosphorus</u> 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.

- <u>Suspended solids and turbidity</u> are low in Springbrook during baseflow, but during storms the downstream site approaches or exceeds the proposed state water quality standard.

  Management discussion: Additional treatment within the stormwater conveyance system will help reduce suspended solids.

- <u>pH and dissolved oxygen</u> were with the range considered normal and healthy for streams in this area in all events but one. pH rose above the 8.5 unit limit at two monitoring sites during one storm event in 2015.

- <u>E. coli bacteria</u> are high throughout Coon Creek during storms.

  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 used. 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 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 which is similar. 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 (0.862 mS/cm compared to 0.362 mS/cm). Median conductivity (all sites, all years) was high both during storms events (0.683 mS/cm) and baseflow (0.979 mS/cm).

Chlorides were even higher – nine times higher than the average of other Anoka County streams. The Springbrook median for chlorides (all sites, all years) were 159 mg/L compared to 17 mg/L for other Anoka County streams. Median chlorides (all sites, all years) during storms (216 mg/L) were 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.

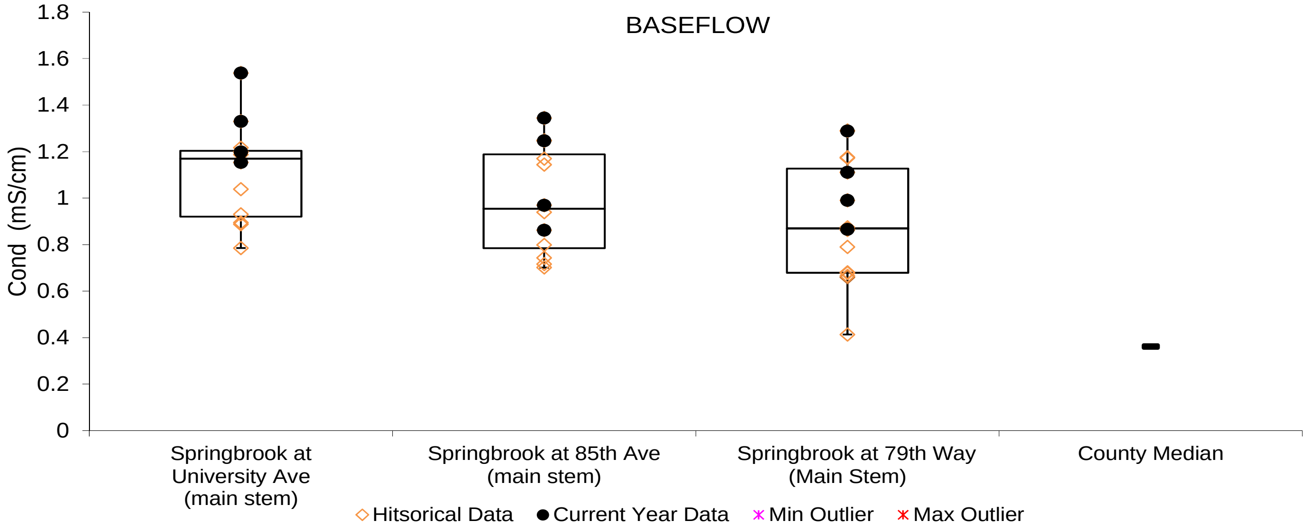
Springbrook's high dissolved pollutants are likely from stormwater runoff, with road deicing salts as one, but not the only, contributor. Greater road densities and a long history of road salting contribute to high chlorides. Chlorides are persistent in the environment; not effectively broken down by stormwater treatment or time. They migrate into the shallow groundwater which feeds the stream during baseflow. This explains why chlorides are high during baseflow. However, at Springbrook stormwater runoff carries even higher concentrations of dissolved pollutants. This is unlike most area streams where baseflow dissolved pollutants is highest, 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.

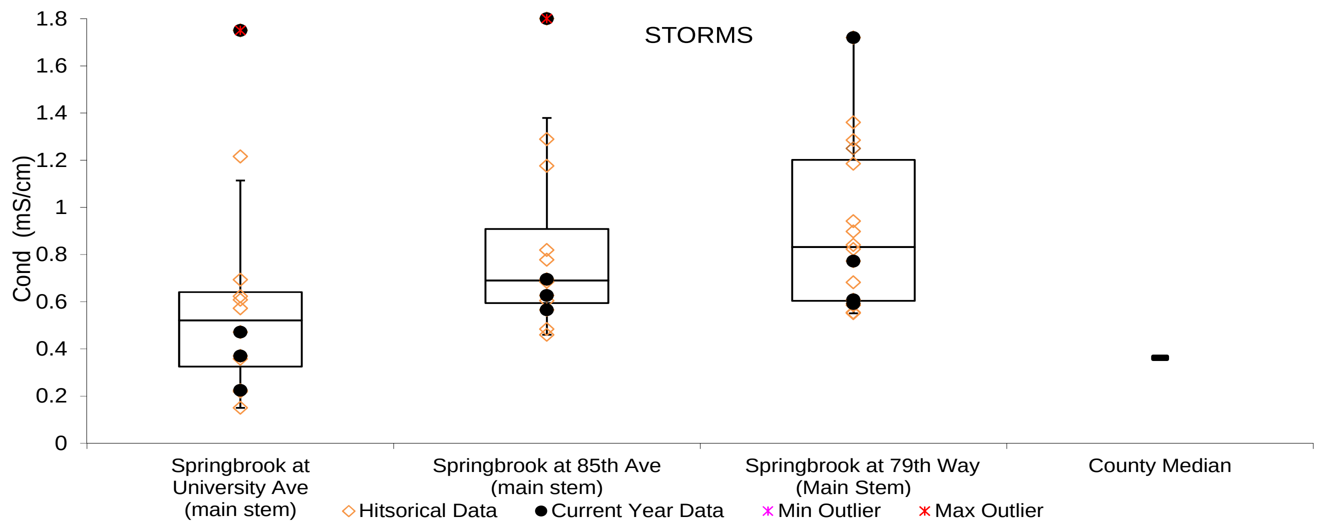
Dissolved pollutants are especially difficult to manage once in the environment. They are not removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also risk contaminating groundwater. The first approach to dissolved pollutant management must be to minimize their release into the environment.

Median conductivity and chlorides in Springbrook Creek. Data is from 79th Way for all years through 2015.

<table>
<tr><th></th><th>Conductivity (mS/cm)</th><th>Chlorides (mg/L)</th><th>State Standard</th><th>N</th></tr>
<tr><td>Baseflow</td><td>0.869</td><td>129</td><td rowspan="3">Conductivity – none
Chlorides 860 mg/L acute, 230 mg/L chronic</td><td>16</td></tr>
<tr><td>Storms</td><td>0.831</td><td>216</td><td>16</td></tr>
<tr><td>All</td><td>0.864</td><td>159</td><td>24</td></tr>
</table>

Conductivity at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2015 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 2015, median Springbrook TP (all sites) during baseflow (85 ug/L) and storm events (149 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.

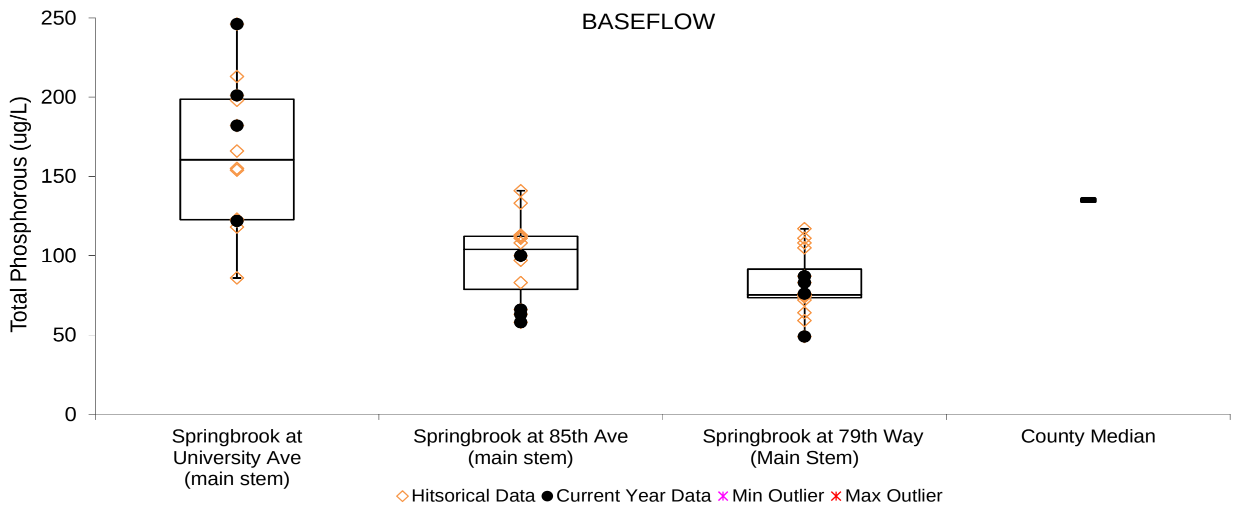
The MN Pollution Control Agency has a phosphorus standard for streams of 100ug/L. Based on data collected to date, Springbrook violates this standard often and may be designated as "impaired."

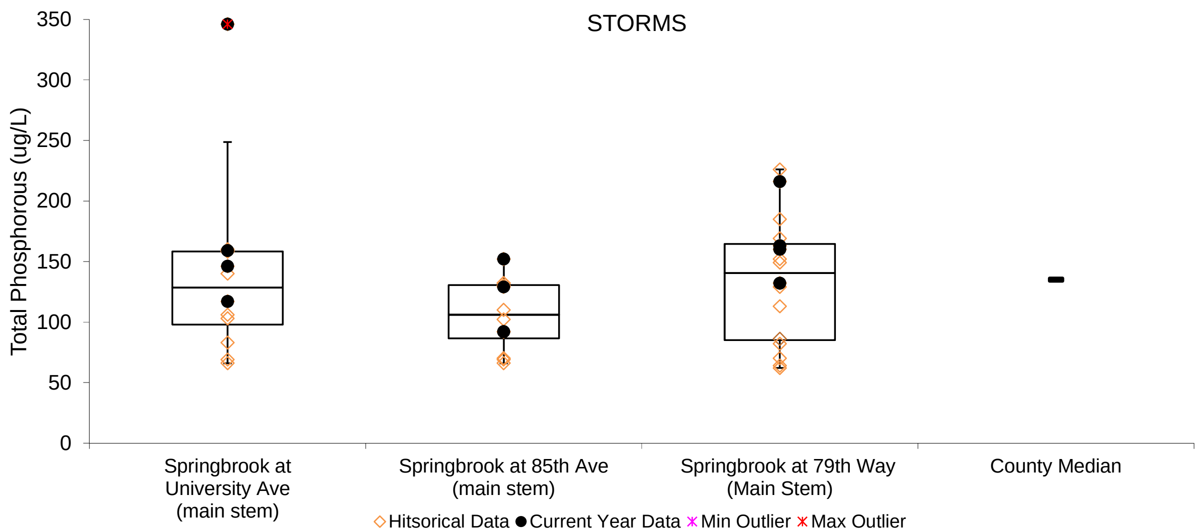
Median total phosphorus in Springbrook Creek. Data is from 79th Way for all years through 2015.

	Total Phosphorus (ug/L)	State Standard*	N
Baseflow	75.5	100	16
Storms	140.5		16
All	86.5		32
Occasions > state standard			15 (11 during storms)

*New state standards are under development. The standard listed is the likely new threshold.

Total phosphorus at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2015 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. 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 2015 was 40 mg/L, and the highest turbidity in 2015 was 62.9 NTU. During baseflow for 2015 turbidity never exceeded 9. In 2015, TSS during baseflow never exceeded 19 and averaged less than 5. Overall, these levels are within the desirable range for streams in this area.

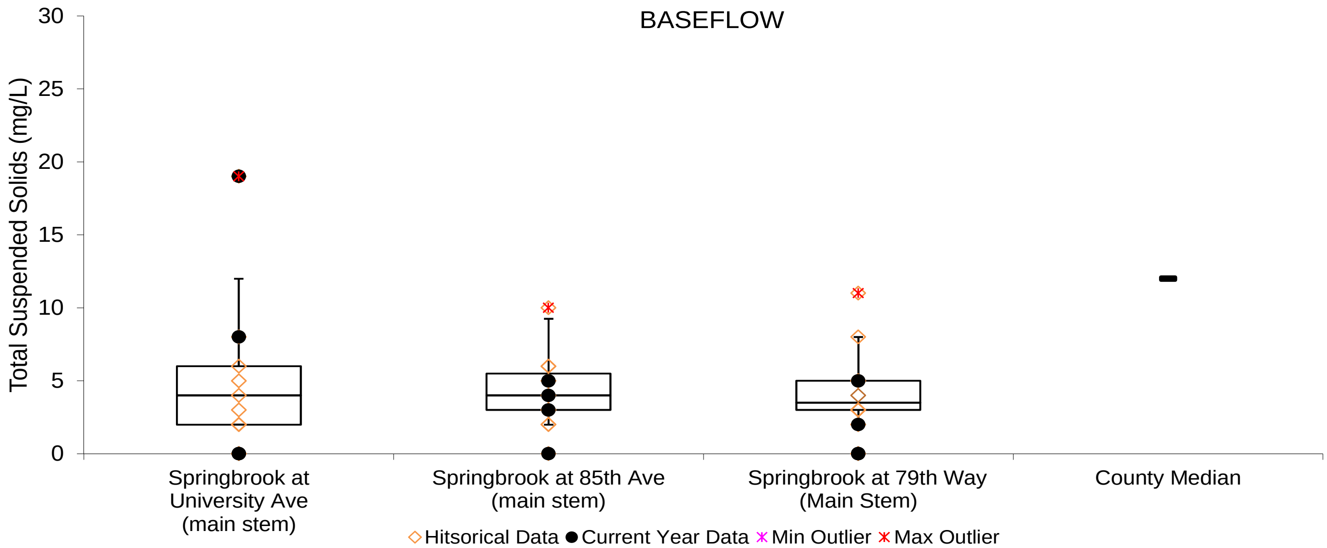
The MN Pollution Control Agency has a state standard for TSS of 30 mg/L. Only two of eighty samples on record exceeded this standard. 20 samples will be needed for the MPCA to determine if water quality standards for suspended solids are being met.

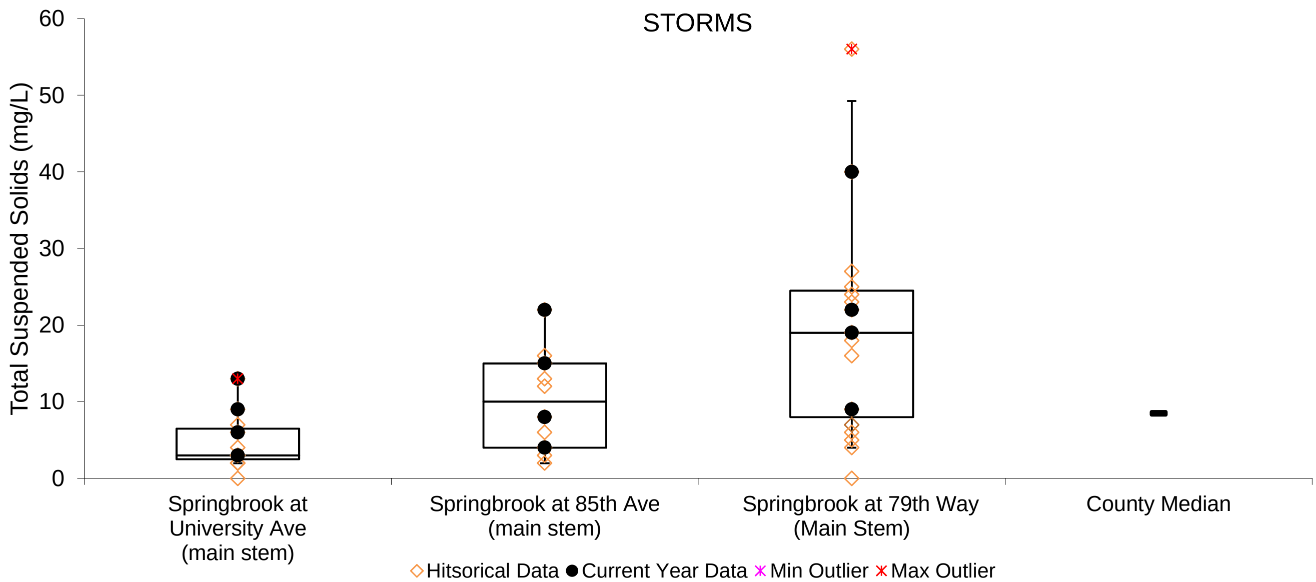
Median turbidity and suspended solids in Springbrook Creek. Data is from 79th Way for all years through 2015.

	Turbidity (FNRU)	Total Suspended Solids (mg/L)	State Standard*	N
Baseflow	1.4	3.5	30 mg/L TSS	16
Storms	14.9	19		16
All	4.3	6		32
Occasions > new state TSS standard				2

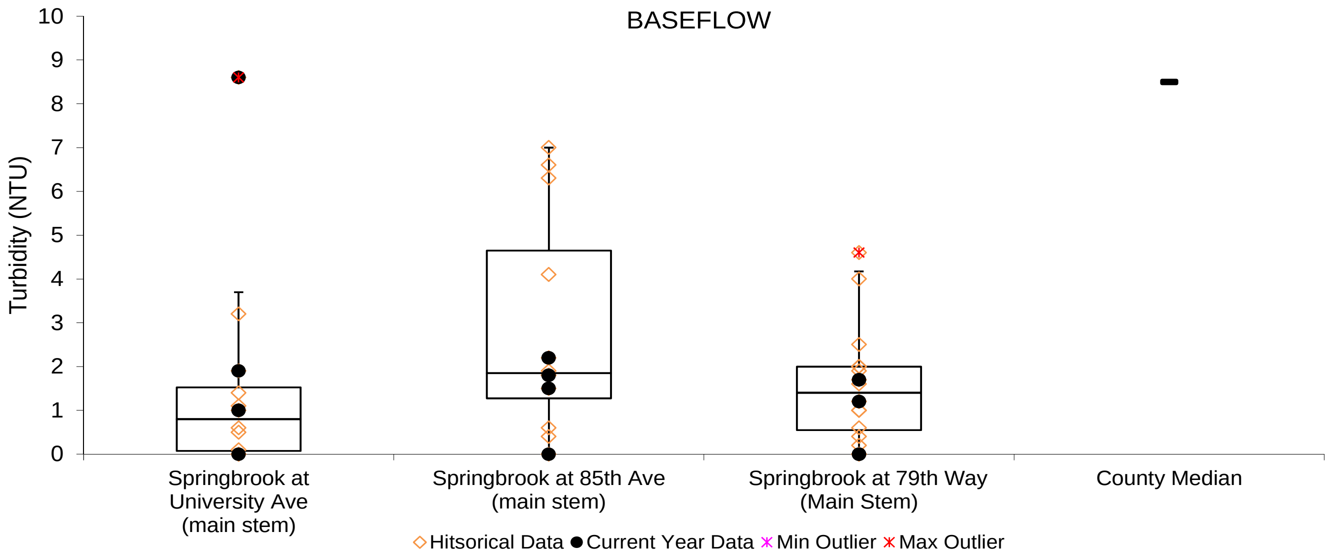
*New state standards are under development. The standard listed is the likely new threshold.

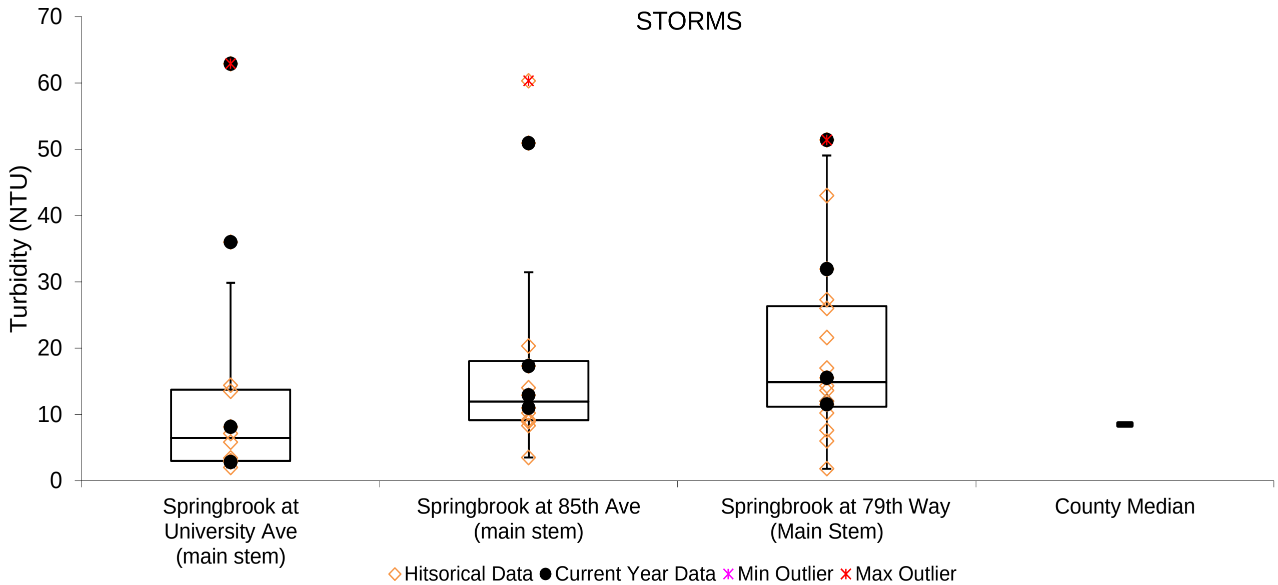
Total suspended solids at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





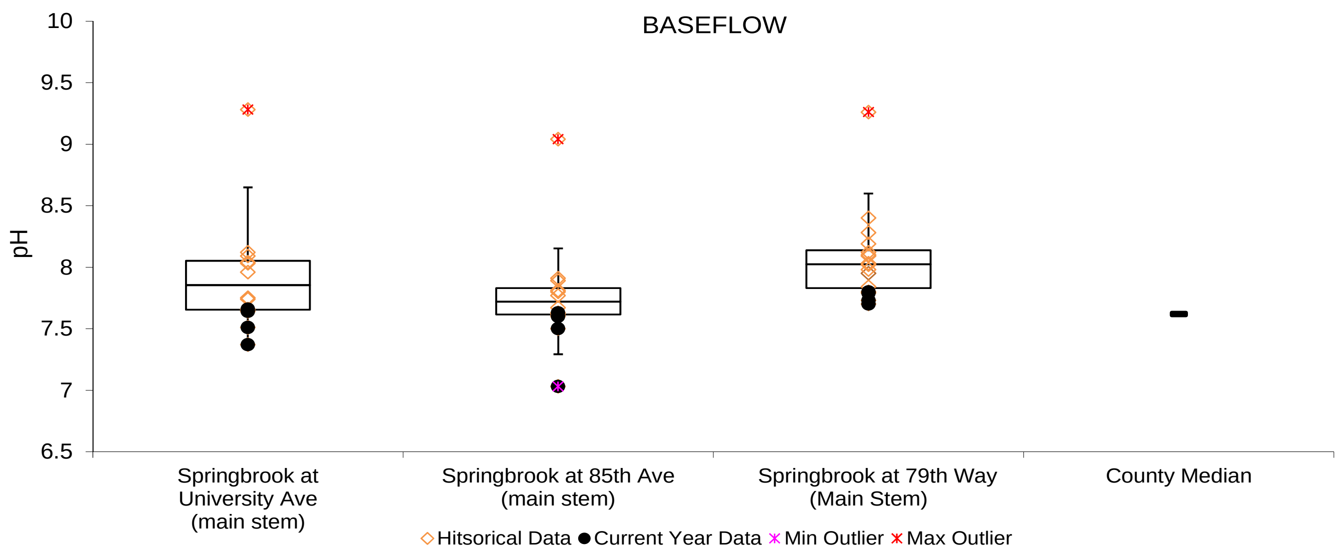
pH

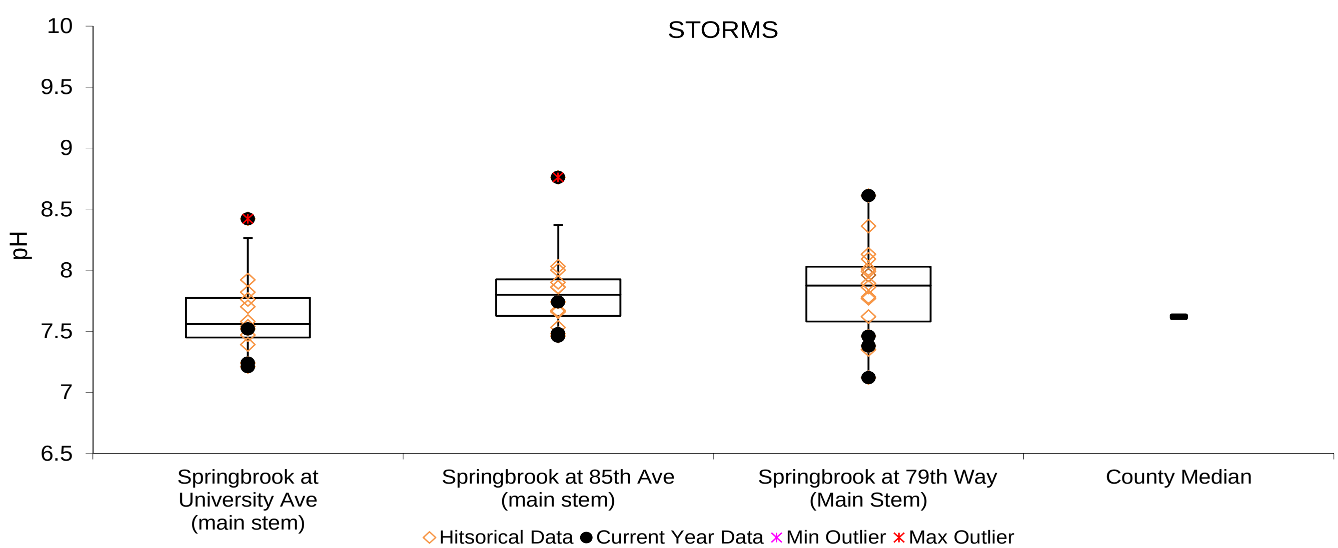
In 2015 Springbrook Creek pH has been within the expected range at all sites and all conditions for all but one sampling event. All measurements collected for Springbrook pH has ranged from 7.00 to 9.28. The Minnesota Pollution Control Agency water quality standards set an expectation for pH between 6.5 and 8.5.

Median pH in Springbrook Creek. Data is from 79th Way for all years through 2015.

	pH	State Standard	N
Baseflow	8.03	6.5-8.5	16
Storms	7.88		16
All	7.97		32
Occasions outside state standard			5, all sites

pH at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





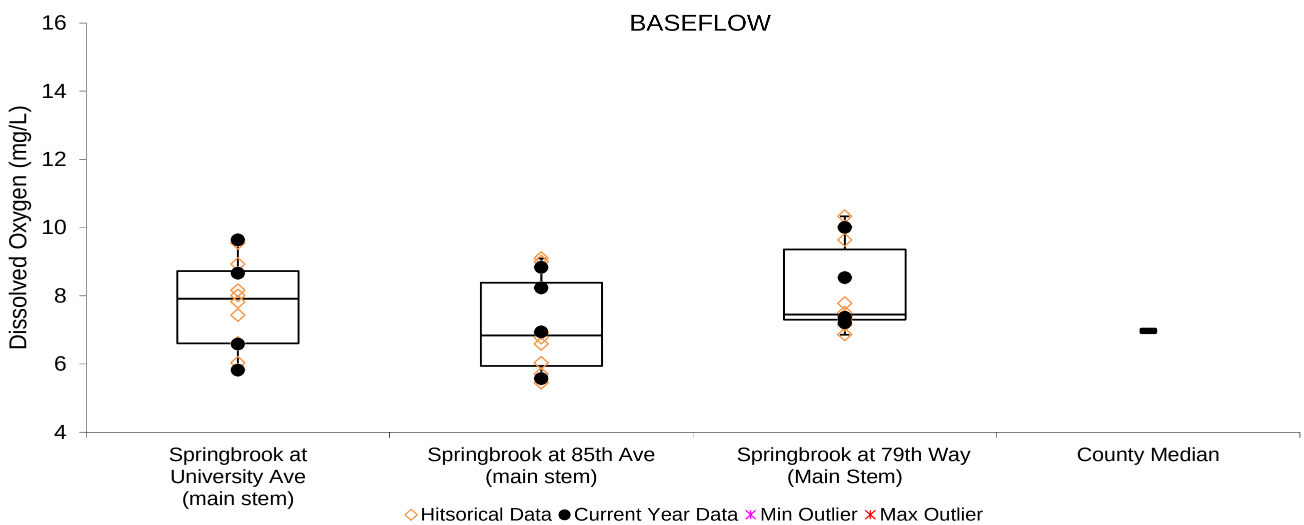
Dissolved Oxygen

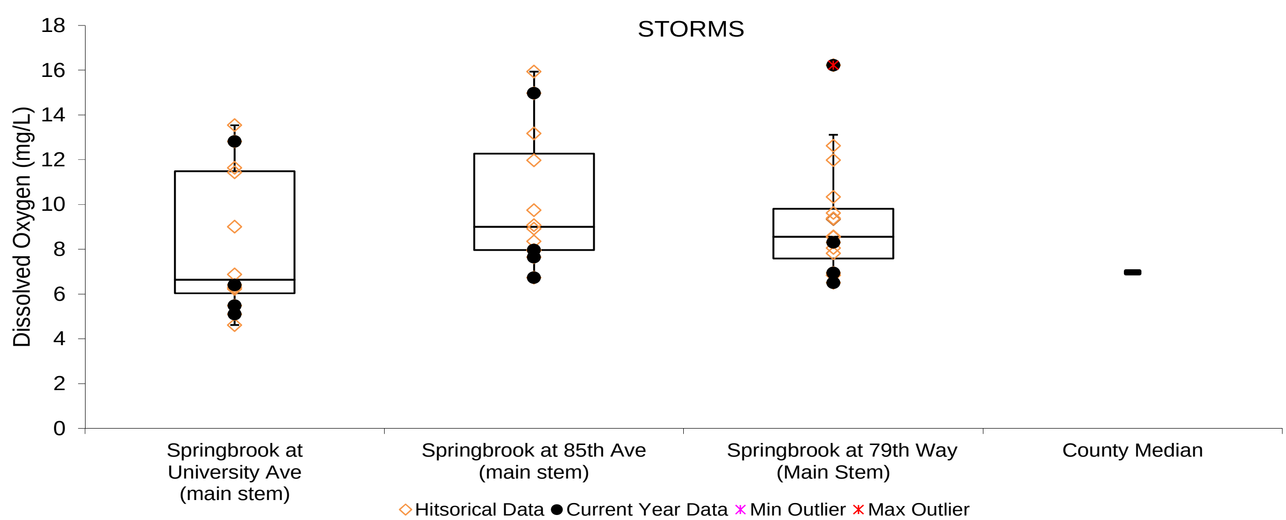
Dissolved oxygen (DO) essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO is below 5 mg/L. Low DO can be a symptom of organic pollution, the decomposition of which reduces oxygen. Dissolved oxygen in Springbrook Creek was within the acceptable level (>5 mg/L) during all site visits. 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 2015.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	7.3	5 mg/L daily minimum	16
Storms	8.55		16
All	8.17		32
Occasions <5 mg/L			0

Dissolved Oxygen at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2015 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 testable 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 examination of the data.

E. *coli* levels in 2015 drastically increased from 2014. During baseflow median E. *coli* for all years from upstream to downstream were 157.5, 43.5, and 119.5 MPN, respectively. E. coli during baseflow exceeded 126 MPN in 58% of samples taken in 2015.

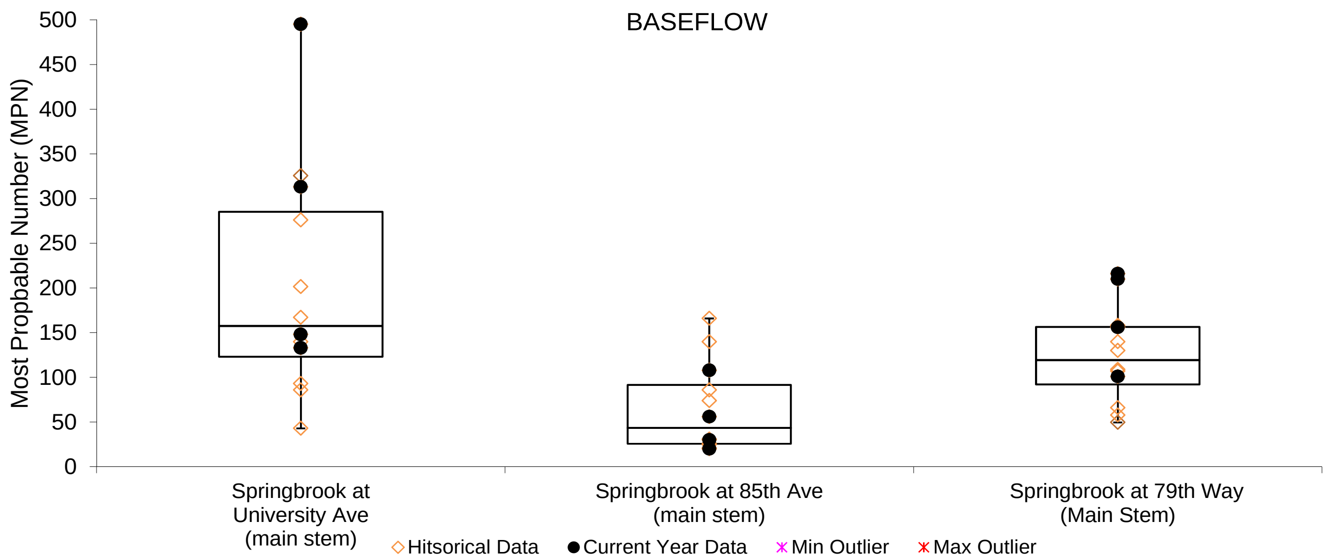
During baseflow the upstream-most at University Avenue had the highest E. coli. It appears that the ponds and wetlands between University Ave and 85^{th} Ave sites may be providing baseflow treatment.

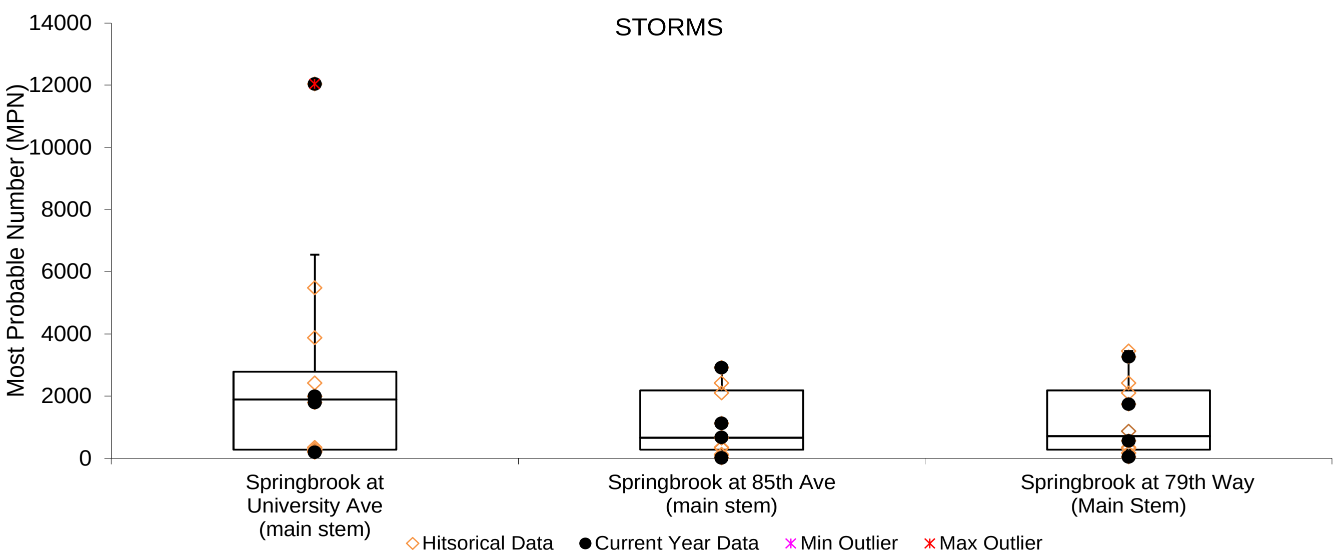
During storms E. coli was significantly higher (note the difference in scale on below charts), and there was very slight increase from upstream to downstream. Median E. coli during storms for all years from upstream to downstream were 1887.5, 659.4, and 711.2 MPN, respectively. 83% of storm samples taken in 2015 exceeded 126 MPN/100ml. All of the events that surpassed the 1260 MPN limit occurred during storms (44% of all storm samples).

Median E. *coli* in Springbrook Creek. Data is from All Sites through 2015.

	E. *coli* (MPN)	**State Standard**	**N**
Baseflow	108.5	Monthly Geometric Mean >126	36
Storms	768.2		36
All	194.2		72
Occasions >126 MPN **Occasions >1260 MPN**		Monthly 10% average >1260	17 baseflow, 32 storm 0 baseflow, 16 storm

E. *coli* at Springbrook. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

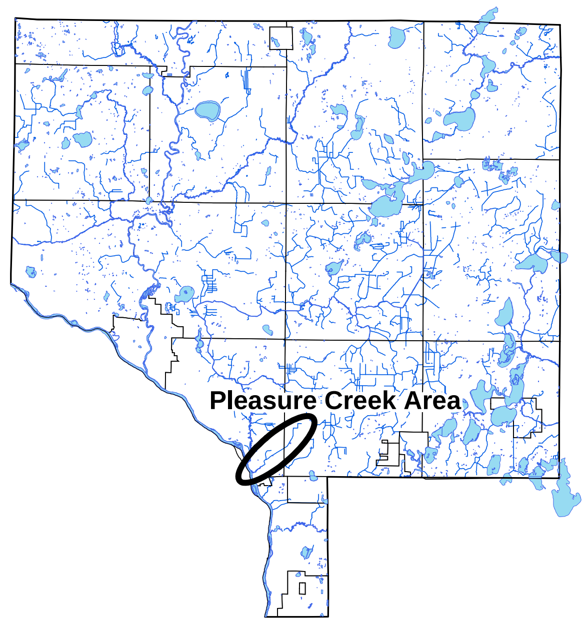




PLEASURE CREEK

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, 2012-2015 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 bottom 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 are in the near future, especially E. coli and total phosphorus.

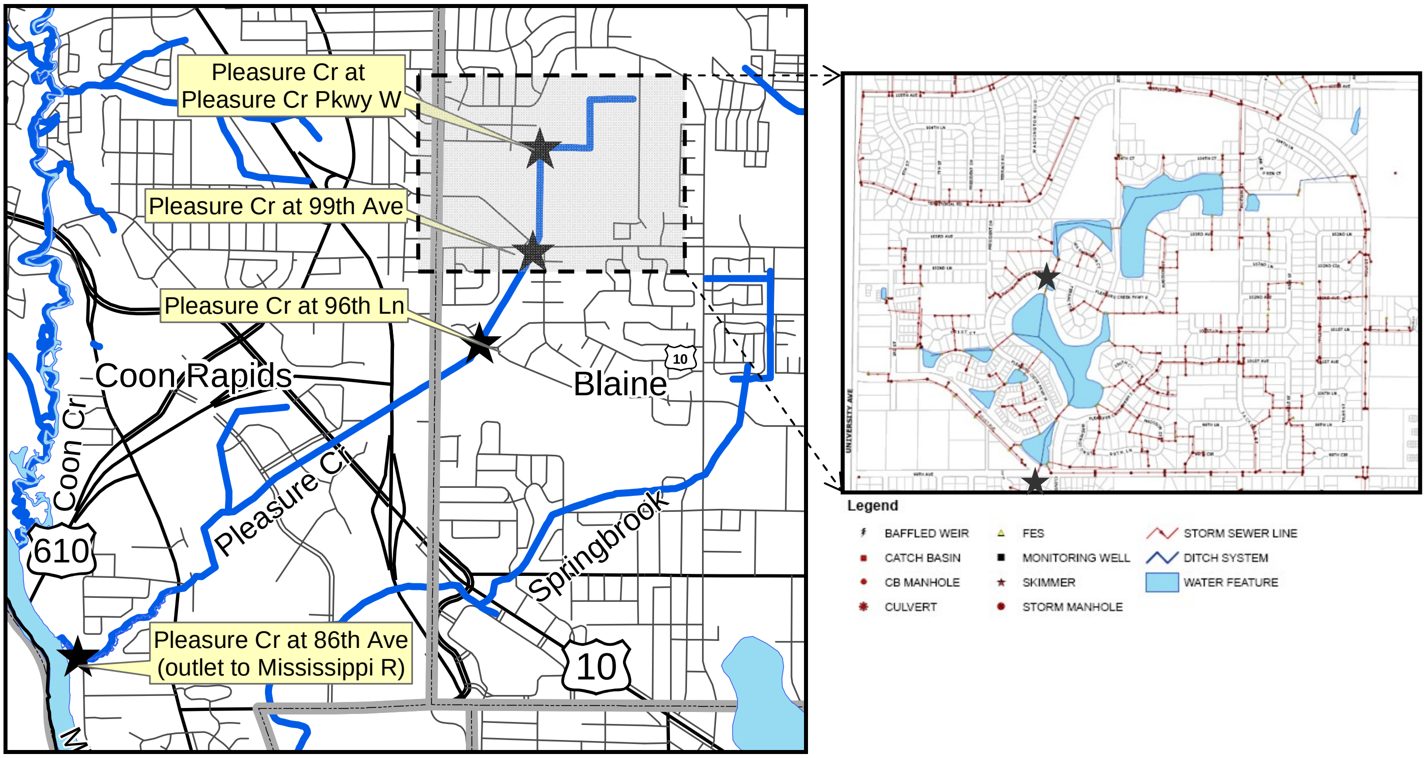
Methods

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, as well as photo-documentation of water appearance. 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 not monitored since 2012.

During every sampling the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using a datalogging electronic gauge 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.

Following is a parameter-by-parameter summary, including a management discussion:

- <u>Dissolved pollutants</u>, as measured by conductivity and chlorides, are higher in Pleasure Creek than any other Anoka Count stream except nearby Springbrook, which is similar. Both were elevated during storms and baseflow, but consistently higher concentrations were 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.

- <u>Phosphorus</u> 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 and storms at the upstream sites, but higher during storms. The low turbidity and TSS at the upstream sites is probably reflective of the effectiveness of large stormwater ponds in that area.

  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 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 used. 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 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, except nearby Springbrook which is similar. Median baseflow conductivity for all years at the 86th Ave site was 0.859 mS/cm. By comparison, the median for all streams in Anoka County is 0.362 mS/cm. There is no state water quality standard for conductivity.

Chlorides increased at the downstream site even more dramatically than conductivity. 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.

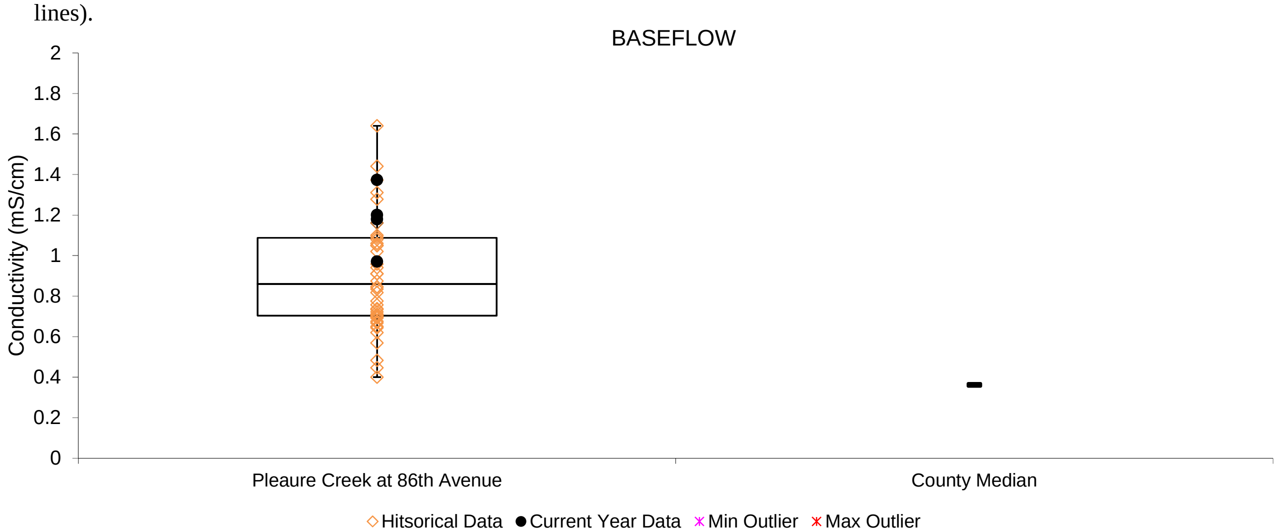
Both conductivity and chlorides where slightly higher during storms than baseflow. Median conductivity (all years) were 0.908 mS/cm during storms and 0.859 mS/cm during baseflow. Median chlorides were 178 mg/L during storms and 147 mg/L during baseflow. This result suggests that dissolved pollutants are high in the shallow groundwater that feeds the stream during baseflow, but slightly 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.

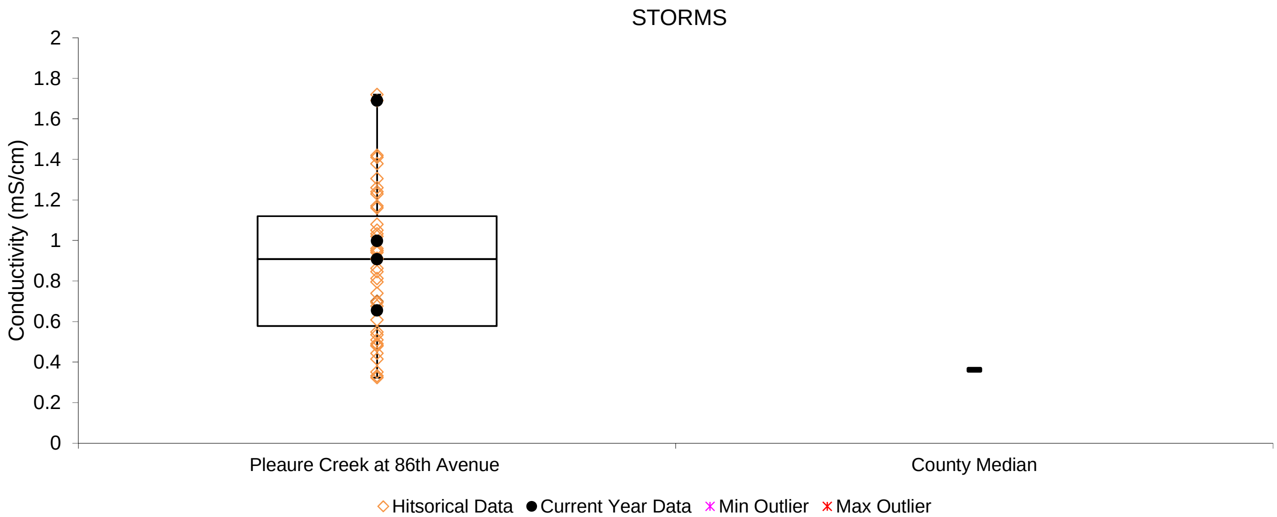
Dissolved pollutants are especially difficult to manage once in the environment. They are not removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also risk contaminating groundwater. The first approach to dissolved pollutant management must be to minimize their release into the environment.

Median conductivity and chlorides in Pleasure Creek at 86th Ave. Data is from all years through 2015.

	Conductivity (mS/cm)	Chlorides (mg/L)	State Standard	N
Baseflow	0.859	147	Conductivity – none Chlorides 860 mg/L acute, 230 mg/L chronic	46
Storms	0.908	178		43
All	0.874	159		89

Conductivity at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Conductivity: All Sites, all years in mS/cm

	Pleasure Creek at Pleasure Cr Pkwy			Pleasure Creek at 99th Ave NE			Pleasure Creek at 96th Ln			Pleasure Creek at 86th Ave		
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max
Baseflow	0.643	0.649	0.707	0.4	0.446	0.675	0.691	0.703	0.738	0.4	0.859	1.64
Storm	0.323	0.545	0.694	0.443	0.529	1.26	0.414	0.507	0.795	0.323	0.908	1.72
All Events	0.323	0.643	0.707	0.4	0.509	1.26	0.414	0.697	0.795	0.323	0.874	1.72

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.

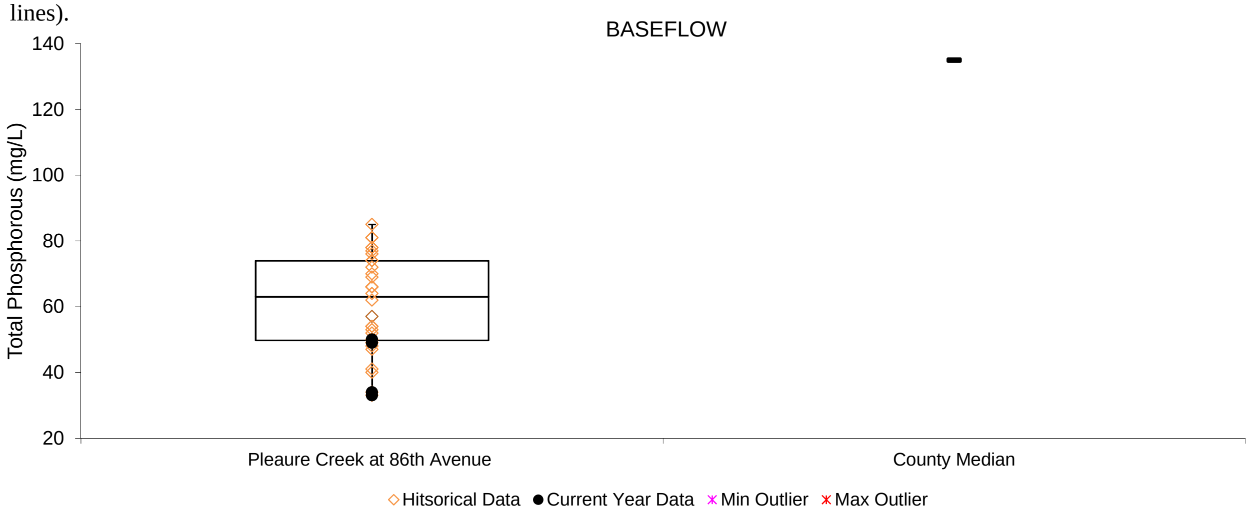
The MN Pollution Control Agency has a state standard of 100 ug/L. Based on data collected to date, Pleasure Creek usually falls within this standard during baseflow and storms.

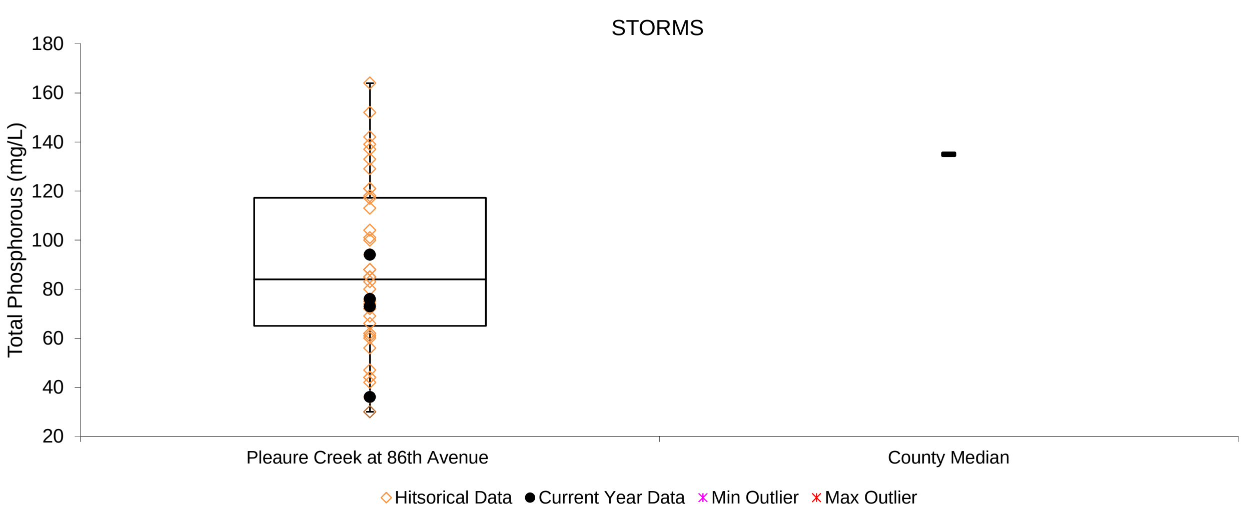
Median TP in Pleasure Creek. Data is from the 86th Avenue site and all years through 2015.

	Total Phosphorus (ug/L)	State Standard*	N
Baseflow	63	100	32
Storms	84		40
All	72		72
Occasions > state standard			14, all during storms

*New state standards are under development. The standard listed is the likely new threshold.

Total phosphorus at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Total Phosphorous: All Sites, all years in ug/L

	Pleasure Creek at Pleasure Cr Pkwy			Pleasure Creek at 99th Ave NE			Pleasure Creek at 96th Ln			Pleasure Creek at 86th Ave		
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max
Baseflow	74	76	78	52	66.5	81	66	73	81	33	63	85
Storm	85	127	152	44	61.5	118	44	80	104	30	84	164
All Events	74	117	152	44	61.5	118	44	74.5	104	30	72	164

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. 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.

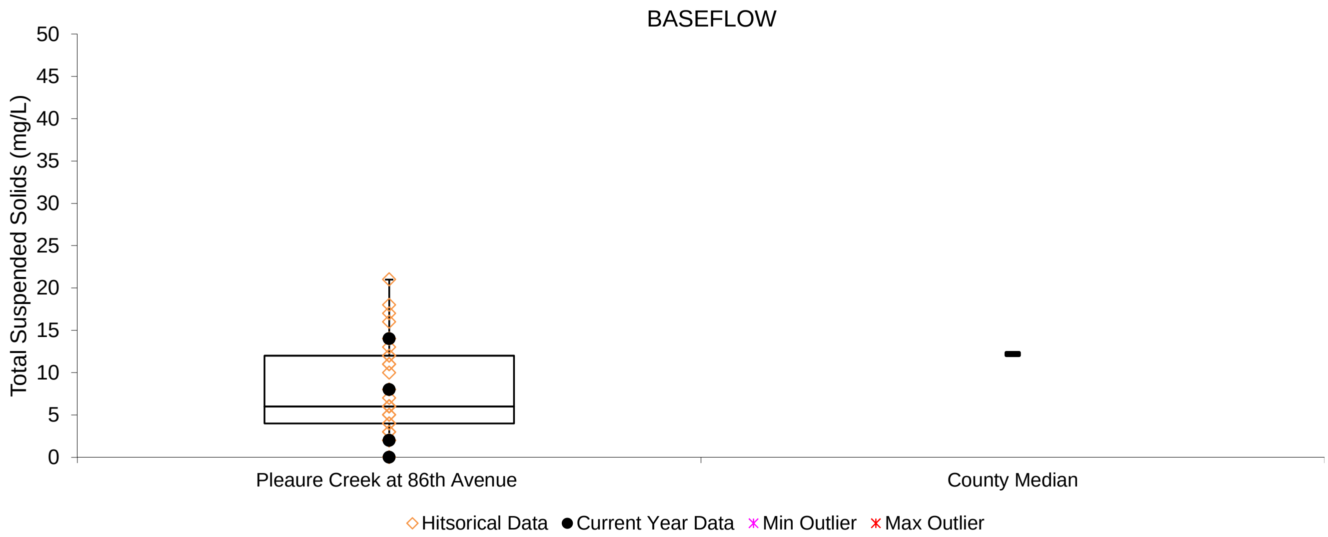
The MN Pollution Control Agency state standard for TSS is 30mg/L in this region. At the outfall to the Mississippi River Pleasure Creek exceeds this standard during storms and may be considered impaired. More than the required 20 samples needed for assessment have been collected, so the impaired designation will likely follow shortly after the new state standard is adopted. Additional stormwater treatment around and downstream of East River Road will be helpful at achieving the water quality standard.

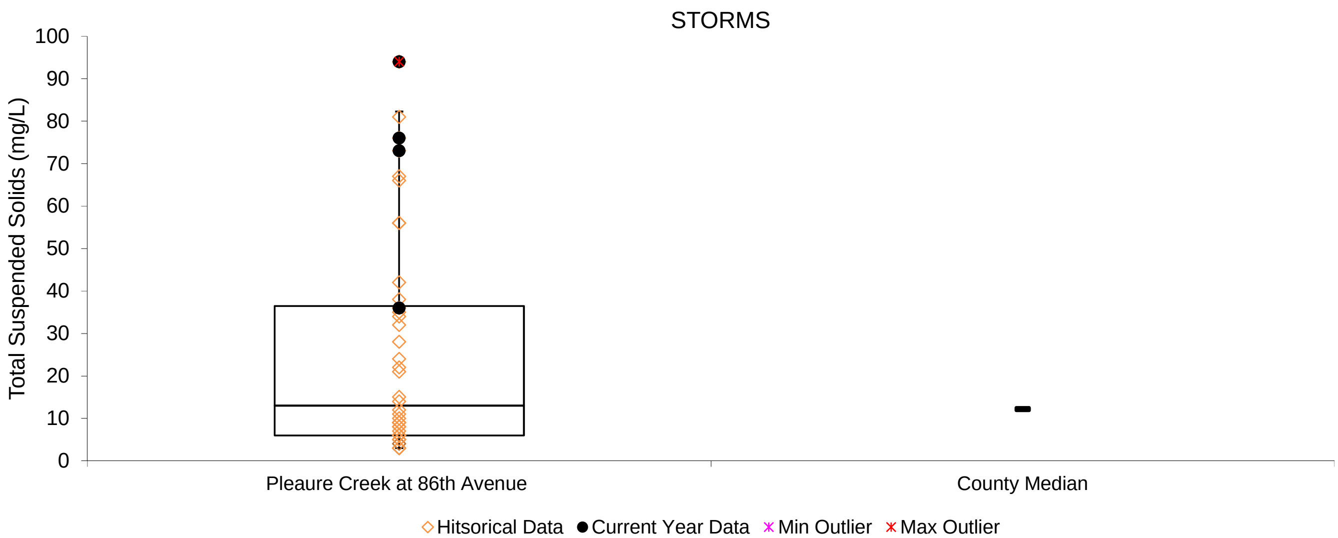
Median turbidity and suspended solids in Pleasure Creek. Data is from the 86th Avenue site and all years through 2015.

	Turbidity (FNRU)	Total Suspended Solids (mg/L)	State Standard*	N
Baseflow	8	6	30 mg/L TSS	45
Storms	18	13		43
All	12	9		83
Occasions > new state TSS standard				14, all during storms

*New state standards are under development. The standard listed is the likely new threshold.

Total suspended solids at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

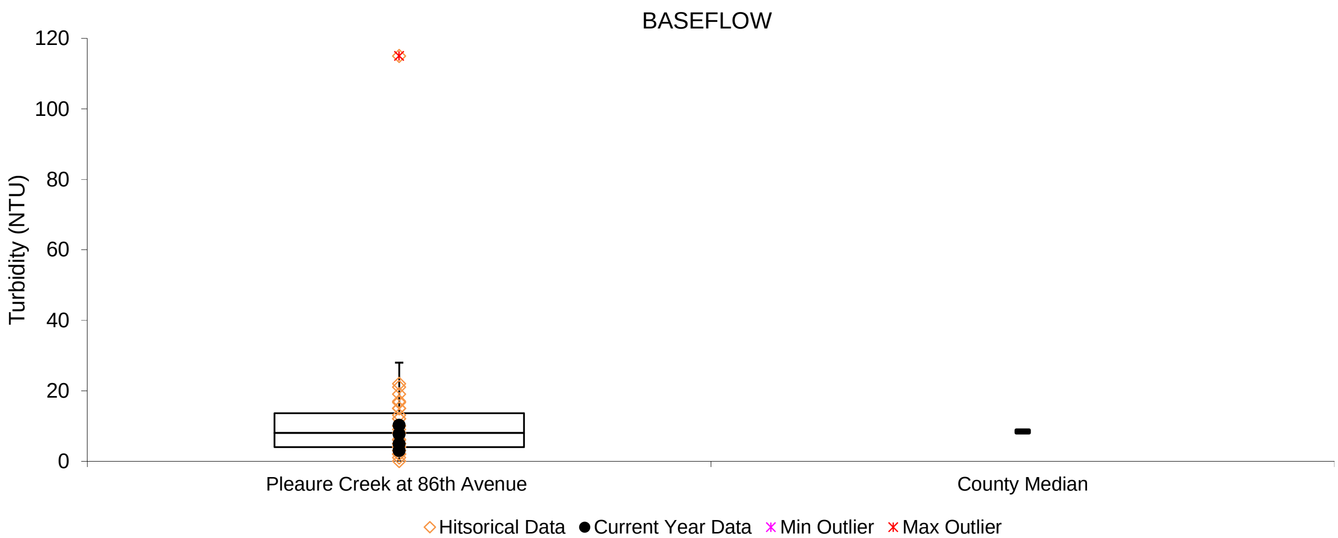


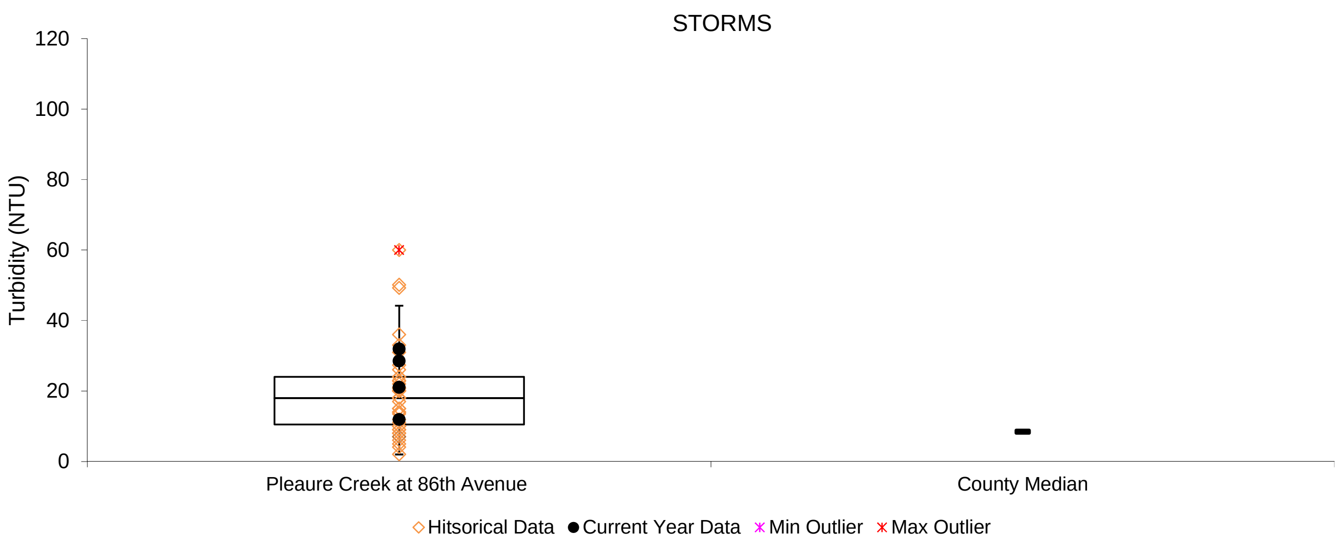


Total Suspended Solids: All Sites, all years in mg/L

	Pleasure Creek at Pleasure Cr Pkwy			Pleasure Creek at 99th Ave NE			Pleasure Creek at 96th Ln			Pleasure Creek at 86th Ave		
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max
Baseflow	6	10	14	2	6	10	2	2.5	3	2	6	21
Storm	6	9	22	3	4	8	5	5.5	8	3	13	94
All Events	6	9	22	2	4	10	2	4	8	2	9	94

Turbidity at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity: All Sites, all years in NTU

	Pleasure Creek at Pleasure Cr Pkwy			Pleasure Creek at 99th Ave NE			Pleasure Creek at 96th Ln			Pleasure Creek at 86th Ave		
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max
Baseflow	2	12	17	2	4	8	0	2	10	0	8	115
Storm	8	14	60	3	12.5	20	5	8.5	20	2	18	60
All Events	2	14	60	2	8	20	0	5	20	0	12	115

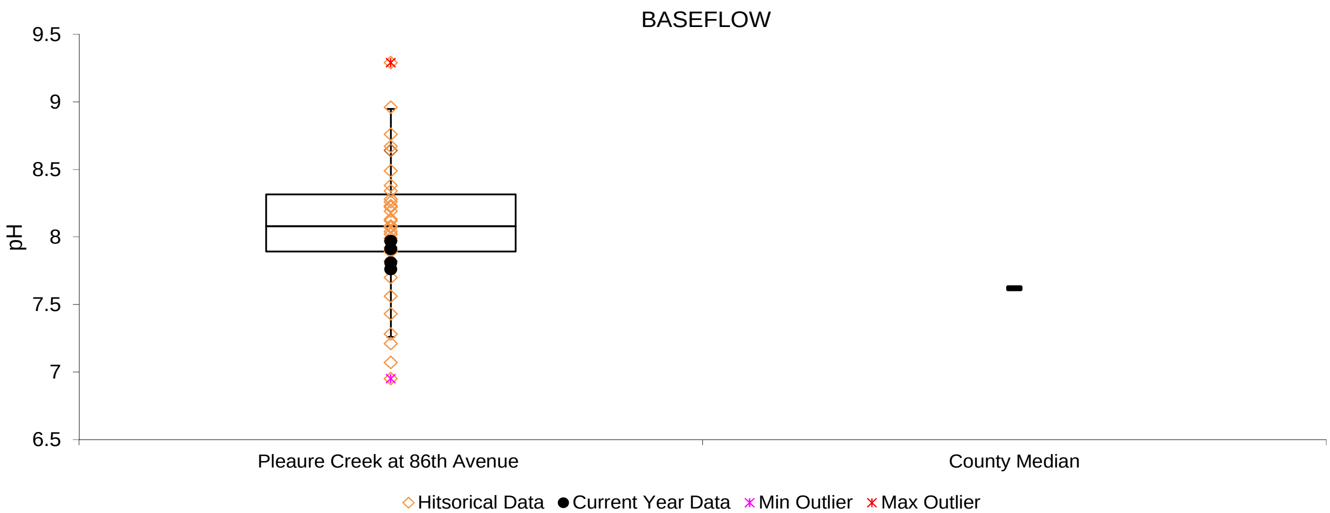
pH

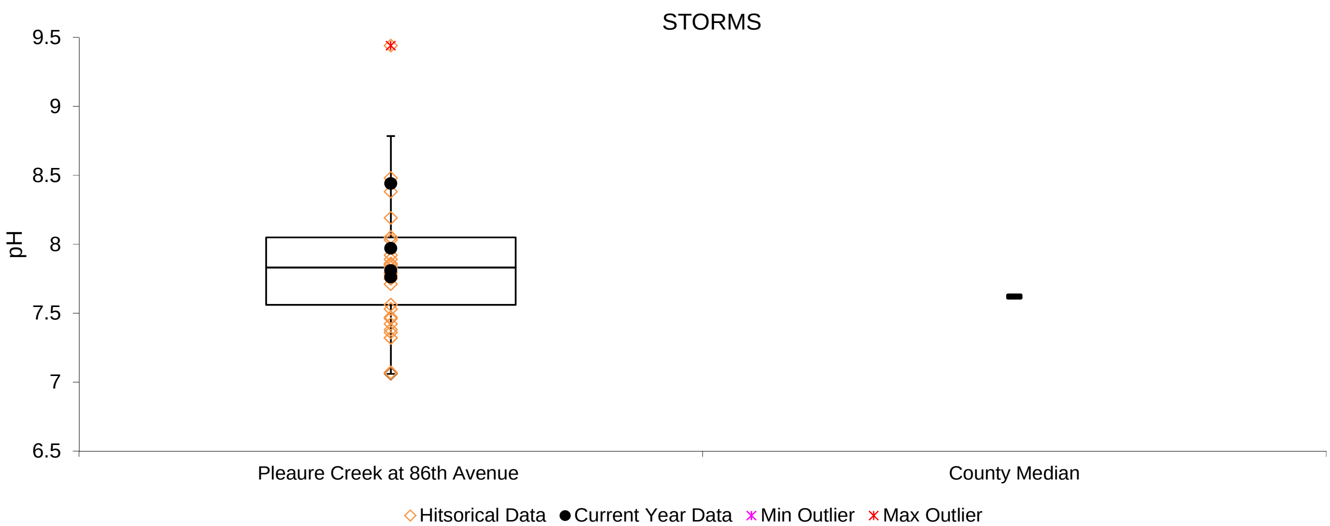
Pleasure Creek pH was within the expected range during all conditions (see figures below). The median for baseflow was 8.08 and the median for storms was 7.83. The Minnesota Pollution Control Agency water quality standards set an expectation for pH between 6.5 and 8.5.

Median pH in Pleasure Creek. Data is from the 86th Avenue site and all years through 2015.

	pH	State Standard	N
Baseflow	8.08	6.5-8.5	46
Storms	7.83		41
All	7.97		87
Occasions outside state standard			7

pH at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





pH: All Sites, all years

	Pleasure Creek at Pleasure Cr Pkwy			Pleasure Creek at 99th Ave NE			Pleasure Creek at 96th Ln			Pleasure Creek at 86th Ave		
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max
Baseflow	7.56	7.7	7.92	7.89	8.49	8.96	6.95	7.21	7.43	6.95	8.08	9.29
Storm	7.32	7.64	7.85	7.32	7.66	8.03	7.07	7.46	7.71	7.06	7.83	9.44
All Events	7.32	7.7	7.92	7.32	7.89	8.96	6.95	7.28	7.71	6.95	7.97	9.44

Dissolved Oxygen

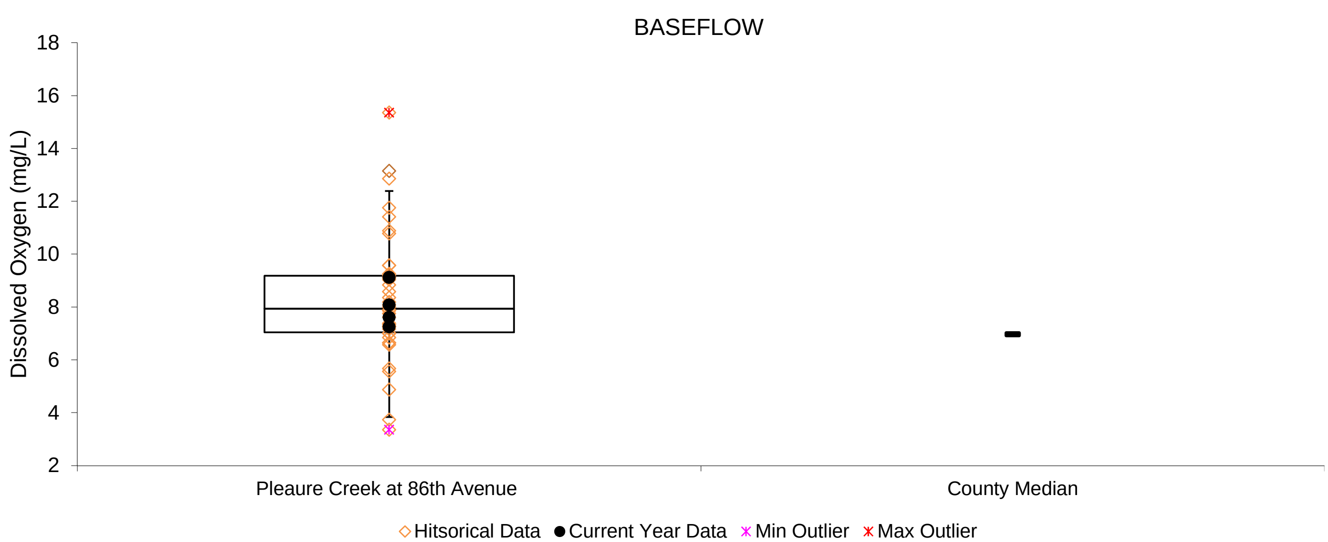
Dissovled oxygen (DO) essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO is below 5 mg/L. Low DO can be a symptom of organic pollution, the decomposition of which reduces oxygen.

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 2015.

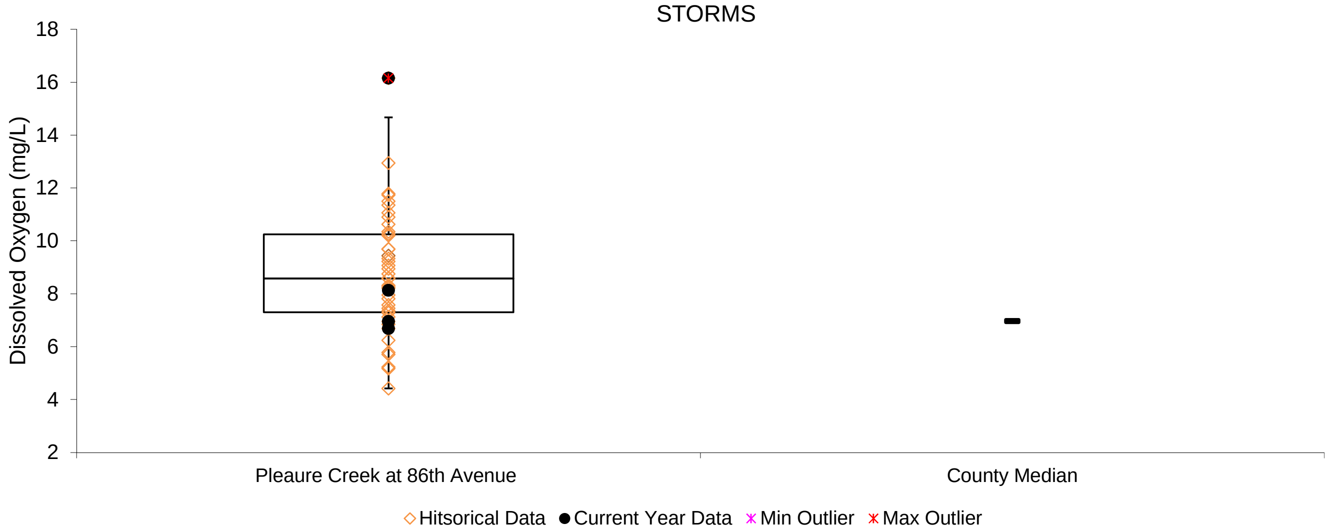
Median dissolved oxygen in Pleasure Creek. Data is from the 86th Avenue site and all years through 2015.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	7.94	5 mg/L daily minimum	42
Storms	8.58		42
All	8.22		84
Occasions <5 mg/L			4

Dissolved Oxygen at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2015 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 Continued…..



DO: All Sites, all years in mg/L

	Pleasure Creek at Pleasure Cr Pkwy			Pleasure Creek at 99th Ave NE			Pleasure Creek at 96th Ln			Pleasure Creek at 86th Ave		
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max
Baseflow	3.35	3.73	7.75	5.56	7.25	12.85	4.87	8.19	11.41	3.35	7.94	15.35
Storm	4.42	6.31	11.49	5.17	7.37	10.62	6.24	9.75	11.78	4.42	8.58	16.15
All Events	3.35	5.78	11.49	5.17	7.28	12.85	4.87	8.59	11.78	3.35	8.22	16.15

E. coli Bacteria

E. *coli* is a bacteria found in the feces of warm blooded animals. E. *coli* is an easily testable 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.

Data collected in 2014 was generally higher than 2013 and more matched previous year's results. Both the baseflow median (261 MPN/100mL) and the storm event median (98 MPN/100mL) were higher than 2013 observations. All of the baseflow monitoring and 63% of total events exceeded 126 MPN/100mL. Only one storm event exceeded 126 MPN/100mL.

E. coli levels were highest and most variable at the outlet to the Mississippi River during storms (see figures below). Average baseflow E. coli was 345.3 MPN/100mL (units MPN/100mL are comparable to cfu/100mL and differ in analytical method) and varied little (standard deviation 305). During storms average E. coli decreased to 252.3 MPN/100mL and varied widely (standard deviation 968). A large part of this variability might be explained by the intensity of the storm, phenology of the storm, and when during the storm the sampling was done. E. coli during storms is higher because storms flush bacteria from impermeable surfaces throughout the watershed, and because higher flows suspend and transport E. coli that were already present in the creek.

In 2008 monitoring occurred at the Blaine-Coon Rapids Boundary (96th Lane) to determine if the problem originated up or downstream of that point. Average baseflow E. coli was 235 MPN/100mL (n=4) and varied little (standard deviation 135). Average storm E. coli was 1102 MPN/100mL (n=3) and varied widely (standard deviation 1187). This is similar to the outlet to the Mississippi River, so it appears that an important bacteria source is within the City of Blaine. It is likely that urban runoff within Coon Rapids is also contributing E. coli to the stream.

In 2009 monitoring moved further upstream to diagnose the bacteria source. The portions of the watershed above the 2008 monitoring site are a network of stormwater ponds in the City of Blaine. 2009 monitoring was designed to determine which drainage areas to these ponds are bacteria sources or if the ponds themselves might be the source. One monitoring site split was mid-way through the pond network (Pleasure Cr Parkway W), while the other was at the outlet of the last pond (99th Avenue, see monitoring sites map above). Most monitoring (6 of 8 occasions) was during storms because the highest bacteria levels were found during storms in previous years. The results suggest that the ponds themselves are a source of E. coli, while additional bacteria may come from the neighborhoods around the ponds.

The monitoring site mid-way through the pond network (Pleasure Cr Parkway W) did have elevated E. coli during baseflow and storms, which suggests that the small drainage area upstream of this site contributes E. coli to the creek. Only two baseflow samples were taken and little flow was moving; E. coli levels were 307 and 770 MPN/100mL, which is moderately high. This would seem to suggest that bacteria levels may have a regular, non-storm related presence in the ponds (i.e. the ponds are a bacteria source). During storms, six samples had widely different E. coli levels. On the low end, one storm had only 34 MPN/100mL and another had only 122 MPN/100mL. These readings are below the state water quality standard. Two other storms had moderate E. coli levels of 307 and 387 MPN/100mL. But during the other two storms E. coli levels were so high they exceeded the laboratory's maximum test result of 2420 MPN/100mL. E. coli levels were not correlated with precipitation totals or stream water level.

The monitoring site at the bottom of the Blaine pond network (99th Avenue) had low E. coli during baseflow. Only two samples were taken during baseflow, and the E. coli levels were low (55 and 58 MPN/100mL). While two samples are too few for a confident assessment, it suggests that few bacteria exit the last stormwater pond during baseflow. The last ponds are the largest and deepest, and therefore least likely to harbor bacteria and most likely to remove them during baseflow. While the smaller, shallower upper ponds may harbor E. coli, the larger, deeper lower ponds remove them during baseflow. Howerver, higher flows during storms can allow bacteria to pass through all of the ponds.

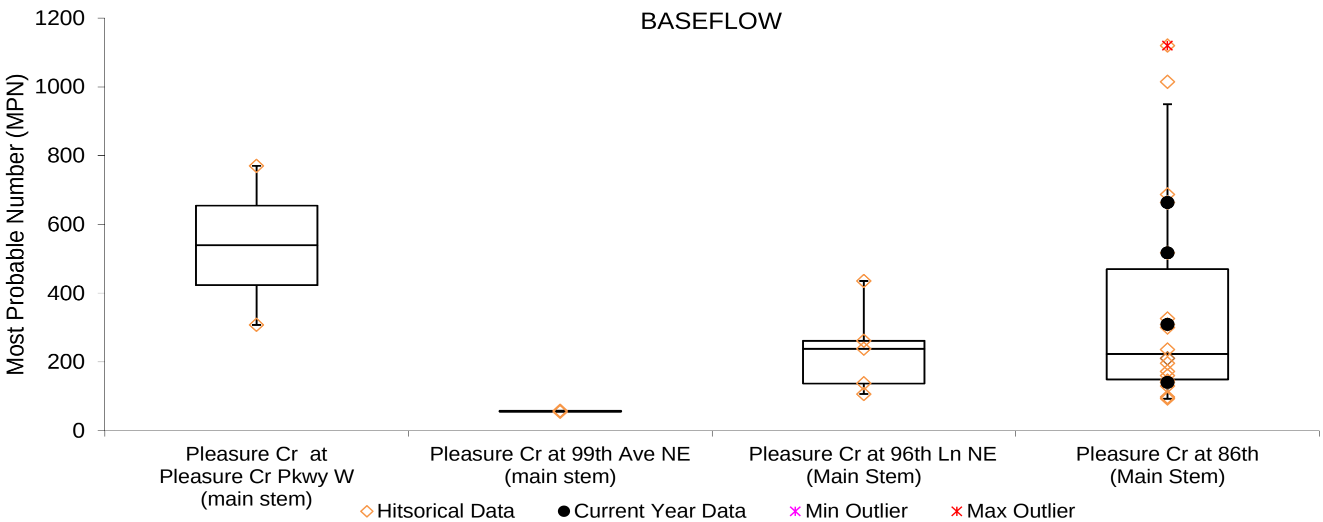
E. coli levels during storms at 99th Avenue were much more variable, similar to what was found in the ponds. While one storm sample had desirably low E. coli (104 MPN/100mL), others were high (248, 435, 727, 727, and 1986 MPN/100mL). This indicates some bacteria pass through the ponds, or are flushed from them, during storms. E. coli levels were not correlated with precipitation totals or stream water level.

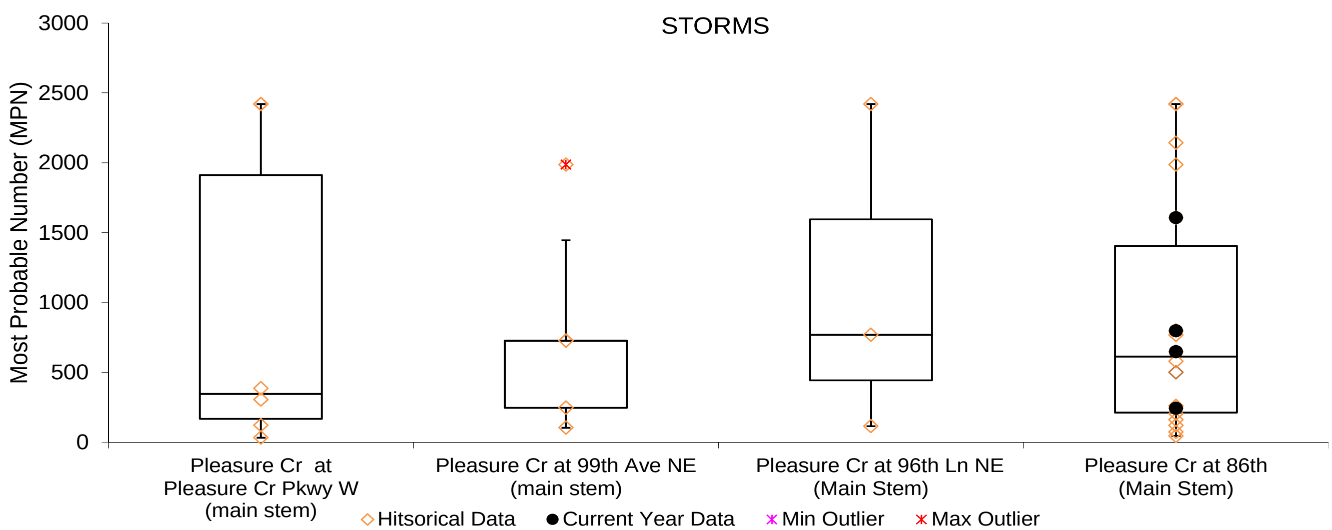
There is some evidence that E. coli is not associated with nutrient-rich sources such as wastewater. Phosphorus in Pleasure Creek is low, especially for an urban stream (see phosphorus section of this report). If wastewater or other nutrient rich sources were significant, phosphorus would be higher.

Median E. *coli* in Pleasure Creek. Data is from Outlet to Mississippi site only, all data through 2015.

	E. *coli* (MPN)	State Standard	N
Baseflow	223	Monthly Geometric Mean >126	18
Storms	614		18
All	305		36
Occasions >126 MPN **Occasions >1260 MPN**		Monthly 10% average >1260	16 baseflow, 15 storm 0 baseflow, 5 storm

E. *coli* at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2015 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Fecal coliform and fecal streptococcus bacteria testing was done at 99th Avenue in 2009 to determine if the bacteria source was human sewage. The feces of different animals have different ratios of these two bacteria types (see table below). Admittedly, this is an imperfect test for several reasons. First, pollution from multiple sources can alter the ratio. Second, bacterial ratios will change over time because of different die-off rates; fecal streptococci die-off faster thereby increasing the ratio and possibly resulting in incorrect determinations that the bacterial source is human. Research has found that these bacteria types can survive and reproduce outside of the digestive tracts of warm-blooded animals. The population dynamics of these "free-living" bacteria could affect the ratio. These limitations are important to recognize when interpreting the data.

Fecal coliform to fecal streptococcus bacteria ratios in the feces of various animals. (source: Microbiological examination of water and wastewater by Csuros and Csuros, 1999)

Source	Ratio	Source	Ratio
Human	4.4	Pig	0.4
Duck	0.6	Cow	0.2
Sheep	0.4	Turkey	0.1
Chicken	0.4		

Fecal coliform to fecal streptococcus ratios consistently indicated that the bacteria source is not human feces (i.e. ratio <4.4). On average, the ratio was 0.30 (n=8, standard deviation 0.31). The highest observed ratio was 1.03 and lowest was 0.03. There was no apparent difference between storms (n=6, average 0.30, standard deviation 0.36) and baseflow (n=2, average 0.28, standard deviation 0.07).

Likely bacterial sources include:

- **Urban stormwater**. It is well documented that urban stormwater runoff has elevated E. coli. There is no reason to believe that this is not true across Pleasure Creek's watershed. The absence of a step-wise increase in bacteria downstream suggests that bacterial concentrations of stormwater entering the stream are not greater than those already in the stream.

  It should be noted that no animal concentrations for feedlots are known to exist in the watershed that would contribute significant fecal or coliform bacteria.

- **Stormwater ponds**. Although stormwater ponds generally remove pollutants by allowing settling there are many documented instances throughout the U.S. where the ponds accumulate fecal bacteria that are then flushed out during larger storms. Research has shown that these bacteria can survive and reproduce outside of the intestines of warm-blooded animals. Survival is longest when the water temperature is lower, sun exposure is less, and bacterivorous predators (nematodes, ciliates, rotifers, etc) are fewer. Some bacteria are attached to particles that settle within stormwater ponds but are still vulnerable to resuspension during storms, while others are "free" and less likely to settle.

Waterfowl congregating on Pleasure Creek near Evergreen Blvd in Coon Rapids, February 2010. 250+ ducks were present in about 350 meters of creek.

  Of particular interest are the 11 stormwater ponds that the creek flows through in its headwaters in the City of Blaine. These ponds and the developments around them were built post-1995. Some are small and shallow and serve as forebays to the larger, deeper ponds. The stormwater pond network in Blaine is likely a source of bacteria, collecting them from polluted runoff, harboring them, and releasing them (especially during storm flushing). Smaller, shallower upper ponds are the most suitable for bacterial survival. The larger, deeper lower ponds are less suitable for bacteria and seem to remove them from the system during baseflow but not during storms. While these ponds do a good job removing suspended solids in all conditions, they do not regulate water rate and volume during storms well. These storm flushes can provide a means for transporting bacteria. The fact that suspended solids seem to be captured by the ponds during storms but not bacteria seems inconsistent and deserves more research.

- **Waterfowl**. Waterfowl congregations on Pleasure Creek primarily occur in winter. During this time several hundred ducks have been observed in Coon Rapids near Evergreen Boulevard (see photo). The ducks keep the water from icing over.

  In the summer small waterfowl congregations do occur in places around the watershed, but none are large. Waterfowl usage of the network of stormwater ponds that the creek flows through in Blaine would be of greatest concern, but few birds congregate there. The ponds are encircled with a >25 foot wide buffer of unmowed vegetation designed to filter runoff, but which also discourages waterfowl. Some birds do use the ponds for resting or feeding on the water, but no concentrations of more than 10 birds were seen by staff during monitoring. The stormwater ponds in Coon Rapids near the railroad tracks have not been checked for summer waterfowl congregations.

Possible, but likely minor, bacterial sources include:

- **Stormwater sumps/catch basins**. The catch basins below many curbside gutters are designed to capture solids. The dark, moist environment with consistently moderate temperatures might be favorable for bacteria, although this is not well documented or researched to our knowledge. Any bacteria in these basins would be flushed out by larger storms. Catch basin sumps have been found to capture solids during small storms but some is flushed out during intense storms.
- **Sanitary sewer.** Sanitary sewer could contribute either through leaking pipes or if a wastewater pipe improperly intersects with a storm water pipe. The extent of this occurring is unknown. Dry-weather screening of stormwater outfalls for illicit discharges could be used to detect any such problems. The lower bacterial concentrations during baseflow suggests this may not be an issue, as does the fecal coliform to streptococcus ratio.

<u>Summary of E. coli Findings</u>

In total, the results of the monitoring efforts can be summarized as follows:

- E. coli bacteria contamination is throughout Pleasure Creek, from the headwaters to the outlet to the Mississippi River.
- Bacteria levels during baseflow exceed state water quality standards on a regular basis.
- Bacteria levels during storm flows grossly exceed state water quality standards on a regular basis.
- The source is not human feces.
- Urban stormwater runoff is a likely E. coli source watershed-wide.
- The stormwater pond network in Blaine is one likely source of bacteria, collecting them from polluted runoff, harboring them, and releasing them (especially during storm flushing). Smaller, shallower upper ponds are the most suitable for bacterial survival. The larger, deeper lower ponds are less suitable for bacteria and seem to remove them from the system during baseflow but not during storms.

We recognize that most of these conclusions cannot be supported with 100% confidence. However, the limited amount of work done to date is consistent in pointing to these conclusions.

It is worth noting that understanding of E. coli impairments and tools to effectively address them are lacking. Historically, E. coli was viewed as an indicator of sewage pollution. In some cases it is. Today we know E. coli levels are elevated in virtually every urban environment, most animal agriculture areas, and even in some forested areas. Elevated E. coli has been documented in places that are counter-intuitive, such as water draining from rooftops. E. coli's ability to survive outside of the gut of warm-blooded animals means that it may not always be a good indicator of the presence of fecal pathogens. The extreme variability in bacterial counts in Pleasure Creek during similar storms illustrates our incomplete understanding of the situation and many factors that are probably affecting it. 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.

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 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.

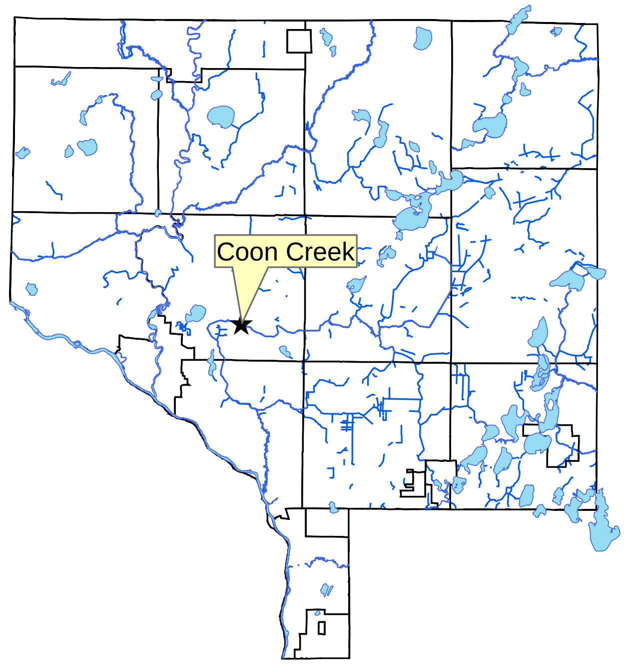
Family Biotic Index (FBI) — An index that utilizes known pollution tolerances for each family. Lower numbers indicate better stream quality.

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.

COON CREEK

at Crosstown Blvd near Andover High School, Andover



Last Monitored

By Andover High School in 2015

Monitored Since

Fall 2003

Student Involvement

90 students in 2015, approximately 1,278 since 2003

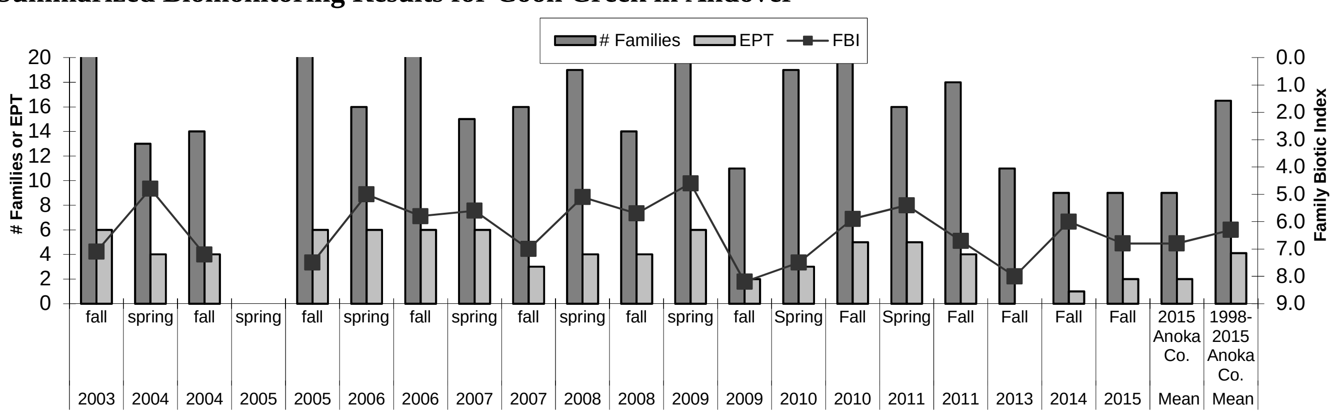
Background

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 2015. 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 2015, fall samples produced invertebrate indices lower than the average for streams in Anoka County.

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	2009	2009	2010	2010	2011	2011	2013	2014	2015	Mean	Mean
Season	Spring	Fall	Spring	Fall	Spring	Fall	Fall	Fall	Fall	2015 Anoka Co.	1998-2015 Anoka Co.
FBI	4.60	8.20	7.5	5.9	5.4	6.7	8.0	6.0	6.7	6.7	6.3
# Families	21	11	19	27	16	18	11	9	10	10.0	16.6
EPT	6	2	3	5	5	4	0	1	2	2.0	4.1
Date	15-May	29-Sep	13-Apr	5-Oct	10-Jun	23-Sep	28-Oct	3-Oct	25-Sep		
Sampled By	AHS	AHS	AHS	AHS	ACD	AHS	AHS	AHS	AHS		
Sampling Method	MH	MH	MH	MH	MH	MH	MH	MH	MH		
Mean # Individuals/Rep.	679	203	207	446	165	154	64.5	198	589		
# Replicates	1	1	1	1	1	1	6	1	1		
Dominant Family	Baetidae	Corixidae	Corixidae	Calopterygidae	Baetidae	Belostomatidae	Corixidae	Corixidae	Siphlonuridae		
% Dominant Family	68.9	51.2	45.4	28.7	24.2	27.9	48.1	37.9	39		
% Ephemeroptera	70.3	1.5	0.5	14.1	28.5	10.4	0.0	0.0	39.0		
% Trichoptera	3.2	2.0	1.9	2.0	9.7	9.1	0.0	0.0	1.3		
% Plecoptera	0.0	0.0	0.0	0.0	9.7	0.0	0.0	0.0	0.0		

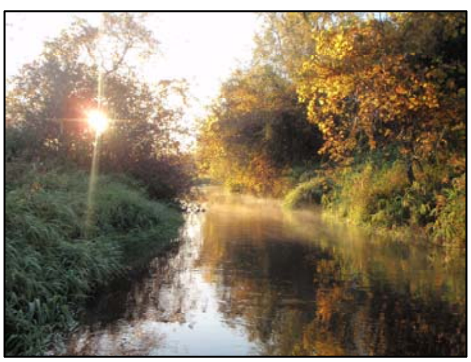
Supplemental Stream Chemistry Readings

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

Parameter	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.

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 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

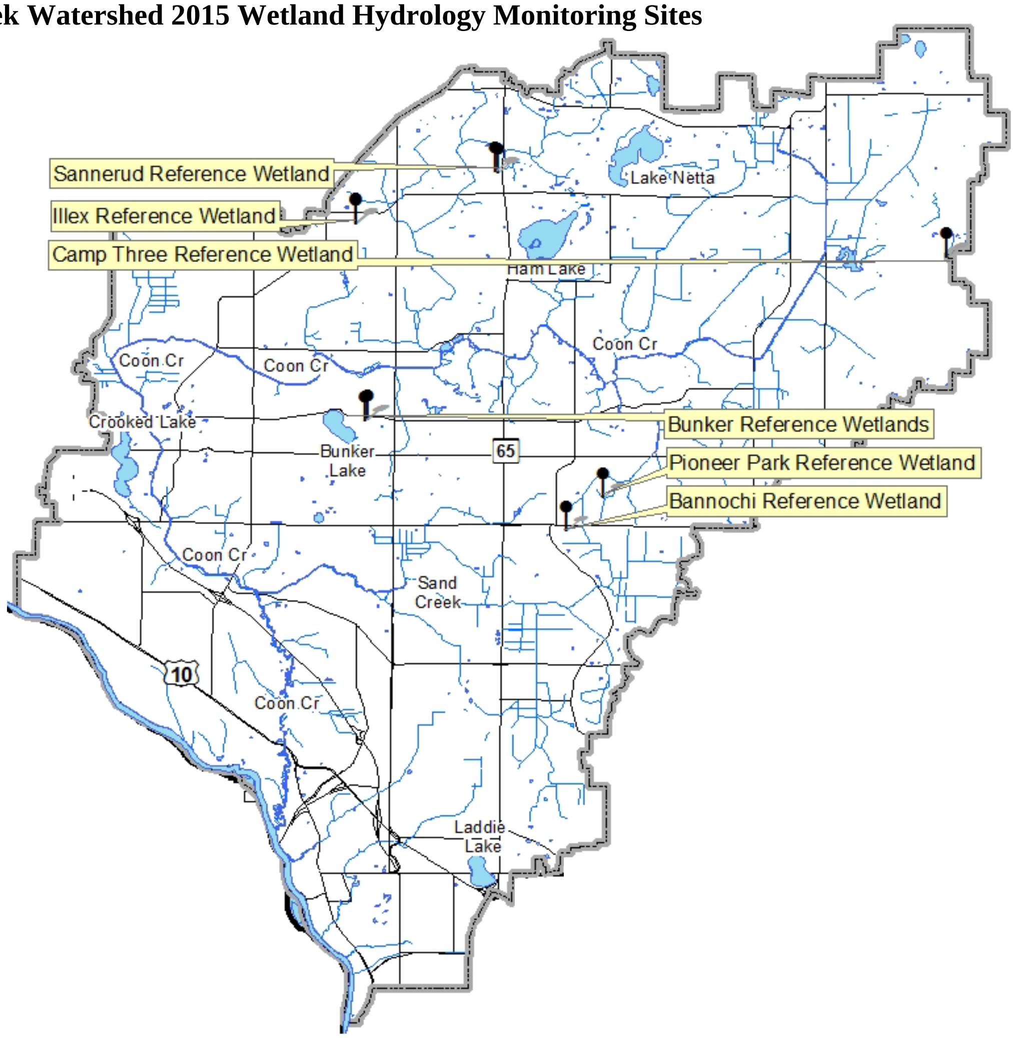
Ilex Wetland, City Park at Ilex St and 159th Ave, Andover
(middle and edge of Ilex Wetland are monitored)

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 2015 Wetland Hydrology Monitoring Sites

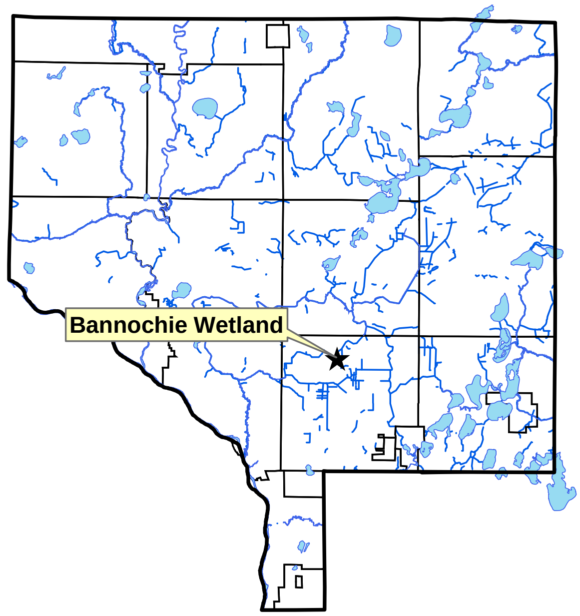


Wetland Hydrology Monitoring

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	-

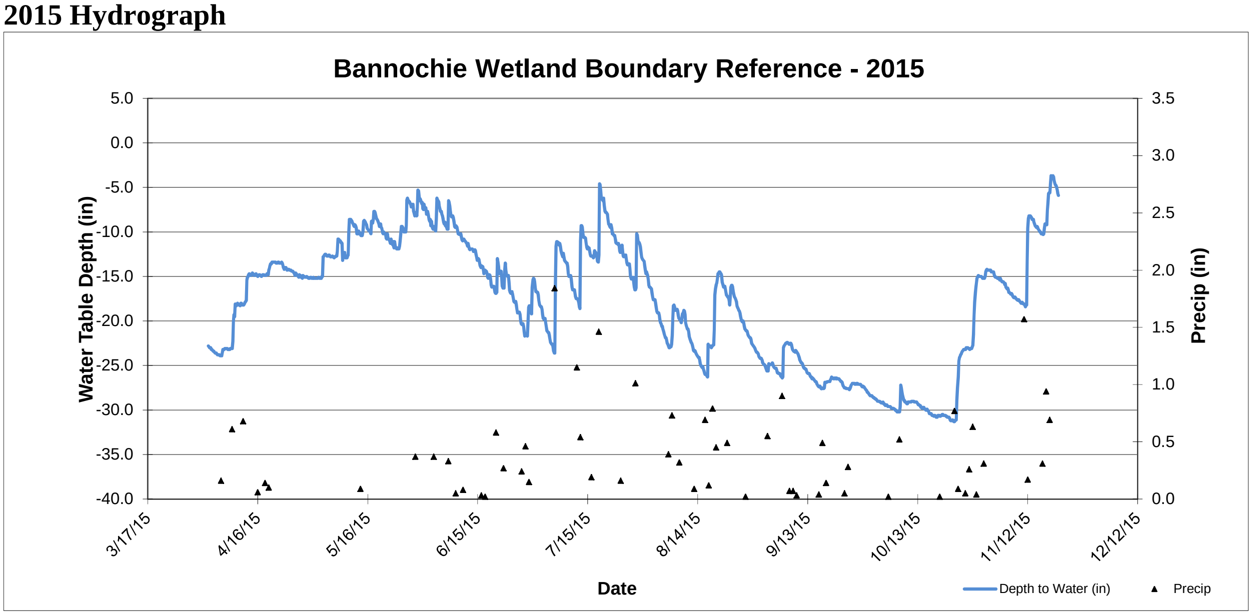
Surrounding Soils: Rifle and some Zimmerman fine sand

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.

2015 Hydrograph



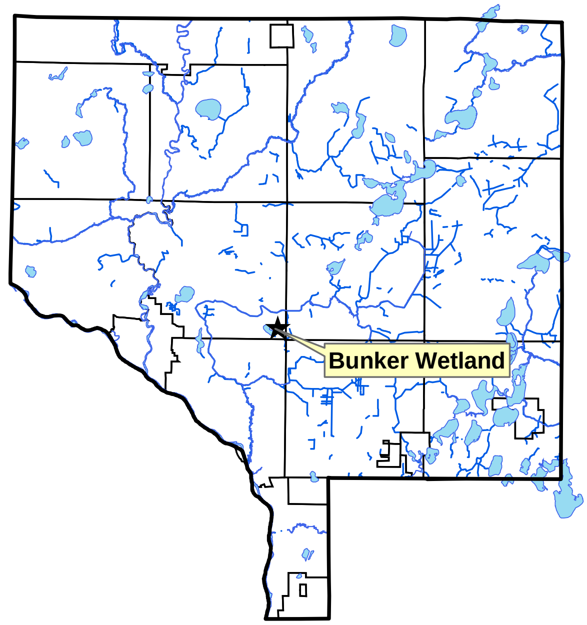
Well depth was 39 inches, so a reading of –39 or less indicates water levels were at an unknown depth greater than or equal to 39 inches.

Wetland Hydrology Monitoring

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	-

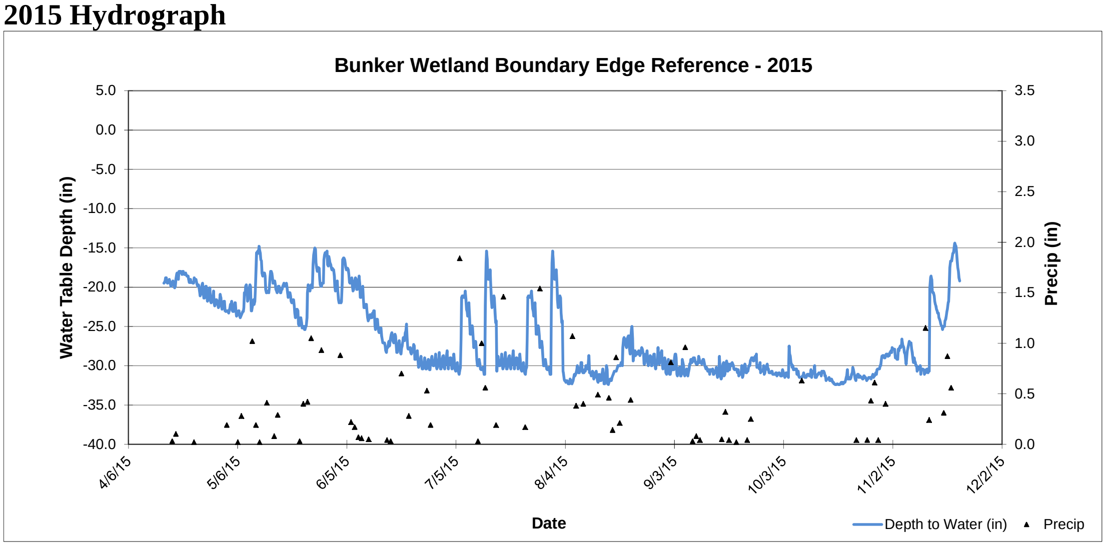
Surrounding Soils: Zimmerman fine sand

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.

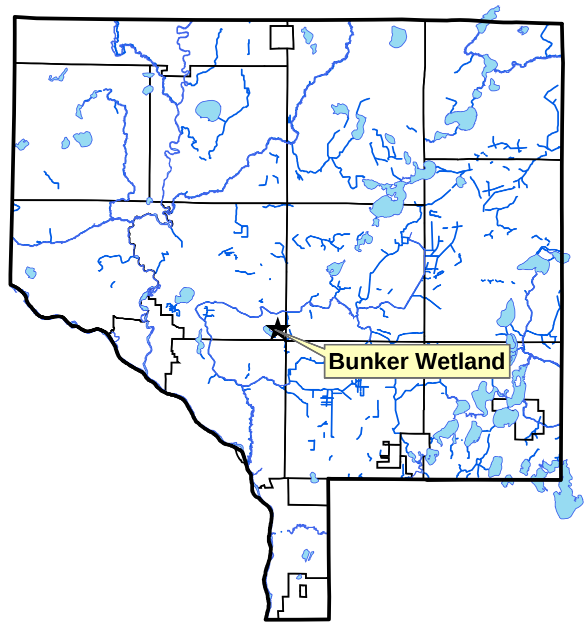
2015 Hydrograph



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	-

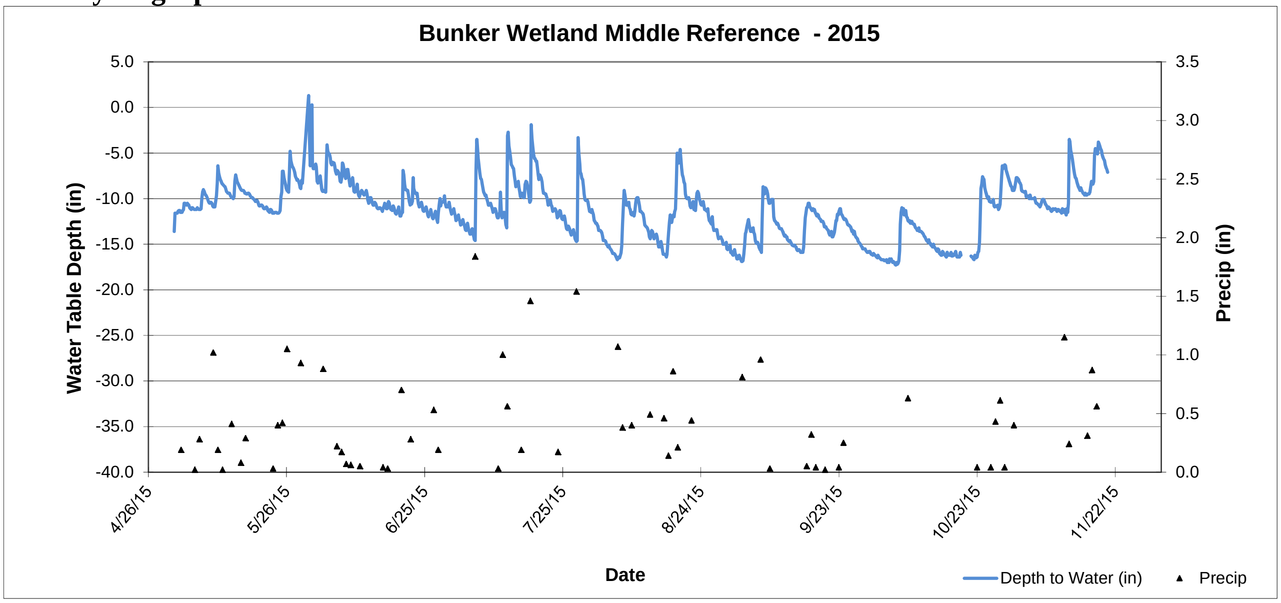
Surrounding Soils: Zimmerman fine sand

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.

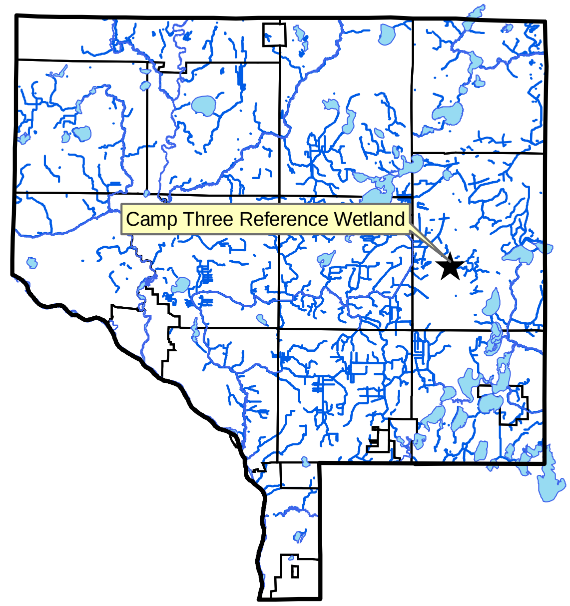
2015 Hydrograph



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.

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

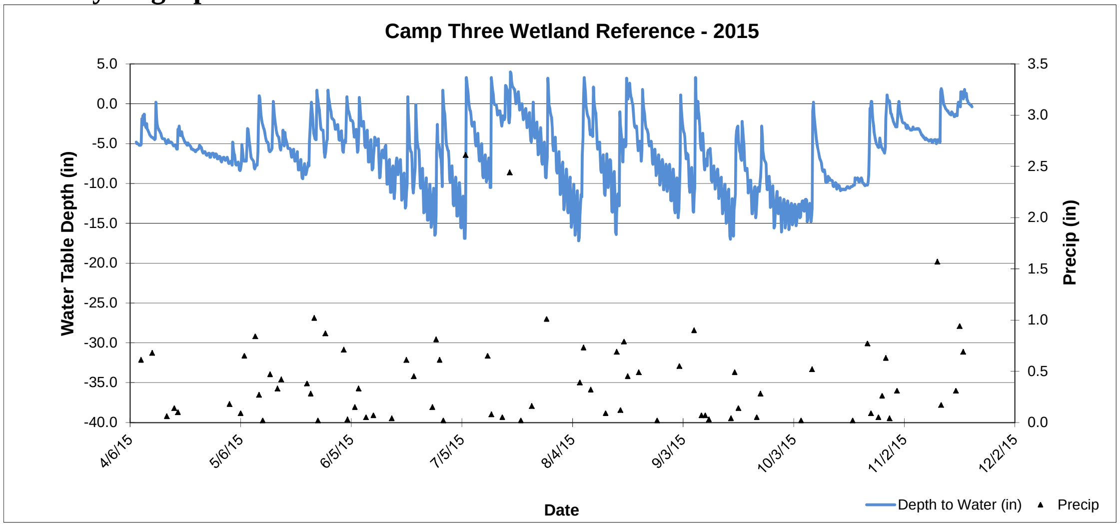
Surrounding Soils: Zimmerman Fine Sand

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.

2015 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

ILEX REFERENCE WETLAND - EDGE

City Park at Ilex St and 159th Ave, Andover

Site Information

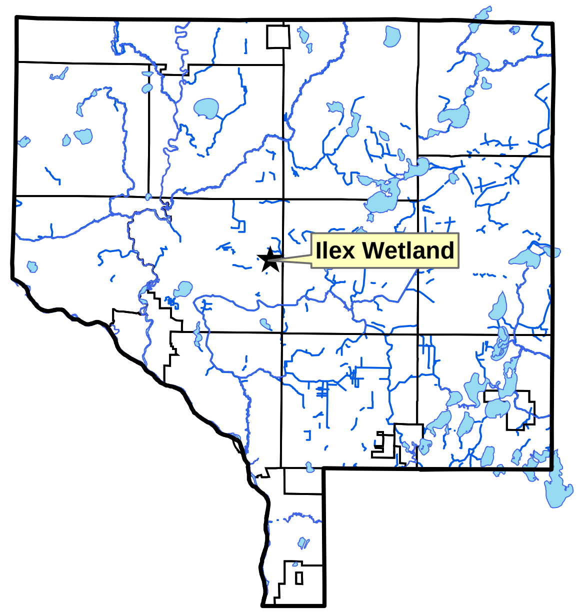
Monitored Since: 1996

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	-

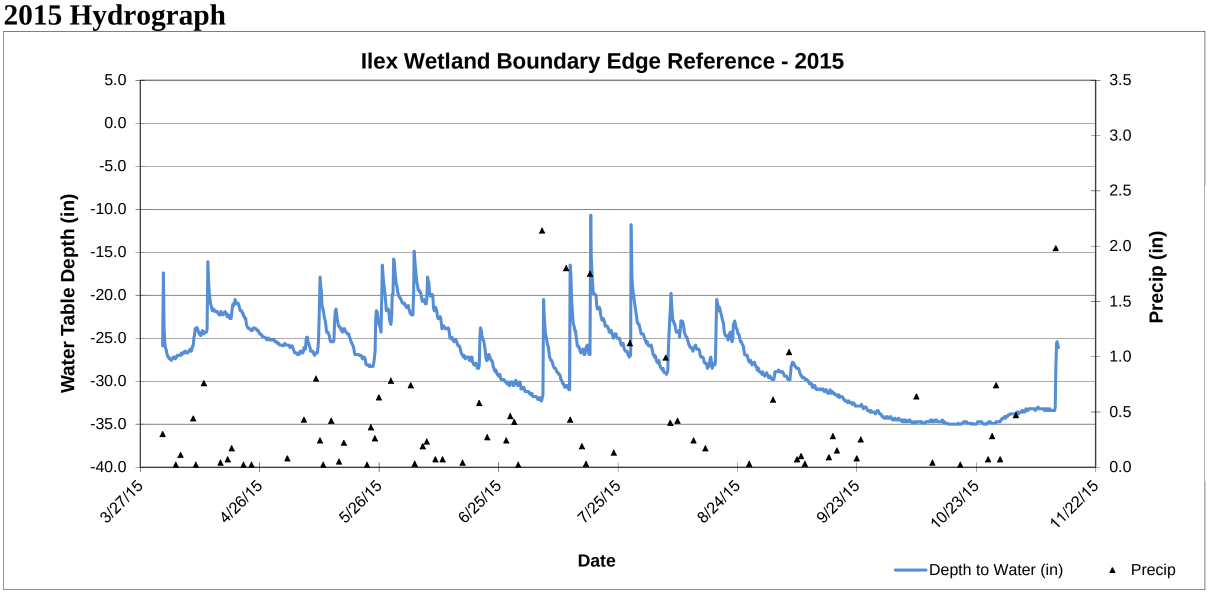
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

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.

2015 Hydrograph

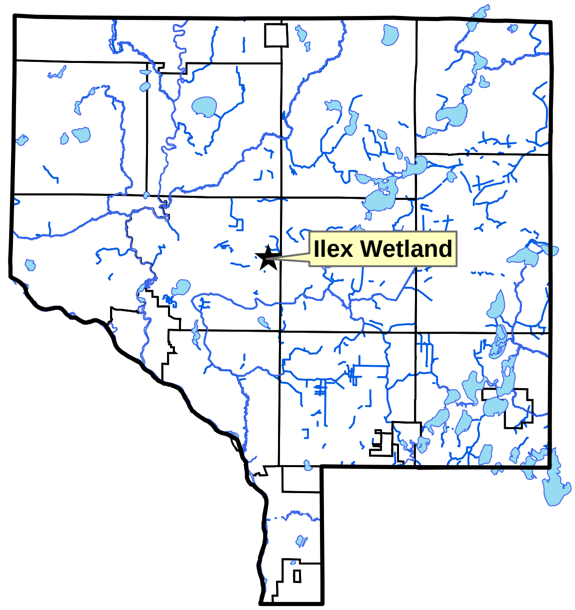


Well depth was 40 inches, so a reading of –40 indicates water levels at an unknown depth greater than or equal to 40 inches.

Wetland Hydrology Monitoring

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	-

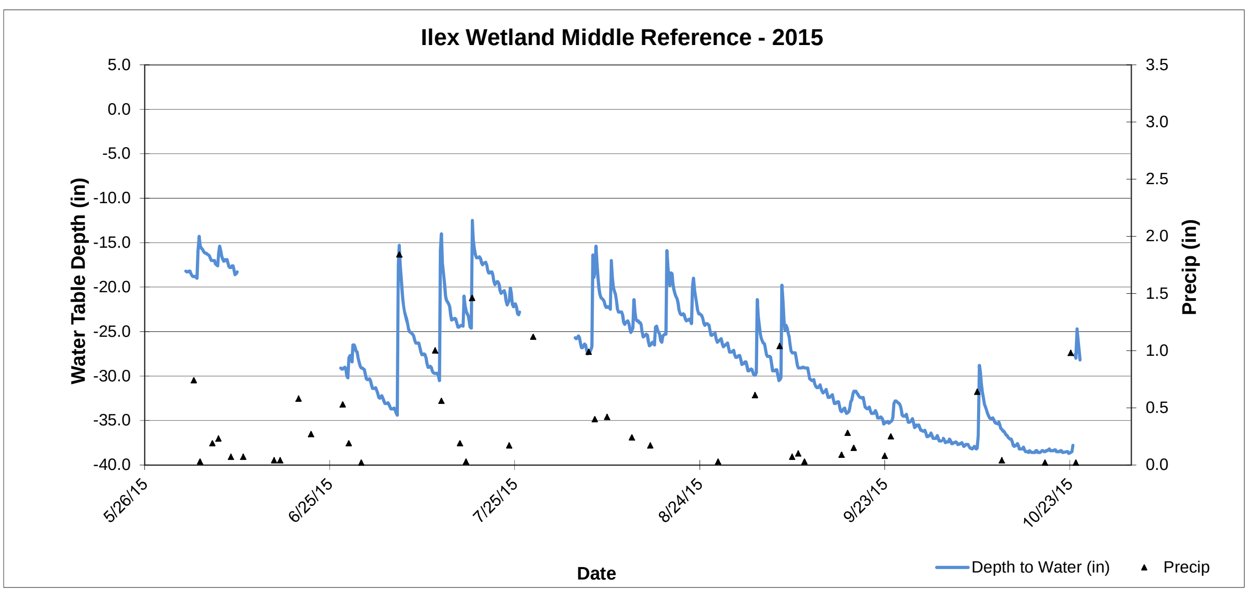
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

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.

2015 Hydrograph



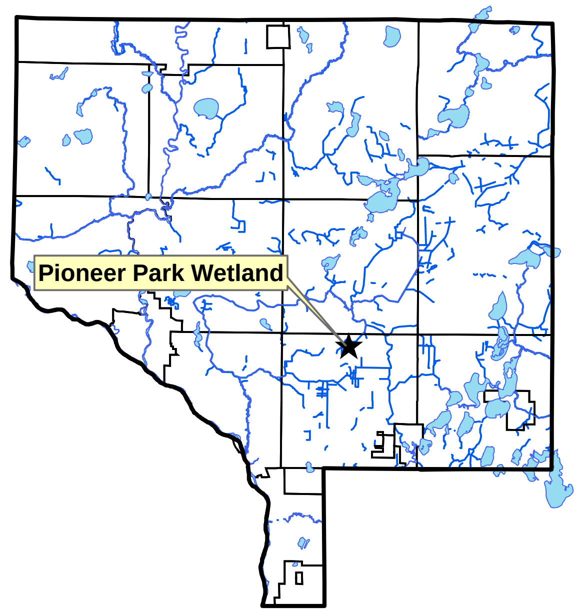
Well depth was 40 inches, so a reading of –40 indicates water levels were at an unknown depth greater than or equal to 40 inches.

Wetland Hydrology Monitoring

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	-

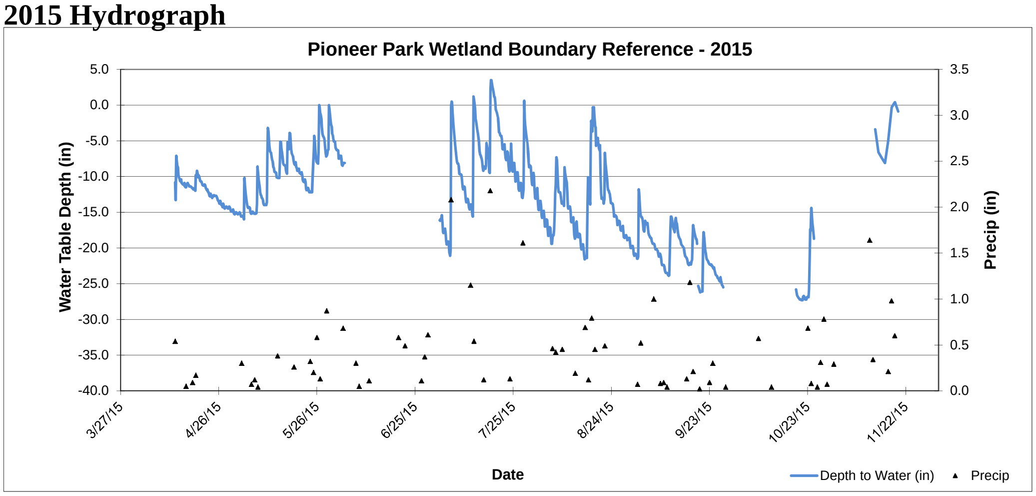
Surrounding Soils: Rifle and loamy wet sand.

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)

2015 Hydrograph

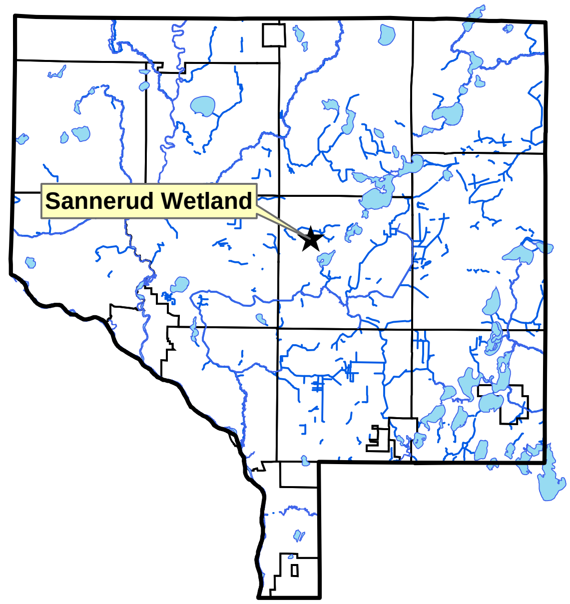


Well depth was 40 inches, so a reading of –40 indicates water levels at an unknown depth greater than or equal to 40 inches.

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	-

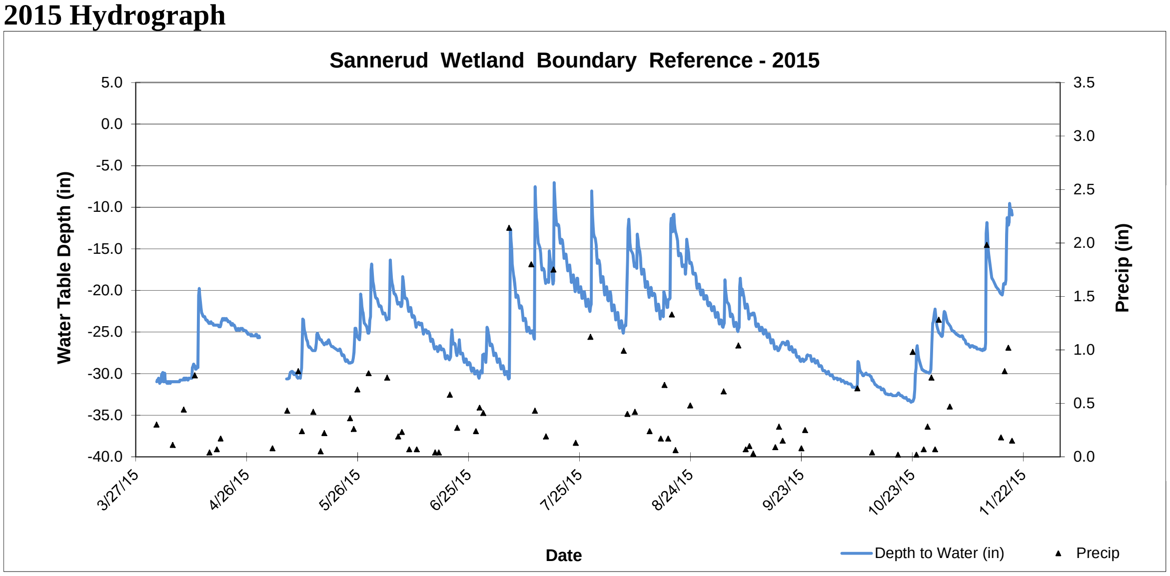
Surrounding Soils: Zimmerman and Lino.

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.

2015 Hydrograph

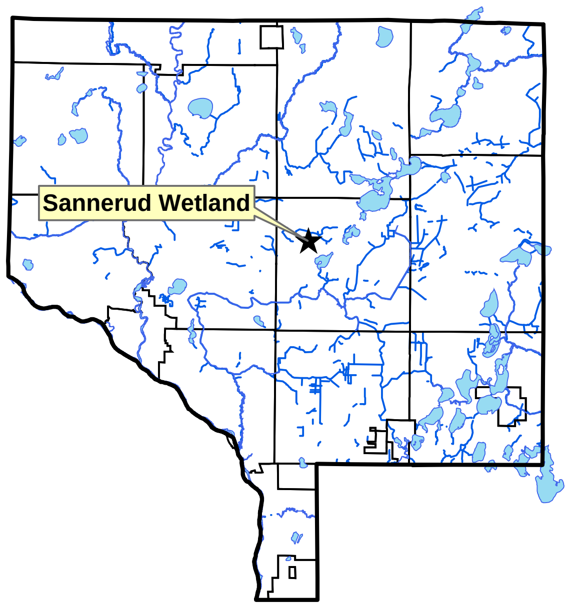


Well depth was 40.8 inches, so a reading of –40.8 indicates water levels were at an unknown depth greater than or equal to 40.8 inches.

Wetland Hydrology Monitoring

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	-

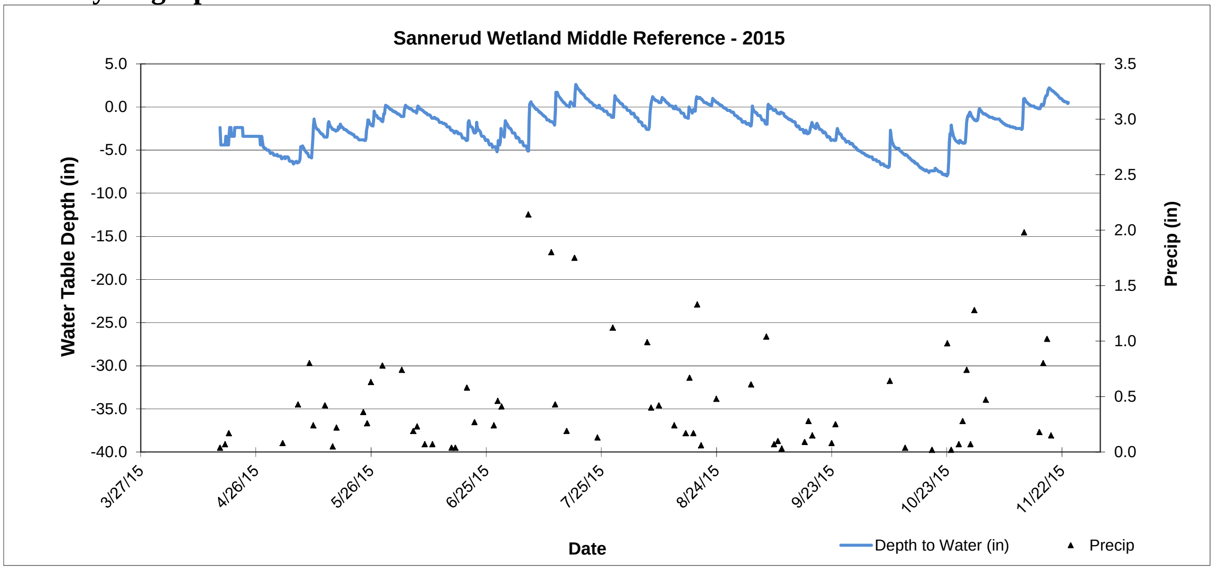
Surrounding Soils: Zimmerman and Lino.

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.

2015 Hydrograph



Well depth was 46.2 inches, so a reading of -46.2 indicates water levels were at an unknown depth greater than or equal to 46.2 inches.

Reference Wetland Analyses

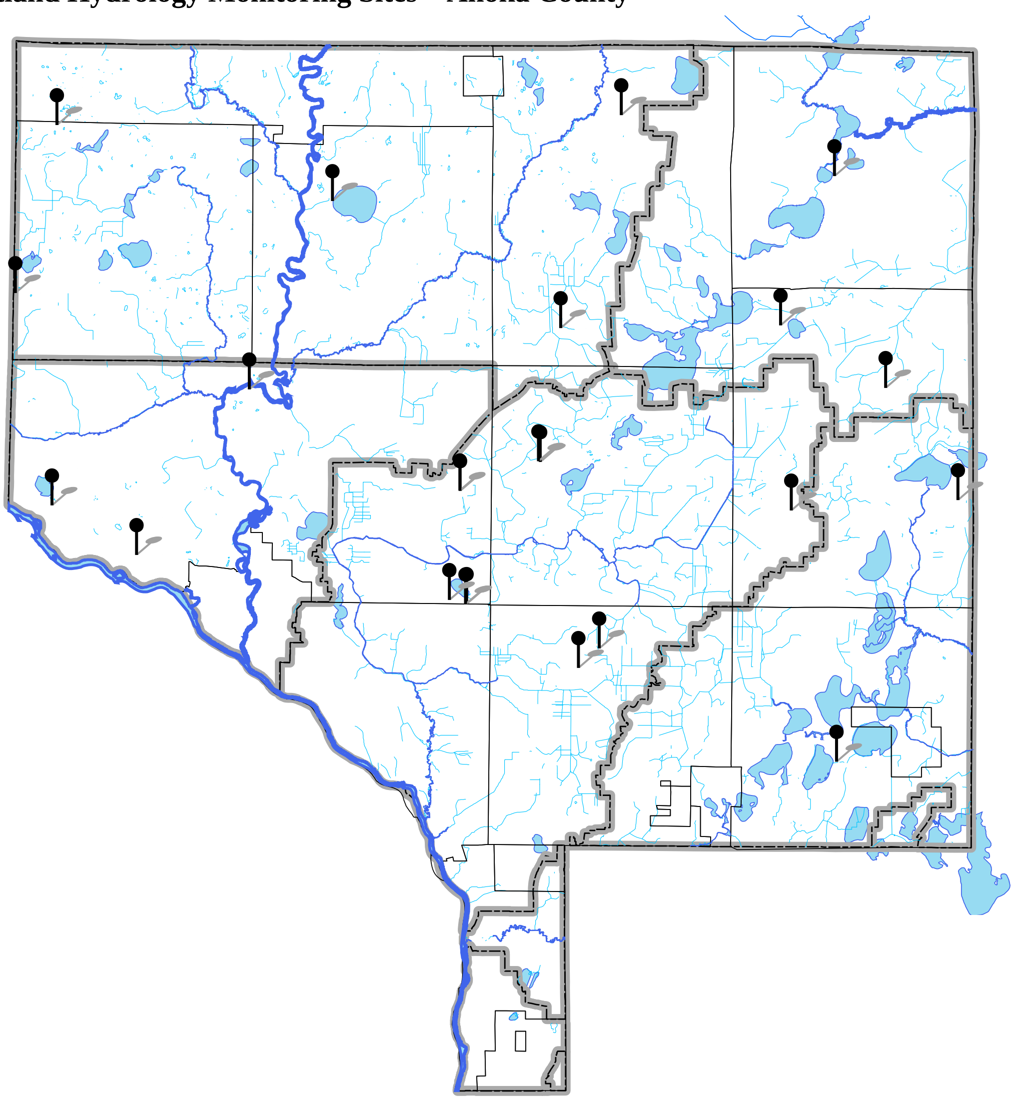
Description: This section includes analyses of wetland hydrology data of 23 reference wetland sites collected at 19 locations. Shallow groundwater levels at the edge of these wetlands are recorded every four hours. Many have been monitored since 1996. These analyses summarize this enormous multi-year, 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.

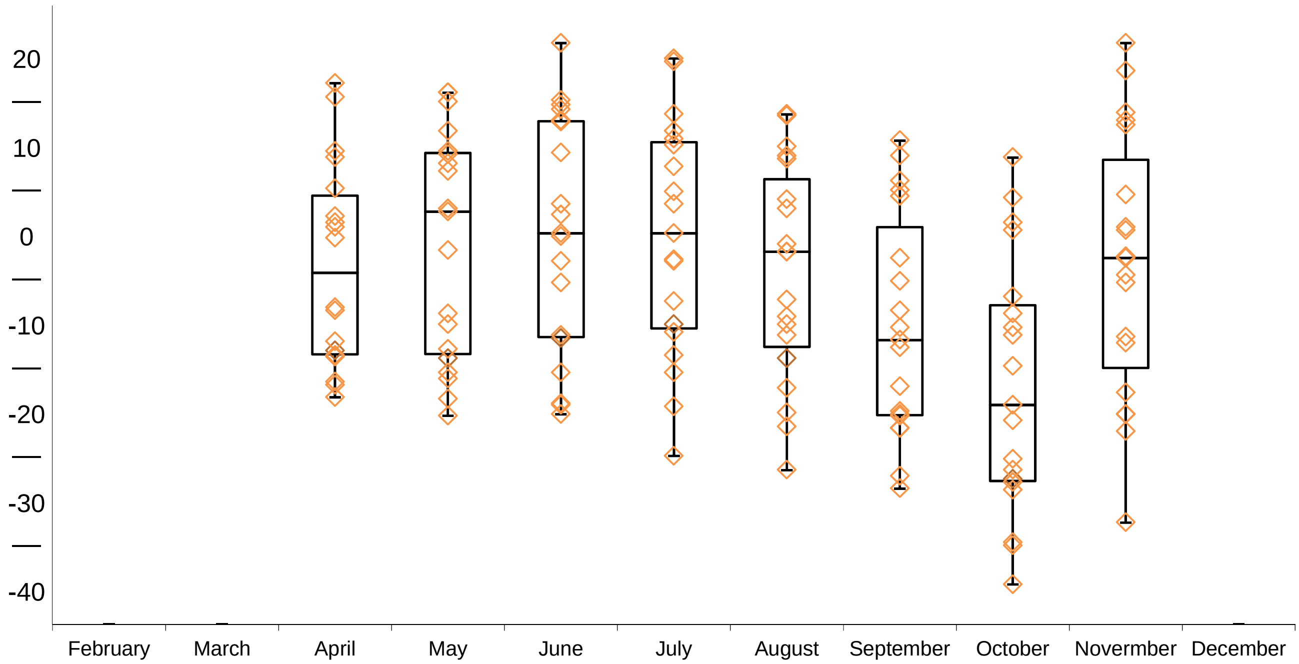
Locations: All 23 reference wetland hydrology monitoring sites in Anoka County.

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



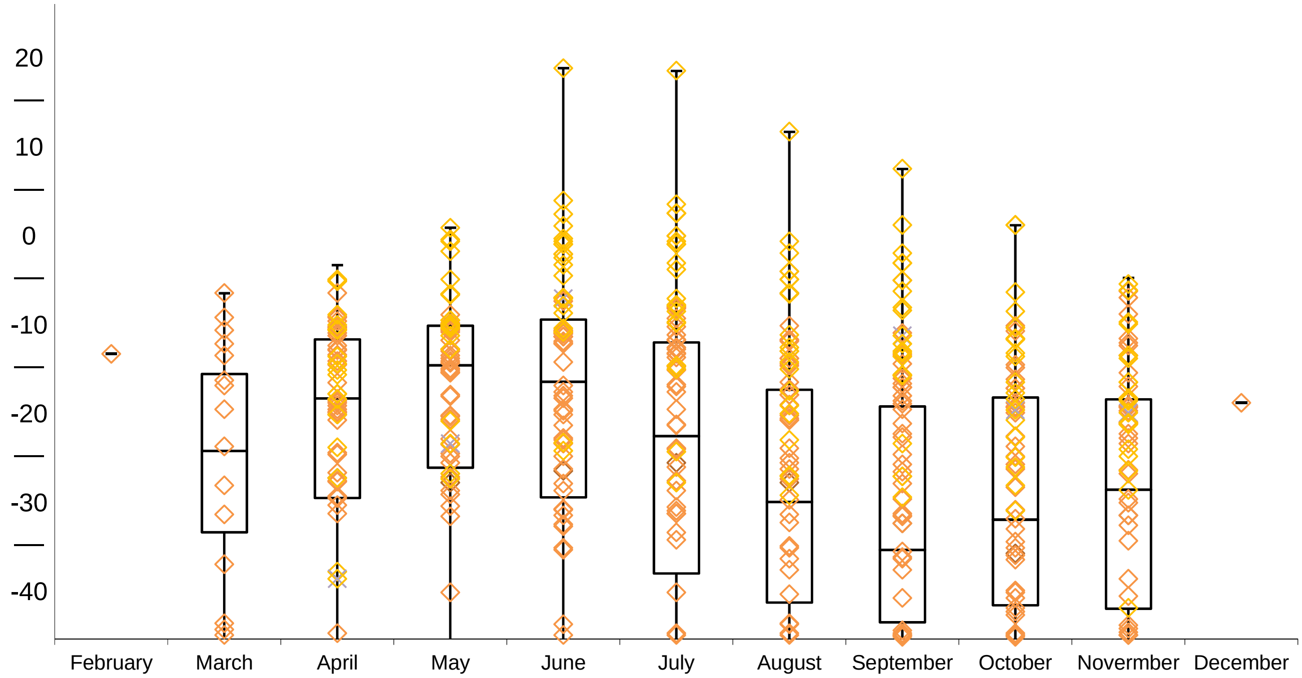
2015 Reference Wetland Water Levels Summary: Each marker represents the median depth to the water table at the edge of one reference wetland for a given month in 2015. The quantile boxes show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (floating horizontal 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	-25.3	-24.4	-22.5	-17.3	-12.3	-8.3	-5.0
5	-26.5	-24.4	-22.5	-13.3	-9.5	-6.1	-5.6
6	-26.4	-25.7	-21.4	-14.7	-7.5	-6.3	-2.4
7	-29.1	-24.1	-20.9	-14.7	-8.8	-6.3	-3.4
8	-30.0	-26.5	-22.1	-15.9	-11.2	-8.7	-7.0
9	-31.2	-27.9	-26.5	-21.6	-14.3	-11.0	-8.7
10	-37.4	-34.7	-30.7	-25.8	-19.4	-13.7	-9.8
11	-33.4	-26.6	-23.4	-16.3	-10.0	-6.4	-2.4

1996-2015 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 2015. 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	-33.4	-24.5	-13.5	-7.0	-4.2	1.2
5	-41.6	-32.0	-21.2	-9.9	-5.5	-2.0	5.3
6	-42.0	-37.5	-24.4	-11.7	-4.8	0.9	22.9
7	-42.2	-39.5	-32.8	-17.7	-7.3	-1.3	22.6
8	-43.0	-40.1	-36.0	-24.9	-12.6	-4.6	15.9
9	-43.0	-40.5	-38.2	-30.2	-14.4	-6.3	11.8
10	-43.1	-40.1	-36.3	-26.9	-13.4	-6.3	5.6
11	-36.6	-40.1	-36.7	-23.6	-13.6	-6.8	-0.2
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, excavations, 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 a disputed, 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 18 reference wetlands (except during winter), and the raw water level data are available through the Data Access tool at www.AnokaNaturalResources.com, or from the Anoka Conservation District.

Woodcrest Creek and Sand Creek Rain Garden Promotion and Design

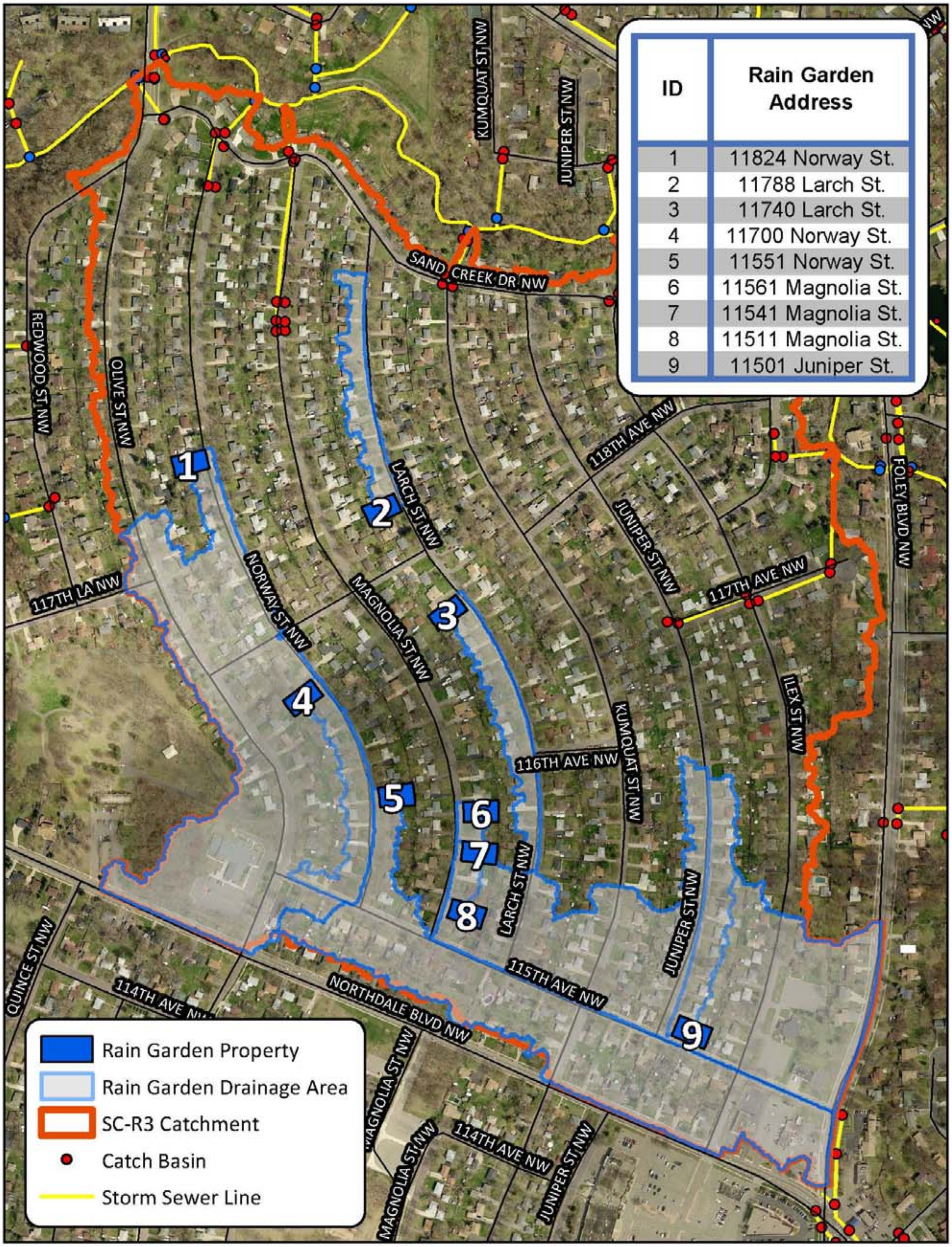
Description: The Coon Creek Watershed District (CCWD) contracted with ACD to manage the promotion, design, and construction oversight of a rain garden project in the WC-4 and SC-R3 catchments of the Woodcrest Creek and Sand Creek subwatersheds.

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 will take place in spring of 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.

Sites of nine rain gardens installed in the WC-4 catchment of the Woodcrest Creek subwatershed in 2015.

Sites of nine rain gardens installed in the SC-R3 catchment of the Sand Creek subwatershed in 2015.



Financial Summary

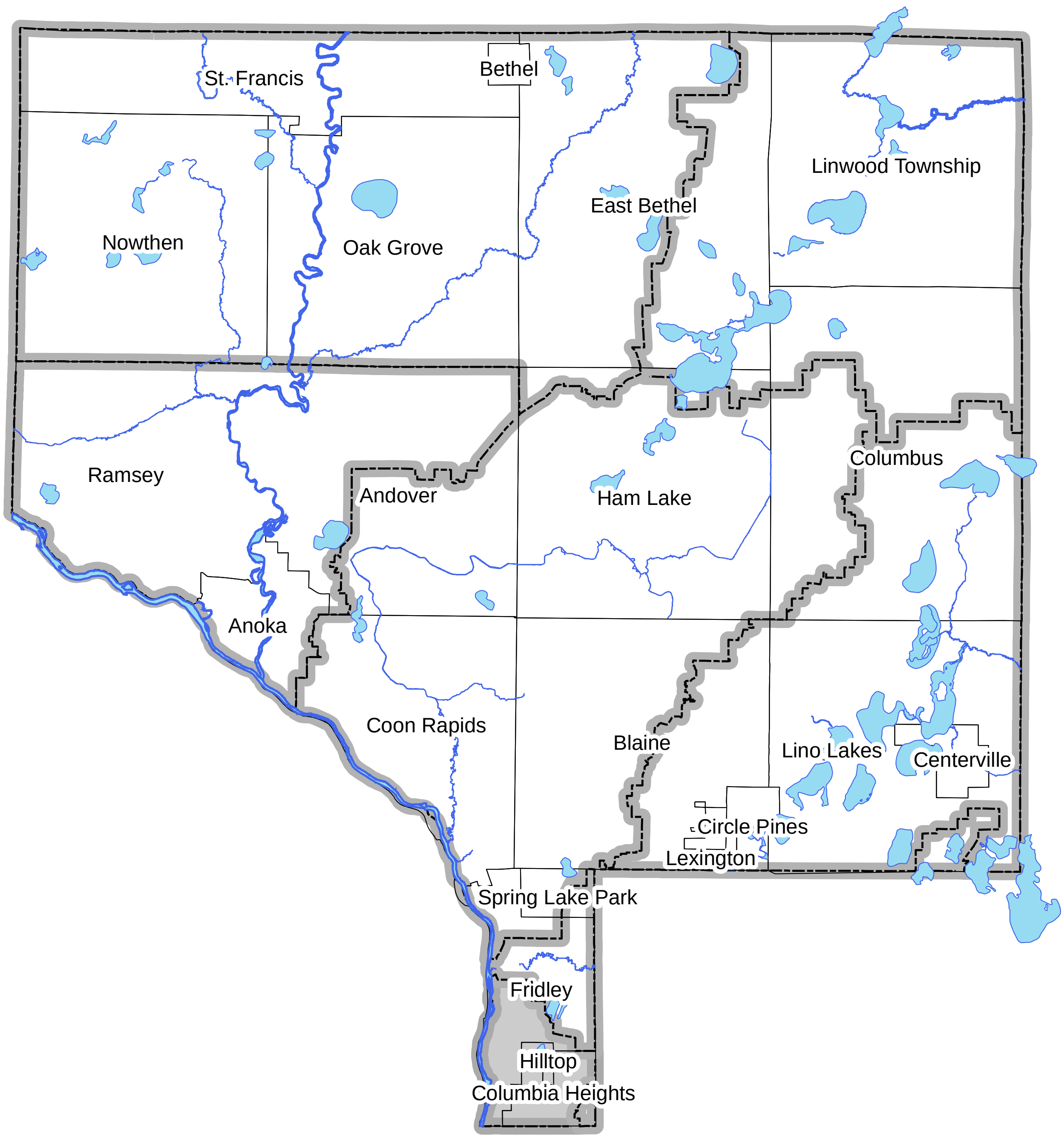
ACD accounting is organized by program and not by customer. This allows us to track all of the labor, materials and overhead expenses for a program, such as our lake water quality monitoring program. We do not, however, know specifically which expenses are attributed to monitoring which lakes. To enable 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 Water Quality	Stream Level	Stream Water Quality	CCWD Hydrolab	Oak Glen Pond/IESF CWF - Admin	Oak Glen Pond/IESF CWF - Proj. Dev.	Oak Glen Pond/IESF CWF - Tech. Eng.	BMP Maintenance	WC-4 Retrofit Promo/Install	SC-R2 Retrofit Promo/Install	SC-R3 Retrofit Promo/Install	Coon Creek WRAPP	Pleasure Creek SRA	Springbrook SRA	Middle Coon Creek SRA	CCWD AIS	Ditch 44 Asset Inventory	Total
Revenues																									
CCWD	0	0	5047	4347	0	0	1000	3250	5000	30400	4200	0	0	0	0	22640	0	21878	1825	0	0	4376	378	0	104341
State	0	0	0	0	0	747	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	747
Anoka Conservation District	0	0	0	139	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	139
Anoka Co. General Services	379	0	0	1865	0	0	0	0	0	0	0	479	283	342	2481	0	1013	0	630	0	0	0	793	381	8645
County Ag Preserves/Projects	0	0	0	0	0	0	0	409	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	409
Regional/Local	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6861	10213	0	0	0	17074
Other Service Fees	0	0	0	74	0	0	0	480	389	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	943
BWSR Cons Delivery	0	0	0	0	152	0	271	543	2331	0	3461	0	0	0	0	0	0	0	0	0	0	0	0	0	6758
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	0
Local Water Planning	0	332	1297	1350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2979
TOTAL	379	332	6344	7774	152	747	1271	4682	7720	30400	7661	479	283	342	2481	22640	1013	21878	2455	6861	10213	4376	1171	381	142036
Expenses-																									
Capital Outlay/Equip	3	3	55	2220	1	6	11	34	66	108	62	4	2	3	21	149	9	143	21	59	88	29	10	3	3112
Personnel Salaries/Benefits	333	292	5570	4756	133	658	1113	3454	6764	11043	6364	421	249	301	2181	15208	891	14552	2161	6039	8990	2958	1031	335	95801
Overhead	21	19	357	305	9	42	71	221	433	707	408	27	16	19	140	974	57	932	138	387	576	190	66	21	6137
Employee Training	2	2	36	30	1	4	7	22	43	70	41	3	2	2	14	97	6	93	14	38	57	19	7	2	611
Vehicle/Mileage	5	4	80	68	2	9	16	50	97	159	92	6	4	4	31	219	13	209	31	87	129	43	15	5	1378
Rent	14	12	231	197	6	27	46	143	280	458	264	17	10	12	90	630	37	603	90	250	373	123	43	14	3971
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	0
Program Supplies	0	0	16	198	0	0	7	758	35	5243	431	0	0	0	4	142	0	512	0	0	0	0	0	0	7346
McKay Expenses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	379	332	6344	7774	152	747	1271	4682	7720	17789	7661	479	283	342	2481	17419	1013	17044	2455	6861	10213	3361	1171	381	118355

Mississippi Watershed



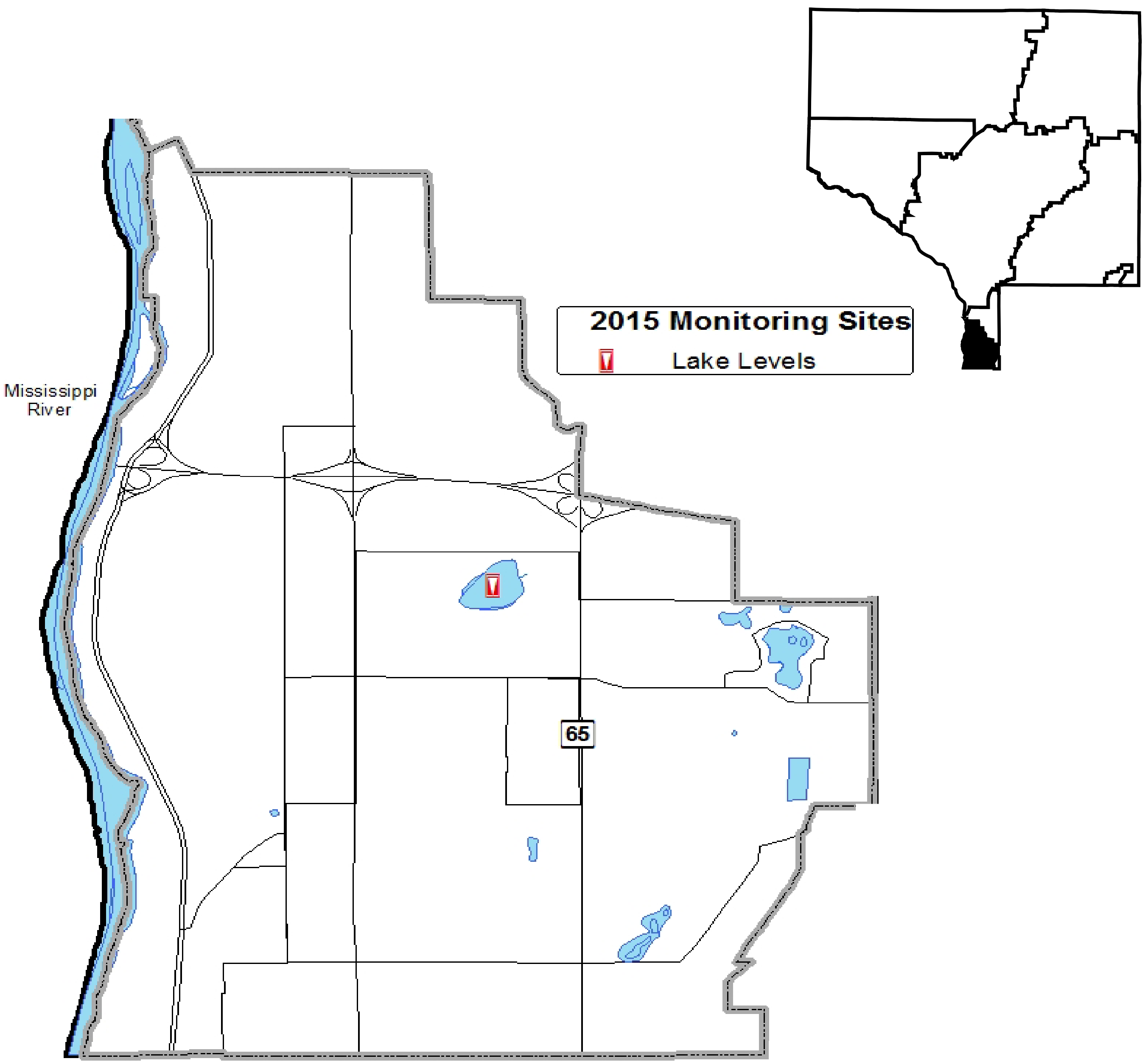
Contact Info: Mississippi Watershed Management Organization
www.mwmo.org
612-465-8780

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

CHAPTER 7:
MISSISSIPPI WATERSHED

Monitoring	Partners	Page
Lake Levels	ACD, MNDNR, volunteers	7-319
Financial Summary		7-320
Recommendations		7-320

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 historic data are available on the Minnesota DNR website using the "LakeFinder" feature (www.dnr.mn.us.state\lakefind\index.html).

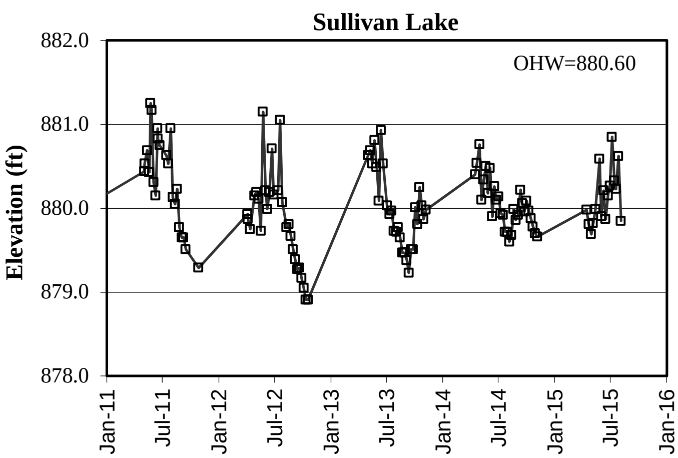
Purpose: To provide understanding of lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake hydrology manipulation decisions.

Locations: Sullivan/Sandy Lake

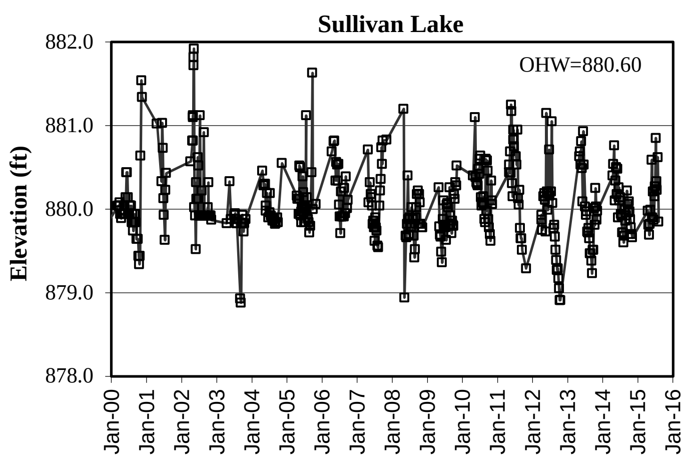
Results: Lake level readings were to be taken weekly. Lake levels were measured 16 times in 2015 for Sullivan Lake. Sullivan water levels fluctuate frequently, routinely bouncing by half a foot in response to rainfall because it receives a large amount of storm water relative to its size and its outlet releases water in all but the lowest water conditions.

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 2010-2015



Sullivan/Sandy Lake Levels 2000-2015



Lake Levels Summary

Lake	Year	Average	Min	Max
Sullivan	2008	880.22	879.42	881.24
	2009	879.92	879.36	880.52
	2010	880.23	879.62	881.10
	2011	880.36	879.29	881.25
	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

Financial Summary

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MWMO Financial Summary

Mississippi WMO	WMO Asst (no charge)	Lake Level	MWMO Modeling	Total
Revenues				
MWMO	0	250	3723	3973
State	0	0	0	0
Anoka Conservation District	0	0	0	0
Anoka Co. General Services	379	0	0	379
County Ag Preserves/Projects	0	0	0	0
Regional/Local	0	0	0	0
Other Service Fees	0	0	0	0
BWSR Cons Delivery	0	68	0	68
BWSR Cost Share TA	0	0	0	0
Local Water Planning	0	0	0	0
TOTAL	379	318	3723	4419
Expenses-				
Capital Outlay/Equip	3	3	30	36
Personnel Salaries/Benefits	333	278	3051	3663
Overhead	21	18	195	235
Employee Training	2	2	19	23
Vehicle/Mileage	5	4	44	53
Rent	14	12	126	152
Program Participants	0	0	0	0
Program Supplies	0	2	0	2
McKay Expenses	0	0	0	0
TOTAL	379	318	3466	4163

Recommendations

- Investigate storm water conveyances draining to Sullivan Lake and determine ways to incrementally improve the water that reaches it. Sullivan Lake's water quality is extremely poor.