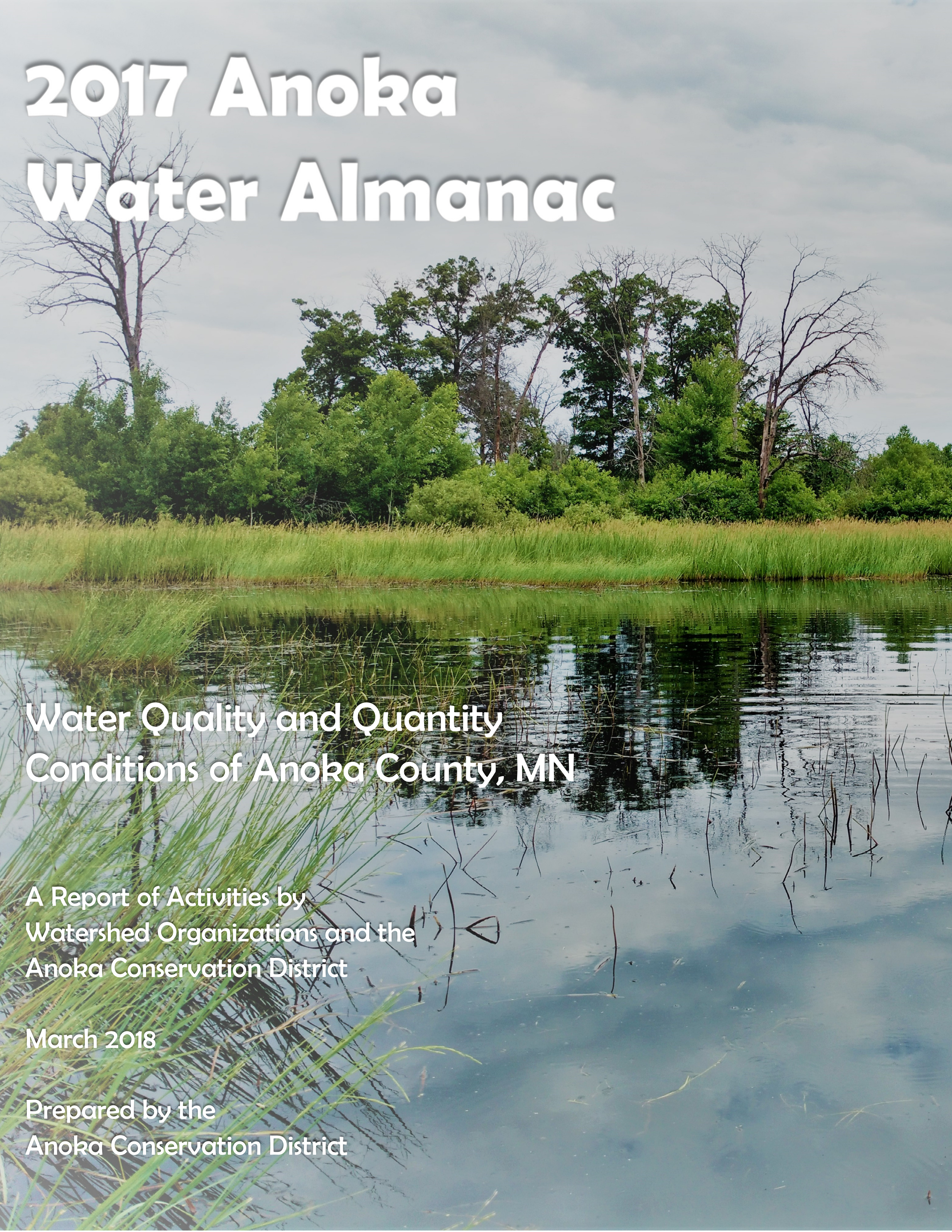

2017 Anoka Water Almanac

Water Quality and Quantity Conditions of Anoka County, MN

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

March 2018

Prepared by the
Anoka Conservation District

2017 ANOKA WATER ALMANAC

Water Quality & Quantity Conditions of Anoka County, Minnesota

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

March 2018

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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 instruction on interpreting data.

The water resource management and monitoring work reported here include:

- Monitoring
  - precipitation,
  - lake levels,
  - lake water quality,
  - stream hydrology,
  - stream water quality,
  - stream benthic macroinvertebrates,
  - shallow groundwater levels in wetlands, and
  - groundwater levels 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
  - reference wetland multi-year summary analyses.
- Public education efforts
  - newsletters and mailings,
  - signage,
  - workshops,
  - web videos, and
  - websites.
- Other work done for watershed management organizations
  - reviews of local water plans,
  - grant searches and applications,
  - annual reports to the State, and
  - other administrative tasks

While this report is perhaps the most comprehensive source of monitoring data on lakes, stream, rivers, groundwater and wetlands in Anoka County, it is not the only source; nor is this report a summary of all work completed throughout Anoka County in 2017. 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 2017 is presented in this almanac (although trend and similar analysis also include previous years' data). For results of work completed in past years, readers should refer to previous Water Almanacs. All data collected in 2017 and prior is available in digital format from the Anoka Conservation District. All applicable data is also submitted to state databases for wider availability; these include the MPCA's EQuIS water quality database, the DNR's lakefinder tool for lake levels, the DNR's Cooperative Groundwater Monitoring (CGM) tool for observation wells, and the State Climatology Office online precipitation database.

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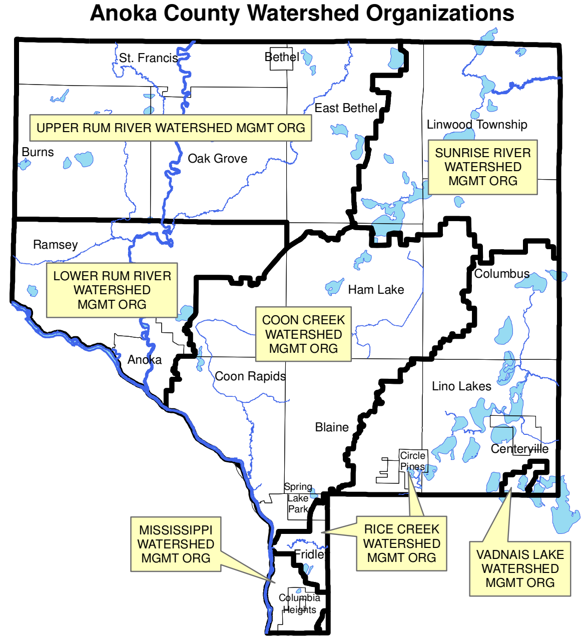
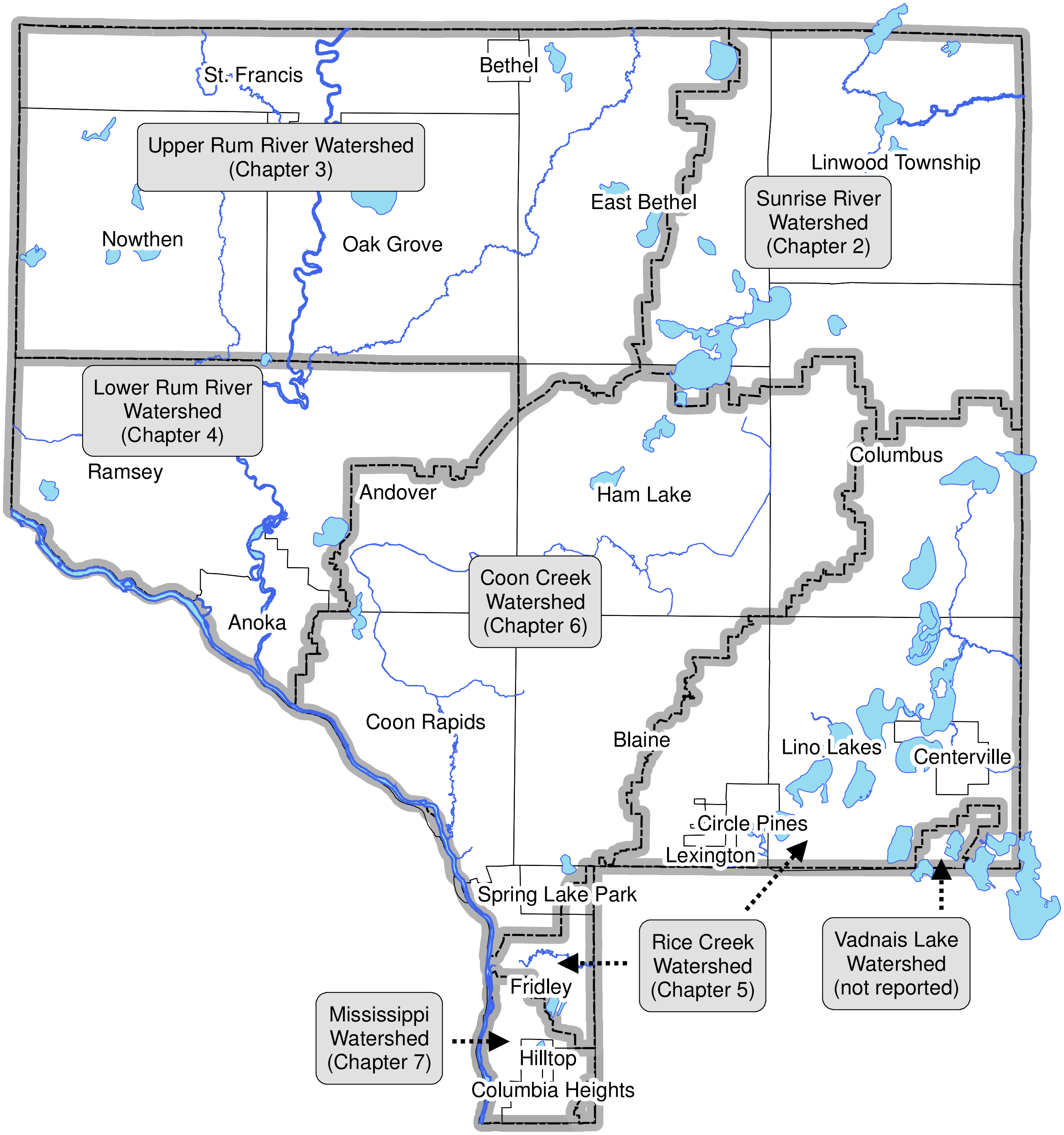
Anoka County Watershed Organizations



Chapter 1 – Primer



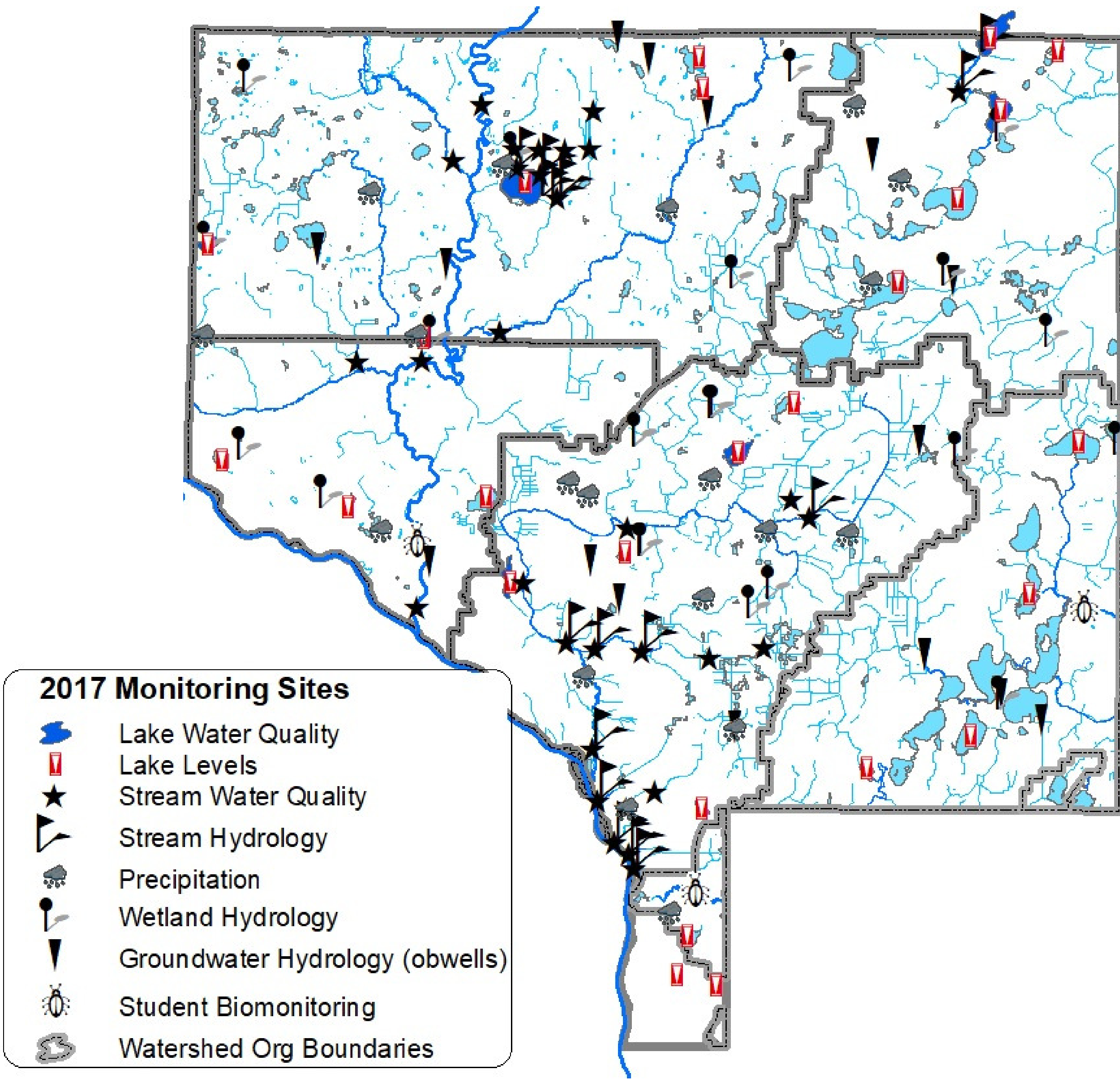
Contact Info: Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 1:
WATER RESOURCE MONITORING PRIMER

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

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

2017 Water Monitoring Sites



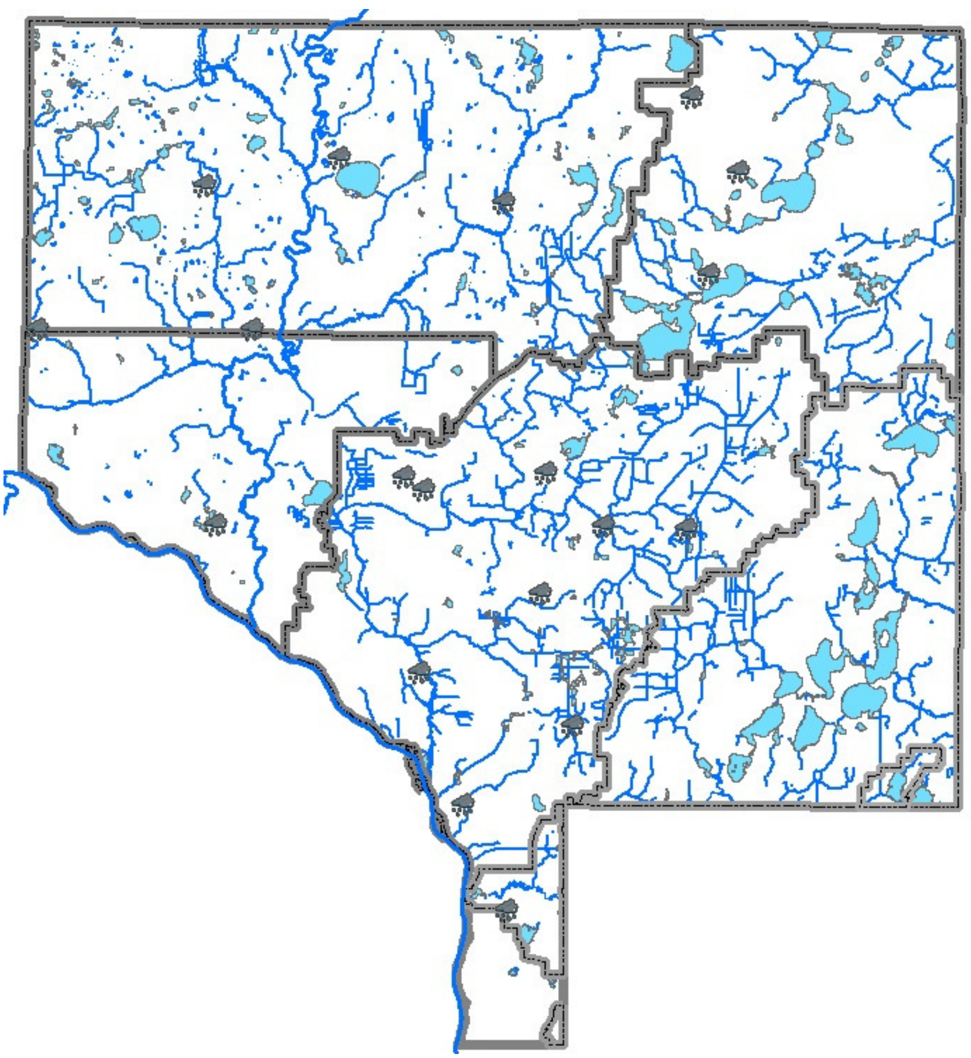
Precipitation

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.

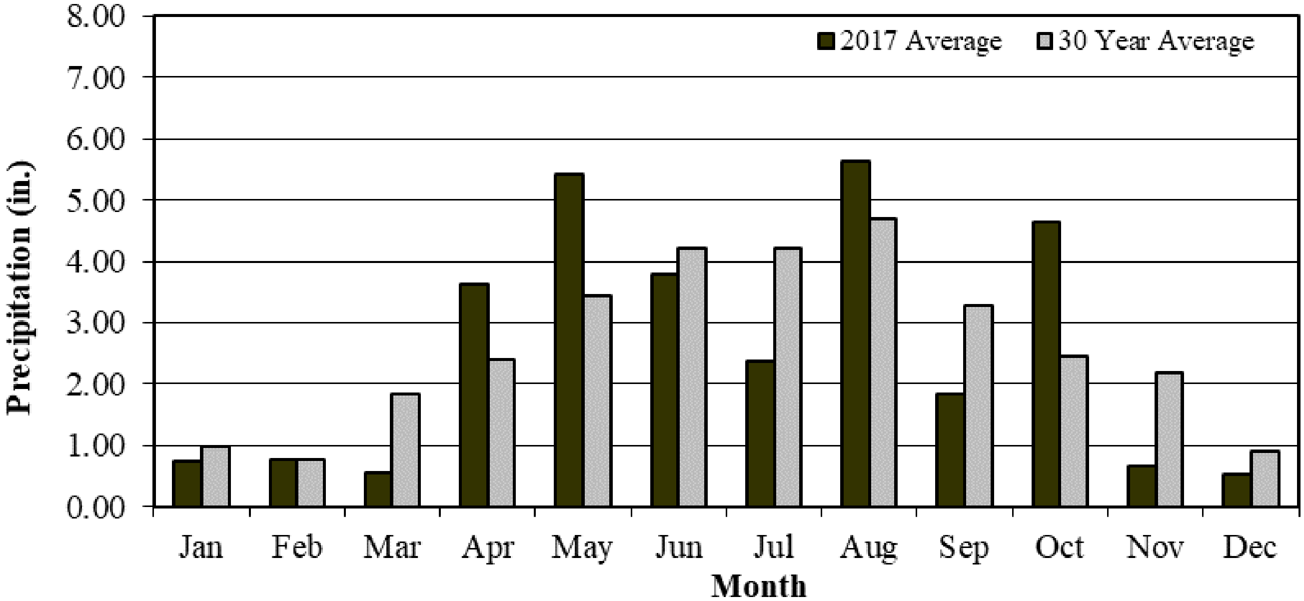
The ACD coordinates a network of 20 rain gauges countywide. Twelve are monitored by volunteers, seven are monitored using data logging stations operated by the ACD for the Coon Creek Watershed District, and one is monitored using a data logging station independently operated by the ACD. The volunteer-operated stations are cylinder-style rain gauges located at the volunteer's home. Total rainfall is read daily. The data logging 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.

2017 Precipitation Monitoring Sites



2017 Anoka County Average Monthly Precipitation (average of all sites)



2017 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			0.37*	3.57	5.41	3.23	2.14	6.15	1.91	4.38	0.59	0.14*	27.38	18.84
Blaine Public Works	Blaine				0.02*	7.17	1.69	1.44	6.75	1.76	5.81	0.63	0.23*	25.25	25.25
Coon Rapids City Hall	Coon Rapids			0.50*	3.88	5.79	4.01	2.42	5.81	1.45	3.58	0.56	0.20*	27.50	19.48
Anoka Cons. District office	Ham Lake			0.34*	3.47	1.93	3.98	0.54*	5.55	2.09	2.83*	0.08*	0.23*	17.02	18.81
Waconia Street	Ham Lake			0.35*	4.15	2.63	3.56	2.37	6.9	1.02	1.38	0.67	0.16*	22.68	16.48
Northern Nat. Gas substation	Ham Lake			0.40*	3.36	6.39	4.95	2.06	6.05	1.62	4.78	0.54	0.16	29.91	21.07
Springbrook Nature Center	Fridley				0.62*	6.6	3.22	2.65	7.64	2.07	6.03	0.71	0.24*	28.92	22.18
Lake George Park	Oak Grove				3.11*	5.52	4.22	2.41	6.97	1.89	6.88	0.92	0.12	28.93	21.01
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.84	0.75	0.65	3.39	5.99	3.57	2.65	5.96	1.85	4.12		0.76	30.53	20.02
J. Rufsvold	Burns				3.48	3.55	4.84	3.06	5.64	1.38	4.54			26.49	18.47
J. Arzdorf	Blaine			0.67	4.39	7.46	4.44	2.17	6.36	2.08	4.32			31.89	22.51
P. Arzdorf	East Bethel				3.52	5.90	3.70	2.27	5.01	1.88	5.25			27.53	18.76
A. Mercil	East Bethel	0.61	0.69	0.31	2.77	4.96	3.78	1.54	4.59	1.89			0.53	21.67	16.76
K. Ackerman	Fridley	0.80	0.70	0.65	3.96	7.16	3.26		5.83	1.30	5.66		0.87	30.19	17.55
B. Myers	Linwood				2.24	4.04	2.90	1.50	4.33	1.59	3.45			20.05	14.36
B. Barkhoff	Nowthen							2.45	5.00	1.59				9.04	9.04
S. Mizell	Ramsey						1.33*	2.81	4.68	1.76				9.25	9.25
ACD Office	Ham Lake		0.94	0.47	4.49	6.77	4.46	3.14	5.72	3.61				29.60	23.70
Y. Lyrenmann	Ramsey				3.96	4.78	3.75	3.47	3.42	2.43				21.81	17.85
S. LeMay	East Bethel							2.17	4.36	1.67	4.81		0.66	13.67	8.20
E. Faherty	Oak Grove						4.42							4.42	4.42
2017 Average	County-wide	0.75	0.77	0.55	3.62	5.41	3.78	2.37	5.64	1.84	4.64	0.66	0.52	30.55	19.04
30 Year Average	Cedar	0.99	0.76	1.84	2.40	3.43	4.22	4.21	4.70	3.29	2.44	2.18	0.90	31.36	19.85

Precipitation as snow is given in melted equivalents.

*Incomplete monthly data not included in averages

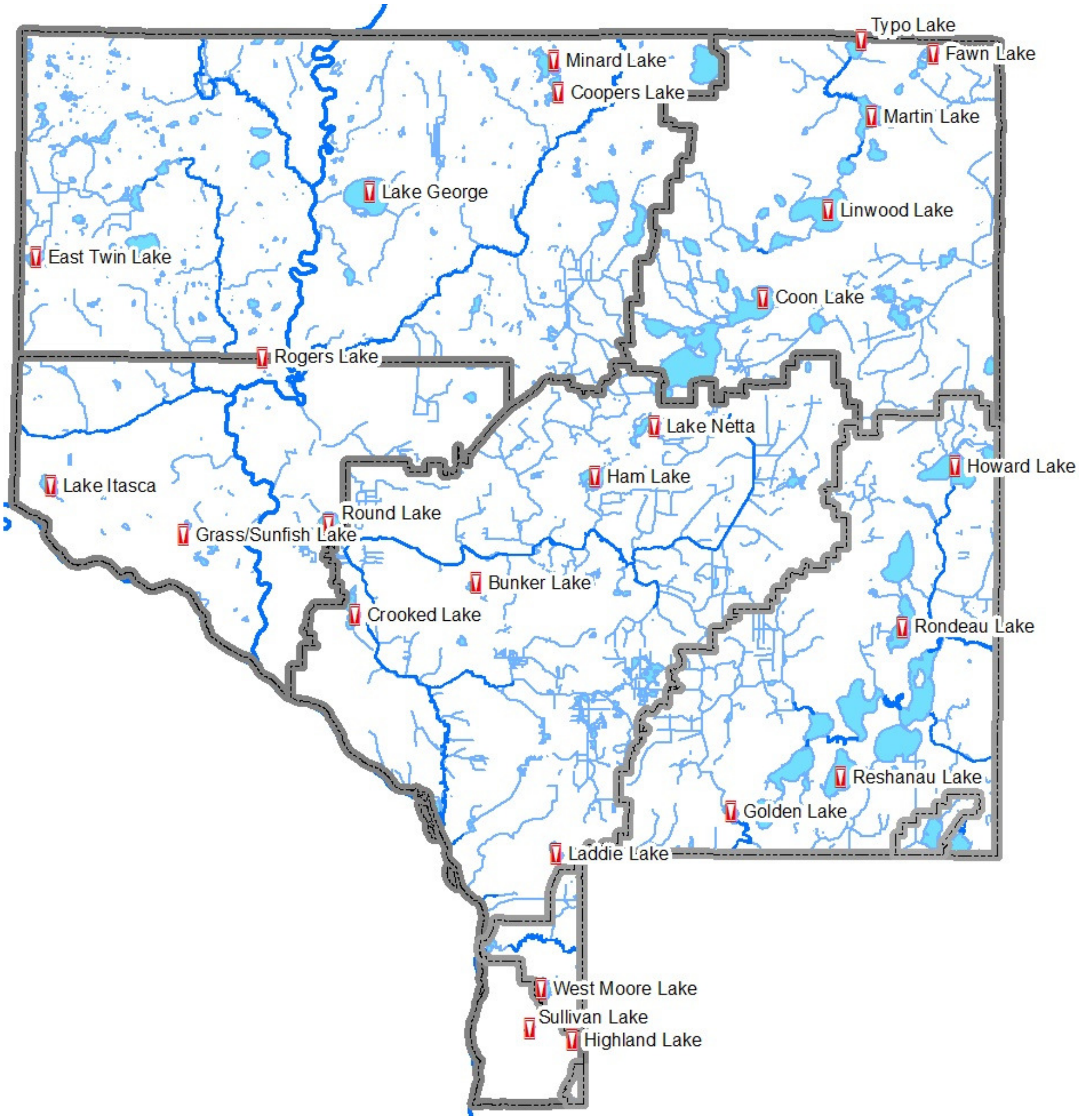
Lake Levels

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

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

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

2017 Lake Level Monitoring Sites



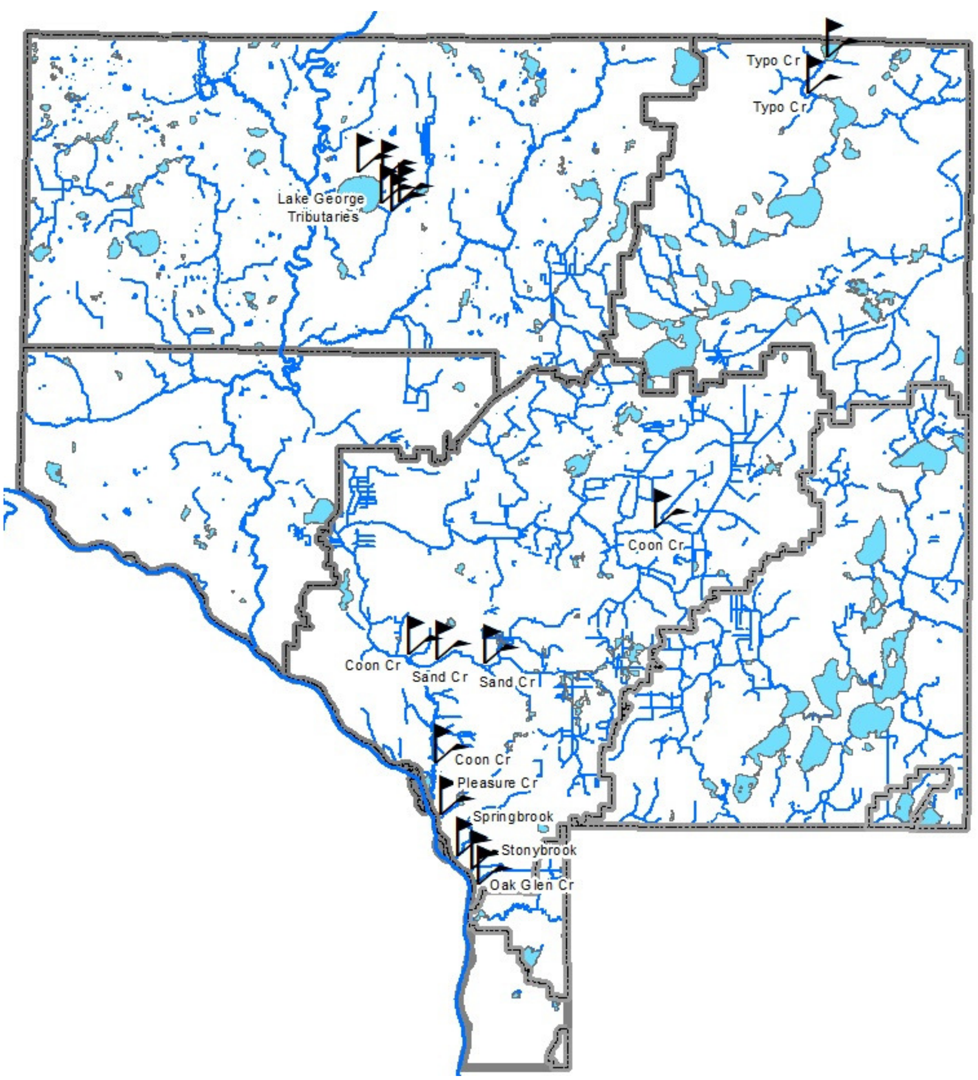
Stream Hydrology

Hydrology is the study of water quantity and movement. 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 are used in computer models and water pollution regulatory determinations.

The ACD monitored hydrology at 16 stream sites in 2017. 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.

2017 Stream Hydrology Monitoring Sites



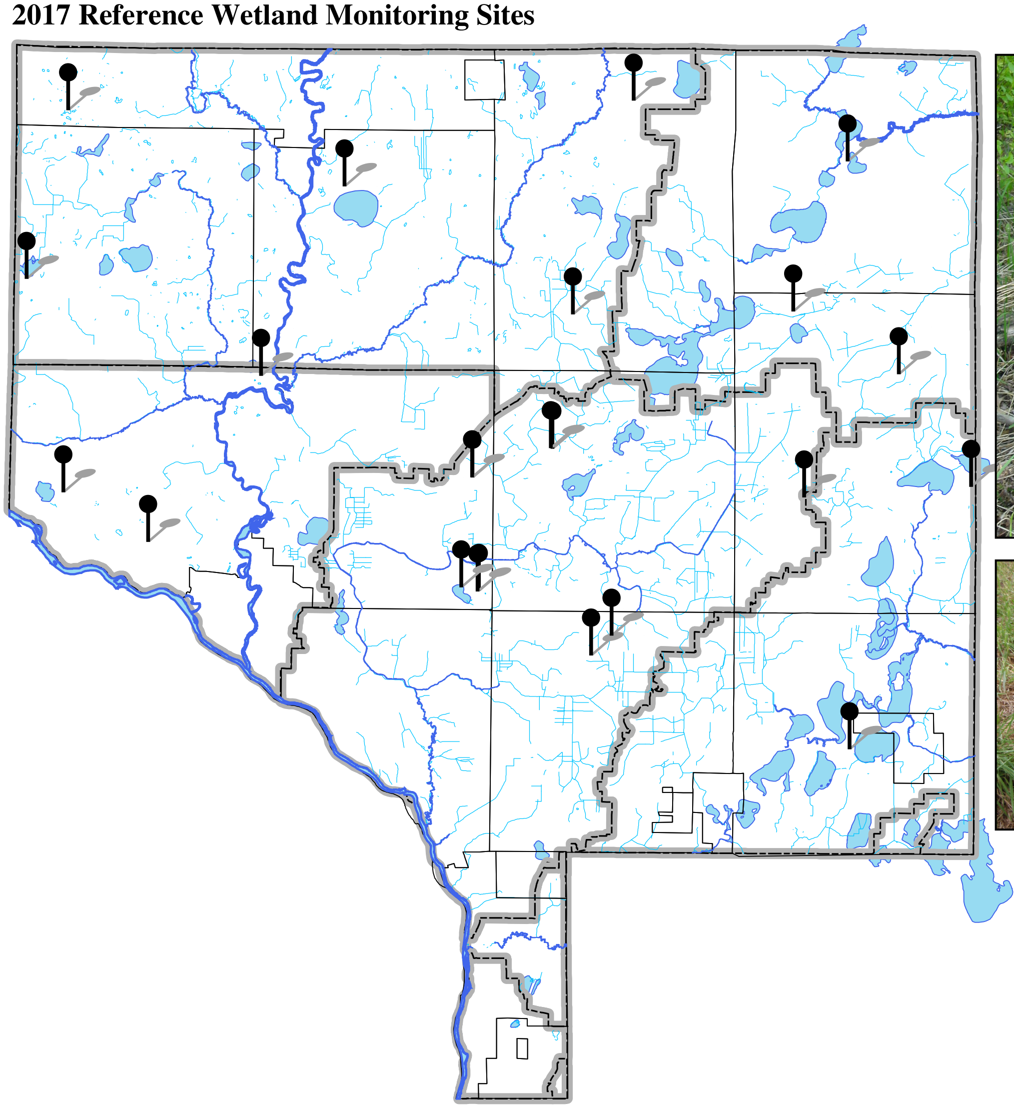
Wetland Hydrology

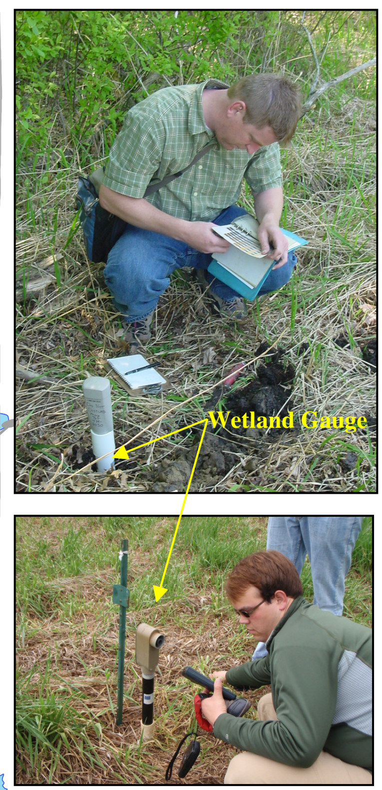
Wetland regulations are often focused upon determining whether an area is, or is not, a wetland. This is difficult at times because most wetlands are not continually wet. In order to facilitate fair, accurate wetland determinations the ACD monitors 19 wetlands throughout the county that serve as a reference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

Reference wetland data provide 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.

2017 Reference Wetland Monitoring Sites





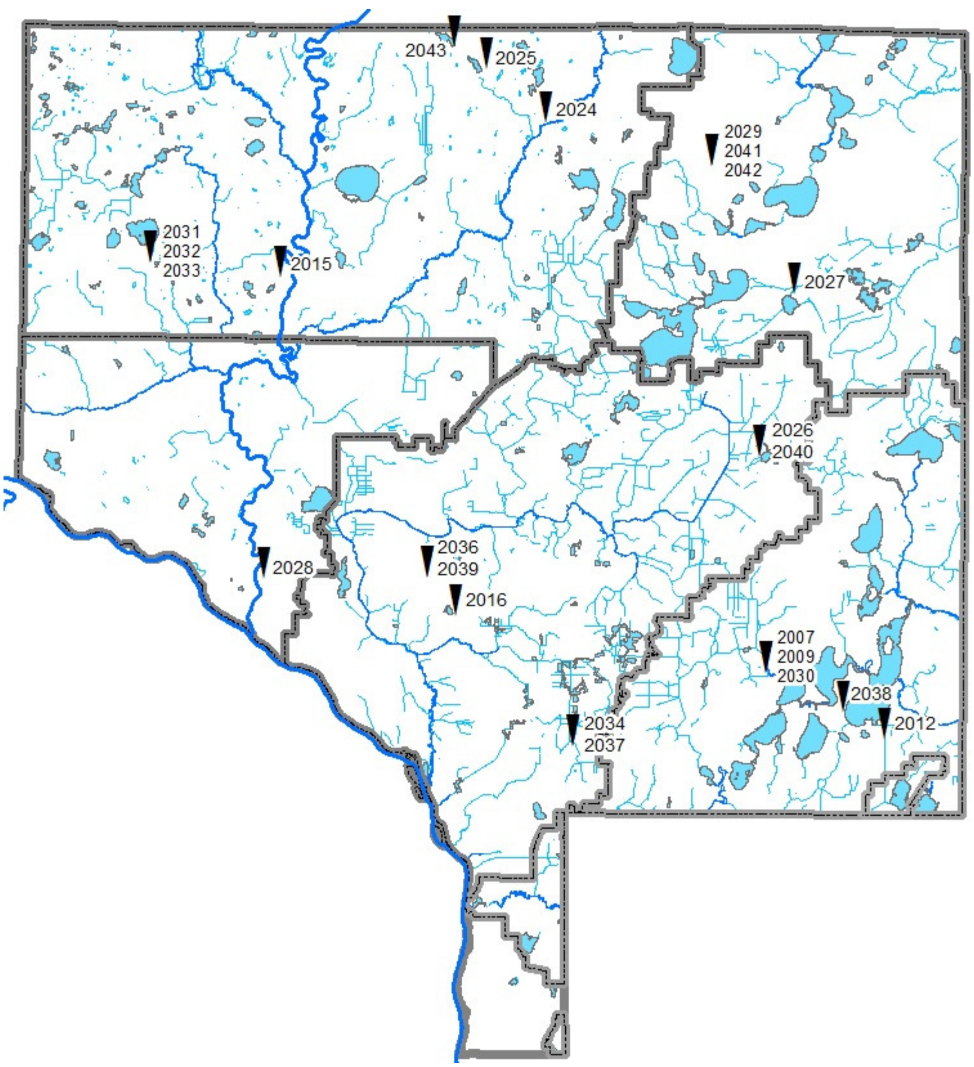
Groundwater Hydrology

The Minnesota Department of Natural Resources (MN DNR) and the ACD are interested in understanding Minnesota's groundwater quantity and flow. The MN DNR maintains a network of groundwater observation wells across the state. The ACD is contracted to take water level readings at 24 wells in Anoka County from March to December. At most sites, the MN DNR now has automated devices taking continuous 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 to the MN DNR and are available on their web site http://www.dnr.state.mn.us/waters/groundwater_section/obwell/index.html

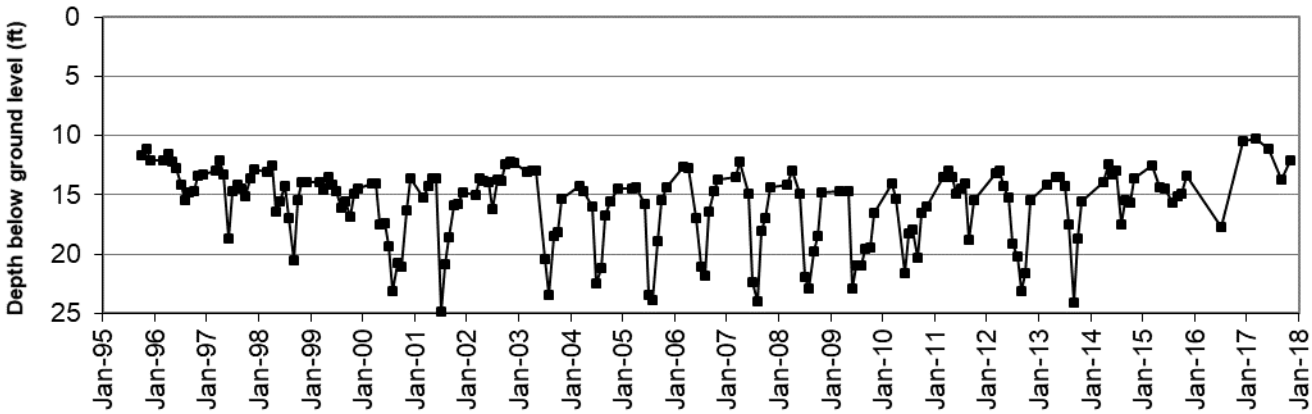
These deep groundwater wells are not as sensitive to precipitation as other hydrologic systems such as wetlands and streams, but rather respond to longer term trends.

The charts on the following pages show groundwater levels hand measured by ACD through 2017 for each well. These results are not presented elsewhere in this report. Raw data can be downloaded from the MN DNR website, as well as continuous data from wells with data loggers installed. ACD still hand measures wells with data loggers periodically to ensure accuracy.

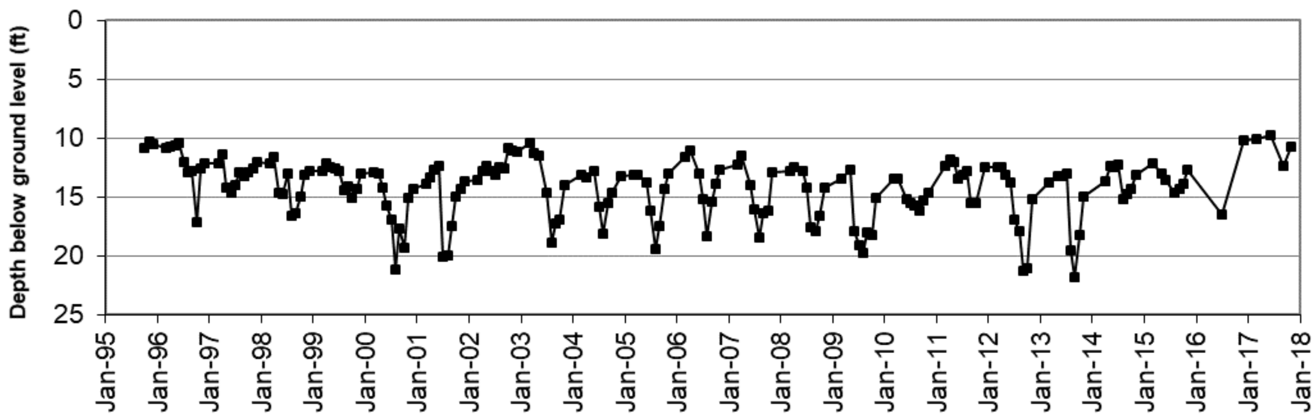
2017 Groundwater Observation Well Sites and Well ID Numbers



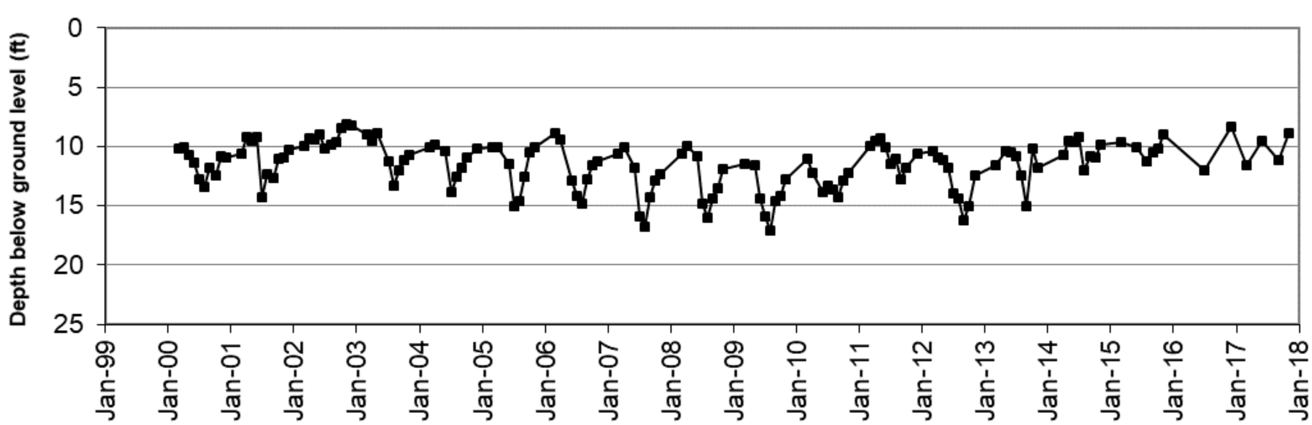
Observation Well #2007 (270 ft deep)—Lino Lakes



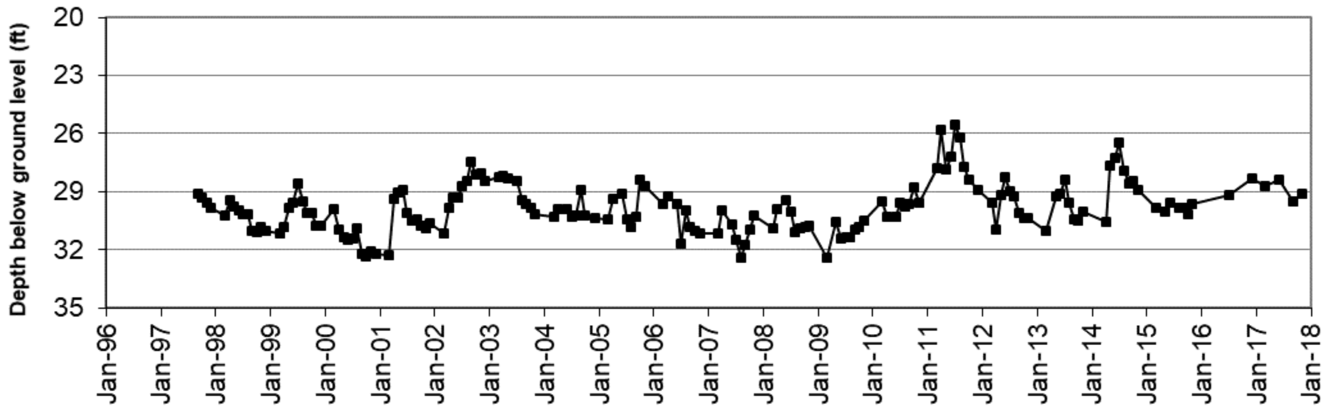
Observation Well #2009 (125 ft deep)—Lino lakes



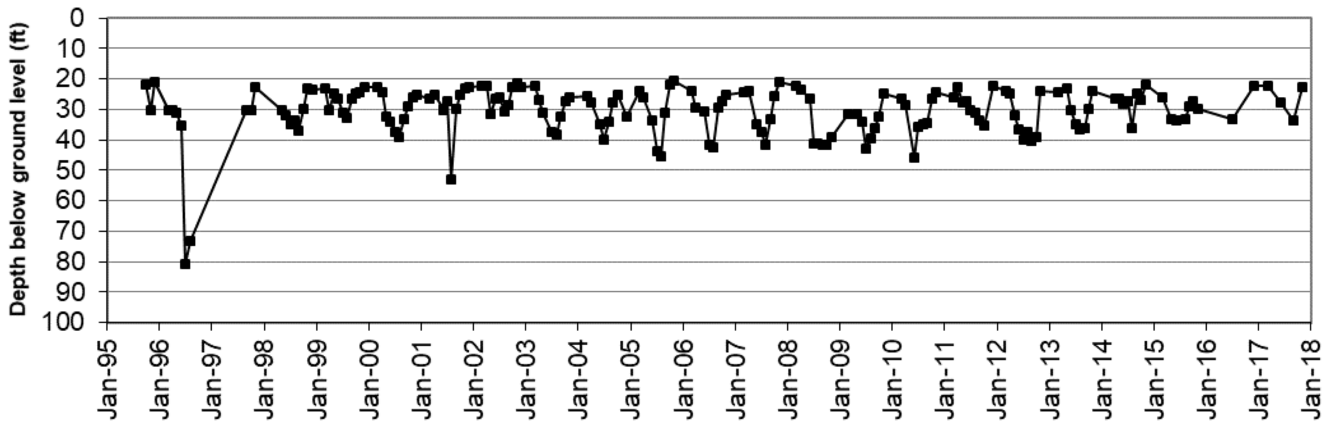
Observation Well #2012 (277 ft deep) – Centerville



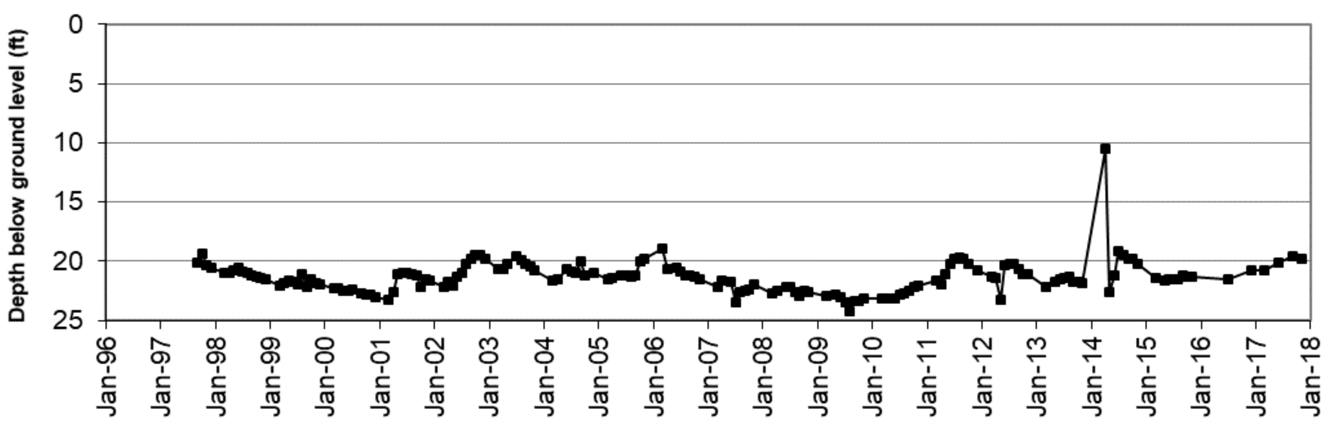
Observation Well #2015 (280 ft deep)—Ramsey



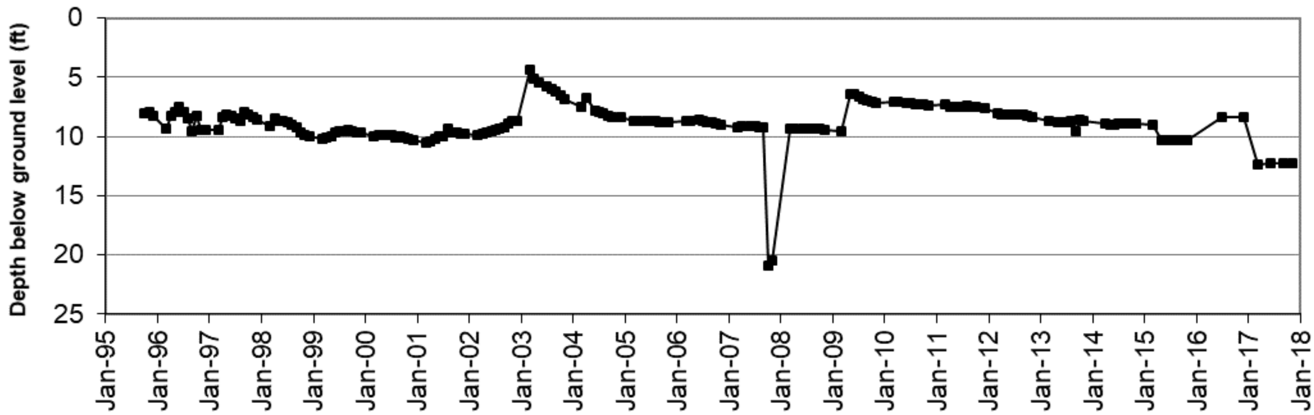
Observation Well #2016 (193 ft deep)—Coon Rapids



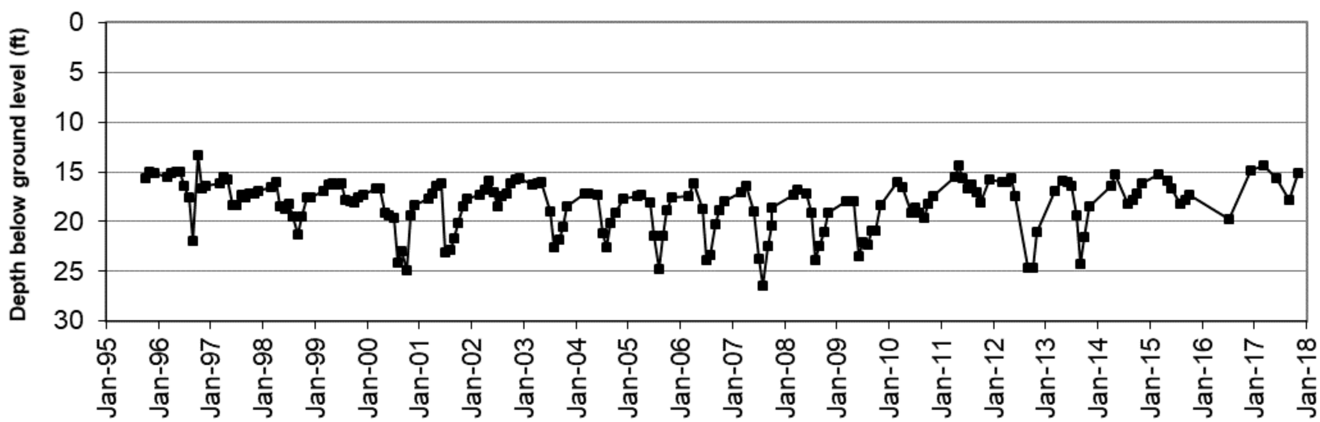
Observation Well #2024 (141 ft deep)—East Bethel



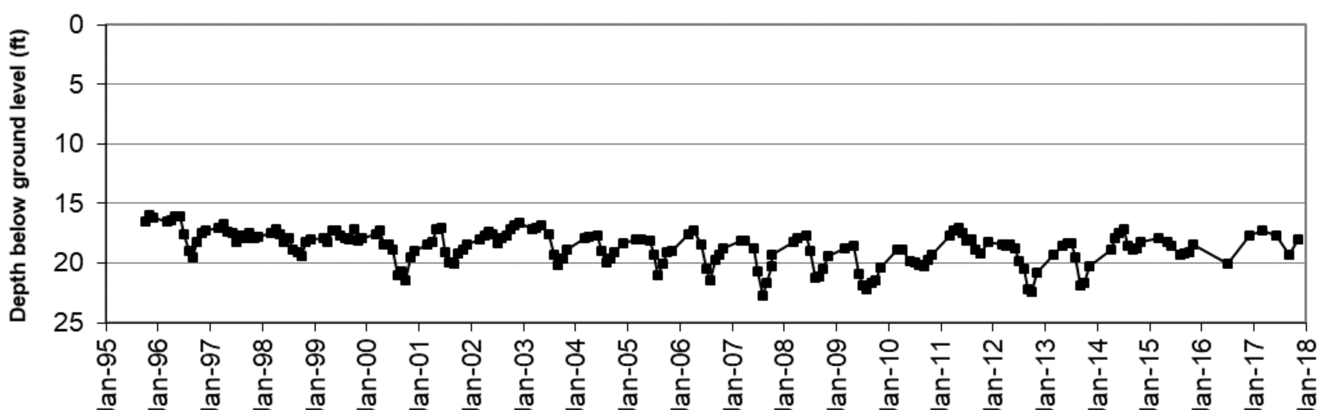
Observation Well #2025 (21 ft deep)—Bethel



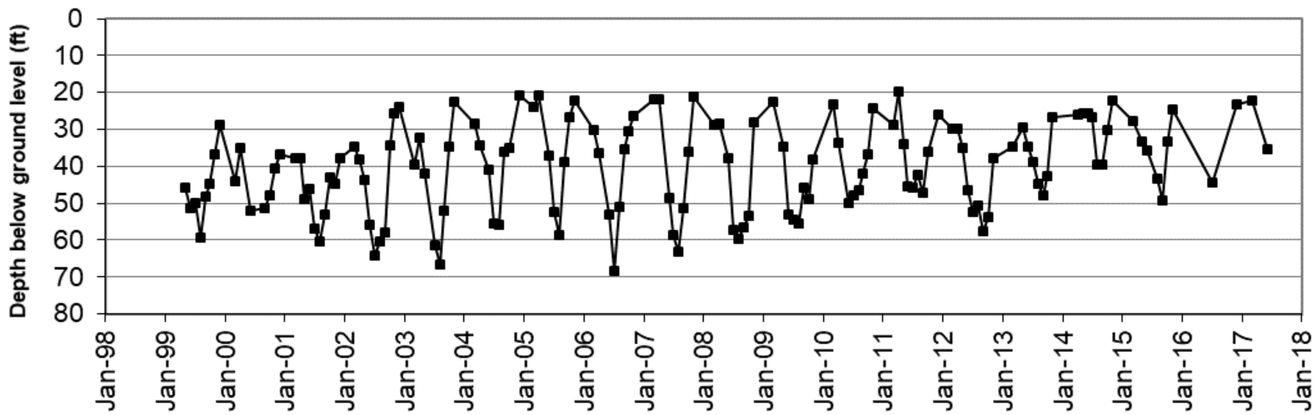
Observation Well #2026 (150 ft deep)— Carlos Avery #4



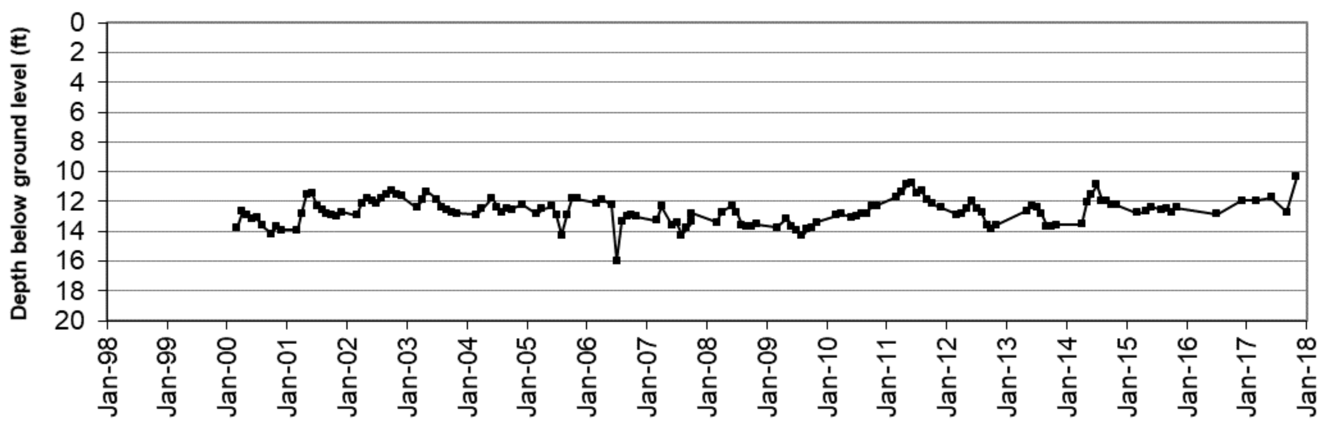
Observation Well #2027 (333 ft deep)— Columbus Twp.



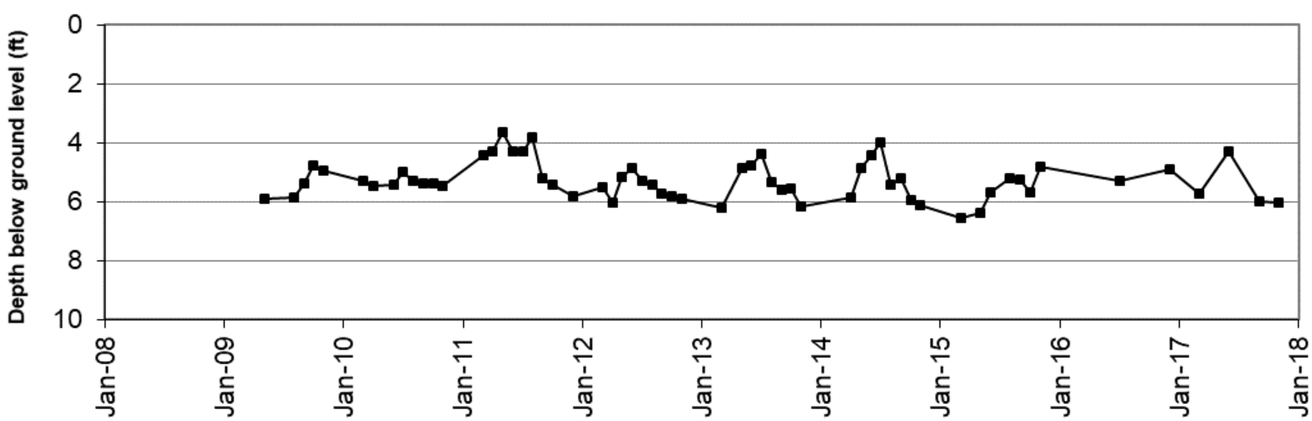
Observation Well #2028 (510 ft deep)—Anoka



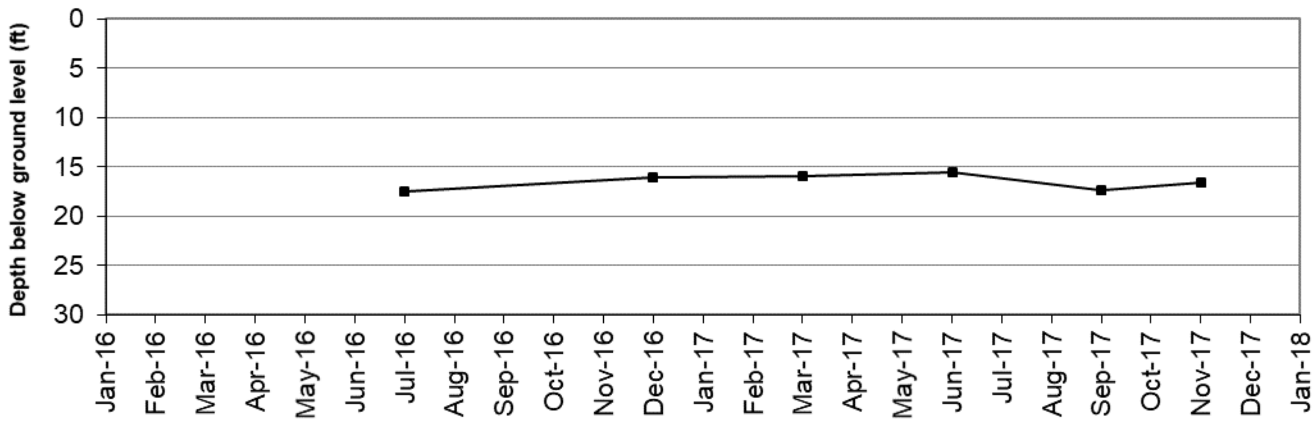
Observation Well #2029 (221 ft deep)—Linwood Twp.



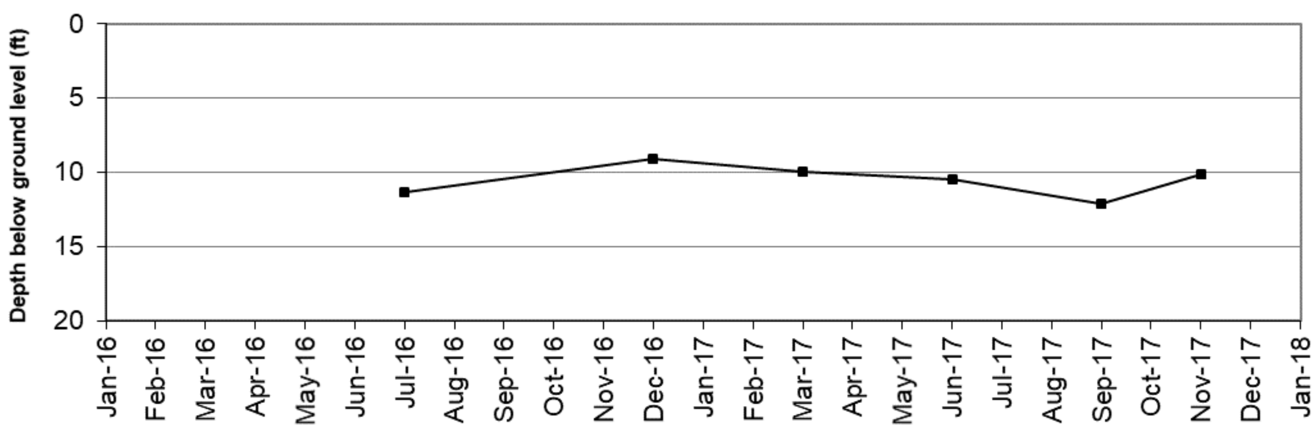
Observation Well #2030 (15 ft deep)—Lino Lakes



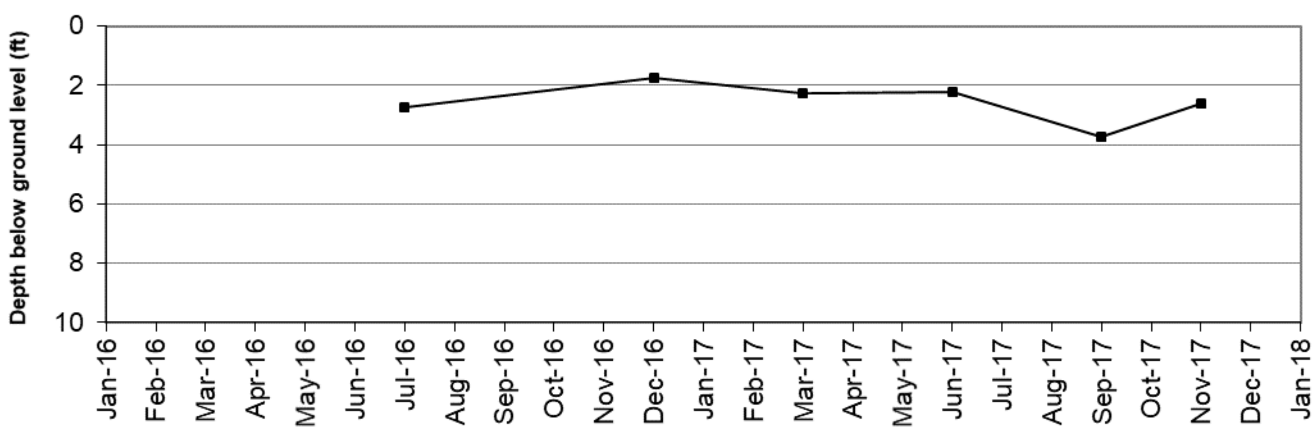
Observation Well #2031 (410 ft deep)—Nowthen



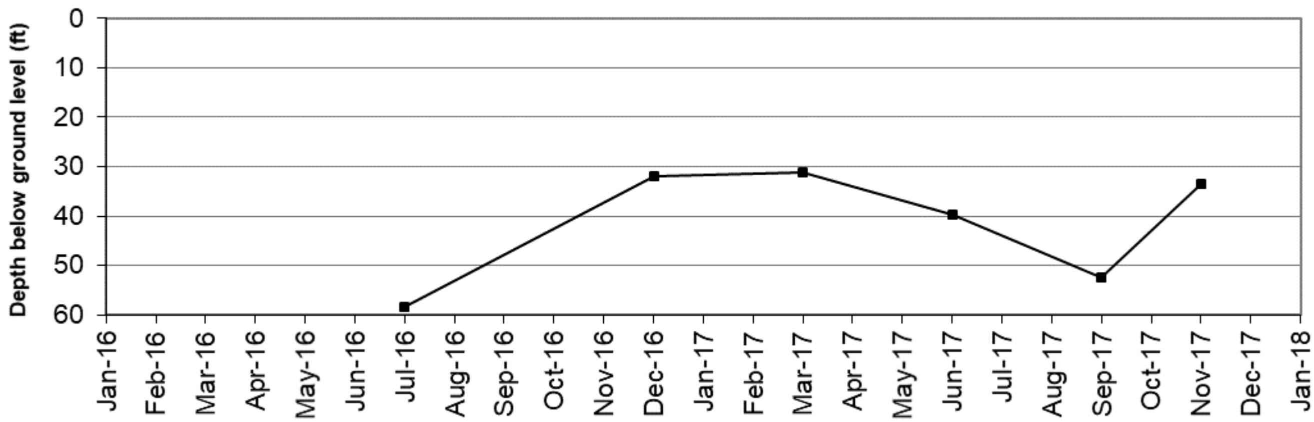
Observation Well #2032 (195 ft deep)—Nowthen



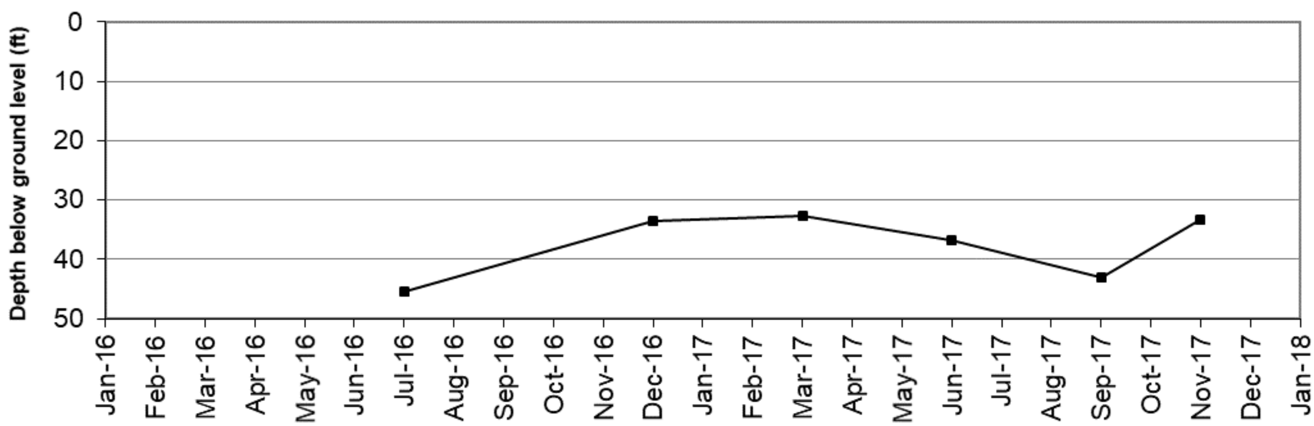
Observation Well #2033 (20.8 ft deep)—Nowthen



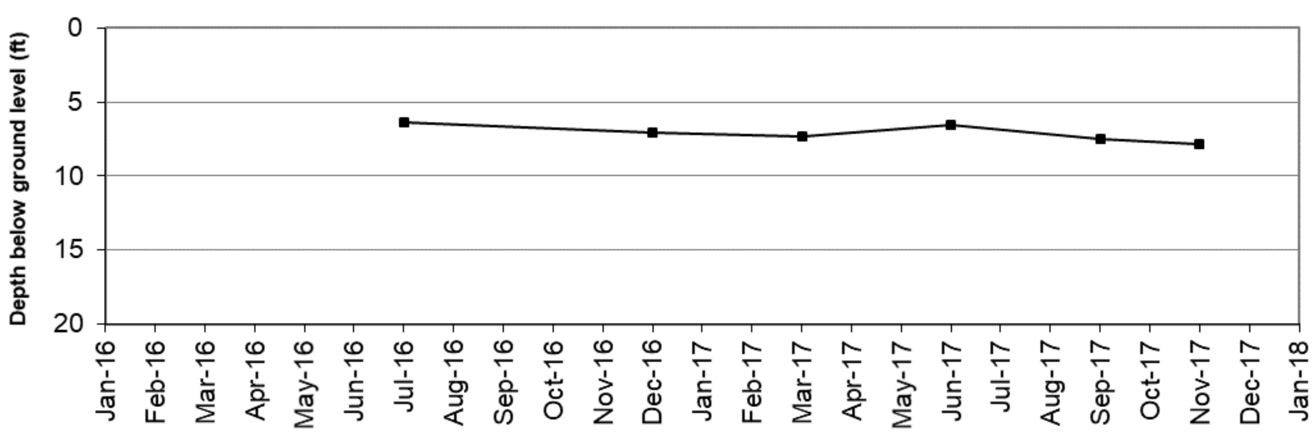
Observation Well #2034 (222 ft deep)—Blaine



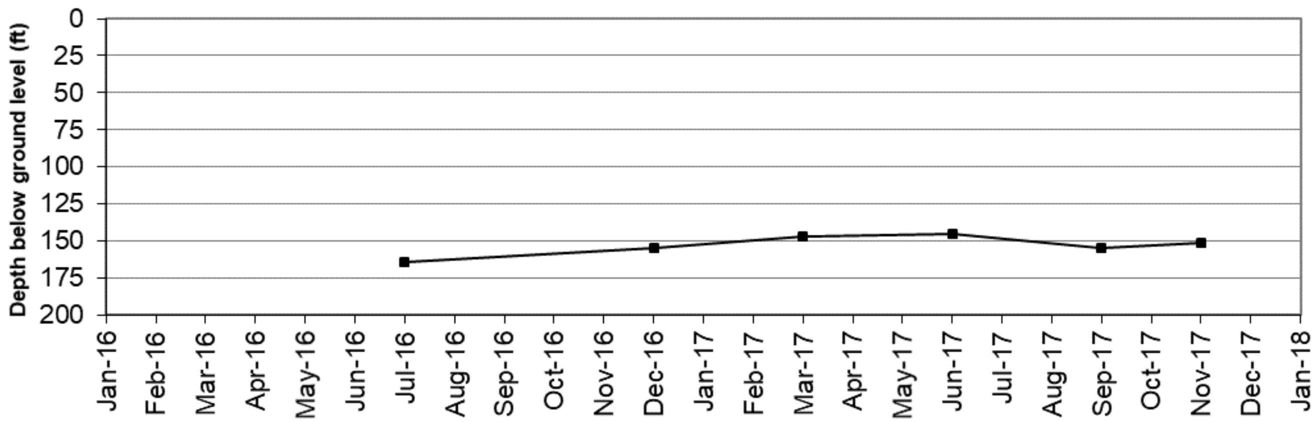
Observation Well #2036 (494 ft deep)—Andover



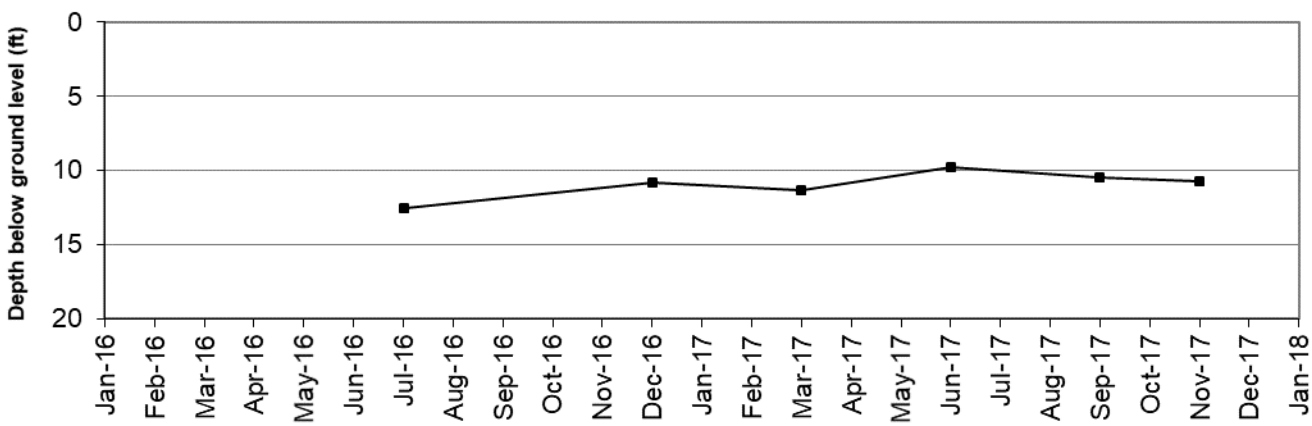
Observation Well #2037 (17.7 ft deep)—Blaine



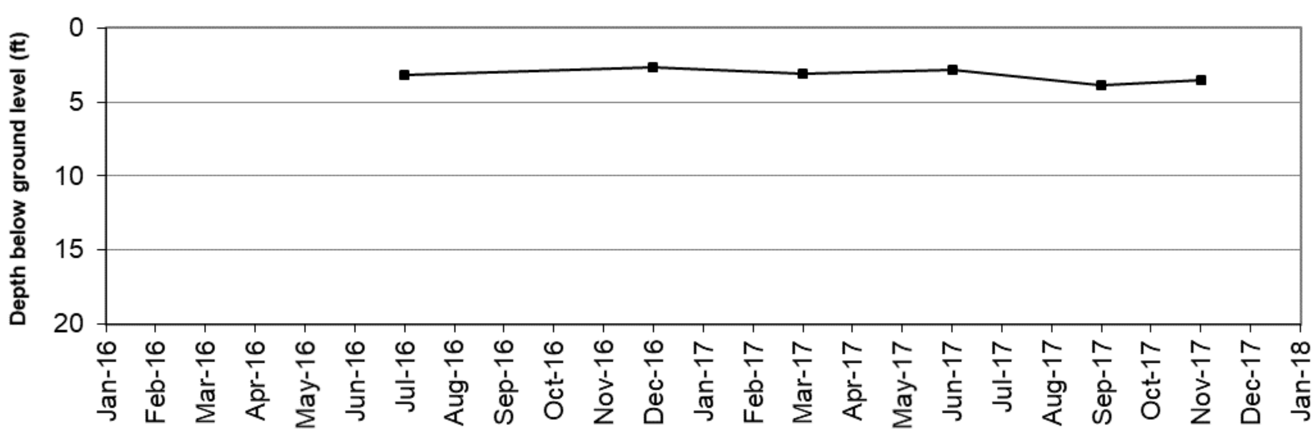
Observation Well #2038 (810 ft deep)—Lino Lakes



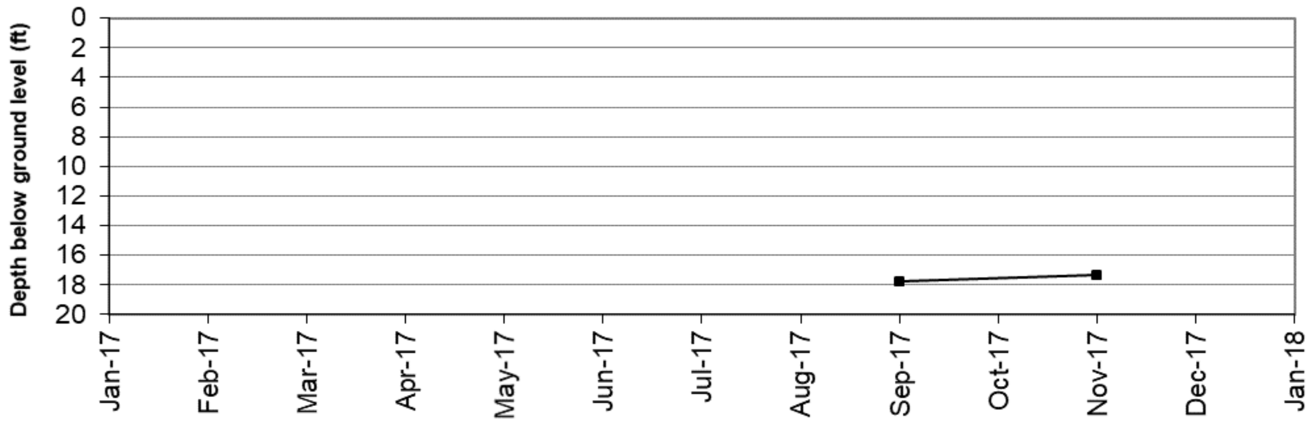
Observation Well #2039 (27.5 ft deep)—Andover



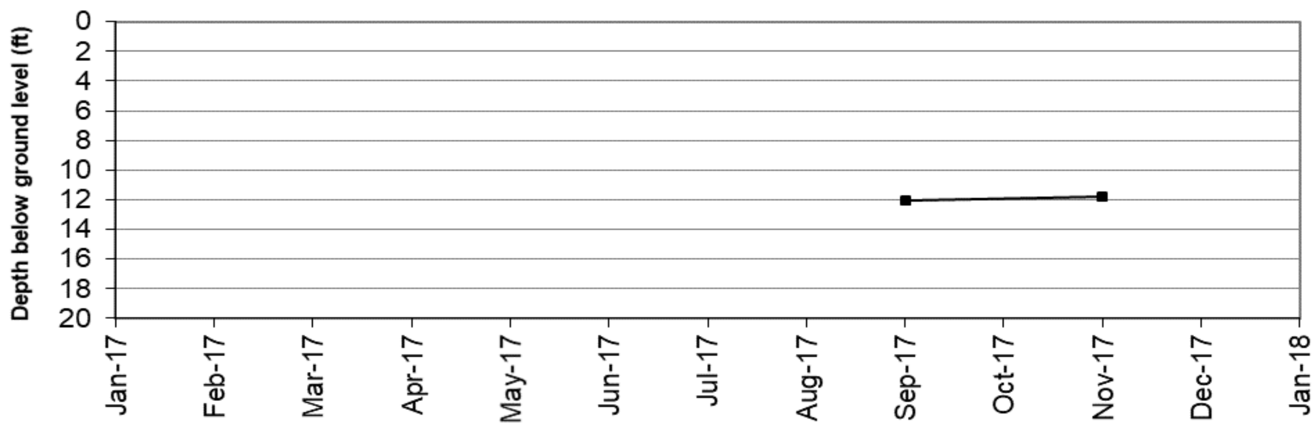
Observation Well #2040 (13 ft deep)—Carlos Avery #4



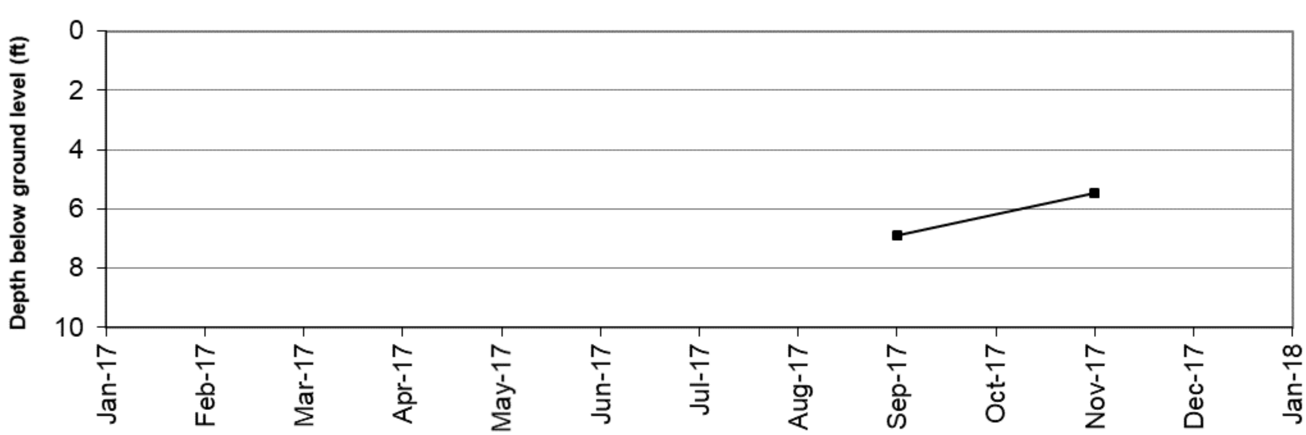
Observation Well #2041 (340 ft deep)—East Bethel, Gordie Mikkelson



Observation Well #2042 (33.1 ft deep)—East Bethel, Gordie Mikkelson



Observation Well #2043 (14.5 ft deep)—Bethel, Bethel WMA

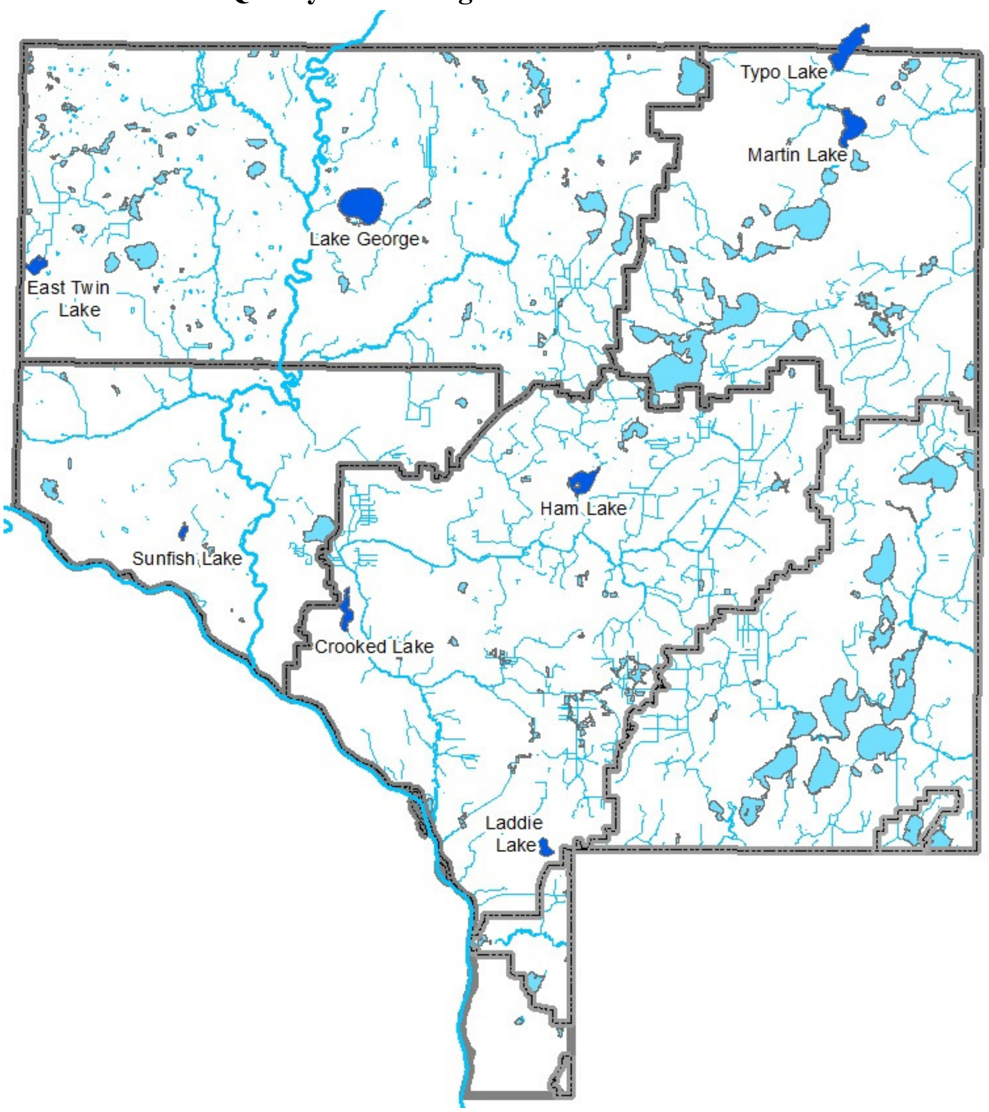


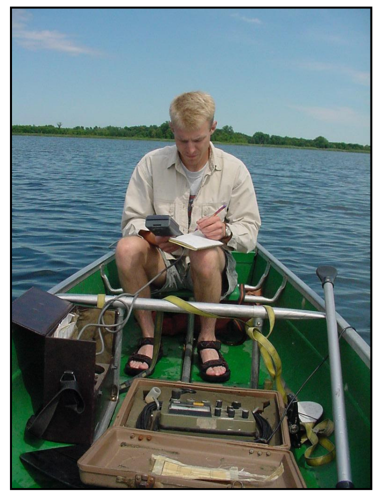
Lake Water Quality

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

In addition to this report, there are several sources of lake water quality data. For lakes monitored by the ACD, Met Council or MPCA prior to the current year, see the letter grade table on page 23. Detailed analyses for the lakes shown in that table are in each respective 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.

2017 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 Hydrolab Quanta multi-probe at a depth of one meter. Water samples are collected with a Kemmerer sampler from a depth of one meter, to be analyzed by an independent laboratory (MVTL Labs) for chlorophyll-a, chlorides, and total phosphorus. Sample bottles are provided by the laboratory. Total phosphorus sample bottles contain preservative sulfuric acid (H_2SO_4), while bottles for Chlorides and Chlorophyll-a analyses do not require preservative. Chlorophyll-a bottles are wrapped in aluminum foil to exclude light. Water samples are kept on ice and delivered to the laboratory within 24 hours of collection.

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

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

Lake Water Quality Questions and Answers

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Lake Water Quality Monitoring Parameters

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

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

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

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

A- The Minnesota Pollution Control Agency has established a subjective ranking system that the ACD staff use during each lake visit (see table, page 1-20). Rankings are based purely upon the observer's perceptions. These physical and recreational rankings are designed to give a narrative description of algae levels (physical condition) and recreational suitability of each lake. While the physical condition is straight-forward, the recreational suitability may be complicated by the impacts of both water quality and dense aquatic vegetation (the influence of these two factors is not separated in the ranking).

Lake Physical and Recreational Conditions Ranking System

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

Q- What is the lake quality letter grading system?

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

Lake Grading System Criteria

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

Q- What is Carlson’s Trophic State Index?

A- Carlson’s Trophic State Index (see figure below) assigns a number used to describe a lake’s stage of eutrophication (nutrient level, amount of algae). The index ranges from oligotrophic (clear, nutrient poor lakes) to hypereutrophic (green, nutrient overloaded lakes). The index values generally range between 0 and 100 with increasing values indicating more eutrophic conditions. Unlike the lake letter grading system, the Carlson’s Trophic State Index does not compare lakes only within the same ecoregion; it is a scale used worldwide. There are four trophic state index values: one each for phosphorus, chlorophyll-a, and transparency, plus an overall trophic state index value which is a composite of the others. The indices are abbreviated as follows:

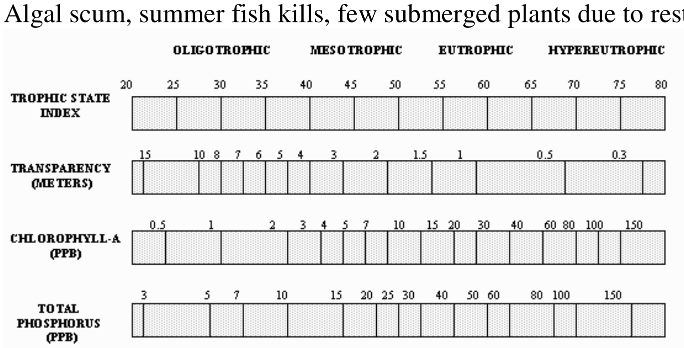
TSI- Overall Trophic State Index.
TSIP- Trophic State Index for Phosphorus.
TSIS- Trophic State Index for Secchi transparency.
TSIC- Trophic State Index for the inorganic part of algae, Chlorophyll-a.

At the conclusion of each monitoring season, the summertime (May to September) average for each trophic state index is calculated.

Carlson's Trophic State Index Scale

CARLSON’S TROPHIC STATE INDEX

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



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

YEAR →	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Cenaiko																		B	A
Centerville		C		C					D										
Coon	C				C					C					C			C	B
Coon (East Bay)					C					C	C	C		C	C	C		B	B
Coon (West Bay)																			
Crooked				C		C				C					B	C	B	B	B
East Twin	A	B		C						B						B		A	B
Fawn									B									A	B
George	A	A	A		A					A								A	B
George Watch		F	D	D		D		D	D	F	D	F					F	D	F
Golden						D	C	D	F	F	F	F		D			C	D	C
Ham					C									A	B		A	A	B
Highland																			
Howard										F	F	F							F
Island				C															
Itasca																			A
Laddie	D													A	B	B			B
Linwood	B	C		C						C					C			C	C
Lochness																			
Martin				D														D	D
Minard																			
E. Moore	C	C	C	C	C	B	C	C							C				C
W. Moore	C	C	F	C	B	C	F	C											
Mud														B					
Netta																		B	C
Peltier				D										D	F	D	D	D	D
Pickerel																B		A	A
Reshanau																			
Rogers																			C
Round																			B
Sullivan (Sandy)														D	D	D		D	D
Sunfish/Grass																			
Typo														F	F	F		F	F

YEAR →	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cenaiko	A	A	B	A	A	A	A	A	A	B	B	B	B	B					
Centerville		C	C		C	C	A												
Coon	A	B	C			C		C		C									
Coon (East Bay)	A	B	C	B		C	C	C	B	A	B	B	B	B	B+	A		B	
Coon (West Bay)												A		A		B		A-	
Crooked		B		B	B		B	B-		B	B		B	A-		A	A		B
East Twin	A	A		A			A			A			A		A				A
Fawn	A	A	A			A		A		A		A		A			A		
George	A	A		A			B			B			B		B	B	A	A	B
George Watch	D	D	F	D	D	F	D	F	F	D	D	D	D	F					
Golden	C	C	D	D	D	D	C	C	C	C	C	C							
Ham		C	C			B	B		B	A		B	B		A	A		B	B
Highland	D	D	D	F	F	F	F	F	F									F	
Howard	D	D																	
Island					B	B	C	C	B	B	C	C	C	C					
Itasca	B	B																	
Laddie	B	B	B	B	B	B	B			B			B					A	B
Linwood	C	C	C		C		C		C	C	C			C			C		
Lochness									A	B		B	C	C					
Martin	C	D	D		D		D		D	D	D			D		C	C	C	C
Minard															A	A			
E. Moore	B	B	C	C	C		C												
W. Moore	B	B	C	C	C		C												
Mud	B	C																	
Netta	A		B		A	A		B+	B+		B	A-		A-	A		A	A	
Peltier	D	D	F	F	D	D	D	F	D										
Pickerel	B	C										A	C		B	A			
Reshanau								D	D	D	D	D	D	D					
Rogers		C			B			D		B	B								
Round	A	B			A		B		C		C	C		A		A		A	
Sullivan (Sandy)	D	D	D	F	D	D	D								D			D	
Sunfish/Grass														B	B			B	A
Typo	F	F	F		F		F		F		F			F		D	F	F	F

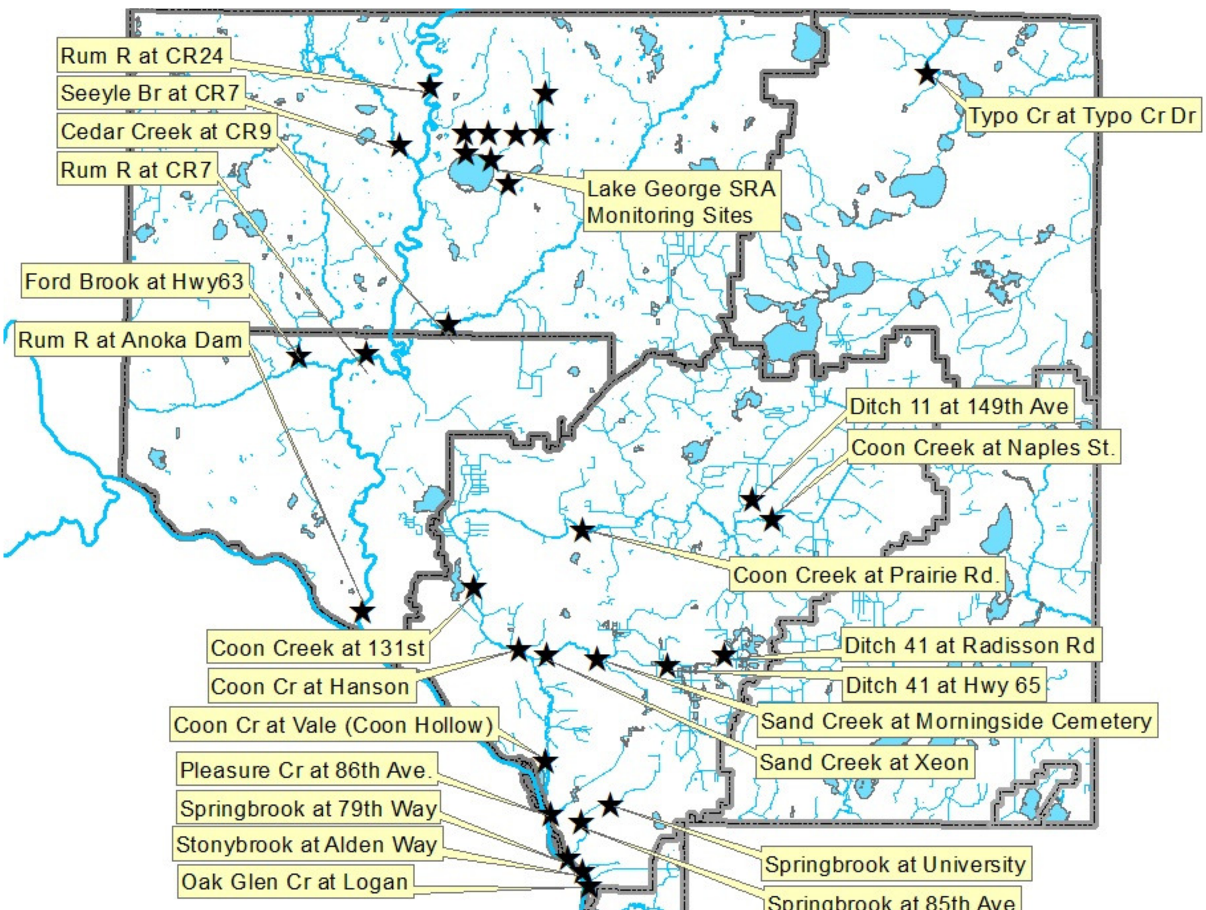
Stream Water Quality – Chemical Monitoring

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

Chemical stream water quality monitoring in 2017 was conducted at four Sand Creek (Ditch 41) sites, six Coon Creek sites including one tributary (Ditch 11), three Springbrook sites, three Rum River sites, and one site each in Ford Brook, Pleasure Creek, Typo Creek, Cedar Creek, Seelye Brook, Stonybrook, and Oak Glen Creek. Eight sites were also monitored as part of a Lake George Stormwater Retrofit Analysis study. 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.

2017 Chemical Stream Water Quality Monitoring Sites



STREAM WATER QUALITY MONITORING METHODS

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

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

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

Stream Water Quality Monitoring Questions and Answers

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

Q- What do the parameters that you test mean?

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

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

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

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.

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

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

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

Analytical Limits for Stream Water Quality Parameters

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

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

A- We make up to three comparisons. First, with published water quality values for the ecoregion. Ecoregions are areas with similar soils, landform, potential natural vegetation, and land use. All of Anoka County is within the North Central Hardwood Forest (NCHF) Ecoregion. Mean values for our ecoregion, and for minimally impacted streams in our ecoregion, are in the table below. Secondly, we compare each stream to 48 other streams the Anoka Conservation District has monitored throughout the county. The county includes urban, suburban, and rural areas so this comparison incorporates water quality expectations in all these land uses.

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

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

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

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

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

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

Parameter	Units	NCHF Ecoregion Mean[1]	NCHF Ecoregion Minimally Impacted Stream[1]	Median of Anoka County Streams
pH	pH units		8.1	7.59
Conductivity	mS/cm	.389	.298	0.363
Turbidity	NTU		7.1	11.24
Dissolved Oxygen	mg/L	-	-	7.54
Temperature	°F		71.6	
Salinity	%		0	0.01
Total Phosphorus	µg/L	220	130	126
Total Suspended Solids	mg/L		13.7	13.66
Chloride	mg/L		8	13.3
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.

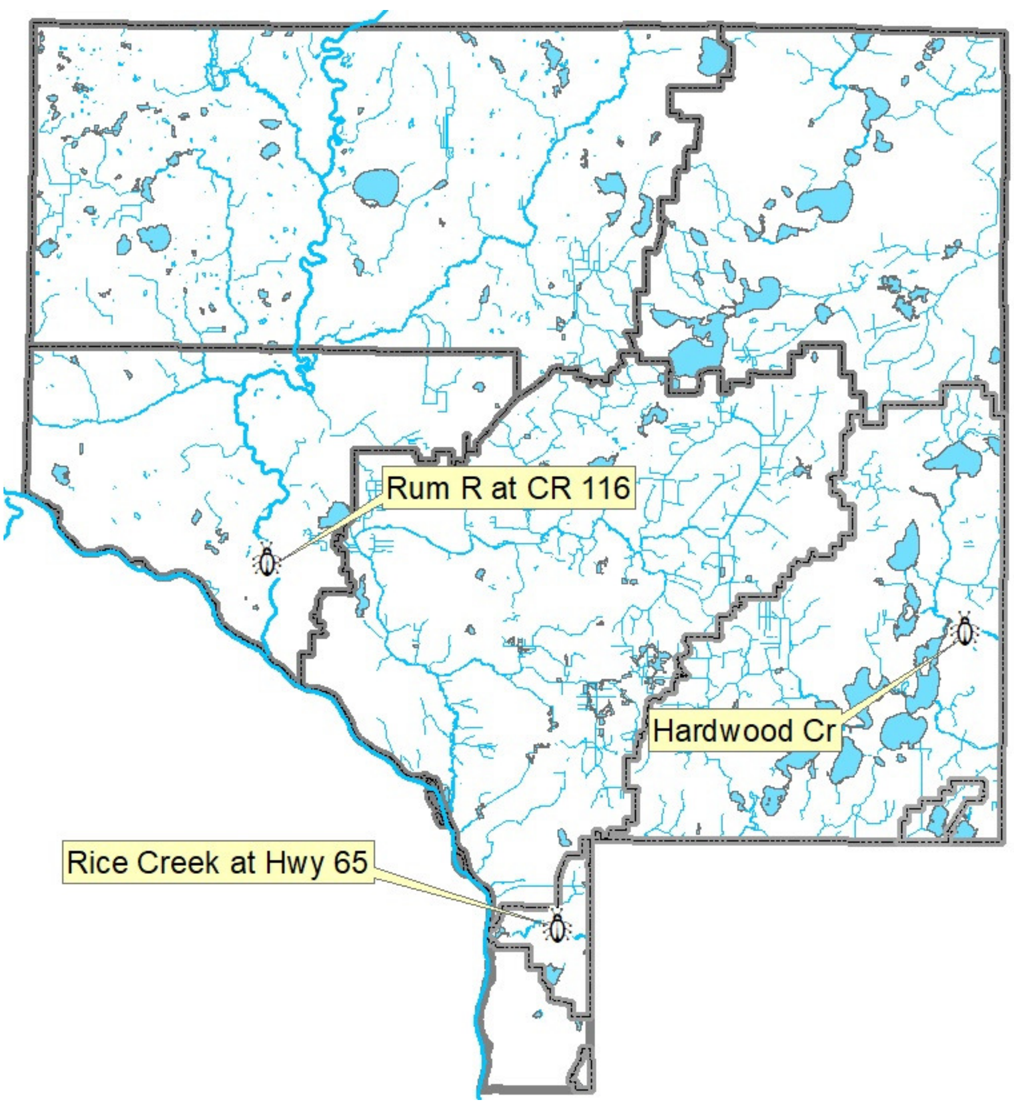
Stream Water Quality – Biological Monitoring

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 2017 there were approximately 220 students from three high schools who monitored three sites, plus a fourth high school class of 16 students in St. Francis that did a rapid assessment project in the Rum River. Since 2000, over 5,000 students have participated. The experience affords students an opportunity to learn scientific methodologies and become involved in local natural resource management.

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

2017 Biological Stream Water Quality Monitoring Sites



Biomonitoring Methods

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

Biomonitoring Indices

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

Taxa Richness and Composition Measures

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

EPT: This is a measure of the number of families in each of three generally pollution-sensitive orders: 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.

% 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).

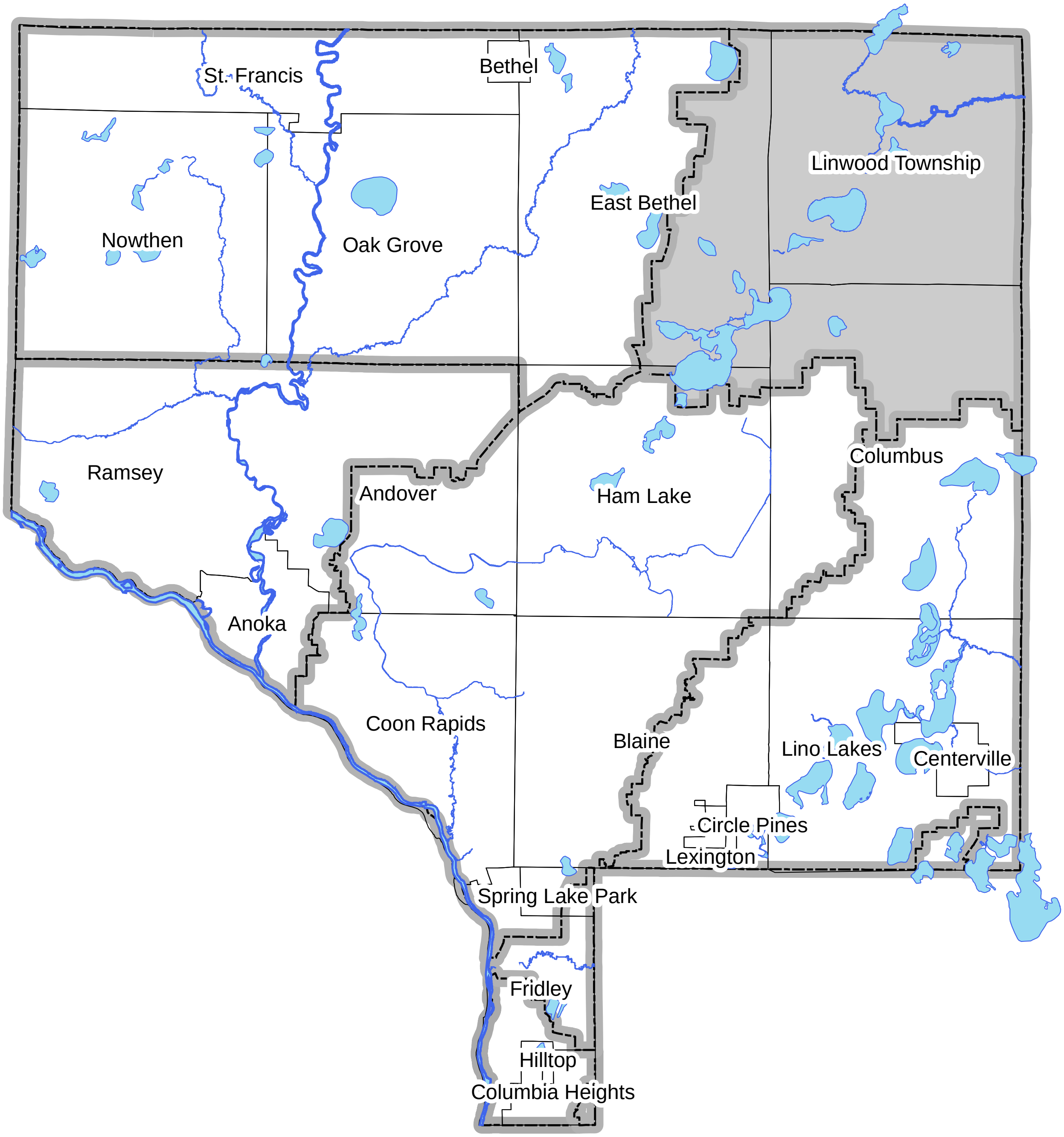
Sites

In 2017, high school classes from Anoka, Totino Grace, and Forest Lake ALC with ACD staff supervision sampled four sites for benthic macroinvertebrates and identified each organism captured to family level. Additionally, ACD staff taught a class from Saint Francis HS biomonitoring methods and groups performed a rapid assessment by counting species within each order captured. Data from the educational quick assessment are not included in this report.

2017 Biomonitoring Sites and Corresponding Monitoring Groups

Monitoring Group	Stream
Anoka High School	Rum River (South)
Forest Lake Area Learning Center	Hardwood Creek
Totino Grace High School	Rice Creek
St. Francis High School	Rum River (North)

Sunrise River Watershed



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

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

Chapter 2:
Sunrise River Watershed

Task	Partners	Page
Lake Levels	SRWMO, ACD, MN DNR, volunteers	2-34
Lake Water Quality	SRWMO, ACD, ACAP	2-36
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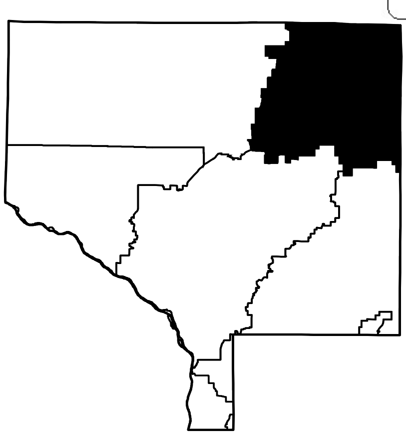
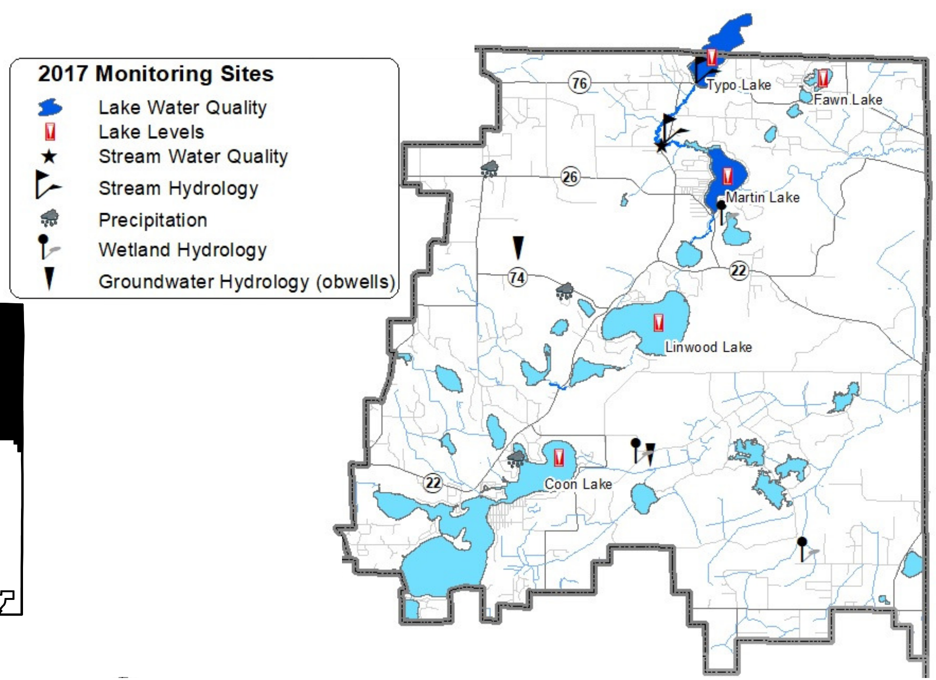
Stream Water Quality	SRWMO, ACD, ACAP	2-43
Wetland Hydrology	SRWMO, ACD, ACAP	2-50
Water Quality Grant Fund	SRWMO, ACD	2-54
Martin and Typo Lake Carp Removal Project	SRWMO, ACD, Martin Lakers Assoc, DNR	2-55
Ditch 20 Feasibility Study	SRWMO,ACD	2-56
Annual Education Publication	SRWMO, ACD	2-58
SRWMO Website	SRWMO, ACD	2-59
Grant Search and Applications	SRWMO, ACD	2-60
SRWMO 2016 Annual Report	SRWMO, ACD	2-61
On-call Administrative Services	SRWMO, ACD	2-62
Financial Summary		2-63
Recommendations		2-64
Groundwater Hydrology (obwells)	ACD, MNDNR	See Chapter 1
Precipitation	ACD, volunteers	See Chapter 1

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





Lake Levels

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

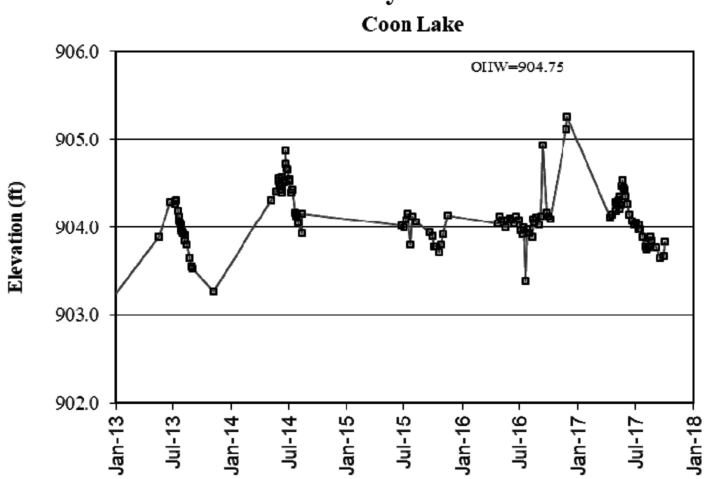
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

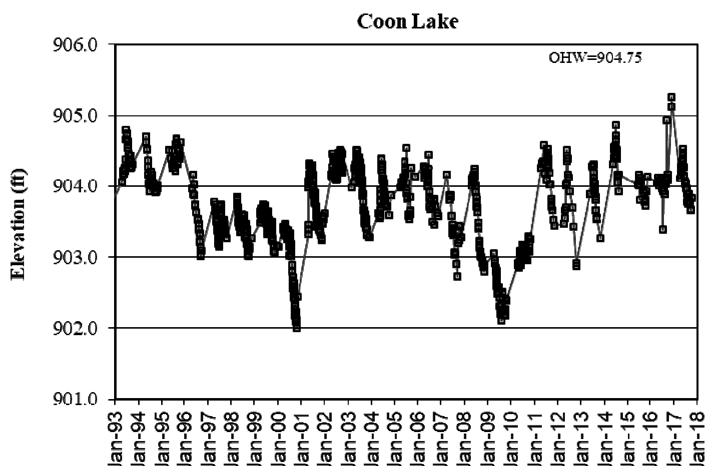
Results: Lake levels were measured by volunteers throughout the 2017 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. In 2017, lakes followed the expected pattern of increasing water levels in spring and early summer and then fell later in the summer due to less rainfall. Martin and Linwood Lakes saw a slight rebound in levels through fall after a large early October rain event.

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

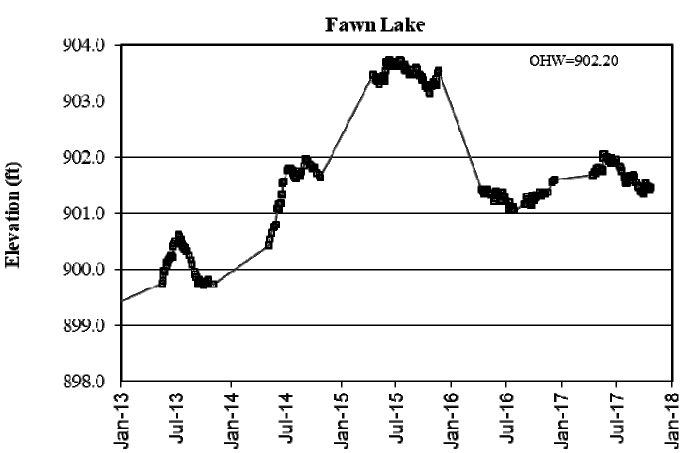
Coon Lake Levels – last 5 years



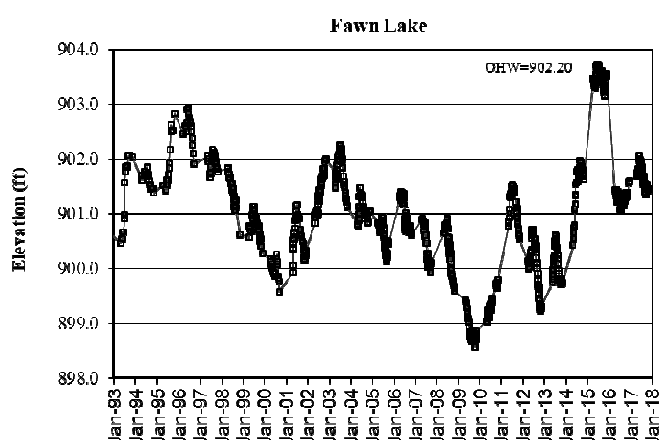
Coon Lake Levels – last 25 years



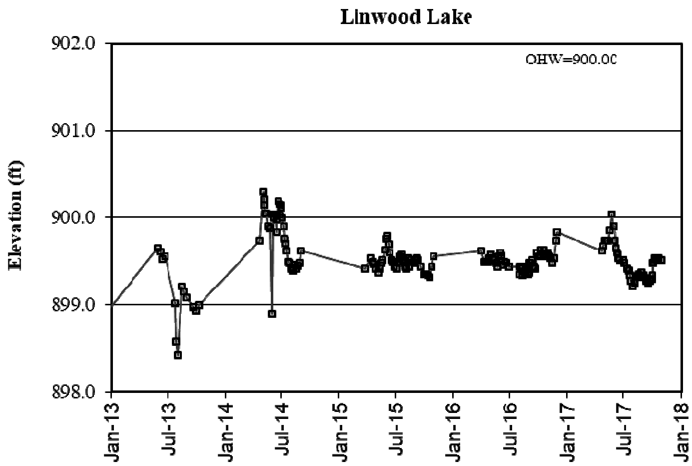
Fawn Lake Levels – last 5 years



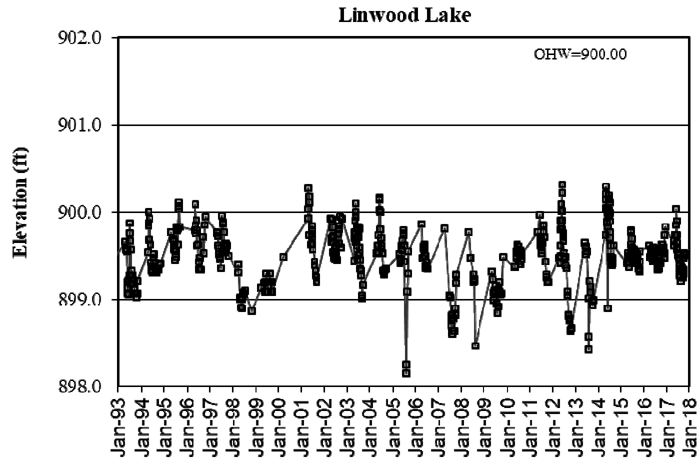
Fawn Lake Levels – last 25 years



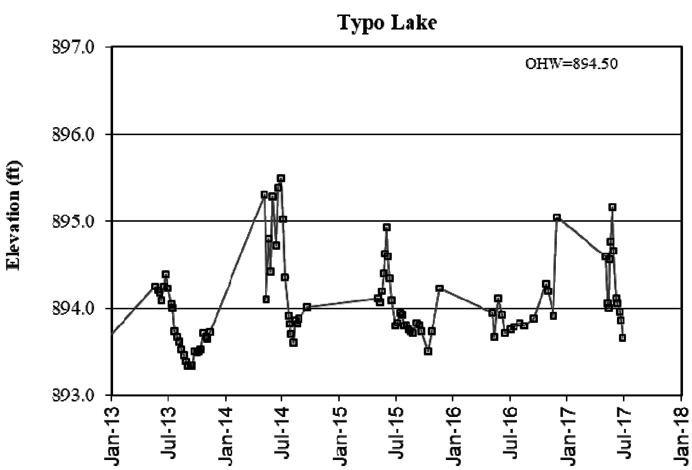
Linwood Lake Levels – last 5 years



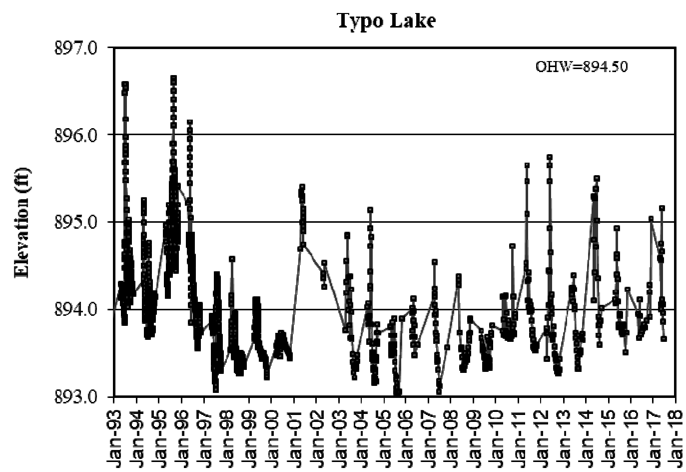
Linwood Lake Levels – last 25 years



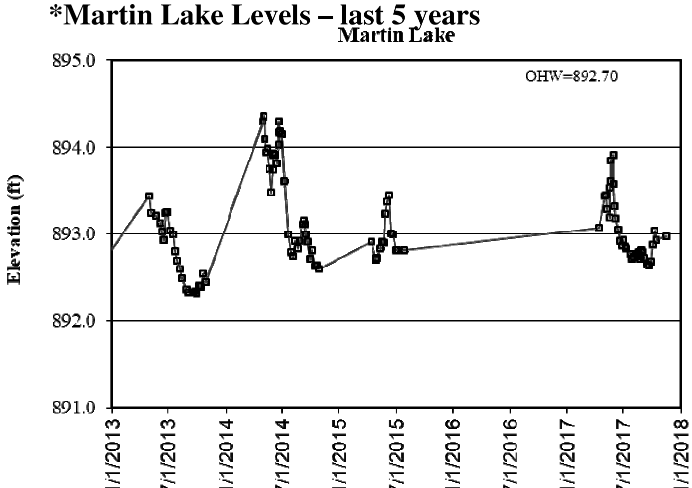
Typo Lake Levels – last 5 years



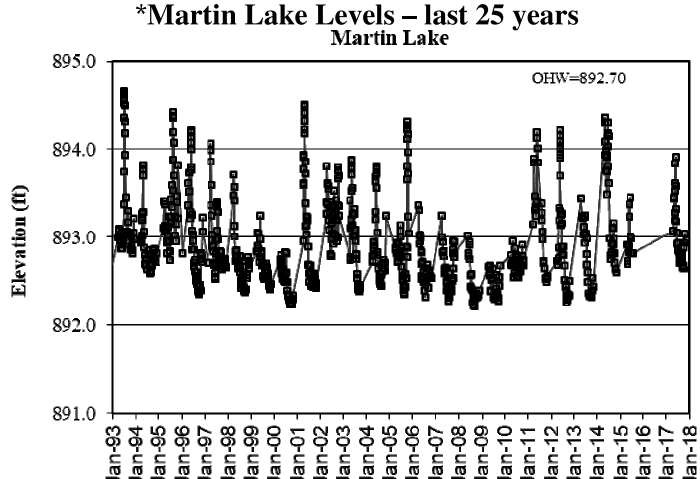
Typo Lake Levels – last 25 years



*Martin Lake Levels – last 5 years



*Martin Lake Levels – last 25 years



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

Lake Water Quality

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

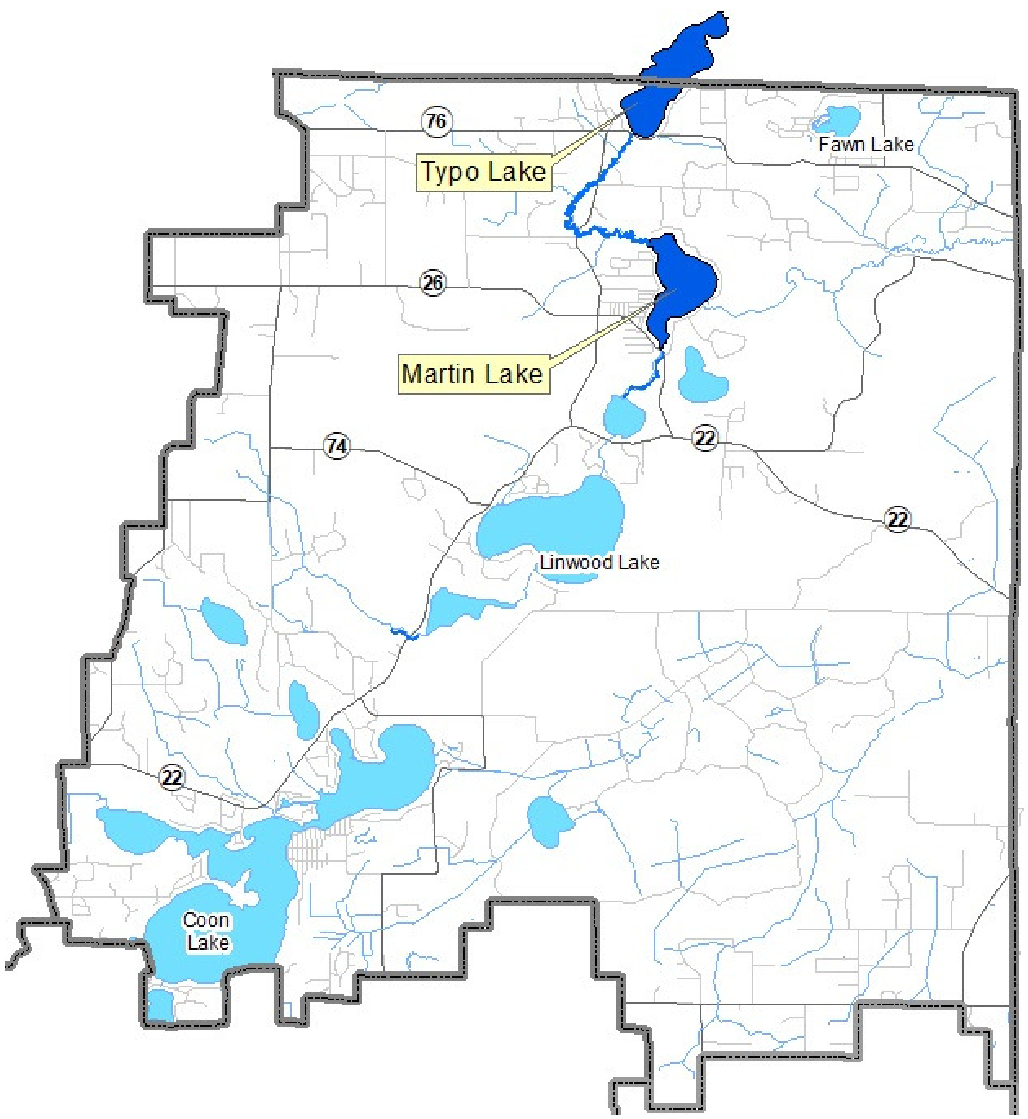
Purpose: To detect water quality trends and diagnose the cause of changes.

Locations: Typo Lake

Martin Lake

Results: Detailed data for each lake are provided on the following pages, including summaries of historical conditions and trend analysis. Previous years' data are available from the MPCA (https://cf.pca.state.mn.us/water/watershedweb/wdip/search_more.cfm) or from ACD. Refer to Chapter 1 for additional information on lake dynamics and interpreting the data.

Sunrise Watershed Lake Water Quality Monitoring Sites



Typo Lake
Linwood Township, Lake ID # 30-0009

Background

Typo Lake is located in northeast Anoka County and southeast Isanti County. It has a surface area of 290 acres and maximum depth of 6 feet (1.82 m), though most of the lake is about 3 feet deep. The lake has a mucky, loose, and unconsolidated bottom in some areas, while other areas have a sandy bottom. The public access is located at the south end of the lake along Fawn Lake Drive. The lake is used 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.

2017 Results

In 2017 Typo Lake had extremely poor water quality compared to other lakes in this region (NCHF Ecoregion), receiving an overall F letter grade. This overall grade is consistent with all previous years monitored except for the D- achieved in 2014. Average total phosphorus (TP) was higher than the previous five years monitored at 226 µg/L. However, removing two very high outliers lowers the average to 134 µg/L, which would be lowest average on record. While total phosphorus levels continue to far exceed the 60 µg/L state standards, average concentrations appear to be staying well below averages from a decade ago. Continuing to pursue and fund restoration projects in the lakeshed, as well as managing rough fish populations in the lake, should continue to produce lower phosphorus levels.

Chlorophyll-a (Cl-a) levels in 2017 averaged 66.7 µg/L. This is well below the historical average of 115.3 µg/L, lower than the 2016 average of 83.4 µg/L, but above average concentrations in 2014 and 2015.

Average Secchi transparency in 2017 was 1.2 feet. While this marks an improvement from a decade ago (in 2007 and 2009 a Secchi disk could be seen only 5-6 inches below the surface, on average) it is still far below the state standard of over 3 feet. There was a slight improvement in 2012 to 9-10 inches and a larger improvement in 2014 to 21-22 inches. In 2016, average Secchi transparency declined back to under a foot (about 11inches).

Trend Analysis

Seventeen 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, 20014-2017). Water quality has improved from 1993 to 2017 in a statistically significant way (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,14}$=5.7, p=0.02). When we tested these response variables individually with one-way ANOVAs TP and Secchi depth still show no significant change across this time period. Cl-a, however, is now showing a statistically significant decline ($F_{1,15}$ =4.55, p=<0.05). A superficial look at graphs of these parameters suggests that total phosphorus is actually generally increasing, though this increase is driven by very high concentrations in 2007 and 2009. Excluding these outliers actually shows a slight declining trend in TP. Secchi depth appears to be increasing. The major driver of improved water quality is decreasing Cl-a concentrations.

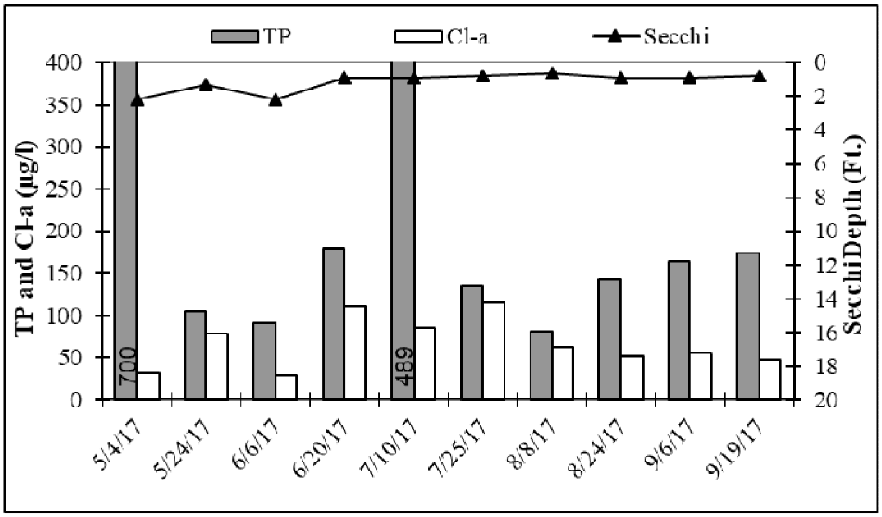
Discussion

Typo Lake, along with Martin Lake downstream, were the subject of a Total Maximum Daily Load (TMDL) study by the Anoka Conservation District, which was approved by the State and EPA in 2012. This study documented the sources of nutrients to the lake, the degree to which each is impacting the lake, and put forward lake rehabilitation strategies. Some factors impacting water quality on Typo Lake include the presence of rough fish, high phosphorus inputs from a ditched wetland west of the lake, and lake sediments. Recent work has included installation of carp barriers (completed in 2016), carp removals (2017-19) and a feasibility study of ditched wetland restorations upstream of Typo Lake (final reporting in early 2018).

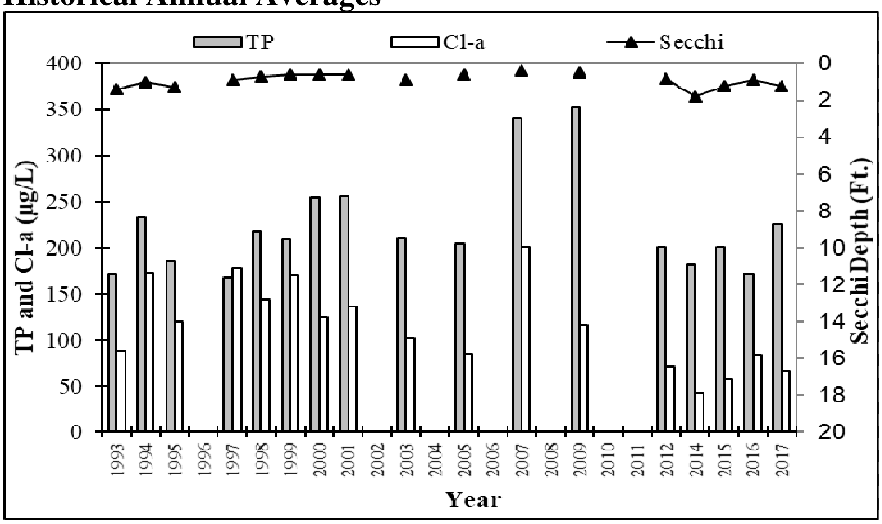
Typo Lake

Linwood Township, Lake ID # 30-0009

2017 Results



Historical Annual Averages



Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1974			F	
1975			F	
1993	F	F	F	F
1994	F	F	F	F
1995	F	F	F	F
1997	F	F	F	F
1998	F	F	F	F
1999	F	D	F	F
2000	F	F	F	F
2001	F	F	F	F
2003	F	F	F	F
2005	F	F	F	F
2007	F	F	F	F
2009	F	F	F	F
2012	F	D	F	F
2014	F	C	F	D-
2015	F	D	F	F
2016	F	F	F	F
2017	F	D	F	F
2017 average	226* µg/L	66.7 µg/L	0.4 meters	
State standards	60 µg/L	20 µg/L	1.0 meters	

*Two outliers removed lowers avg. to 134 µg/L

2017 Raw Data

	Units	Date / Time / R.L.*	5/4/2017	5/24/2017	6/6/2017	6/20/2017	7/10/2017	7/25/2017	8/8/2017	8/24/2017	9/6/2017	9/19/2017			
		Time	13:40	13:40	14:50	13:10	10:25	10:15	10:25	11:00	10:20	10:10			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	9.06	9.10	8.78	9.16	8.44	8.92	9.48	9.34	9.18	9.05	9.05	8.44	9.48
Conductivity	mS/cm	0.01	0.213	0.228	0.297	0.280	0.264	0.265	0.250	0.240	0.255	0.276	0.257	0.213	0.297
Turbidity	NTU	1	23.40	32.40	30.50	89.30	86.20	123.00	84.50	79.20		96.90	65	23	97
D.O.	mg/l	0.01	14.02	13.38	9.61	12.13	7.40	10.38	13.55	12.13	10.72	8.64	11.20	7.40	14.02
D.O.	%	1	136%	135%	116%	146%	92%	127%	161%	138%	112%	95%	126%	92%	161%
Temp.	°C	0.1	13.0	14.1	22.1	22.5	24.8	24.2	23.0	21.8	16.3	17.5	19.93	13.00	24.82
Temp.	°F	0.1	55.4	57.3	71.8	72.4	76.7	75.6	73.5	71.2	61.4	63.4	67.9	55.4	76.7
Salinity	%	0.01	0.10	0.11	0.14	0.13	0.13	0.13	0.12	0.12	0.12	0.13	0.1	0.1	0.1
Cl-a	µg/l	1	32.0	78.3	28.5	112.0	85.4	115.0	61.9	51.3	55.5	47.0	66.7	28.5	115.0
T.P.	mg/l	0.005	0.700	0.105	0.091	0.179	0.489	0.136	0.081	0.143	0.165	0.174	0.226	0.081	0.700
T.P.	µg/l	5	700	105	91	179	489	136	81	143	165	174	226	81	700
Secchi	ft	0.1	2.2	1.3	2.2	0.9	0.9	0.8	0.7	0.9	0.9	0.8	1.2	0.7	2.2
Secchi	m	0.1	0.7	0.4	0.7	0.3	0.3	0.2	0.2	0.3	0.3	0.2	0.4	0.2	0.7
Field Observations			Brown, Cloud	Brown	Brown	Murky	Brown	Green	Brown	Brown	Brown	Brown			
Physical			4	4	4	4	4	3	4	5	4	5	4.1	3.0	5.0
Recreational			4	4	4	3	3	2	2	4	4	4	3.4	2	4

*reporting limit

Martin Lake

Linwood Township, Lake ID # 02-0034

Background

Martin Lake is located in northeast Anoka County. It has a surface area of 223 acres and maximum depth of 20 ft. The public access is located on the southern end of the lake. The lake is used moderately by recreational boaters and fishers, and would likely be used more if water quality improved. Martin Lake is almost entirely surrounded by private residences. The 5,402 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.

2017 Results

In 2017 Martin Lake had typical water quality compared to other recent years, which compares poorly to other lakes in the North Central Hardwood Forest Ecoregion (NCHF), and received a C letter grade. Martin Lake is quite eutrophic for a lake of its size and depth due to chronically high total phosphorus (TP) and chlorophyll-a (Cl-a). In 2017 total phosphorus levels, however, continued a three-year improvement averaging 59.3 µg/L. This is the lowest average on record, though it remains above the impairment threshold of 40 µg/L. This now marks two consecutive years with lowest average total phosphorus on record for Martin Lake following the previous record low average of 69.1 µg/L in 2016. These averages are half, or less than half, of averages from a decade ago (135.0 µg/L in 2007)

Chlorophyll-a dropped slightly from the previous year to 24.9 µg/L in 2017. While the 5 year average since 2012 (22.19 µg/L) has been much lower than the 2005-2009 average (108.3 µg/L), this average still remains above the impairment standard of 14 µg/L.

Average Secchi transparency was 3.0 feet in 2017, exactly matching its historical average. This average remains about 30% below the State impairment threshold of 4.6 feet. The ACD staff continue to note green water during late summer months.

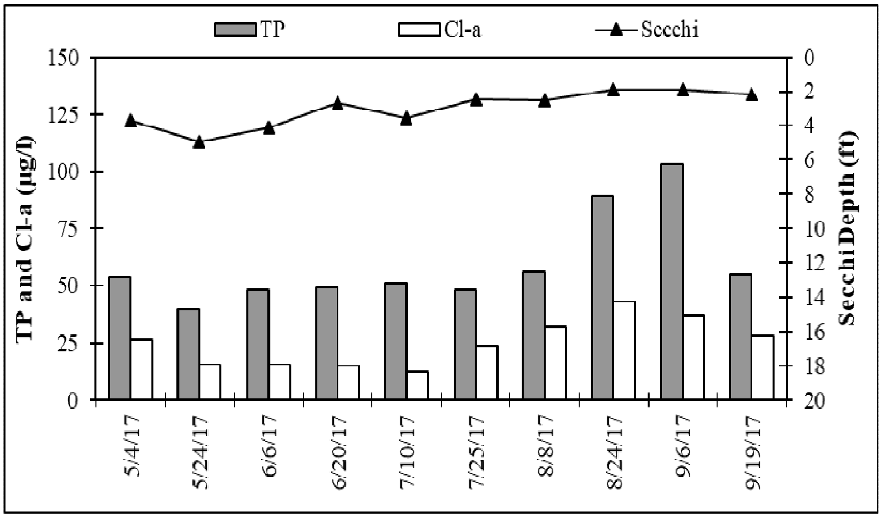
Trend Analysis

Sixteen years of water quality data have been collected by the Minnesota Pollution Control Agency (1983), Metropolitan Council (1998, 2008), and the ACD (1997, 1999-2001, 2003, 2005, 2007, 2009, 2012-2017). Citizens monitored Secchi transparency 17 other years. Anecdotal notes from DNR fisheries data indicate poor water quality dating back to at least 1954. Although still pretty poor, water quality in Martin Lake has actually shown an improvement from 1983 to 2017 that is statistically significant (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2,13}$=5.82, p=<0.02). Further examination of the data (one-way ANOVAs on the individual response variables) shows that while TP and Secchi depth appear to be staying virtually flat, Cl-a has shown a statistical decrease ($F_{1,14}$=9.25, p=<0.01). Similar to Typo Lake, a decrease in Cl-a concentrations are driving a statistically significant improvement in overall water quality.

Discussion

Martin Lake, along with Typo Lake upstream, was the subject of a TMDL study by the Anoka Conservation District that was approved by the State and EPA in 2012. This study documented the source of nutrients to the lake, the degree to which each is impacting the lake, and put forward lake rehabilitation strategies. Water from Typo Lake and internal loading (carp, septic systems, sediments, etc.) are two of the largest negative impacts on Martin Lake water quality. Installation of carp barriers was completed in 2016. Carp removals and other management efforts are taking place in 2017-19. Upstream of Typo Lake, a feasibility study is being completed in early 2018 regarding restoration of ditched wetlands. In the neighborhoods adjacent to Martin Lake three rain gardens were installed in 2011. Recent water quality monitoring results suggest these management approaches are improving conditions in these lakes, but reaching goals will require additional efforts and time.

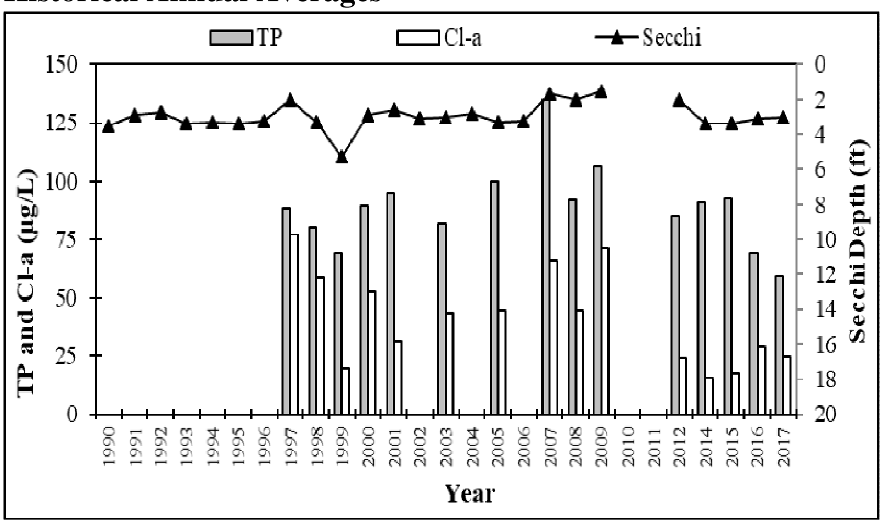
2017 Results



Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1996			D	
1997	D	D	F	D
1998	D	D	D	D
1999	C	B	C	C
2000	D	C	D	D
2001	D	C	D	D
2002			D	
2003	D	C	D	D
2004			D	
2005	D	C	D	D
2006			D	
2007	D	D	F	D
2008	D	C	F	D
2009	D	D	F	D
2012	D	C	F	D
2014	D	B	D	C
2015	D	B	D	C
2016	C	C	D	C
2017	C	C	D	C
2017 average	59.3 µg/L	24.9 µg/L	0.4 meters	
State standards	40 µg/L	14 µg/L	1.4 meters	

Historical Annual Averages



2017 Raw Data

	Units	R.L.*	5/4/2017	5/24/2017	6/6/2017	6/20/2017	7/10/2017	7/25/2017	8/8/2017	8/24/2017	9/6/2017	9/19/2017	Average	Min	Max
Time:			14:15	14:10	15:25	13:45	9:50	9:45	9:55	10:35	9:55	9:45			
			Results	Results	Results	Results	Results	Results	Results	Results	Results	Results			
pH		0.1	13.090	8.070	8.280	8.170	8.600	8.490	8.740	8.700	8.920	9.200	9.026	8.070	13.090
Conductivity	mS/cm	0.01	0.25	0.28	0.30	0.29	0.29	0.35	0.34	0.31	0.31	0.30	0.30	0.25	0.35
Turbidity	NTU	1	12.00		8.40	26.10	7.80	33.60	28.60	33.40		22.30	19.80	7.80	33.40
D.O.	mg/l	0.01	1308%	872%	989%	904%	818%	991%	1117%	1054%	1053%	943%	1005%	818%	1308%
D.O.	%	1	1.2	1.0	1.2	1.1	1.0	1.2	1.4	1.2	1.2	1.1	1.2	1.0	1.4
Temp.	°C	0.1	11.9	14.8	22.4	22.7	25.2	24.8	23.6	22.0	19.3	19.2	20.6	11.9	25.2
Temp.	°F	0.1	53.38	58.57	72.23	72.77	77.27	76.59	74.41	71.64	66.67	66.47	69.00	53.38	77.27
Salinity	%	0.01	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2
Cl-a	µg/l	1.000	26.300	15.700	15.700	15.000	12.100	23.900	32.000	42.700	37.400	27.800	24.860	12.100	42.700
T.P.	mg/l	0.005	0.054	0.040	0.048	0.049	0.051	0.048	0.056	0.089	0.103	0.055	0.059	0.040	0.103
T.P.	µg/l	5	54.0	40.0	48.0	49.0	51.0	48.0	56.0	89.0	103.0	55.0	59.3	40.0	103.0
Secchi	ft		3.7	4.9	4.1	2.7	3.6	2.4	2.5	1.9	1.9	2.2	3.0	1.9	4.9
Secchi	m		1.1	1.5	1.2	0.8	1.1	0.7	0.8	0.6	0.6	0.7	0.9	0.6	1.5
Field Observations/Appearance			Fairly Brown	Murky	Brown	Brown	Green	Brown	Brown	Green	Green	Green			
Physical			2	1	1	1	3	3	3	4	3	4	3	1	4
Recreational			2	1	1	1	1	1	1	3	2	3	1.6	1	3

*reporting limit

Stream Hydrology Monitoring

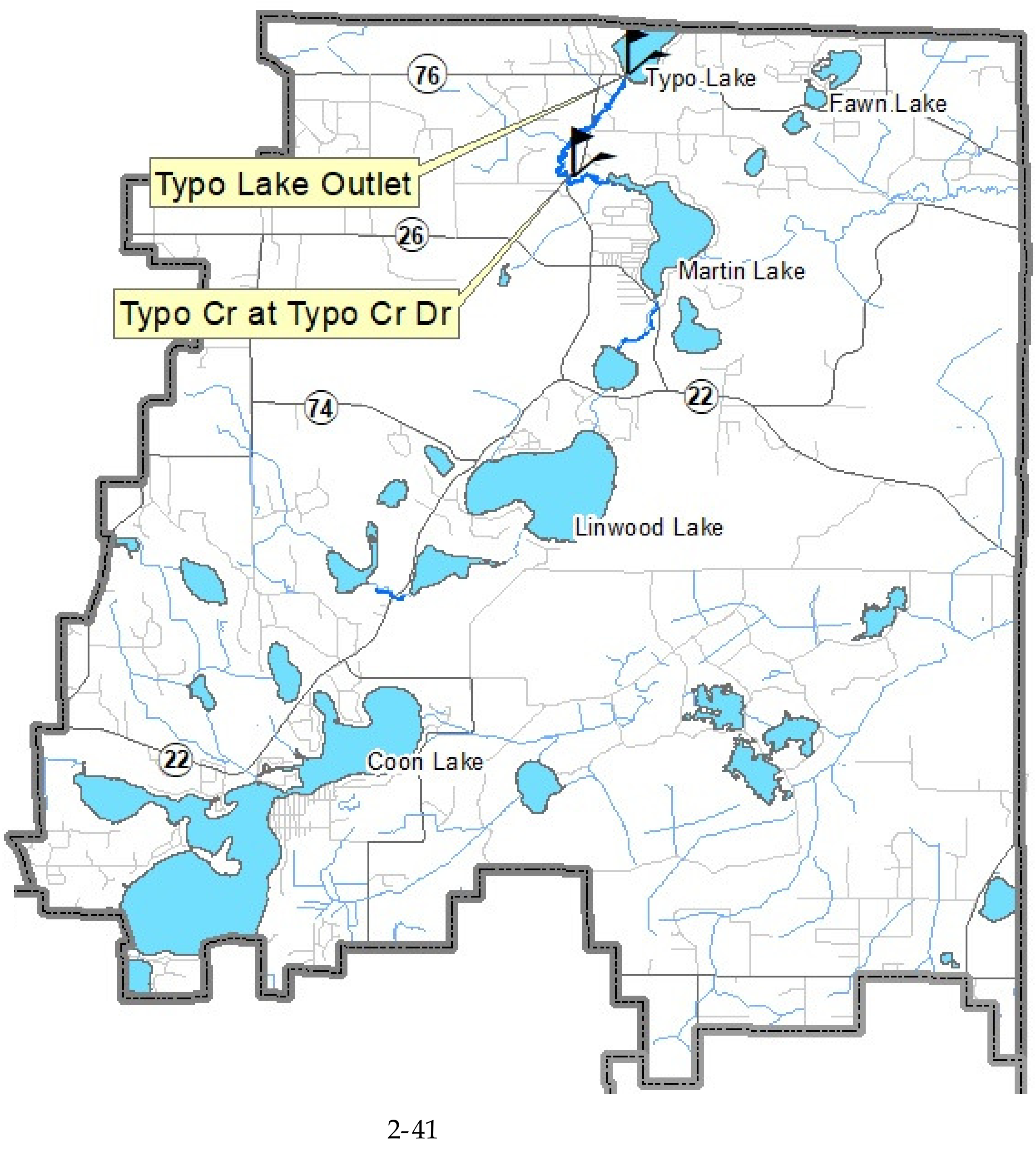
Description: Continuous water level monitoring in streams.

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. The Typo Lake outlet and Typo Creek carp barriers were monitored on either side to assess whether the barriers were affecting flow.

Locations: Typo Lake outlet carp barrier and Typo Creek carp barrier

Results: Results are presented on the following pages

2017 Sunrise River Watershed Stream Hydrology Monitoring Sites



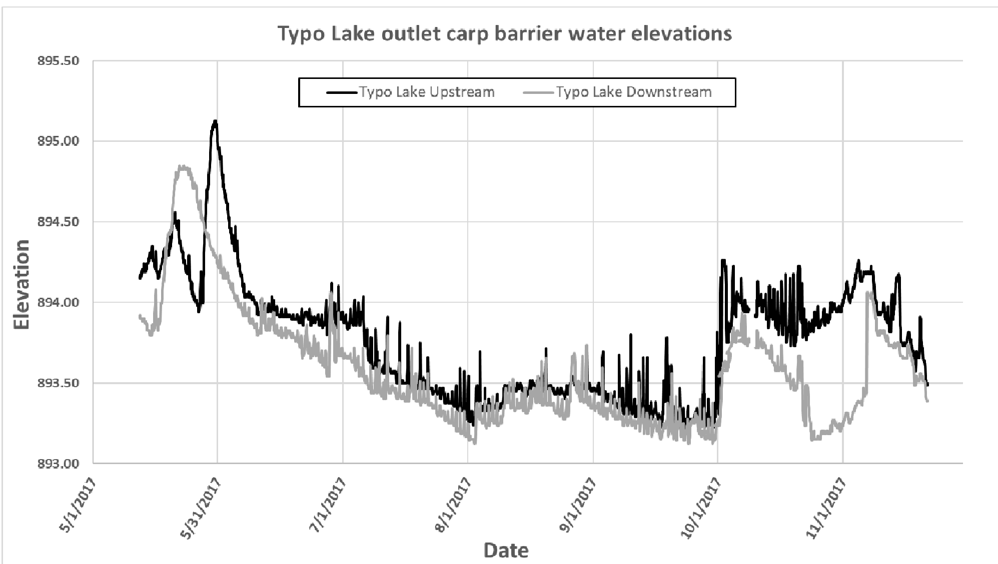
TYPO CREEK

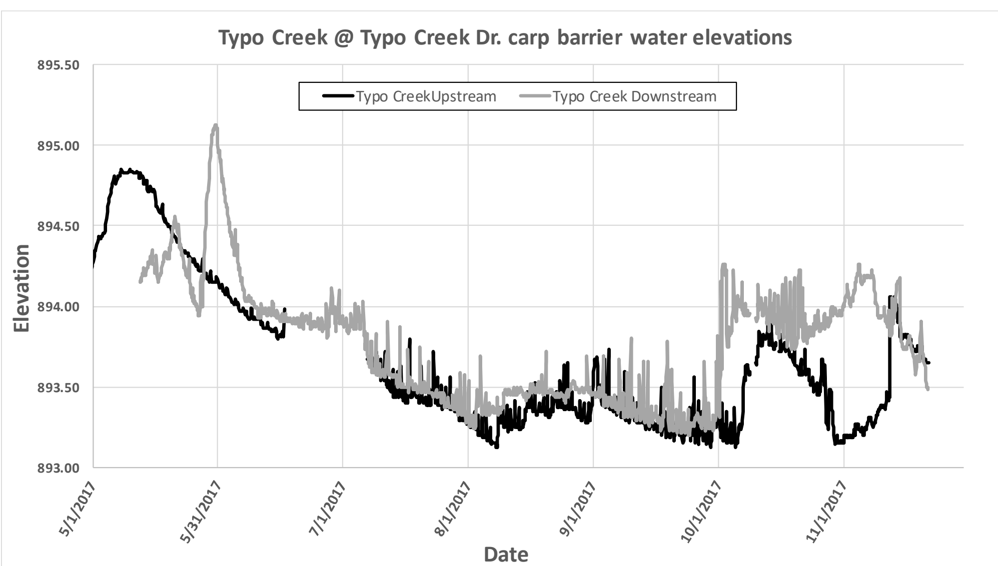
At Typo Lake outlet and Typo Creek Drive, Linwood Township

Years Monitored: 2016-2017

Background: The carp barrier structures installed in Typo Creek are made up of a series of stacked aluminum grates between two secure piling structures. The metal grates facilitate water passage out of Typo Lake and through Typo Creek, while preventing carp from migrating through to spawn. There was concern during the early stages of the projects that the barriers may clog up with floating cattail rafts, algae, and other debris, holding water back and causing flooding. The Anoka Conservation District installed and surveyed continuous level loggers on the upstream and downstream sides of both carp barriers to assess whether the barriers were affecting flow. Throughout most of the year, both sites read very similar levels upstream and downstream. Differences early and late in the year are likely, at least partially, due to instrument performance.

2017 Typo Lake outlet and Typo Creek at Typo Creek Drive carp barrier water elevations





Stream Water Quality

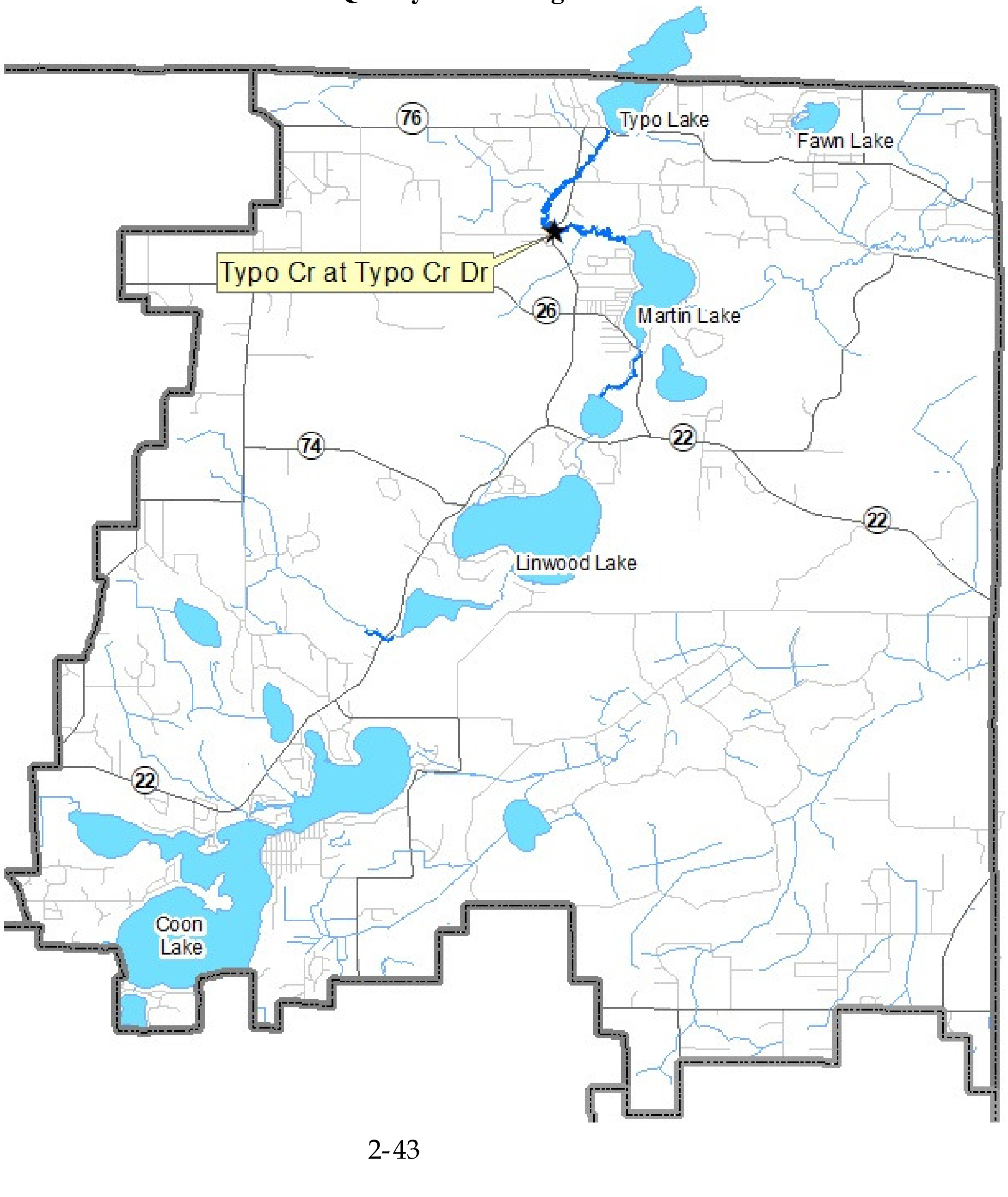
Description: Stream water quality is monitored with grab samples on eight occasions throughout the open water season, including four times immediately following a storm (1" of rain within a 24hr period) and four times during baseflow conditions. The selected site was chosen to monitor the impacts of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

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

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

Results: Results are presented on the following pages.

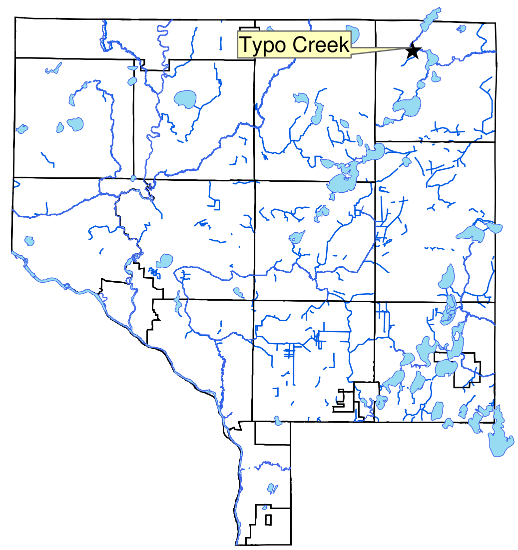
2017 Sunrise River Watershed Stream Water Quality Monitoring Sites



TYPO CREEK AT TYPO CREEK DR.

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

STORET SiteID = S003-188



Years Monitored

1998, 2000, 2001, 2003, 2016-2017

Background

The northern inlet to Martin Lake, also called Typo Creek, flows from the outlet of Typo Lake about 1.9 miles south to Martin Lake. It is the primary inlet to Martin Lake. The watershed is primarily undeveloped. This stream carries a relatively large volume of water, with flows ranging from 4-6 cfs during baseflow and 10-17 cfs during stormflow. Upstream water quality projects including carp barriers (completed 2016) and carp harvests (2017-2019) are aimed at improving water quality in this stream and the lakes it connects.

Methods

The creek was monitored by grab samples. Eight water quality sampling events were conducted in 2017, four during baseflow and four following storms. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, dissolved oxygen, and salinity. Parameters tested by water samples sent to a state-certified lab included total phosphorus, and total suspended solids.

Summary

Summarized water quality monitoring findings and management implications include:

- Dissolved pollutants, as measured by conductivity and chlorides, are at low and healthy levels. However, 2016 and 2017 baseflow concentrations were higher than years tested previously.

  Management discussion: Road deicing salts are a concern region-wide. They are measurable in area streams year-round, including Typo Creek. While they may be acceptably low now, levels do appear to be higher during recent years. Excessive de-icing efforts should be minimized in the area, and future monitoring should consider testing chlorides approximately every third year.

- Phosphorus loading and eutrophication remains the largest concern for Typo Creek. Measured total phosphorus (TP) routinely exceeds state impairment standards. TP in 2017 was within the same range observed in other years. Phosphorus levels here are reflective of conditions in Typo Lake immediately upstream. Typo Creek phosphorus is discharged into Martin Lake.

  Management discussion: Management in response to the TMDL report, including projects like the installation of carp barriers and harvesting of carp, should reduce phosphorus levels in the creek as well as the upstream and downstream lakes. Additional funding and projects are likely necessary into the future to bring phosphorus in this system as a whole down to healthy levels.

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

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

- pH, on average, was within the range considered normal and healthy for streams in this area again during 2017. In previous years it was outside the range that is considered healthy. The creek was listed by the State as impaired for high pH in 2006 due to swings above and below state standards. pH appears to be more stable and within the acceptable range in recent years. Improved water quality in Typo Lake upstream due to restoration projects should continue to help bring pH to more stable and neutral levels.
- Dissolved oxygen (DO) remains lower in Typo Creek than would be ideal. The excessive nutrients and algal growth, and subsequent decomposition, is likely driving low DO levels.

  Management discussion: Low dissolved oxygen is likely having an impact on native aquatic life. For example, it may favor rough fish species over game fish because they can tolerate lower oxygen levels. This issue is primarily driven by the nutrient loading in Typo Lake, and subsequent decomposition, as well as organic soils in the waterway. Because of the long history of nutrient and organic matter loading to this creek, even the best management practices will take many years to achieve goals.

Results and Discussion

Excessive nutrient loading is the root cause of intense high algae, turbidity and pH in Typo Creek. This, along with populations of common carp, is having a profound negative impact on the water quality, and likely the flora and fauna, of this system as a whole. A TMDL study has been completed for this stream, and corrective projects are being implemented. While the lakes seem to be experiencing improved water quality in response to these projects, notable improvement has not been observed in Typo Creek. The severity of the issues facing this creek, and the rest of its watershed, will require a large amount of time, involvement and project development to reach goals.

Conductivity and chlorides

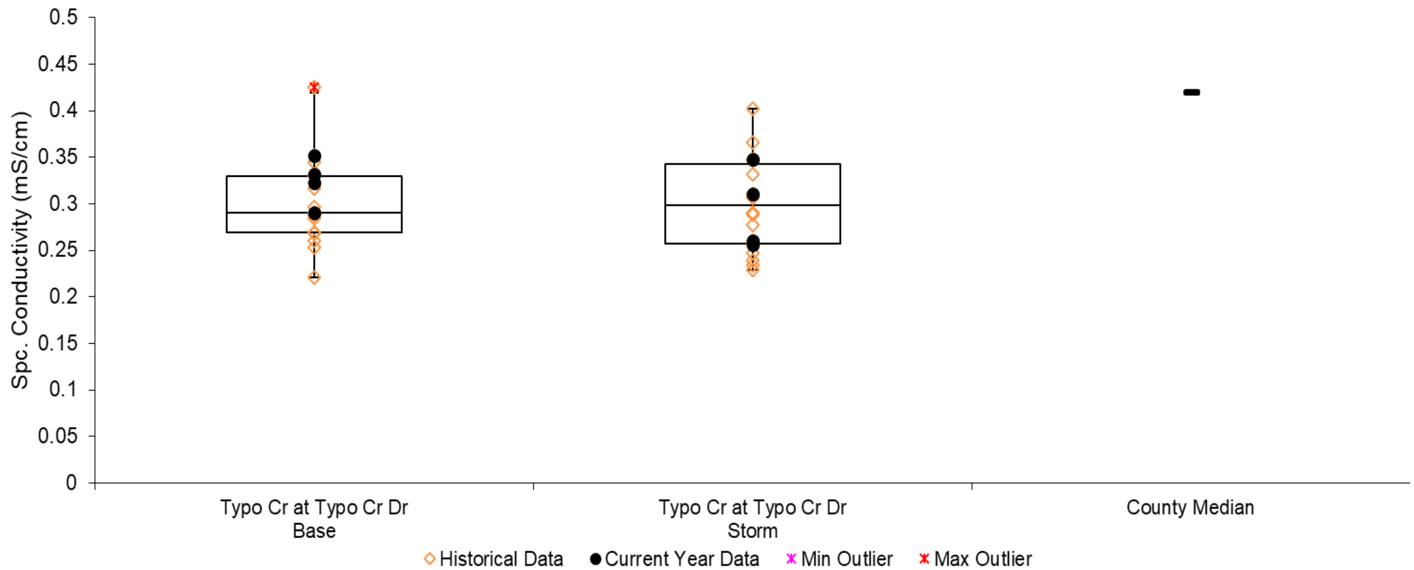
Conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include urban road runoff and industrial chemicals, among many others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved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

Conductivity was higher than typical in Typo Creek, averaging 0.309 mS/cm over the 2017 sampling season. This is lower than the median for 34 Anoka County streams of 0.420 mS/cm (county-wide average is driven by urban areas with greater road density and road salting). In other years, Typo Creek conductivity has been similar to 2017. These conductivity levels are not problematic, but could become problematic if baseflow levels continue to increase.

Conductivity was slightly lower during storms, suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow conductivity has been observed in many other area streams with the largest cause believed to be road salts that have infiltrated into the shallow aquifer.

Chlorides were not tested in 2017, and were last sampled at this site in 2003. Chloride results in 2003 ranged between 8 mg/L and 12 mg/L, far below the Minnesota Pollution Control Agency's (MPCA) chronic standard for aquatic life of 230 mg/L. Given that conductivity has increased, it would be prudent to periodically monitor chlorides to determine if chlorides are a cause of increased conductivity.

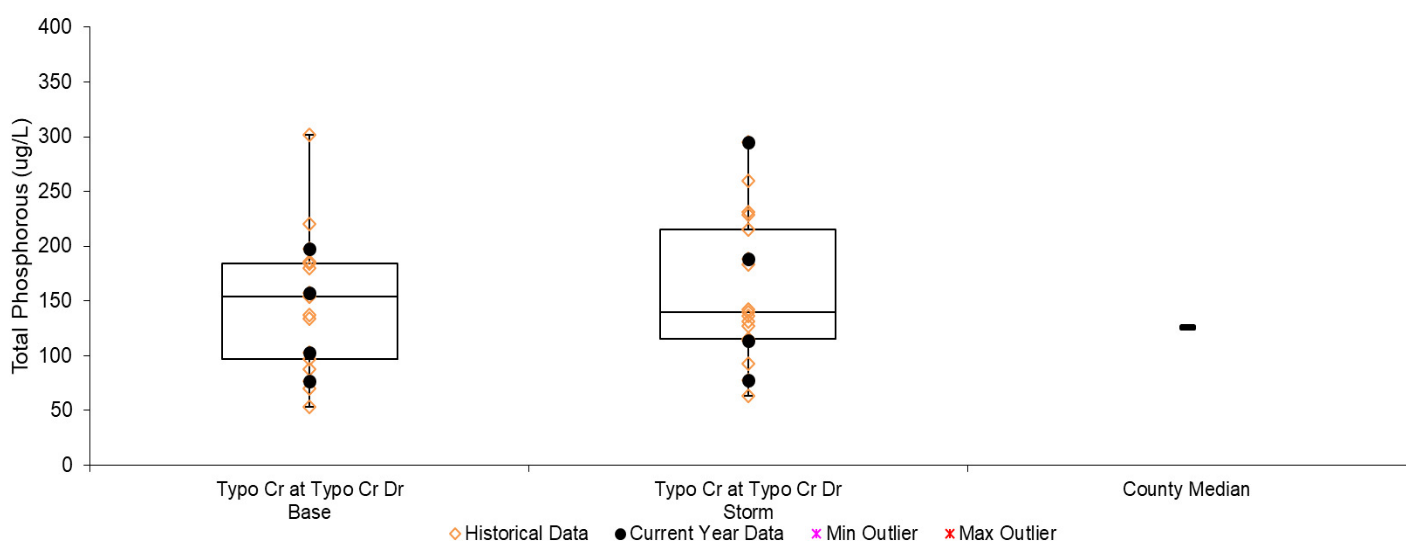
Conductivity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Total Phosphorus

The nutrient phosphorus is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. The average total phosphorus concentration of Typo Creek in 2017 was 151 µg/L, up from the 2016 average of 138 µg/L and within the range observed since 2001.

Total phosphorus during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 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)

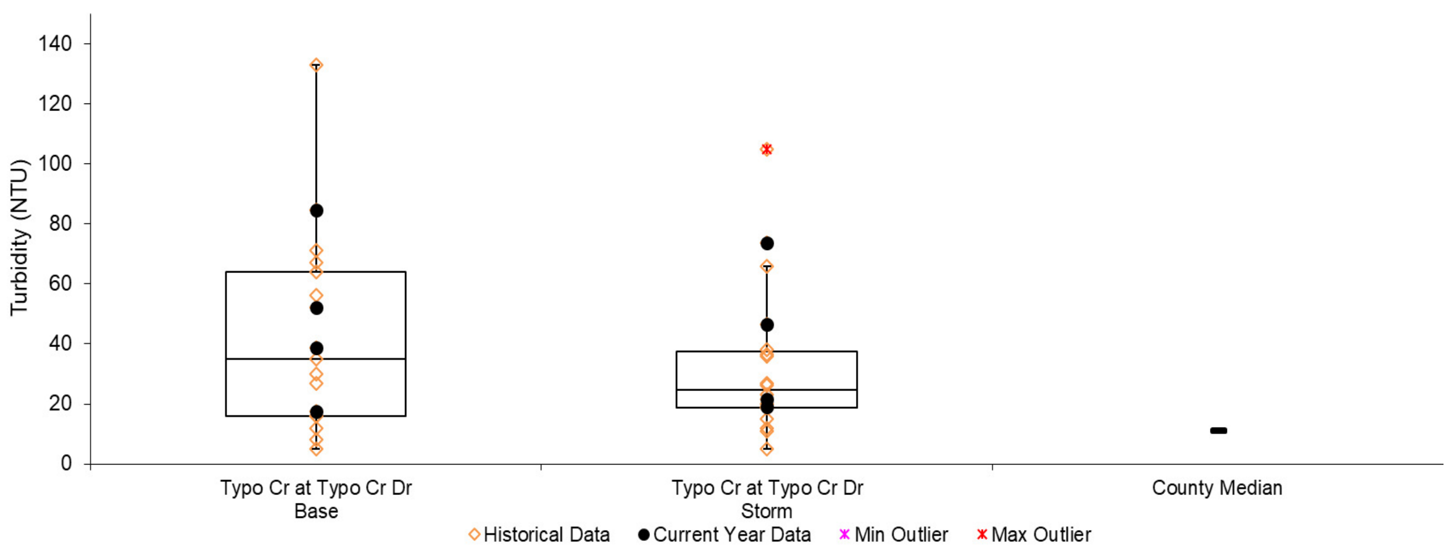
Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by refraction of a light beam passed through a water sample and is most sensitive to large particles. TSS is measured by filtering solids from a water sample and weighing 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 that suspended solids can come from sources both internal and external of the stream. Sources on land include soil erosion, road sanding, and many others. Internally, bank erosion and movement of the bottom substrate also contributes to suspended solids. Algal production and sediment disturbance in upstream lakes, like Typo Lake, also contribute strongly to Typo Creek.

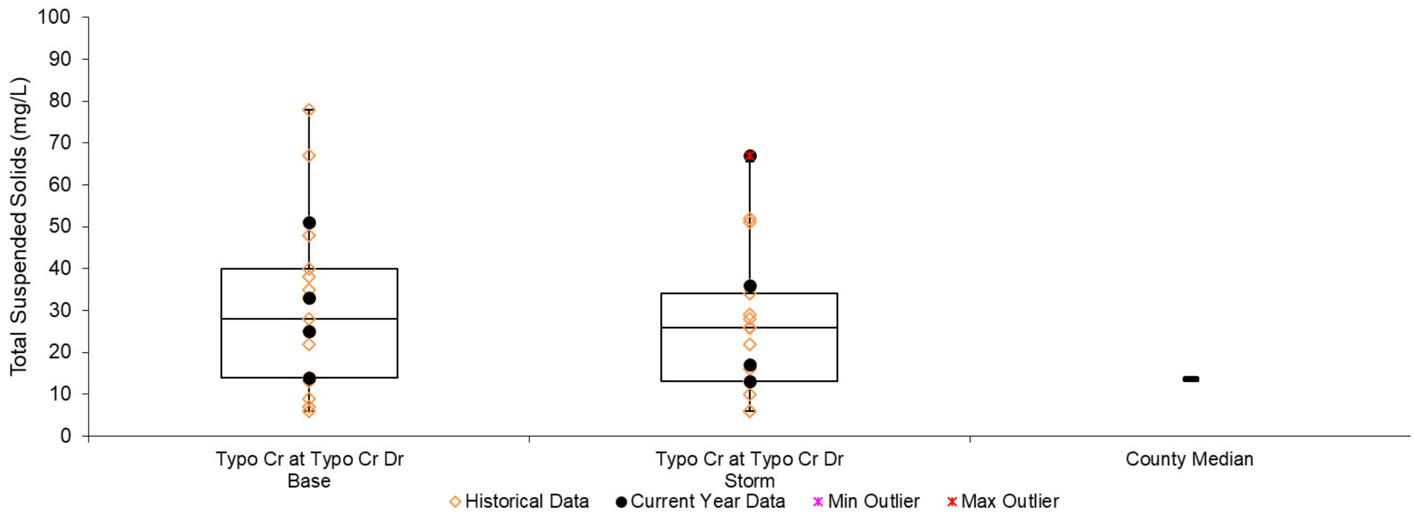
Typo Creek has been on the MPCA Impaired Waters List for high turbidity since 2006. The threshold is 25 NTU turbidity. If a stream exceeds this value on three occasions and at least 10% of all sampling events it is declared impaired for turbidity. Based on all years of ACD sampling, Typo Creek has exceeded 25 NTU turbidity on 19 of 35 sampling occasions, or 54% of the time. In both 2016 and 2017 five of eight samples had turbidity in excess of 25 NTU, with levels over 70 NTU measured each year. The average turbidity in 2017 was 44 NTU.

The high turbidity levels in Typo Creek are likely due to many factors within the watershed. Typo Lake upstream is hypertrophic, and Typo Creek therefore has high algal levels. Additionally, Typo Creek and Typo Lake each have a very loose, unconsolidated, silty bottom that easily mixes with the water column and readily remains suspended. Rough fish are abundant in this system and disturb the sediments.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 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 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

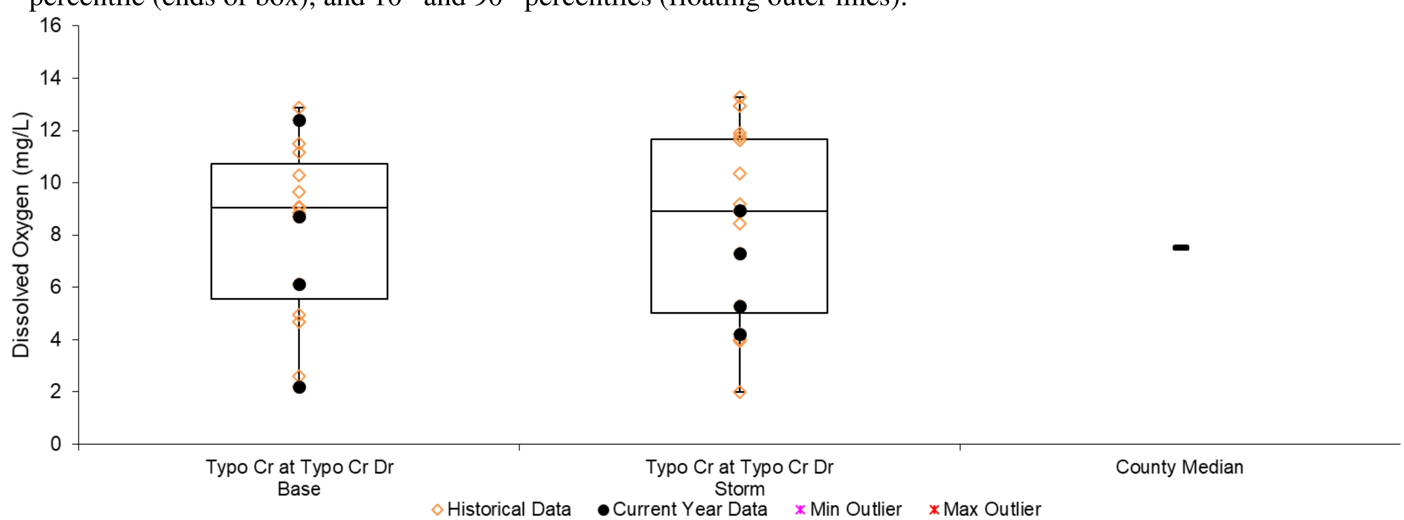


Dissolved Oxygen

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

In three years of sampling from 2000-2003, Typo Creek only had a DO level below 5 mg/L on one occasion. In 2016, five of eight samples yielded sub-5 mg/L results. This result was concerning and one reason for continued monitoring in 2017. In 2017, two of eight samples were <5mg/L. Average DO concentrations were over 6.5mg/L in 2016 and 2017. This suggests a mildly impaired condition. High algal production in upstream Typo Lake and subsequent decomposition is a likely cause.

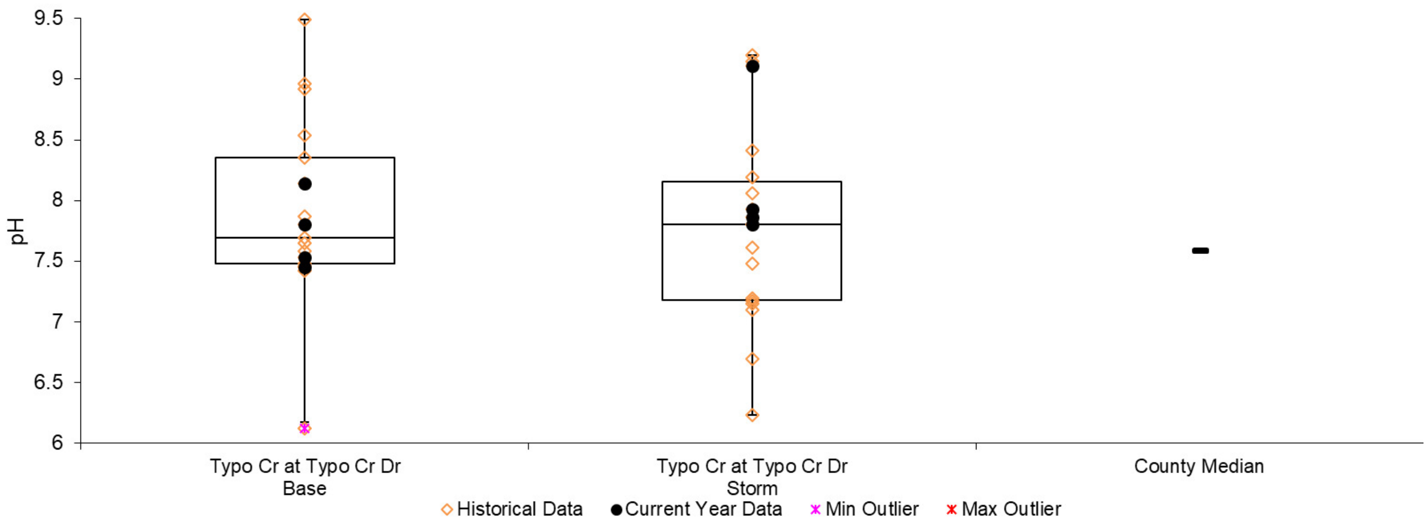
Dissolved oxygen results during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

pH refers to the acidity of the water, and has an effect on a stream's ability to support aquatic life. The Minnesota Pollution Control Agency's water quality standard is for pH to be between 6.5 and 8.5. Typo Creek has been listed as impaired for pH since 2006 due to great swings both above and below the state standard range. In 2016, however, pH was much more stable, ranging from 7.10 to 8.06. In 2017, pH on average was higher than in 2016, but only one measurement occurred above 8.5 (9.11). These recent results are an improvement.

pH results during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Recommendations

A Total Maximum Daily Load (TMDL) plan was approved in 2012 for Typo Creek for pH and turbidity. Water quality issues in Typo Creek are driven by the nutrient loading, eutrophication and carp activity in upstream Typo Lake. Projects including the Martin and Typo Lake carp barriers (completed in 2016), carp removal (2017-19) and projects in ditched wetlands upstream of Typo Lake (feasibility study completed early 2018) aim to address these issues. Conditions in Typo Creek are not likely to improve until the water quality of Typo Lake upstream improves.

Wetland Hydrology

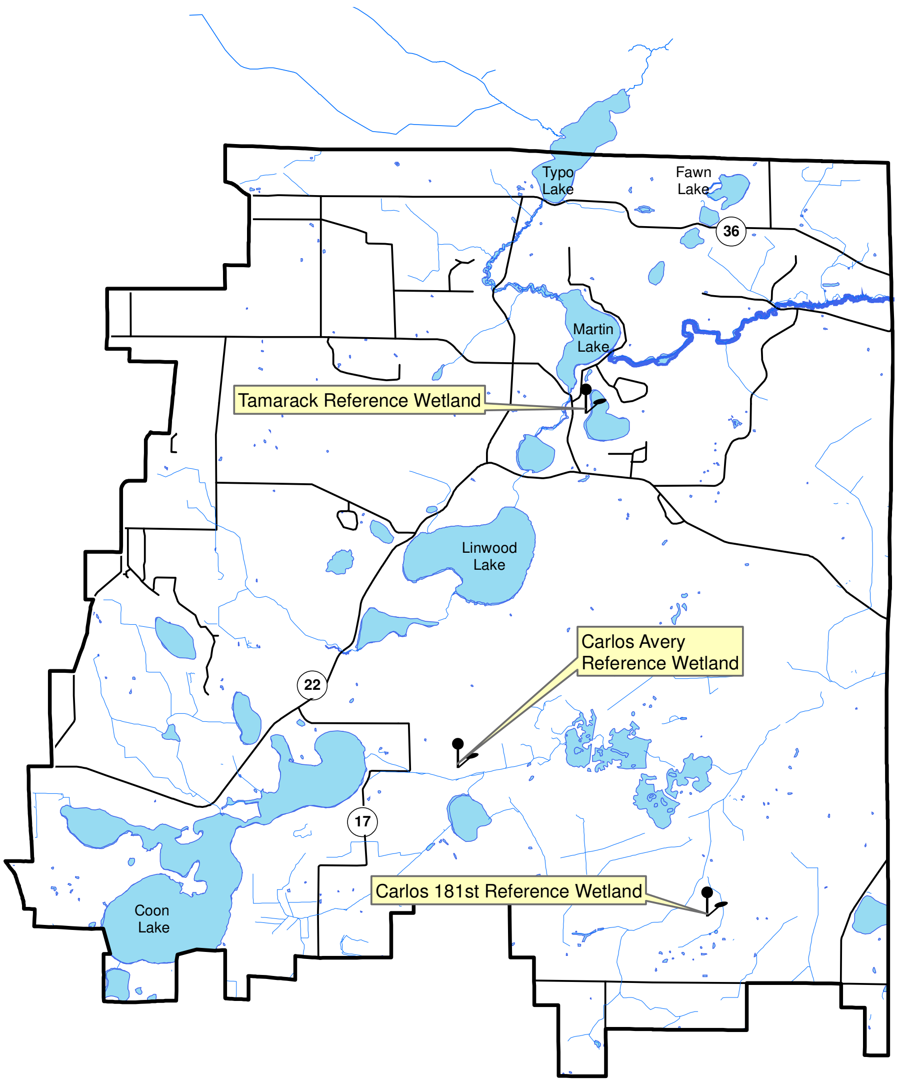
Description: Continuous groundwater level monitoring at a wetland boundary. Countywide, the ACD maintains a network of 23 wetland hydrology monitoring stations.

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

Locations: Carlos Avery Reference Wetland, Carlos Avery Wildlife Management Area, City of Columbus
Carlos 181st Reference Wetland, Carlos Avery Wildlife Management Area, City of Columbus
Tamarack Reference Wetland, Linwood Township

Results: See the following pages.

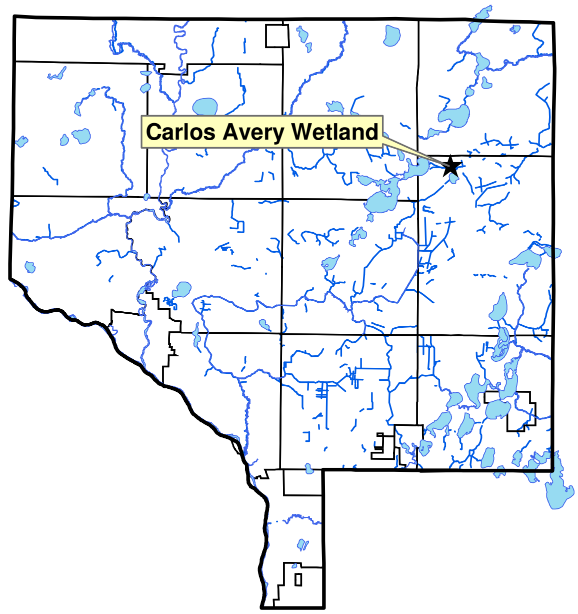
Sunrise Watershed Wetland Hydrology Monitoring Sites



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

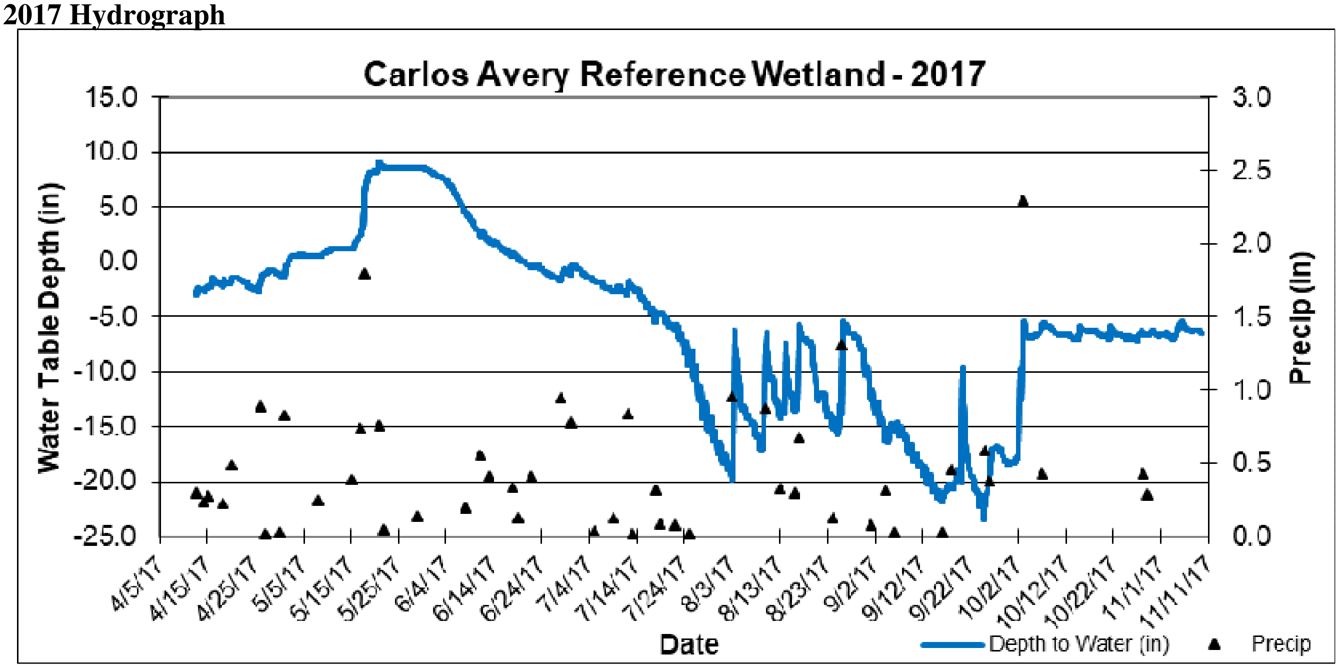
Surrounding Soils: Lino loamy fine sand

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

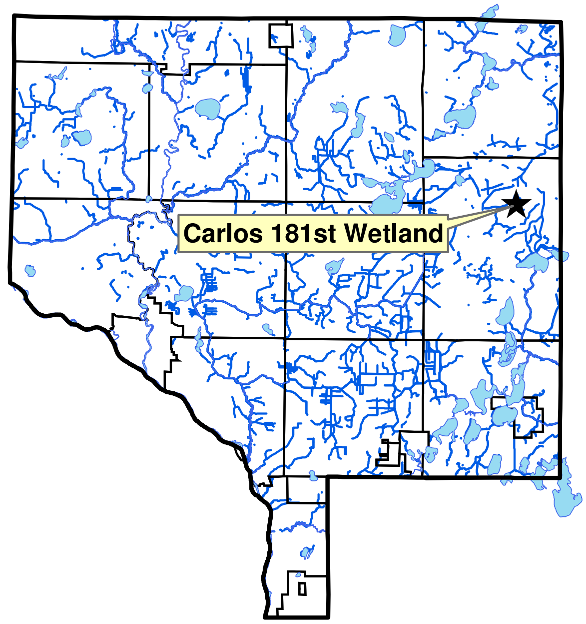
Other Notes: This is a broad, expansive wetland within a state-owned wildlife management area. Cattails dominate within the wetland.

2017 Hydrograph



CARLOS 181ST REFERENCE WETLAND

Carlos Avery Wildlife Management Area, City of Columbus



Site Information

Monitored Since: 2006

Wetland Type: 2-3

Wetland Size: 3.9 acres (approx)

Isolated Basin? Yes

Connected to a Ditch? Roadside swale only

Soils at Well Location:

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

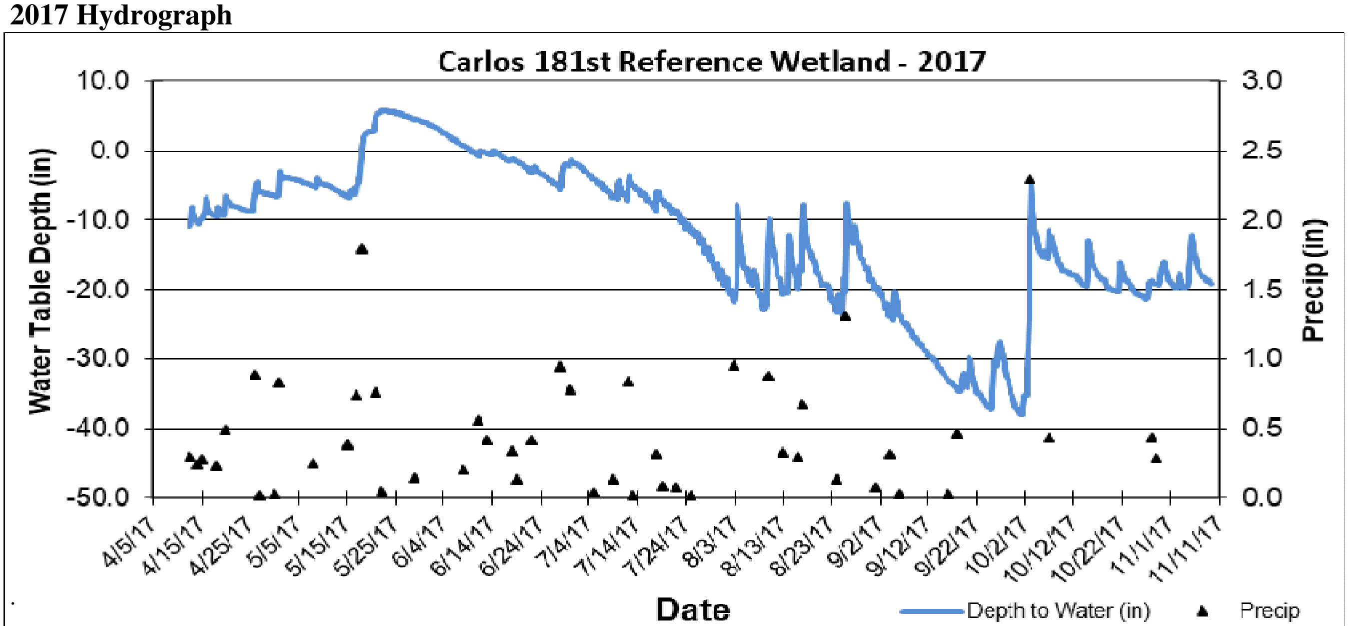
Surrounding Soils: Soderville fine sand

Vegetation at Well Location:

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

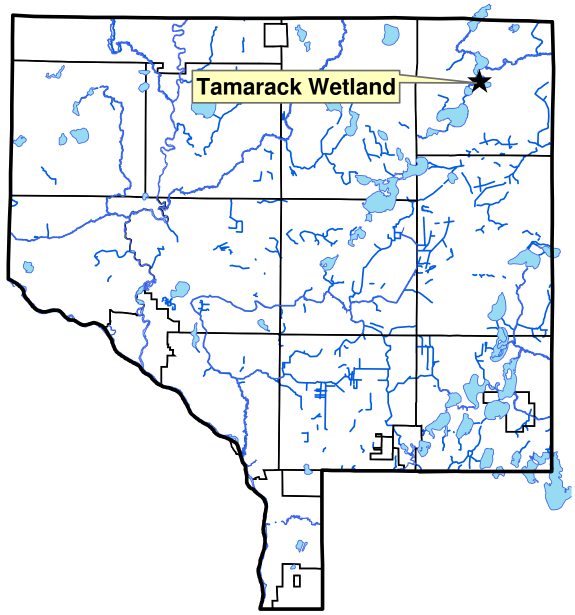
Other Notes: The site is owned and managed by the MN DNR. Access is from 181st Avenue.

2017 Hydrograph



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	-

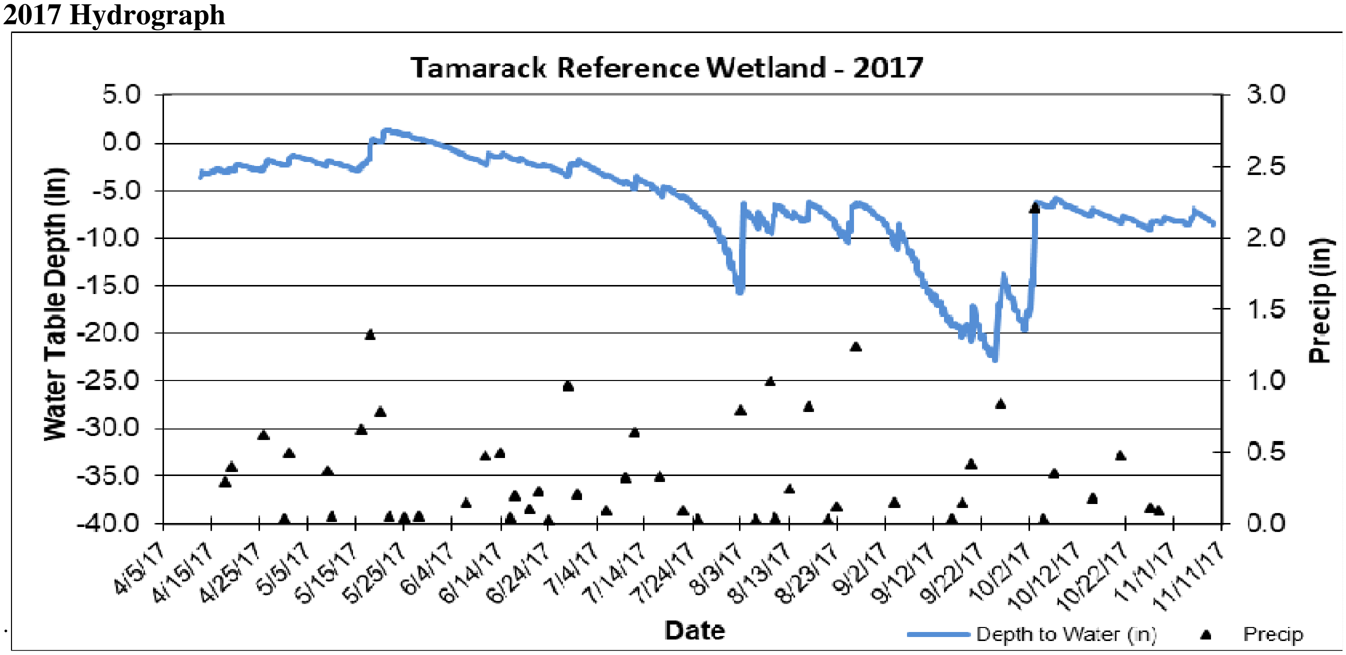
Surrounding Soils: Sartell fine sand

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.

2017 Hydrograph



Water Quality Grant Fund

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

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

Locations: Throughout the watershed.

Results: Projects reported in the year they are installed.

SRWMO Cost Share Fund Summary

2005 SRWMO Contribution	+	$1,000.00
2006 SRWMO Contribution	+	$1,000.00
2006 Expense - Coon Lake, Rogers Property Project	-	$ 570.57
2007 – no expenses or contributions		$ 0.00
2008 SRWMO Contribution	+	$2,000.00
2008 Expense - Martin Lake, Moos Property Project	-	$1,091.26
2009 SRWMO Contribution	+	$2,000.00
2010 SRWMO Contribution	+	$1,840.00
2011 SRWMO Contribution	+	$2,000.00
2012 SRWMO Contribution	+	$2,000.00
2012 Expense – Linwood Lake, Gustafson Property Project	-	$ 29.43
2012 Expense – Transfer to Martin-Typo Lakes Carp Barriers	-	$4,300.00
2013 – no expenses or contributions		$ 0.00
2014 SRWMO Contribution	+	$2,000.00
2015 SRWMO Contribution		$ 0.00
2016 SRWMO Contribution		$ 0.00
2016 Expense – Voss Rain Garden	-	$1,229.31
2017 Expense – Voss Rain Garden Plants	-	$ 654.50
2017 SRWMO Contribution	+	$1,000.00
2018 Surplus Funds Returned from ACD to SRWMO Gen Fund	-	$2,000.00
2018 Anticipated Expense – Gunnink Coon Lakeshore	-	$1,148.40
Fund Balance		**$3,816.53**

Martin and Typo Lake Carp Removal Project

Description: Martin and Typo 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. Efforts to manage and reduce carp are being undertaken to improve water quality and improve the fishery.

In 2015-2016 carp barriers were installed at four strategic locations near the inlets and outlets of both lakes to prevent carp migration, overwintering and spawning. In 2017-2018 carp are being removed. Additionally, a detailed assessment of the carp population, age structure and spawning history is being completed. A long-term management plan for carp will be prepared in 2019.

Purpose: To improve water quality in Typo and Martin Lakes, as well as downstream waterways.

Location: Typo and Martin Lakes

Results: In 2017 the following work was completed:

- 20 carp were radio tagged and released back into each Typo and Martin Lakes. These carp are being tracked monthly. They will also be used to locate schools in the winter for commercial harvest.
- 209 carp heads were preserved for aging during winter 2017-18. Fish age is determined by internal balance organs called otoliths. The population age structure reveals the spawning history.
- 2,100 carp were removed from Typo Lake using box nets.

Radio transmitter being surgically implanted in a carp. A Total of 40 carp were implanted with radio loggers, 20 from each Typo and Martin Lakes. Radio loggers will help track the schooling, feeding, and movement patterns of the carp to aide in future harvesting efforts.

A sprung box net in Typo Lake. Nets were set, baited and sprung at three sites in Typo Lake for a total of 17 nettings on seven different days from August through October, 2017.

A boat full of harvested carp. A total of 2,100 carp were removed from Typo Lake during the fall of 2017. Harvest efforts in both lakes will continue through 2019.

Ditch 20 Feasibility Study

Description: In 2016-17 a feasibility study was undertaken to improve understanding of how wetland adjacent to Ditch 20 exported phosphorus that negatively affected downstream lakes. The study identified and ranked projects that would reduce this problem.

This project was undertaken because Ditch 20 was identified as a significant contributor of phosphorus to impaired waters during Total Maximum Daily Load (TMDL) studies for Martin and Typo Lakes. Ditch 20 flows to Typo Lake, Martin Lake, the Sunrise River and St. Croix River

CLEAN WATER LAND & LEGACY AMENDMENT

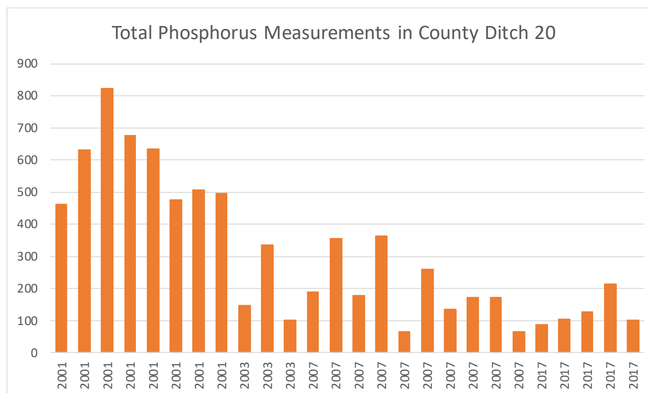
Purpose: To identify and evaluate projects that will reduce phosphorus export from lands adjacent to Ditch 20, thereby benefitting water quality in downstream impaired waterbodies including Typo Lake and Martin Lake.

Location: Ditch 20 subwatershed – northeastern Anoka, southeastern Isanti Counties

Results: A suite of four projects were identified which are cost effective, feasible and have landowner support. Concept designs and cost estimates were developed. Projects were ranked by cost effectiveness at reducing phosphorus. A full report was produced and is available from the Anoka Conservation District.

Water Monitoring

Water quality and quantity were monitored at two locations in the main channel of Ditch 20 and in one lateral ditch throughout the summer of 2017. Previous monitoring had been conducted in the Ditch 20 and Data Creek system in 2001-2007. Initial years of monitoring found extremely high phosphorus (see figure to right). Subsequently, total phosphorus has decreased without any management activity or landscape changes. In fact, in 2017 phosphorus levels averaged 127.6 µg/L, which is only slightly worse than the State water quality standard and right at the median of Anoka County streams (126 µg/L). This may lead watershed managers to make projects on Ditch 20 a lower priority.



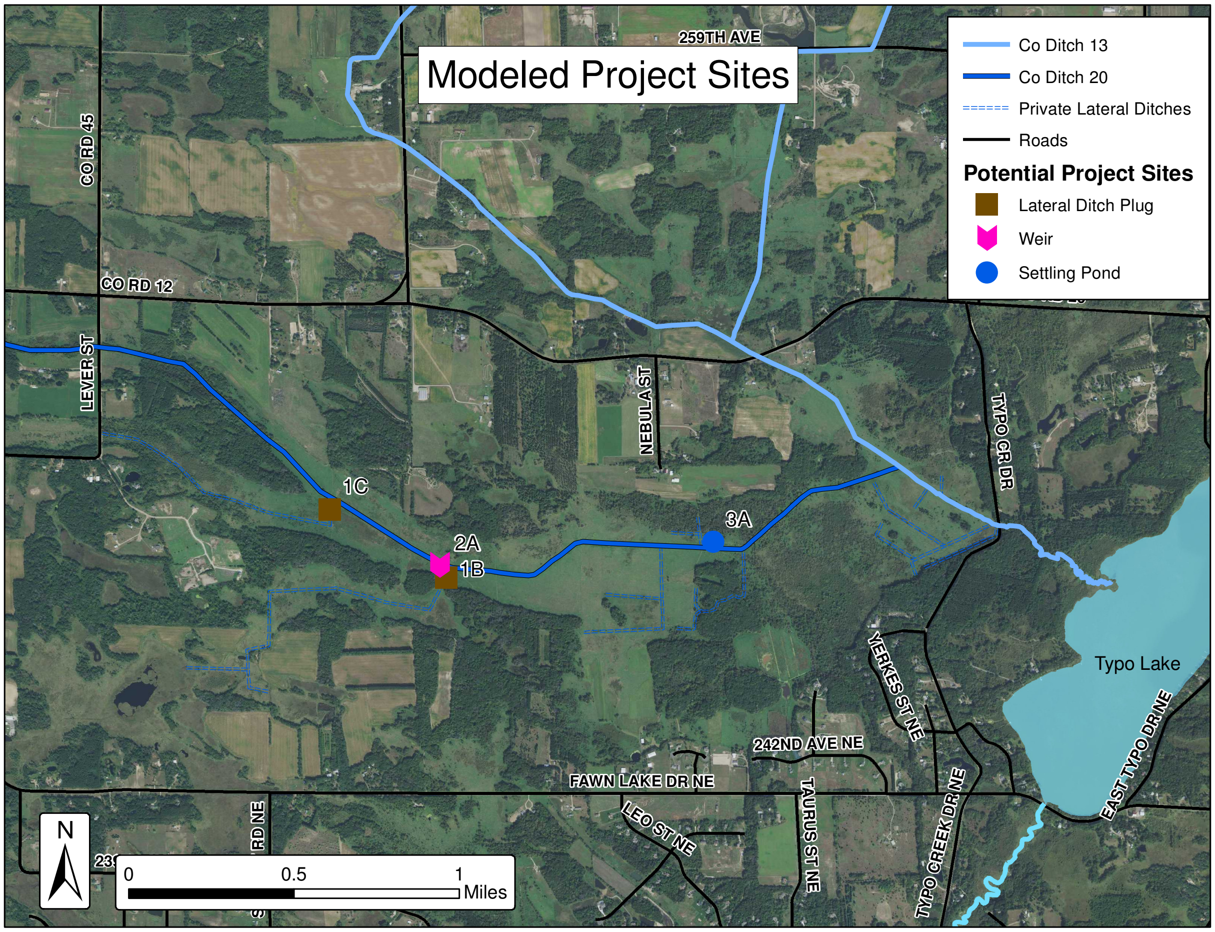
Identification and Ranking of Potential Water Quality Projects

During this feasibility study a number of possible water quality projects were examined. Projects that appeared most feasible and had landowner support were explored in detail through hydrologic modeling, concept designs, phosphorus reduction estimation, and cost estimation. Those projects (see map below) included two lateral ditch plugs and one weir on Ditch 20 that restore wetland hydrology to ditched wetland. We also explored constructing a settling pond through which the ditch would flow.

From a cost effectiveness standpoint, all of these projects are favorable. We calculated cost effectiveness by comparing the total costs of permitting, design, construction and maintenance over a 30-year lifespan and estimated phosphorus reductions during the same period. Costs per pound of phosphorus removed were <$100 for each project.

There is uncertainty in these cost effectiveness estimates. First, phosphorus reductions from wetland restorations can vary widely, and even result in phosphorus increases. While we utilized a typical result, actual results found in the literature vary widely. Moreover, construction of certain projects may require new bypass ditches, which, if built, may cause more drainage than the current condition and result in overall greater phosphorus export.

Permitting costs also carry uncertainty. Permitting of projects that may affect upstream drainage and impact wetlands is a substantial undertaking. Needed permits may include County (wetland impacts, mining) and the US Army Corps of Engineers. Several years of hydrological monitoring may be needed in advance of any construction to assure permitting agencies that there will be no negative hydrological repercussions. Moreover, permitting agencies will want there to be an entity willing to own and maintain these practices, and all likely entities have so far expressed disinterest.



Recommendations

Because they may offer cost effective habitat restoration and water quality projects, the projects identified by this study are worth pursuing. Given the uncertainties with phosphorus reduction and challenges with permitting, maintenance and construction, it might be best to view these primarily as wetland restoration projects with secondary water quality benefits. The MN Board of Water and Soil Resources has a program for wetland restorations, and these projects may be a good fit. That program's staff would be best equipped to address the technical challenges. The program also offers financial benefits to cooperating landowners.

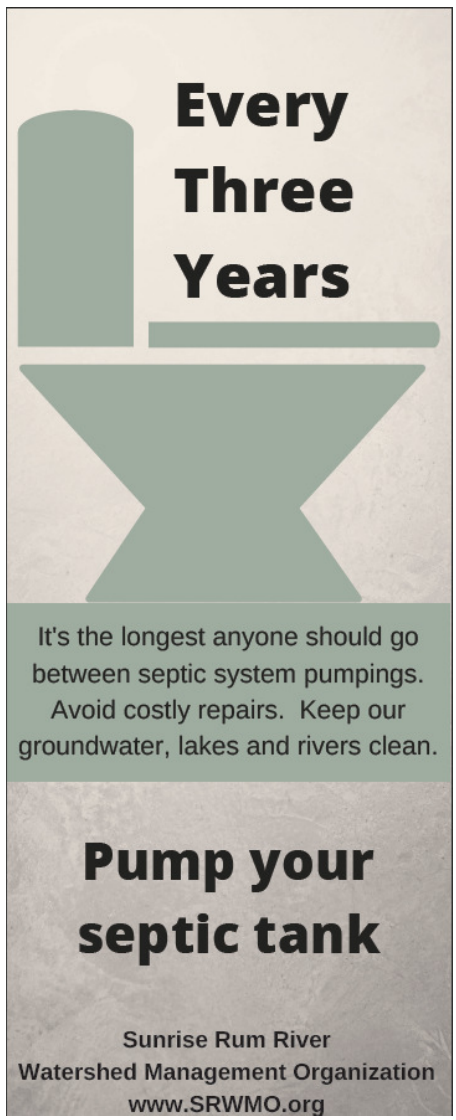
Four entities should pursue these projects: Anoka Conservation District, Sunrise River Watershed Management Organization, Isanti Soil and Water Conservation District and Isanti County. Each should consider including these projects in their comprehensive plans.

Full results of this feasibility study are available from the Anoka Conservation District.

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, accomplishments and water quality issues.
Location:	Watershed-wide
Results:	In 2017 the SRWMO contracted with the ACD to prepare its annual education publication. Instead of a traditional newsletter article, the WMO decided to utilize an infographic after presenting this approach to the MN Board of Water and Soil Resources, which oversees WMOs. This method is more likely to be consumed by the public and better fits within the limited publishing space available. To ensure broad distribution and manage costs, educational materials are provided to the SRWMO's member communities for publication in their newsletters. SRWMO Board chose to focus their 2017 education infographic on septic system maintenance.

SRWMO 2017 Education Infographic



SRWMO Website

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

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

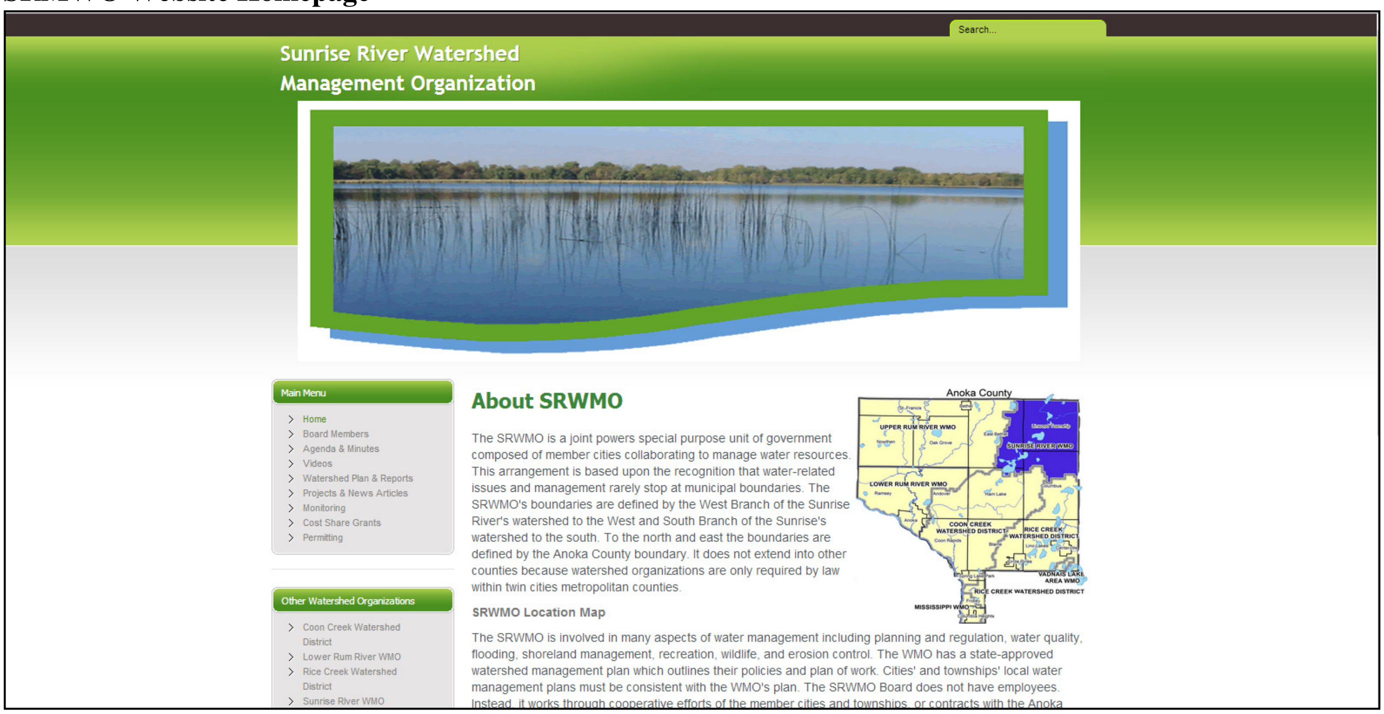
Location: www.SRWMO.org

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

Regular website updates occurred throughout 2017. 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 2017 a grant application was prepared for a Martin and Typo Lakes Carp Harvest Project. A $99,000 grant from the MN DNR Conservation Partners Legacy Grant Program was secured. Work to secure the grant included:

- Securing matching funds from the SRWMO ($5,000), Martin Lakers Association ($4,900) and the Anoka Conservation District ($5,000).
- Negotiating and securing a contract with Carp Solutions, Inc.
- Preparing the grant application.

Since 2014 the following grants have been secured for SRWMO projects though the assistance of the Anoka Conservation District:

2014 Martin and Typo Lake Carp Barriers, site 2	MN DNR CPL	$ 35,770
2014 Martin and Typo Lake Carp Barriers, sites 1,3,4	MN DNR CPL	$399,983
2014 Coon Lake Area Stormwater Retrofits	BWSR CWF	$ 42,987
2015 Ditch 20 Wetland Restoration Feasibility Study	BWSR CWF	$ 72,400
2017 Martin and Typo Lake Carp Harvests	MN DNR CPL	$ 99,000
2017 Septic System Fix Up Fund*	MPCA	$ 25,931
	TOTAL	$676,071

*Septic system fix up funds are available county-wide but the grant application was prompted by septic system inventory work by Linwood Township and the SRMWO.

SRWMO Annual Report to BWSR and State Auditor

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

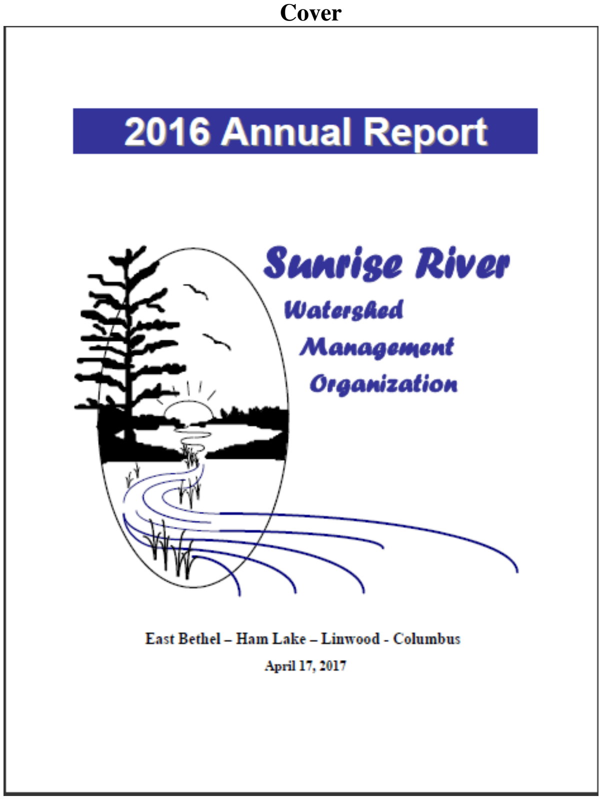
The SRWMO must also submit an annual financial report to the State Auditor. They accept unaudited financial reports for financial districts with annual revenues less than $185,000.

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

Locations: Watershed-wide

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

Cover



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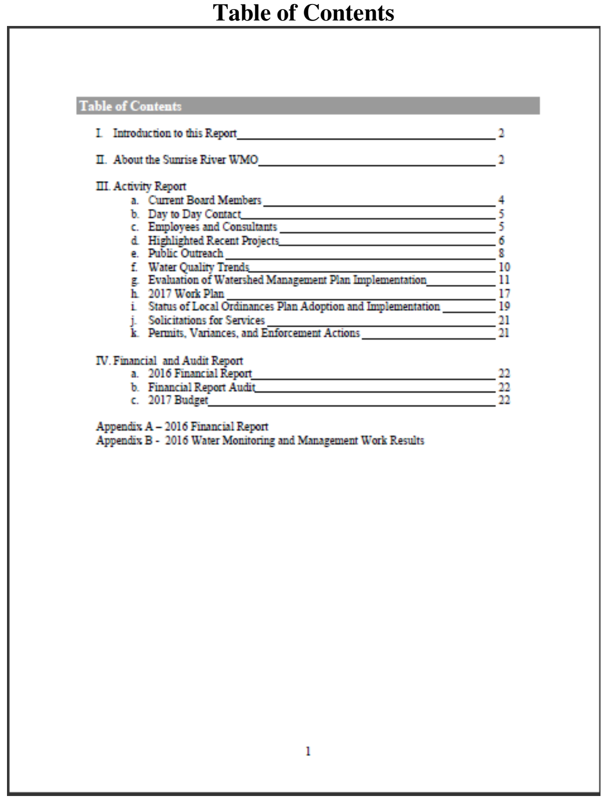

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1

On-call Administrative Services

Description: The Anoka Conservation District Watershed Projects Manager 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 2017 a total of 77 hours of administrative assistance were provided to the SRWMO by the Anoka Conservation District. The following tasks were accomplished:

- **Meeting prep** - Planned 5 SRWMO meeting agendas, prepared meeting packets and emailed them to the board a week in advance.
- **Meeting attendance** - Attended 5 SRWMO meetings to provide project updates and advise the board.
- **Plan addendum** - Prepared a required SRWMO Watershed Plan addendum to incorporate new state buffer law information and presented it to the board for approval.
- **Funding updates** - Emailed Watershed Based Funding (aka fund the plan) to SRWMO board members and city staff.
- **State inquiries** - Responded to the State Campaign Finance Board regarding failure of a board member to complete required Campaign Finance Disclosure forms. The member resigned over objections to the form as an intrusion.
- **Boundary adjustments** – Addressed proposals for 3 SRWMO boundary adjustments sought by the City of Ham Lake. They were contentious, and included several meetings with city and watershed district staff. The proposals were mapped and presented to the SRMWO board. None of the adjustments was finalized.
- **Regional reporting** – Reported SRWMO projects to the St. Croix River Partnership to document TMDL progress.
- **Inquiries** – Fielded approximately 8 inquiries from developers, landowners and others about SRWMO permitting (there is none), grants and other programs.
- **1W1P** - Attended 4 Lower St. Croix "One Watershed, One Plan" meetings to represent the SRWMO. Nearly all other WMOs, watershed districts, counties and SWCDs also had staff present.
- **2018 budget** – Completed the 2018 budget through revisions directed by the board, providing it to cities for ratification, and tracking city ratification.
- **2019 budget** – Prepared the 1st draft 2019 budget to present to the board.

Financial Summary

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

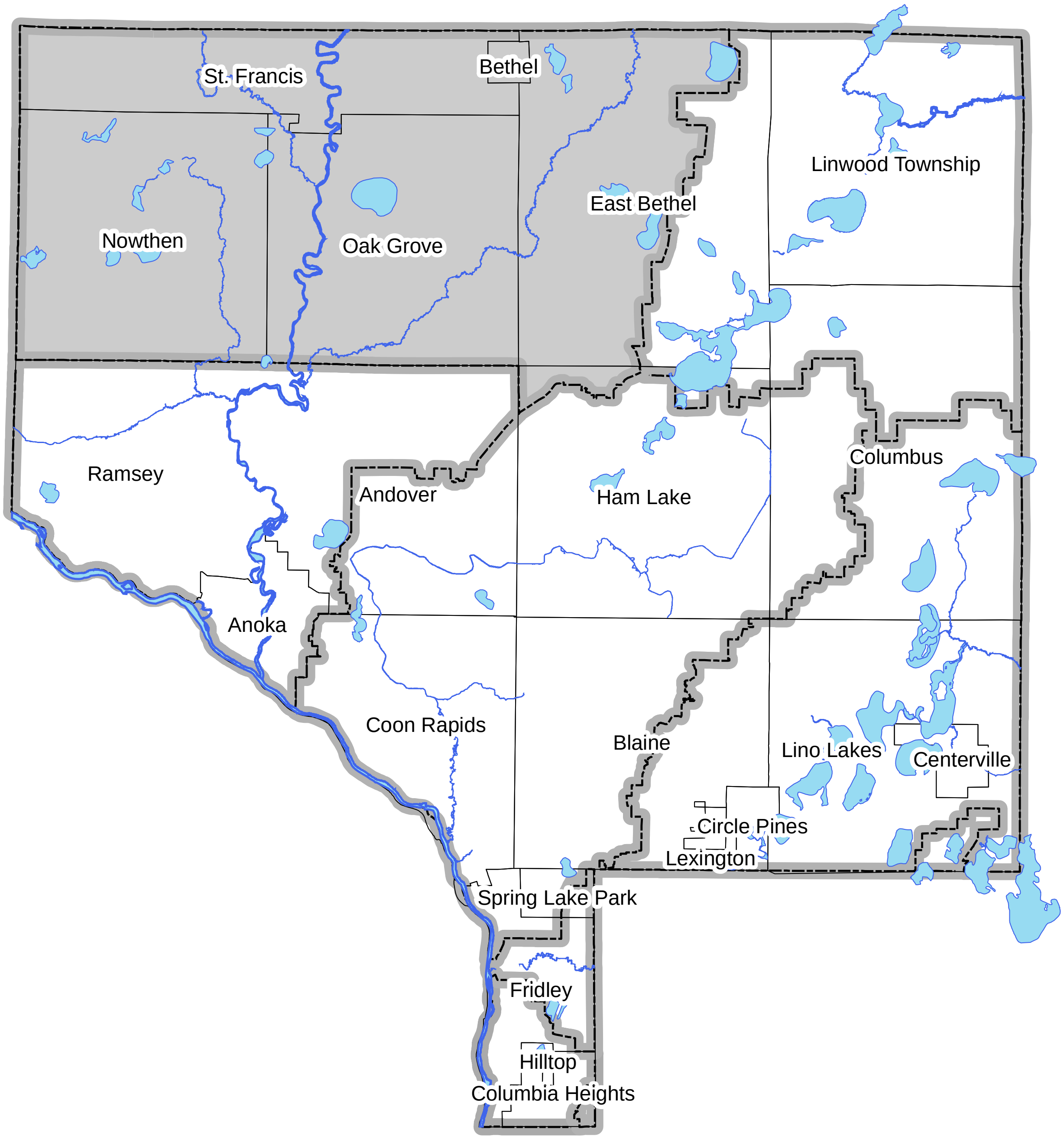
Sunrise River Watershed Financial Summary

Sunrise River Watershed	SRWMO Admin/Reporting/Grant Search	County, City, SWCD Asst (no charge)	WMO Asst (no charge)	SRWMO Promo/Website	Volunteer Precip	Reference Wetlands	DNR Groundwater Wells	Lake Levels	Lake Water Quality	Stream Levels	Stream Water Quality	Shoreland - NRBG - Linwood Lake SSTS	Martin/Typo Lake Carp Barriers	Carp Management - Typo and Martin Lakes	Coon Lake Retrofits	Ditch 20 Analysis	Inventory - Linwood Lake SSTS	Total
Revenues																		
SRWMO	4040			1305		1725		1250	3500	1350	1400			2350	131	4881		21932
State - Other							280					2615				41836		44731
MPCA																		0
DNR OHF																		0
DNR CPL													43778	37473				81251
BWSR Cons Delivery	1669	417	416				295								101			2897
BWSR Capacity Staff														5289			4126	9414
BWSR Capacity Direct																		0
BWSR Cost Share																		0
BWSR Cost Share TA																		0
BWSR Local Water Planning	207		175	58	219				165	371					10			1205
Metro ETA & NPEAP																		0
Metro AWQCP																		0
Regional/Local															524			524
Anoka Co. General Services	32	336	416									29		2630	242	1653		5338
County Ag Preserves/Projects																5000	958	5958
Service Fees															600			600
Investment Dividend																		0
Rents																		0
Product Sales																		0
TOTAL	5947	754	1006	1363	219	1725	575	1250	3665	1721	1400	2644	43778	47742	1608	53371	5083	173851
Expenses-																		
Capital Outlay/Equip	225	19	59	51	10	50	39	48	140	47	21	3	209	223	130	1065	69	2409
Personnel Salaries/Benefits	5299	680	874	962	180	1421	459	1160	2309	1348	423	137	6272	9281	1217	27808	4529	64359
Overhead	235	27	41	49	12	107	40	68	157	106	30	7	252	319	86	1316	178	3029
Employee Training	16	3	3	2	1	12	3	6	18	11	2	1	11	61	3	126	30	308
Vehicle/Mileage	52	8	5	10	3	43	10	22	48	38	10	2	83	112	6	361	59	871
Rent	120	17	24	24	6	75	24	42	115	61	19	3	160	273	37	779	106	1886
Project Installation													18754		22			18775
Project Supplies				266	7	17		13	878	69	271	2491	9588	37473	109	22553	112	73848
McKay Expenses																		0
TOTAL	5947	754	1006	1363	219	1726	575	1359	3665	1680	776	2644	35328	47742	1608	54009	5083	165484
NET	0	0	0	0	0	-1	0	-109	0	41	624	0	8450	0	0	-638	0	8367

Recommendations

- **Begin update of the SRWMO Watershed Management Plan** no later than May 2018 in order to complete by December 2019 when the current plan expires.
- **Engage in the Lower St. Croix One Watershed, One Plan process.** This plan will identify regional priorities.
- **Secure new Watershed Based Funding for SRWMO priority projects.** This new program replaces some competitive grants and is aimed at projects in approved water plans. $826,000 is available in Anoka County to be divided by mutual agreement of eligible entities by June 30, 2018.
- **Pursue Linwood Lake management activities.** The association has recently become more active, and has requested partnerships to manage aquatic invasive species and improve water quality. Ongoing and upcoming projects include 2018 Boot Lake water quality monitoring, 2017-18 septic system outreach. Projects to consider include an assessment of the carp population and alum dosing.
- **Support the Linwood Lake Association.** The association has recently become more active, and has requested partnerships to manage aquatic invasive species and improve water quality. The SRWMO may be able to help with identifying and promoting projects, or assisting with fundraising.
- **Forward wetland restoration projects near Ditch 20 by connecting landowners with State wetland banking programs.** A feasibility study was recently completed. Three identified wetland restorations would likely benefit water quality in Typo and Martin Lakes. These are challenging projects from a feasibility and permitting standpoint, but the State wetland banking program may provide the resources and expertise.
- **Continue installation of stormwater retrofits around Coon and Martin Lakes** where completed studies have identified and ranked projects.
- **Promote newly available Septic System Fix Up Grants to landowners,** particularly in shoreland areas.
- **Identify likely ailing septic systems in shoreland areas.** Work done at Linwood Lake in 2017-18 can serve as a model.
- **Bolster lakeshore landscaping education efforts.** The SRWMO Watershed Management Plan sets a goal of three lakeshore restorations per year. Few are occurring. Fresh approaches should be welcomed.
- **Encourage communities to report water quality projects to the SRWMO.** An overarching goal in the SRWMO Plan is to reduce phosphorus by 20% (986 lbs). State oversight agencies will evaluate efforts toward this goal. Both WMO and municipal project benefits should be counted.

Upper Rum River Watershed



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

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

CHAPTER 3:
UPPER RUM RIVER WATERSHED

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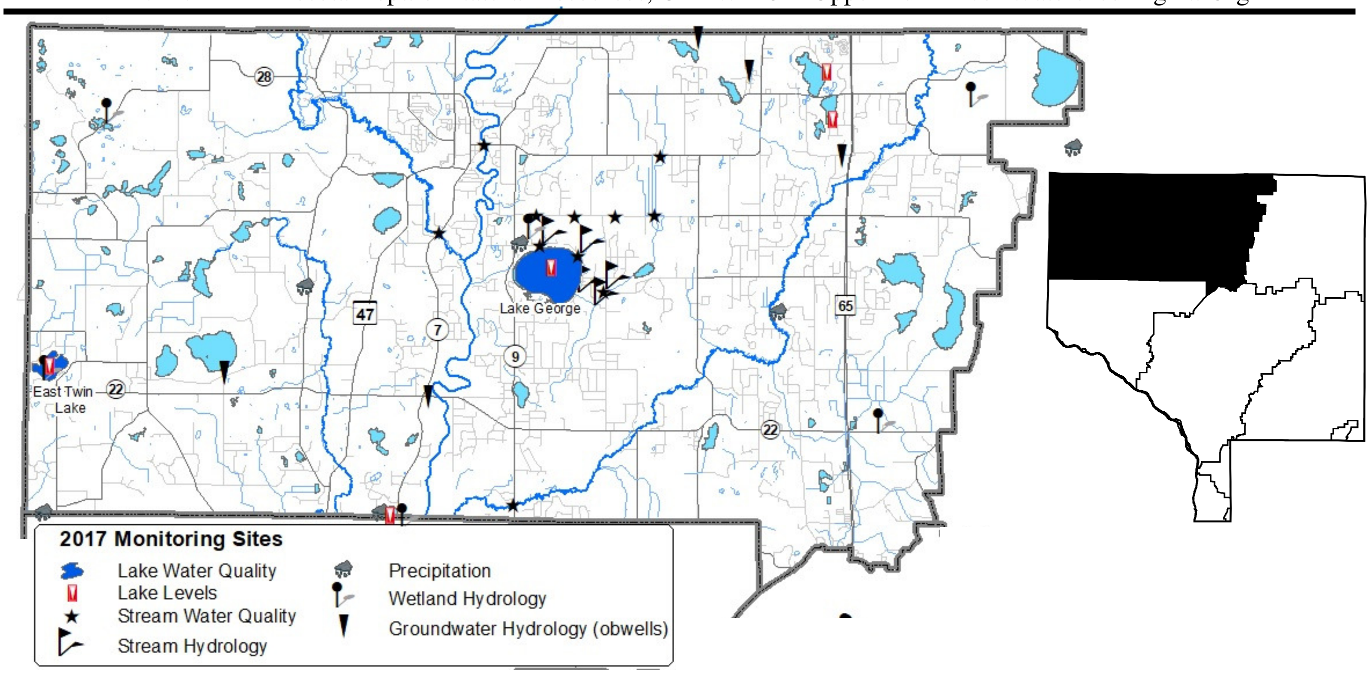
ACAP = Anoka County Ag Preserves, ACD = Anoka Conservation District, LID= Lake Improvement District
LRRWMO = Lower Rum River Watershed Mgmt. Org, MC = Metropolitan Council
MNDNR = Minnesota Dept. of Natural Resources, URRWMO = Upper Rum River Watershed Mgmt. Org



Lake Levels

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

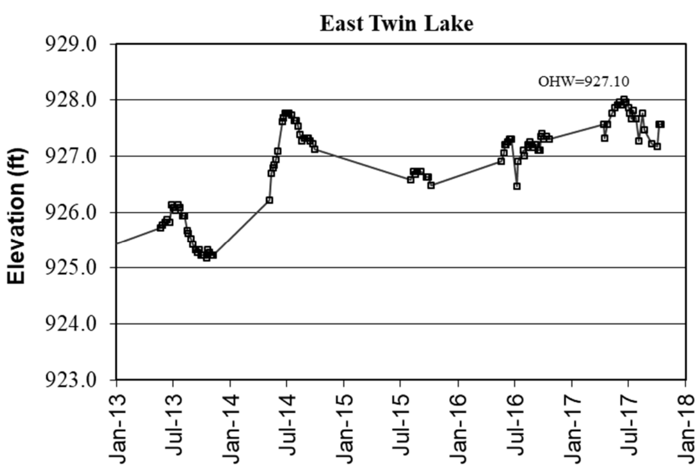
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

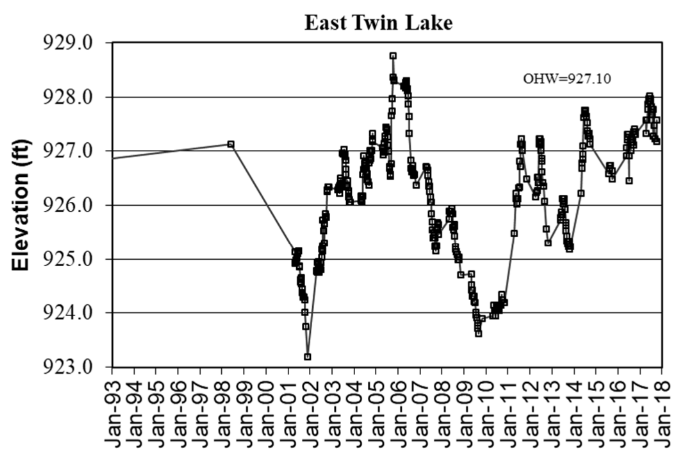
Results: Lake levels were measured by volunteers throughout the 2017 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes generally followed the expected trend of increasing water levels in spring and early summer and declining levels by mid-summer. A resurgence of rainfall late into fall, especially the largest storm of the year in early October, caused a small rebound in lake levels at the end of the year. Overall lake levels were near or slightly above average.

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.

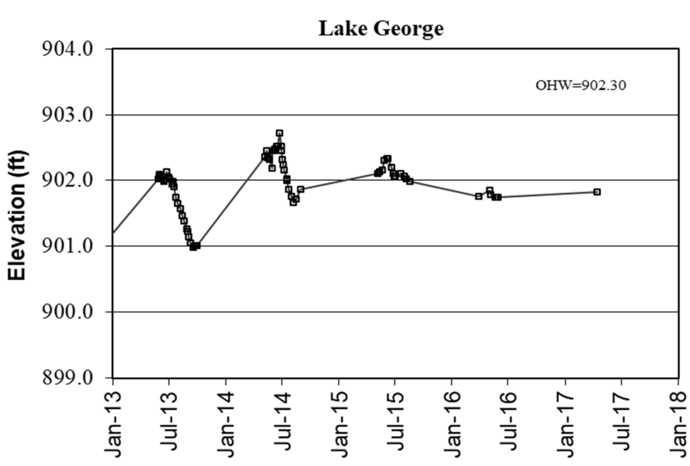
East Twin Lake Levels – last 5 years



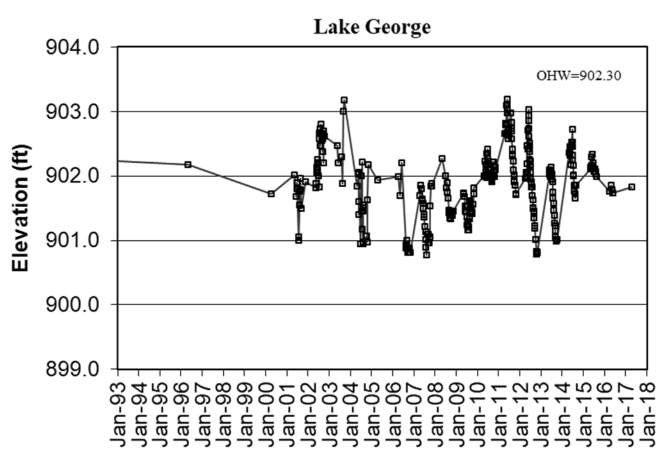
East Twin Lake Levels – last 25 years



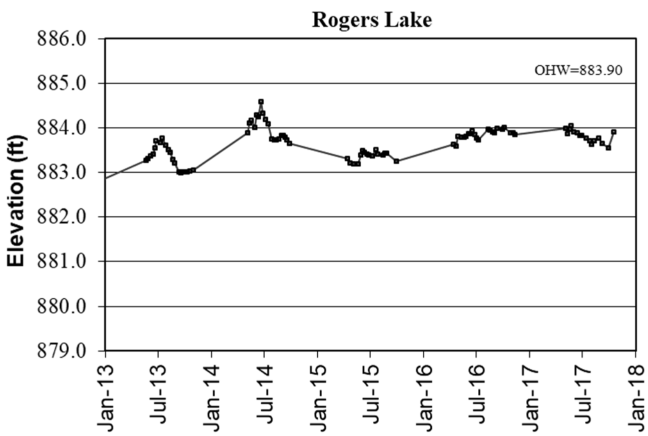
***Lake George Levels – last 5 years**



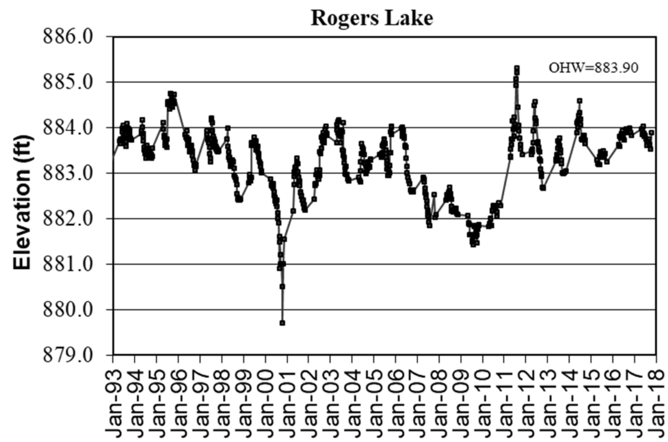
Lake George Levels – last 25 years



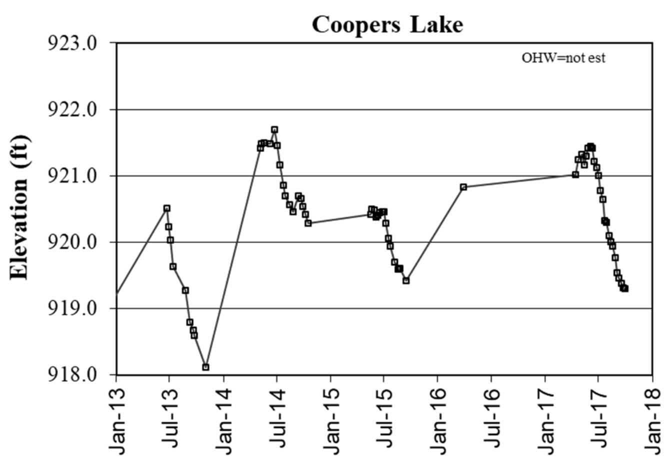
Rogers Lake Levels – last 5 years



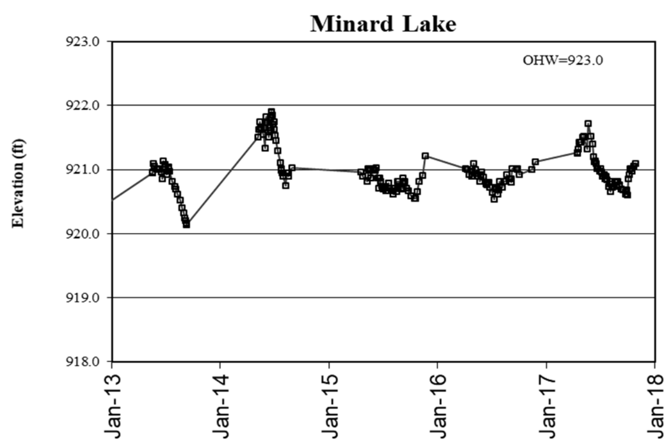
Rogers Lake Levels – last 25 years



Coopers Lake Levels – last 5 years



Minard Lake Levels – last 5 years



*Only one reading was received from the Lake George volunteer in 2017. A new volunteer will be pursued for 2018.

Lake Water Quality

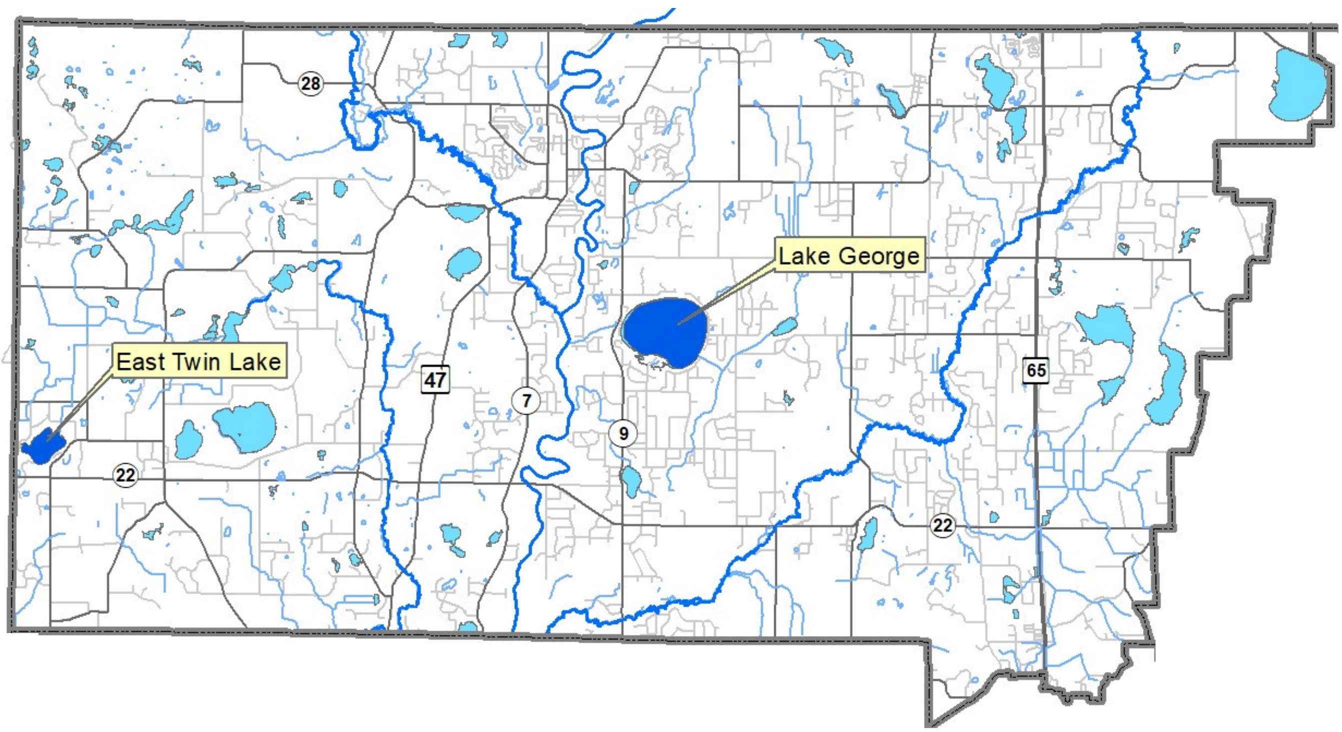
Description: May through September twice-monthly monitoring of the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

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

Locations: 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



East Twin Lake

City of Nowthen, Lake ID # 02-0133

Background

East Twin Lake is located near Anoka County's western boarder in the City of Nowthen. The lake has a surface area of 116 acres with a maximum depth of 77 feet (20.1 m), making it Anoka County's deepest lake. Public access is from East Twin Lake City Park, where there is both a swimming beach and boat launch. The lakeshore is only moderately developed, with residences being mostly of low density and encompassing about half of the shoreline. The watershed is >75% undeveloped, with low-density residential areas. This lake is one of the clearest in the county. One exotic invasive plant, curly leaf pondweed, has been discovered in this lake.

2017 Results

In 2017, East Twin Lake had excellent water quality for this region of the state (NCHF Ecoregion), receiving an overall A grade; a mark it has achieved 14 of the 15 years monitored since 1980 (1983 is the exception with an overall B grade). The lake is mesotrophic, meaning low nutrients drive a moderate to low amount of production. The lake has excellent Secchi transparency, averaging over 10 feet in 2017. Some historically high Secchi readings in this lake include; 19.1 ft. Secchi transparency on June 12, 2013, 18.7 ft. in May of 2011, 22 ft. on May 28, 2008 and 20 ft. in spring 2002; these are the deepest at any Anoka County lake since at least 1996. East Twin is locally unique maintaining >10 feet of transparency late into summer. The lake's poorest water quality parameter on the grading scale is total phosphorus (TP), receiving more B letter grades than A grades going back to 1980. 2017 was a return to an A grade for TP, however, after B grades in 2011 and 2013. TP concentrations averaged 27.1 µg/L without a lot of fluctuation throughout the sampling season. Chlorophyll-a (Cl-a) concentrations averaged just 3.9 µg/L. Additionally, subjective observation by ACD staff ranked physical and recreational conditions optimal.

Trend Analysis

Fifteen years of water quality data have been collected by the Metropolitan Council (1980, '81,'83, '95, and '98), the Minnesota Pollution Control Agency (1989), and the Anoka Conservation District (1997, '99, 2000, 2002, 2005, 2008, 2011, 2013, and 2017). A statistically significant improvement in overall water quality since 1980 has been shown (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,12}$= 4.06, p=<0.05). Analyzing each data type individually offers some clues as to the drivers of that water quality improvement. One-way ANOVAs revealed that chlorophyll-a has declined in a significant manner ($F_{1,13}$ = 11.38, p= 0.005) and continues to be the most important factor in the multi-parameter trend. Total phosphorus also shows a downward trend, though not statistically significant, and Secchi transparency shows a very weak trend towards improvement.

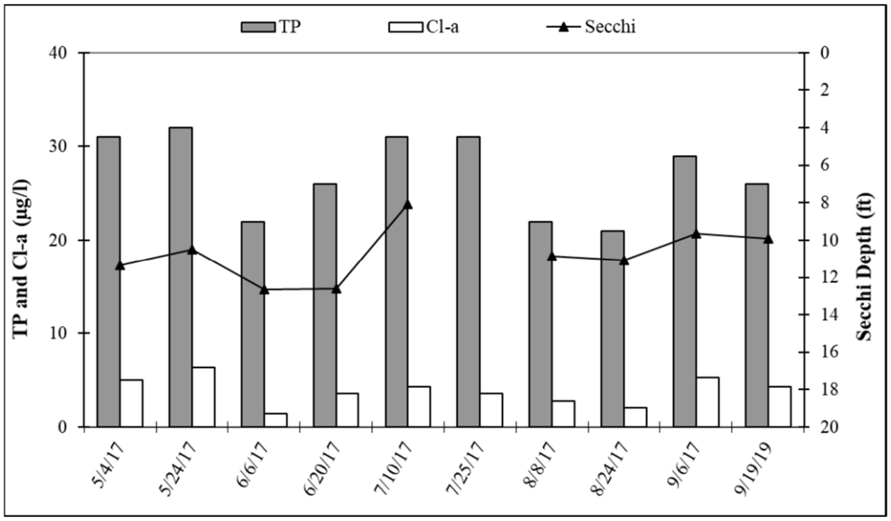
Discussion

East Twin Lake has had good water quality as long as it has been monitored back to 1980, never receiving lower than a B letter grade for any parameter. Statistical analysis shows that the water quality is improving. The ecology of this lake is different from that of other Anoka County lakes because it is so deep. Sediment and dead algae can sink to the bottom and are essentially lost from the system because resuspension by wind, rough fish, and other forces is minimal. In shallower lakes, these nutrients circulate within the lake much more readily and the lake sediments can be a source of nutrients and turbidity that affect water quality. Additionally, East Twin Lake's watershed is small, so there is a small area from which polluted runoff might enter the lake. Aquatic vegetation is also healthy, but not so prolific as to be a nuisance, further contributing to high water quality. One exotic invasive plant is present in the lake, Curly-leaf pondweed (CLP), though its growth is moderate and restricted in extent due to lake depth. CLP, unlike most aquatic vegetation, does not contribute to increasing water quality.

East Twin Lake

City of Nowthen, Lake ID # 02-0133

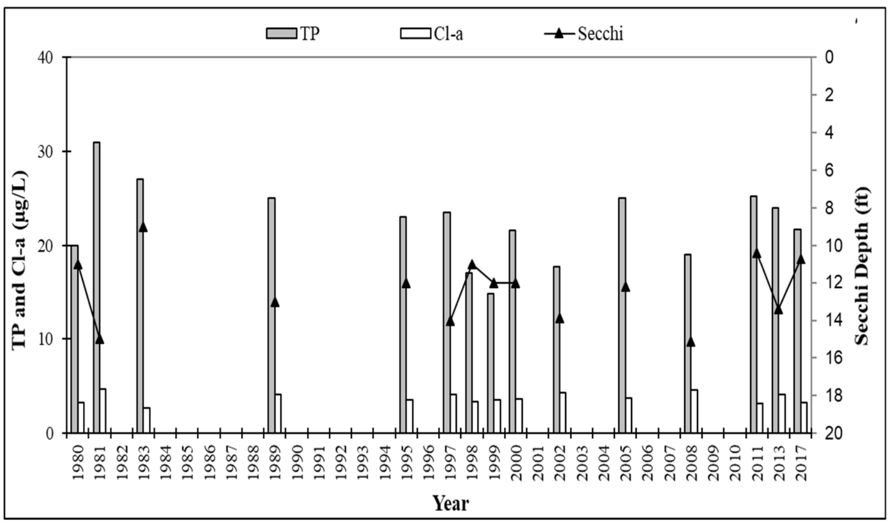
2017 Daily Results



Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1980	A	B	A	**A**
1981	B	A	A	**A**
1983	B	B	B	**B**
1989	B	A	A	**A**
1995	B	A	A	**A**
1997	B	A	A	**A**
1998	B	A	A	**A**
1999	A	A	A	**A**
2000	A	A	A	**A**
2002	A	A	A	**A**
2005	B	A	A	**A**
2008	A	A	A	**A**
2011	B	A	A	**A**
2013	B	A	A	**A**
2017	A	A	A	**A**
2017 average	21.7 µg/L	3.9 µg/L	3.3 meters	
State standards	40 µg/L	14 µg/L	1.4 meters	

Historical Annual Averages



2017 Medians

pH		7.76
Conductivity	mS/cm	0.23
Turbidity	NTU	2.55
Dissolved Oxygen	mg/l	7.94
Dissolved Oxygen	%	0.97
Temp	°C	22.18
Temp	°F	71.92
Salinity	%	0.11
Chlorophyll-a	µg/L	3.95
Total Phosphorus	mg/l	0.02
Total Phosphorus	µg/l	21.50
Secchi	ft	10.83
Secchi	m	3.30

2017 Raw Data

East Twin Lake		Date:	5/4/2017	5/24/2017	6/6/2017	6/20/2017	7/10/2017	7/25/2017	8/8/2017	8/24/2017	9/6/2017	9/19/2019			
2017 Water Quality Data		Time:	12:00	11:55	13:10	11:35	12:00	11:40	12:00	12:25	11:45	11:30			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	7.97	8.08	8.25	7.94	7.66	7.31	7.39	7.69	7.70	7.81	7.78	7.31	8.25
Conductivity	mS/cm	0.01	0.191	0.220	0.240	0.222	0.215	0.247	0.261	0.232	0.227	0.234	0.229	0.191	0.261
Turbidity	NTU	1	2.80		3.10	2.80	1.40	10.60	2.30	0.00		0.00	2.88	0.00	10.60
D.O.	mg/l	0.01	11.19	10.29	9.83	8.52	7.98	7.62	6.88	7.16	6.75	7.89	8.41	6.75	11.19
D.O.	%	1	103.6%	104.7%	115.0%	102.0%	99.8%	95.1%	82.1%	84.4%	75.4%	88.6%	95%	75%	115%
Temp.	°C	0.1	11.08	14.49	22.38	22.62	24.81	24.87	23.14	21.98	19.40	19.42	20.4	11.1	24.9
Temp.	°F	0.1	51.9	58.1	72.3	72.7	76.7	76.8	73.7	71.6	66.9	67.0	68.8	51.9	76.8
Salinity	%	0.01	0.09	0.10	0.12	0.11	0.10	0.12	0.12	0.11	0.11	0.11	0.11	0.09	0.12
Cl-a	µg/L	1	5.00	6.40	1.40	3.60	4.30	3.60	2.80	2.10	5.30	4.30	3.9	1.4	6.4
T.P.	mg/l	0.005	0.021	0.023	0.022	0.021	0.027	0.025	0.017	0.013	0.029	0.019	0.022	0.013	0.029
T.P.	µg/l	5	21	23	22	21	27	25	17	13	29	19	21.7	13	29
Secchi	ft		11.3	10.5	12.7	12.6	8.1		10.8	11.1	9.7	9.9	10.7	8.1	12.7
Secchi	m		3.5	3.2	3.9	3.8	2.5		3.3	3.4	2.9	3.0	3.3	2.5	3.9
Field Observations			Clear	Clear	Clear	Clear	Dark/Clear	Clear	Clear	Clear	Clear	Clear			
Physical			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
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

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 park land. 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. ACD does annual mapping of densities for each type of plant, and the Lake George Improvement District treats both with herbicide.

2017 Results

In 2017 Lake George had good water quality for this region of the state (NCHF Ecoregion), receiving an overall B letter grade and mesotrophic rating. Dating back to 2009, Lake George has maintained this overall B grade each year with the exception of 2015 when a slight decline in average total phosphorus (TP) bumped that score to an A. Total phosphorus in 2017 averaged 23.3 µg/L, the second lowest on record since 2008. Secchi transparency was as high as 12.2 feet in June, but dropped to as low as 4.5 feet in early September. Average Secchi transparency was 7.7 feet, a slight improvement from 2016, but still 2-3 ft. poorer than a decade ago. Chlorophyll-a (Cl-a) averaged 5.7 µg/L, which was similar to the last 5 years, with the exception of a moderate increase in 2016 to 7.8 µg/L. Total phosphorous, chlorophyll-a, and transparency were all poorest in early September. All three parameters were better than water quality standards for deep lakes in this region (<40 µg/L TP, <14 µg/L Cl-a, and >1.4m Secchi transparency). While conforming with state standards is great, it does not help the lake earn the frequent A letter grades it enjoyed during the beginning of the millennium (1997-2002 the lake received an overall A letter grade each year except 1998).

Trend Analysis

Twenty years of water quality data have been collected by the Metropolitan Council (between 1980 and 2009) and the Anoka Conservation District (1997, 1999, 2000, 2002, 2005, 2008, 2011, 2013-2017). During this period there is a statistically significant trend of declining Secchi transparency (one-way ANOVA $F_{1,18}$= 16.56, p=<0.001). The Rum River Watershed Restoration and Protection Strategy (WRAPS) report also found "strong evidence" of declining water clarity using a Kendall-Mann statistical analysis. However, an Anoka Conservation District broader analysis of overall water quality that simultaneously considers TP, Cl-a and Secchi transparency did not find a statistically significant trend looking at all years of data (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,17}$= 2.0, p=0.17). Looking at only the last 10 sampling years' worth of data since 2000, however, shows a statistically significant increase in TP (one-way ANOVA $F_{1,9}$ =5.63, *p*=<0.05) as well as a trend (though not significant) towards increased Cl-a. Much of the decline in transparency has occurred since the year 2000 or slightly before. In short, since 2000 a solid trend of poorer (lower) transparency is occurring and a less dramatic trend of poorer (higher) total phosphorus is occurring. Chlorophyll-a (algae) levels show no statistically significant trend of change.

Lake George

CITY OF OAK GROVE, LAKE ID # 02-0091

Discussion

Lake George remains one of the clearest of the Anoka County lakes, but its trend toward declining Secchi transparency is seriously concerning (see graph below). 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).

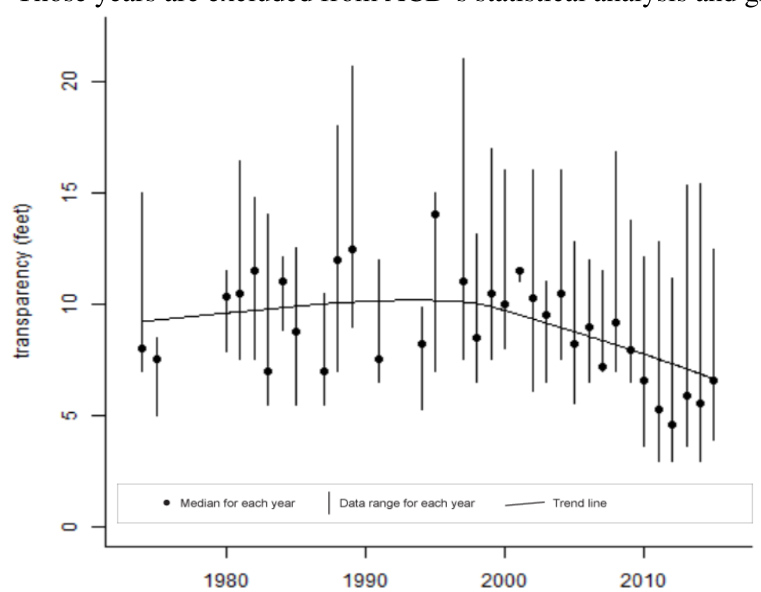
An additional concern for Lake George is noted in the 2017 Rum River Watershed Fish-Based Lake IBI Stressor Identification Report by the MN DNR. That report found Lake George's fish community was not impaired, but was of special concern and vulnerable. Lack of aquatic habitat and near-shore development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

In 2016 the ACD began monitoring and data collection for phase 1 of an in depth study into lake water quality declines, with the objective of identifying measures that would reverse the trends. Phase 1 is focused on the lake's watershed, but not in-lake processes. Two years of water quality data have been collected at two outfalls into Lake George and contributing streams into the wetlands that feed those outfalls, as well as numerous monitoring sites in the County Ditch 19 system. The study includes watershed modeling, project identification, and ranking of those project by cost effectiveness. A final report is expected in 2018. This study is funded by the Lake George Improvement District, Lake George Conservation Club, Anoka Conservation District, a State Clean Water Fund grant and others. If necessary, a phase 2 of the study in the future may occur which would focus on in-lake factors affecting water quality.

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

Two exotic invasive plants are present in Lake George, Curly-leaf pondweed and Eurasian Water Milfoil. The Lake George Improvement District was formed to control these plants, and multiple years of localized treatments have occurred. In coordination with the MN DNR, the Lake Improvement District continually works to achieve control of these invasive plants without harming native plants or water quality. Water quality has been monitored immediately before and after herbicide treatments in some recent years, and no obvious causal relationship between weed treatment and water quality was found.

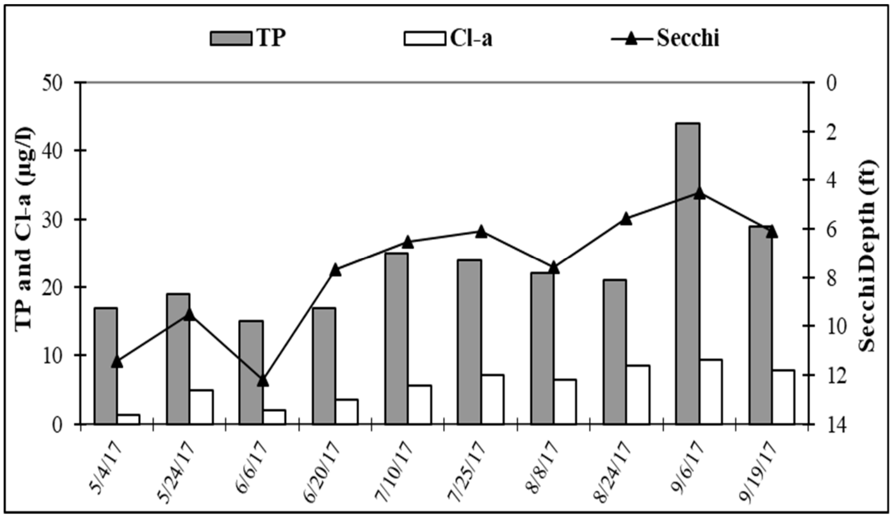
Lake George Secchi transparency trend- MN DNR. Note: Includes years with partial datasets not covering all open water months. Those years are excluded from ACD's statistical analysis and graphs on the following page.



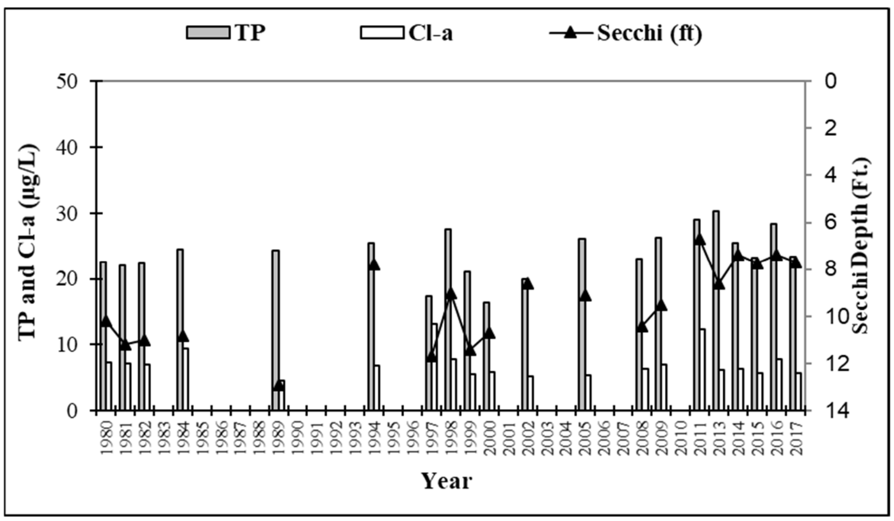
Lake George

City of Oak Grove, Lake ID # 02-0091

2017 Daily Results



Historical Annual Averages



Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1980	A	A	A	**A**
1981	A	A	A	**A**
1982	A	A	A	**A**
1984	B	A	A	**A**
1989	B	A	A	**A**
1994	B	A	B	**B**
1997	A	B	A	**A**
1998	B	A	B	**B**
1999	A	A	A	**A**
2000	A	A	B	**A**
2002	A	A	B	**A**
2005	B	A	B	**B**
2008	B	A	A	**A**
2009	B	A	B	**B**
2011	B	B	C	**B**
2013	B	A	B	**B**
2014	B	A	B	**B**
2015	A	A	B	**A**
2016	B	A	B	**B**
2017	B	A	B	**B**
2017 average	23.3 µg/L	5.7 µg/L	2.35 meters	
State standard	40 µg/L	14 µg/L	1.4 meters	

2017 Medians

pH		8.45
Conductivity	mS/cm	0.23
Turbidity	NTU	3.50
Dissolved Oxygen	mg/l	8.99
Dissolved Oxygen	%	1.05
Temp	°C	22.30
Temp	°F	72.14
Salinity	%	0.11
Chlorophyll-a	µg/L	6.05
Total Phosphorus	mg/l	0.02
Total Phosphorus	µg/l	21.50
Secchi	ft	7.06
Secchi	m	2.15

2017 Raw Data

		Date:	5/4/2017	5/24/2017	6/6/2017	6/20/2017	7/10/2017	7/25/2017	8/8/2017	8/24/2017	9/6/2017	9/19/2017			
		Time:	12:45	12:45	14:00	12:20	11:15	11:00	11:15	11:45	11:00	10:50			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	7.96	8.23	8.74	8.46	8.72	8.42	8.50	8.43	8.11	8.51	8.41	7.96	8.74
Conductivity	mS/cm	0.01	0.195	0.219	0.230	0.210	0.203	0.236	0.247	0.225	0.228	0.233	0.223	0.195	0.247
Turbidity	NTU	1	3.30		3.70	4.50	1.50	15.800	7.00	1.60		2.20	4.95	2	16
D.O.	mg/l	0.01	10.76	9.87	9.91	8.54	8.71	9.59	8.89	9.09	8.75	8.46	9.26	8.46	10.76
D.O.	%	1	100.9%	100.7%	117.1%	102.5%	110.2%	118.2%	107.2%	108.9%	98.0%	95.5%	106%	96%	118%
Temp.	°C	0.1	11.22	14.50	22.43	22.48	25.37	25.03	23.68	22.17	19.63	19.58	20.6	11.2	25.4
Temp.	°F	0.1	52.2	58.1	72.4	72.5	77.7	77.1	74.6	71.9	67.3	67.2	69.1	52.2	77.7
Salinity	%	0.01	0.09	0.10	0.11	0.10	0.10	0.11	0.12	0.11	0.11	0.11	0.11	0.09	0.12
Cl-a	µg/L	1	1.4	5.0	2.1	3.6	5.7	7.1	6.4	8.5	9.4	7.8	5.7	1.4	9.4
T.P.	mg/l	0.005	0.017	0.019	0.015	0.017	0.025	0.024	0.022	0.021	0.044	0.029	0.023	0.015	0.044
T.P.	µg/l	5	17	19	15	17	25	24	22	21	44	29	23.3	15	44
Secchi	ft		11.4	9.5	12.2	7.7	6.5	6.1	7.6	5.6	4.5	6.1	7.7	4.5	12.2
Secchi	m		3.5	2.9	3.7	2.3	2.0	1.9	2.3	1.7	1.4	1.9	2.35	1.4	3.7
Field Observations			Clear, Green Tint	Clear	Clear	Green	Dark Green	Clear	lear, Green ti	Clear	Murky	Cloudy			
Physical			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.1	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

Lake George

City of Oak Grove, Lake ID # 02-0091

2017 Aquatic Invasive Vegetation Mapping

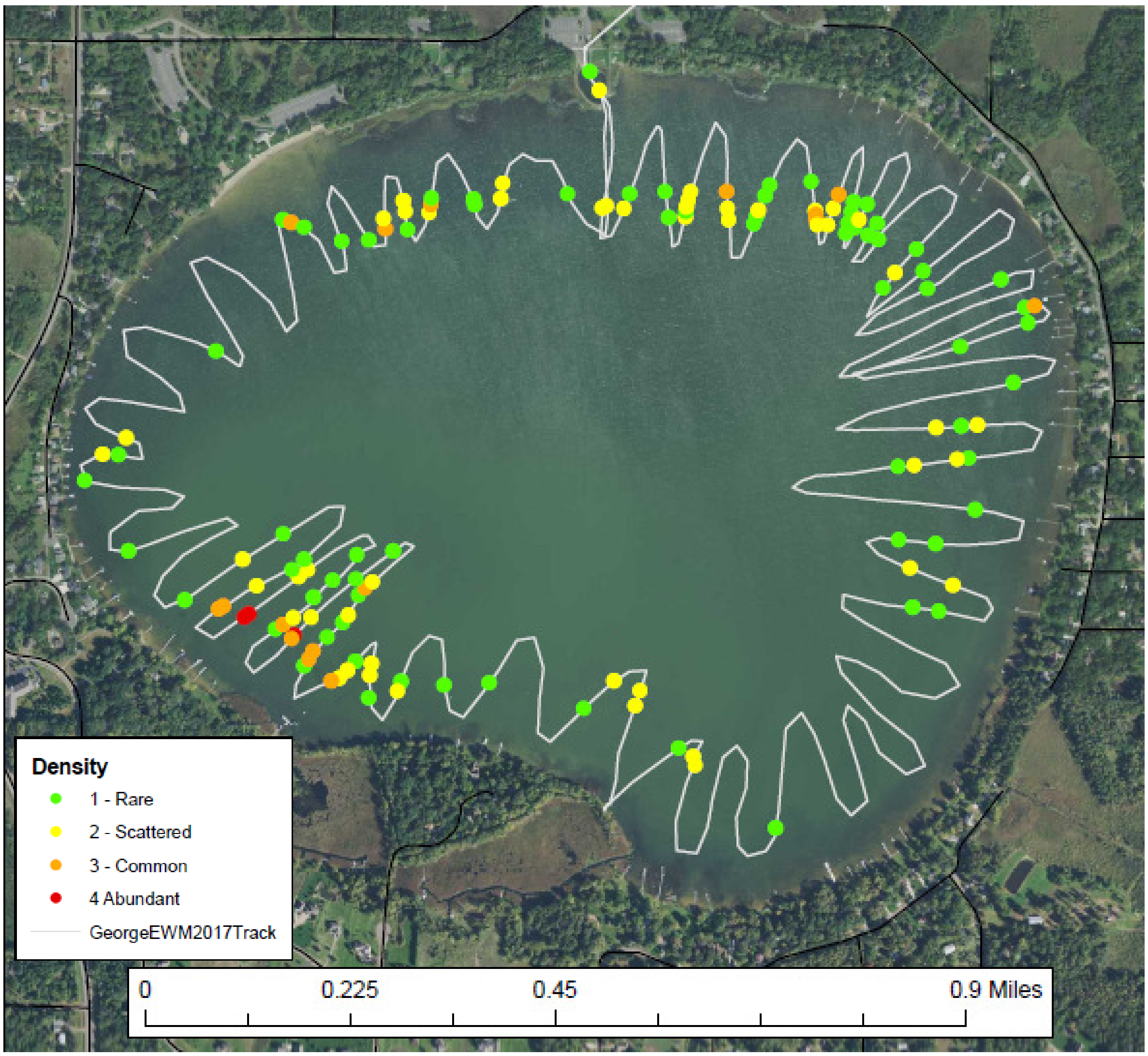
Description: The Anoka Conservation District (ACD) was contracted by the Lake George Lake Improvement District (LID) to conduct an aquatic invasive vegetation delineation.

Purpose: To map out the presence of Curly Leaf Pondweed (CLP) and Eurasian Water Milfoil (EWM) as required for MN DNR herbicide treatment permits. A goal was to map these invasive species as early as possible in the growing season to allow for herbicide treatment as early as possible for reduced impacts on native plants and lessened possible impacts on water quality.

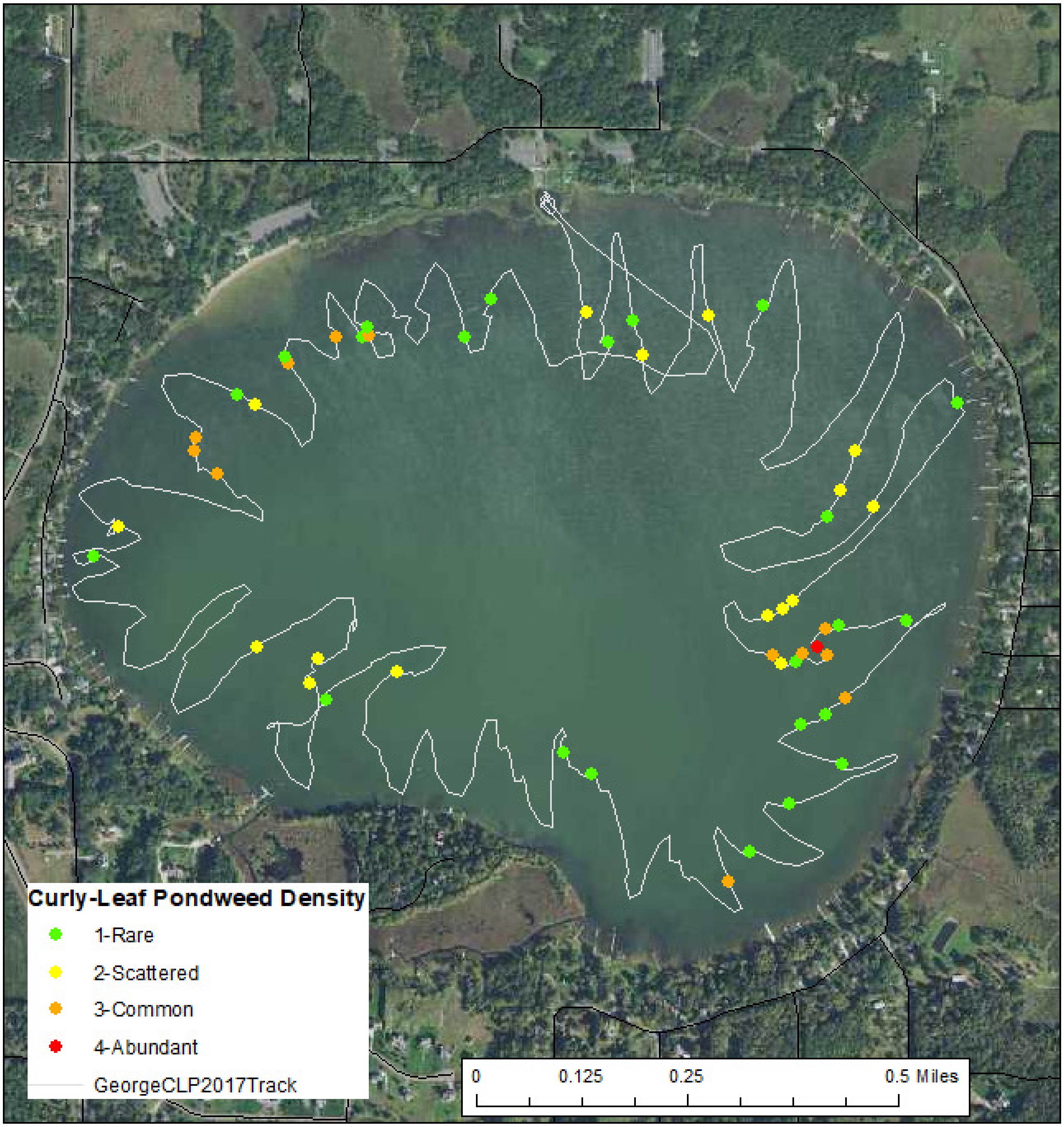
Locations: Lake George

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

May 12, 2017 Lake George Eurasian Water Milfoil (EWM) Survey



April 21, 2017 Lake George Curly Leaf Pondweed (CLP) survey



Stream Water Quality - Chemical Monitoring

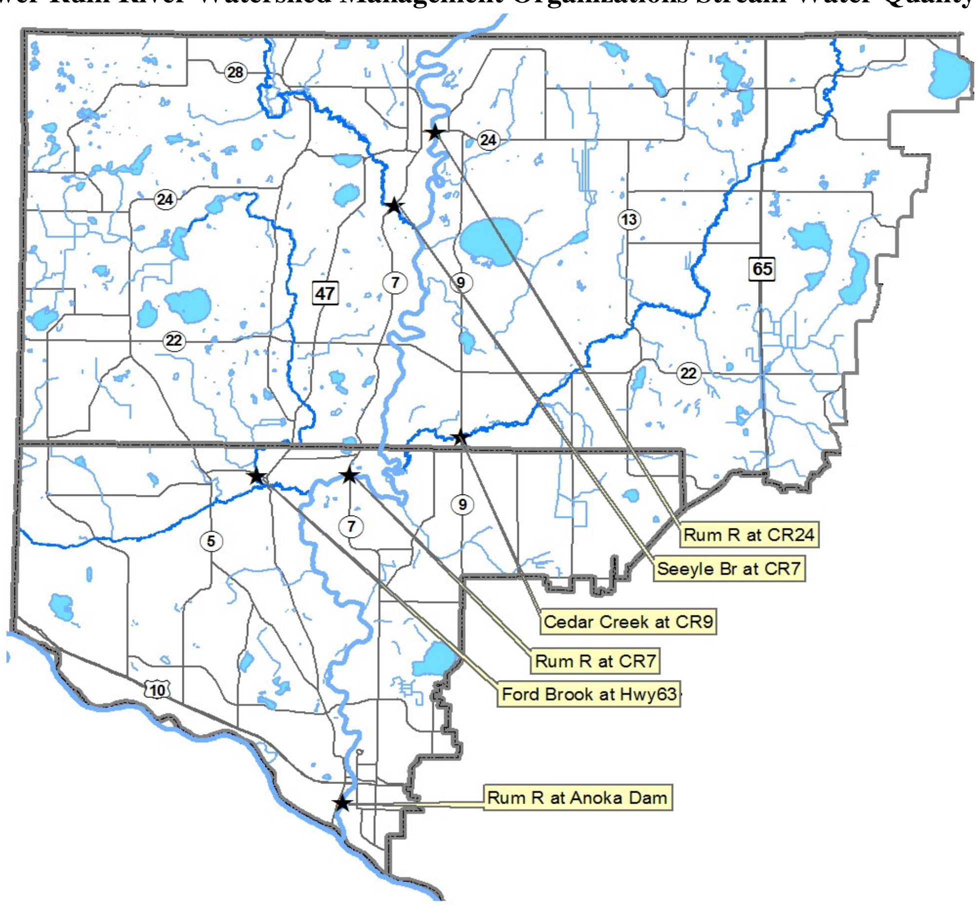
Description: The Rum River and several tributary streams were monitored in 2017. The locations of river monitoring include the approximate top and bottom of the Upper and Lower Rum River Watershed Management Organizations. Tributaries were monitored simultaneously with Rum River monitoring for greatest comparability near their outfalls into the river. Collectively, these data allow for an upstream to downstream water quality comparison within Anoka County, as well as within each watershed organization. It also allows us to examine whether the tributaries degrade Rum River water quality. Monitoring occurred in May through September for each of the following parameters: total suspended solids, total phosphorus, Secchi tube transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

Purpose: To detect water quality trends, diagnose and identify the source of any problems, and guide management.

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

Results: Results are presented on the following pages.

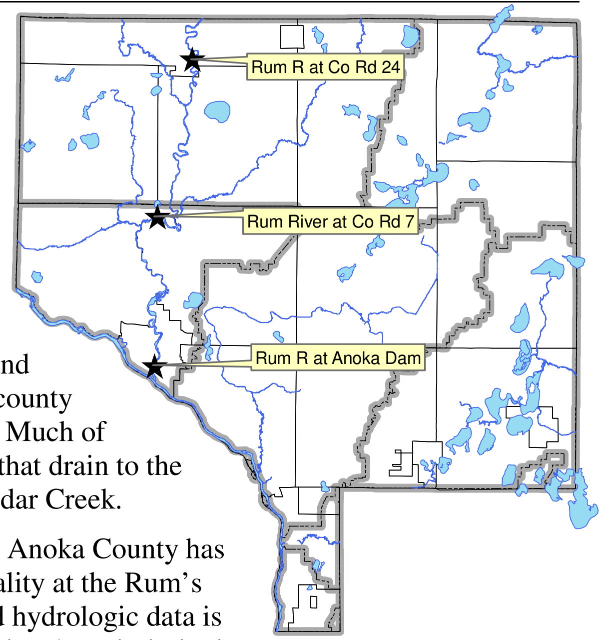
Upper and Lower Rum River Watershed Management Organizations Stream Water Quality Sites



RUM RIVER

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

*Located in and paid by the URRWMO, but reported with other Rum River data for a more complete analysis.



Years Monitored

At Co. Rd. 24 –	2004, 2009-2011, 2014-2017
At Co. Rd. 7 –	2004, 2009- 2011, 2014-2017
At Anoka Dam –	1996-2011(MC WOMP), 2015-2017

Background

The Rum River is 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 Brook, Trott Brook, and Ford Brook, and Cedar Creek.

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

Methods

In 2004, 2009- 2011 and 2014-2017 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 for all sites together for a more comprehensive analysis of the river from upstream to downstream.

In 2017 the river was monitored during both storm and baseflow conditions by grab samples. At the two further downstream locations, eight water quality samples were taken; half during baseflow and half following storms. At the upstream site, only four samples were taken due to lower funding levels. Storms were generally defined as one-inch or more of rainfall in 24 hours, or a significant snowmelt event combined with rainfall. In some years, particularly the drought year of 2009, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus and total suspended solids. During every sampling event the water level (stage) was recorded. The monitoring station at the Anoka Dam includes automated equipment that continuously tracks water levels and calculates flows. Water level and flow data for other sites were 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 2017. 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 https://eims.metc.state.mn.us/. All other raw data can be obtained from the Anoka Conservation District, and is also available through the Minnesota Pollution Control Agency's EQuIS database, which is available through their website.

Results Summary

This report includes data from 2017 and an overview of previous year's data. The following is a summary of results.

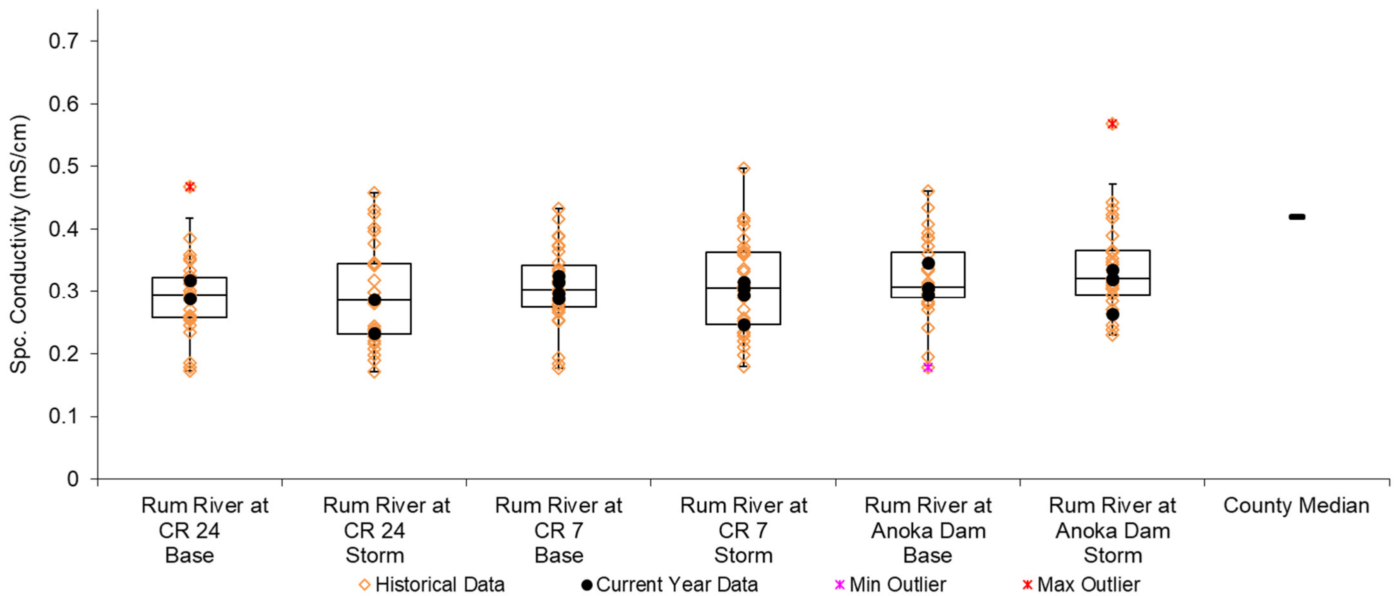
- Dissolved constituents, were measured by conductivity and chlorides. Conductivity in the Rum River is lower than other Anoka County streams. There is cause for concern however, as conductivity consistently increases moving downstream. Average conductivity for sites tested in 2017 from upstream to downstream was 0.282, 0.299 and 0.311 mS/cm respectively. This increase is likely caused by higher road and development density contributing higher loads of road salts and water softener salt. As development continues in all parts of the Rum River watershed, particular attention should be paid to minimizing road salt use, new water softening technology.
- Phosphorous in the Rum River in recent years has been near the State water quality standard of 100 µg/L at all sampled sites, but in 2017 somewhat better conditions were found. Sites exceeded this mark on two single sampling occasions in 2017, once during baseflow, and once after a storm event. 2017 total phosphorus in the Rum River in 2017 averaged 66, 74 and 69 µg/L at sampled sites moving upstream to downstream. Compared to other Anoka County streams, and even the Rum in recent years, these averages are low. Because small increases in phosphorus could cause the Rum River to exceed State standards and be declared "impaired," preventing phosphorus increases should be a focus of watershed management.
- Suspended solids and turbidity generally remained at acceptable levels in the Rum River and are lower than most other Anoka County streams. Average turbidity actually decreased from upstream to downstream in 2017 with averages of 8.0, 7.4, and 7.0 NTU respectively. TSS levels were low in the Rum River compared to other Anoka County streams with 2017 sampling site averages of 7.25, 8.0 and 5.4 mg/L upstream to downstream. Though suspended solids remain well under state impairment thresholds in the Rum, turbidity does show a moderate increase during storm events, and stormwater runoff mitigation should be a focus of management efforts.
- pH was relatively high in 2017 in the Rum River. pH should remain between 6.5 and 8.5 to support aquatic life and meet State water quality standards. On one occasion in May 2017, all three sampled sites exceeded pH 9. pH levels over 9 are quite alkaline for natural waterways. There is a variety of potential factors leading to temporary spikes in pH. What is disconcerting is the fact that the spikes over 8.5 seem to be happening more frequently in recent years. pH should continue to be monitored in the Rum River in the future to see if the spikes get worse or become even more common.
- Dissolved oxygen remained well above the state standard of 5 mg/L in 2017 and previous monitored years. The lowest concentration recorded at any of the three sites in 2017 was 6.89 mg/L.

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

Conductivity

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

Conductivity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 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 shows a consistent pattern of increasing downstream (see figure above) and is usually higher during baseflow conditions. Average conductivity from upstream to downstream of the sites monitored in 2017 (all conditions) was 0.282 mS/cm, 0.299 and 0.311 mS/cm, respectively. All three sites are lower than the historical median for 34 Anoka County streams of 0.420 mS/cm, but each site averaged slightly higher conductivity than in 2016. The 2017 maximum observed conductivity in the Rum River was 0.346 mS/cm at the Anoka Dam during baseflow conditions. This spike was still lower than the median for all other Anoka County streams.

Conductivity is lower on average during storm events (especially in the upstream sites), suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow conductivity has been observed in most other nearby streams as well. This occurrence has been studied extensively, and the largest cause has been found to often be road salts that have infiltrated into the shallow aquifer. Water softening salts and geologic materials also contribute, but to a lesser degree.

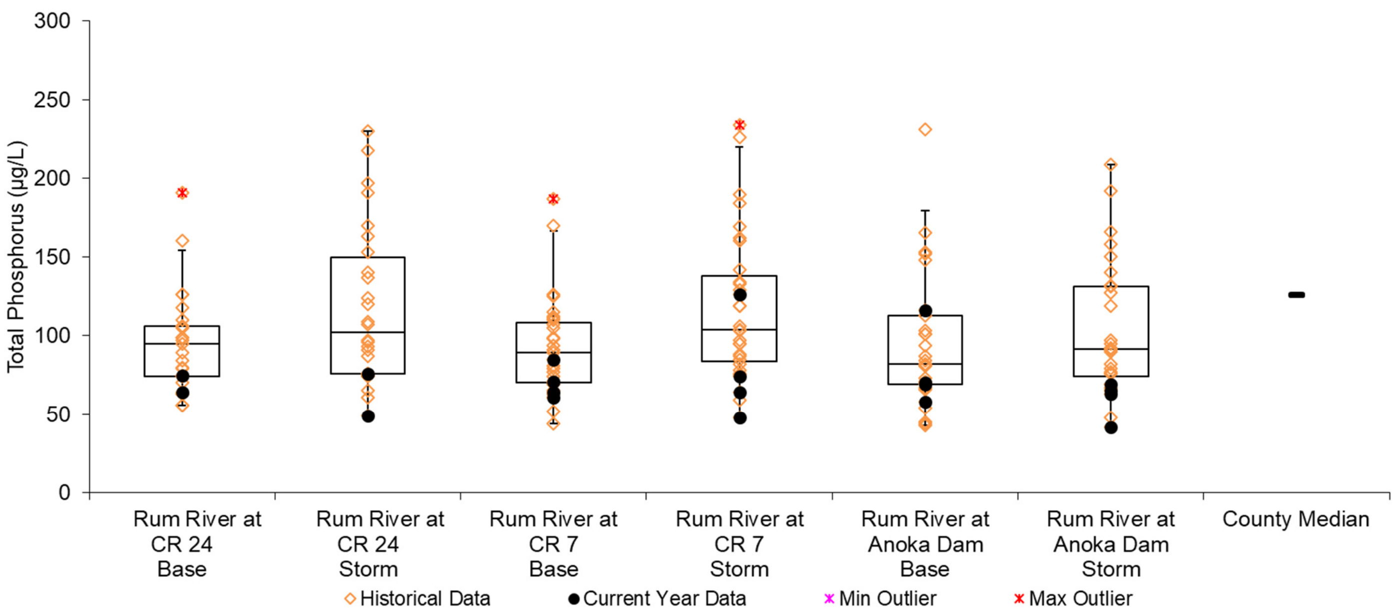
Conductivity increased from upstream to downstream. During baseflow, this increase from upstream to downstream likely reflects greater road densities and deicing salt application. During storms, the higher conductivity downstream is reflective of greater stormwater runoff and pollutants associated with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

Total Phosphorus

Total phosphorus in the Rum River was low in 2017, but in previous years is close to exceeding State water quality standards. Phosphorus is one of the most common pollutants in this region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. The average phosphorus concentration in 2017 at the three monitored sites (all conditions) moving upstream to downstream was 66, 74 and 69 µg/L. Two samples events in 2017 yielded total phosphorus concentrations over 100 µg/L. In previous years, phosphorus concentrations were near the 100 µg/L State water quality standard.

Understanding that the Rum River is close to exceeding State water quality standards for phosphorus, future monitoring should be continued and every effort should be made to prevent phosphorus increases which would likely result in the Rum River being designated a State "impaired" water. Future upgrades to wastewater treatment plants throughout the Rum River watershed may offer phosphorus reductions. At the same time, development in the lower watershed, including increased stormwater discharges, may result in phosphorus increases. Development controls that result in no net increase in phosphorus should be considered.

Total phosphorus during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Turbidity and Total Suspended Solids (TSS)

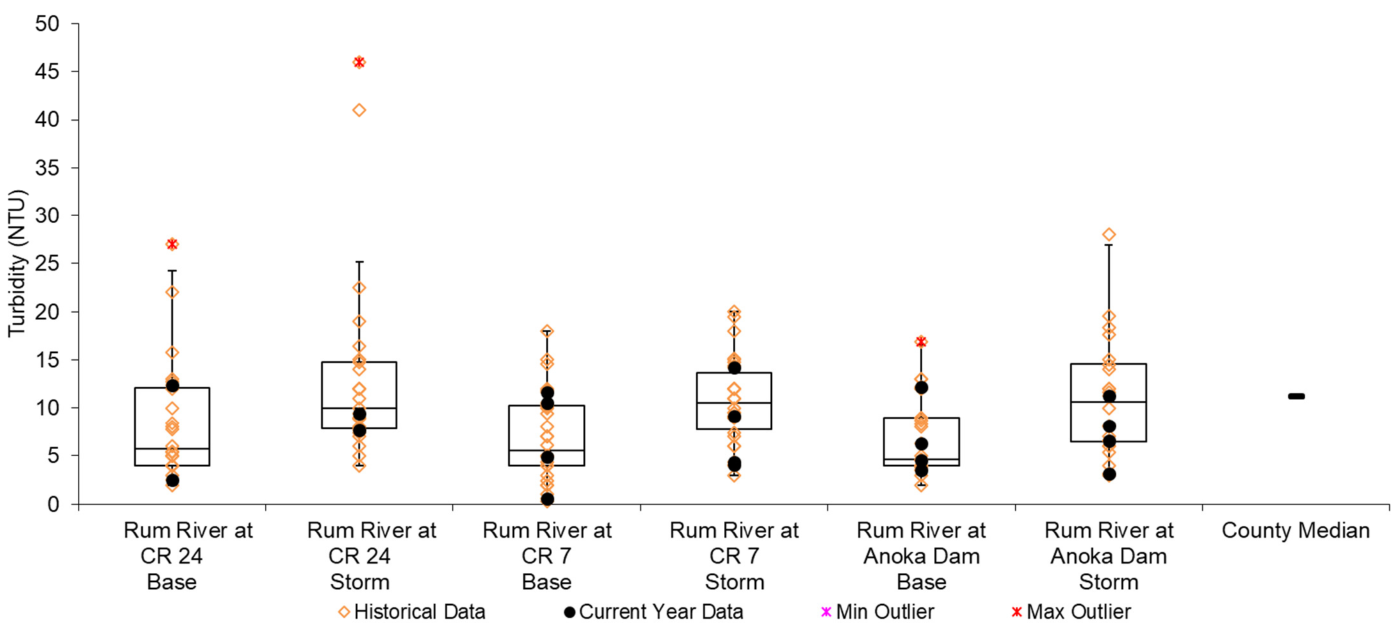
Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by the refraction of a light beam passed through a water sample and is most sensitive to large particles. Total suspended solids is measured by filtering solids from a water sample and weighing the filtered material. The amount of suspended material is important because it affects transparency and aquatic life, and because many other pollutants are attached to particles. Many stormwater treatment practices such as street sweeping, sumps, and stormwater settling ponds target sediment and attached pollutants. In 2017, turbidity and total suspended solids in the Rum River were lower than the historical median for Anoka County streams.

In the Rum River, turbidity is generally low but increases during storms. There is substantial variability (see figure below). There is no clear change in turbidity or suspended solids upstream to downstream. The average turbidity, in 2017 (storms and baseflow) for each site moving upstream to downstream was 8.0, 7.4, and 7.0 NTU. The historical median for Anoka County streams is 11.2 NTU. Turbidity was elevated on a few occasions, especially during and after storm events, though the maximum turbidity measured at County Road 7 after a storm event of 14.2 NTU is quite low for a highest annual recording.

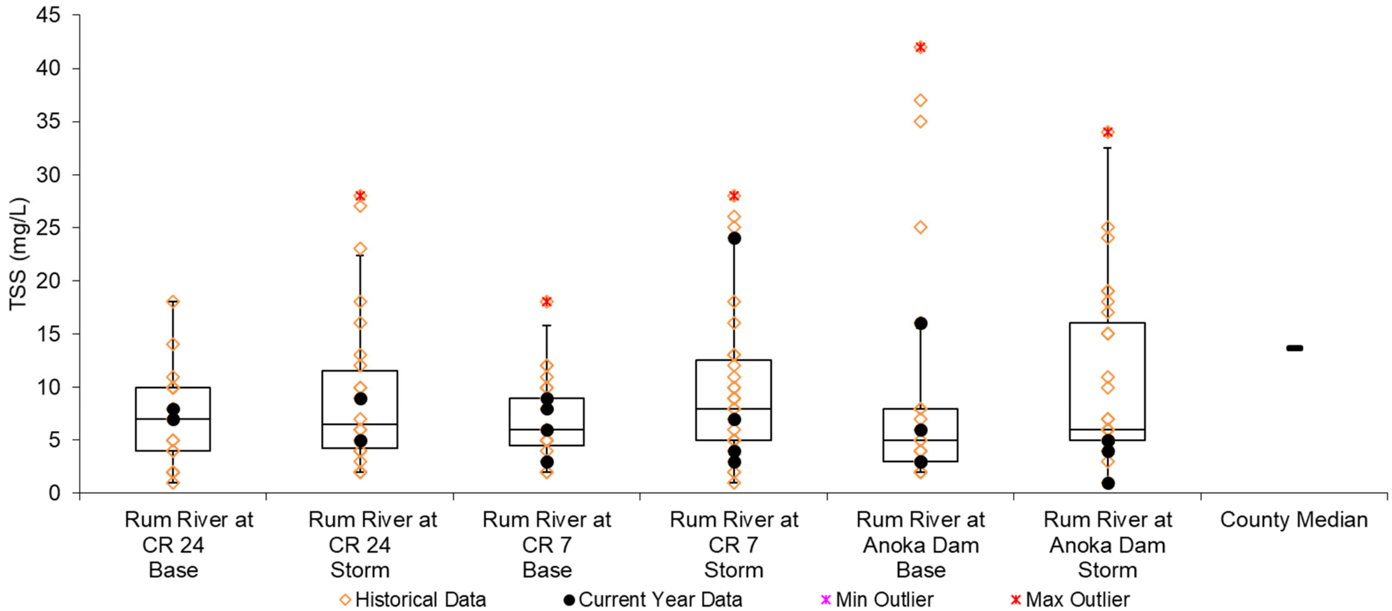
Average TSS results (all conditions) in 2017 for sites moving upstream to downstream was 7.25, 8.0 and 5.4 mg/L. These are all lower than the Anoka County stream median for TSS of 13.66 mg/L. It is important to note the suspended solids can come from sources within and outside of the river channel. Sources 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. The state threshold for TSS impairment in the Rum River is 10% of samples April 1-September 30 exceeding 30 mg/L TSS. The highest concentration recorded in 2017 was 24 mg/L. ACD has not collected a sample over 30 mg/L TSS since May of 2010.

Though the Rum River remains well under the impairment threshold for TSS, rigorous stormwater treatment should occur as the Rum River watershed continues to be developed, or the collective pollution caused by many small developments could seriously impact the river. Bringing stormwater treatment up to date in older developments is also important.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



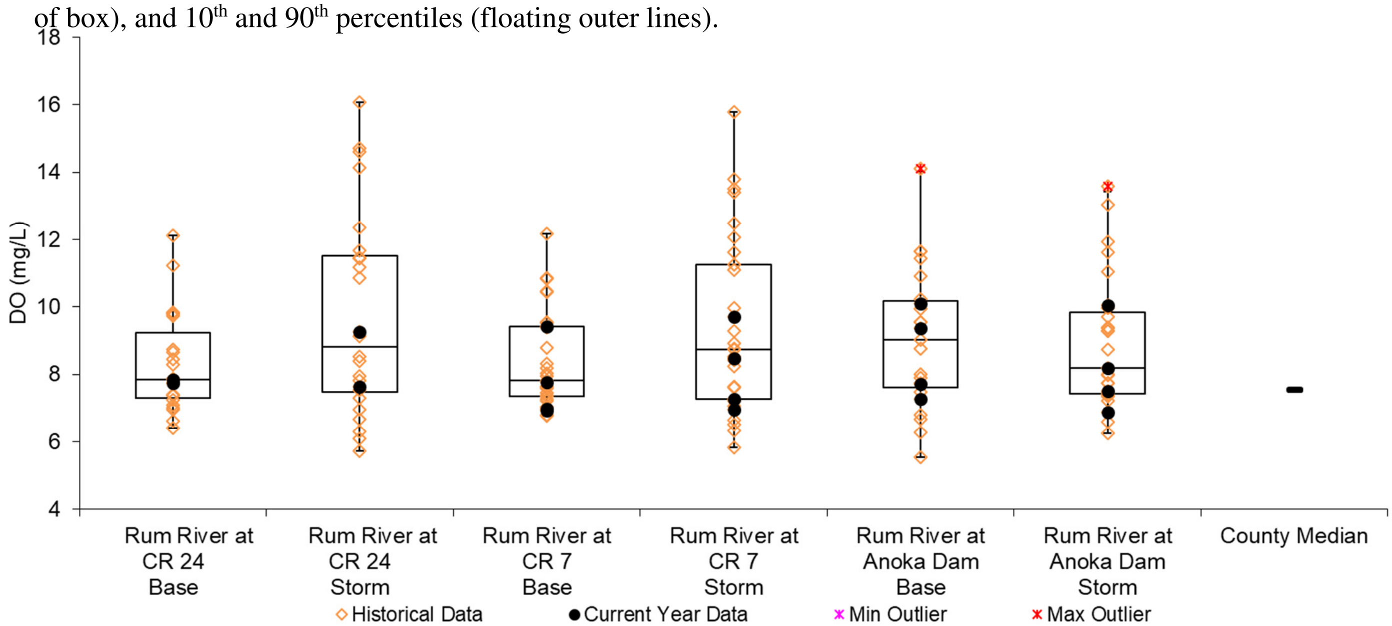
Total suspended solids during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution causes oxygen to be consumed during decomposition. If oxygen levels fall below the state water quality standard of 5 mg/L, aquatic life begins to suffer. A stream is considered impaired if 10% of observations are below this level in the last 10 years. Dissolved oxygen levels are typically lowest in the early morning because of decomposition consuming oxygen at night without offsetting oxygen production by photosynthesis. In 2017, dissolved oxygen in the Rum River was always above 5 mg/L at all monitoring sites, with 6.89 mg/L being the lowest concentration recorded. ACD has never recorded a dissolved oxygen concentration below 6 mg/L in the Rum with sampling dating back to 2004.

Dissolved oxygen during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

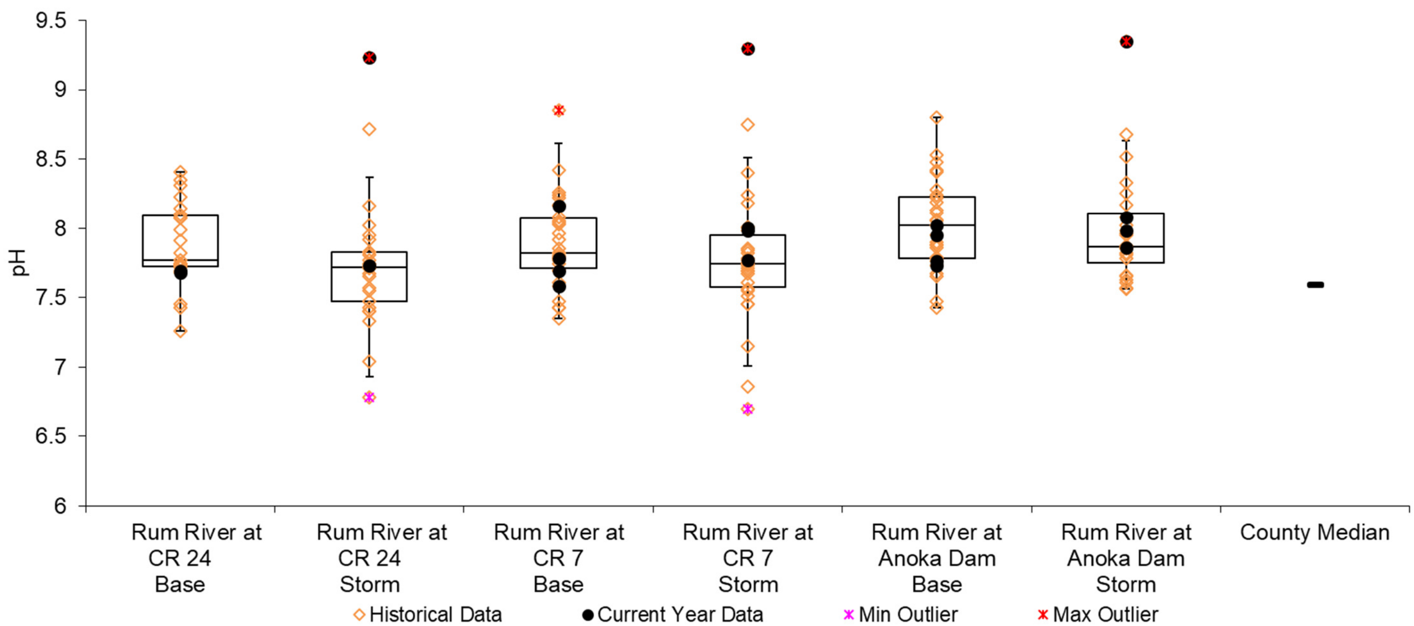


pH

pH refers to the acidity of the water. The Minnesota Pollution Control Agency's water quality standard is for pH to remain between 6.5 and 8.5. The Rum River is generally within this range, but has exceeded 8.5 on rare occasions in the past. In recent years (2015, 2017) however, exceedances of 8.5 have been commonplace at all sites. In 2017, pH levels over 9 were recorded at all three sites after a storm event on 5/18/2017. Exceedances were recorded in 2015 after a spring storm in March at the lower two sampling sites as well as at the Anoka Dam during baseflow conditions in July.

There is a variety of potential factors leading to temporary spikes in pH. What is disconcerting is the fact that the spikes over 8.5 seem to be happening more frequently in recent years. pH should continue to be monitored in the Rum River in the future to see if the spikes get worse or become even more common.

pH during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

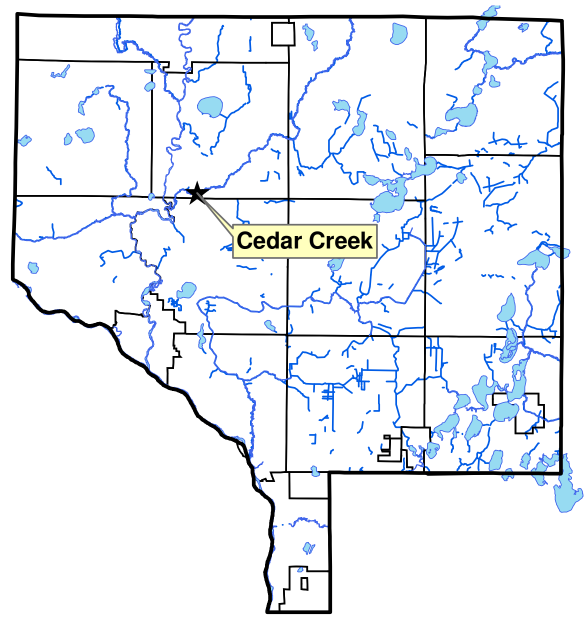


Summary and Recommendations

The Rum River's water quality in general is good. However, there is a slight increase in conductivity moving downstream, phosphorus levels are near state water quality standards, and pH spikes over 8.5 seem to be happening more frequently. Protection of the Rum River should continue to be a high priority for local officials. Large population increases are expected to continue in the Rum River's watershed within Anoka County, and this continued development has the potential to degrade water quality unless carefully planned and managed with the river in mind. Development pressure is likely to be especially high near the river because of its scenic and natural qualities. Local ordinances to preserve the scenic nature of the river, treat stormwater thoroughly before discharge, and minimizing road salting should be considered. A proposed "One Watershed, One Plan" across the entire Rum River watershed may offer a chance for multi-county planning. The recently completed Rum River Watershed Restoration and Protection Strategies (WRAPS) offers management strategies for throughout the watershed.

CEDAR CREEK

at Hwy 9, Oak Grove STORET SiteID = S003-203



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. However, the stream is on the State's list of impaired waters for high *E. coli* bacteria.

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

Results Summary

This report includes data from 2017 and an overview of previous year's data. The following is a summary of results.

- Dissolved constituents, as measured by conductivity in Cedar Creek are higher in recent years at baseflow conditions. Conductivity averaged 0.398 mS/cm with a long term baseflow median now up to 0.426 mS/cm. This increase in baseflow conductivity is a concerning trend. Chlorides were last sampled in 2013, but sampling of chlorides should be considered again given the increase in conductivity levels. Road deicing salt is believed to be a large contributor to elevated chlorides.
- Phosphorous averaged over the State water quality standard of 100 µg/L. Cedar Creek often exceeds the state standard, even during baseflow periods and should be a high priority management focus due to the lasting effects of nutrient loading downstream. Phosphorous results in Cedar Creek averaged 151 µg/L in 2017. Phosphorus is highest after storms. Much of the watershed is in an undeveloped state, and a portion of the phosphorus is likely from natural sources such as wetlands.
- Suspended solids and turbidity ranged widely. Total suspended solids averaged 22.3 mg/L, and turbidity averaged 15.8 NTU. These findings are within the range observed in other years, and are better than State standards.
- pH was generally within the acceptable range of 6.5-8.5. On one occasion in 2017 reached 8.94, the highest pH ever recorded in Cedar Creek. There has been one other such case historically, and interestingly, both occasions happened during storm flows when pH is generally lower.
- Dissolved oxygen was within the range considered healthy for streams in this area. DO averaged 7.75 mg/L.

Cedar Creek 2017 Water Quality Data

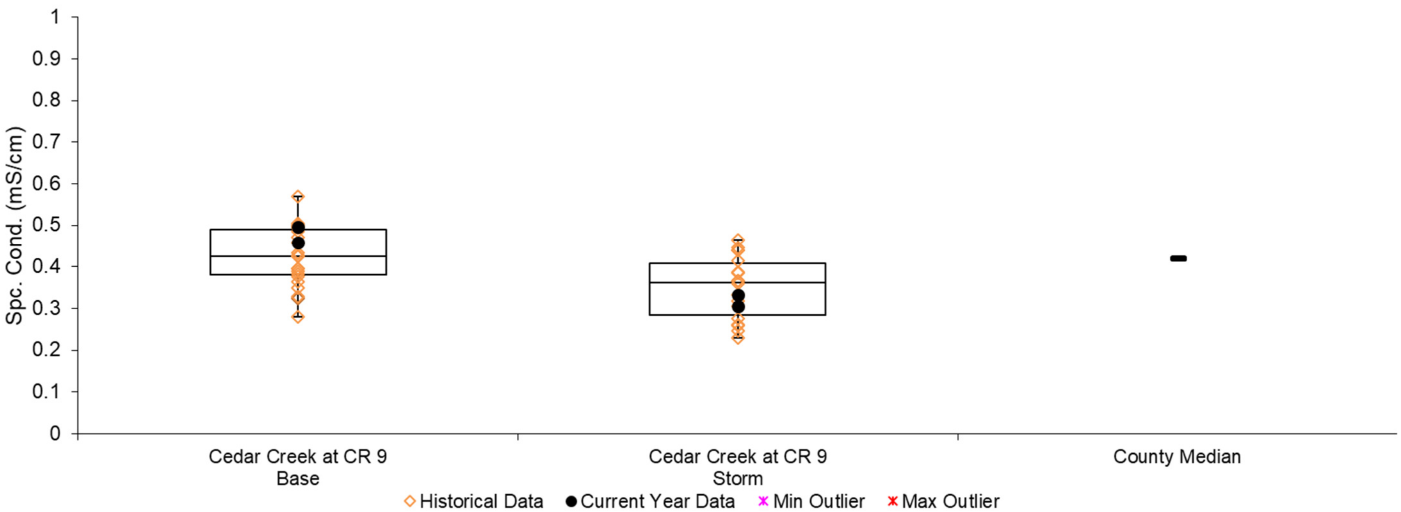
			4/20/2017	5/18/2017	6/7/2017	7/17/2017				
	Units	R.L.*	Results	Results	Results	Results	Median	Average	Min	Max
pH		0.1	7.46	8.94	7.70	7.89	7.80	8.00	7.46	8.94
Conductivity	mS/cm	0.01	0.305	0.333	0.458	0.496	0.40	0.398	0.305	0.496
Turbidity	NTU	1	9.0	30.9	20.9	2.4	14.95	15.80	2.40	30.90
D.O.	mg/L	0.01	9.14	5.66	8.37	7.82	8.10	7.75	5.66	9.14
D.O.	%	1	80.1	54.9	91.7	91.2	85.65	79.5	54.9	91.7
Temp.	°C	0.1	8.05	13.57	19.33	21.66	16.45	15.7	8.1	21.7
Salinity	%	0.01	0.14	0.15	0.22	0.24	0.19	0.19	0.14	0.24
T.P.	ug/L	10	70	196	242	95	145.50	151	70	242
TSS	mg/L	2	11	32	38	8	21.50	22.3	8.0	38.0
Secchi-tube	cm			43.00	63	>100	53.00	>90	43	>100
Appearance			Brown	Murky, Debris	Clear, light brown	Clear				

*reporting limit

Conductivity

Conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include road runoff and industrial chemicals, among many others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we use. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides are the measure of chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community. Historical chloride data can be obtained from the Anoka Conservation District and is also available through the Minnesota Pollution Control Agency's EQuIS database, which is available through their website.

Conductivity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



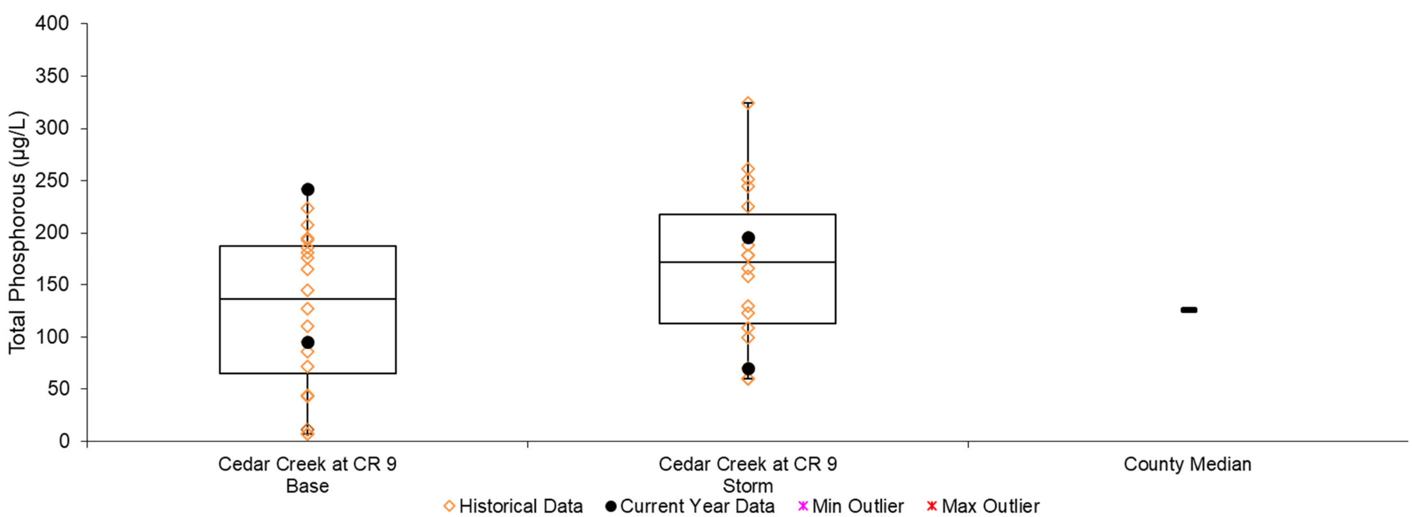
Conductivity is right on par in Cedar Creek at CR 9 compared to other Anoka County streams. Median conductivity (all years) is 0.426 mS/cm during baseflow and 0.363 mS/cm during storm events, respectively. The long-term countywide median conductivity for all conditions is 0.420 mS/cm. This however includes many heavily urbanized streams as well. Baseflow conductivity appears to be higher over the last few sampling years (since 2014). The median baseflow conductivity since 2014 is 0.485 mS/cm, above the long-term median suggesting increasing levels. However, the median storm flow conductivity since 2014, 0.319 mS/cm, is lower than the long-term average.

This increase in baseflow conductivity levels reveals some information about sources of loading into the stream. Higher levels at baseflow conditions indicate that the surficial groundwater of the watershed is being loaded with salts and other chemicals that increase conductivity. Some common sources of this type of pollution are road salts, septic leaks, and agricultural chemicals. These chemicals appear to be entering the stream in higher concentrations from the local surficial groundwater. Storm runoff then dilutes conductivity levels during rain events.

Total Phosphorus

Total phosphorus in Cedar Creek remained high in 2017 averaging 151 µg/L during all conditions. 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) is 136 µg/L during baseflow, similar to the County stream median, and 172 µg/L during storm events. 14 of the 18 measurements taken since 2014 were >100 µg/L, the State water quality standard. In 2017, the highest observed total phosphorus concentrations were recorded during May and June at 196 µg/L and 242 µg/L. Individual results over 200 µg/L have become an annual occurrence since 2015. In all, phosphorus concentrations in Cedar Creek are at concerning levels and should be an area of pollution control efforts. Sources may include a mix of natural sources, such as wetlands, in combination with agricultural and suburban runoff.

Total phosphorus during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



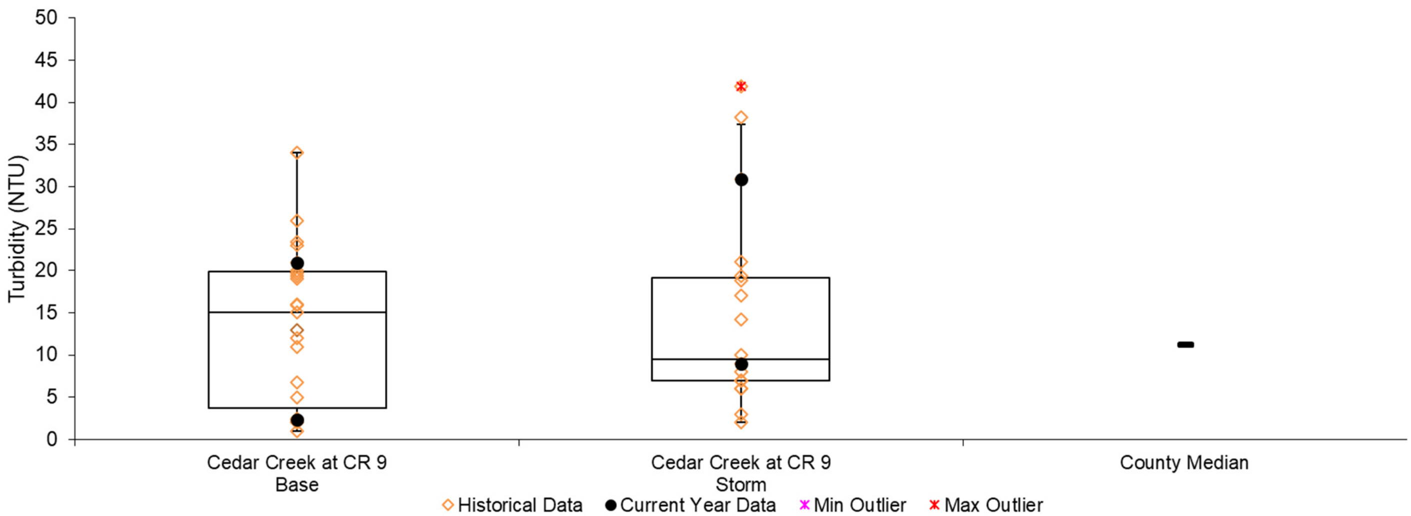
Turbidity and Total Suspended Solids (TSS)

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.

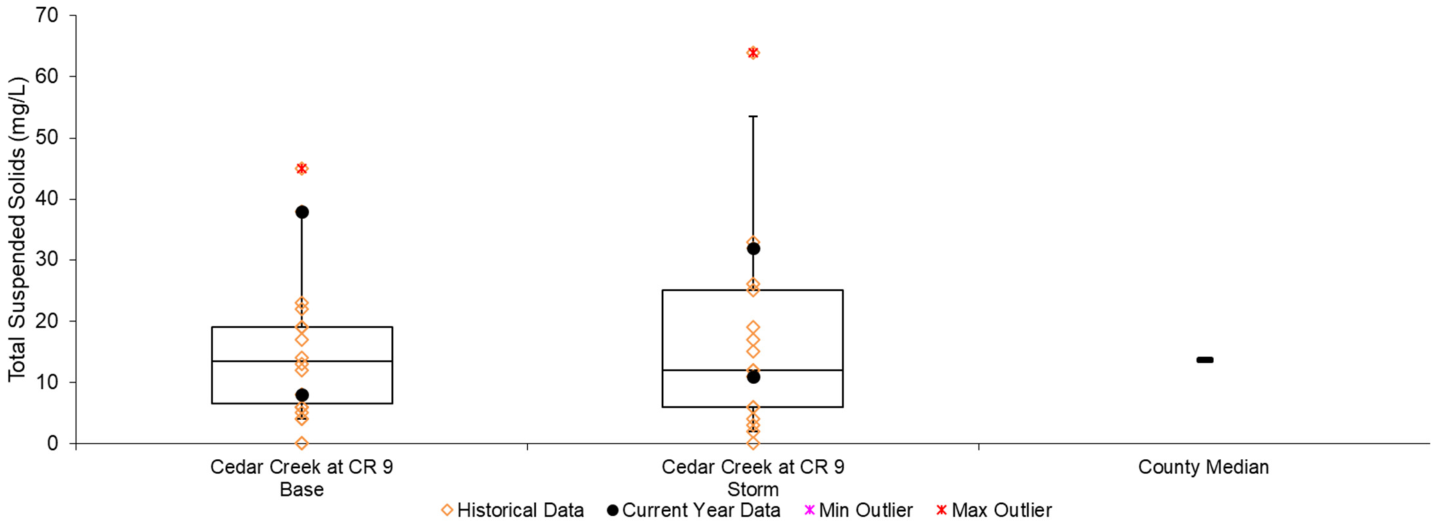
Cedar Creek turbidity in 2017 was variable amongst the four samples taken. A low storm flow result of 9 NTU in early spring and a low baseflow result of 2.4 NTU in July were bracketed by higher results (20.9 and 30.9 NTU) in May and June. The median turbidity (all years) remains 15 NTU during baseflow and rose slightly to 9.5 NTU during storm events after 2017 results were added. Both are higher than the median for Anoka County streams of 8.5 NTU. The maximum turbidity measured in 2017 was 30.9 NTU.

TSS was similar to turbidity with low spring and summer results bracketing high early summer results. The median TSS concentration for Cedar Creek is 12 mg/L, matching the median for all Anoka County streams. TSS is lower than the State water quality standard of no more than 10% of observations greater than 30 mg/L.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



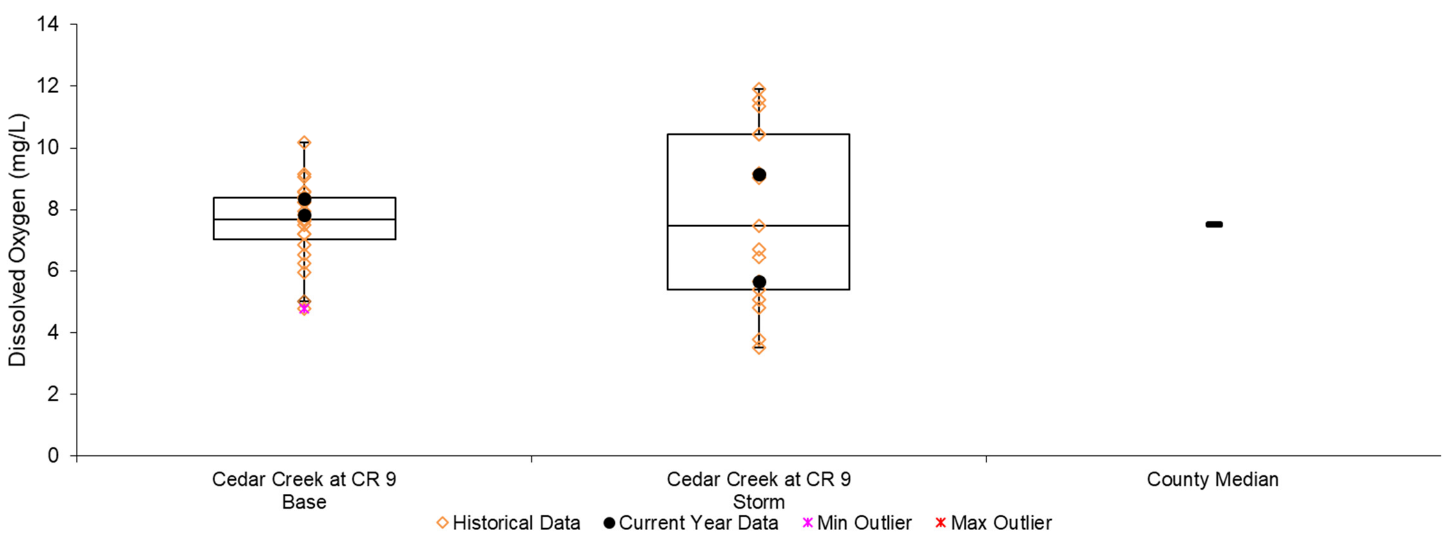
Total Suspended Solids during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution consumes oxygen when it decomposes. If oxygen levels fall below the state standard of 5 mg/L aquatic life begins to suffer. In 2017, dissolved oxygen in Cedar Creek was always above 5 mg/L. Median dissolved oxygen of all years of data is 7.68mg/L during baseflow and 7.46 mg/L during storm events. Few readings of <5 mg/L have been observed at Cedar Creek, and there is no management concern at this time.

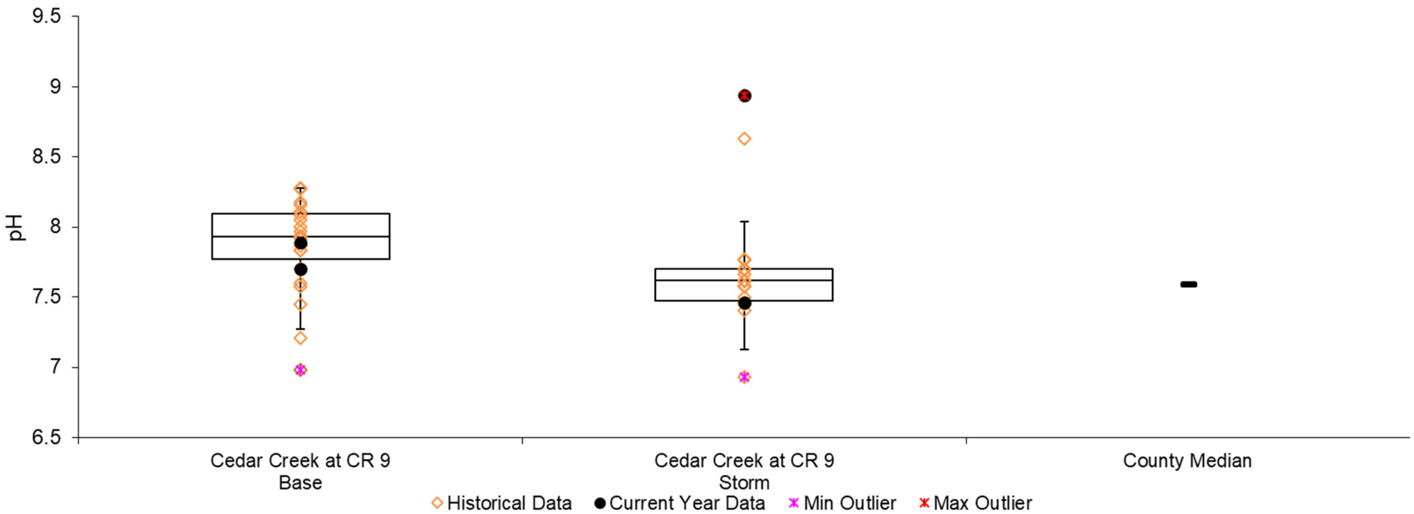
Dissolved oxygen during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

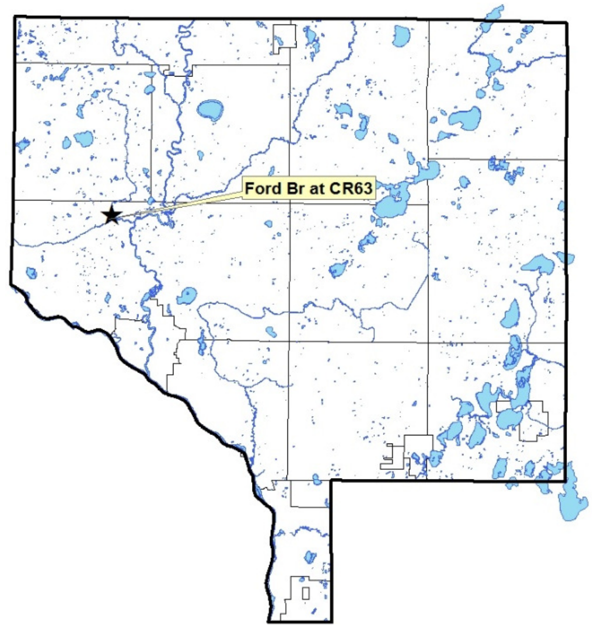
pH refers to the acid or base nature of the water. The Minnesota Pollution Control Agency's water quality standard is for pH to be between 6.5 and 8.5. Including 2017, Cedar Creek has only had two measurements outside of this range, one of which was in 2017. A pH of 8.94 measured on 5/18/2017 is the highest pH ever recorded in Cedar Creek. pH is generally lower during storms than during baseflow, but interestingly, the two highest pH readings historically have been high outliers during storm flows. The pH of rain is typically lower (more acidic). The rare occasion when pH exceeds the State standard should not be concerning.

pH during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 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 County Road 63, Nowthen STORET SiteID = S003-200



Background

Ford Brook originates at Goose Lake in northwestern Anoka County and flows south. Ford Brook is a tributary to the Rum River. It joins Trott Brook just prior to the Rum River. The watershed is moderately developed with scattered single-family homes, but continues to be developed as large-lot residential.

Results Summary

This report includes data from 2017 and an overview of previous year's data. The following is a summary of results.

- Dissolved constituents, as measured by conductivity, in Ford Brook were greater in 2017 during baseflow conditions than recent years and above average when compared to similar Anoka County streams. Conductivity averaged 0.481 mS/cm in 2017. Levels are not highly problematic today, but could become so over time. Like many streams in the area, Ford Brook seems to be experiencing a baseflow conductivity increase. Conductivity is commonly linked to road deicing salts, although other sources like water softeners and dissolved pollutants can contribute. Periodic chloride sampling is recommended to verify if observed conductivity increases are due to salts. Road deicing practices and technologies continue to develop and be adopted locally, but more appears needed.
- Total Phosphorous remained, on average, in excess of the MPCA water quality standard of 100 µg/L. Ford Brook often exceeds the limit, even during baseflow conditions. This is common for streams in the area. Phosphorous results in Ford Brook averaged 116 µg/L with a maximum of 145µg/L and a minimum of 73 µg/L. Modest phosphorus reduction efforts could realistically keep Ford Brook off the State list of impaired waters. New development that could increase phosphorus should utilize appropriate phosphorus reduction practices.
- Suspended solids and turbidity both averaged below (better than) State standards. Total suspended solids averaged 17.25 mg/L. Turbidity averaged 15.6 NTU. There is no current management concern.
- pH was well within the acceptable range for three of four reading in 2017. The fourth reading, during a storm, had the highest pH on record of 9.26. The average pH for 2017 was 8.12. The rare high reading is not a management concern.
- Dissolved oxygen was within the health range for streams. DO averaged 8.16 mg/L (maximum of 9.62 mg/L and a minimum of 7.29 mg/L).

Ford Brook 2017 Water Quality Data

			4/20/2017	5/18/2017	6/7/2017	7/17/2017				
	Units	R.L.*	Results	Results	Results	Results	Median	Average	Min	Max
pH		0.1	7.63	9.26	7.74	7.86	7.80	8.12	7.63	9.26
Conductivity	mS/cm	0.01	0.411	0.470	0.514	0.527	0.49	0.481	0.411	0.527
Turbidity	NTU	1	18.6	29.6	10.4	3.8	14.50	15.60	3.80	29.60
D.O.	mg/L	0.01	9.62	7.29	8.13	7.61	7.87	8.16	7.29	9.62
D.O.	%	1	83.4	70.1	89.7	91.5	86.55	83.7	70.1	91.5
Temp.	°C	0.1	7.53	13.44	21.43	23.01	17.44	16.4	7.5	23.0
Salinity	%	0.01	0.19	0.22	0.25	0.25	0.24	0.23	0.19	0.25
T.P.	ug/L	10	73	145	114	132	123	116	73	145
TSS	mg/L	2	15	33	12	9	13.50	17.3	9.0	33.0
Secchi-tube	cm			57	98	>100	98	>90	57	>100
Appearance			Brown, White Foam	Brown	Clear	Clear				

*reporting limit

Conductivity

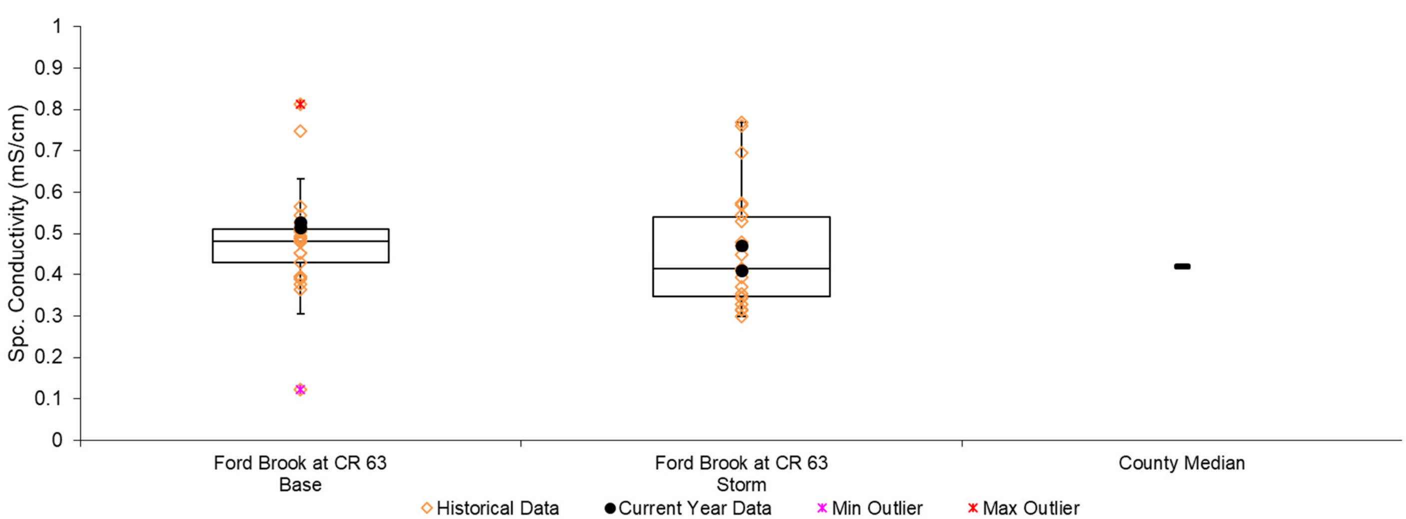
Median conductivity results in Ford Brook are higher than the median for other Anoka County streams. Median conductivity in Ford Brook is 0.481 mS/cm (all years) during baseflow conditions and 0.414 mS/cm during storms, compared to the countywide median of 0.420 mS/cm during all conditions. Baseflow conductivity in 2017 was higher than recent years sampled dating back to 2011 when monitoring resumed in this stream (no monitoring occurred 2004-2010). Baseflow conductivity levels appear to be rising throughout the county, and Ford Brook is no exception.

The baseflow vs storm flow comparison lends some insight into the pollutant sources. If dissolved pollutants were only elevated during storms, stormwater runoff would be suspected as the primary contributor. If dissolved pollutants were highest during baseflow, pollution of the shallow groundwater which feeds the stream during baseflow would be suspected to be a primary contributor. In Ford Brook we find similar, but slightly lower dissolved pollutants during storms. In other words, both stormwater runoff and groundwater are sources of dissolved pollutants, with shallow groundwater contributing slightly more. While storms dilute some of the baseflow pollutants, they also carry additional pollutants, which can offset the dilution.

A likely cause of the increase in conductivity in streams at baseflow is chlorides from road salting. Water softener discharge or dissolved pollutants can also contribute. These salts both runoff into the water and infiltrate into the shallow groundwater that feeds the stream during baseflow. WMOs should consider periodic chloride sampling to assess the contribution of salts to the dissolved pollutant load.

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. Training and equipment that minimize road salting while keeping roads safe is being increasingly emphasized by watershed managers throughout the region.

Conductivity at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

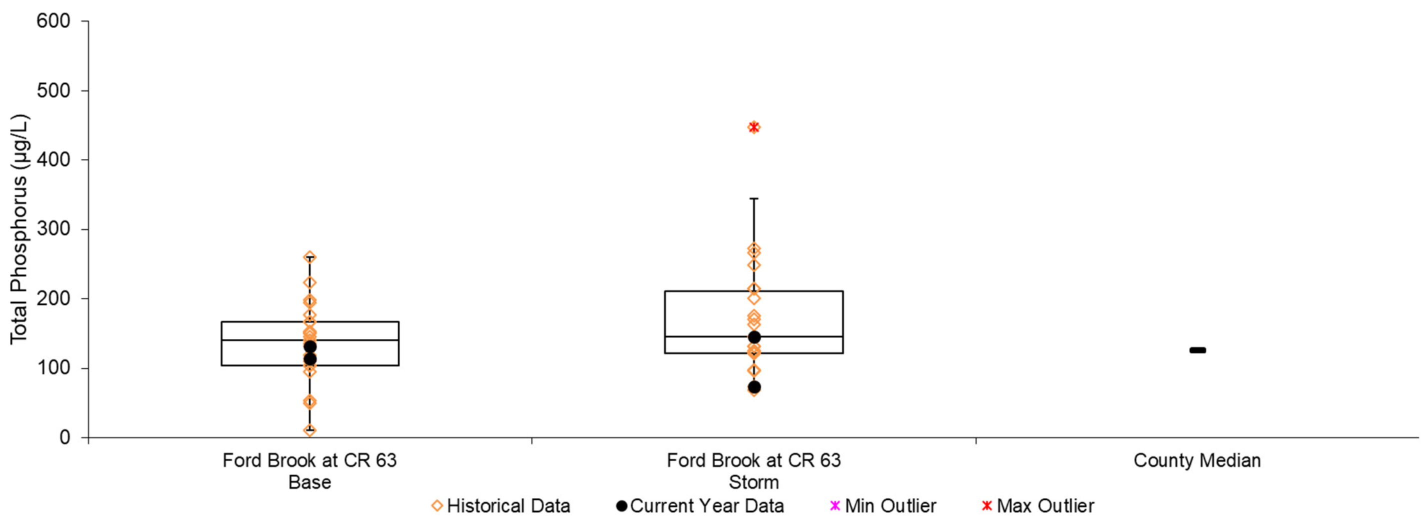


Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant. It is limiting for most algal growth. In the past, total phosphorus in Ford Brook has been moderate during baseflow conditions and increased during storms (see figures below). TP levels in 2017 were still similar, and regularly exceeded the State standard of 100 µg/L. TP levels during storms in 2017, while still averaging higher than the State standard, were on the low end of the range historically observed in this stream.

The phosphorus levels observed are common for Anoka County streams, but do exceed the State's water quality standard. Efforts to reduce phosphorus should be considered but even higher priority should be put on ensuring adequate water treatment for stormwater discharges from new development. The Ford Brook watershed is likely to experience significant development in the years to come. Most of it is current planned as large lot residential.

Total Phosphorus at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2017 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 (TSS) and Turbidity

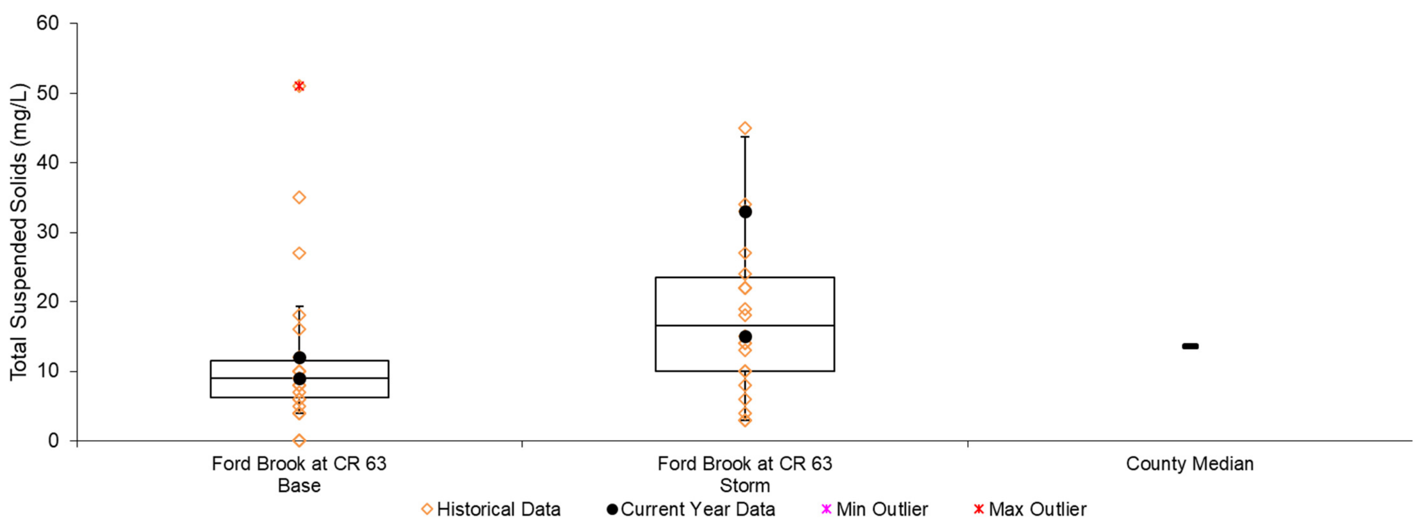
Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by refraction of a light beam passed through a water sample. It is most sensitive to large particles. Total suspended solids are measured by filtering solids from 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 Ford Brook, both TSS and turbidity are generally low, though considerably higher during storm events than baseflow. Overall, the levels observed are similar to other streams in the region, below (better than) State water quality standards, and not a significant management concern.

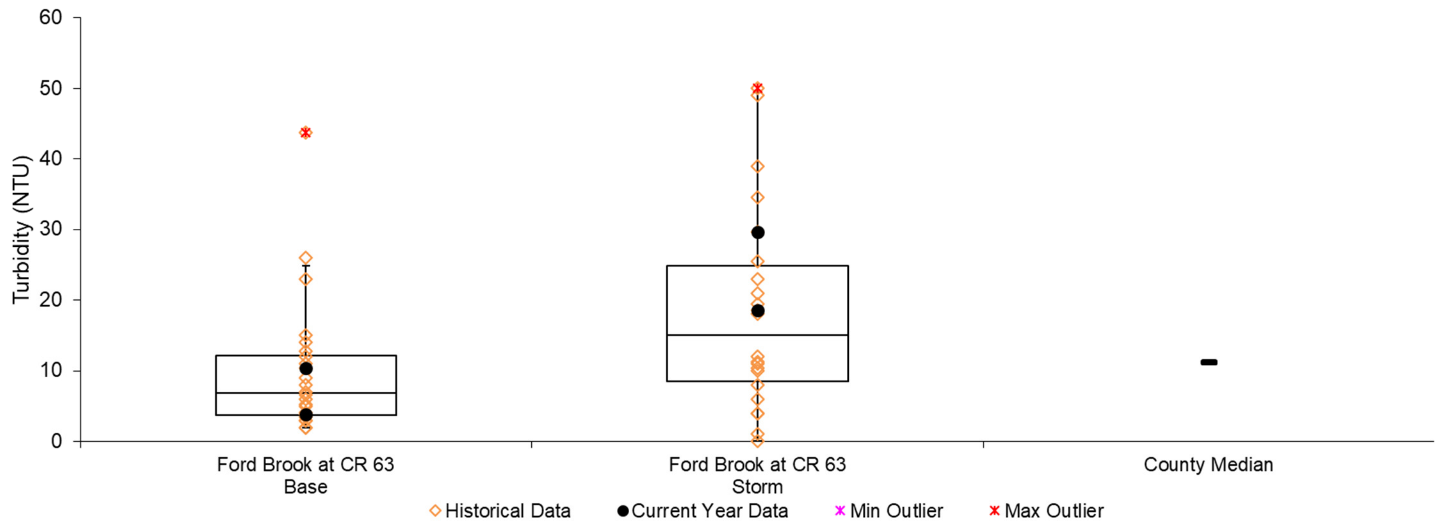
Median turbidity for Ford Brook during baseflow (all years) is 6.8 NTU. Turbidity during storm events is has a median (all years) of 15 NTU. The countywide median for all streams is 8.5 NTU for all conditions. In 2017, one of four readings exceeded the MPCA's water quality threshold of 25 NTU, after two of five eclipsed in in 2016.

Average TSS in 2017 was 17.25 mg/L, and the long term median for all conditions is 10 mg/L. The highest TSS measurement in 2017 was 33 mg/L. The State TSS water quality standard is that no more than 10% of samples should exceed 30 mg/L. Ford Brook's TSS and turbidity appear to be better than State standards.

Total Suspended Solids at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



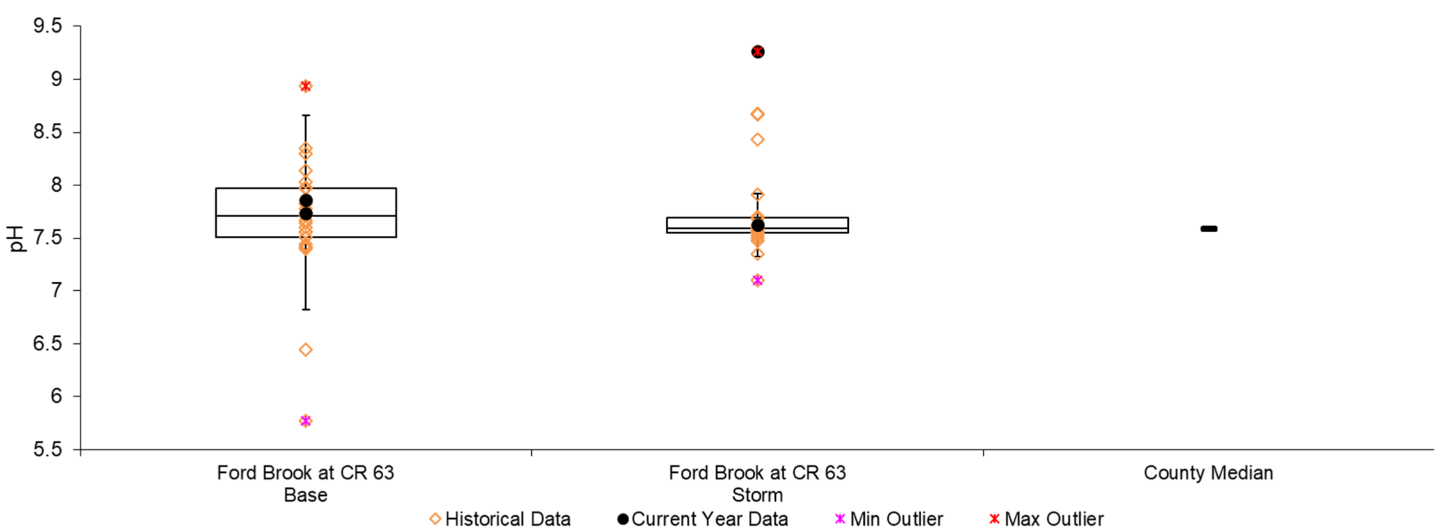
Turbidity at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

pH refers to the acid or base nature of the water. The Minnesota Pollution Control Agency's water quality standard is for pH to be between 6.5 and 8.5. Three of the four pH readings taken in 2017 were within the State standard range of 6.5-8.5. One storm flow sample had a pH of 9.26, the highest pH ever recorded in Ford Brook. While occasional readings outside of this range have occurred in previous years, they were not large departures that generated concern.

pH at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

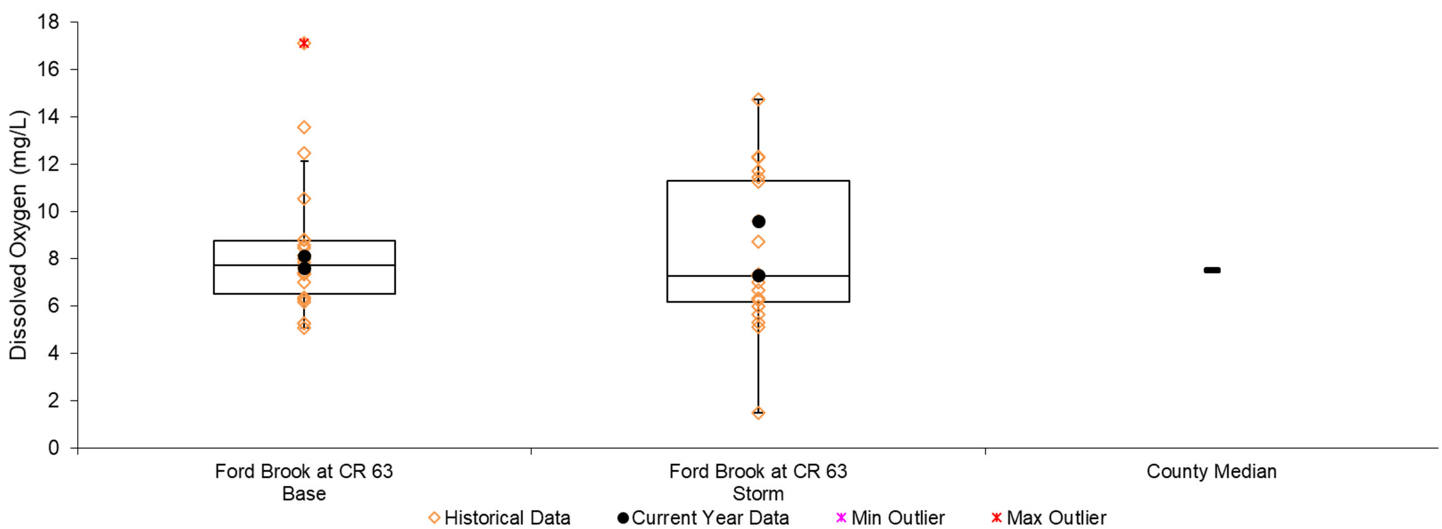


Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution causes oxygen to be consumed when it decomposes. If oxygen levels fall below the state standard of 5 mg/L, aquatic life begins to suffer.

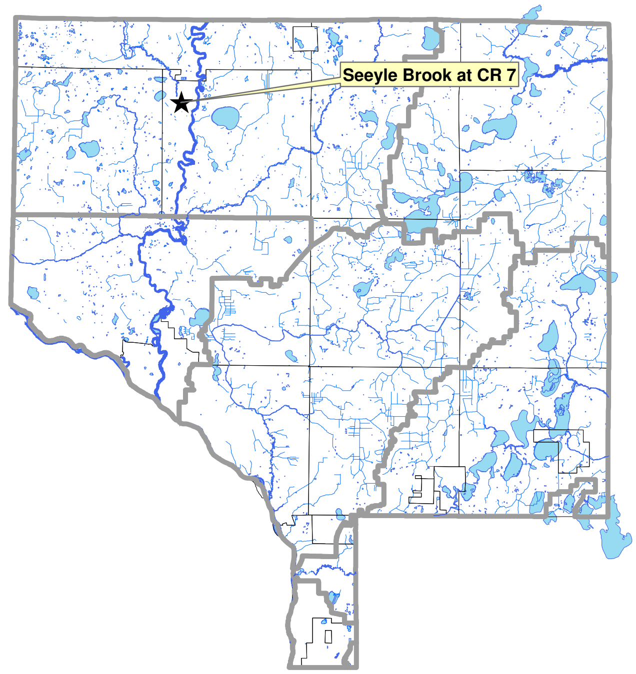
Dissolved oxygen in Ford Brook was within acceptable levels. None of the samples collected in 2017 were below the 5 mg/L State standard, when aquatic life suffers.

Dissolved Oxygen at Ford Brook. Orange diamonds are historical data from previous years and black circles are 2017 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

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. Aside from the bridge footings and concrete-grouted stone around the bridge, the stream at this location has a sandy bottom. This site experiences scour during high water because flow is constricted under the bridge. Banks are steep and undercut.

Results Summary

This report includes data from 2017 and an overview of previous year's data. The following is a summary of results.

- Dissolved constituents, as measured by conductivity have been rising in recent years, particularly during baseflow conditions. The baseflow median conductivity since 2014 is 0.515 mS/cm, pre-2014 baseflow median conductivity was 0.397 mS/cm. These levels are becoming concerning, and it is likely that chlorides are a cause and following suit; thus they should be monitored as well.
- Phosphorous remain at concerning levels and again averaged above the MPCA water quality standard of 100 µg/L. Seelye Brook often exceeds the limit, even during baseflow periods. Phosphorous in Seelye Brook averaged 108.25 µg/L (maximum of 151 µg/L and a minimum of 50 µg/L) in 2017.
- Suspended solids and turbidity remain quite low in Seelye Brook compared to other streams. Both parameters had an elevated reading and a very low reading. Turbidity averaged 7.65 NTU while TSS averaged 8.5 mg/L.
- Dissolved oxygen was within the healthy range for a stream. DO averaged 7.79 mg/L (maximum of 8.75 mg/L and a minimum of 6.70 mg/L).
- pH on average was within the range considered normal and healthy for streams in this area, averaging 8.07. A record high reading of 9.14 was recorded in 2017, but this is not a recurring problem in Seelye Brook.

			4/20/2017	5/18/2017	6/7/2017	7/17/2017				
	Units	R.L.*	Results	Results	Results	Results	Median	Average	Min	Max
pH		0.1	7.53	9.14	7.80	7.81	7.81	8.07	7.53	9.14
Conductivity	mS/cm	0.01	0.313	0.382	0.539	0.522	0.45	0.439	0.313	0.539
Turbidity	NTU	1	6.2	15.2	8.0	1.3	7.10	7.68	1.30	15.20
D.O.	mg/L	0.01	8.75	6.70	8.43	7.26	7.85	7.79	6.70	8.75
D.O.	%	1	75.7	63.9	88.2	83.6	79.65	77.9	63.9	88.2
Temp.	°C	0.1	7.58	13.29	18.33	20.78	15.81	15.0	7.6	20.8
Salinity	%	0.01	0.15	0.18	0.17	0.25	0.18	0.19	0.15	0.25
T.P.	ug/L	10	50	129	151	103	116.00	108	50	151
TSS	mg/L	2	<2	16	12	4	12.00	8.5	<2	16.0
Secchi-tube	cm			89.00	91	>100	90.00	>90	89	>100
Appearance			Clear, Tanin Tinted	Murky	Clear	Clear				

*reporting limit

Conductivity

Conductivity is a broad measure of dissolved constituents in water. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Dissolved pollutant sources include urban road runoff, industrial chemicals, deicing salts and others. Overall, baseflow conductivity in Seelye Brook is moderately high and rising.

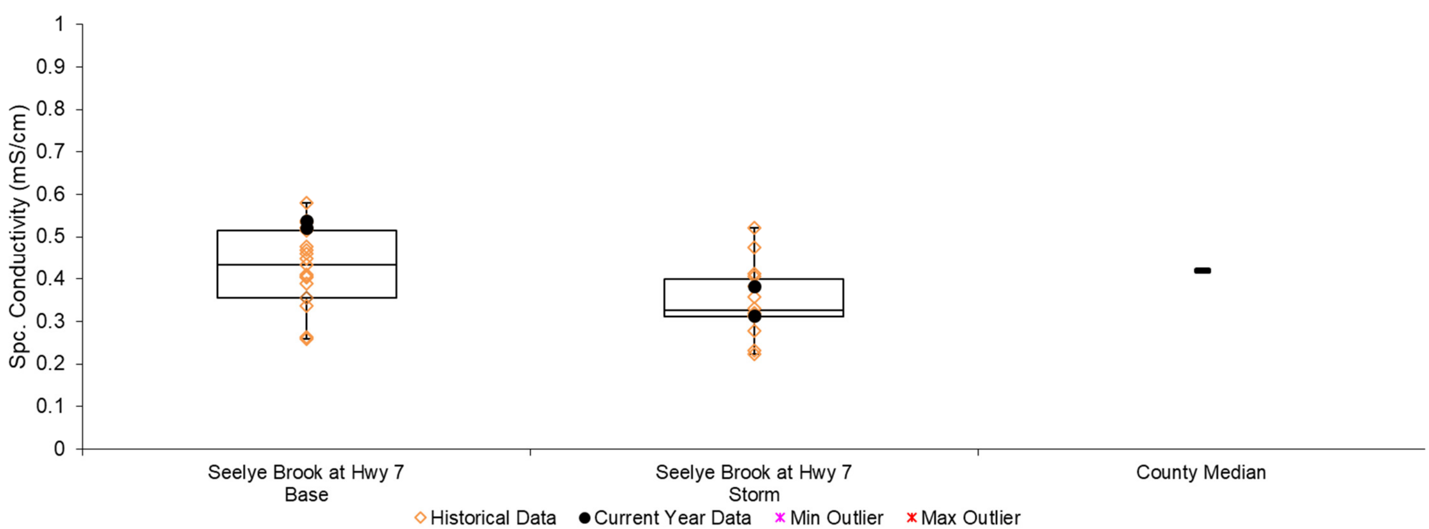
Conductivity has historically been low in Seelye Brook at Hwy 7, but has increased during baseflow conditions in recent years. Median conductivity (all years) is 0.433 mS/cm during baseflow and 0.325 mS/cm during storm events. The overall median for all conditions is 0.403 mS/cm, just below the median for Anoka County streams of 0.420 mS/cm, which includes many streams in very highly urbanized areas. Since August of 2014, however, the median baseflow conductivity is 0.515 mS/cm. Both of the 2017 baseflow samples were at the upper quartile of historical samples, both exceeding 0.5 mS/cm.

The baseflow vs storm flow comparison lends some insight into the pollutant sources. If dissolved pollutants were only elevated during storms, stormwater runoff would be suspected as the primary contributor. If dissolved pollutants were highest during baseflow, pollution of the shallow groundwater which feeds the stream during baseflow would be suspected to be a primary contributor. In Seelye Brook we find lower dissolved pollutants during storms. In other words, both stormwater runoff and groundwater are sources of dissolved pollutants, with shallow groundwater contributing more. While storms dilute some of the baseflow pollutants, they also carry additional pollutants, which can offset the dilution.

A likely cause of the increase in conductivity in streams is chlorides from road salting. Water softener discharge or dissolved pollutants can also contribute. These salts both runoff into the water and infiltrate into the shallow groundwater that feeds the stream during baseflow. WMOs should consider periodic chloride sampling to assess the contribution of salts to the dissolved pollutant load.

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. Training and equipment that minimize road salting while keeping roads safe is being increasingly emphasized by watershed managers throughout the region.

Conductivity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



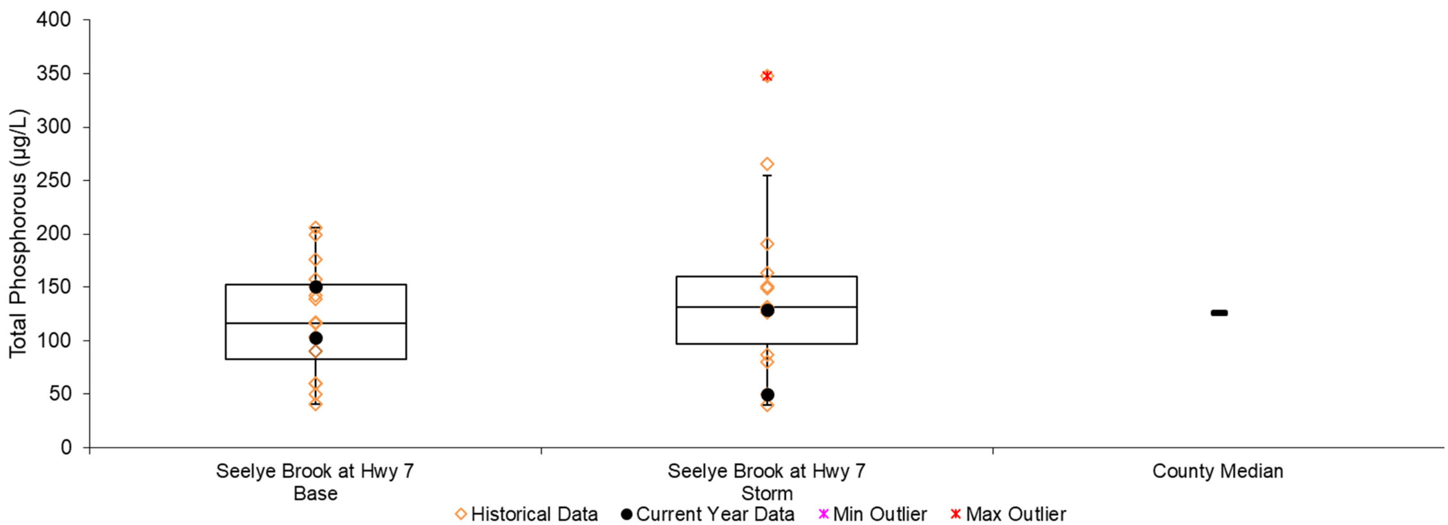
Total Phosphorus

Total phosphorus concentrations in Seelye Brook in 2017 were lower than in recent years, though still averaged over the State water quality standard of 100 µg/L (108.25 µg/L). This nutrient is one of the most common pollutants in our region and can be associated with runoff from various sources. The median phosphorus concentration at Seelye Brook at Hwy 7 (all years) is 116.5 µg/L during baseflow and 131 µg/L during storm events. Only one of sixteen samples taken since June of 2014 has resulted in TP concentrations below the state water quality standard of 100 µg/L, with some samples doubling the standard.

The benefits of a recent upgrade to the City of St. Francis wastewater plant are unclear in this data. The new plant went online in April 2017 with new nutrient reduction technologies. The new plant discharges entirely to Seeyle Brook; previously there were discharges to both Seelye Brook and the Rum River.

Phosphorus in Seelye Brook is at concerning levels and should continue to be an area of pollution control effort as the area urbanizes. Cooperative efforts with Isanti County and Isanti Soil and Water Conservation District would likely be helpful, given that Seelye Brook originates in Isanti County.

Total phosphorus during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 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)

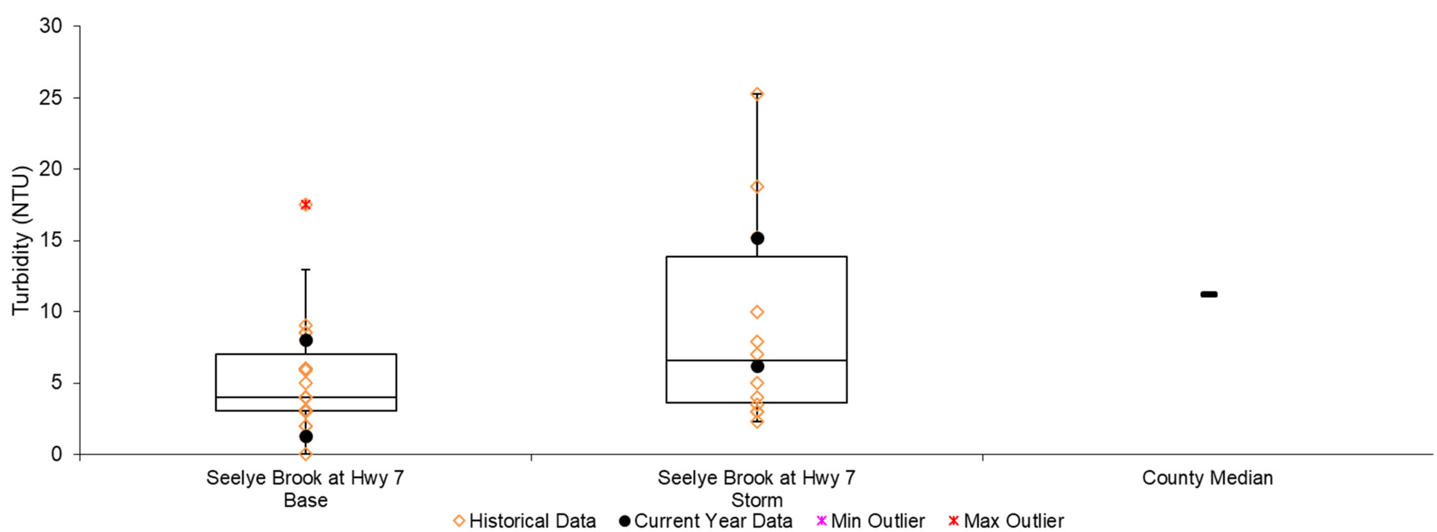
Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by refraction of a light beam passed through a water sample. It is most sensitive to large particles. Total suspended solids are measured by filtering solids from 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. Turbidity and TSS are low in Seelye Brook, and there are no management concerns at this time.

Overall, turbidity in Seelye Brook remains low compared to other streams with its highest reading ever recorded last year in 2016 of just 25.3 NTU. The median turbidity (all years) is 4.0 NTU during baseflow and 6.6 NTU during storm events, both lower than the median for Anoka County streams of 8.5 NTU. The State water quality standard is 25 NTU.

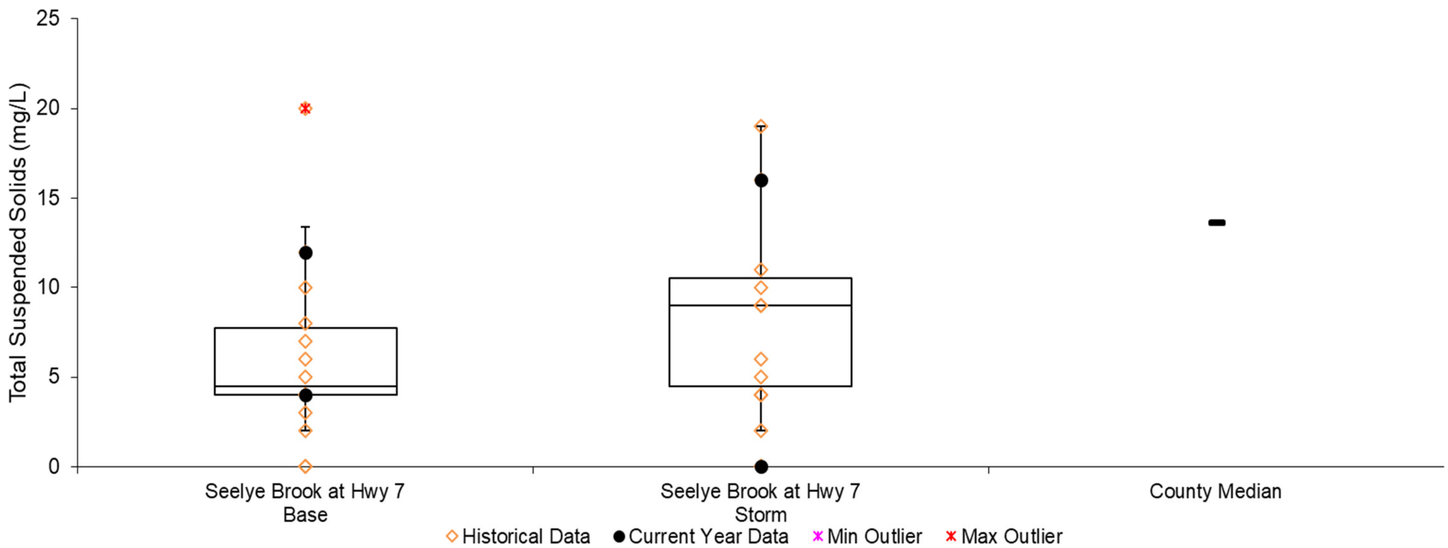
TSS concentrations in 2017 were similarly low. The median TSS concentration in Seelye Brook during baseflow conditions was 4.0 mg/L and the storm flow median was just 5.5 mg/L. These medians, along with the historical average of 6.6 mg/L are well below the state water quality standard of 30 mg/L.

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

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 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 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

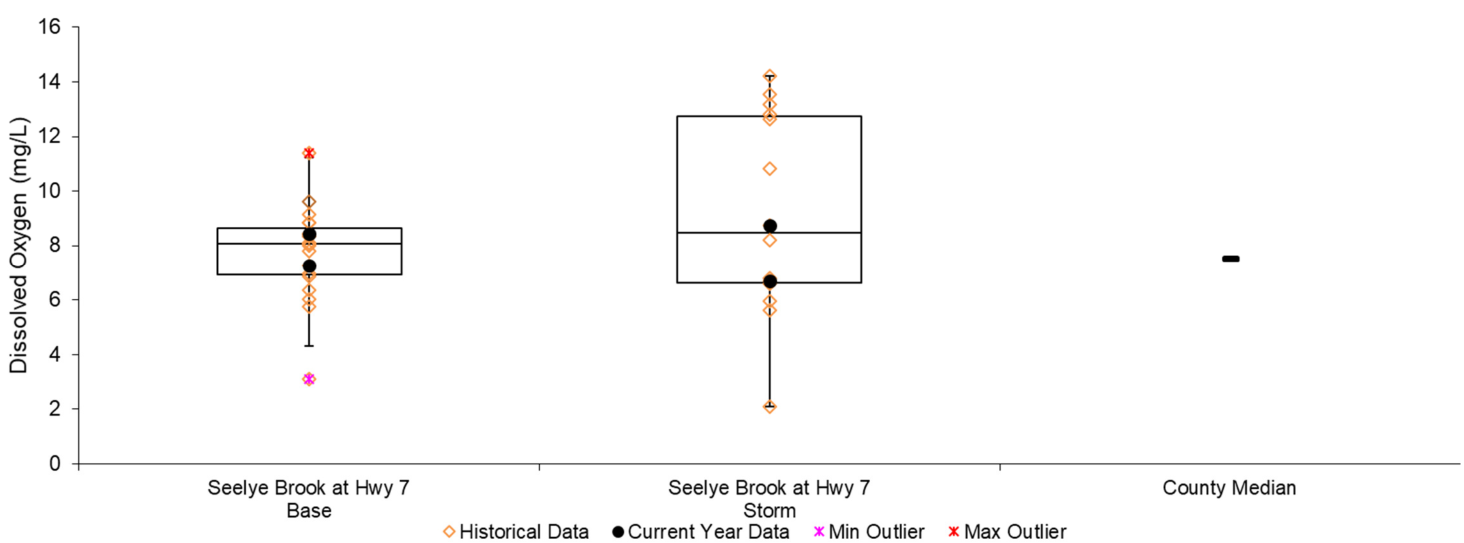


Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution causes oxygen to be consumed when it decomposes. If oxygen levels fall below the state standard of 5 mg/L, aquatic life begins to suffer.

Seelye Brook's dissolved oxygen levels are typically well above 5 mg/L, and 2017 was no exception. Median dissolved oxygen (all years) is 8.08 mg/L during baseflow and 8.48 mg/L during storm events. The average dissolved oxygen concentration in 2017 was 7.79 mg/L with a minimum reading of 6.70 mg/L.

Dissolved oxygen during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

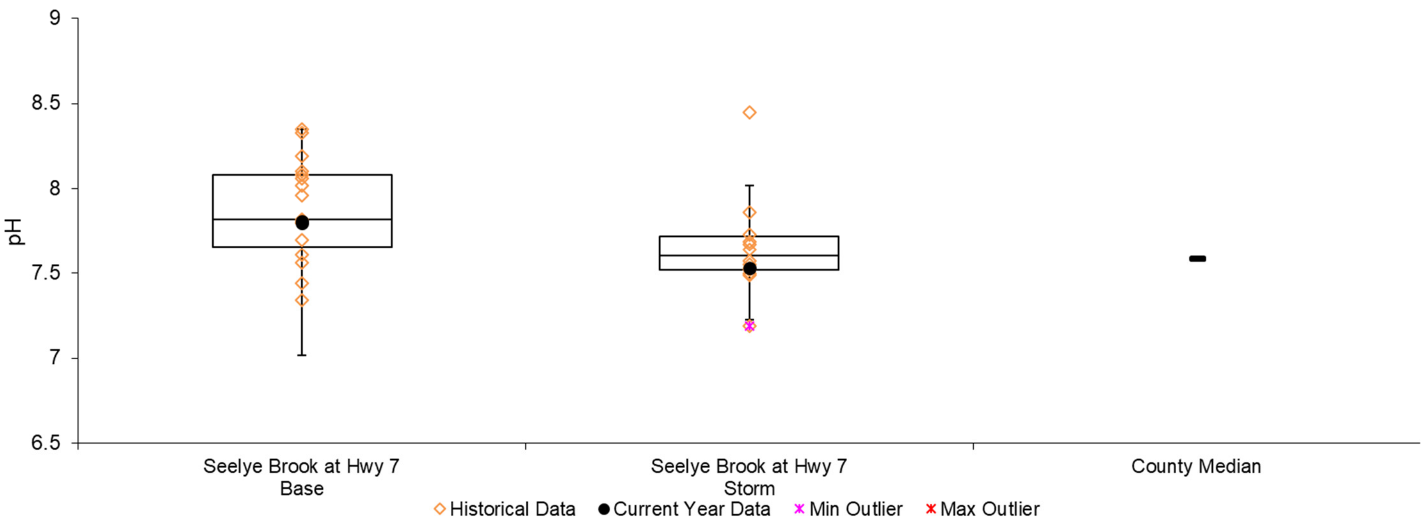


pH

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 had not exceeded this range during any of the years the ACD has sampled it until 2017. A high pH reading of 9.14 was recorded during a storm flow in 2017. This high reading is an exception and an outlier, especially during a storm flow event, for Seelye Brook. It is not a concern unless additional similar readings are found in the future.

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

pH during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Wetland Hydrology

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

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

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

Cedar Creek, Cedar Creek Natural History Area, East Bethel

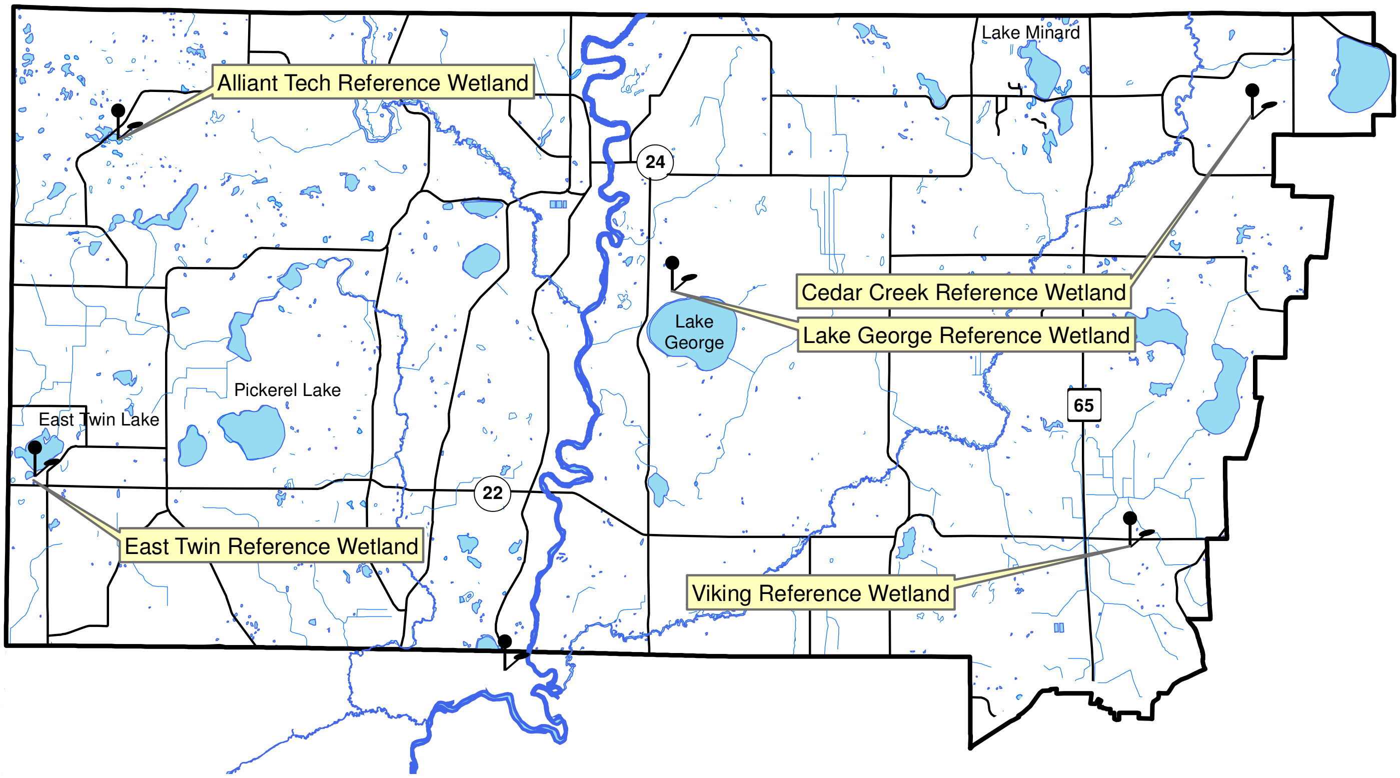
East Twin Reference Wetland, East Twin Township Park, Nowthen

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

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

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

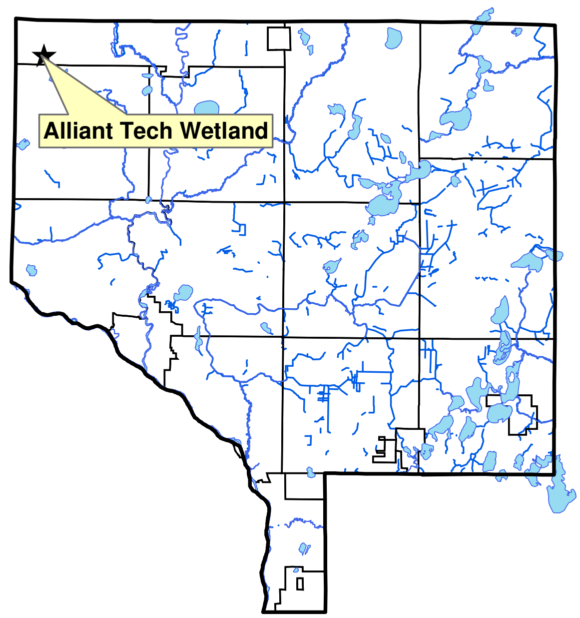
Upper Rum River Watershed Wetland Hydrology Monitoring Sites



ALLIANT TECH REFERENCE WETLAND

Alliant Techsystems Property, St. Francis

Site Information



Monitored Since: 2001

Wetland Type: 5

Wetland Size: ~12 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

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

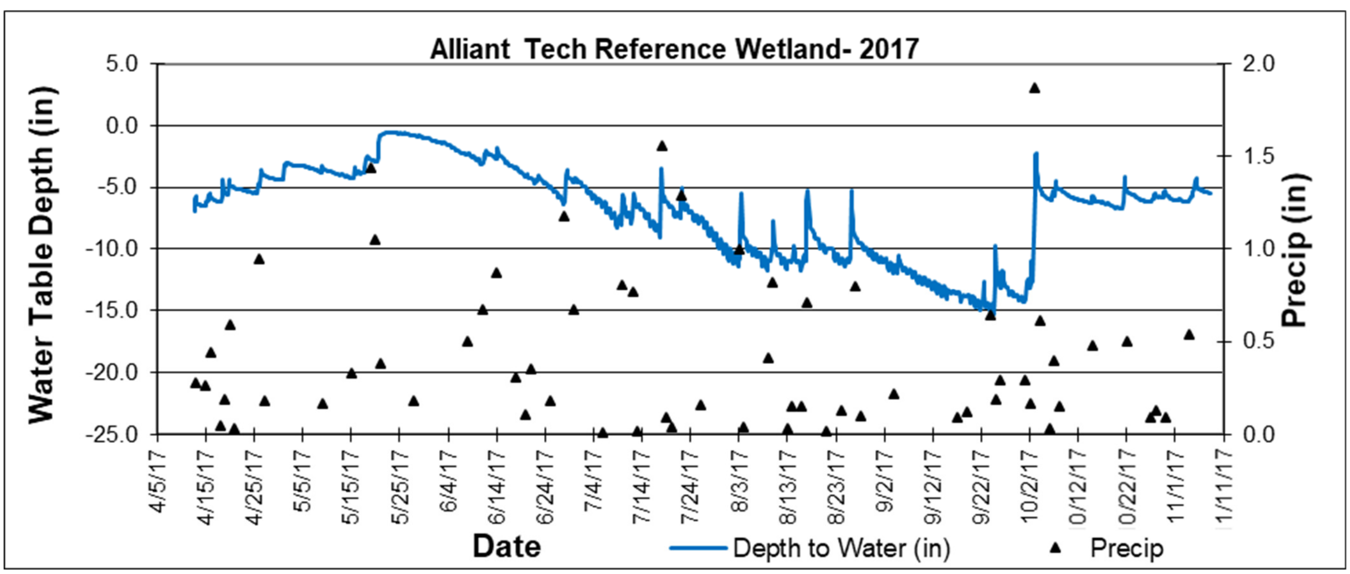
Surrounding Soils: Emmert

Vegetation at Well Location:

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

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

2017 Hydrograph

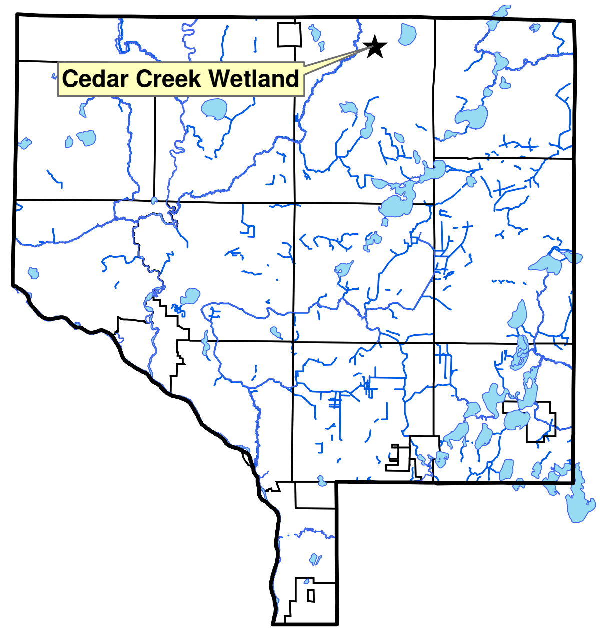


Wetland Hydrology Monitoring

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

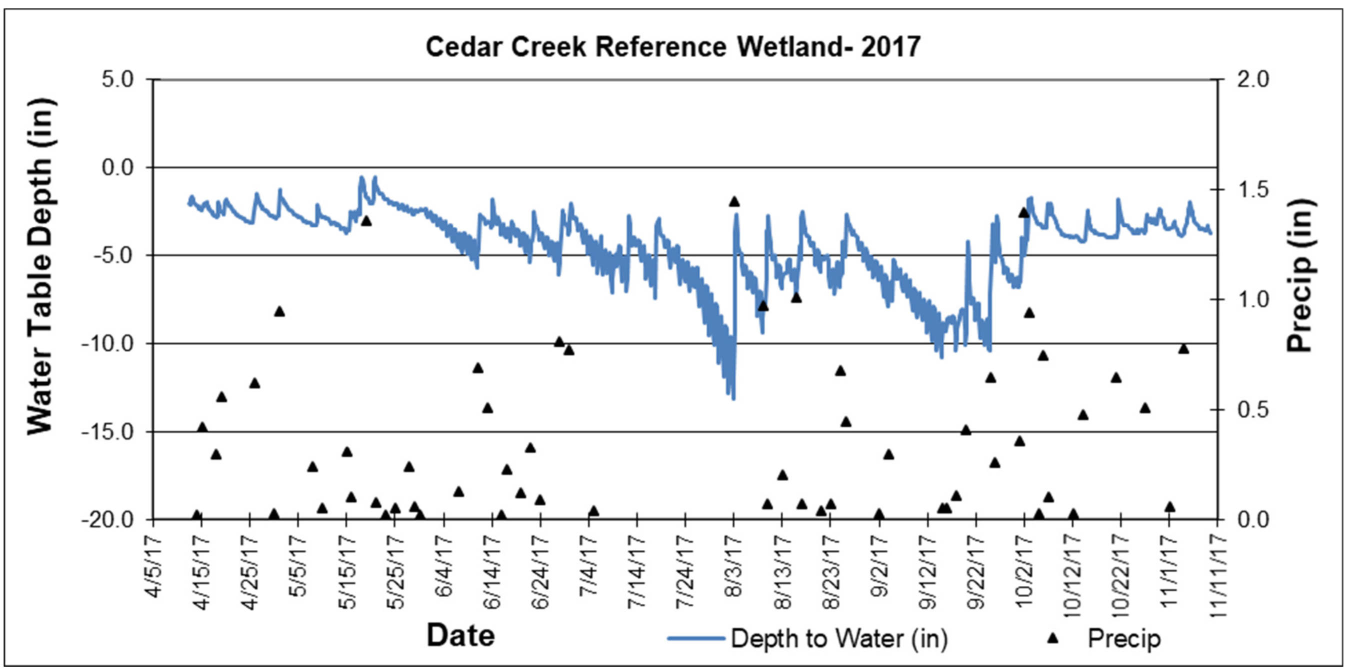
Soils at Well Location: not yet available

Surrounding Soils: Zimmerman

Vegetation at Well Location: not yet available

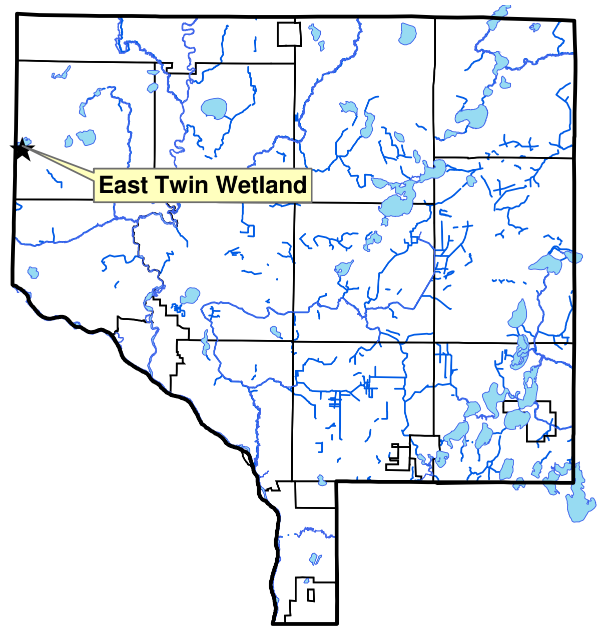
Other Notes: The Cedar Creek Ecosystem Science Reserve, where this wetland is located, is a University of Minnesota research area. Much of this area, including the area surrounding the monitoring site, is in a natural state. This wetland probably has some hydrologic connection to the floodplain of Cedar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

2017 Hydrograph



East Twin Reference Wetland

East Twin Lake Township Park, Nowthen



Site Information

Monitored Since: 2001

Wetland Type: 5

Wetland Size: ~5.9 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

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

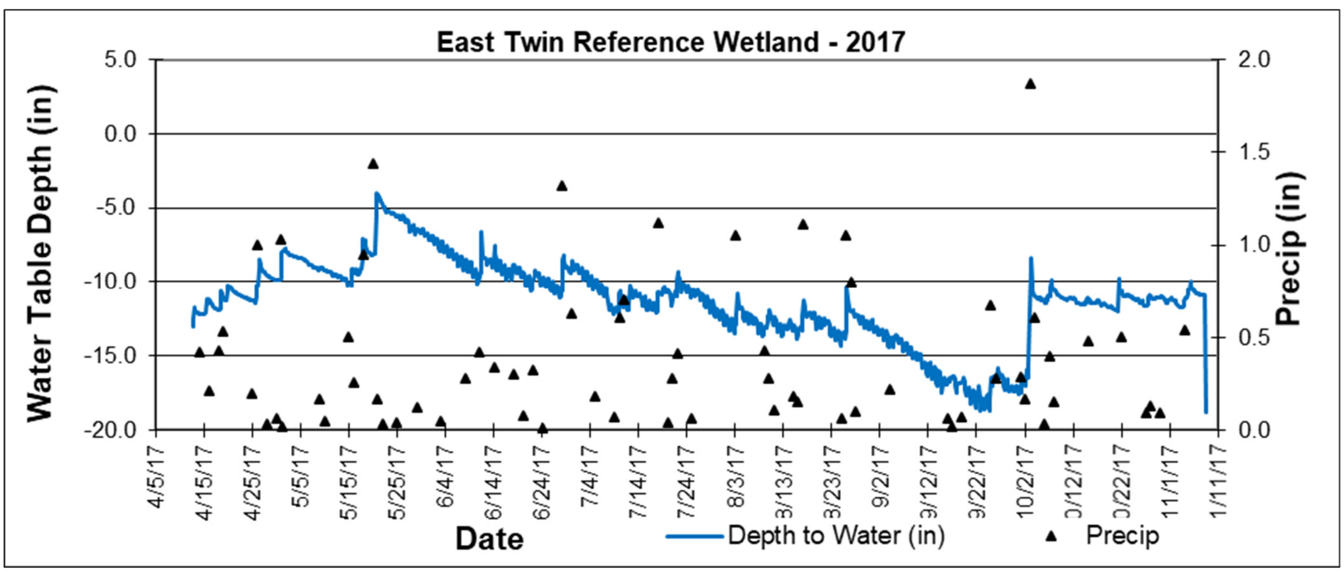
Surrounding Soils: Lake Beach, Growton and Heyder fine sandy loams

Vegetation at Well Location:

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

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

2017 Hydrograph

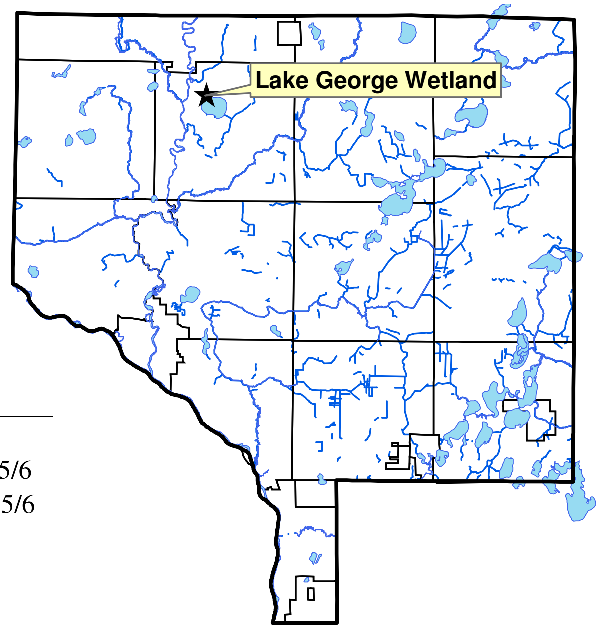


Wetland Hydrology Monitoring

LAKE GEORGE REFERENCE WETLAND

Lake George County Park, Oak Grove

Site Information



Monitored Since: 1997

Wetland Type: 3/4

Wetland Size: ~9 acres

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

Connected to a Ditch? No

Soils at Well Location:

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

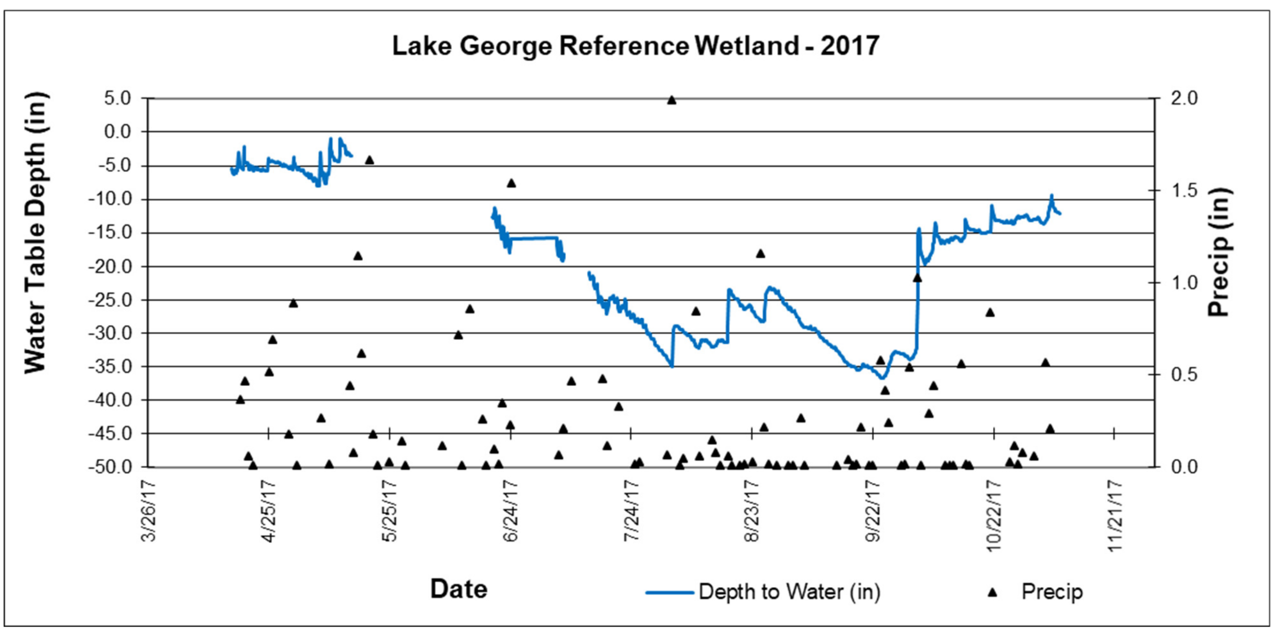
Surrounding Soils: Lino loamy fine sand and Zimmerman fine sand

Vegetation at Well Location:

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

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

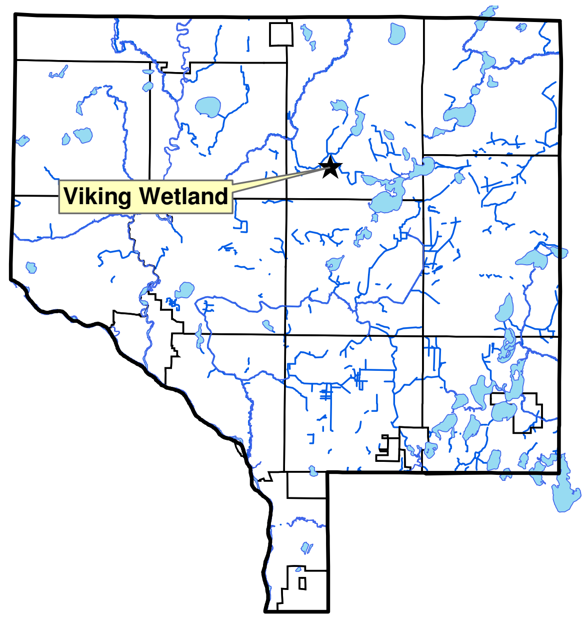
2017 Hydrograph



Wetland Hydrology Monitoring

VIKING MEADOWS REFERENCE WETLAND

Viking Meadows Golf Course, East Bethel



Site Information

Monitored Since: 1999

Wetland Type: 2

Wetland Size: ~0.7 acres

Isolated Basin? No

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

Soils at Well Location:

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

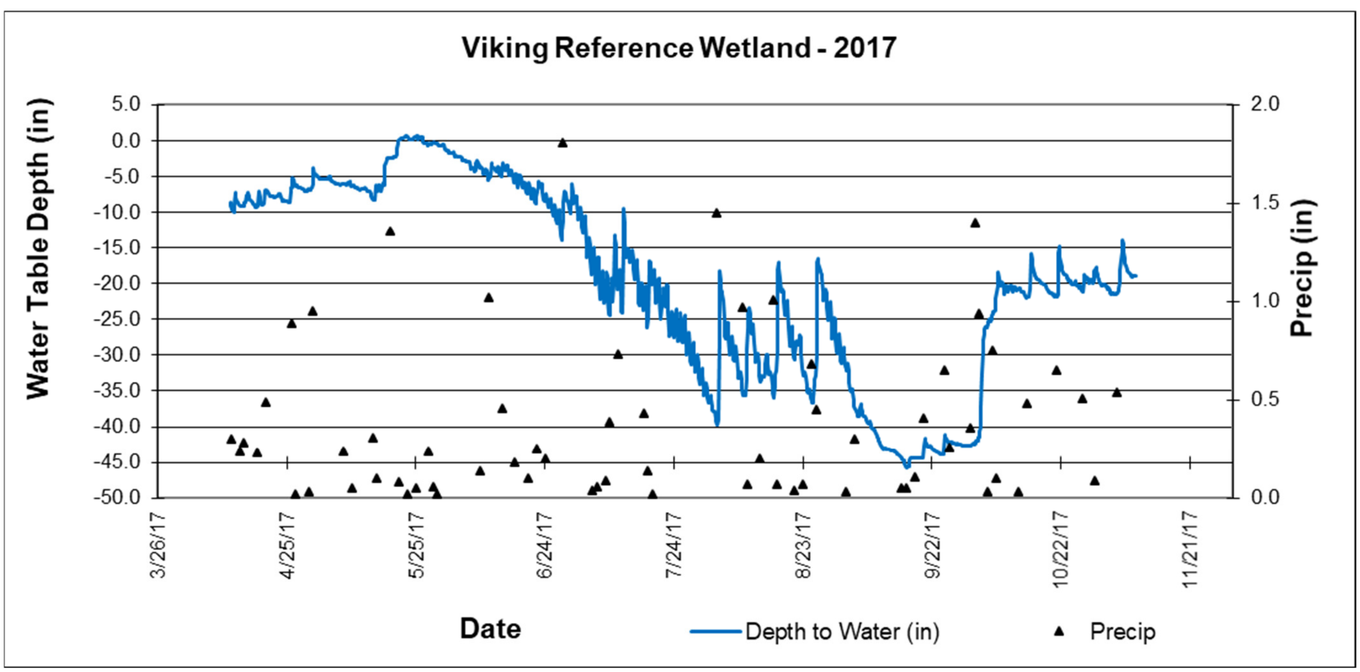
Surrounding Soils: Zimmerman fine sand

Vegetation at Well Location:

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

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

2017 Hydrograph



Lake George Stormwater Retrofit Analysis – Interim Study Report

Description: Lake George is a premier recreation lake in Anoka County. Water quality, especially Secchi transparency, has been declining in Lake George in the past decade. The Lake George Improvement District, Lake George Conservation Club and Anoka Conservation District have partnered on a State Clean Water Fund grant to determine the sources of pollution to Lake George and identify specific projects to correct the lake water quality decline. Study components include monitoring, modeling, project identification and project cost effectiveness ranking. Final work products include a prioritized list of projects and concept designs.

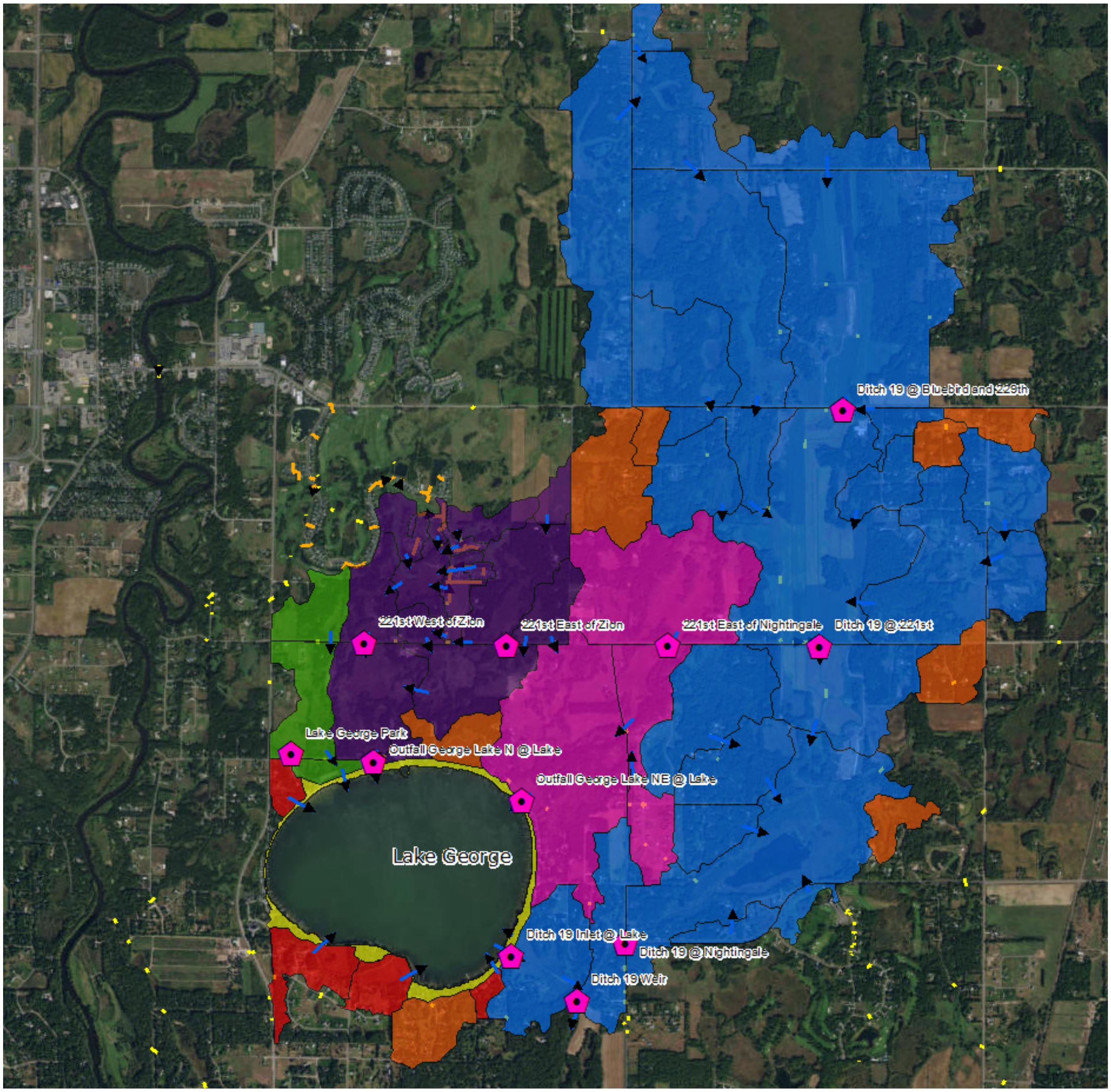
Purpose: To guide managers to the most cost effective approaches of stopping the decline in Lake George water quality and assist in securing grant funds for project installations.

Results: In 2016 and 2017 all inlets and outlets of the lake were subject to hydrologic and water quality monitoring. Nine sites total were monitored. In late 2017 this data was used to build and calibrate a computer hydrologic model of the watershed. GIS and field reviews have identified 11 possible water quality projects which will be modeled in 2018.

Discussion: As of February 2018, general observations include:

- During wetter years, the direct tributary wetlands are likely discharging more, and their discharge into the lake tends to be tannin stained. This can contribute to a decline in lake water clarity.
- The decline in transparency appeared to start around 2010 (or slightly before) which coincides with the increase in lake levels.
- During drier years, when tributary wetlands may be discharging less, lake clarity is generally better.
- Water quality in County Ditch 19 is generally better than the other tributaries. Whether water from County Ditch 19 flows into the lake, or the lake outflows to the ditch, is controlled by a State-owned weir. That weir is deteriorated – the weir is lower than originally constructed due to rust. The lower weir level would contribute to less frequent inflow of Ditch 19 water into Lake George. In this scenario, a disproportionately large part of the lake's water budget is from the other tributaries that have poorer water quality.
- Possible approaches to correct the situation include rehabilitation of the County Ditch 19 weir (planned by the State in 2018-19), hydraulic restorations of the direct tributary wetlands and/or smaller projects throughout the watershed that reduce nutrients reaching the lake. 11 possible water quality projects sites are being explored.

These observations are preliminary only. Final reporting is expected by December 31, 2018.



Lake George watershed and subcatchments as modeled for the Lake George Targeted BMP Analysis. Water monitoring sites are shown as hexagons.

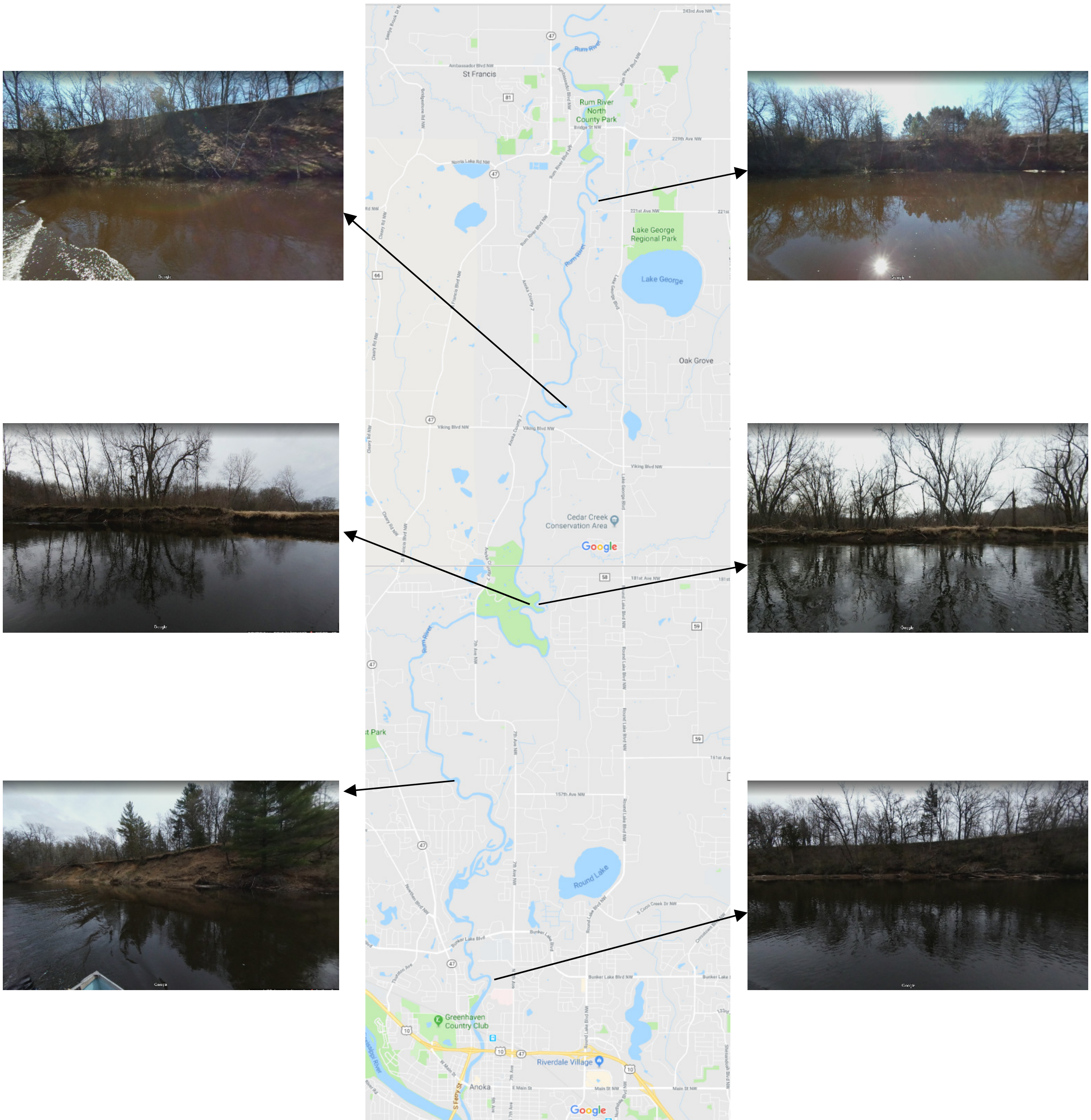
Rum River 360^{O} Photo Inventory

Description: The Anoka Conservation District performed a full 360^{O} photo inventory of bank conditions on the Rum River throughout Anoka County in the spring of 2017. This photo inventory was uploaded to Google Maps and is available to the public.

Purpose: To create a photo inventory of bank conditions to be used to guide future restoration projects and track bank condition changes in the future.

Location: Rum River through Anoka County

Results: 360^{O} images are available on Google Maps Street View. The user is able to zoom down to water level and pan around the full 360^{O} to view the River and bank conditions.



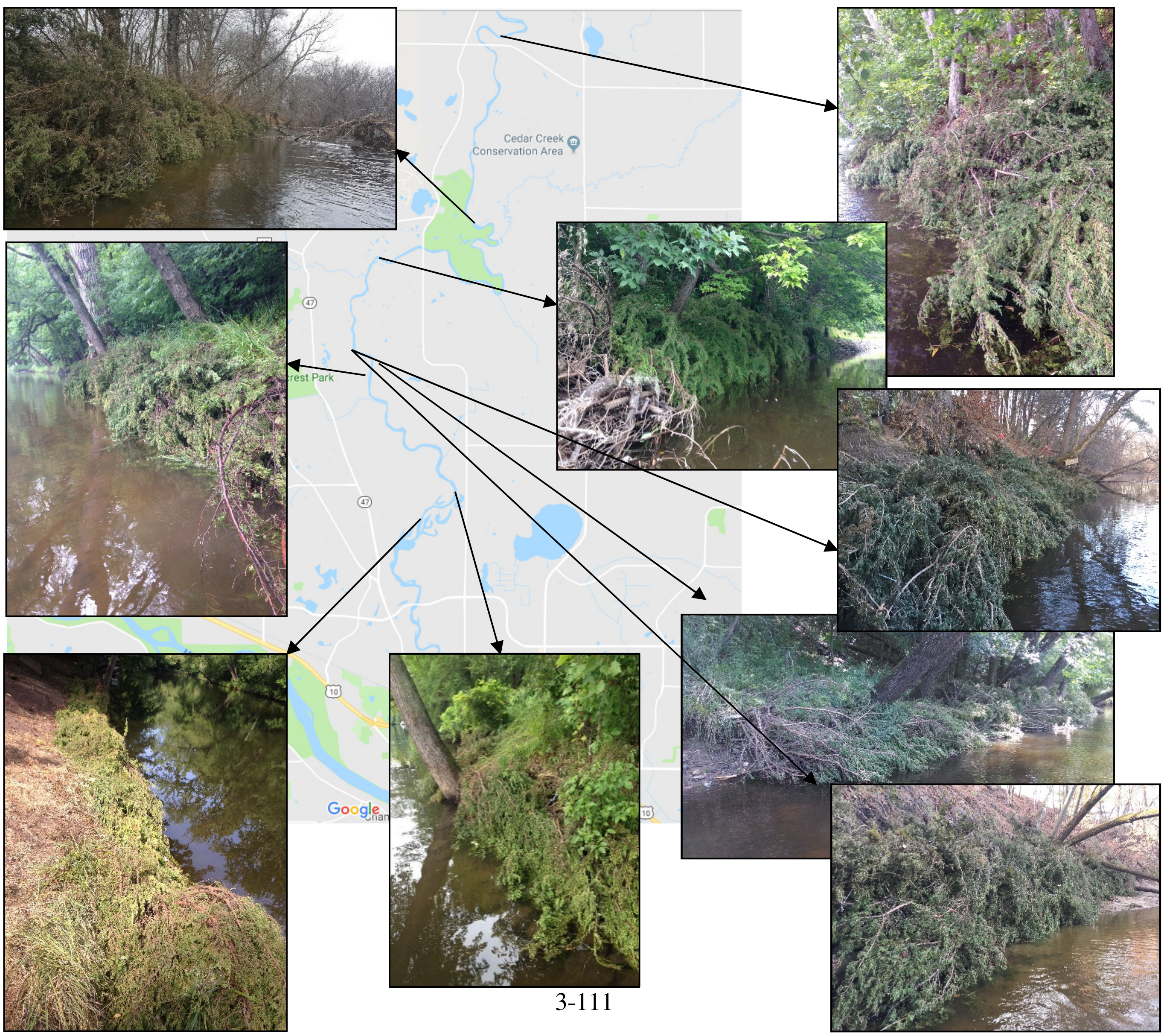
Rum River Bank Stabilizations

Description: 12 riverbank stabilization projects were installed on the Rum River in Anoka and Isanti Counties in 2017. At these sites, cedar tree revetments and willow stakes were used to stabilize eroding banks. The projects were installed in partnership with the Conservation Corps Minnesota (CCM). Funding for the 9 Anoka County projects came from the Conservation Partners Legacy Grant Program from the MN DNR. Another grant supported by the MN Clean Water Fund provided construction crew labor from the Conservation Corps of Minnesota. Other funding came from the Upper and Lower Rum River Watershed Management Organizations and landowners. Funding for 3 revetments in Isanti County came from the Lessard-Sams Outdoor Heritage Council, a Clean Water Fund CCM crew labor grant and landowner contribution.

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

Location: Rum River Central Regional Park, 8 residential properties in Anoka County, City of Isanti park, and 2 residential properties in Isanti County.

Results: Stabilized 2,223 linear feet of riverbank on the Rum River in Anoka and Isanti Counties.



Water Quality Grant Fund

Description: Through 2017 the Upper River Watershed Management Organization (URRWMO) partnered with the Anoka Conservation District's (ACD) Water Quality Cost Share Program. The URRWMO contributed funds to be used as cost share grants for projects that improve water quality in lakes, streams, or rivers within the URRWMO area. The ACD provides administration of the grants. Grant awards follow ACD policies and generally cover 50% or 70% of materials cost (see ACD website for full policies).

In early 2017 the URRWMO decided to discontinue this program. It directed that the balance of program funds be allocated to Rum Riverbank stabilization projects planned in 2017 through the Anoka Conservation District's Cedar Tree Revetment project. That program installed two projects in the URRWMO in 2017.

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

Locations: Throughout the watershed.

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

URRWMO Cost Share Fund Summary

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

* URRWMO directed ACD to transfer remaining funds into ACD's fund for Rum Riverbank stabilizations using cedar tree revetments. No URRWMO funds remain in this program.

URRWMO Website

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

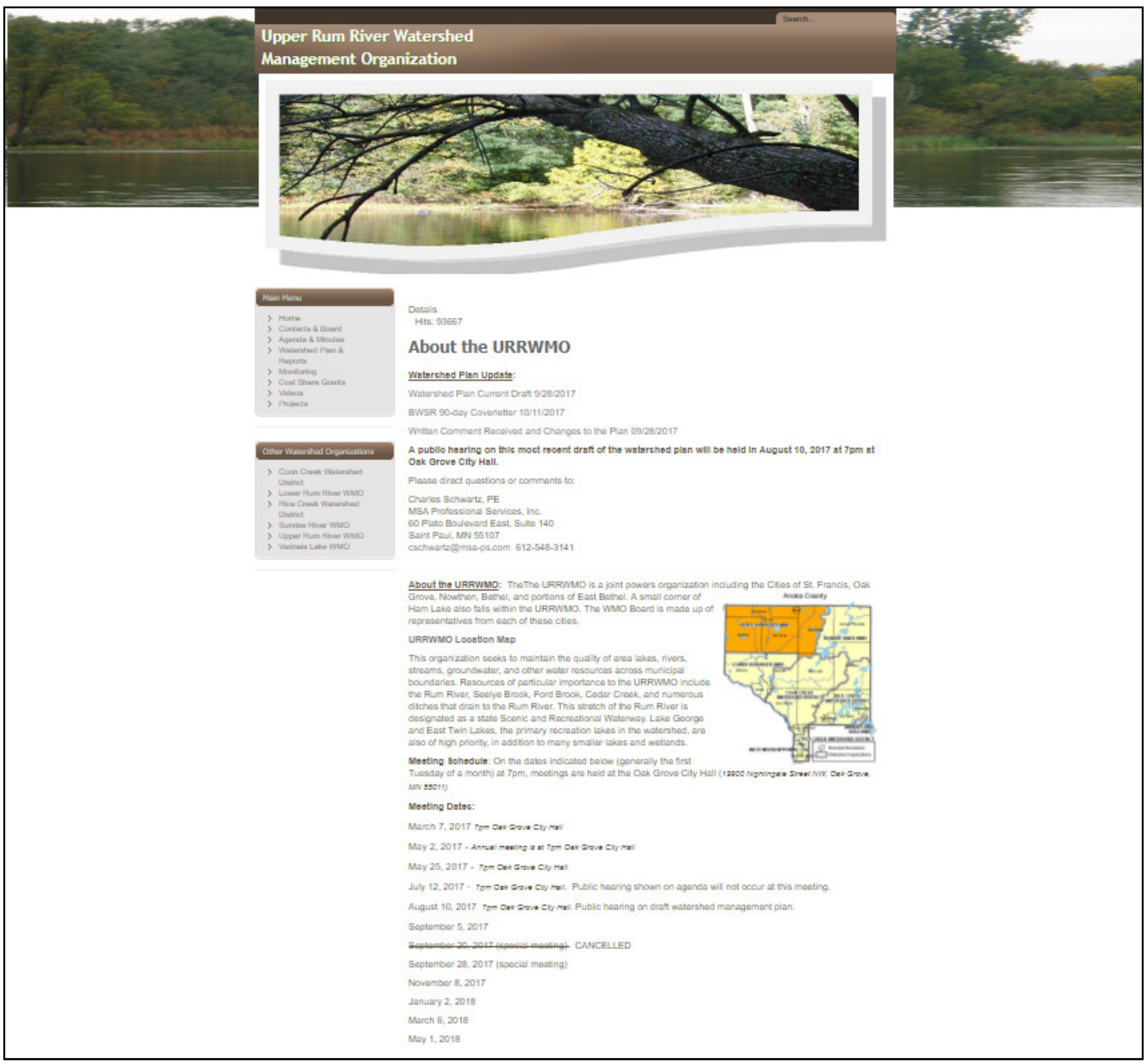
Purpose: To increase awareness of the URRWMO and its programs. The website also provides tools and information that helps users better understand water resources issues in the area.

Location: www.URRWMO.org

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

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

URRWMO Website Homepage



URRWMO Annual Newsletter

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

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

Locations: Watershed-wide.

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

2017 URRWMO Newsletter Article

Upper Rum River
Watershed Management Organization

MEDIA RELEASE

Contact person:	Jamie Schurbon, 763-434-2030 ext. 12
Date:	November 27, 2017

Local Plan for Lakes, Waterways
Near Completion

A new local plan for the Rum River, Lake George and other local waterways is in its final stages. The plan focuses on water quality, but also addresses stormwater management, flood prevention and other topics. Once approved by the State, this management plan outlines projects that will be led by the Upper Rum River Watershed Management Organization (URRWMO) over the next 10 years.

The URRWMO is comprised of representatives from the cities of Bethel, East Bethel, Oak Grove, Nowthen, St. Francis and Ham Lake. Its purpose is to address water management issues which often cross city boundaries. The organization, and its new plan, put emphasis on implementing already-existing rules and finding the highest priority problems upon which to focus limited funding. The plan positions the organization to compete for State water quality grants to fund larger projects. Work outlined in the plan includes water quality improvement projects, fixing shoreline erosion, culvert and stormwater inspections, and regular water quality monitoring.

The Rum River and Lake George are two high priorities in the new plan. The Rum River is in relatively good condition, and a highly valued State Scenic and Recreational River. Phosphorus levels are near, but slightly better than state water quality standards and lower than the median of 34 other Anoka County streams. It will continue to be monitored. Lake George has good water quality for this region of the state, receiving an overall A letter grade, however declining secchi transparency is a concern. East Twin Lake, Pickerel Lake, Seelye Brook, Cedar Creek, Ford Brook and Crooked Brook are some other waterbodies also discussed in the plan.

The plan is being considered by the State for final approvals. The most updated plan draft and information about the URRWMO is available at www.URRWMO.org or contact Chuck Schwartz at 612-548-3141.

URRWMO 2016 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 30^{th}).

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.

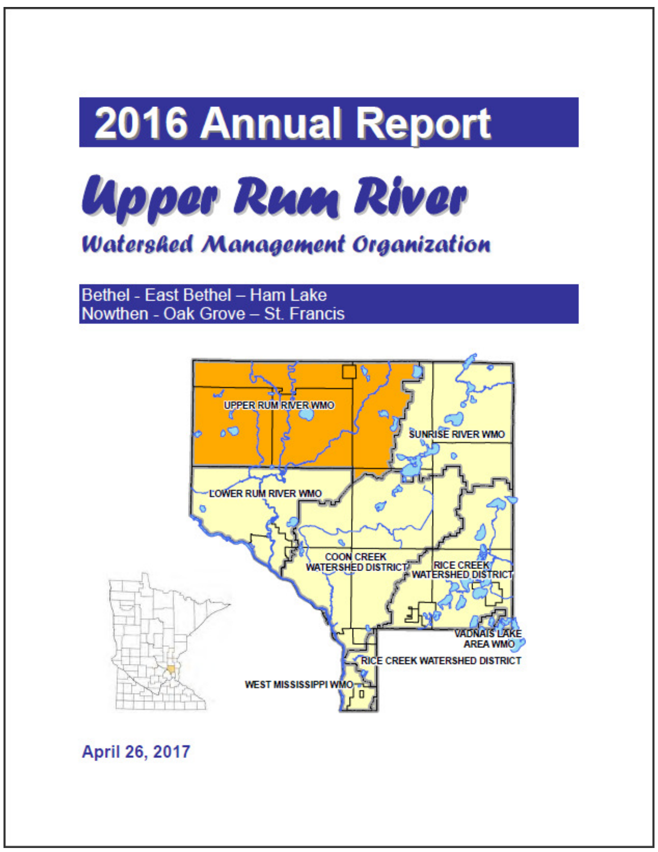
Locations: Watershed-wide

Results: The Anoka Conservation District assisted the URRWMO with preparation of a 2016 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 2017. The report to BWSR and financial report are available on the URRWMO website.

Report to BWSR Cover



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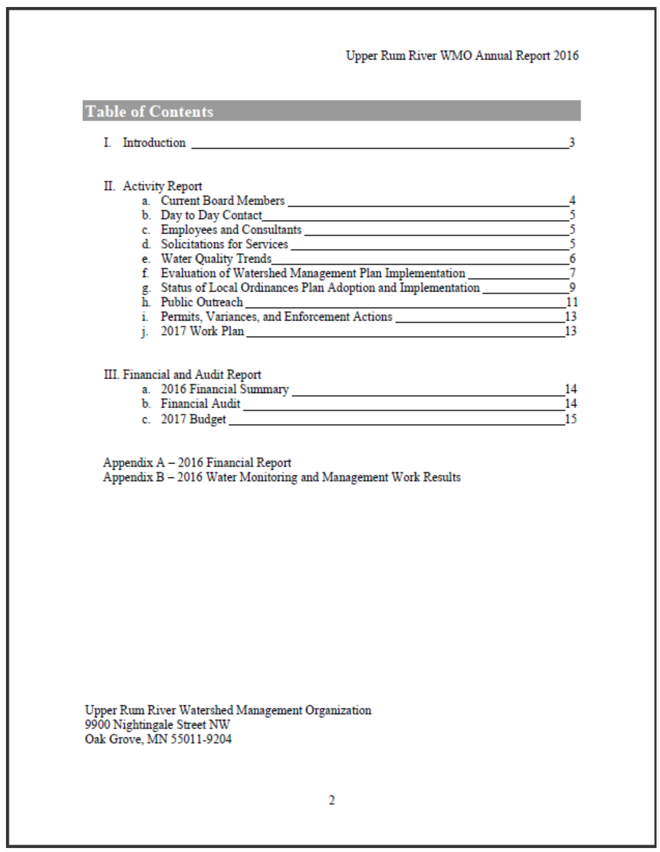
Upper Rum River WMO Annual Report 2016

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Appendix A – 2016 Financial Report
Appendix B – 2016 Water Monitoring and Management Work Results

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.

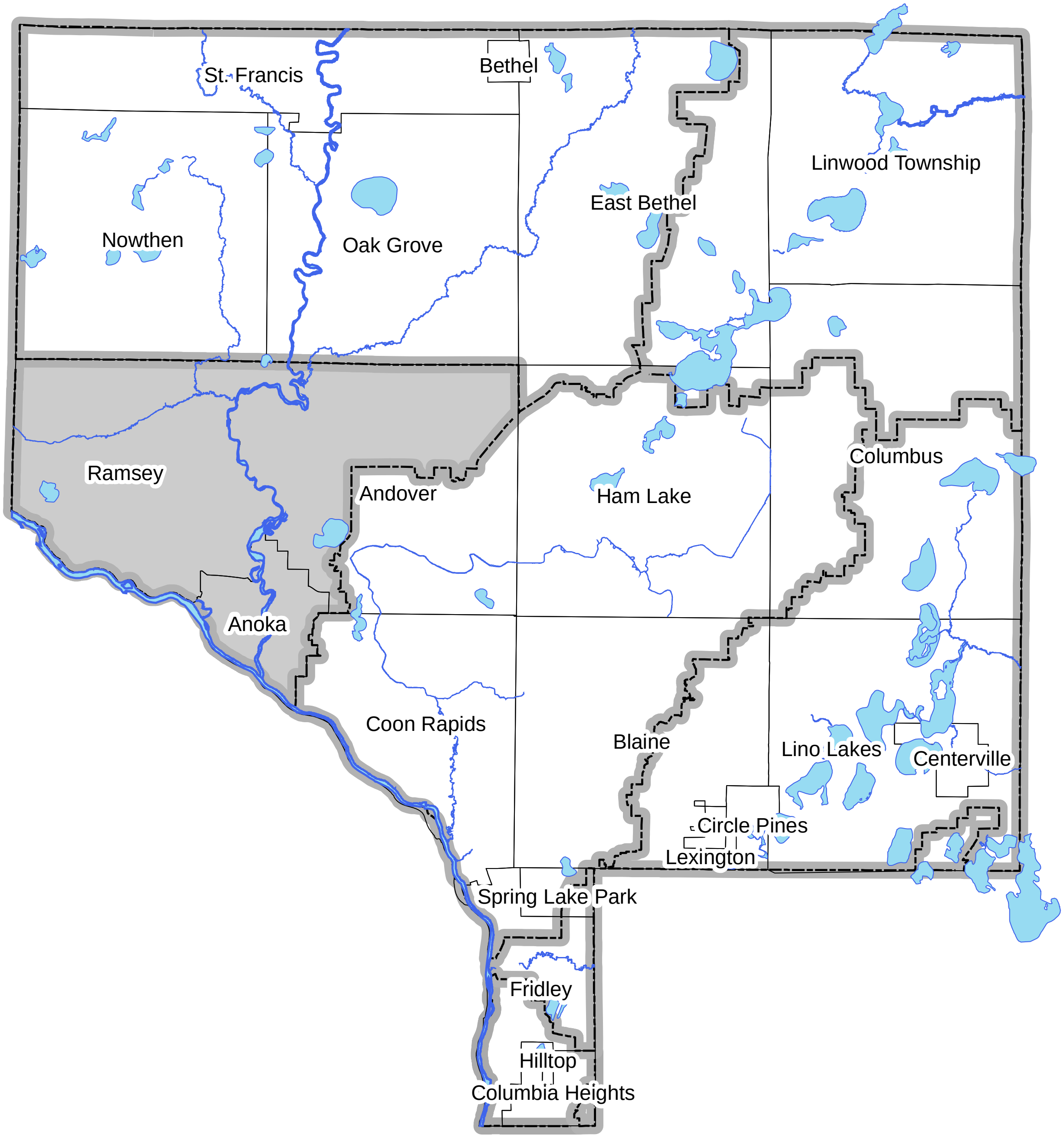
Upper Rum River Watershed Financial Summary

Upper Rum River Watershed	URRWMO Admin/Reporting/Grant Search	County, City, SWCD Asst (no charge)	WMO Asst (no charge)	Rum River 1W1P	URRWMO Promo/Website	Volunteer Precip	Reference Wetlands	DNR Groundwater Wells	Lake Levels	Lake Water Quality	Stream Water Quality	WOMP	Rum River Revets	Targeted BMP Promotion & Design	Rum River WRAPP	Lake George Phase 1 SRA	AIS Lake George Mapping	Inventory - Rum River Erosion	Total
Revenues																			
URRWMO	1000				1305		1950		1200	3500	4200		1599						14754
State - Other								490								28706			29196
MPCA															6691				6691
DNR OHF													9148						9148
DNR CPL																			0
BWSR Cons Delivery		877	416					517										51	1860
BWSR Capacity Staff				2763										567				1910	5240
BWSR Capacity Direct																			0
BWSR Cost Share																			0
BWSR Cost Share TA																			0
BWSR Local Water Planning	112		175		47	219				165					161		962		1841
Metro ETA & NPEAP																			0
Metro AWQCP																			0
Regional/Local												880	19189			3000	1088		24157
Anoka Co. General Services		706	416	366									5400						6888
County Ag Preserves/Projects																12335			12335
Service Fees													6261			3000			9261
Investment Dividend																			0
Rents																			0
Product Sales																			0
TOTAL	1112	1582	1006	3129	1352	219	1950	1007	1200	3665	4200	880	41597	567	6852	47041	2050	1961	121370
Expenses-																			
Capital Outlay/Equip	42	39	59	73	27	10	50	69	39	140	53	20	629	19	91	787	49	11	2208
Personnel Salaries/Benefits	991	1428	874	2817	942	180	1421	803	928	2309	1058	682	26638	592	1815	27860	1817	2143	75297
Overhead	41	56	41	74	36	12	107	71	55	157	74	36	1481	27	83	1479	84	87	4001
Employee Training	2	6	3	20	5	1	12	5	5	18	6	3	226	1	2	181	1	1	498
Vehicle/Mileage	10	18	5	24	11	3	43	17	17	48	25	15	463	10	19	493	34	50	1305
Rent	25	36	24	82	24	6	75	42	33	115	47	26	816	17	44	899	52	63	2425
Project Installation													5479						5479
Project Supplies				39	306	7	17		10	878	677		1382		4799	15343	12		23471
McKay Expenses																			0
TOTAL	1112	1582	1006	3129	1352	219	1726	1007	1087	3665	1940	783	37113	666	6852	47041	2050	2355	114685
NET	0	0	0	0	0	0	224	0	113	0	2260	97	4484	-100	0	0	0	-394	6685

Recommendations

- **Integrate the Rum River WRAPP (Watershed Restoration and Protection Plan) into the URRWMO's activity plans.** This WRAPP is an assessment of the entire Rum River watershed, including recommended management strategies, that was produced by the MPCA and local water managers.
- **Update the URRWMO's water monitoring plan**, which expired in 2017. The current draft plan lacks a monitoring schedule, which should be developed. Projects identified in an approved plan are eligible for Watershed Based Funding from the State.
- **Install projects identified in the St. Francis stormwater assessment** that is aimed at improving Rum River water quality. The study identified numerous stormwater treatment opportunities and ranking them by cost effectiveness. It lays the groundwork for project installations.
- **Collaborate in county-wide efforts to allocate Watershed Based Funding to deserving projects.** This funding is a new, non-competitve way of distributing Clean Water Funds as of 2018. $826,000 is available throughout Anoka County. Projects must be in the WMO plan.
- **Collaborate on efforts to diagnose declining water quality in Lake George and fix it.** The Lake George Improvement District and the Anoka Conservation District have begun study. Results are anticipated in 2018.
- **Periodically monitor chlorides in streams** to verify if observed baseflow conductivity increases are due to salts. Every 3 years minimum is recommended.
- **Promote practices that limit road deicing salt applications** while keeping roads safe. Streams throughout the URRWMO have increasing conductivity.
- **Protect streams from phosphorus increases.** Streams throughout the URRWMO have phosphorus that is near or exceeding State water quality thresholds. Yet none are on the State impaired waters list for this problem. Projects that reduce nutrient loads and prevent additional nutrient loading as the area develops are advised.
- **Monitor Lake George water quality at least every other year.** The lake has a declining trend. The Lake Improvement District has taken up monitoring every other year when the URRWMO has not funded that work, but would prefer to put their dollars into projects.
- **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.

Lower Rum River Watershed



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

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

CHAPTER 4:
LOWER RUM RIVER WATERSHED

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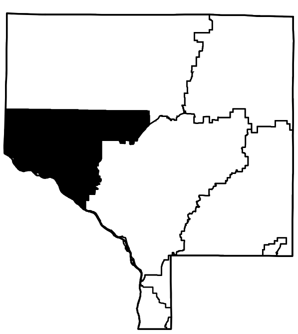
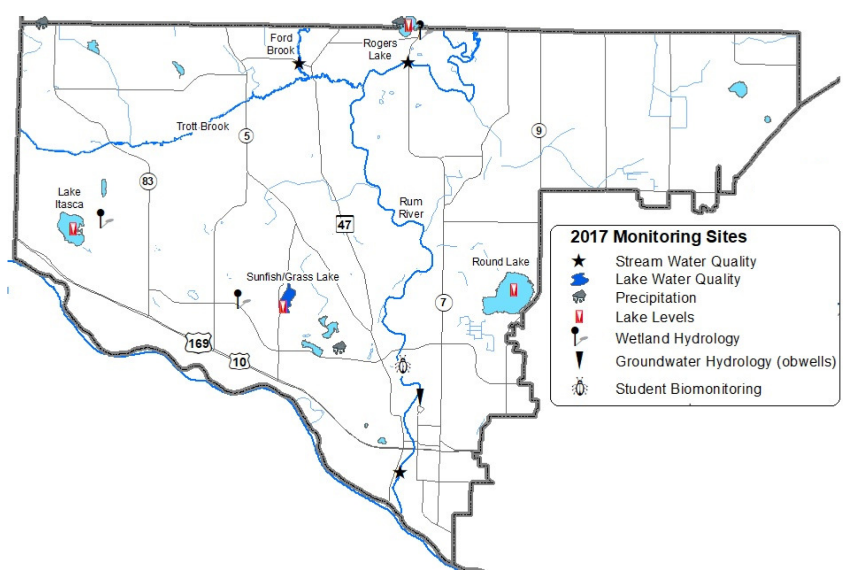
ACAP = Anoka County Ag Preserves, ACD = Anoka Conservation District, LRRWMO = Lower Rum River Watershed Mgmt. Org, MC = Metropolitan Council, MNDNR = MN Dept. of Natural Resources, LSOHC = Lessard-Sams Outdoor Heritage Council





Lake Level Monitoring

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

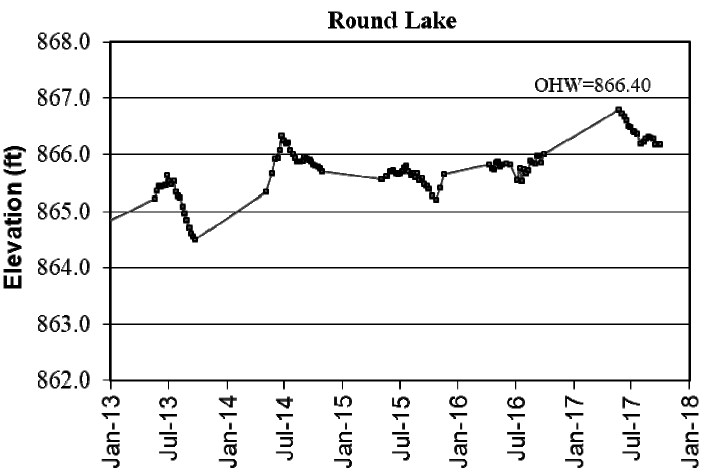
Purpose: To understand lake hydrology, including the impacts of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

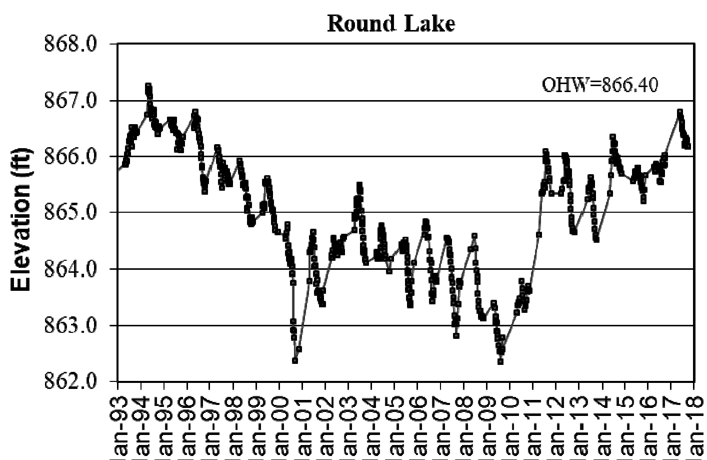
Results: Lake levels were measured by volunteers throughout the 2017 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. 2017 levels were generally higher than 2016 levels. All lakes followed the expected pattern of high levels in the spring with declining levels through summer. Sunfish Lake appears to be rising over the past 25 years, and Round Lake has almost rebounded to its 1994 levels after dropping almost five feet through 2010.

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

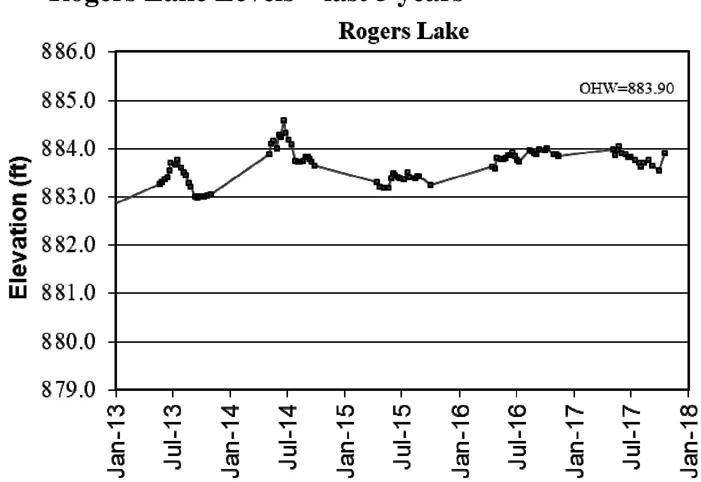
Round Lake Levels – last 5 years



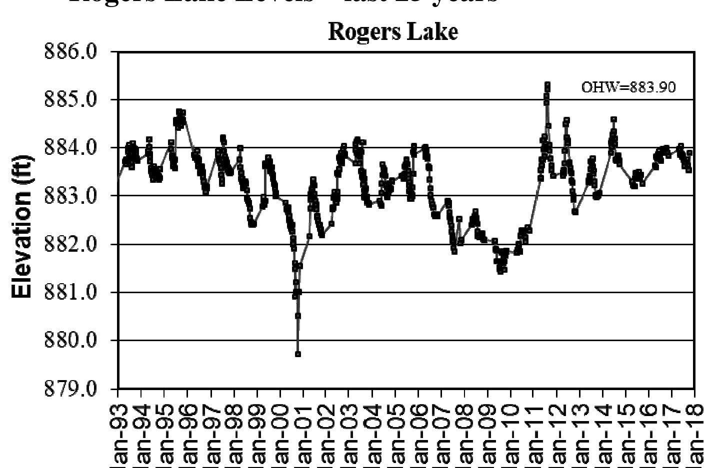
Round Lake Levels – last 25 years



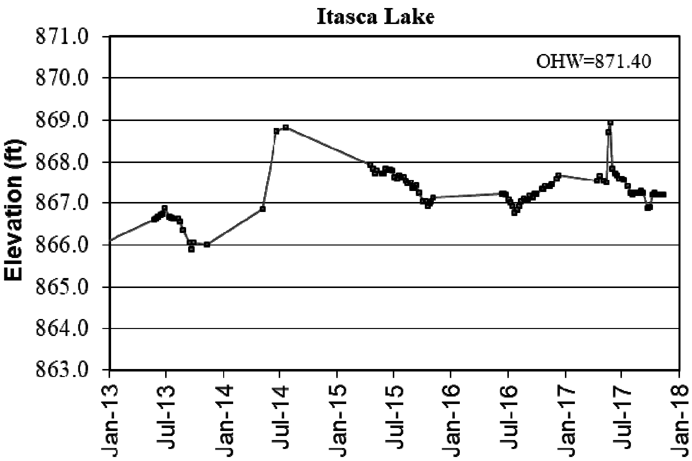
Rogers Lake Levels – last 5 years



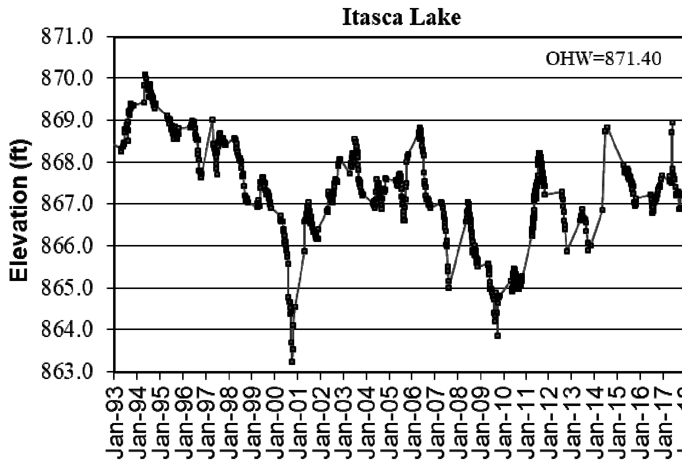
Rogers Lake Levels – last 25 years



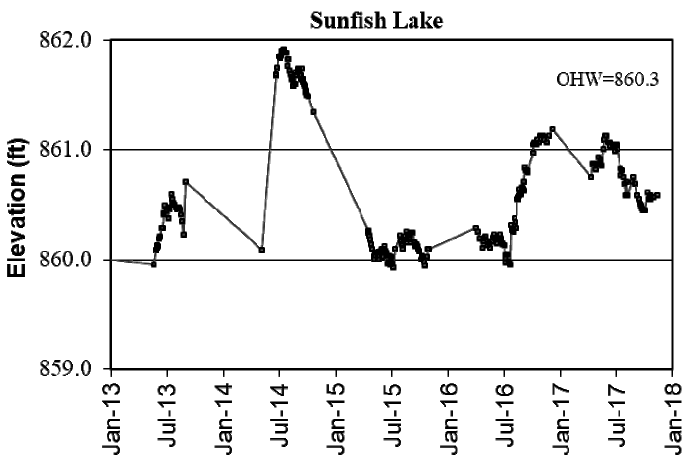
Itasca Lake Levels – last 5 years



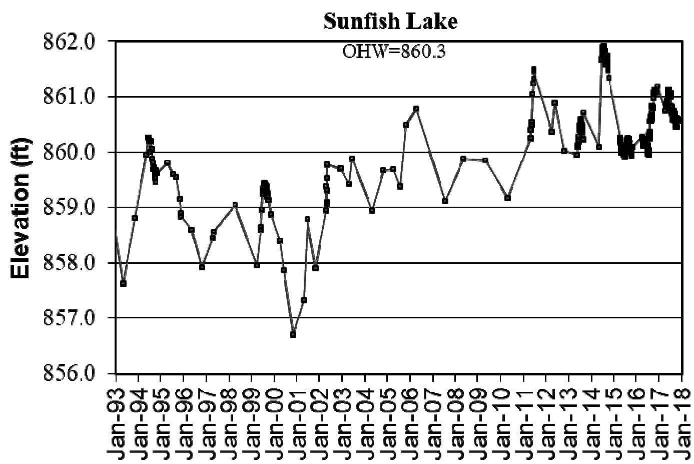
Itasca Lake Levels – last 25 years



Sunfish/Grass Lake Levels – last 5 years



Sunfish/Grass Lake Levels – last 25 years



Lake Water Quality

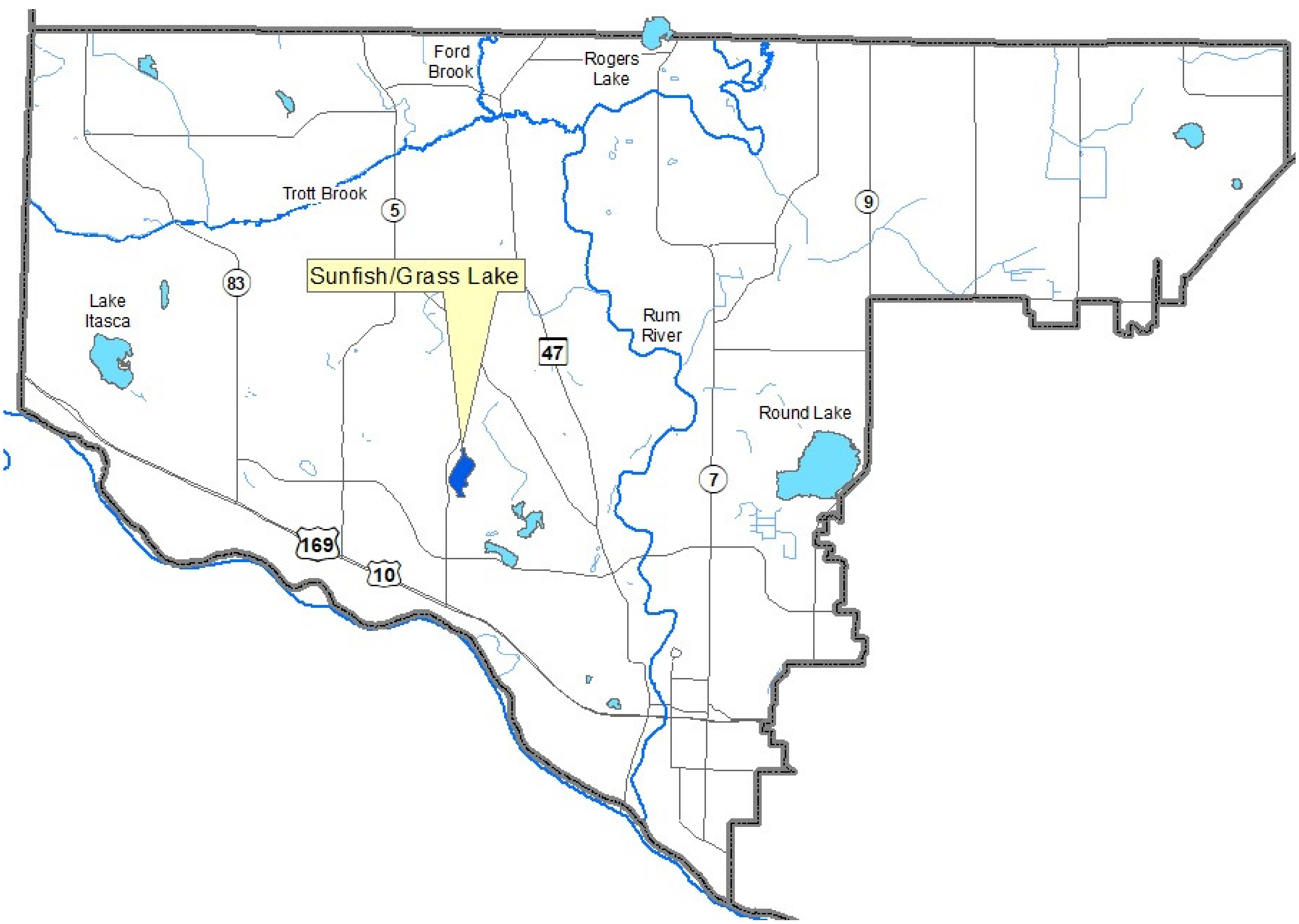
Description: May through September, every-other-week, monitoring is conducted for the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

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

Locations: Sunfish/Grass Lake

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

LRRWMO Lake Water Quality Monitoring Sites



Sunfish/Grass Lake

City of Ramsey, Lake ID #02-0113

Background

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

2017 Results

Sunfish/Grass Lake has not been extensively monitored in the past. 2017 was the second year in which the Anoka Conservation District (ACD) monitored the lake as part of the regular lake sampling efforts. The lake was monitored by ACD in 2016 and four additional years through the MPCA Citizen Lake Monitoring Program (CLMP) with varying degrees of intensity. In 2017 Sunfish Lake's water quality was good compared with other lakes in this region (NCHF Ecoregion), receiving an overall A letter grade. Total phosphorus (TP), Chlorophyll-a (CL-a) and Secchi readings were all better than state water quality standards. The average total phosphorus concentration in 2017 of only 16.6 µg/L was down from 25 µg/L in 2016. The average chlorophyll-a concentration of 3.09 µg/L was the lowest on record over four monitoring years. In fact, average chlorophyll-a concentrations have decreased each year monitored since 2012. On each sampling occasion in 2017 Secchi depth was greater than lake depth, the first time in this lake's short monitoring history that this has been the case.

Discussion

Grass Lake looks to be in good health, receiving an overall A letter grade in 2017 after receiving B grades in each of the previous three years monitored for each parameter since 2012. This letter grade would likely be further substantiated if Secchi readings were not limited by the depth of the lake.

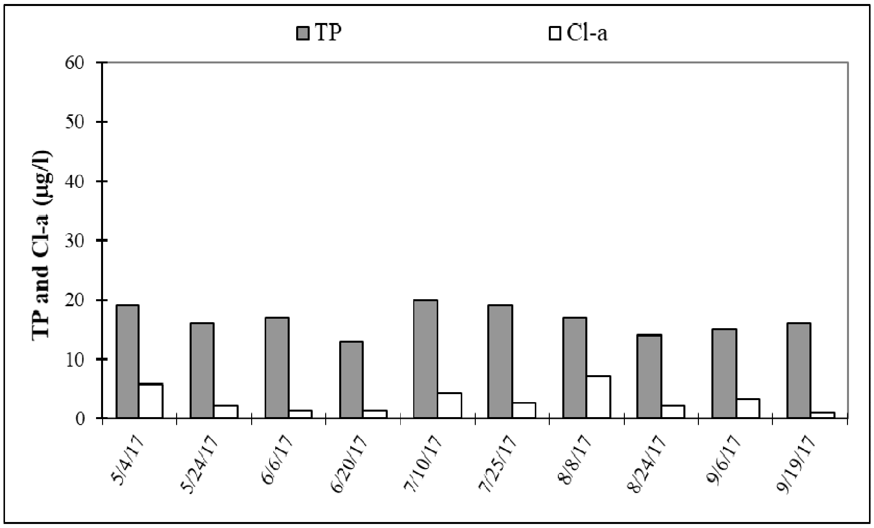
Trend Analysis

There is not yet enough data for a trend analysis of any parameter. Secchi transparency and chlorophyll-a have improved in each year monitored, but no true trend may exist.

Sunfish/Grass Lake

City of Ramsey, Lake ID #02-0113

2017 Daily Results

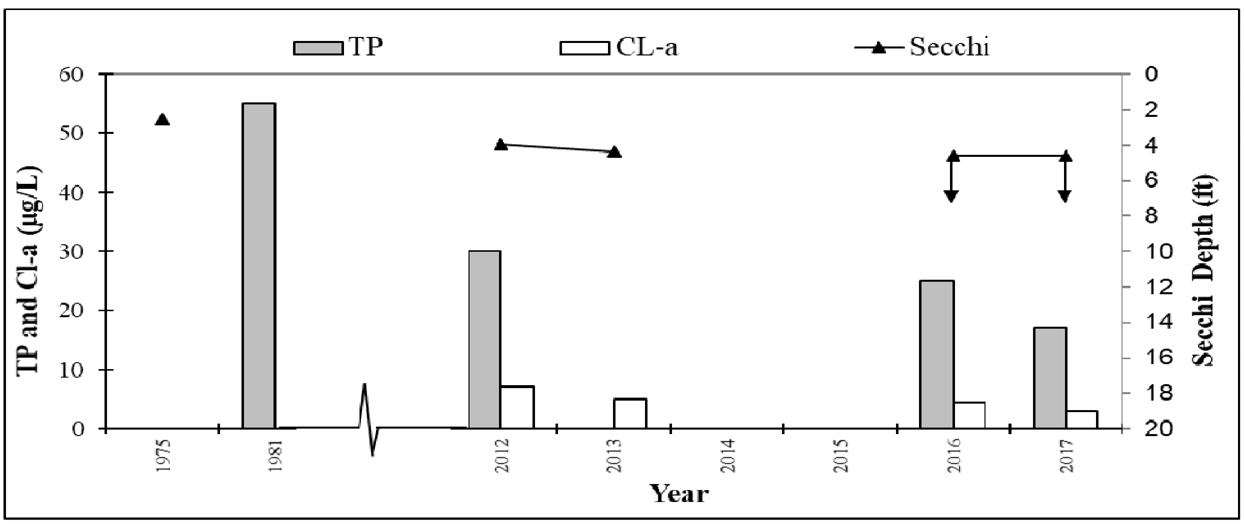


Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1975			D	
1981	C			
2012	B	A	C	B
2013		A	C	B
2016	C	A	N/A	B
2017	A	A	N/A	A
2017 average	16.6 µg/L	3.09 µg/L	>1.4 meters	
State standards	60 µg/L	20 µg/L	1.0 meters	

Due to Secchi transparency exceeding lake depth in recent years, it was not included in the overall grade. It is likely overall grades would have been even better if the good clarity of the lake could be incorporated.

Historical Annual Averages



2017 Raw Data

	Units	R.L.*	5/4/2017	5/24/2017	6/6/2017	6/20/2017	7/10/2017	7/25/2017	8/8/2017	8/24/2017	9/6/2017	9/19/2017	Average	Min	Max
Time:			11:20	11:15	12:30	10:50	12:45	12:25	12:25	13:00	12:20	12:05			
pH		0.1	8.86	8.79	9.53	8.34	7.98	7.48	24.23	8.01	7.95	8.08	9.93	7.48	24.23
Conductivity	mS/cm	0.01	0.278	0.309	0.316	0.324	0.358	0.471	0.497	0.423	0.422	0.414	0.381	0.278	0.497
Turbidity	NTU	1	3.0		3.6	3.2	1.9	13.1	1.6	0.0		0.0	2	0	4
D.O.	mg/l	0.01	12.88	10.96	13.48	6.66	6.89	7.66	10.96	10.17	8.30	5.46	9.34	5.46	13.48
D.O.	%	1	125.8%	113.8%	160.1%	80.8%	88.5%	95.9%	133.1%	128.8%	91.3%	62.7%	1	1	2
Temp.	°C	0.1	12.76	14.91	24.69	23.34	26.43	25.52	24.23	23.23	19.61	20.06	21.5	12.8	26.4
Temp.	°F	0.1	55.0	58.8	76.4	74.0	79.6	77.9	75.6	73.8	67.3	68.1	70.7	55.0	79.6
Salinity	%	0.01	0.13	0.15	0.15	0.16	0.17	0.23	0.24	0.20	0.20	0.20	0.18	0.13	0.24
Cl-a	µg/L	1	5.70	2.10	1.40	1.40	4.30	2.60	7.10	2.10	3.20	1.0000	3.09	1.0	7.1
T.P.	mg/l	0.005	0.019	0.016	0.017	0.013	0.020	0.019	0.017	0.014	0.015	0.016	0.017	0.013	0.020
T.P.	µg/l	5	19	16	17	13	20	19	17	14	15	16	17	13	20
Secchi	ft		>5.3	>5.3	>4.6	>5.1	>4	>4.5	>5	>3.8	>4.1	>4.4	>4.6		
Secchi	m		>1.6	>1.6	>1.4	>1.5	>1.2	>1.4	>1.5	>1.2	>1.2	>1.3	>1.4		
Field Observations			Clear	Clear	Clear	Clear/Slight (	Clear	Clear	Clear	Clear	Clear	Clear			
Physical			1	1	1	1	1	1	1	1	1	1	1.0	1.0	1.0
Recreational			2	2	2	3	3	1	2	2	2	1	2.0	1.0	3.0

* Reporting Limit

Stream Water Quality - Chemical Monitoring

Description: In 2017, monitoring events were scheduled May through September for each of the following parameters: total suspended solids, total phosphorus, Secchi tube transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

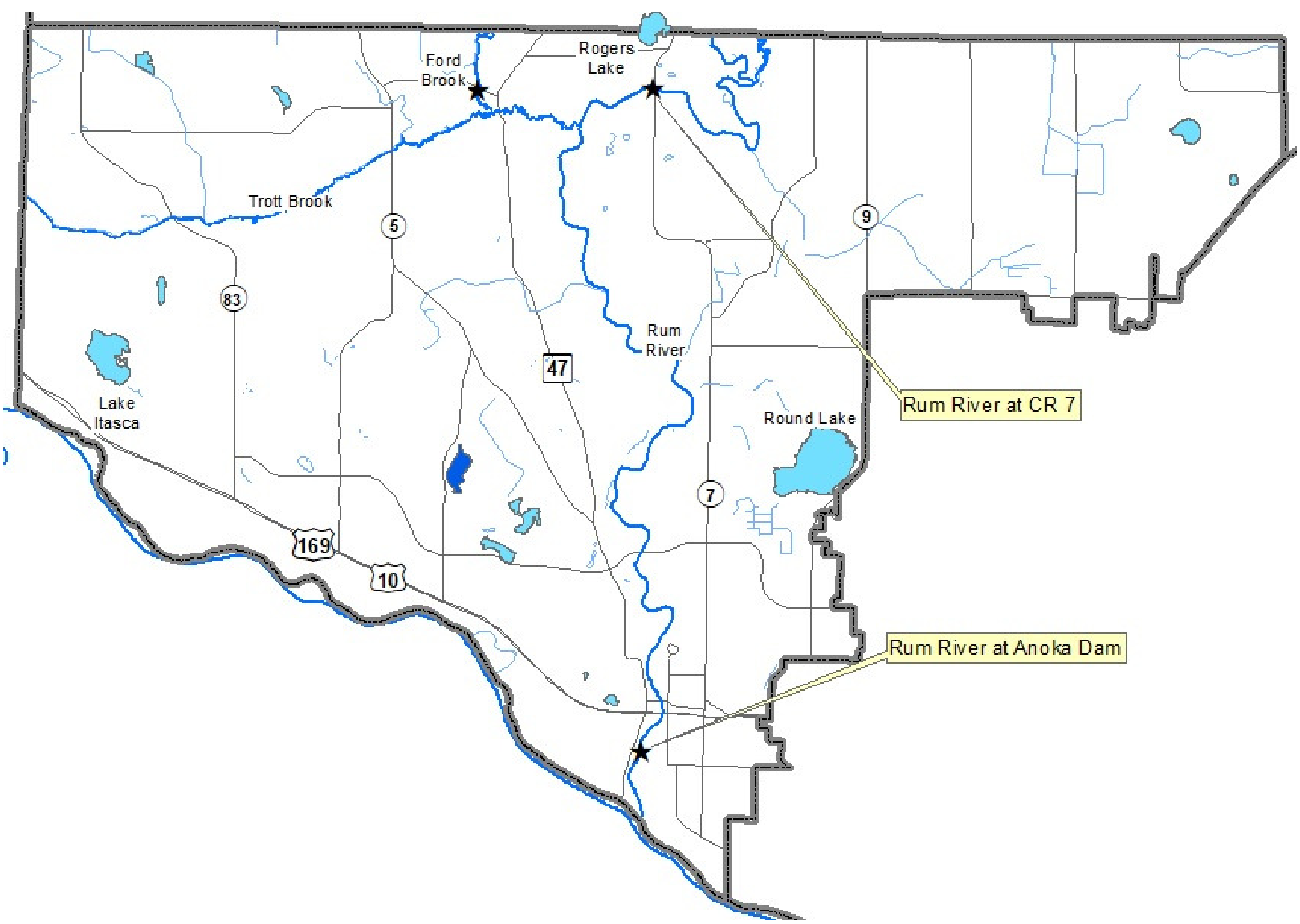
Purpose: To provide an assessment of water quality to be used in the completion of the Rum River Watershed Restoration and Protection Plan (WRAPP).

Locations: Rum River at County Road 7

Rum River at Anoka Dam

Results: Results are presented on the following pages.

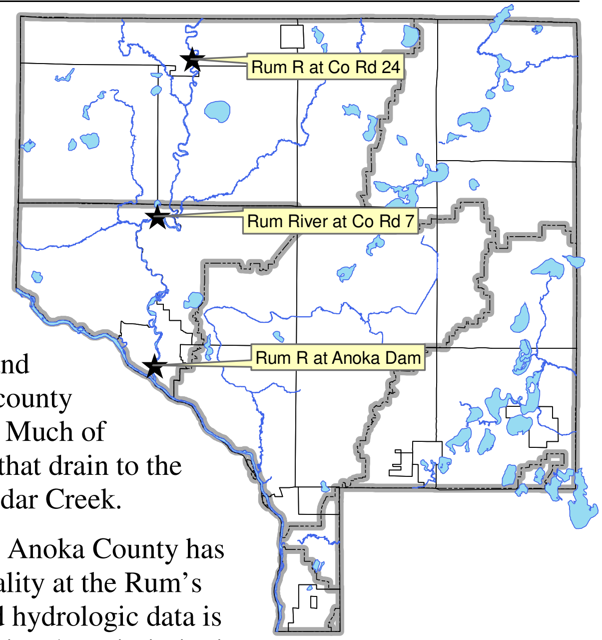
2017 Lower Rum River Monitoring Sites



RUM RIVER

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

*Located in and paid by the URRWMO, but reported with other Rum River data for a more complete analysis.



Years Monitored

At Co. Rd. 24 – 2004, 2009-2011, 2014-2017

At Co. Rd. 7 – 2004, 2009- 2011, 2014-2017

At Anoka Dam – 1996-2011(MC WOMP), 2015-2017

Background

The Rum River is 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 Brook, Trott Brook, and Ford Brook, and Cedar Creek.

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

Methods

In 2004, 2009- 2011 and 2014-2017 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 for all sites together for a more comprehensive analysis of the river from upstream to downstream.

In 2017 the river was monitored during both storm and baseflow conditions by grab samples. At the two further downstream locations, eight water quality samples were taken; half during baseflow and half following storms. At the upstream site, only four samples were taken due to lower funding levels. Storms were generally defined as one-inch or more of rainfall in 24 hours, or a significant snowmelt event combined with rainfall. In some years, particularly the drought year of 2009, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus and total suspended solids. During every sampling event the water level (stage) was recorded. The monitoring station at the Anoka Dam includes automated equipment that continuously tracks water levels and calculates flows. Water level and flow data for other sites were 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 2017. 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 https://eims.metc.state.mn.us/. All other raw data can be obtained from the Anoka Conservation District, and is also available through the Minnesota Pollution Control Agency's EQuIS database, which is available through their website.

Results Summary

This report includes data from 2017. The following is a summary of results.

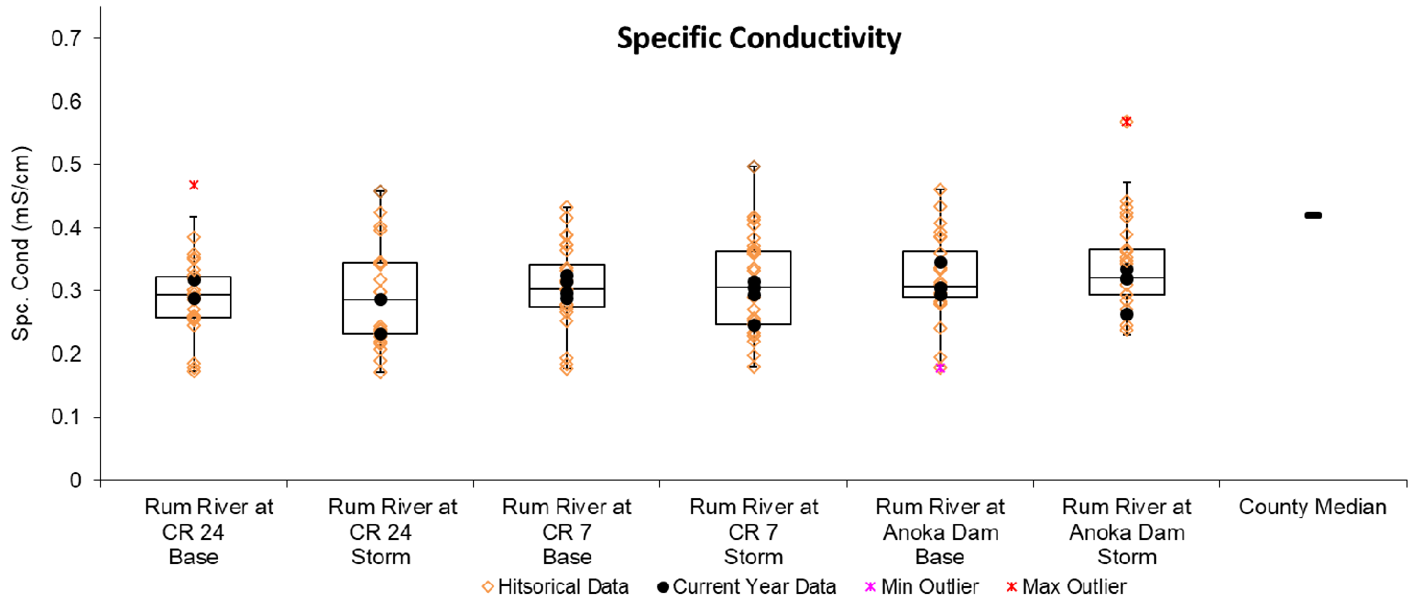
- Dissolved constituents, were measured by conductivity and chlorides. Conductivity in the Rum River is lower than other Anoka County streams. There is cause for concern however, as conductivity consistently increases moving downstream. Average conductivity for sites tested in 2017 from upstream to downstream was 0.282, 0.299 and 0.311 mS/cm respectively. This increase is likely caused by higher road and development density contributing higher loads of road salts and water softener salt. As development continues in all parts of the Rum River watershed, particular attention should be paid to minimizing road salt use, new water softening technology.
- Phosphorous in the Rum River in recent years has been near the State water quality standard of 100 µg/L at all sampled sites, but in 2017 somewhat better conditions were found. Sites exceeded this mark on two single sampling occasions in 2017, once during baseflow, and once after a storm event. 2017 total phosphorus in the Rum River in 2017 averaged 66, 74 and 69 µg/L at sampled sites moving upstream to downstream. Compared to other Anoka County streams, and even the Rum in recent years, these averages are low. Because small increases in phosphorus could cause the Rum River to exceed State standards and be declared "impaired," preventing phosphorus increases should be a focus of watershed management.
- Suspended solids and turbidity generally remained at acceptable levels in the Rum River and are lower than most other Anoka County streams. Average turbidity actually decreased from upstream to downstream in 2017 with averages of 8.0, 7.4, and 7.0 NTU respectively. TSS levels were low in the Rum River compared to other Anoka County streams with 2017 sampling site averages of 7.25, 8.0 and 5.4 mg/L upstream to downstream. Though suspended solids remain well under state impairment thresholds in the Rum, turbidity does show a moderate increase during storm events, and stormwater runoff mitigation should be a focus of management efforts.
- pH was relatively high in 2017 in the Rum River. pH should remain between 6.5 and 8.5 to support aquatic life and meet State water quality standards. On one occasion in May 2017, all three sampled sites exceeded pH 9. pH levels over 9 are quite alkaline for natural waterways. There is a variety of potential factors leading to temporary spikes in pH. What is disconcerting is the fact that the spikes over 8.5 seem to be happening more frequently in recent years. pH should continue to be monitored in the Rum River in the future to see if the spikes get worse or become even more common.
- Dissolved oxygen remained well above the state standard of 5 mg/L in 2017 and previous monitored years. The lowest concentration recorded at any of the three sites in 2017 was 6.89 mg/L.

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

Conductivity

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

Conductivity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 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 shows a consistent pattern of increasing downstream (see figure above) and is usually higher during baseflow conditions. Average conductivity from upstream to downstream of the sites monitored in 2017 (all conditions) was 0.282 mS/cm, 0.299 and 0.311 mS/cm, respectively. All three sites are lower than the historical median for 34 Anoka County streams of 0.420 mS/cm, but each site averaged slightly higher conductivity than in 2016. The 2017 maximum observed conductivity in the Rum River was 0.346 mS/cm at the Anoka Dam during baseflow conditions. This spike was still lower than the median for all other Anoka County streams.

Conductivity is lower on average during storm events (especially in the upstream sites), suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. High baseflow conductivity has been observed in most other nearby streams as well. This occurrence has been studied extensively, and the largest cause has been found to often be road salts that have infiltrated into the shallow aquifer. Water softening salts and geologic materials also contribute, but to a lesser degree.

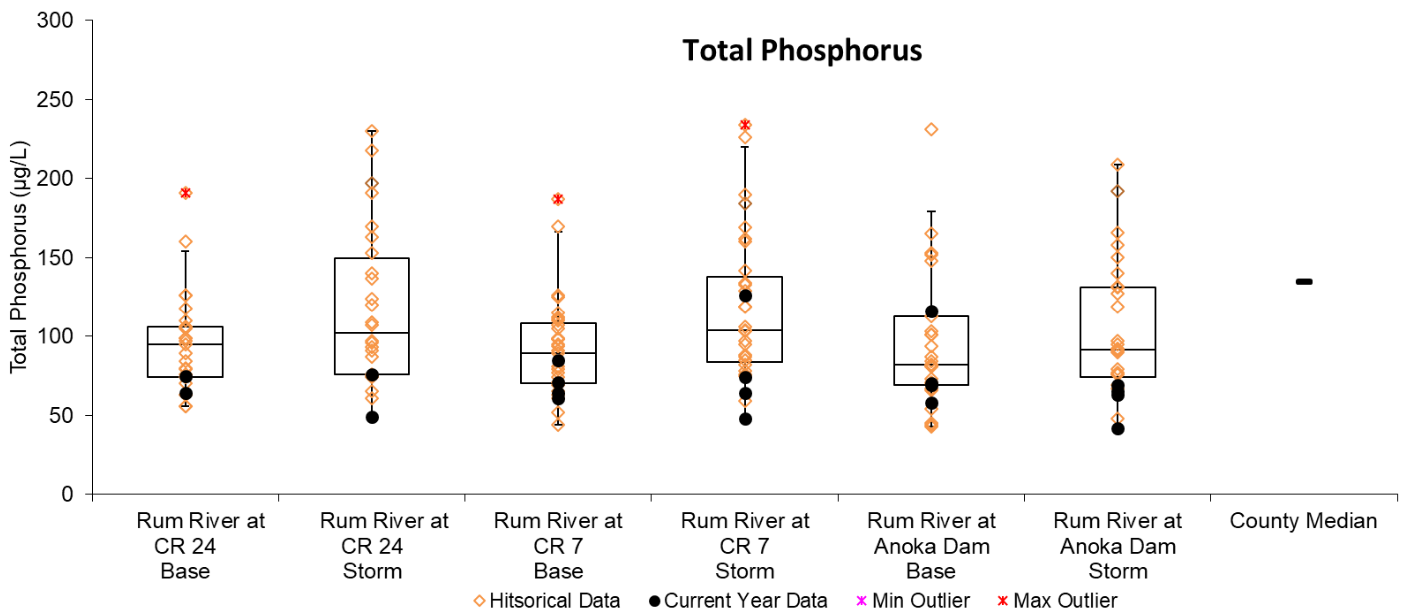
Conductivity increased from upstream to downstream. During baseflow, this increase from upstream to downstream likely reflects greater road densities and deicing salt application. During storms, the higher conductivity downstream is reflective of greater stormwater runoff and pollutants associated with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

Total Phosphorus

Total phosphorus in the Rum River was low in 2017, but in previous years is close to exceeding State water quality standards. Phosphorus is one of the most common pollutants in this region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. The average phosphorus concentration in 2017 at the three monitored sites (all conditions) moving upstream to downstream was 66, 74 and 69 µg/L. Two samples events in 2017 yielded total phosphorus concentrations over 100 µg/L. In previous years, phosphorus concentrations were near the 100 µg/L State water quality standard.

Understanding that the Rum River is close to exceeding State water quality standards for phosphorus, future monitoring should be continued and every effort should be made to prevent phosphorus increases which would likely result in the Rum River being designated a State "impaired" water. Future upgrades to wastewater treatment plants throughout the Rum River watershed may offer phosphorus reductions. At the same time, development in the lower watershed, including increased stormwater discharges, may result in phosphorus increases. Development controls that result in no net increase in phosphorus should be considered.

Total phosphorus during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Turbidity and Total Suspended Solids (TSS)

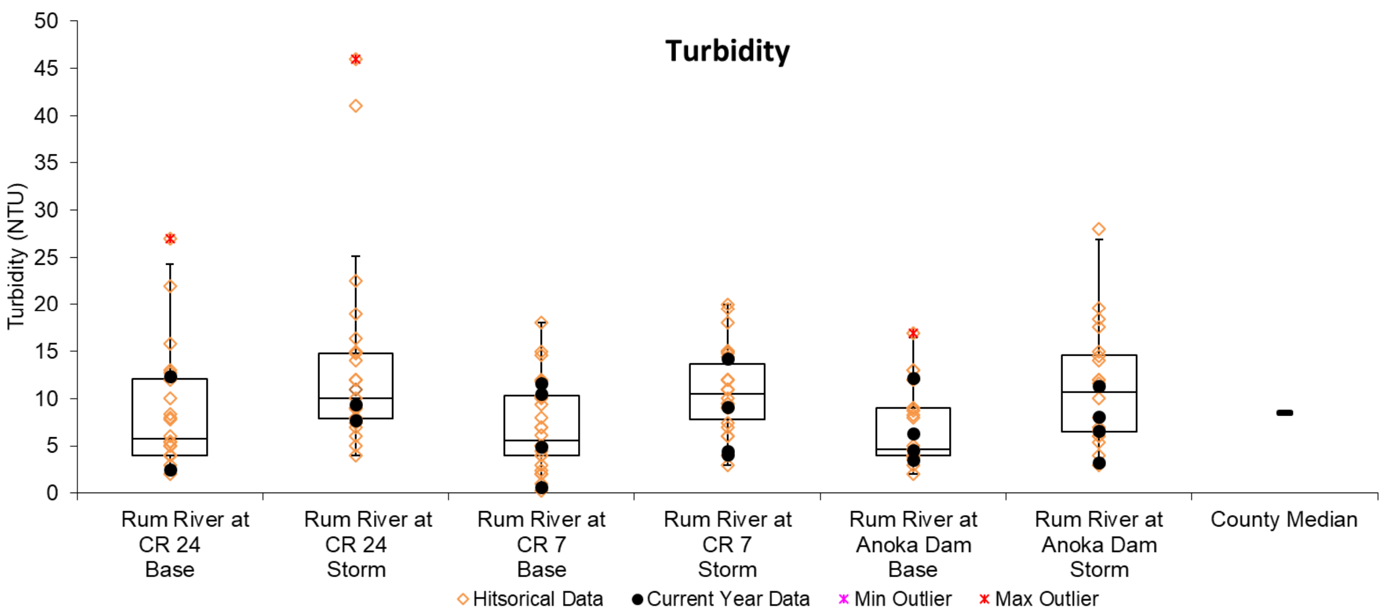
Turbidity and total suspended solids (TSS) are two different measurements of solid material suspended in the water. Turbidity is measured by the refraction of a light beam passed through a water sample and is most sensitive to large particles. Total suspended solids is measured by filtering solids from a water sample and weighing the filtered material. The amount of suspended material is important because it affects transparency and aquatic life, and because many other pollutants are attached to particles. Many stormwater treatment practices such as street sweeping, sumps, and stormwater settling ponds target sediment and attached pollutants. In 2017, turbidity and total suspended solids in the Rum River were lower than the historical median for Anoka County streams.

In the Rum River, turbidity is generally low but increases during storms. There is substantial variability (see figure below). There is no clear change in turbidity or suspended solids upstream to downstream. The average turbidity, in 2017 (storms and baseflow) for each site moving upstream to downstream was 8.0, 7.4, and 7.0 NTU. The historical median for Anoka County streams is 11.2 NTU. Turbidity was elevated on a few occasions, especially during and after storm events, though the maximum turbidity measured at County Road 7 after a storm event of 14.2 NTU is quite low for a highest annual recording.

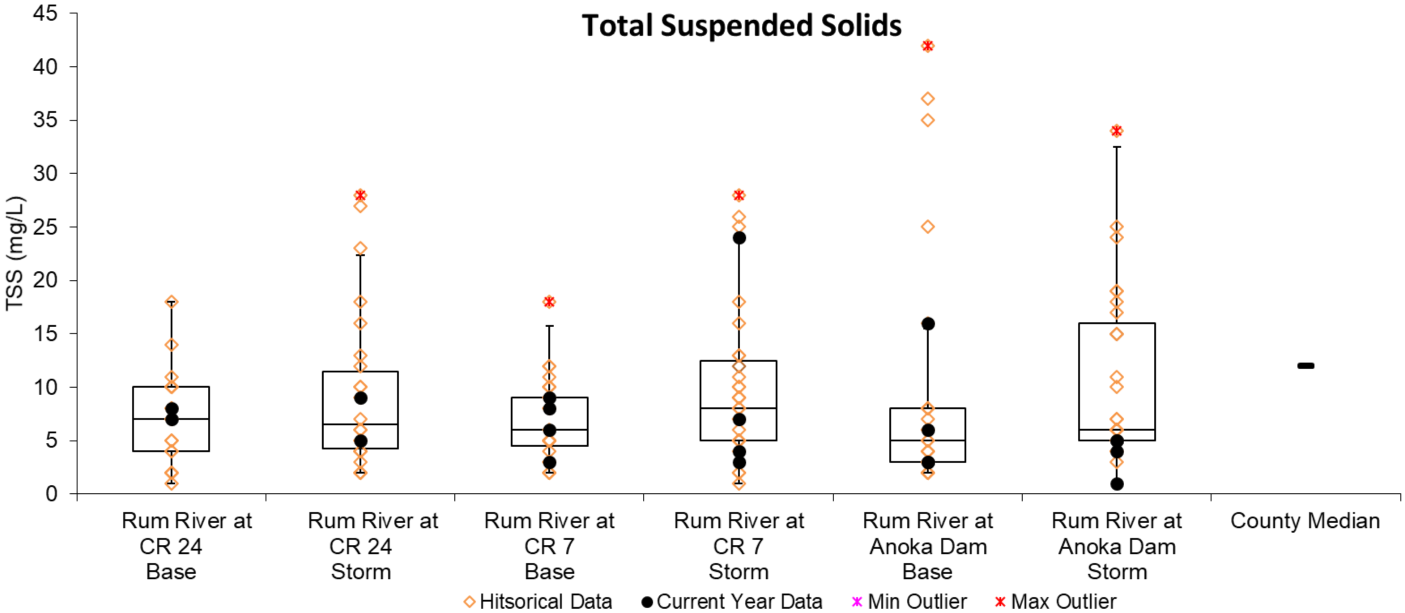
Average TSS results (all conditions) in 2017 for sites moving upstream to downstream was 7.25, 8.0 and 5.4 mg/L. These are all lower than the Anoka County stream median for TSS of 13.66 mg/L. It is important to note the suspended solids can come from sources within and outside of the river channel. Sources 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. The state threshold for TSS impairment in the Rum River is 10% of samples April 1-September 30 exceeding 30 mg/L TSS. The highest concentration recorded in 2017 was 24 mg/L. ACD has not collected a sample over 30 mg/L TSS since May of 2010.

Though the Rum River remains well under the impairment threshold for TSS, rigorous stormwater treatment should occur as the Rum River watershed continues to be developed, or the collective pollution caused by many small developments could seriously impact the river. Bringing stormwater treatment up to date in older developments is also important.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



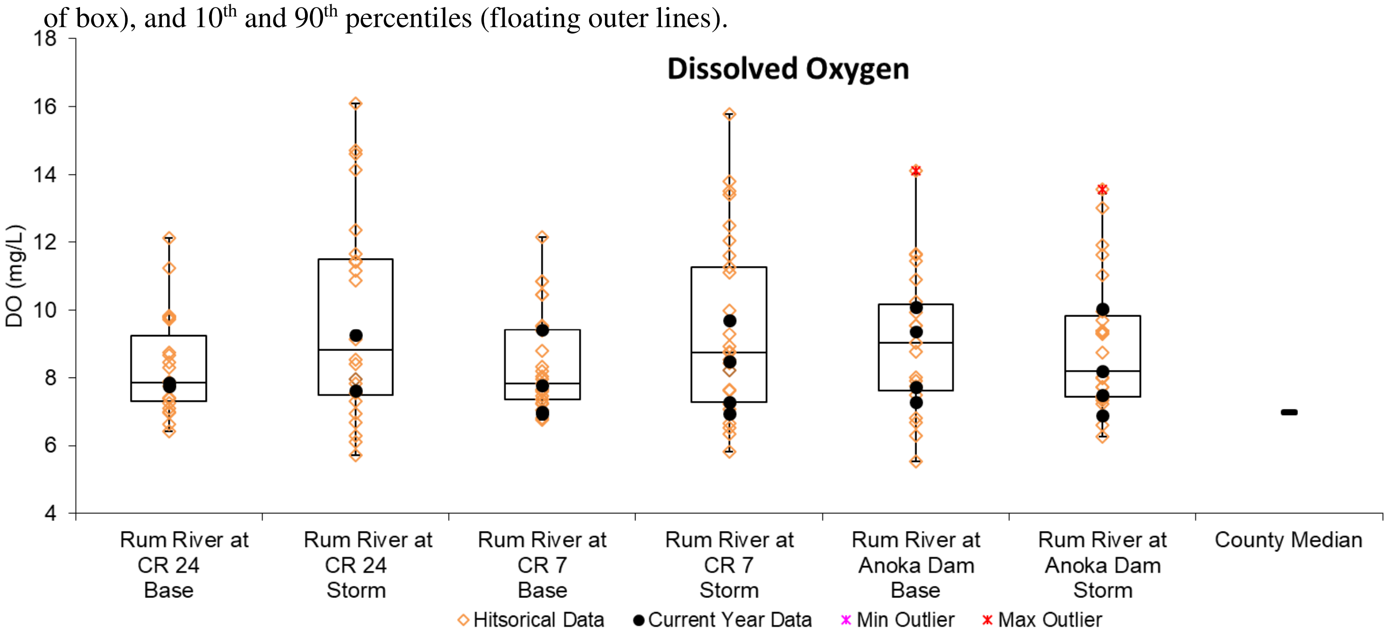
Total suspended solids during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

Dissolved oxygen is necessary for aquatic life, including fish. Organic pollution causes oxygen to be consumed during decomposition. If oxygen levels fall below the state water quality standard of 5 mg/L, aquatic life begins to suffer. A stream is considered impaired if 10% of observations are below this level in the last 10 years. Dissolved oxygen levels are typically lowest in the early morning because of decomposition consuming oxygen at night without offsetting oxygen production by photosynthesis. In 2017, dissolved oxygen in the Rum River was always above 5 mg/L at all monitoring sites, with 6.89 mg/L being the lowest concentration recorded. ACD has never recorded a dissolved oxygen concentration below 6 mg/L in the Rum with sampling dating back to 2004.

Dissolved oxygen during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 readings Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

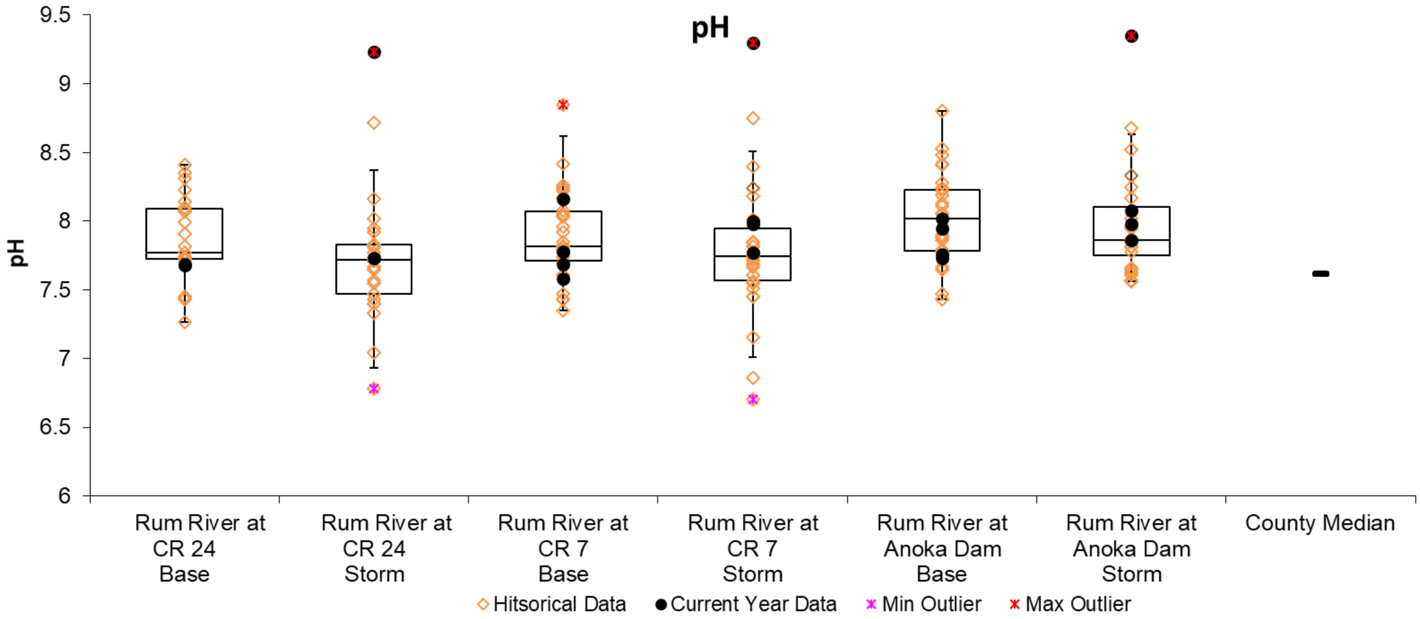


pH

pH refers to the acidity of the water. The Minnesota Pollution Control Agency's water quality standard is for pH to remain between 6.5 and 8.5. The Rum River is generally within this range, but has exceeded 8.5 on rare occasions in the past. In recent years (2015, 2017) however, exceedances of 8.5 have been commonplace at all sites. In 2017, pH levels over 9 were recorded at all three sites after a storm event on 5/18/2017. Exceedances were recorded in 2015 after a spring storm in March at the lower two sampling sites as well as at the Anoka Dam during baseflow conditions in July.

There is a variety of potential factors leading to temporary spikes in pH. What is disconcerting is the fact that the spikes over 8.5 seem to be happening more frequently in recent years. pH should continue to be monitored in the Rum River in the future to see if the spikes get worse or become even more common.

pH during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2017 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 in general is good. However, there is a slight increase in conductivity moving downstream, phosphorus levels are near state water quality standards, and pH spikes over 8.5 seem to be happening more frequently. Protection of the Rum River should continue to be a high priority for local officials. Large population increases are expected to continue in the Rum River's watershed within Anoka County, and this continued development has the potential to degrade water quality unless carefully planned and managed with the river in mind. Development pressure is likely to be especially high near the river because of its scenic and natural qualities. Local ordinances to preserve the scenic nature of the river, treat stormwater thoroughly before discharge, and minimizing road salting should be considered. A proposed "One Watershed, One Plan" across the entire Rum River watershed may offer a chance for multi-county planning. The recently completed Rum River Watershed Restoration and Protection Strategies (WRAPS) offers management strategies for throughout the watershed.

Stream Water Quality – Biological Monitoring

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

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

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

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.

% 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).

RUM RIVER

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

Last Monitored

By Anoka High School in 2017

Monitored Since

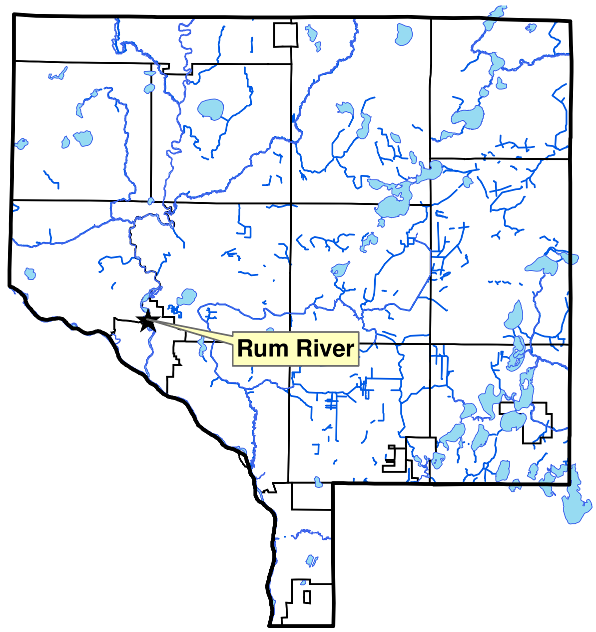
2001

Student Involvement

About 130 students in 2017, over 1,100 total since 2001

Background

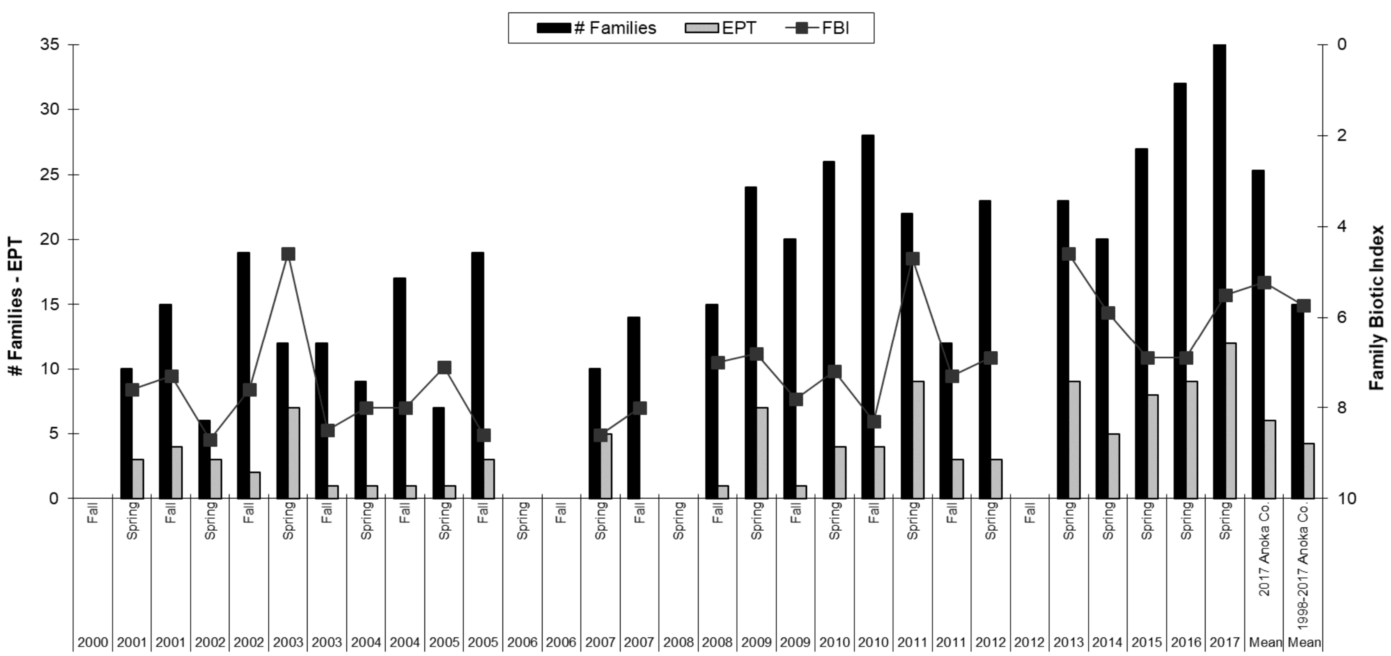
The Rum River originates from Lake Mille Lacs, and flows south through western Anoka County where it joins the Mississippi River in the City of Anoka. In Anoka County the river has both rocky riffles (northern part of county) as well as pools and runs with sandy bottoms. The River's condition is generally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



Results

Anoka High school classes monitored the Rum River in spring of 2017 with Anoka Conservation District (ACD) oversight. The results for spring 2017 were better than previous years. The most families ever collected in 20 years of student biomonitoring by ACD, 41 in total, were collected. The most sensitive taxa (Ephemeroptera, Plecoptera, and Trichoptera; EPT), 12, ever collected at this site were found in 2017. The past two years have now consecutively been the best two years at this site in terms of family and EPT family numbers.

Historical Biomonitoring Results for Rum River behind Anoka High School



Biomonitoring Data for the Rum River behind Anoka High School - Most Recent Five Years

Year	2013	2014	2015	2016	2017	Mean	Mean
Season	Spring	Spring	Spring	Spring	Spring	2017 Anoka Co.	1998-2017 Anoka Co.
FBI	4.60	5.90	6.90	6.90	5.50	5.2	5.7
# Families	23	20	27	32	41	25.3	15.0
EPT	9	5	8	9	12	6.0	4.2
Date	14-May	20-May	11-May	17-May	15-May		
sampling by	AHS	AHS	AHS	AHS	AHS		
sampling method	MH	MH	MH	MH	MH		
Mean # individuals	357	350	767	3363	1439		
# replicates	4	4	2	1	2		
Dominant Family	Perlodidae	Siphlonuridae	Siphlonuridae	Siphlonuridae	Pelecypoda		
% Dominant Family	42.1	33.4	69.3	74.9	26.6		
% Ephemeroptera	19.4	57.8	78.9	78.7	14.9		
% Trichoptera	0.2	0.1	1.4	0	0.1		
% Plecoptera	42.6	0.5	0	0.4	26		
% EPT	62.2	58.4	80.3	79.1	41		

Discussion

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

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

Wetland Hydrology

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

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

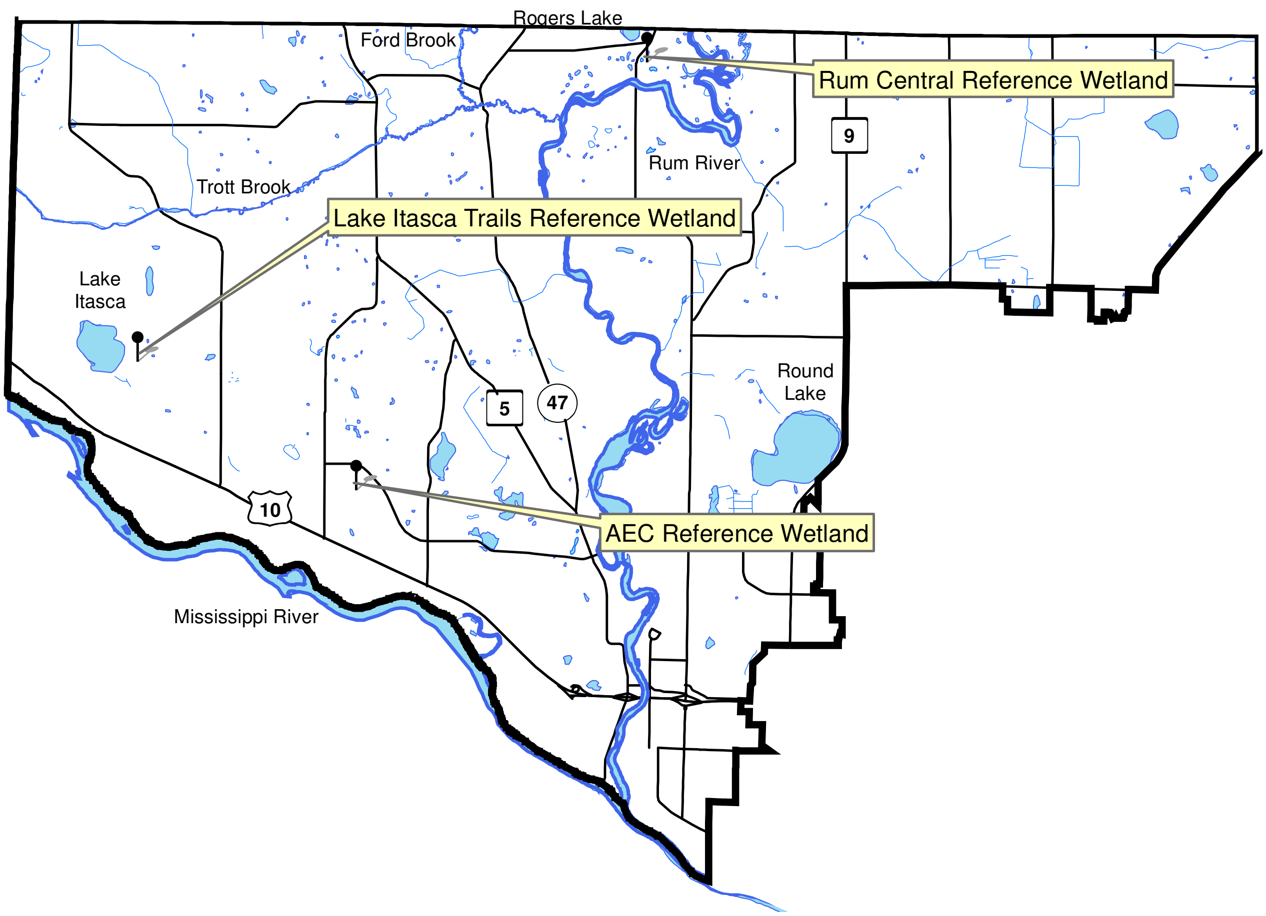
Locations: AEC Reference Wetland, Connexus Energy Property on Bunker Lake Blvd, Ramsey

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

Lake Itasca Trail Reference Wetland, Lake Itasca Park, Ramsey

Results: Depicted on the following pages.

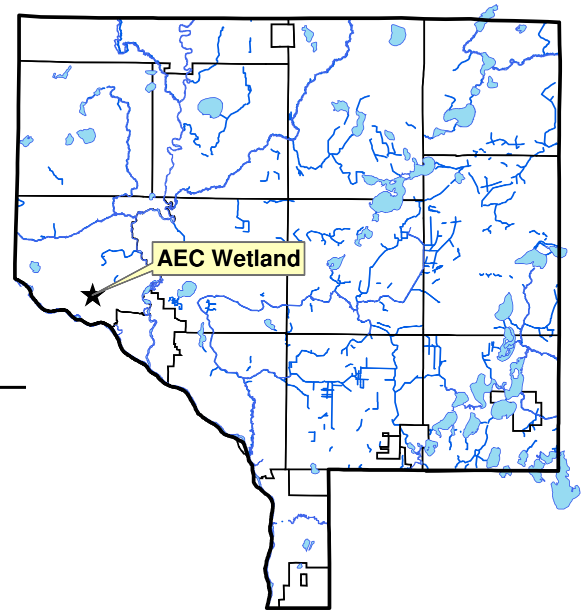
Lower Rum River Watershed Wetland Hydrology Monitoring Sites



Wetland Hydrology Monitoring

AEC Reference Wetland

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



Site Information

Monitored Since: 1999

Wetland Type: 3

Wetland Size: ~18 acres

Isolated Basin? No, probably receives storm water

Connected to a Ditch? No

Soils at Well Location:

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

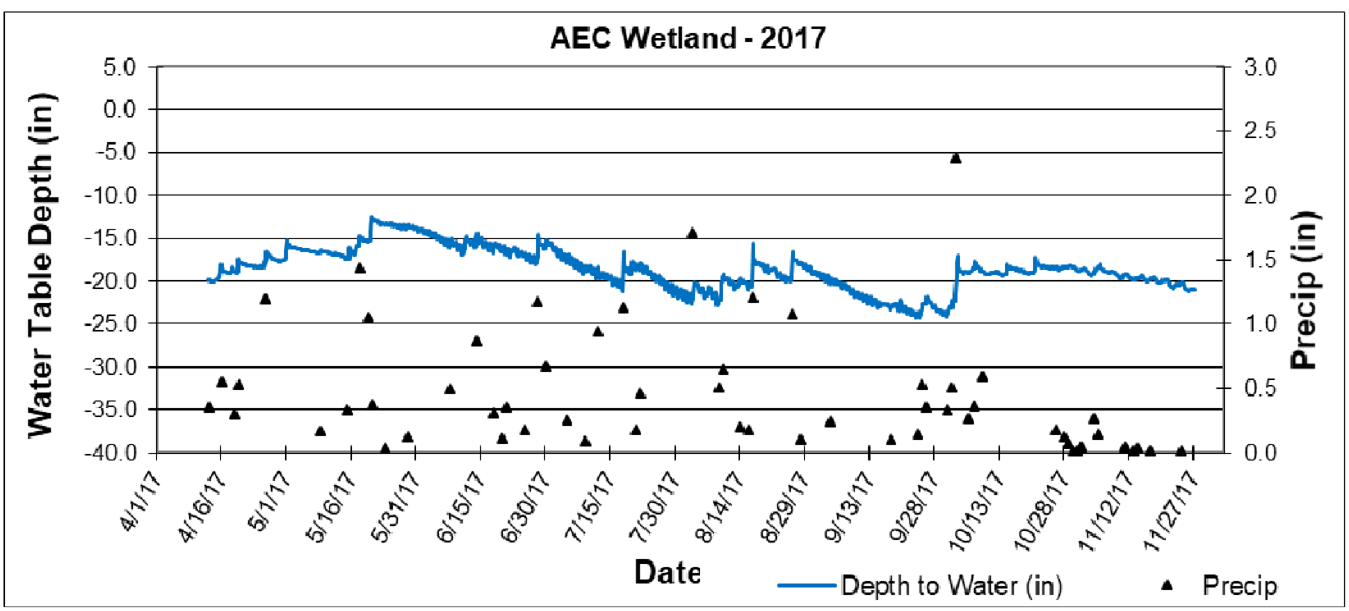
Surrounding Soils: Hubbard coarse sand

Vegetation at Well Location:

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

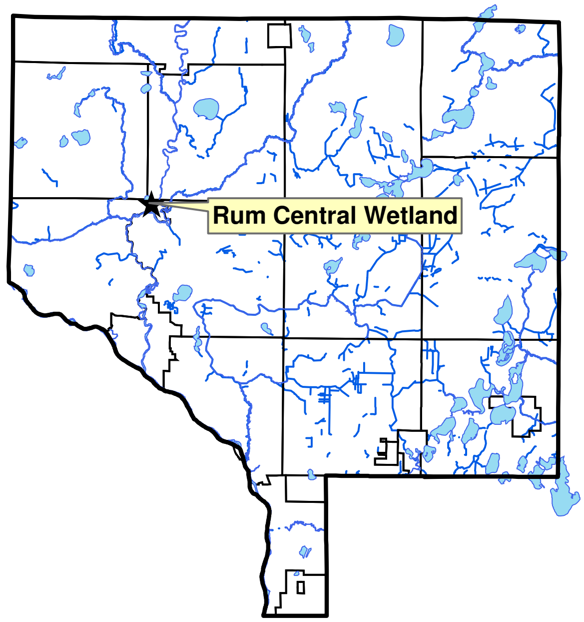
Other Notes: Well is located at the wetland boundary.

2017 Hydrograph



Rum River Central Reference Wetland

Rum River Central Regional Park, Ramsey



Site Information

Monitored Since: 1997

Wetland Type: 6

Wetland Size: ~0.8 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

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

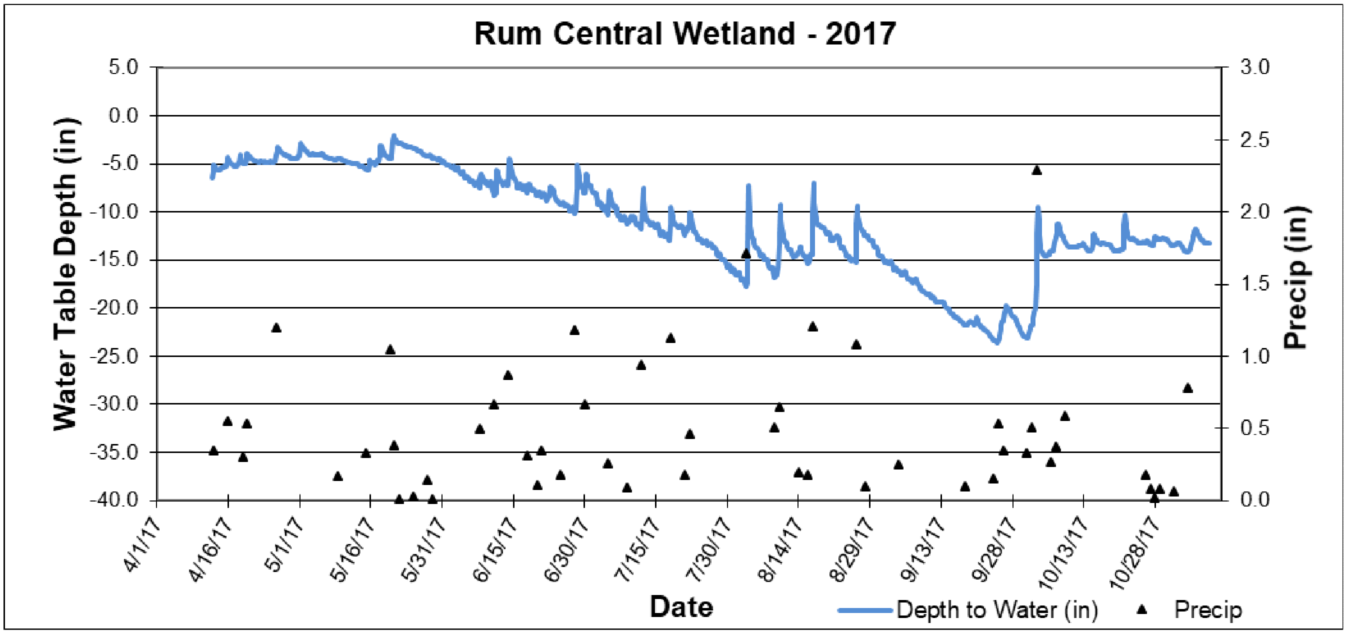
Surrounding Soils: Zimmerman fine sand

Vegetation at Well Location:

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

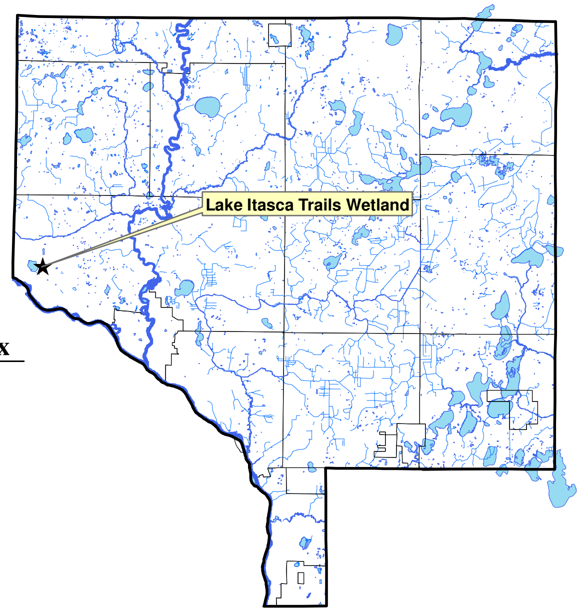
Other Notes: Well is located at the wetland boundary.

2017 Hydrograph



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	-

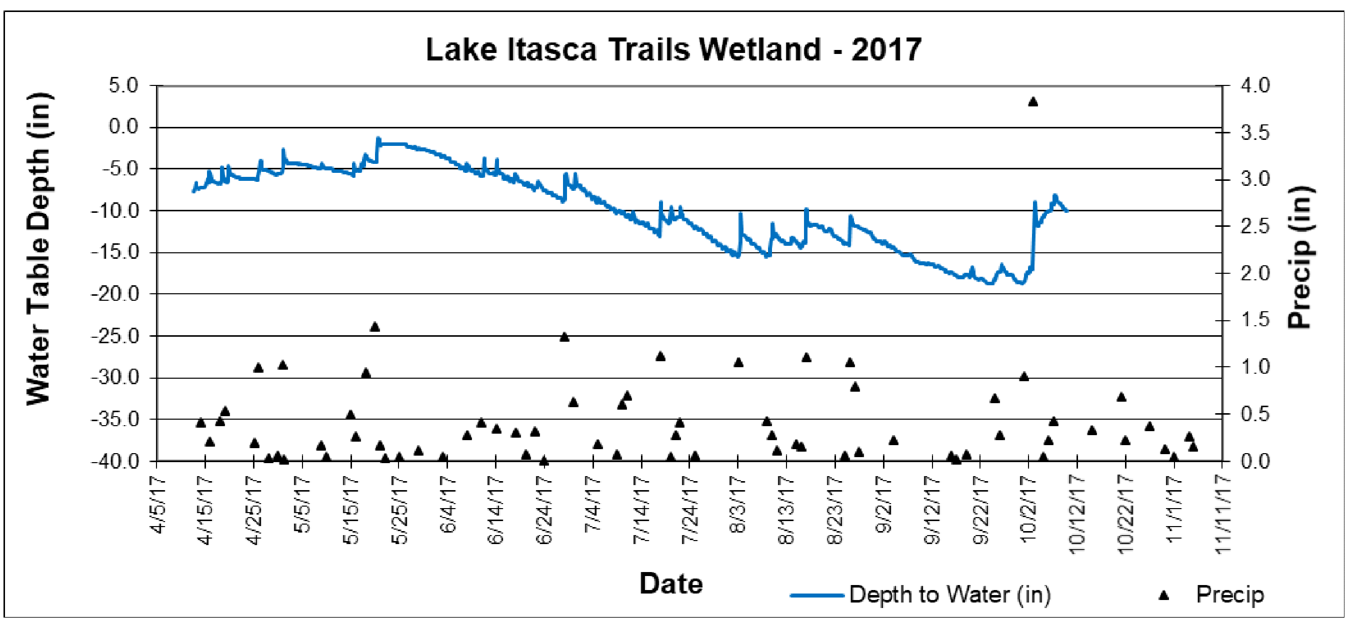
Surrounding Soils: Hubbard coarse sand

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.

2017 Hydrograph



Water Quality Grant Fund

Description: The LRRWMO provides cost share for projects on either public or private property that will improve water quality, such as repairing streambank erosion, restoring native shoreline vegetation, or rain gardens. This funding is administered by the Anoka Conservation District. Projects affecting the Rum River are given the 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.

LRRWMO Cost Share Fund Summary

2006 LRRWMO Contribution	+	$1,000.00
2008 Expense – Herrala Rum Riverbank stabilization	-	$ 150.91
2008 Expense – Rusin Rum Riverbank stabilization	-	$ 225.46
2009 LRRWMO Contribution	+	$1,000.00
2009 Expense – Rusin Rum Riverbank bluff stabilization	-	$ 52.05
2010 LRRWMO Contribution	+	$ 0
2010 LRRWMO Expenses	-	$ 0
2011 LRRWMO Contribution	+	$ 0
2011 Expense - Blackburn Rum riverbank	-	$ 543.46
2012 LRRWMO Contribution	+	$1,000.00
2012 Expense – Smith Rum Riverbank	-	$1,596.92
2013 LRRWMO Contribution	+	$1,000.00
2013 Expense – Geldacker Mississippi Riverbank	-	$1,431.20
2014 LRRWMO Contribution	+	$2,050.00
2015 LRRWMO Contribution	+	$1,000.00
2015 Expense – Smith Rum Riverbank	-	$ 533.65
2016 LRRWMO Contribution	+	$1,000.00
2016 Expense – Brauer Rum Riverbank	-	$ 1,150.00
2017 LRRWMO Contribution	+	$1,000.00
2017 Expense – Rum River Revetments	-	$1,000.00
Fund Balance		**$2,366.35**

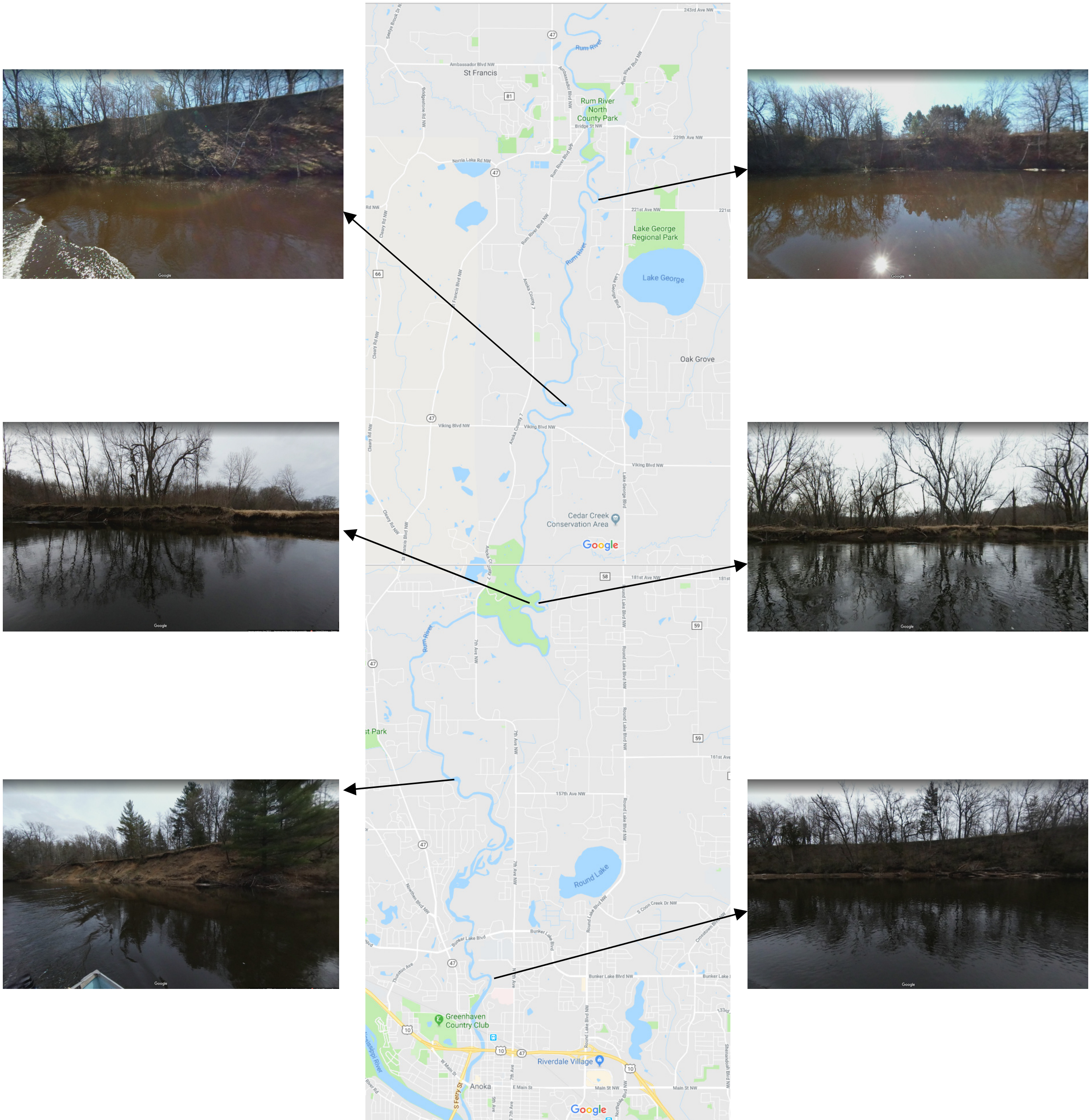
Rum River 360^{O} Photo Inventory

Description: The Anoka Conservation District performed a full 360^{O} photo inventory of bank conditions on the Rum River throughout Anoka County in the spring of 2017. This photo inventory was uploaded to Google Maps and is available to the public.

Purpose: To create a photo inventory of bank conditions to be used to guide future restoration projects and track bank condition changes in the future.

Location: Rum River through Anoka County

Results: 360^{O} images are available on Google Maps Street View. The user is able to zoom down to water level and pan around the full 360^{O} to view river and bank conditions.



Rum River Bank Stabilizations

Description: 12 riverbank stabilization projects were installed on the Rum River in Anoka and Isanti Counties in 2017. At these sites, cedar tree revetments and willow stakes were used to stabilize eroding banks. The projects were installed in partnership with the Conservation Corps Minnesota (CCM). Funding for the 9 Anoka County projects came from the Conservation Partners Legacy Grant Program from the Outdoor Heritage Fund, a Clean Water Fund CCM crew labor grant, cost share from the URRWMO and LRRWMO, and a landowner contribution. Funding for 3 additional revetments in Isanti County came from the Lessard-Sams Outdoor Heritage Council, a Clean Water Fund CCM crew labor grant and landowner contribution.

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

Location: Rum River Central Regional Park, 8 residential properties in Anoka County, City of Isanti, and 2 residential properties in Isanti County.

Results: Stabilized 2,223 linear feet of riverbank on the Rum River in Anoka and Isanti Counties.

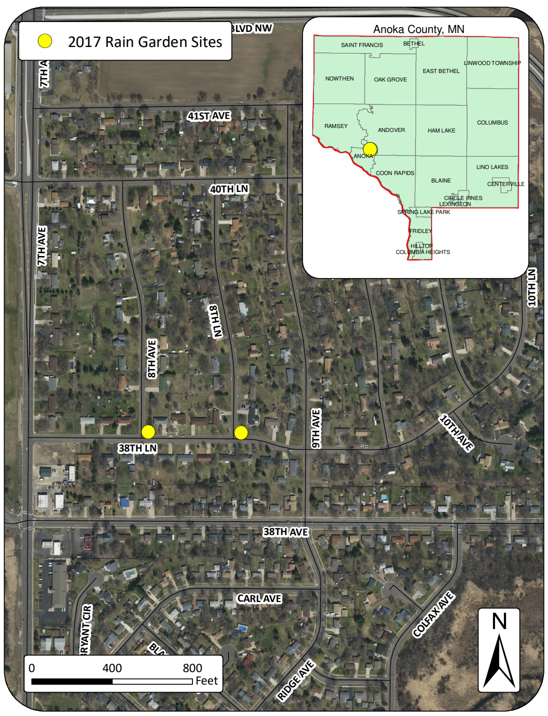
Anoka Rain Gardens

Description: In 2015 and 2016 a stormwater retrofit analysis (SRA) was done on selected areas in the Cities of Ramsey and Anoka. Many potential projects were modelled with cost-benefit analyses performed. Two of the identified projects, both residential curb-cut rain gardens, were installed in Anoka in 2017. Funding was from Clean Water Funds through the Anoka Conservation District (ACD) and a Metropolitan Council Grant to the Lower Rum River WMO. ACD managed the project.

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

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

Results: Two curb-cut rain residential gardens were constructed on 38th lane in Anoka.



807 38th Lane, Anoka

3900 8th Lane NW, Anoka

Newsletters

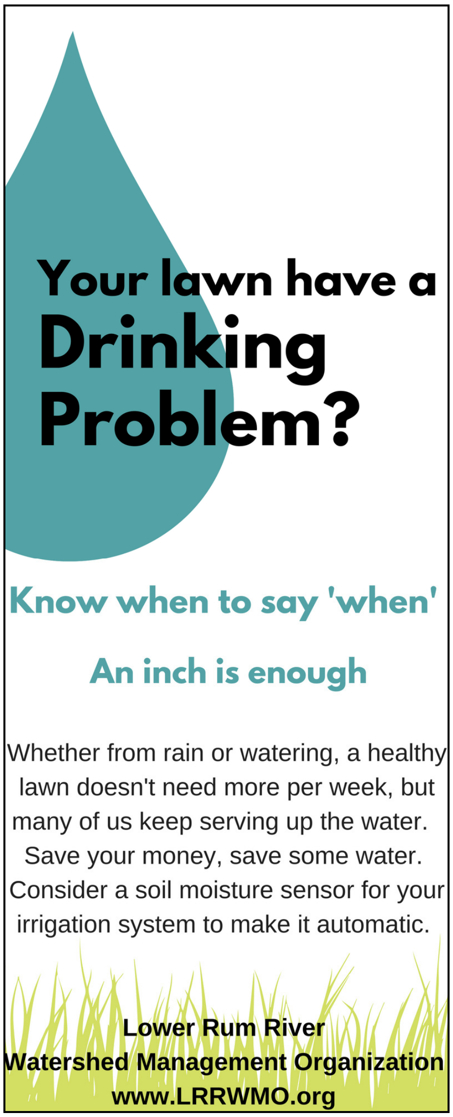
Description: The Lower Rum River Watershed Management Organization (LRRWMO) contracts the Anoka Conservation District (ACD) to create public education materials. The LRRWMO is required to distribute an annual publication under State Rules. This requirement is met through newsletters or infographics in city newsletters. This method ensures wide distribution at minimal cost.

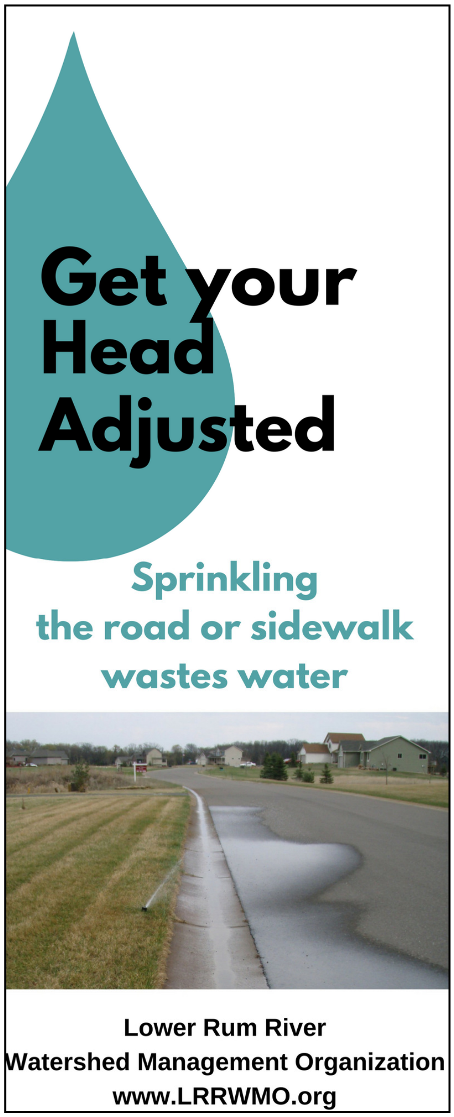
Purpose: To improve public understanding of the LRRWMO, its functions, and accomplishments.

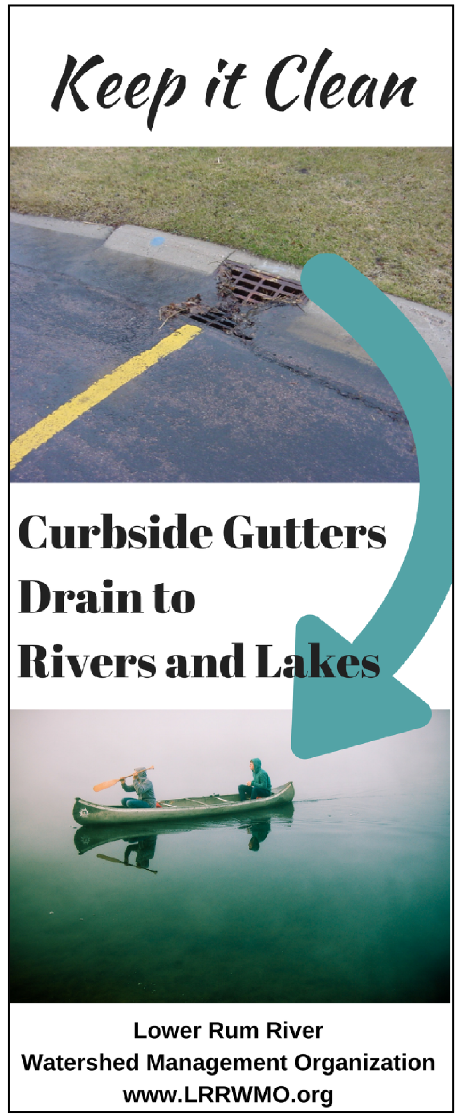
Location: Watershed-wide

Results: In 2017, the Anoka Conservation District (ACD) drafted three newsletter infographics and sent them to cities for inclusion in their newsletters. Two of the 2017 infographics focus on reducing water wasted during lawn irrigation. The third focuses on keeping curbside gutters clean as they are conveyances to rivers and lakes.

2017 Newsletter Infographics







LRRWMO Website

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

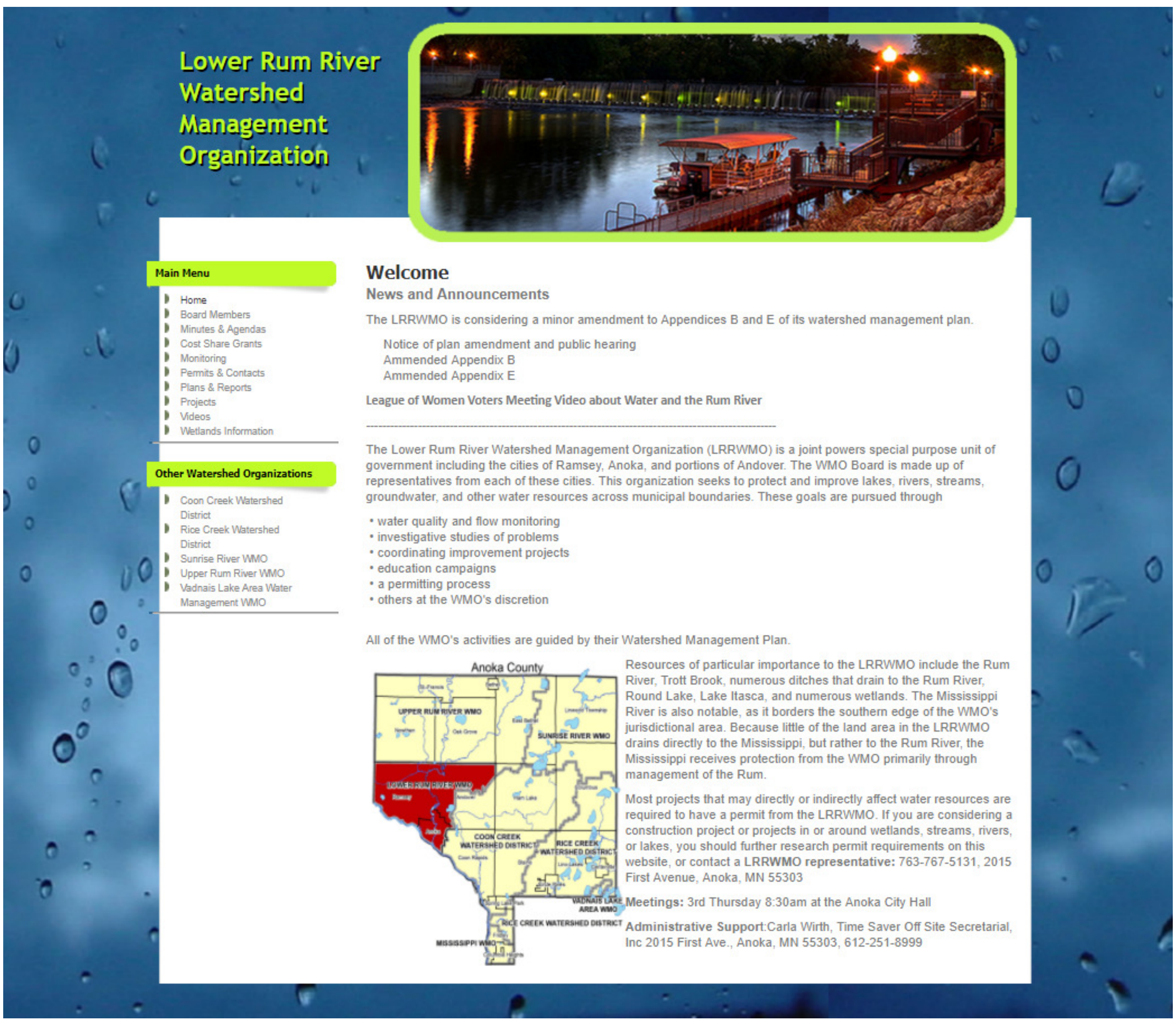
Purpose: To increase awareness of the LRRWMO and its programs. The website also provides tools and information that helps users better understand water resources issues in the area.

Location: LRRWMO.org

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

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

LRRWMO Website Homepage



Financial Summary

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

Lower Rum River Watershed Financial Summary

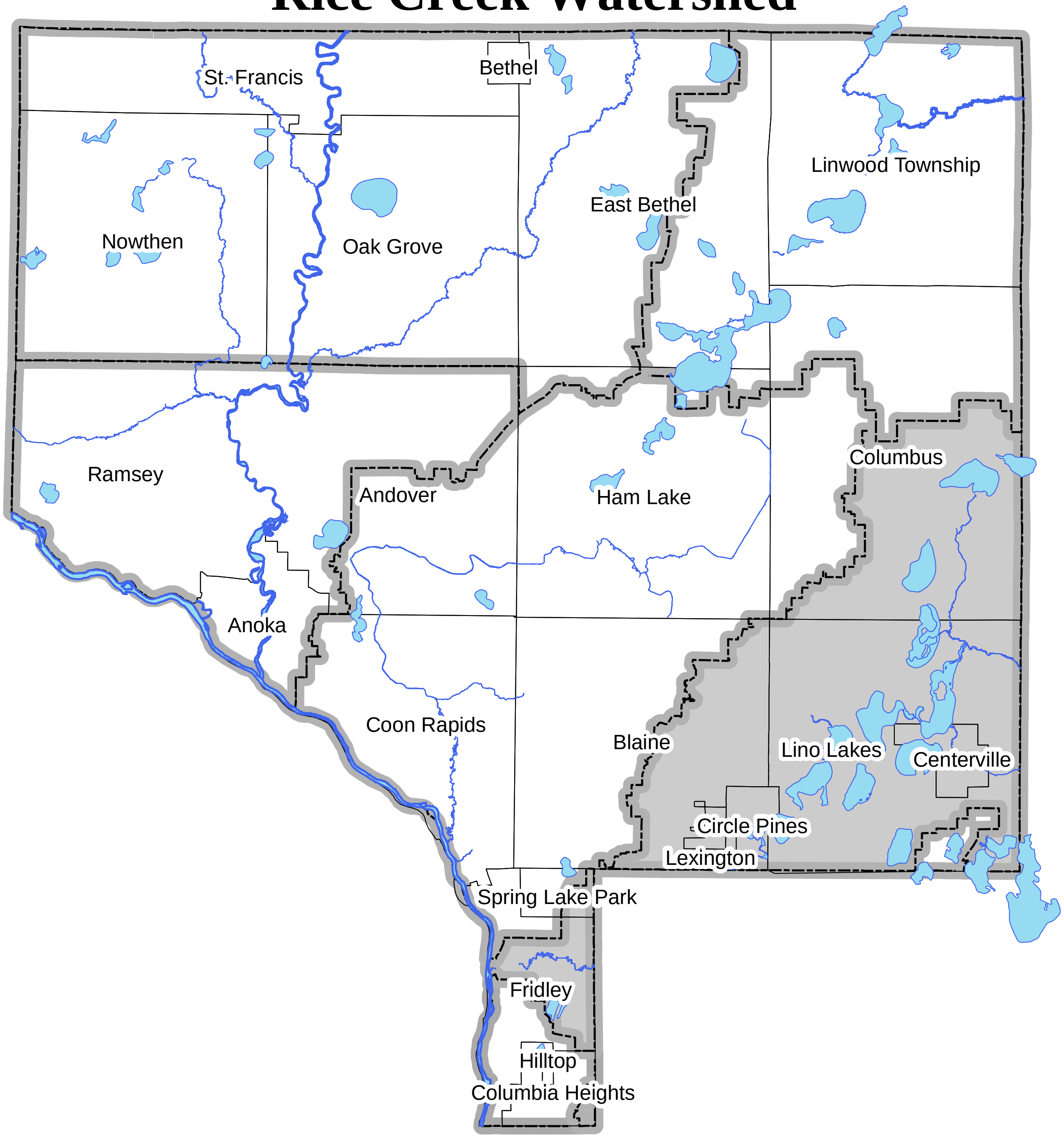
Lower Rum River Watershed	LRRWMO Admin/Reporting/Grant Search	County, City, SWCD Asst (no charge)	WMO Asst (no charge)	Rum River 1W1P	LRRWMO Promo/Website	Volunteer Precip	Reference Wetlands	DNR Groundwater Wells	Lake Levels	Lake Water Quality	Stream Water Quality	WOMP	Biomonitoring	Rum River Revets	Rum River Stabilization	LRRWMO Retrofits	Targeted BMP Promotion & Design	Rum River WRAPP	Inventory - Rum River Erosion	Project Tech Asst	Total
Revenues																					
LRRWMO	850				2165		1950		1200	1750	2240		825	1000		32442					44422
State - Other								70													6857
MPCA																		6691			9147
DNR OHF														9148							9148
DNR CPL																					0
BWSR Cons Delivery	105	577	416					74											51		2701
BWSR Capacity Staff				2763												17548	373		1910	295	33323
BWSR Capacity Direct																					137
BWSR Cost Share																					0
BWSR Cost Share TA																					0
BWSR Local Water Planning	112		175			73				82			76					161			679
Metro ETA & NPEAP															10176						10176
Metro AWQCP																					2009
Regional/Local	0				0		0			0	0	880	0	19189		0					24953
Anoka Co. General Services		464	416	366										5400		3137					25167
County Ag Preserves/Projects													547		2571						3478
Service Fees														6261							6425
Investment Dividend																					0
Rents																					0
Product Sales																					0
TOTAL	1067	1041	1006	3129	2165	73	1950	144	1200	1832	2240	880	1448	40998	12747	53128	373	6852	1961	295	178621
Expenses-																					
Capital Outlay/Equip	33	26	59	73	80	3	50	10	39	70	32	20	68	629	486	690	13	91	11	2	3909
Personnel Salaries/Benefits	958	939	874	2817	1520	60	1421	115	928	1155	635	682	1169	26638	9812	18290	389	1815	2143	324	111191
Overhead	41	37	41	74	76	4	107	10	55	78	45	36	84	1481	456	865	18	83	87	10	5470
Employee Training	1	4	3	20	4	0	12	1	5	9	3	3	4	226	40	74	0	2	1	0	598
Vehicle/Mileage	12	12	5	24	15	1	43	2	17	24	15	15	23	463	92	249	7	19	50	5	1588
Rent	22	23	24	82	38	2	75	6	33	58	28	26	42	816	257	517	11	44	63	7	3255
Project Installation														5479	945	32442					38867
Project Supplies				39	306	2	17		10	439	406		76	1382	660			4799			10755
McKay Expenses																					0
TOTAL	1067	1041	1006	3129	2039	73	1726	144	1087	1832	1164	783	1464	37113	12747	53128	438	6852	2355	349	175631
NET	0	0	0	0	126	0	224	0	113	0	1076	97	-17	3886	0	0	-65	0	-394	-54	2990

Recommendations

- **Continue to install projects identified in the stormwater retrofitting studies for the Cities of Anoka and Ramsey.** Projects have been identified and ranked that would improve stormwater runoff before it is discharged to the Rum or Mississippi River.

  A Metropolitan Council grant for construction was secured for 2017-18. Two rain gardens were constructed in 2017. Sufficient funding remains for a third project in 2018. Future funding requests should be considered.
- **Engage with upstream entities in the Rum River One Watershed, One Plan**, if funded by BWSR.
- **Implement the MPCA Rum River WRAPP (Watershed Restoration and Protection Plan).** This WRAPP was an assessment of the entire Rum River watershed. It outlines regional priorities and management strategies, and attempts to coordinate them across jurisdictions.
- **Maintain or reduce Rum River phosphorus.** Phosphorus levels are close to exceeding State water quality standards. It may be appropriate to review development and stormwater discharge ordinances to ensure no phosphorus increases in coming years.
- **Implement water conservation measures** throughout the watershed and promote it metro-wide. Depletion of surficial water is a concern region-wide.
- **Continue lake level monitoring, especially on Round Lake** where residents have expressed concerns with levels. Other nearby lakes should be monitored for comparison and to potentially detect problems.
- **Consider chloride sampling at all sites on a rotating basis.** Chloride sampling has not been done in recent years. Conductivity levels are rising in the entire county, and this may be due to chlorides.

Rice Creek Watershed



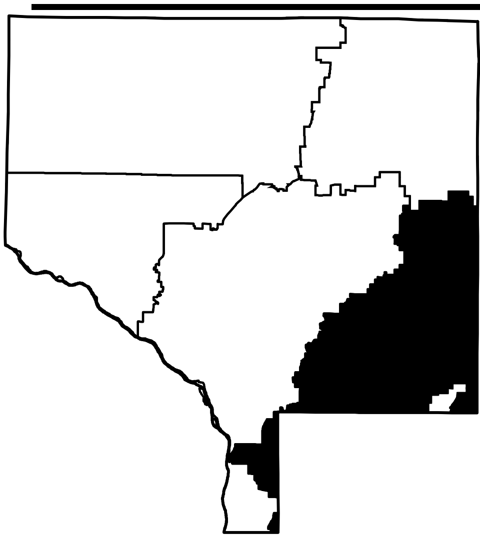
Contact Info: Rice Creek Watershed District
www.ricecreek.org
763-398-3070

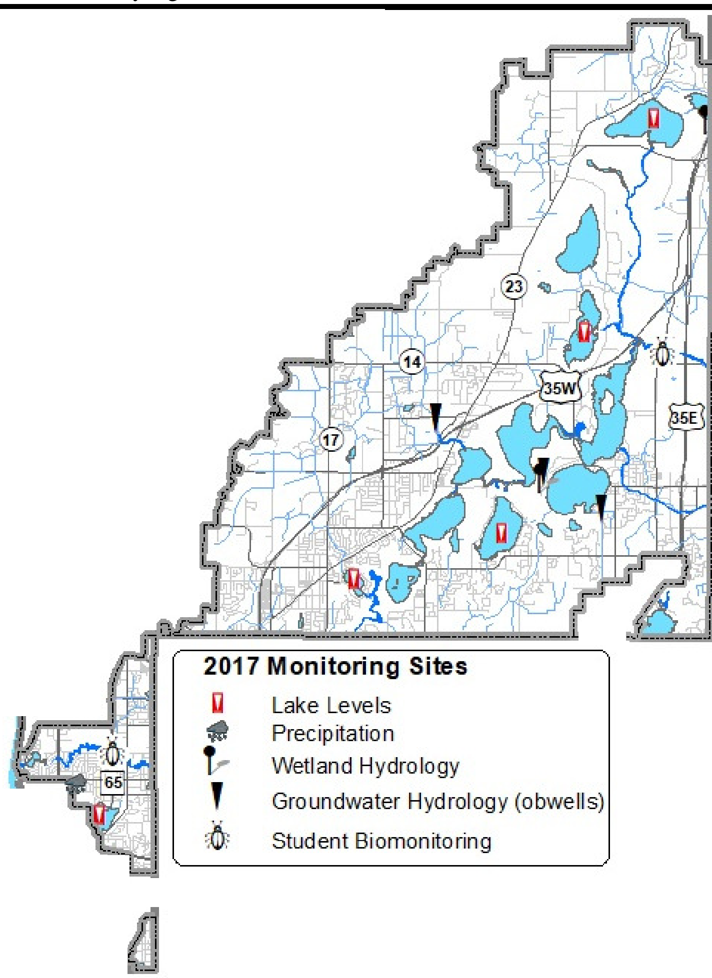
Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

CHAPTER 5: RICE CREEK WATERSHED

Task	Partners	Page
Lake Levels	RCWD, ACD	5-150
Wetland Hydrology	RCWD, ACD	5-152
Stream Water Quality – Biological	RCWD, ACD, ACAP, Forest Lake Area Learning Center, Totino Grace HS	5-155
Water Quality Grant Administration	RCWD, ACD	5-160
Financial Summary		5-163
Recommendations		5-164
Precipitation	ACD, volunteers	see Chapter 1
Ground Water Hydrology (obwells)	ACD, MNDNR	see Chapter 1
Additional work not reported here	RCWD	contact RCWD

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





Lake Levels

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

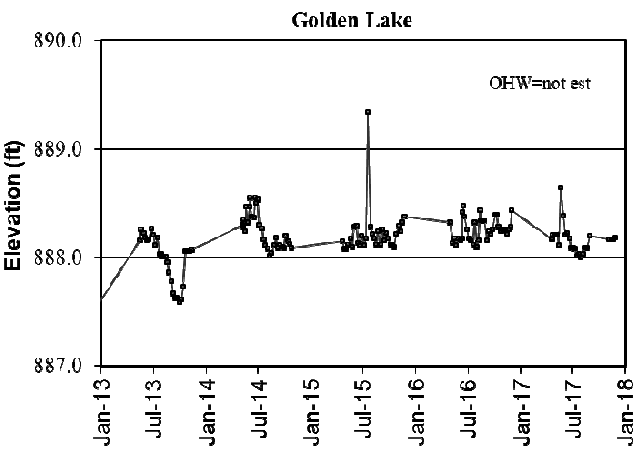
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

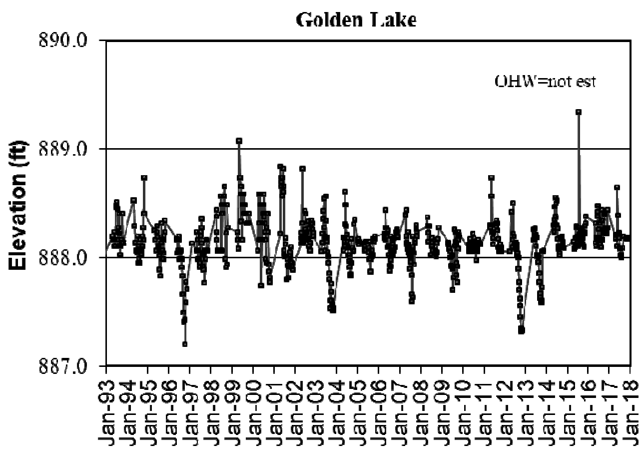
Results: Lake levels were measured by volunteers throughout the 2017 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes typically followed the expected pattern of increasing water levels through spring and early summer, followed by a decline through late summer and early fall. A moderate rebound in levels occurred in most lakes after large rain events in October. Overall, lake levels averaged at or slightly above long term averages in 2017.

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

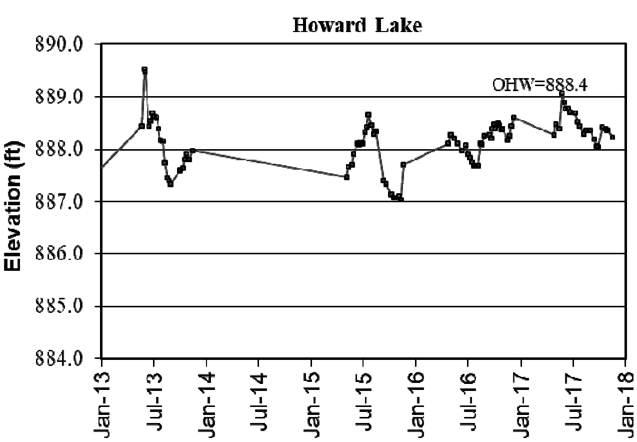
Golden Lake Levels- Last 5 Years



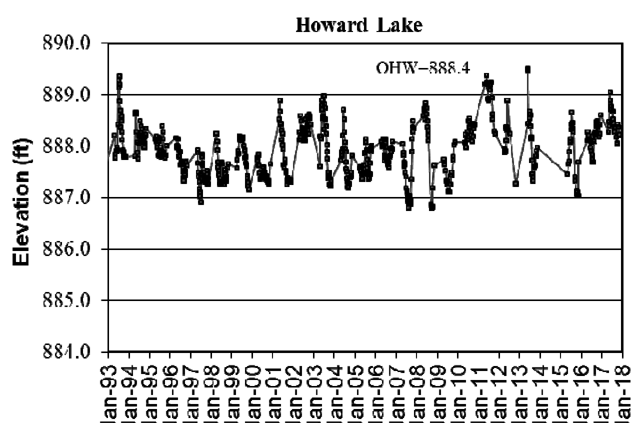
Golden Lake Levels- Last 25 Years



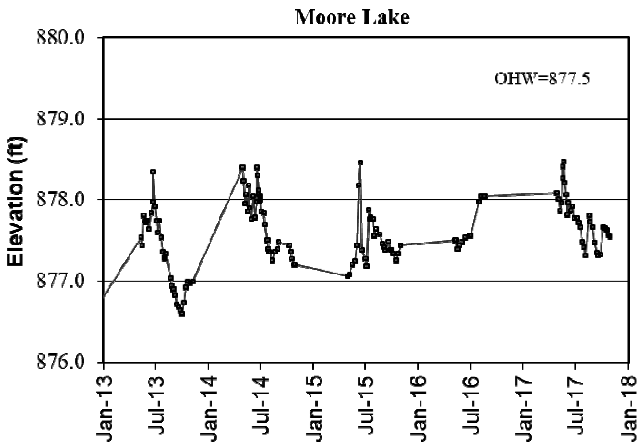
Howard Lake Levels- Last 5 Years



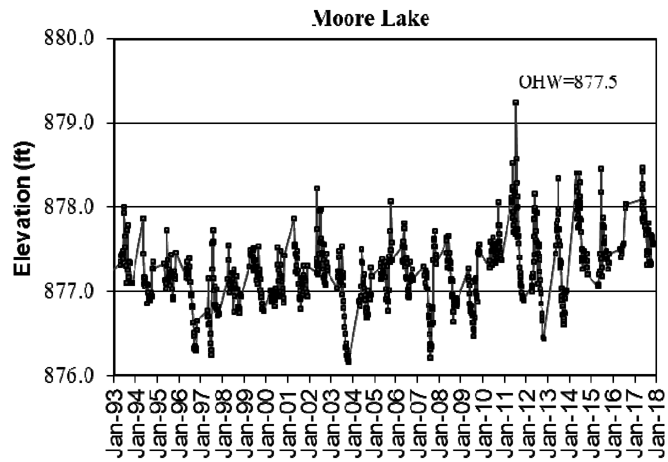
Howard Lake Levels- Last 25 Years



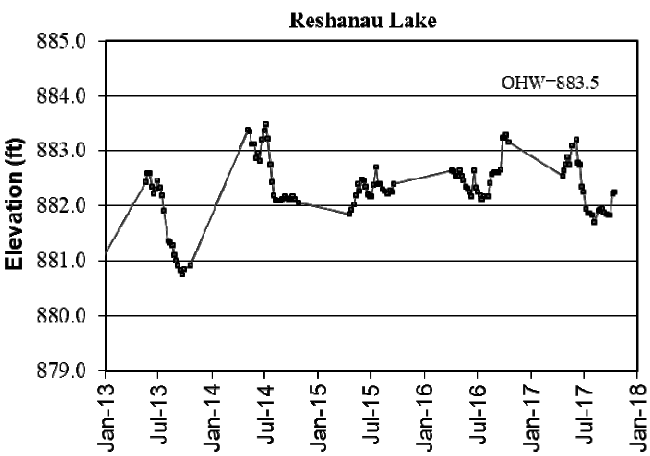
Moore Lake Levels- Last 5 Years



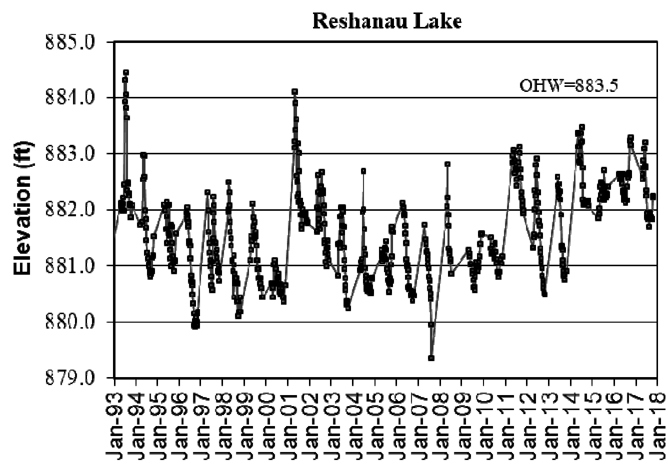
Moore Lake Levels- Last 25 Years



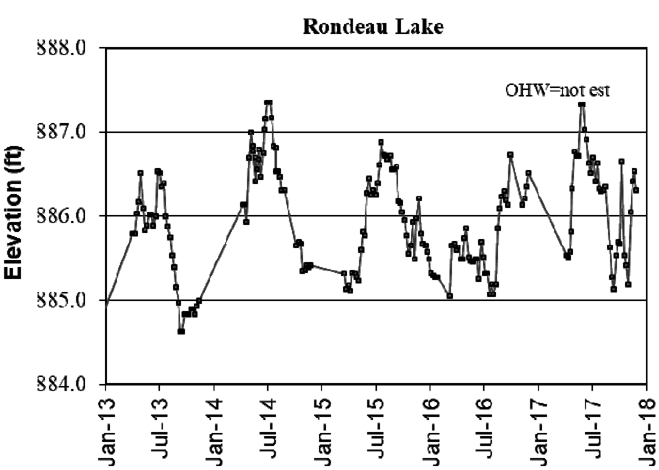
Reshanau Lake Levels- Last 5 Years



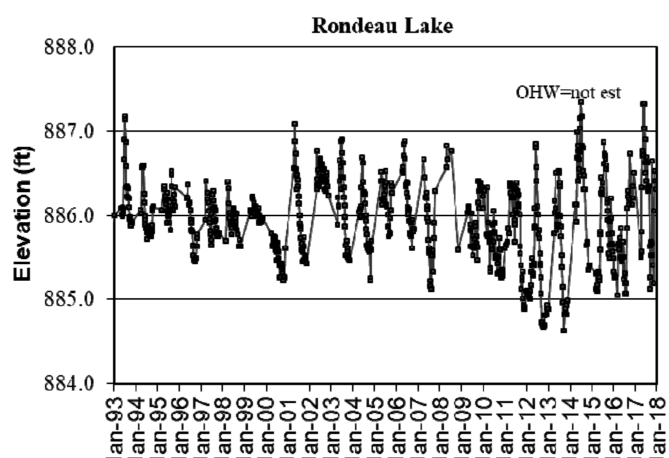
Reshanau Lake Levels- Last 25 Years



Rondeau Lake Levels- Last 5 Years



Rondeau Lake Levels- Last 25 Years



Wetland Hydrology

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

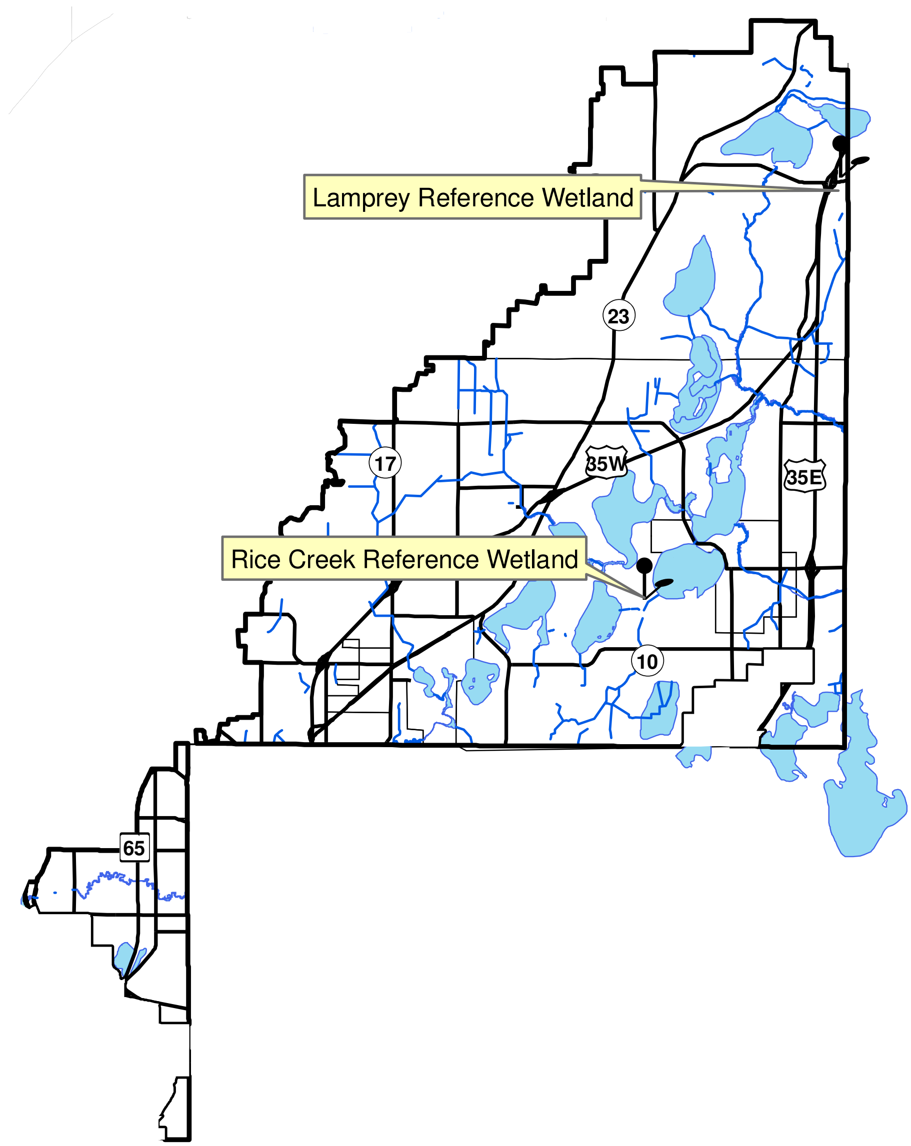
Purpose: To provide an understanding of wetland hydrology, including the impact of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

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

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

Results: See the following pages.

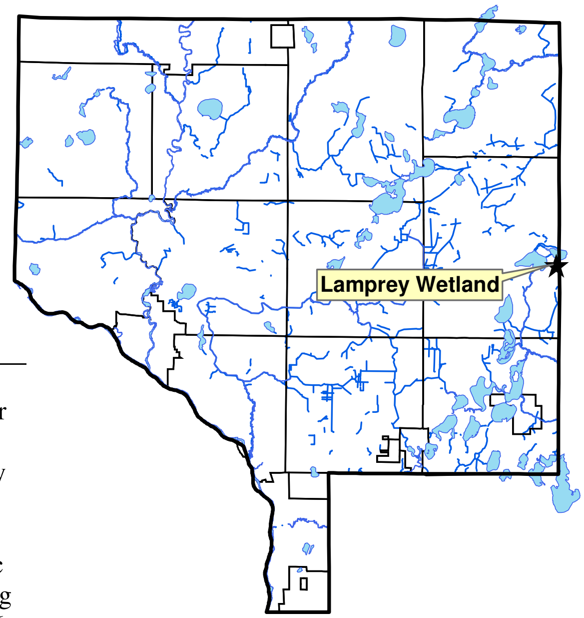
Rice Creek Watershed Wetland Hydrology Monitoring Sites



LAMPREY REFERENCE WETLAND

Lamprey Pass Wildlife Mgmt Area, Columbus

Site Information



Monitored Since: 1999

Wetland Type: 4

Wetland Size: ~0.5 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

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

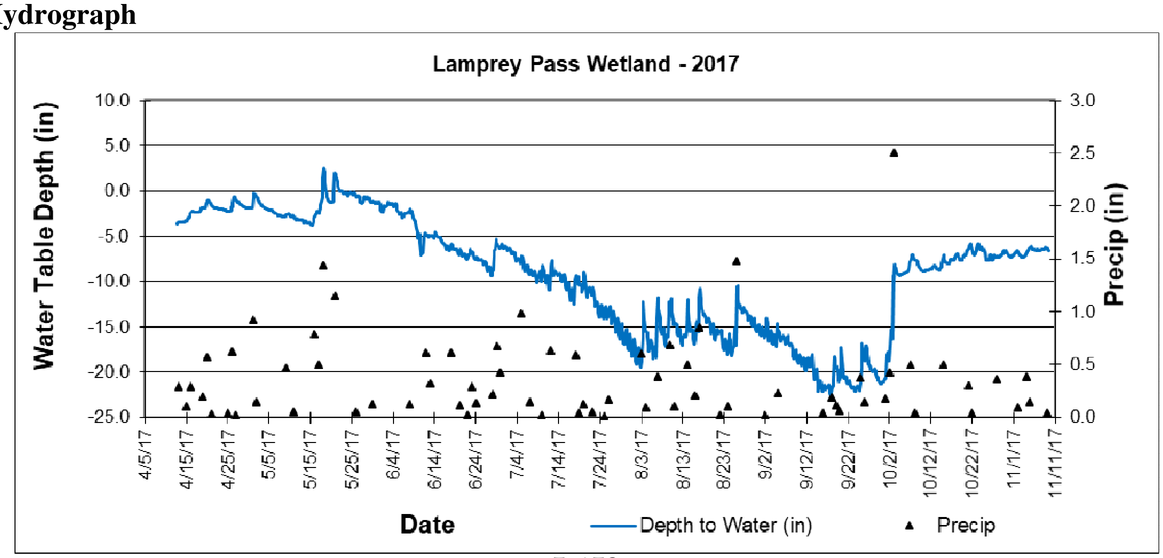
Surrounding Soils: Braham loamy fine sand

Vegetation at Well Location:

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

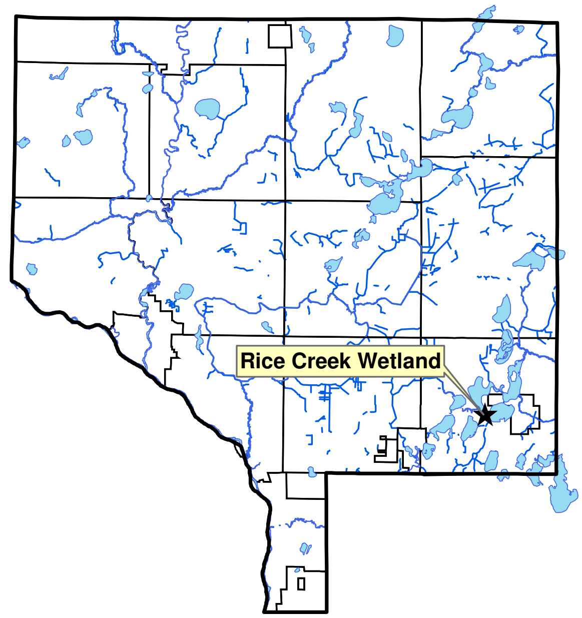
Other Notes: Wetland is about 200 feet west of Interstate Highway 35, but within a state wildlife management area. Well is located at the wetland boundary.

2017 Hydrograph



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

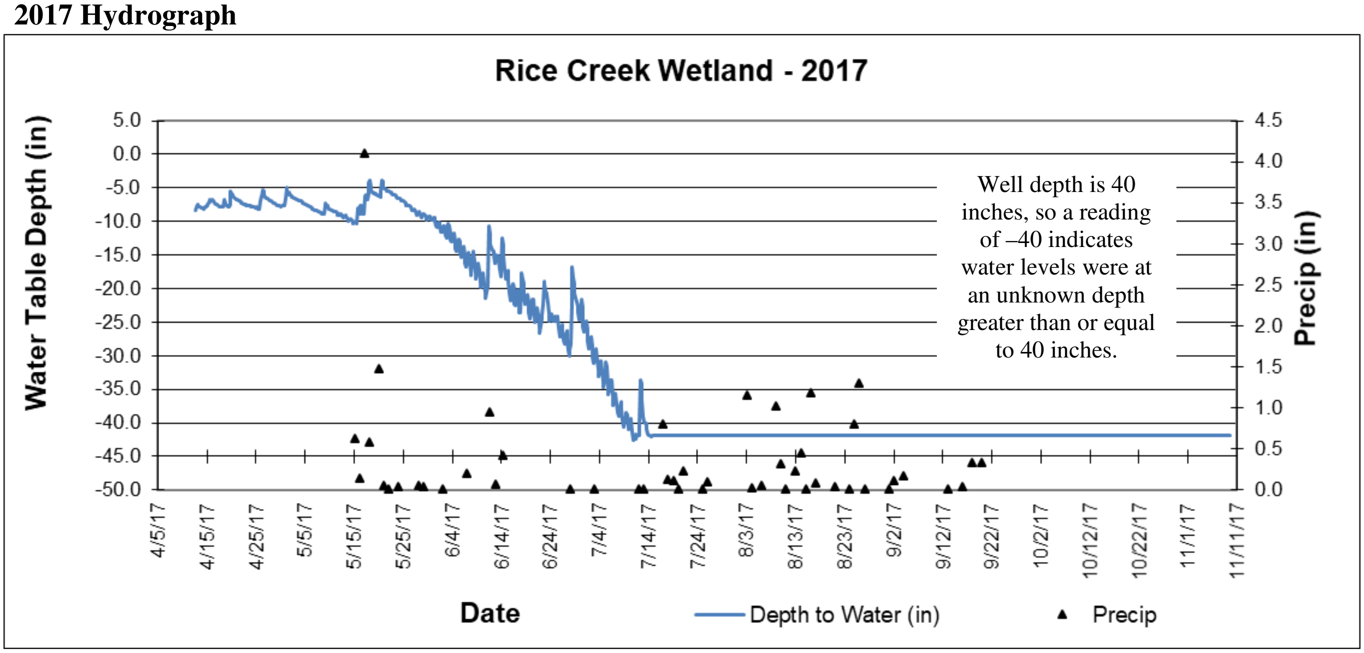
Surrounding Soils: Nessel fine sandy loam and Blomford loamy fine sand

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.

2017 Hydrograph



Stream Water Quality – Biological Monitoring

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

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

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

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

Tips for Data Interpretation

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

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

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

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

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

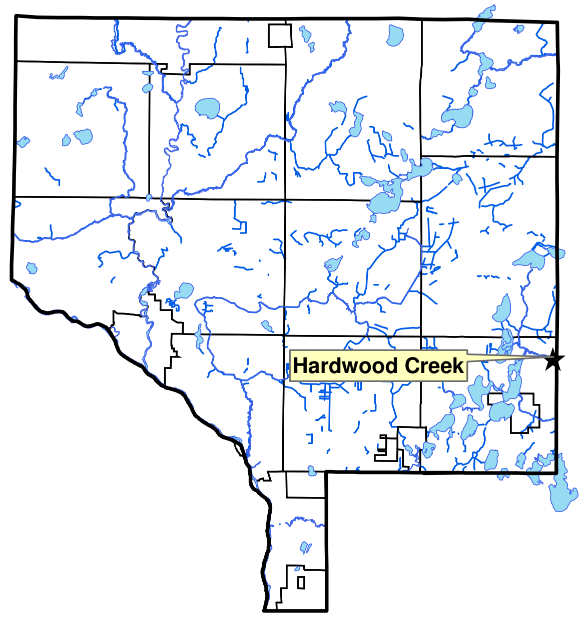
Population Attributes Metrics

% 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.

% 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).

HARDWOOD CREEK

see list of monitoring locations below



Last Monitored

By Forest Lake Area Learning Center in fall of 2017

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
2009-2017 at Cecelia LaRoux property 600 m W of I-35

Student Involvement

9 students in 2017, approximately 270 since 2001

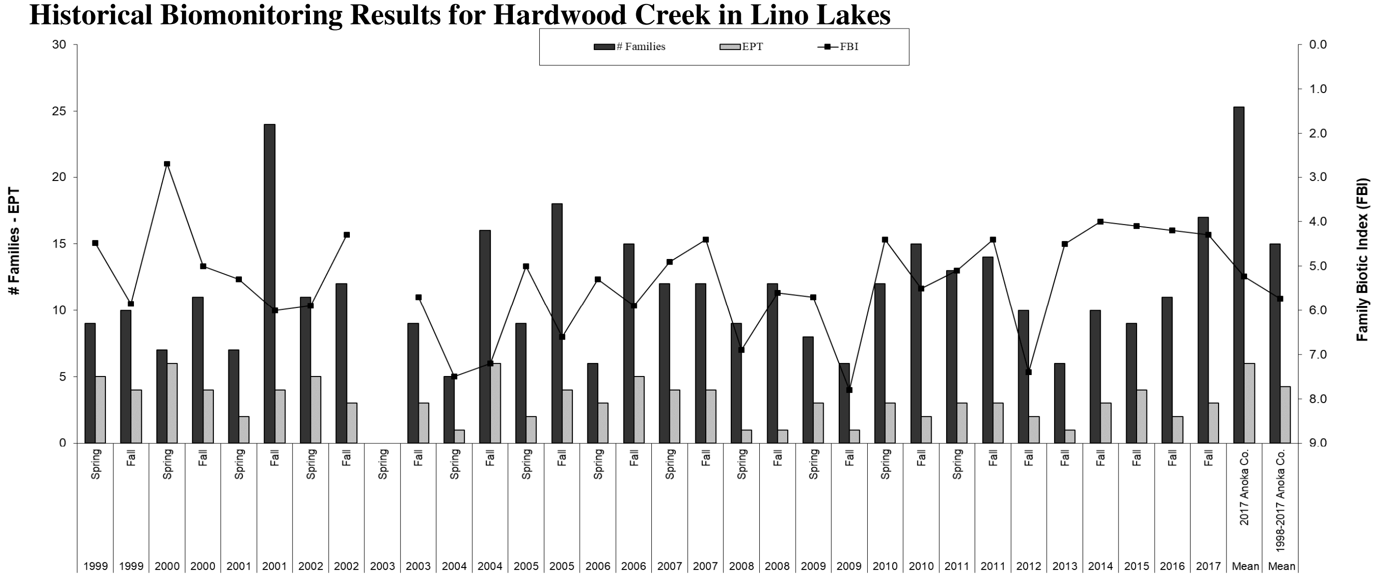
Background

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

Results

A Forest Lake Area Learning Center class monitored Hardwood Creek in the fall of 2016, facilitated by the Anoka Conservation District. This site was the subject of a stream restoration project that included rock veins, brush bundles and willow staking. An improvement in stream health documented in 2010-11was followed up by consecutive years of decreases in number of families and EPT in 2012-13. An upward trend in both has been occurring since 2013. 2017 was one of the better years of sampling at this site, with the most families collected (17) since 2005. Only three of the sensitive EPT taxa were collected, however, an increase from two the previous year, but well behind the county average of 6 for 2017 and 4.2 for all years. Gammarid amphipods are extremely numerous at this site and have been the dominant taxa most recent years.

Historical Biomonitoring Results for Hardwood Creek in Lino Lakes



Biomonitoring Data for Hardwood Creek in Lino Lakes- Previous Five Years

Year	2013	2014	2015	2016	2017	Mean	Mean
Season	Fall	Fall	Fall	Fall	Fall	2017 Anoka Co.	1998-2017 Anoka Co.
FBI	4.5	4.0	4.1	4.2	4.3	5.2	5.7
# Families	6	10	9	11	17	25.3	15.0
EPT	1	3	4	2	3	6.0	4.2
Date	10-Oct	10-Oct	8-Oct	10-Oct	11-Oct		
Sampled By	FLALC	FLALC	FLALC	FLALC	FLALC		
Sampling Method	MH	MH	MH	MH	MH		
Mean # Individuals/Rep.	87	359	158	469	264		
# Replicates	1	1	1	1	1		
Dominant Family	Gammaridae	Gammaridae	Gammaridae	Gammaridae	Gammaridae		
% Dominant Family	87.4	97.2	62.7	91.7	79.5		
% Ephemeroptera	3.4	0.8	32.3	2.3	6.1		
% Trichoptera	0	0.3	0.6	0	0.4		
% Plecoptera	0.0	0.0	0.0	0.0	0.0		
% EPT	3.4	1.1	32.9	2.3	6.5		

Discussion

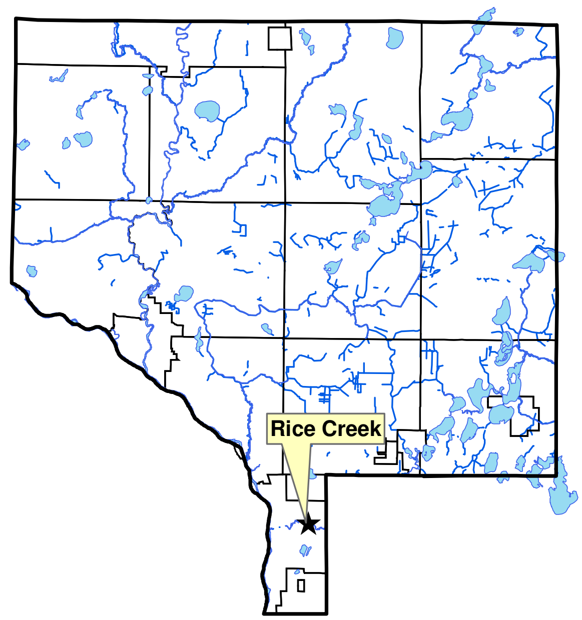
Hardwood Creek is on the Minnesota Pollution Control Agency's 303(d) list of impaired waters for impaired biota and dissolved oxygen. The Rice Creek Watershed District has conducted a TMDL investigative study. Our biological monitoring does indicate a below average biological community but lends only 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, but overall the invertebrate biota is indicative of substandard stream health.

Forest Lake Area Learning Center students at Hardwood Creek.

RICE CREEK

at Hwy 65, Locke Park, Fridley



Last Monitored

By Totino Grace High School in fall 2017

Monitored Since

1999

Student Involvement

64 students in 2017, approximately 1,200 since 2001

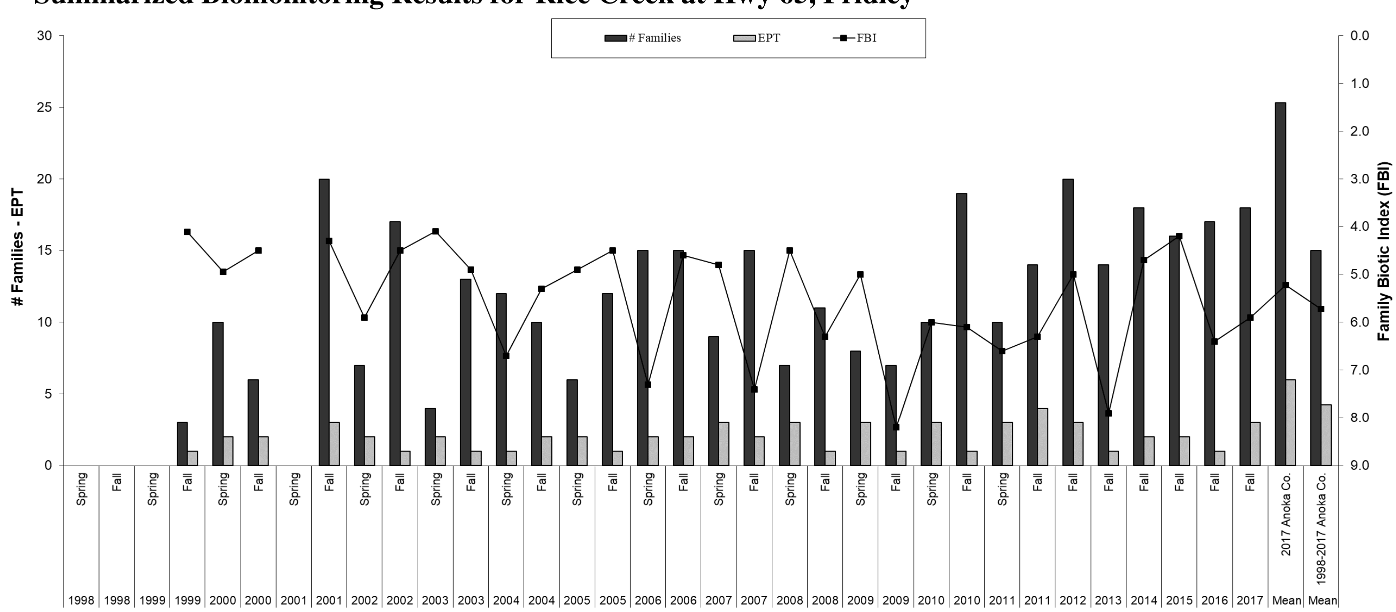
Background

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 2017, facilitated by the Anoka Conservation District. At this site, Rice Creek has a macroinvertebrate community indicative of poor stream health. While the number of families present has been similar to, or above the long-term average for Anoka County streams on several occasions, most of these are generalist species that can tolerate polluted conditions. The most dominant family in 2017 was the Simulidae, or black fly larvae, a very generalist organism. The number of EPT families present has been below the county average in all years. EPT are generally pollution-sensitive, but the EPT family most often found in Rice Creek the caddisfly family Hydropsychidae, is an exception to that rule. It thrives in relatively poor environmental conditions. In addition to being the dominant species found in Rice Creek occasionally, Hydropsychidae was one three EPT families collected in 2017.

Summarized Biomonitoring Results for Rice Creek at Hwy 65, Fridley



Biomonitoring Data for Rice Creek at Hwy 65, Fridley- Previous Five Years

Year	2013	2014	2015	2016	2017	Mean	Mean
Season	Fall	Fall	Fall	Fall	Fall	2017 Anoka Co.	1998-2017 Anoka Co.
FBI	7.9	4.7	4.2	6.4	5.9	5.2	5.7
# Families	14	18	16	17	18	25.3	15.0
EPT	1	2	2	1	3	6.0	4.2
Date		16-Oct	13-Oct	18-Oct	17-Oct		
Sampled By	TGHS	TGHS	TGHS	TGHS	TGHS		
Sampling Method	MH	MH	MH	MH	MH		
# Individuals	107	670.5	730	272	545		
# Replicates	2	2	1	1	1		
Dominant Family	Corixidae	Hydropsychidae	Hydropsychidae	Hydropsychidae	Simuliidae		
% Dominant Family	38.0	76.7	92.6	41.5	65.2		
% Ephemeroptera	0.0	0.1	0.4	0	2		
% Trichoptera	6.4	76.7	92.6	41.5	12.3		
% Plecoptera	0.0	0.0	0.0	0	0		
% EPT	6.4	76.8	93.0	41.5	14.3		

Discussion

The poor macroinvertebrate community in this creek is likely due to poor water quality and flashy flows during storms, 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. During storms, water levels in the creek can rise sharply.

Totino Grace High School students at Rice Creek.

Water Quality Grant Administration

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

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

Results: Below is a summary of technical assistance provided in 2017.

2017 Highlights:

- 22 formal property reviews/site visits throughout the Rice Creek watershed in Anoka County (see overview map below). Projects included:
  - Rain Gardens
    - Design, cost-share coordination, and construction oversight for a residential curb-cut rain garden in Columbia Heights (Silver Lake).

    - Cost-share coordination and construction oversight for the retrofit of a curb-cut rain garden with a pretreatment chamber in Circle Pines (Golden Lake).

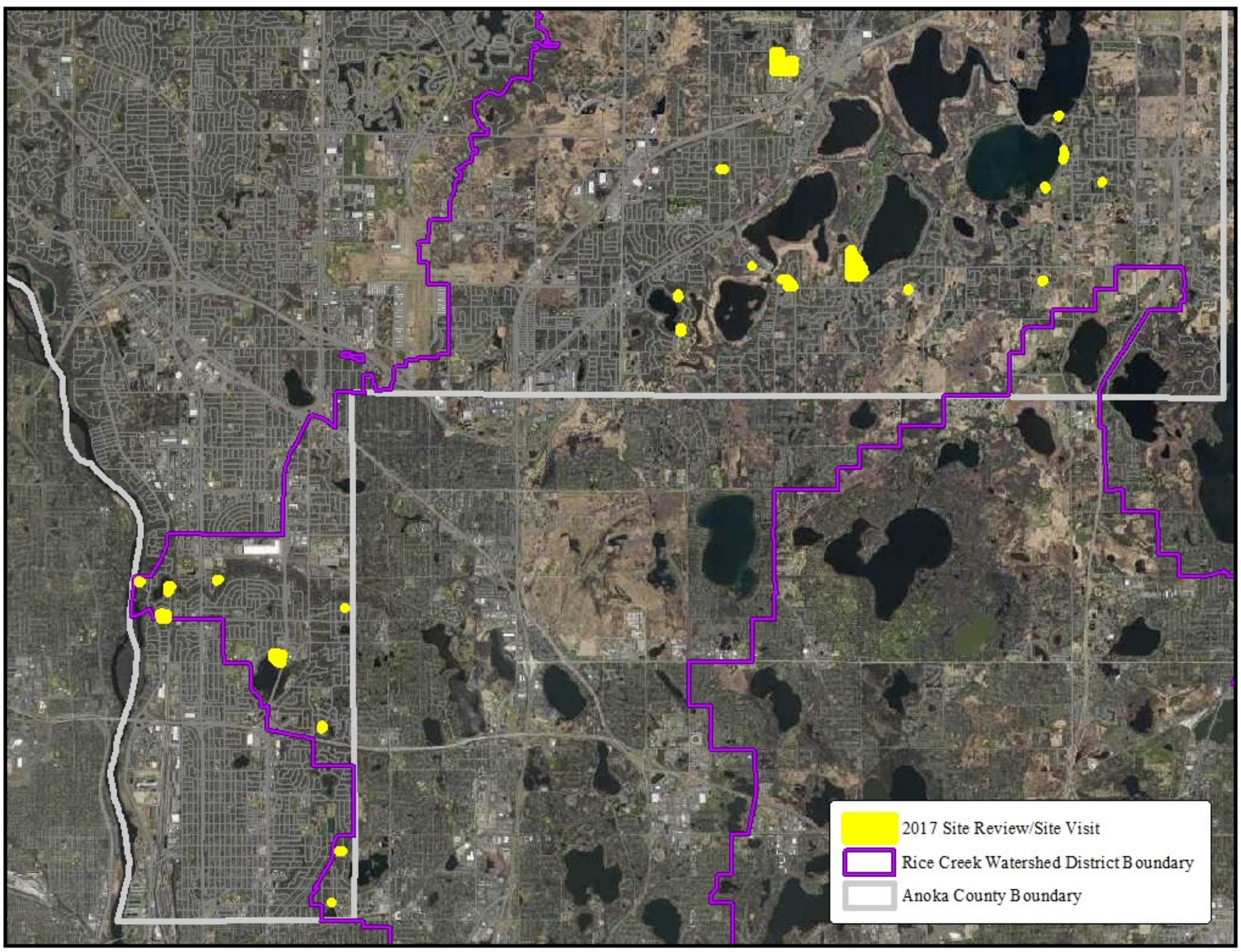
- Design, cost-share coordination, and construction oversight for a church campus curb-cut rain garden in Fridley (Rice Creek).

- Shoreland Restorations
  - Design, cost-share coordination, and construction oversight for a cedar tree revetment in Fridley (Locke Lake).

  - Design and cost-share coordination for a shoreline stabilization within a public park in the City of Centerville (Centerville Lake).
- Streambank Stabilizations
  - Design, cost-share coordination, and construction oversight for a streambank stabilization in the City of Fridley (Rice Creek).

- Swales
  - Design, cost-share coordination, and construction oversight for the retrofit of a vegetated swale with a pretreatment chamber in Fridley (West Moore Lake).

Map of sites that ACD provided technical assistance for in RCWD, Anoka County



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	County, City, SWCD Asst (no charge)	Volunteer Precip	Reference Wetlands	DNR Groundwater Wells	Lake Levels	Biomonitoring	Golden Lake Pond IESF	RCWD Project Tech Asst	RCWD Cost Share Admin	Total
Revenues										
RCWD			1300		1500	1700		13264	1737	19500
State - Other				350						350
MPCA										0
DNR OHF										0
DNR CPL										0
BWSR Cons Delivery	577			369						945
BWSR Capacity Staff								1207		1207
BWSR Capacity Direct										0
BWSR Cost Share										0
BWSR Cost Share TA										0
BWSR Local Water Planning		73				152				225
Metro ETA & NPEAP										0
Metro AWQCP										0
Regional/Local			0			0	21255	0	0	21255
Anoka Co. General Services	464						2368			2832
County Ag Preserves/Projects						1093				1093
Service Fees								2493		2493
Investment Dividend										0
Rents										0
Product Sales										0
TOTAL	1041	73	1300	719	1500	2945	23623	16964	1737	49901
Expenses-										
Capital Outlay/Equip	26	3	33	49	48	135	345	311	36	987
Personnel Salaries/Benefits	939	60	947	573	1160	2337	11467	14333	1439	33256
Overhead	37	4	71	51	68	167	433	605	55	1490
Employee Training	4	0	8	4	6	8	90	70	2	192
Vehicle/Mileage	12	1	29	12	22	45	136	196	21	474
Rent	23	2	50	30	42	84	371	344	35	982
Project Installation								729		729
Project Supplies		2	12		13	151	10781			10959
McKay Expenses										0
TOTAL	1041	73	1151	719	1359	2928	23623	16588	1588	49069
NET	0	0	149	0	141	17	0	376	149	832

Recommendations

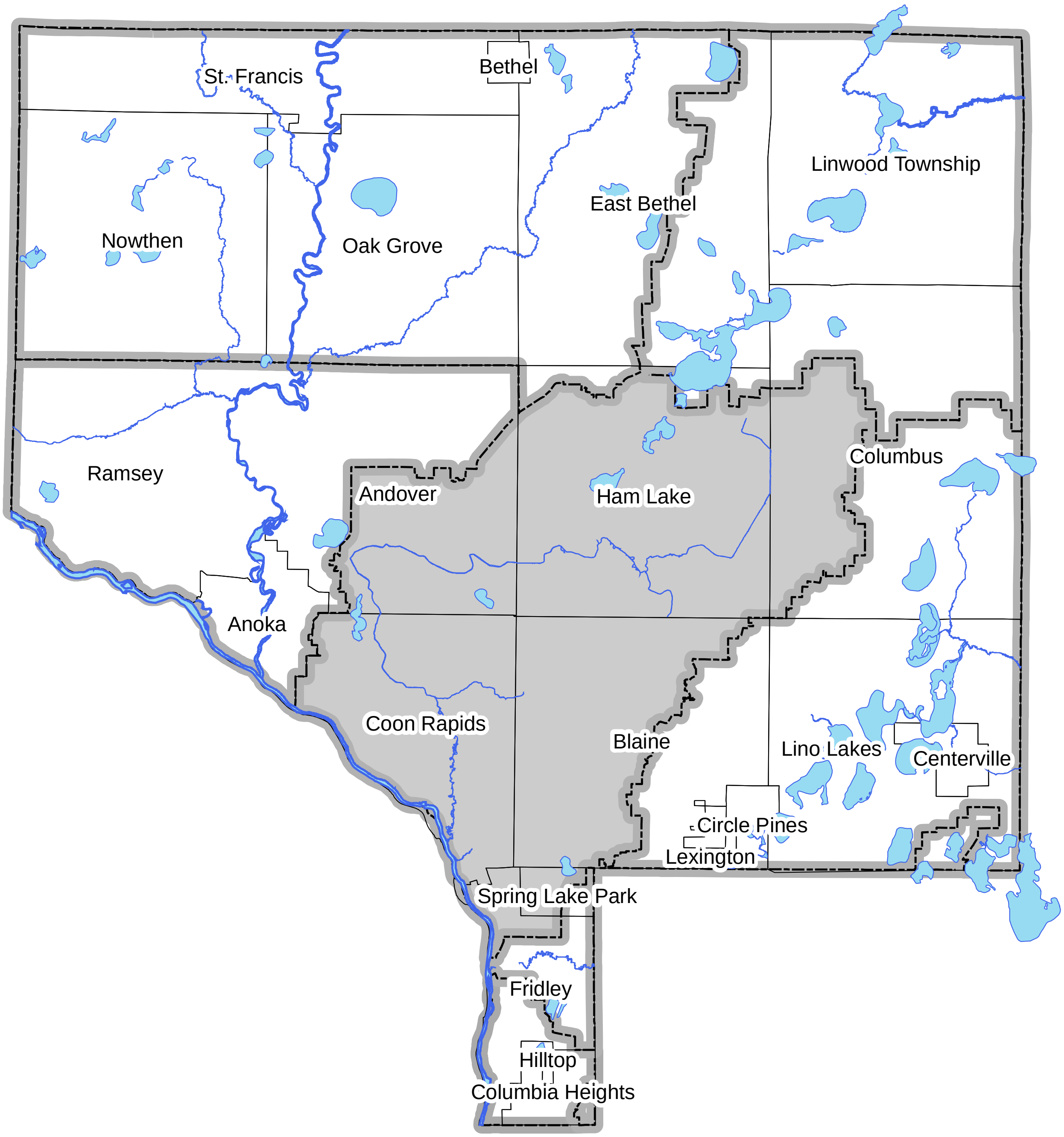
- **Continue to install cost effective projects** identified in previously completed Subwatershed Retrofit Analyses and prioritized in newly completed sub-catchment analyses. Install and maintain water quality improvement projects.

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

- **Continue efforts to reduce road salt use.** Chlorides are pervasive throughout shallow aquifers and the streams that feed them. Conductivity readings are increasing throughout the County, and it is likely that stream chloride concentrations are following suit.

- **Continue the biomonitoring program** with area schools. This program provides dual benefits in contributing to a long-term bio-indicator dataset as well as educating local youth on their natural resources.

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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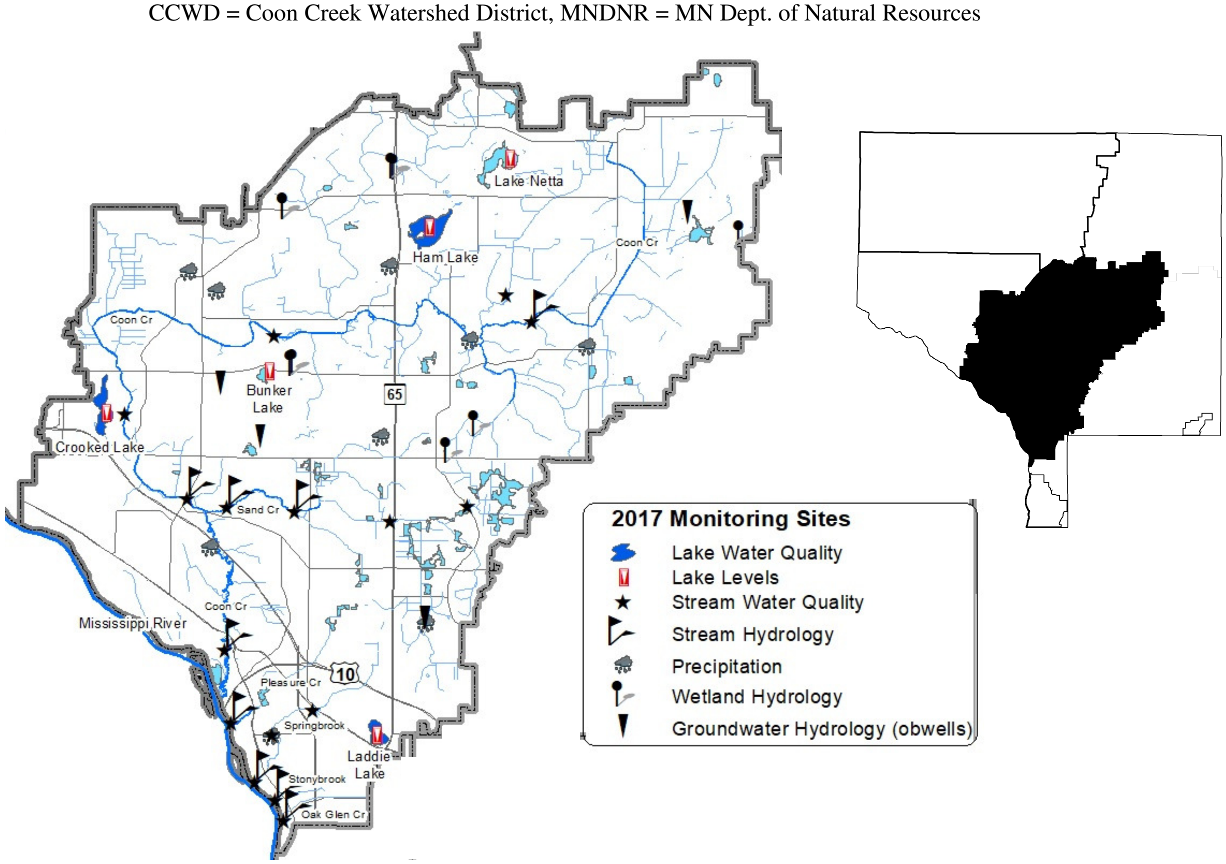
Groundwater Hydrology (obwells)	ACD, MNDNR	see Chapter 1

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



Summary of Findings

Description:

This is a brief summary of new findings and notable results from 2017. Detailed analyses for all individual sites can be found below in the appropriate section of the work results.

Lake Water Quality:

- Ham Lake received an overall B grade in 2017 for the second straight year due to a recent increase of chlorophyll-a (Cl-a) and phosphorus. Cl-a still shows a long-term statistical improvement, and both Secchi clarity and phosphorus appear to be trending toward improved conditions, but the last couple of years' data have not bolstered that trend. Lakeshore practices, septic systems, tributary loading, and potential impacts of AIS treatments should be a focus of study if water quality starts to decline.
- Laddie Lake, after very good water quality in 2016, declined back to a B overall letter grade in 2017. A rebound in both phosphorus and Cl-a caused the grade drop. There was a large increase in both parameters, particularly in July 2017. Even with the slight decline in water quality in 2017, Laddie Lake maintains very high water quality for a shallow lake in a fully developed watershed, supporting all state eutrophication standards.
- Crooked Lake has steadily been improving in a statistically significant fashion since the 1980s and 1990s. However, over the last two years of sampling (2015 and 2017), the overall letter grade declined back to a B after receiving A grades in 2012 and 2014. Phosphorus and Cl-a were at their highest levels since 2009, though the fluctuation of each was <5 µg/L. Secchi transparency still shows a long-term statistical improvement and has stabilized around 8.5 ft. since 2011.

Lake AIS Surveys

- AIS early detection surveys were conducted on Ham, Laddie, Crooked and Netta Lakes on 5/25/2017 and 9/13/2017. No new infestations were found.

Stream Water Quality:

- Overall, high conductivity levels have been observed throughout Coon Creek Watershed District (CCWD), and the small subwatersheds in the southern portion of CCWD that drain directly to the Mississippi have very high conductivity levels. Chloride testing, which has not been done for a number of years, should be considered again on a recurring basis. Over 8 years sampled from 2005-2012 chlorides increased in a statistically significant fashion in Coon Creek. Strategically timed chloride monitoring would help determine if the cause is salts, such as road deicing salts or fertilizers, as is often found elsewhere. Efforts to reduce winter salt use and curb other sources of pollutants may be considered an increased priority.
- Two subwatersheds were sampled for the first time in 2017: Oak Glen Creek and Stonybrook. Both appear to have major water quality issues, including the highest average conductivity levels ever recorded in streams in Anoka County. Both streams become very turbid during stormflows. Stonybrook also has very high levels of phosphorus and *E. coli.* These streams are both likely overwhelmed by rapid stormwater delivery from storm sewer systems to undersized, deeply cut, and highly eroding channels descending to the Mississippi. The effectiveness of an expanded stormwater pond and iron-enhanced sand filter constructed in the Oak Glen subwatershed in 2017 will be monitored by the City of Fridley.
- The main stem of Coon Creek has high phosphorus levels during storm flows, exceeding the 100µg/L State standard in 90% of storm samples at Vale Street. Observed concentrations are often 3-7 times that standard. Loading is occurring at all stages of the watershed, with Ditch 11 being a large upstream contributor. TSS is similarly high during storms, with a long-term storm sample median right at the State

standard of 30 mg/L at Vale St with 48% of storm samples exceeding state standards. TSS and phosphorus likely share common loading sources in the watershed such as in-channel and streambank erosion, agricultural runoff, and urban stormwater inputs.

E. coli levels in Coon Creek are also high with median levels during all conditions, even baseflow, in the lower watershed exceeding the chronic standard of 126 MPN. Sampling frequency does not allow State standard compliance calculations, but medians exceeding the chronic standard levels indicate that an impairment designation would be likely if the sampling regime were modified.

- The Sand Creek subwatershed has high specific conductivity, though it does not appear to be trending upward over time. Phosphorus is lower in Sand Creek than most streams in Anoka County, including Coon Creek, but there are occasional exceedances of State standards during storms (37% of storm samples). Suspended solid loads increase during storm flows in Sand Creek, approaching state standard levels and contributing to high TSS in Coon Creek.

  E. coli is a problem in Sand Creek with high concentrations at most monitoring sites, especially during storm flows. Interestingly, the sampling site at Highway 65 consistently has much lower *E. coli* concentrations than the sites upstream and downstream at Radisson Road and Morningside Cemetery, respectively. Treatment by ponds in the Club West development and golf course ponds in this reach may be responsible, but more research is needed. It has been hypothesized that the ponds capture *E. coli* or chemical applications to these ponds may decrease *E. coli*. It is however also possible for ponds to serve as sources of *E. coli* due to waterfowl populations and/or nutrient cycling dynamics.

- Monitored small subwatersheds draining directly to the Mississippi River in the southern portions of CCWD (Springbrook Cr, Pleasure Cr, Oak Glen Cr, Stonybrook) all have major water quality concerns. All of these systems drain highly urbanized subwatersheds and are likely overloaded with untreated or under-treated storm water rapidly conveyed through storm sewer systems. All of these small waterways have high conductivity, phosphorus, suspended solids, and *E. coli*, with storms exacerbating the problems in each. Each of these systems would benefit from storm water retention and treatment projects in their respective subwatersheds, ultimately resulting in cleaner water entering the Mississippi.

Stream Hydrology:

- Overall, 2017 stream levels were lower than 2016 levels, and averaged at or slightly below average for recent years.
- Hydrology in the two streams that had not been previously monitored, Oak Glen Creek and Stonybrook, was flashy. We found that electronic measurements of water level every two hours, as is done at most other streams, was too infrequent. Entire storm surges were missed at Stonybrook if a two-hour recording interval was used, and the interval was decreased to every half hour in June at that site. Both streams increase and decrease multiple feet in short time periods before and after storms.

Precipitation:

- 2017 was a dryer year than 2016 and slightly dryer than the 30-year average. Average annual rainfall totaled 30.84 inches across the CCWD, and precipitation was spread out throughout the year with few very large or intense events.
- Precipitation gauges at the ACD office, Coon Rapids and Andover City Halls, and Coon Creek at Waconia St. did not record a 1-year recurrence interval storm events by Atlas 14 standards.
- The Blaine Public Works gauge recorded the only 5-year recurrence interval rain event in the watershed in May, as well as one 2-year event in October.
- The Northern Natural Gas gauge recorded three 1-year storm events and one 2- year storm event.
- The Springbrook Nature Center gauge recorded two, 2-year storm events.

Recommendations

- **Continue to phase out aging RDS data loggers** and budget for replacement with OTT Orpheus Mini data loggers for hydrology measurements. The RDS manufacturer is out of business and only one downloading cord is available. That cord has been repaired many times and will be irreplaceable when no longer repairable.

- **Phase out RDS precipitation gauges and move toward online weather stations.** The RDS manufacturer is out of business and downloading is dependent upon one remaining functional cord. Davis brand weather stations include high quality tipping buckets and also offer online connectivity as well as data logging capability.

- **Add chloride monitoring** at all stream sites on a recurring basis of at least once every three years. Conductivity throughout the county has been rising, with some waterways approaching concerning levels. Chloride monitoring will help gauge the extent to which salts (deicing, water softeners, etc.) are contributing and target corrective management.

- **Refine grab sampling of Stonybrook and Oak Glen Creek** to capture storm flows. Storm flows are brief due to the small, urbanized watershed. Special sampling trips or automated samplers may be appropriate.

- **Consider refining *E. coli* sampling**, particularly where previously found to be high, to match requirements of State standards. At least five samples in a calendar month are required.

- **Continue YSI continuous water quality monitoring of creeks.** This continuous Data are useful for diagnosing pollutant magnitudes, sources, and developing management strategies, especially at sites not previously monitored.

- **Consider updating and adding stream rating curves.** Coon Creek at Vale Street last had rating curve measurements in 2010. Newly sampled streams Stonybrook and Oak Glen Creek have not had rating curves developed. Curves at sites which have them were last updated in 2013. Rating curves are mathematical relationships between water level and flow, such that water level can be monitored and flow calculated. Changes in stream morphology necessitate periodic updates by manually measuring flow and stage under a variety of water levels.

- **Continue installing water quality improvement projects that target stormwater runoff and provide treatment or retention.** Water quality monitoring shows most water quality problems are associated with storms; baseflow water quality is good in most locations. Dissolved pollutants, as measured by conductivity are a pervasive problem throughout the system that is growing worse. Aside from these generalizations, some areas of need include:
    - Lower watershed streams that directly discharge to the Mississippi River including Pleasure, Oak Glen, Springbrook and Stonybrook all have high *E. coli*, conductivity, and suspended solids. Phosphorus is high for some, but others including Pleasure and Oak Glen Creeks have lower phosphorus.
    - Sand Creek has elevated suspended sediment loads during storm flows.
    - Coon Creek has high phosphorus and sediment loads, with the Ditch 11 tributary being a specific area to target in upstream reaches of the watershed. There are also several unmonitored tributaries to Coon Creek that may be pollutant-loading hotspots.

- **Promote the availability of reference wetland data** among wetland regulatory personnel as well as consultants as a means for efficient, accurate wetland determinations. We're finding these data to be more and more helpful in developing areas and have seen demand for data increase accordingly.

Precipitation

Description: Continuous monitoring of precipitation with both data-logging rain gauges and non-logging cylinder 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.

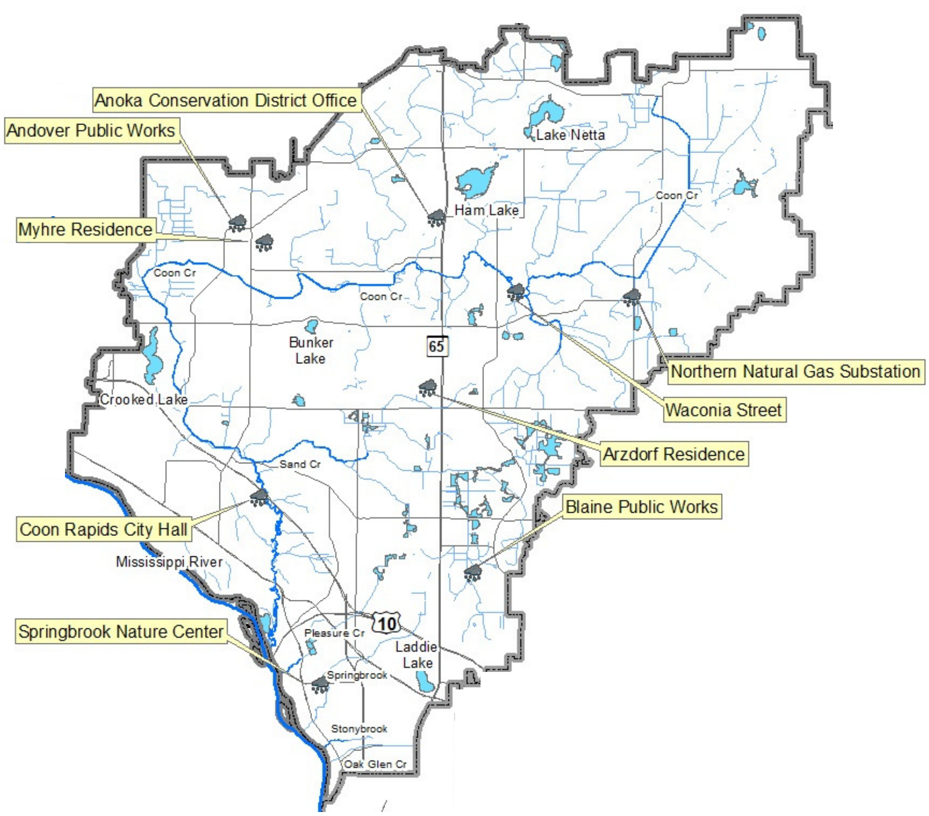
Locations:

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	Springbrook Nature Center	Fridley
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: 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 2017 Precipitation Monitoring Sites

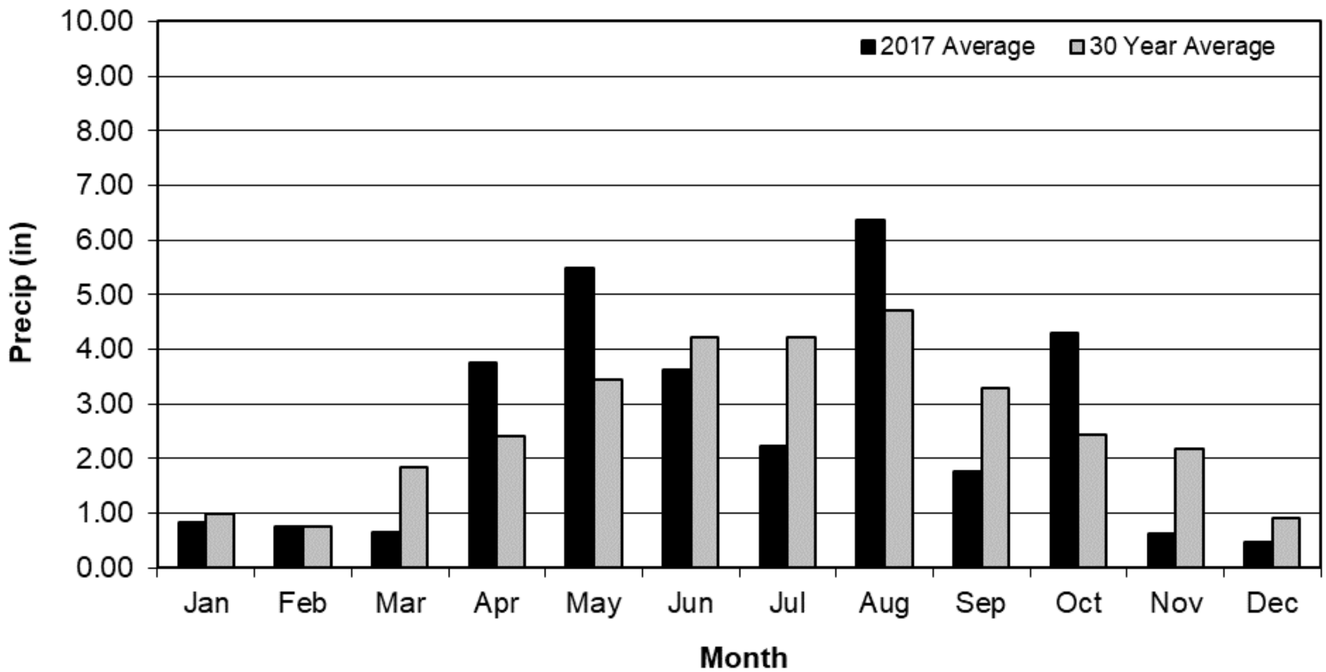


Coon Creek Watershed 2017 Precipitation Summary Table and Graph

Location or Volunteer	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total	Growing Season (May-Sept)
Tipping bucket, datalogging rain gauges (Time and date of each 0.01" is recorded)															
Andover City Hall	Andover			0.37*	3.57	5.41	3.23	2.14	6.15	1.91	4.38	0.59	0.14*	27.38	18.84
Blaine Public Works	Blaine				0.02*	7.17	1.69	1.44	6.75	1.76	5.81	0.63	0.23*	25.25	18.81
Coon Rapids City Hall	Coon Rapids			0.50*	3.88	5.79	4.01	2.42	5.81	1.45	3.58	0.56	0.20*	27.50	19.48
Anoka Cons. District office	Ham Lake			0.34*	3.47	1.93	3.98	0.54*	5.55	2.09	2.83*	0.08*	0.23*	17.02	13.55
Waconia Street	Ham Lake			0.35*	4.15	2.63	3.56	2.37	6.9	1.02	1.38	0.67	0.16*	22.68	16.48
Northern Nat. Gas substation	Ham Lake			.40*	3.36	6.39	4.95	2.06	6.05	1.62	4.78	0.54	0.16	29.91	21.07
Springbrook Nature Center	Fridley				0.62*	6.6	3.22	2.65	7.64	2.07	6.03	0.71	0.24*	28.92	22.18
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.84	0.75	0.65	3.39	5.99	3.57	2.65	5.96	1.85	4.12		0.76	30.53	24.99
J. Arzdorf	Blaine			0.67	4.39	7.46	4.44	2.17	6.36	2.08	4.32			31.89	26.45
2017 Average	CCWD-wide	0.84	0.75	0.66	3.74	5.49	3.63	2.24	6.35	1.76	4.30	0.62	0.46	30.84	19.46
30 Year Average	Cedar	0.99	0.76	1.84	2.40	3.43	4.22	4.21	4.70	3.29	2.44	2.18	0.90	31.36	19.85

precipitation as snow is given in melted equivalents

*Incomplete monthly data not included in averages



Precipitation Analyses

Description: Two different precipitation analyses were done – 1) 2017 storm analyses and 2) long term precipitation trend analysis.

1.) **2017 Storm Analyses:** Precipitation events at each of the six Coon Creek Watershed District data-logging rain gauges were analyzed. Total precipitation, storm duration, intensity, and recurrence interval were determined for all precipitation events of >0.03 inches. Storms with a recurrence interval of one year or less frequent according to the NOAA Atlas 14 table for Blaine, MN at Highway 65 and 125th Avenue were analyzed further. For these storms, intensity was tracked throughout the storm duration and graphed. The rate of effective precipitation was determined from the rainfall intensity and surrounding soil type. Effective precipitation was defined as precipitation occurring at an intensity that is lower than the soil infiltration rate (i.e. rain that soaks in and doesn't run off).

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

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

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

Locations:

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

Results:

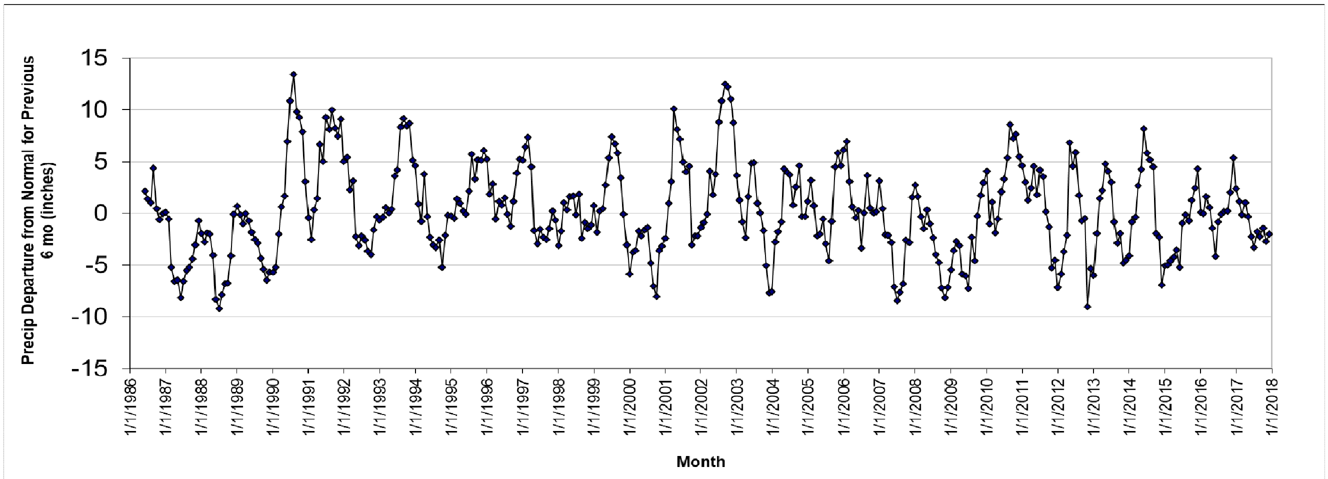
1.) **2017 Storm Analyses:** The results of these analyses were delivered to the Coon Creek Watershed District in digital form and are not reported here due to complexity and lengthiness.

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

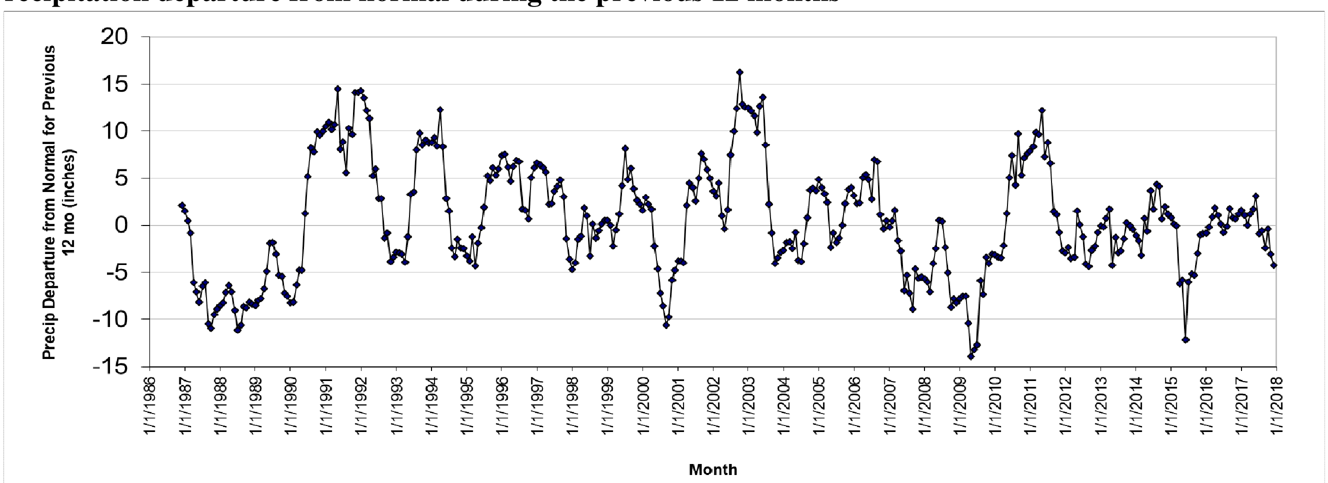
Long Term Precipitation Trends

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.

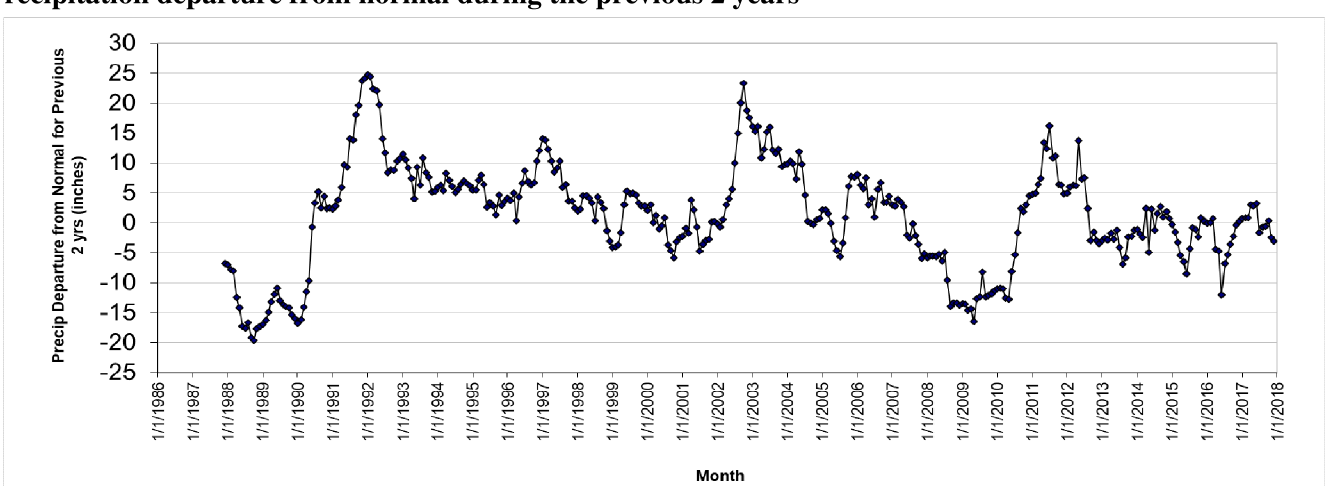
Precipitation departure from normal during the previous 6 months



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:

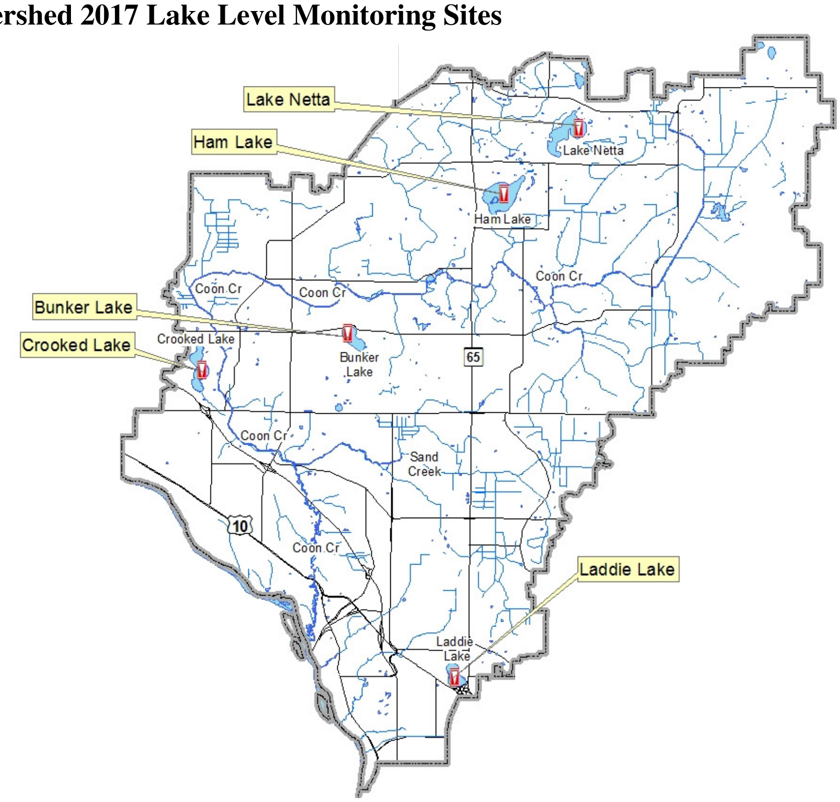
Site	City
Bunker Lake	Andover
Crooked Lake	Andover/Coon Rapids
Ham Lake	Ham Lake
Lake Netta	Ham Lake
Laddie Lake	Blaine

Results: In 2017 lake levels were measured by volunteers 48 times at Crooked Lake, 47 times at Ham Lake, 29 times at Lake Netta, and 24 times at Laddie Lake. Levels in Bunker Lake were monitored June (equipment was malfunctioning prior) through November using an electronic gauge, which resulted in 154 days of measurements generated by averaging six readings from each day.

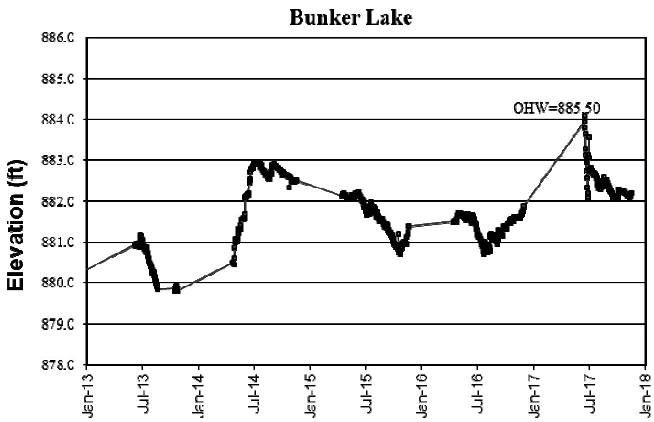
Overall, lakes had increasing water levels in spring and early summer that declined into mid-summer. Higher rainfalls in fall caused a small increase in lake levels into the end of the year. Levels did not fluctuate greatly, and were generally at or slightly above average in 2017.

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.

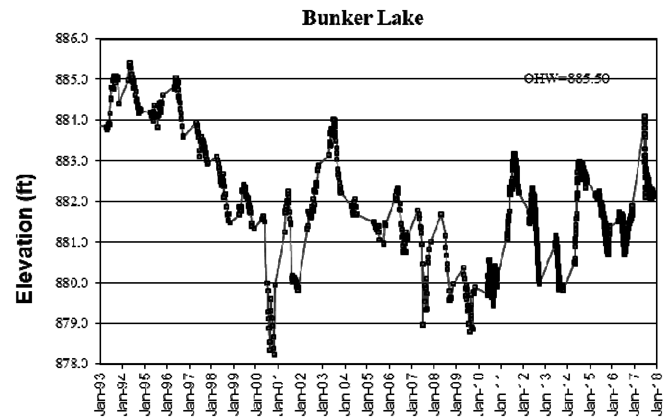
Coon Creek Watershed 2017 Lake Level Monitoring Sites



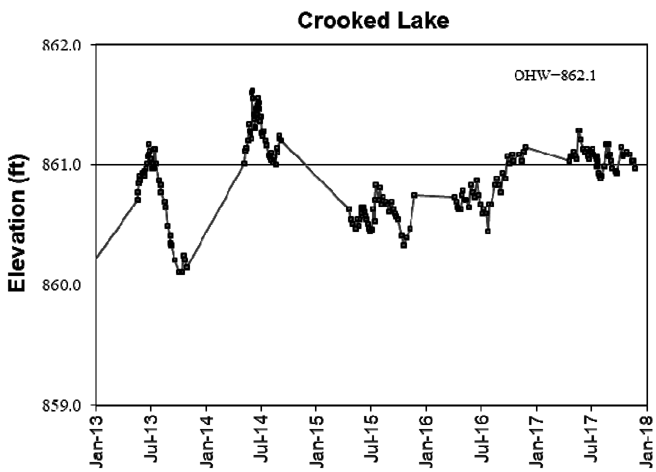
Bunker Lake Levels – last 5 years



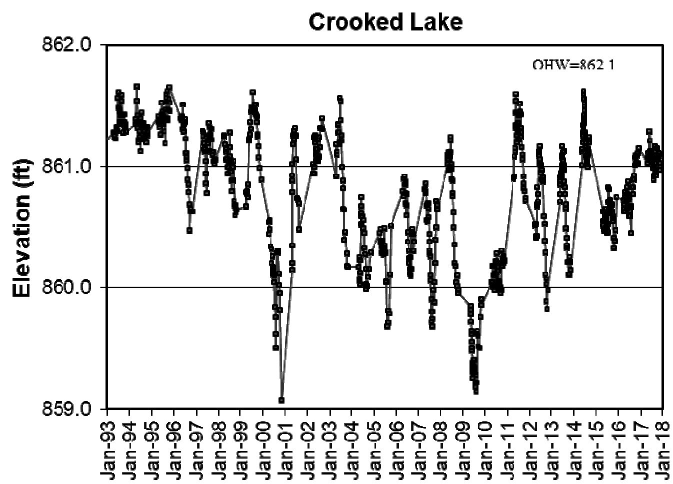
Bunker Lake Levels- last 25 years



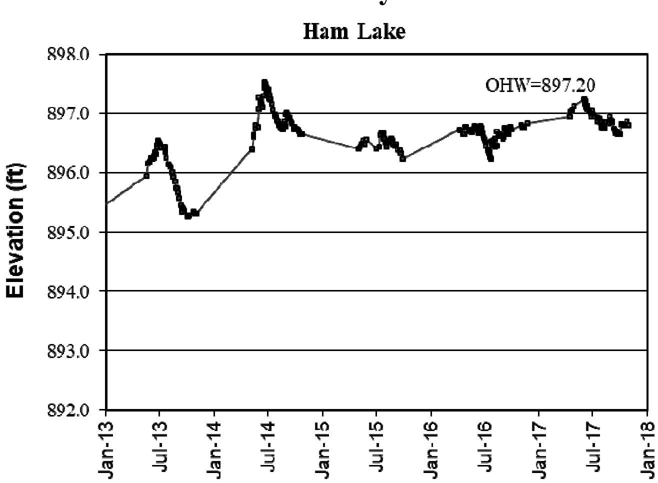
Crooked Lake Levels- last 5 years



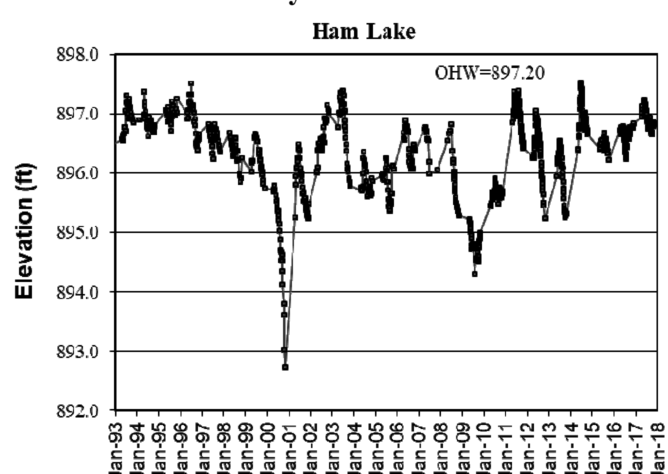
Crooked Lake Levels- last 25 years



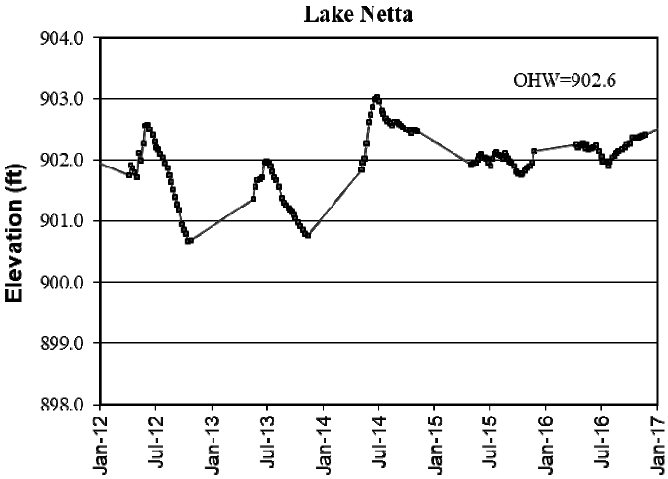
Ham Lake Levels- last 5 years



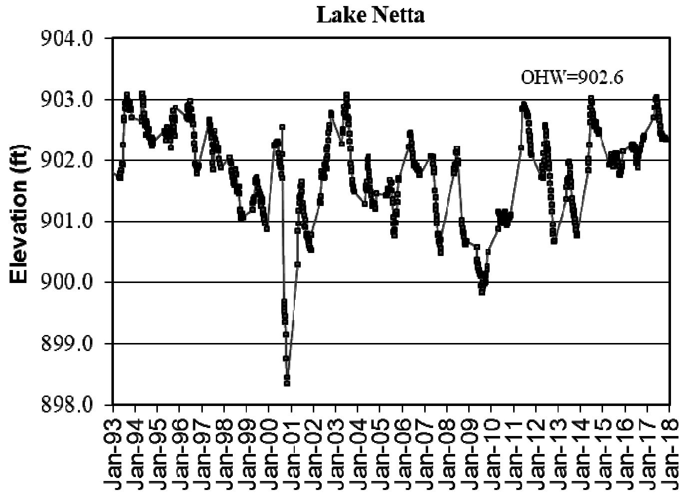
Ham Lake- Last 25 years



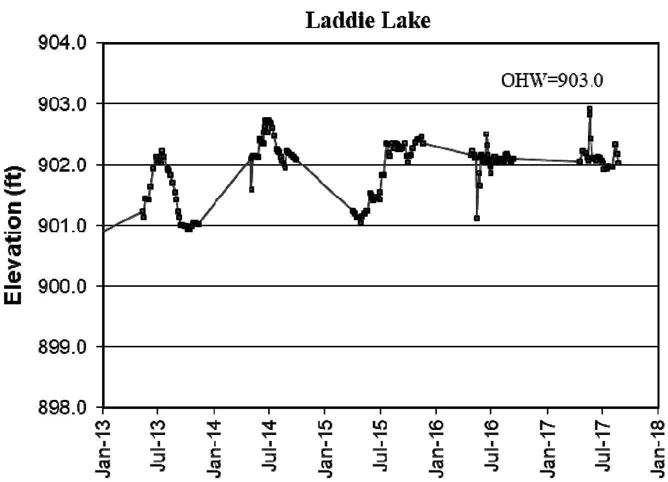
Lake Netta Levels- last 5 years



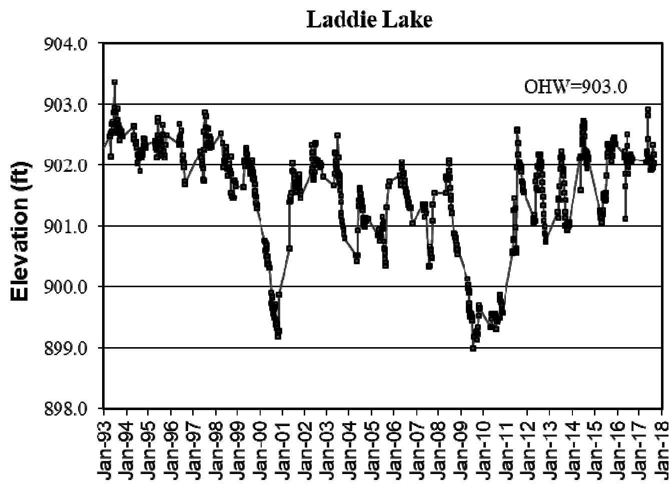
Lake Netta Levels- last 25 years



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	2013	880.57	879.81	881.17
	2014	882.40	880.45	882.96
	2015	881.61	880.72	882.23
	2016	881.37	880.70	881.88
	2017	882.42	882.05	884.07
Crooked	2013	860.76	860.11	861.17
	2014	861.28	861.00	861.62
	2015	860.58	860.33	860.83
	2016	860.77	860.45	861.09
	2017	861.06	860.89	861.29
Ham	2013	896.04	895.29	896.54
	2014	896.97	896.39	897.53
	2015	896.49	896.23	896.69
	2016	896.64	896.24	896.84
	2017	896.91	896.65	897.24

Lake	Year	Average	Min	Max
Netta	2013	901.40	900.76	901.98
	2014	902.56	901.84	903.02
	2015	901.97	901.76	902.14
	2016	902.16	901.89	902.35
	2017	902.62	902.34	903.04
Laddie	2013	901.47	900.93	902.23
	2014	902.30	901.59	902.73
	2015	901.83	901.05	902.45
	2016	902.07	901.12	902.50
	2017	902.16	901.92	902.92

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.

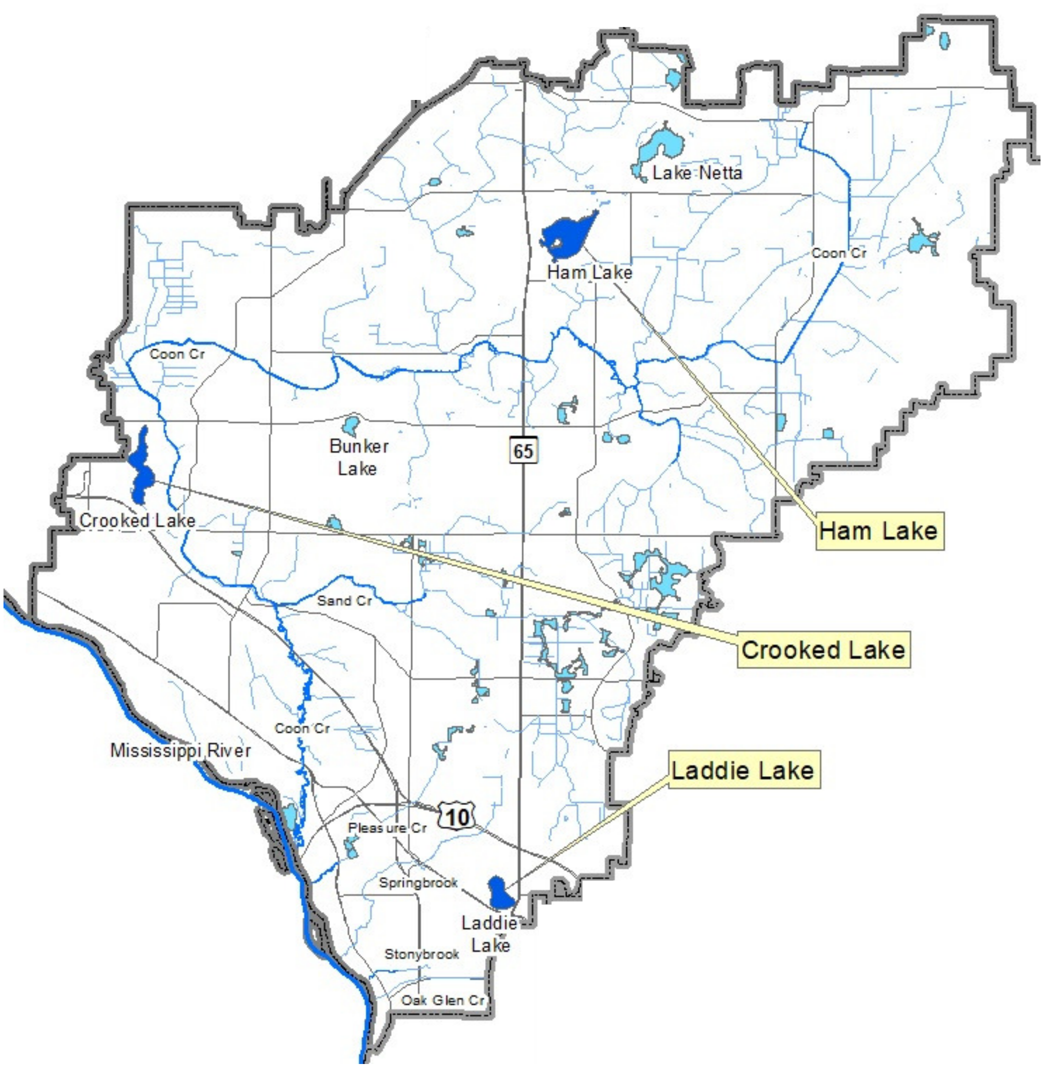
Purpose: To detect water quality trends and diagnose the cause of changes.

Locations:

Site	City
Crooked Lake	Andover/Coon Rapids
Ham Lake	Ham Lake
Laddie Lake	Blaine/Spring Lake Park

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

Coon Creek Watershed 2017 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 anglers. 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 liquid fluridone was conducted that eradicated nearly all aquatic vegetation. EWM was discovered again in 1996. In 2002 the DNR implemented a low dose treatment of liquid fluridone, which reduced the EWM while having a lesser impact on native vegetation. Spot treatments using triclopyr or 2,4-D have been conducted since 2010 with variable success and EWM still reached nuisance levels in some areas. In 2016, an experimental treatment using low-dose granular fluridone was implemented and resulted in reduction of EWM (confirmed to be hybrid EWM) from 60% occurrence in the littoral zone to less than 1% occurrence in 2017. The native plant community remained unharmed and was supplemented by transplanting 5 species of native plants from Lake Norris in northern Anoka County. The exotic, invasive plant curly leaf pondweed is also present and is periodically managed with herbicide treatments to alleviate nuisance conditions.

2017 Results

In 2017, Crooked Lake had above-average water quality for this region of the state (NCHF Ecoregion) receiving an overall B letter grade and meeting state water quality standards. The lake had received overall A grades from 2012-2014. In 2017 total phosphorus (TP) was 27.1 µg/L and chlorophyll-a (Cl-a) was 6.7 µg/L. Cl-a in 2017 was the highest average since 2011, but remains low for a lake in a developed metro watershed. 2017 Secchi transparency was 7.8 feet, a slight decline from the 9.1 foot average in 2015. Secchi transparency appeared to be steadily improving from the mid-1990s until 2011. Since 2011, however, Secchi transparency appears to be stabilizing at around 8.5 ft.

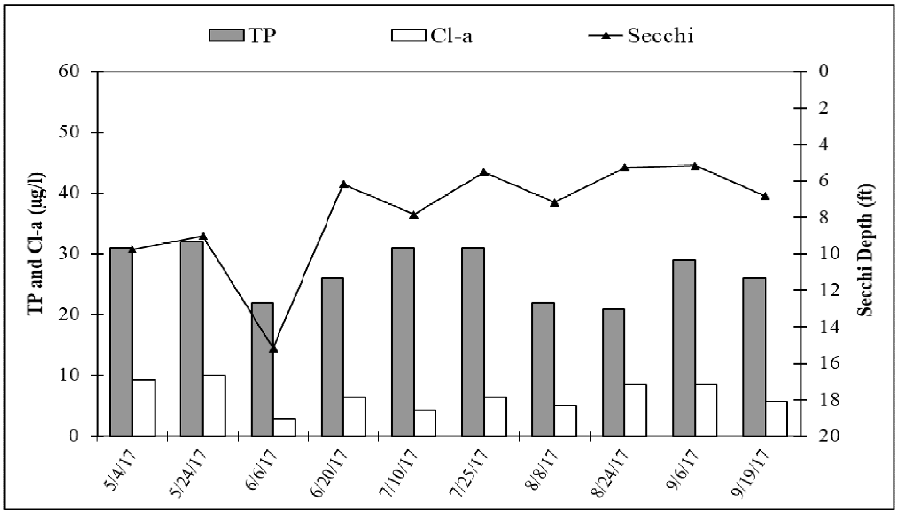
Trend Analysis

Twenty years of water quality data including the full suite of total phosphorus, Cl-a, and Secchi have been collected between 1983 and 2017. There have been four additional years of TP and eight additional years of transparency measurements by citizens. Using all historical data, water quality has shown a significant improvement from 1983 to 2017 (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,17} = 5.30$, $p = 0.0001$). The most dramatic improvements in water quality occurred between 1989 and 1994. However, if only data after 1993 are examined a strong statistically significant trend of improvement is still found (same MANOVA, $F_{2,14} = 17.79$, $p =< 0.0001$). Examining the trend during this period (1994-2017) for each individual parameter (one-way ANOVA) we find no statistically significant change in phosphorus (although close, $F_{1,16} = 4.32$, $p = 0.054$), but we do observe statistically significant trends toward improvements in both Cl-a ($F_{1,15} = 27.40$, $p = 0.0001$) and Secchi transparency ($F_{1,16} = 60.24$, $p =< 0.0001$).

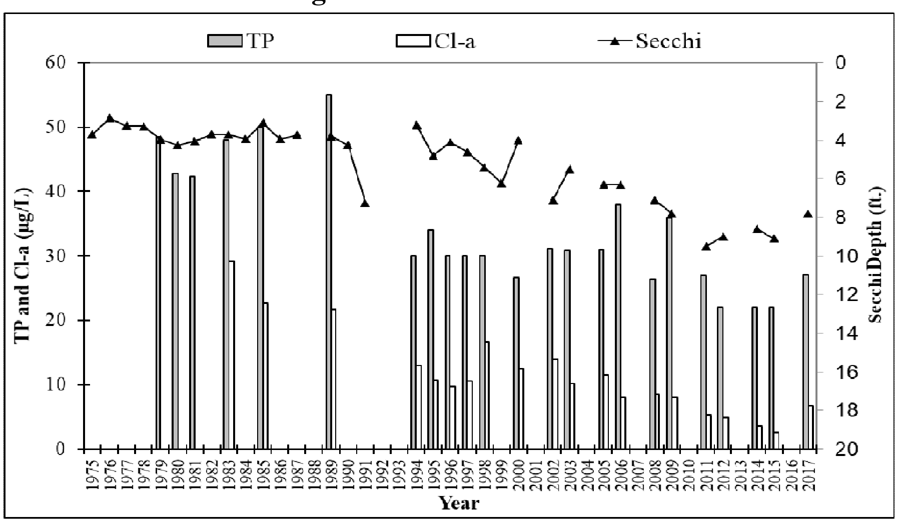
Discussion

Water quality in Crooked Lake is quite 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 and 2017, 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. Despite a very successful EWM treatment in 2016, invasive aquatic plants will continue to present challenges for Crooked Lake. The aquatic plant community should be closely monitored for a resurgence of EWM, expansion of curly leaf pondweed, establishment of any new invaders, and persistence of a healthy native plant community. Native plants like 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 2008 comprehensive lake management plan (updated in 2014) and DNR Lake Vegetation Management Plan provide direction for protecting water quality and managing plants and should continue to be referenced.

2017 Results



Historical Annual Averages



Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1975			C	
1976			D	
1977			D	
1978			D	
1979			C	
1980			C	
1981			C	
1982			D	
1983	C	C	D	C
1984				
1985	C	C	D	C
1986			C	
1987			D	
1989	C	C	D	C
1990			C	
1991			C	
1994	B	B	C	B
1995	C	B	C	C
1996	B	A	C	B
1997	B	B	C	B
1998	B	B	C	B
1999			C	
2000	B	B	C	B
2002	B	B	C	B
2003	B	B	C	B
2005	B	B	C	B
2006	C	A	C	B-
2008	B	A	B	B
2009	C	A	B	B
2011	B	A	B	B
2012	A	A	B	A
2014	A	A	B	A
2015	B	A	B	B
2017	B	A	B	B
2017 average	27.1 µg/L	6.7 µg/L	2.4 meters	
State standards	40 µg/L	14 µg/L	1.4 meters	

2017 Raw Data

		Date:	5/4/2017	5/24/2017	6/6/2017	6/20/2017	7/10/2017	7/25/2017	8/8/2017	8/24/2017	9/6/2017	9/19/2017			
		Time:	10:40	10:30	11:35	9:55	13:50	13:00	13:15	13:40	12:55	12:40			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.30	8.69	8.39	8.43	8.27	8.31	8.20	8.49	8.17	8.54	8.38	8.17	8.69
Conductivity	mS/cm	0.01	0.477	0.523	0.570	0.515	0.512	0.593	0.618	0.538	0.541	0.545	0.543	0.477	0.618
Turbidity	NTU	1	4.8	0.00	3.50	6.90	1.60	13.60	3.20	0.10		0.70	4	0	14
D.O.	mg/l	0.01	11.03	11.03	9.10	8.90	8.20	10.23	8.19	9.66	8.24	8.42	9.30	8.19	11.03
D.O.	%	1	104.7%	111.6%	112.9%	107.5%	103.6%	129.1%	100.7%	116.0%	93.6%	97.2%	108%	94%	129%
Temp.	°C	0.1	11.63	15.22	22.96	23.30	25.76	25.70	24.65	23.31	20.51	20.50	21.4	11.6	25.8
Temp.	°F	0.1	52.9	59.4	73.3	73.9	78.4	78.3	76.4	74.0	68.9	68.9	70.4	52.9	78.4
Salinity	%	0.01	0.23	0.25	0.28	0.25	0.25	0.28	0.30	0.26	0.26	0.26	0.26	0.23	0.30
Cl-a	µg/L	1	9.30	10.00	2.80	6.40	4.30	6.40	5.00	8.50	8.50	5.70	6.7	2.8	10.0
T.P.	mg/l	0.005	0.031	0.032	0.022	0.026	0.031	0.031	0.022	0.021	0.029	0.026	0.027	0.021	0.032
T.P.	µg/l	5	31	32	22	26	31	31	22	21	29	26	27	21	32
Secchi	ft		9.8	9.0	15.2	6.2	7.8	5.5	7.2	5.3	5.2	6.8	7.8	5.2	15.2
Secchi	m		3.0	2.7	4.6	1.9	2.4	1.7	2.2	1.6	1.6	2.1	2.4	1.6	4.6
Field Observations			Clear	Clear	Clear	Slightly Green	Green	Clear	Clear	Clear	Clear	Clear			
Physical			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	1.1	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

Ham Lake

City of Ham Lake, Lake ID # 02-0053

Background

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

2017 Results

Ham Lake's water quality was slightly above-average for this region of the state (NCHF Ecoregion) in 2017, receiving a B letter grade for the second year in a row after consecutive A grades in prior sampled years. After receiving C letter grades in 2000-2001, Ham Lake has fluctuated between A and B overall grades in the sampling years since. The 2017 average total phosphorus (TP) of 26.1 µg/L was the highest in the last five years sampled since 2010. Chlorophyll-a (Cl-a) averaged 6.0 µg/L, a typical level in this lake since 2008, but a higher than the 2.6 and 1.9 µg/L averages in 2013 and 2014, respectively. Secchi transparency increased slightly from 2016 with an average depth of 7.2 feet in 2017. Throughout the sampling year, Cl-a trended higher and Secchi transparency decreased from May to early September. This is a common trend as algal activity increases while the water warms and daily sunlight increases.

Trend Analysis

Nineteen years of water quality data have been collected by the Minnesota Pollution Control Agency (between 1984 and 1997) and the Anoka Conservation District (between 1998 and 2017). Lake water quality has fluctuated from "A" to "C" and back to "A" water quality grades, but there is no significant long-term trend (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,16} = 3.11$, $p = 0.07$). We also examined individual variables TP, Cl-a, and Secchi depth across all years of existing data using a one-way ANOVA. Including all years, a significant trend of improving Cl-a ($F_{1,17}$=7.3, p=<0.02) is found. While not statistically significant, Secchi transparency and total phosphorus appear to be improving as well. All three parameters appear to be trending in the right direction, and it's possible that a statistically significant improvement in overall water quality will be found in coming sampling years.

Discussion

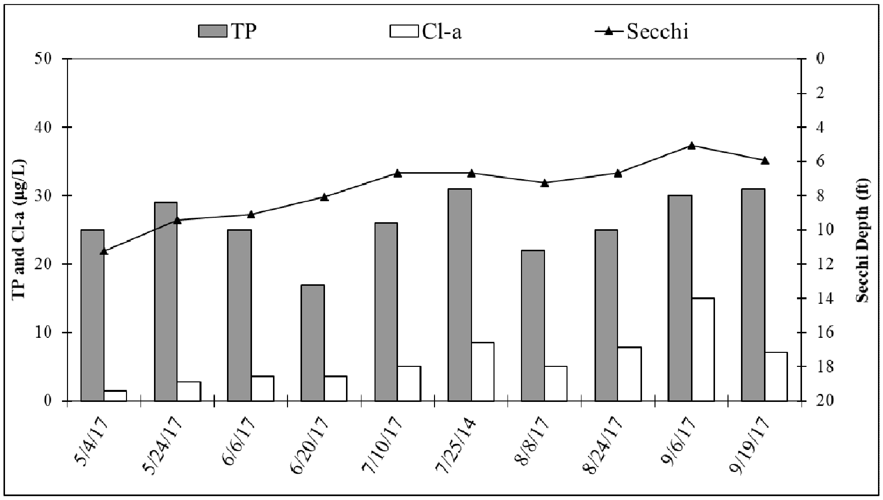
Water quality in Ham Lake remains good for a metro-area lake, though 2016 and 2017 did not continue the trends of improving quality observed the previous four years monitored (2010-11, 2013-14). Current threats to lake water quality include shoreline activities, aging septic systems, aquatic plant removal by lakeshore homeowners, curly leaf pondweed, and the 2013 discovery of Eurasian and hybrid water milfoil (EWM). In 2013, mapping efforts indicated that approximately 12% of the littoral area of Ham Lake was infested with EWM. Lake residents have organized a lake association and raised funds to begin management of the invasive plants. Chemical treatment began in 2014 and continues annually as needed. Over the past 4 years from 2014 through 2017, the frequency of occurrence of EWM in the littoral zone of Ham Lake observed during MN DNR plant surveys was 22%, 7%, 14%, and 10% respectively. Water quality results seem to have also declined since 2014, but are still within the historically observed range. The timing of this decline may coincidentally relate to the AIS chemical treatments. A focus of continued monitoring should be tracking water quality trends with herbicide treatments.

A 2018-2022 comprehensive lake management plan was recently completed for Ham Lake that focuses on aquatic AIS inventory, treatment and prevention as well as promoting landowners' adoption of lake-friendly shoreline practices and enforcement of septic system compliance. Overall, TP, Cl-a, and Secchi clarity all remain well within state standard thresholds in Ham Lake and implementation of the comprehensive lake management plan should ensure that trend into the future.

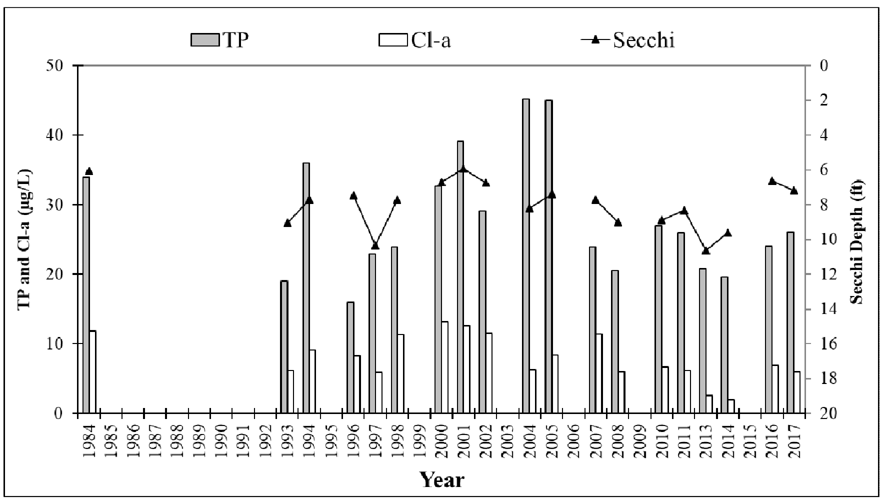
Ham Lake

City of Ham Lake, Lake ID # 02-0053

2017 Results



Historical Annual Averages



Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1984	C	B	C	C
1993	A	A	B	A
1994	C	A	B	B
1996	A	A	B	A
1997	A	A	A	A
1998	B	B	B	B
2000	C	B	C	C
2001	C	B	C	C
2002	B	B	C	B
2004	C	A	B	B
2005	C	A	B	B
2007	B	B	B	B
2008	A	A	B	A
2010	B	B	B	B
2011	B	B	B	B
2013	A	A	A	A
2014	A	A	B	A
2016	B	A	C	B
2017	B	A	B	B
2017 average	26.1 µg/L	6.0 µg/L	2.3 meters	
State standards	60 µg/L	20 µg/L	1.0 meter	

2017 Raw Data

Ham Lake		Date:	5/4/2017	5/24/2017	6/6/2017	6/20/2017	7/10/2017	7/25/2014	8/8/2017	8/24/2017	9/6/2017	9/19/2017			
2017 Water Quality Data		Time:	9:00	8:40	9:20	14:25	8:45	9:00	9:05	9:50	9:10	8:53			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.34	8.28	8.52	8.11	8.09	7.76	7.91	7.99	8.02	8.15	8.12	7.76	8.52
Conductivity	mS/cm	0.01	0.315	0.338	0.359	0.327	0.328	0.372	0.381	0.341	0.346	0.350	0.346	0.315	0.381
Turbidity	NTU	1	7.00		4.60	4.90	2.10	21.20	5.60	6.40		1.30	7	1	21
D.O.	mg/l	0.01	11.97	10.01	10.16	8.30	7.56	8.63	8.26	8.72	8.34	7.56	8.95	7.56	11.97
D.O.	%	1	112.0%	100.4%	116.4%	101.1%	94.4%	106.1%	99.2%	103.0%	93.4%	85.8%	101%	86%	116%
Temp.	°C	0.1	10.92	14.77	21.84	23.55	25.10	24.94	23.50	22.00	19.53	19.51	20.6	10.9	25.1
Temp.	°F	0.1	51.7	58.6	71.3	74.4	77.2	76.9	74.3	71.6	67.2	67.1	69.0	51.7	77.2
Salinity	%	0.01	0.15	0.16	0.17	0.16	0.16	0.18	0.18	0.17	0.16	0.17	0.17	0.15	0.18
Cl-a	µg/L	1	1.40	2.80	3.60	3.60	5.00	8.50	5.00	7.80	15.00	7.10	6.0	1.4	15.0
T.P.	mg/l	0.005	0.025	0.029	0.025	0.017	0.026	0.031	0.022	0.025	0.030	0.031	0.026	0.017	0.031
T.P.	µg/l	5	25.0	29	25	17	26	31	22	25	30	31	26.1	17.0	31.0
Secchi	ft		11.3	9.4	9.1	8.1	6.7	6.7	7.3	6.7	5.1	5.9	7.6	5.1	11.3
Secchi	m		3.4	2.9	2.8	2.5	2.0	2.0	2.2	2.0	1.5	1.8	2.3	1.5	3.4
Field Observations			Clear	Clear	Clear	Clear	Dark/Clear	Clear	Clear	Brown	Cloudy	Clear			
Physical			1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0	1.0	1.2	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

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

Background

Laddie Lake is located in south-central Anoka County, half in Blaine and half in Spring Lake Park. It has a surface area of 77 acres and maximum depth of 4 feet (1.2 m). Public access is limited to a city park at the north end of the lake. There is no easy access to the water's edge from this park, as the lake's cattail fringe is wide. The lake is used little for recreation because of its shallow depths, abundance of aquatic plants, and lack of public access to the water's edge. It does, however, attract waterfowl. The west side of the lake is bordered by single-family homes, the south and east by four-lane highways and associated businesses, and the north by the city park. An aquatic invasive species survey in 2017 showed no infestations.

2017 Results

Laddie Lake was monitored for the second consecutive year in 2017 after a four year monitoring gap from 2012-2015. Water quality was above average this region, receiving an overall B letter grade, down from the A it received in 2016. It's likely that the overall grade would be better each year if the lake wasn't shallow enough to prevent Secchi transparency readings. Secchi transparency exceeded the lake's depth at the sampling point on each occasion monitored. Total phosphorus (TP) averaged 36 µg/L, the highest average since 2003, and a large increase from the average of 20 µg/L in 2016, though it remains below the shallow lake TP standard of 60 µg/L. Chlorophyll-a (Cl-a) averaged 12.1 µg/L, a stark jump from the 2.9 µg/L average in 2016, and the highest average recorded since Met Council's sampling in 1995, though Cl-a also remains below the state standard of 20 µg/L. Both total phosphorus and Cl-a saw a large increase in average concentrations in July 2017.

The lake is slightly eutrophic, but much of the plant growth is manifested as macrophytes (large plants), not algae. Large numbers of plants are healthy in a shallow lake such as this one, and keep the water quite clear compared to most shallow lakes. Macrophytes grow to the surface on 95% of the lake from June through September. Even when they reached the surface, the plants were not excessively dense from an ecological perspective, spaced about 1-2 feet apart.

Trend Analysis

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

In 1980 water quality was quite poor but has greatly improved since the early 1990s. To analyze trends since 1993, a repeated measures MANOVA with response variables Total Phosphorus and Chlorophyll-a was used on those years only. Results from 1980 were excluded because they are such far outliers in the dataset. Secchi depth was excluded because the shallow depth of the lake does not allow for true Secchi clarity readings. No statistically significant water quality trend was detected ($F_{1,13}$=0.65, p=0.43). We also examined variables TP and Cl-a individually, excluding results from 1980, using a one-way ANOVA. While neither parameter changed significantly, it is worth noting that both parameters show a best fit line trending upward, though the Cl-a trend is close to flat. Total phosphorus, however, shows a fairly pronounced upward trend.

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

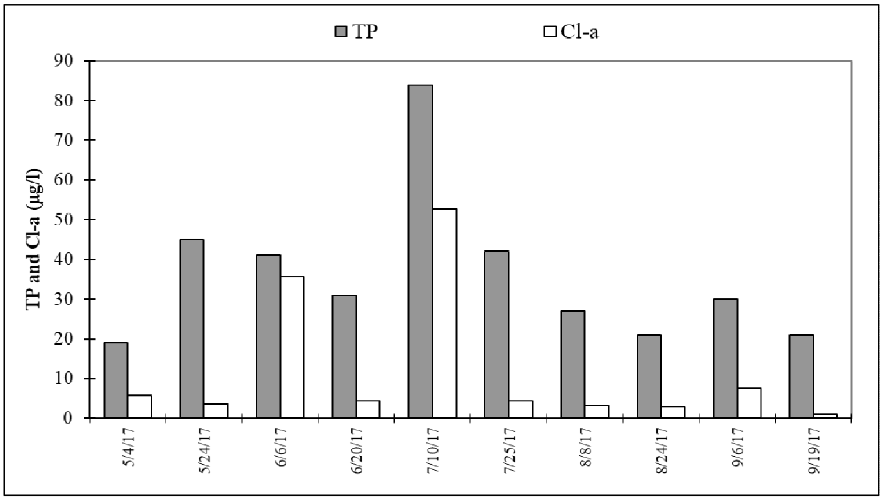
Discussion

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

Laddie Lake

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

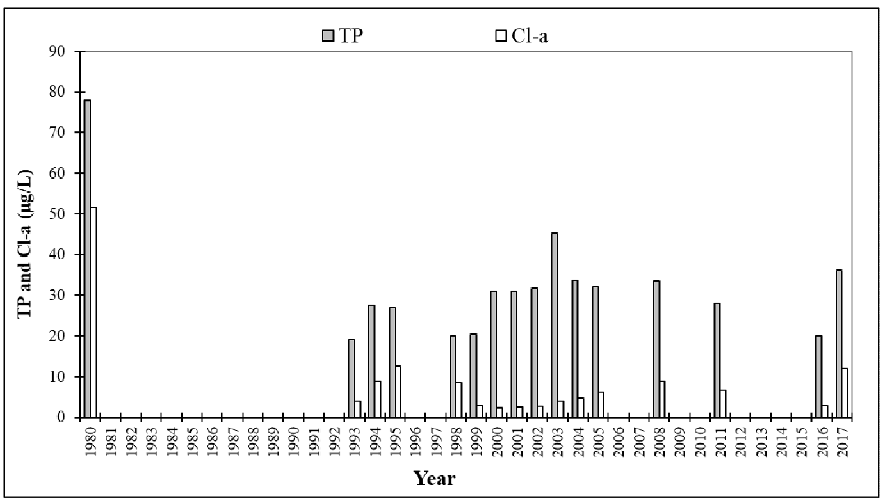
2017 Results



Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1980	D	D	N/A	D
1993	A	A	N/A	A
1994	B	A	N/A	B
1995	B	B	N/A	B
1998	B	A	N/A	B
1999	B	A	N/A	B
2000	B	A	N/A	B
2001	B	A	N/A	B
2002	B	A	N/A	B
2003	C	A	N/A	B
2004	C	A	N/A	B
2005	B	A	N/A	B
2008	C	A	N/A	B
2011	B	A	N/A	B
2016	A	A	N/A	A
2017	C	B	N/A	B
2017 average	36.0 µg/L	12.1 µg/L	meters	
State standards	60 µg/L	20 µg/L	1.0 meters	

Historical Annual Averages



Due to Secchi transparency exceeding lake depth, it was not included in the lake grading scale or graphs. It is likely grades would be improved if the exceptional clarity of Laddie Lake could be included in the grading system.

2017 Raw Data

Laddie Lake		Date:	5/4/2017	5/24/2017	6/6/2017	6/20/2017	7/10/2017	7/25/2017	8/8/2017	8/24/2017	9/6/2017	9/19/2017			
		Time:	9:45	9:30	10:25	9:00	14:15	13:45	14:05	14:20	13:45	13:25			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	9.24	9.06	9.89	8.18	9.65	9.49	9.49	9.79	9.56	9.30	9.37	8.18	9.89
Conductivity	mS/cm	0.010	0.679	0.600	0.743	0.708	0.736	0.877	0.913	0.870	0.944	1.123	0.819	0.600	1.123
Turbidity	NTU	1	0.5		5	3.8	2.1	6.1	4.8	0		0	2	0	5
D.O.	mg/L	0.01	14.12	12.01	11.80	6.84	9.34	13.07	12.26	13.63	11.25	10.15	11.45	6.84	14.12
D.O.	%	1	137.0%	122.1%	139.9%	81.1%	123.4%	163.5%	153.8%	163.7%	124.9%	114.7%	132%	81%	164%
Temp.	°C	0.1	12.83	14.37	23.54	22.39	27.81	25.48	25.92	23.71	19.40	19.74	21.52	12.83	27.81
Temp.	°F	0.1	55.1	57.9	74.4	72.3	82.1	77.9	78.7	74.7	66.9	67.5	71	55	82
Salinity	%	0.01	0.33	0.31	0.36	0.34	0.36	0.44	0.45	0.42	0.46	0.54	0.40	0.31	0.54
Cl-a	µg/L	1	5.70	3.60	35.60	4.30	52.70	4.30	3.20	2.80	7.50	1.0000	12.1	1.0	52.7
T.P.	mg/L	0.005	0.019	0.045	0.041	0.031	0.084	0.042	0.027	0.021	0.030	0.021	0.036	0.019	0.084
T.P.	µg/L	5	19	45	41	31	84	42	27	21	30	21	36	19	84
Secchi	ft	0.1	>4.0833	>4.0	>3.33	>1.0833	>3.0833	>3.25	>2.75	>3.167	>2.75	>3.0833	>3.05	0.00	0.00
Secchi	m	0.1	> 1.2446	>1.219	>1.016	>0.9398	>0.9398	>0.9906	>0.8382	>0.965	>0.838	>0.9398	>0.993	0.00	0.00
Field Observations			Clear	Clear	Weed cover	Clear	r , Floating w	Clear	r, Floating w	Clear	Clear	Clear			
Physical			1.00	1.00	3.00	1.00	3.00	1.00	1.00	1.00	1.00	1.00	1.4	1.0	3.0
Recreational			3.00	3.00	3.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00	2.7	2.0	3.0

*Reporting Limit

Stream Hydrology and Rating Curves

Description: Continuous water level monitoring in streams.

Purpose: To provide an 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.

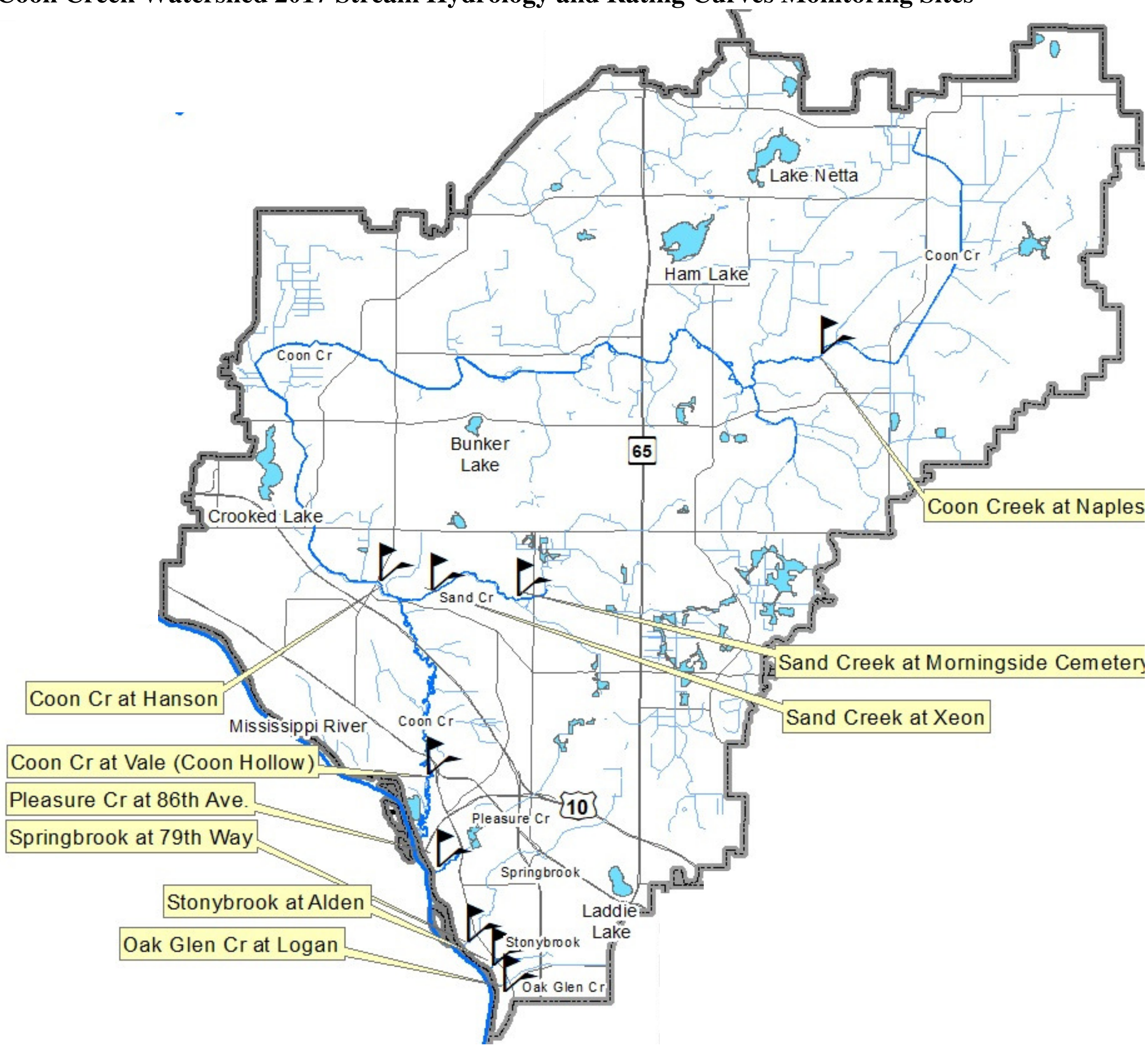
Locations:

Stream	Location	City
Coon Creek	Naples St.	Ham Lake
Coon Creek	Coon Hollow	Coon Rapids
Coon Creek	Hanson (Lions Park)	Coon Rapids
Pleasure Creek	86th Ave. NW	Coon Rapids

Stream	Location	City
Sand Creek	Morningside Cemetery	Coon Rapids
Sand Creek	Xeon St.	Coon Rapids
Springbrook	79th Way NE	Fridley
Stonybrook	Alden Way	Fridley
Oak Glen Cr.	Logan Pkwy.	Fridley

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

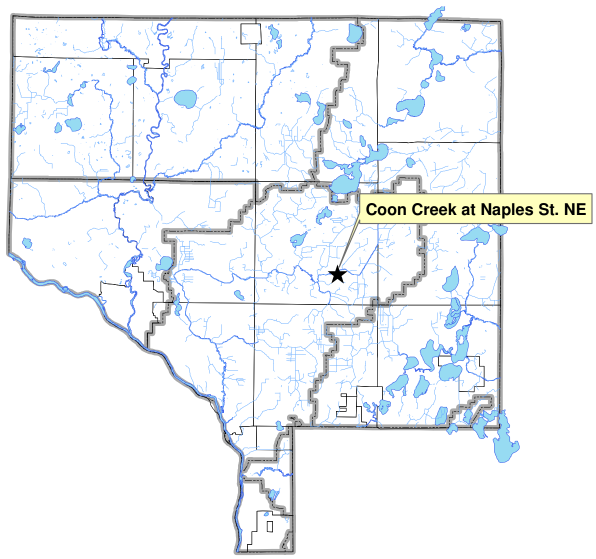
Coon Creek Watershed 2017 Stream Hydrology and Rating Curves Monitoring Sites



COON CREEK

at Naples St. NE, Ham Lake

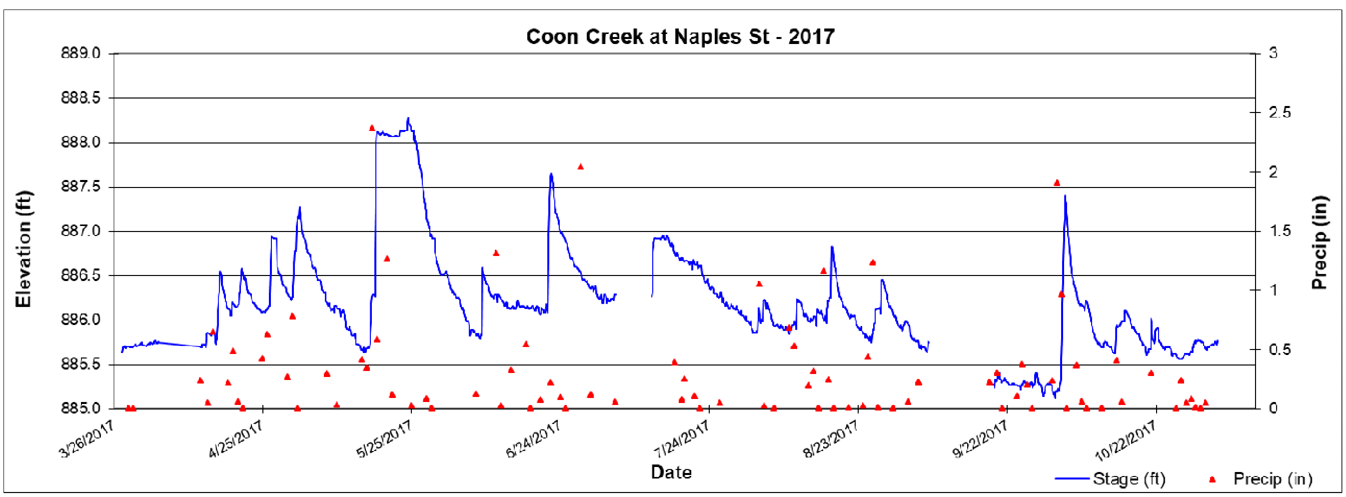
Notes



Coon Creek is a major drainage through central Anoka County. This monitoring location is just upstream of the intersection of Coon Creek with Naples St. NE and is the most upstream sampling site of the entire Coon Creek system. Land use in the upstream watershed is comprised of rural residential and sod fields. The creek is approximately 15 feet wide and 1 foot deep at the monitoring site during baseflow conditions.

Stream level was monitored for the first time at this site in 2012. This site has a flashy hydrograph and reacts quickly to precipitation. A good example of this relationship occurred on May 16-17, 2017 when the stage rose 2.43ft in 36 hours in reaction to a 2.37" rain event. These flashes are illustrated well in the hydrograph below. Stream levels reached their peak in late May and declined the rest of the year other than surges from rain events. Manual flow measurements were last collected in 2013 to generate the rating curve detailed below.
The peak stage was just a couple tenths of a foot higher in 2017 than in previous years monitored, but higher baseflow levels in 2017 elevated the minimum and median flows up to a foot higher than levels recorded in 2012-2014. This resulted in higher baseflow stages but lower stage variability by range in 2017.

2017 Hydrograph

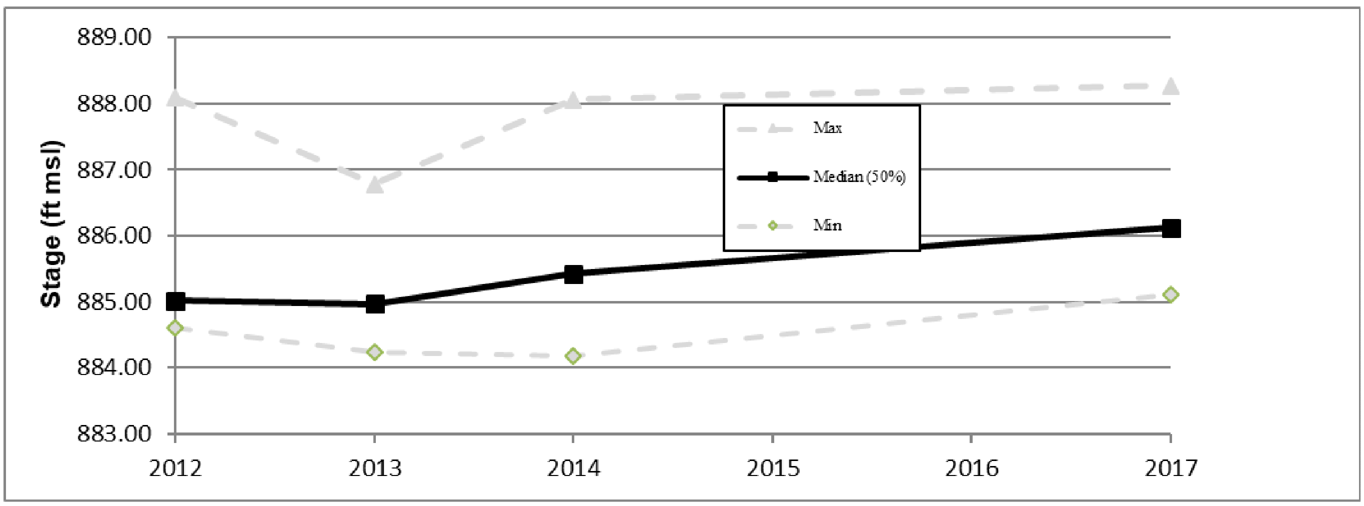


COON CREEK

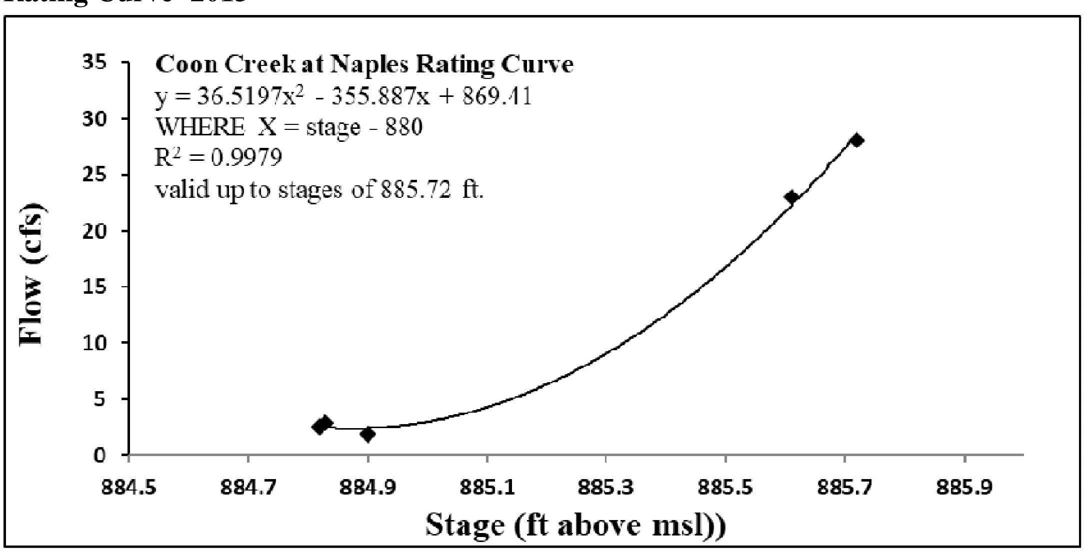
at Naples St. NE, Ham Lake

Summary of All Monitored Years

Percentiles	2012	2013	2014	2017
Min	884.61	884.24	884.18	885.11
2.5%	884.71	884.41	884.69	885.26
10.0%	884.81	884.46	884.88	885.65
25.0%	884.89	884.55	885.06	885.78
Med 50%	885.01	884.97	885.42	886.12
75.0%	885.49	885.42	886.38	886.42
90.0%	885.89	885.84	887.76	886.92
97.5%	887.78	886.22	888.01	888.09
Max	888.09	886.78	888.06	888.27



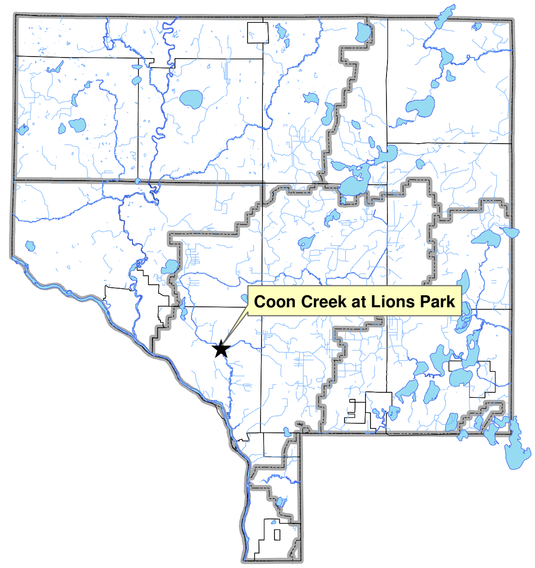
Rating Curve- 2013



COON CREEK

at Lions Park, Hanson Blvd., Coon Rapids

Notes

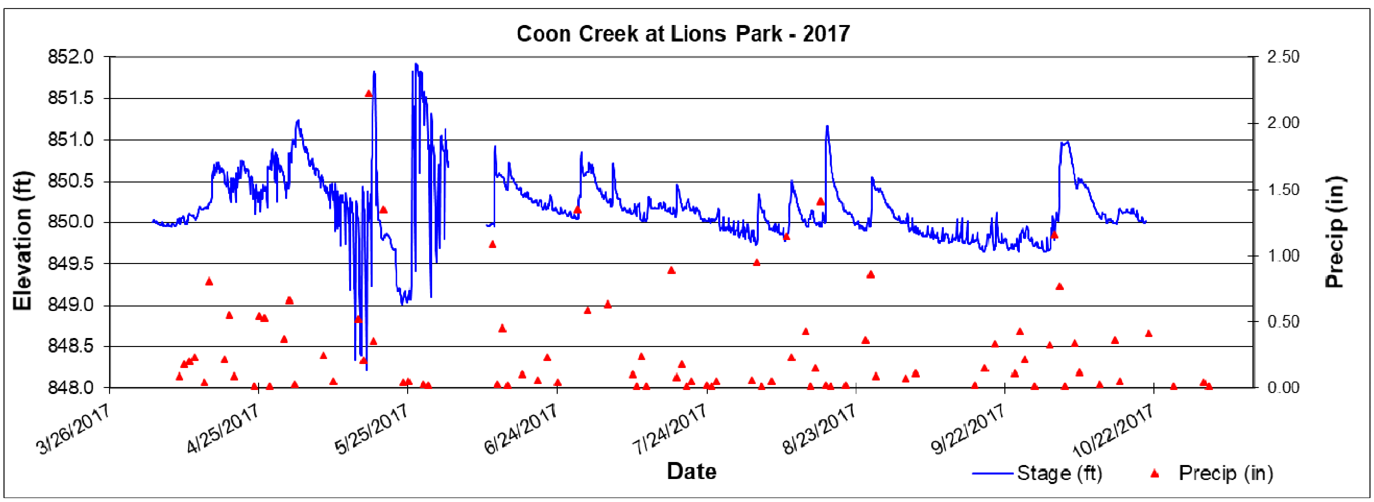


Coon Creek is a major drainage through central Anoka County. This monitoring location is within Lions Park in Coon Rapids, just downstream of the intersection of Coon Creek with Hanson Blvd. Land use in the upstream watershed ranges from rural residential to highly urbanized. The creek is approximately 35 feet wide and 2 to 2.5 feet deep at the monitoring site during baseflow. Both creek water levels and flow are available for this site.

Stream level was monitored for the first time at this site in 2012, and a rating curve was developed in 2012-2013. This site has a flashy hydrograph due to the urbanized watershed, similar to the Coon Creek at Coon Hollow site. Some of the data contains inaccurate "noise" during the second half of May and early June 2017 due to the meter getting wet (see hydrograph).

A rating curve developed in 2013 is available for this site and presented below.

2017 Hydrograph

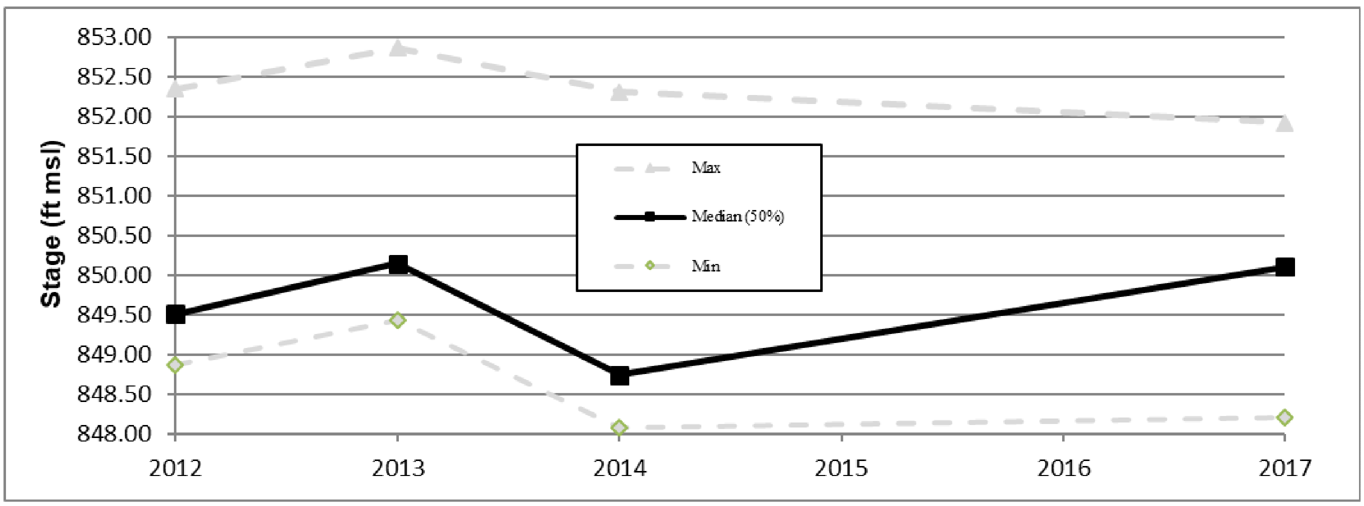


COON CREEK

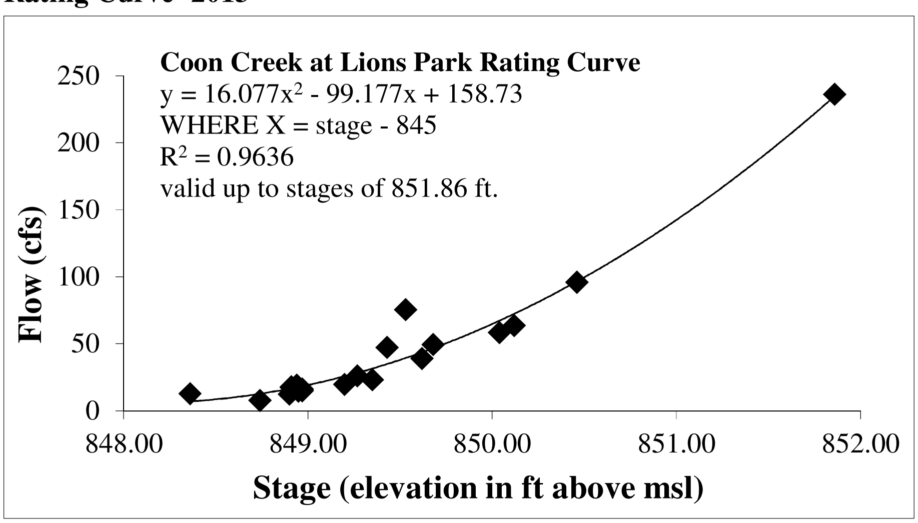
at Lions Park, Hanson Blvd., Coon Rapids

Summary of All Monitored Years

Percentiles	2012	2013	2014	2017
Min	848.87	849.43	848.08	848.21
2.5%	848.91	849.54	848.25	849.54
10.0%	848.96	849.60	848.33	849.78
25.0%	849.11	849.73	848.46	849.95
Median 50%	849.51	850.15	848.75	850.10
75.0%	849.78	850.51	849.67	850.36
90.0%	850.31	850.78	850.90	850.66
97.5%	851.94	851.33	852.02	851.10
Max	852.35	852.87	852.31	851.93



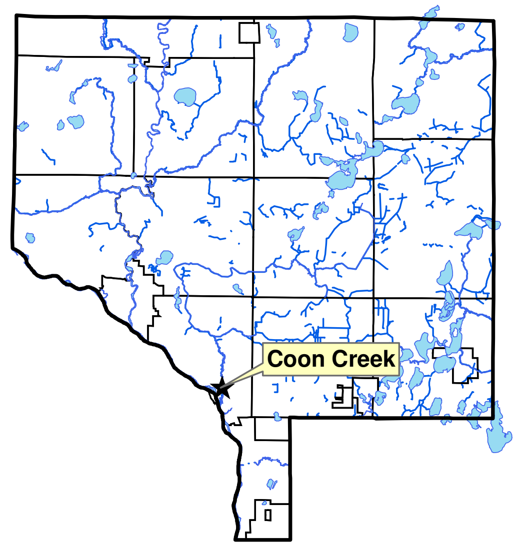
Rating Curve- 2013



COON CREEK

at Coon Creek Hollow, Vale Street, Coon Rapids

Notes

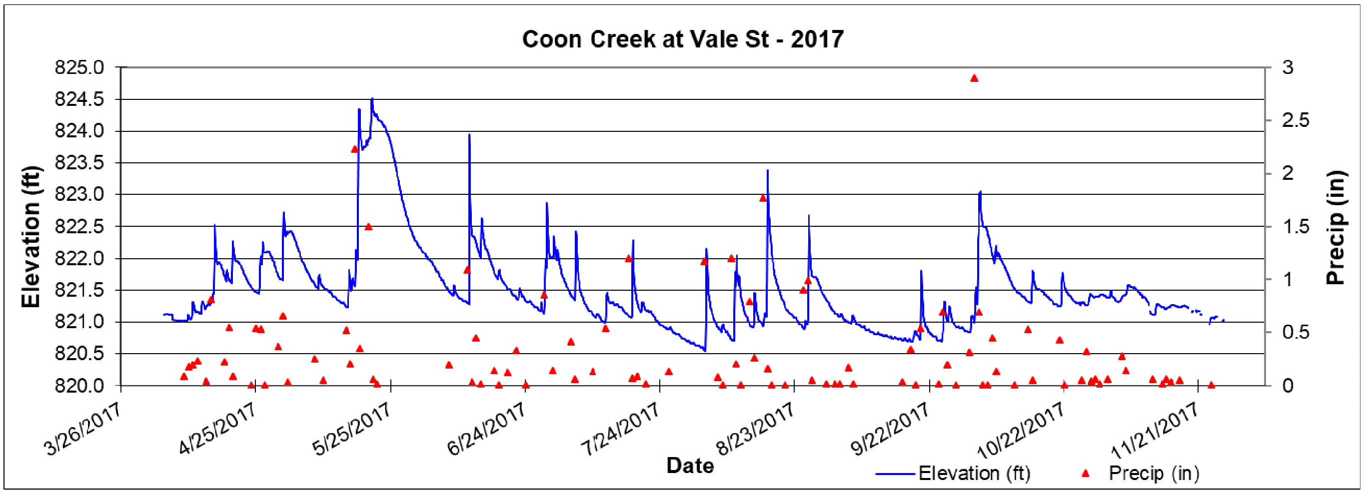


Coon Creek is a major drainage through central Anoka County. This monitoring location is the closest to the outlet to the Mississippi River that is accessible and does not have backwater effects from the Mississippi during high water. Land use in the upstream watershed ranges from rural residential upstream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

In 2017, Coon Creek water levels spanned a range of 4.18 feet at Vale St. The maximum observed stream level (824.51feet) was recorded in May, and the minimum level (820.03) was recorded in early August after a dry mid-summer. Frequent rain events through fall kept the creek slightly over baseflow into freeze up.

Coon Creek has flashy responses to storms, water levels rise quickly in response to precipitation, but return to baseflow conditions more slowly. The quick, intense response to rainfall is likely due to 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 2006-2017 serve to illustrate this. In the few hours following larger storms, water levels can rise nearly 4 feet. An event in June, 2017 caused stage to rise 2.66 feet in just 4 hours after 1.09 inches of rain fell in 2 hours.

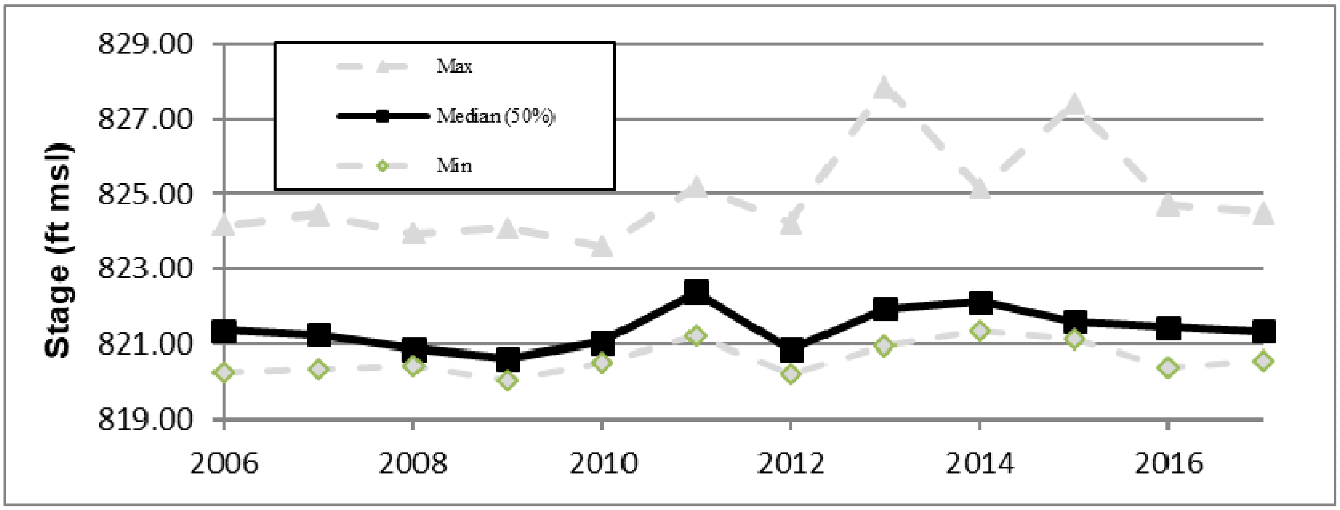
2017 Hydrograph



COON CREEK

at Coon Creek Hollow, Vale Street, Coon Rapids

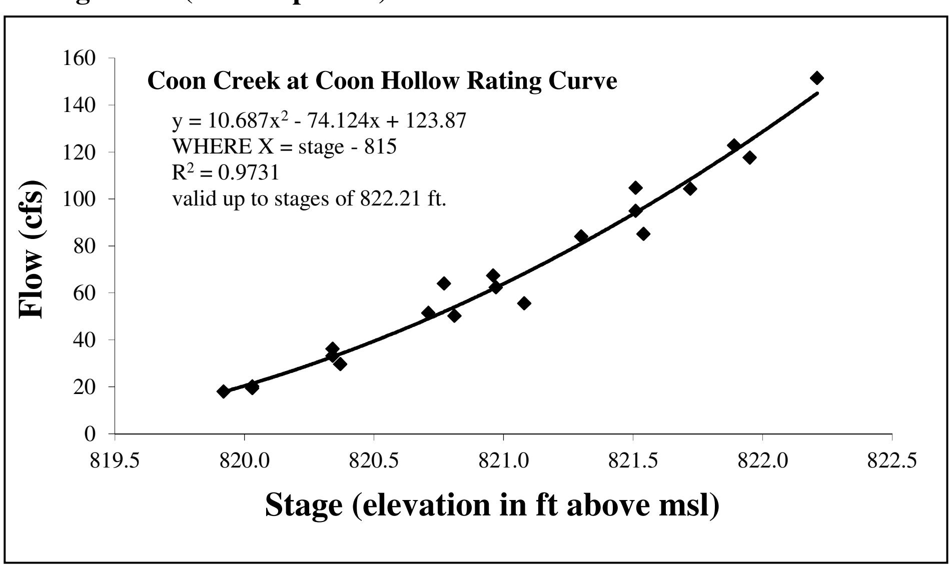
Summary of All Monitored Years



Summary of All Monitored Years

Percentiles	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Min	820.04	820.26	820.33	820.43	820.03	820.54	821.23	820.22	820.97	821.35	821.13	820.39	820.54
2.5%	820.06	820.42	820.40	820.52	820.12	820.64	821.27	820.28	820.99	821.47	821.19	820.58	820.70
10.0%	820.19	820.53	820.53	820.57	820.20	820.73	821.31	820.33	821.00	821.51	821.31	820.78	820.84
25.0%	820.57	820.78	820.73	820.63	820.35	820.85	821.83	820.45	821.20	821.67	821.41	820.99	821.08
Median (50%)	820.91	821.35	821.25	820.88	820.61	821.05	822.38	820.85	821.95	822.15	821.60	821.44	821.34
75.0%	821.26	821.78	821.88	821.78	820.93	821.32	822.99	821.28	827.87	823.33	821.92	821.91	821.72
90.0%	821.77	822.27	822.63	822.26	821.31	821.68	823.70	821.89	827.87	824.38	822.30	822.24	822.25
97.5%	822.92	822.76	823.21	822.79	822.05	822.33	824.56	823.60	827.87	824.87	823.08	822.76	823.84
Max	823.26	824.18	824.47	823.96	824.11	823.62	825.18	824.25	827.87	825.13	827.42	824.70	824.51

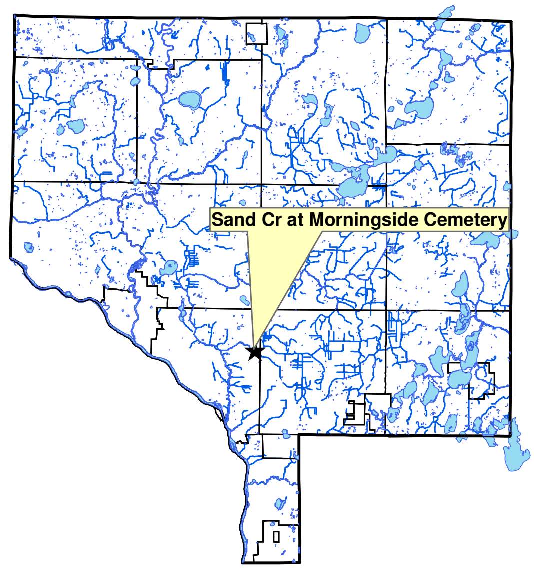
Rating Curve (2010 - updated)



SAND CREEK

at Morningside Cemetery, Coon Rapids

Notes



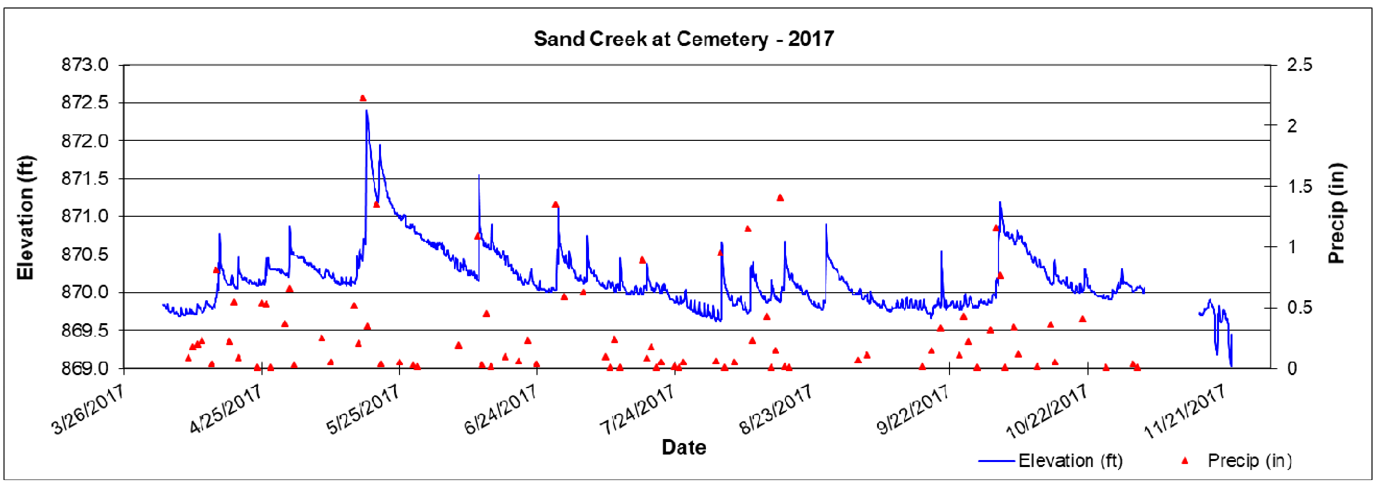
Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial and retail areas throughout northeastern Coon Rapids and western Blaine. The stream is approximately 8 feet wide and 3 feet deep at the monitoring site during baseflow.

Sand Creek at Morningside Cemetery was first monitored in 2010. The site was added because of its position between the cities of Blaine and Coon Rapids, which could provide an estimate of the flow contributions from Blaine pending the development of a rating curve. In addition, the site is located immediately downstream of the confluence of Ditch 39 with Sand Creek.

At this site, creek levels often rise more than downstream at Xeon Street following rainstorms. In 2017, this site fluctuated 3.38 feet throughout the year, with the site further downstream only fluctuating 2.48 feet. It is likely that flow volumes are similar or less at the cemetery, but because the channel is narrower, the vertical rise in water levels is greater. Equipment was pulled in mid-November, 2017 with freeze up imminent. The equipment was then redeployed in late November with a potential storm in the forecast. The lowest levels ever recorded at this site were recorded in late November 2017.

No rating curve exists at this site.

2017 Hydrograph

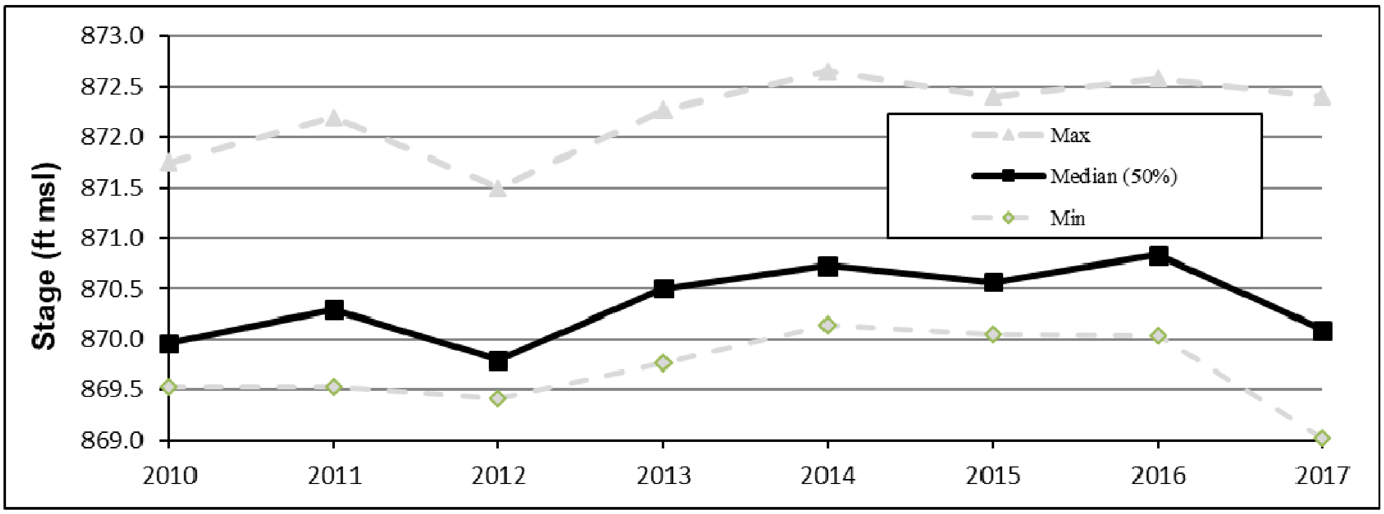


SAND CREEK

at Morningside Cemetery, Coon Rapids

Summary of All Monitored Years

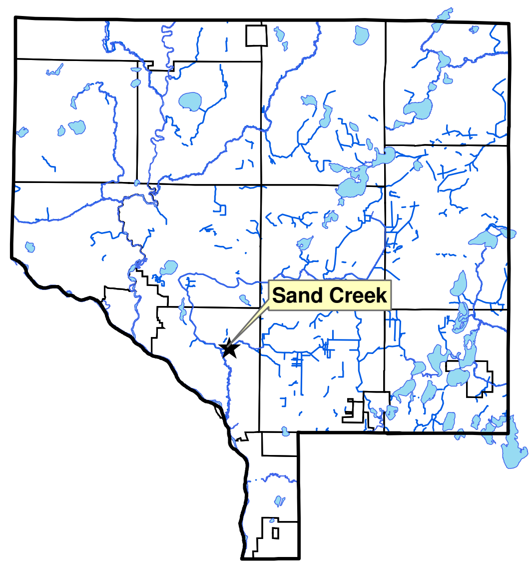
Percentiles	2010	2011	2012	2013	2014	2015	2016	2017
Min	869.53	869.53	869.42	869.76	870.14	870.04	870.03	869.03
2.5%	869.61	869.59	869.44	869.99	870.19	870.10	870.34	869.69
10.0%	869.70	869.67	869.47	870.09	870.25	870.24	870.43	869.78
25.0%	869.79	870.03	869.59	870.19	870.44	870.38	870.55	869.88
Median (50%)	869.96	870.29	869.79	870.50	870.73	870.57	870.83	870.09
75.0%	869.96	870.53	870.09	870.74	871.06	870.77	871.11	870.32
90.0%	870.29	870.86	870.38	871.23	871.35	870.97	871.39	870.65
97.5%	870.60	871.17	870.82	871.56	871.79	871.28	871.78	871.18
Max	871.75	872.20	871.50	872.27	872.65	872.40	872.58	872.40



SAND CREEK

at Xeon Street, Coon Rapids

Notes

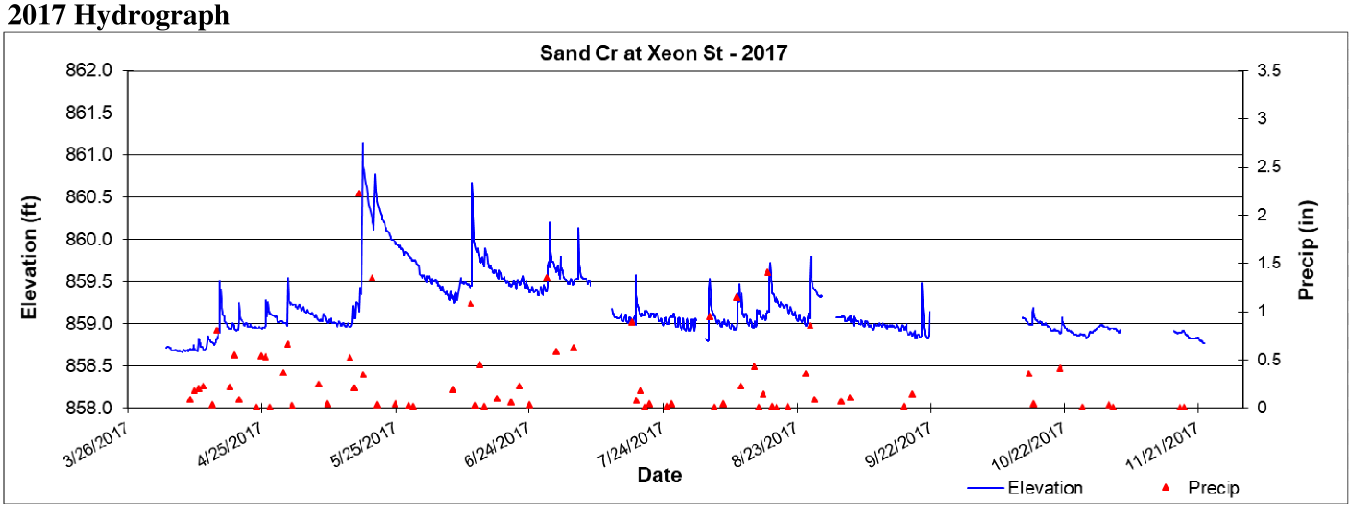


Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial and retail areas throughout northeastern Coon Rapids and western Blaine. The stream is about 15 feet wide and 3 feet deep at the monitoring site during baseflow.

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. Individuals storms also cause much smaller fluctuations at this site than at the further upstream site at Morningside Cemetery, with some years fluctuating less than 2 feet the entire season. In 2017, this site ranged just 2.48 feet from minimum to maximum compared to 3.38 feet just upstream. Sand Creek maintains a similar depth throughout most of its lower watershed, and spreads out wider to accommodate its flow. Because of this, far smaller fluctuations in stage occur downstream.

A rating curve for this site was last updated in 2013 and is presented below.

2017 Hydrograph



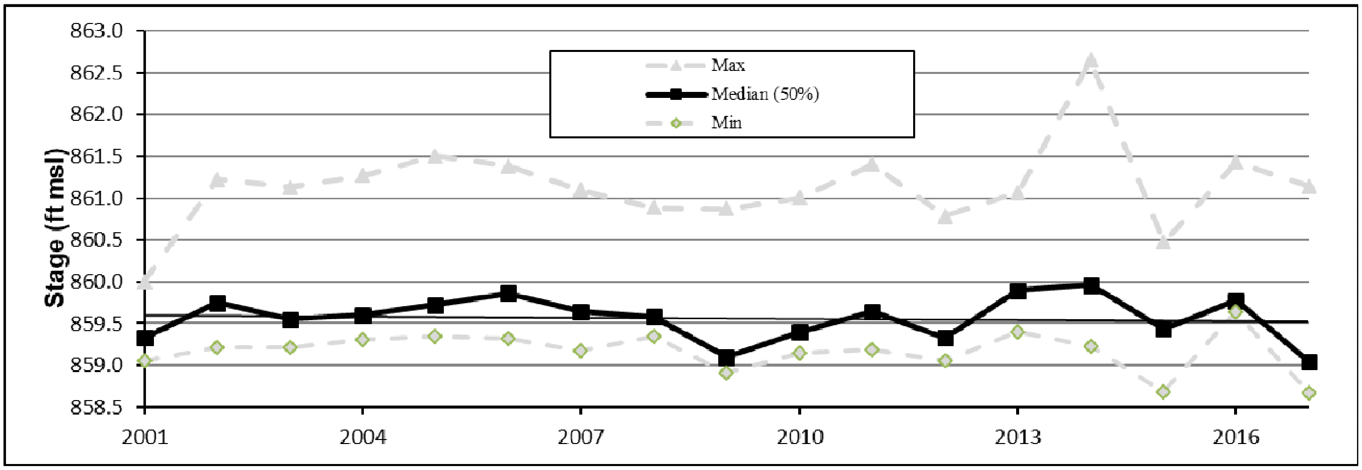
Summary of All Monitored Years

Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Min	859.06	859.22	859.21	859.31	859.35	859.32	859.17	859.35	858.91	859.15	859.19	859.06	859.40	859.23	858.69	859.64	858.66
2.5%	859.09	859.44	859.26	859.33	859.41	859.43	859.30	859.44	858.99	859.24	859.22	859.07	859.53	859.42	858.96	859.67	858.69
10.0%	859.15	859.48	859.32	859.40	859.45	859.54	859.41	859.48	859.03	859.28	859.28	859.11	859.60	859.61	859.03	859.70	858.84
25.0%	859.23	859.61	859.41	859.46	859.55	859.70	859.47	859.53	859.05	859.33	859.47	859.18	859.70	859.79	859.16	859.73	858.94
Median (50%)	859.33	859.75	859.55	859.60	859.72	859.86	859.64	859.58	859.10	859.40	859.65	859.33	859.90	859.96	859.44	859.78	859.04
75.0%	859.49	859.93	859.75	859.80	859.97	860.01	859.81	859.78	859.29	859.52	859.89	859.53	860.04	860.28	859.66	859.84	859.36
90.0%	859.54	860.09	860.00	860.03	860.21	860.12	859.98	859.94	859.38	859.60	860.08	859.76	860.18	861.08	859.82	860.00	859.57
97.5%	859.65	860.32	860.28	860.32	860.51	860.27	860.11	860.13	859.54	859.75	860.33	860.11	860.37	861.93	860.04	860.38	859.96
Max	860.00	861.22	861.13	861.27	861.50	861.38	861.10	860.88	860.87	861.01	861.40	860.78	861.06	862.65	860.48	861.43	861.15

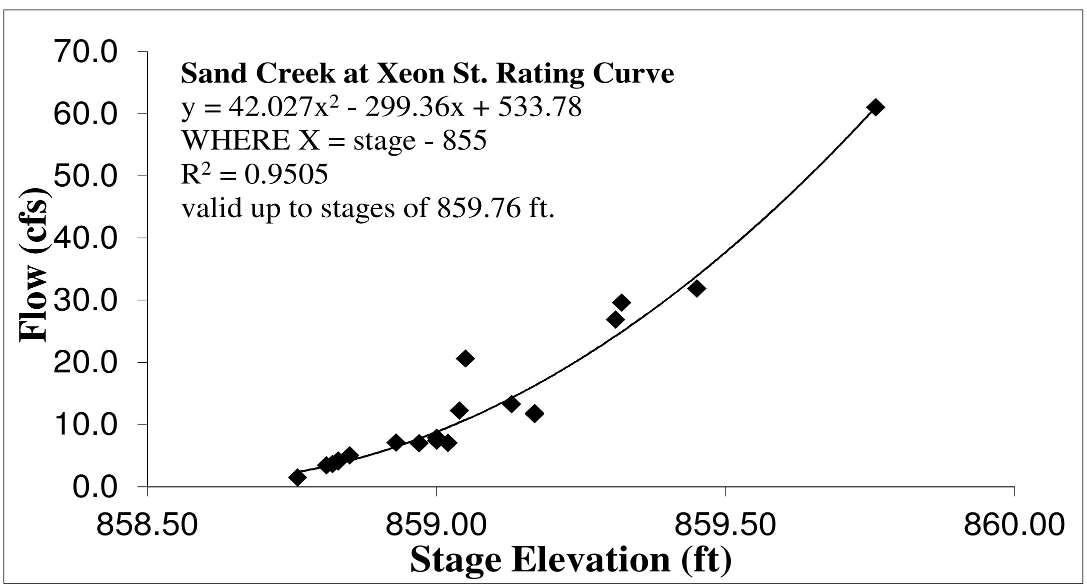
SAND CREEK

at Xeon Street, Coon Rapids

Summary of All Monitored Years



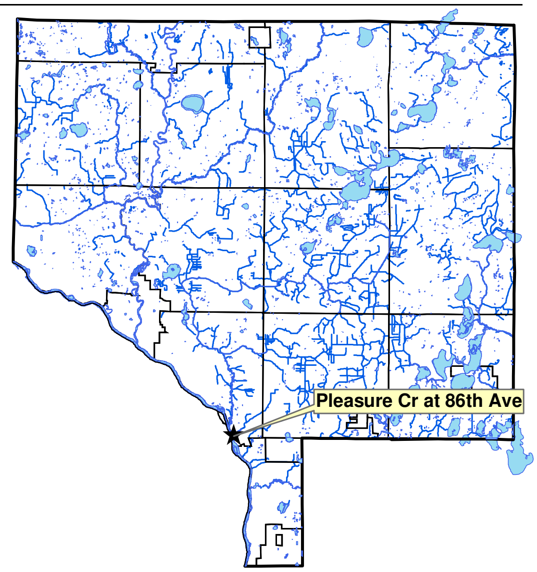
Rating Curve (2013)



PLEASURE CREEK

at 86th Ave, Coon Rapids

Notes

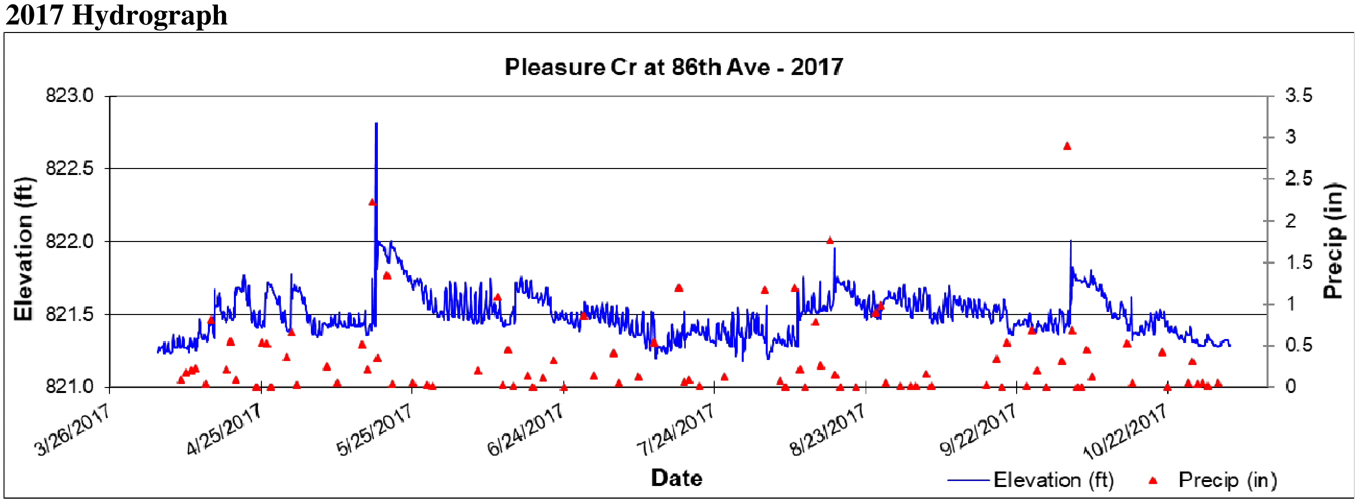


Pleasure Creek flows through the southwestern portion of Blaine and southern Coon Rapids. The watershed is urbanized. The creek is about 8-10 feet wide and 0.5 to 1 foot deep during baseflow. It flows through an interconnected network of stormwater ponds in the upper part of the watershed.

Variations in the water level at Pleasure Creek are seldom more than one foot, but happen with extreme rapidity. As an example, a 2.27 inch storm in 2014 caused the creek to rise 0.75 feet in the first two hours and had retreated 0.64 feet in the following two hours. A 1.99 inch storm in 2015 reacted similarly rising 0.81 feet in the first two hours and then retreating 0.42 feet in the following two hours. In September of 2016, a 3.19 inch storm caused a spike of 1.6 feet in 4 hours, which the stream dropped back 0.95 feet of in the following 6 hours. A May 2017 storm of 2.23 inches caused a jump in stage of 1.39 feet in 4 hours.

A rating curve for this site was last updated in 2013 and is presented below. The rating curve R^2 value of 0.86 is not as robust as desired; and additional flow measurements should be considered to refine this rating curve.

2017 Hydrograph



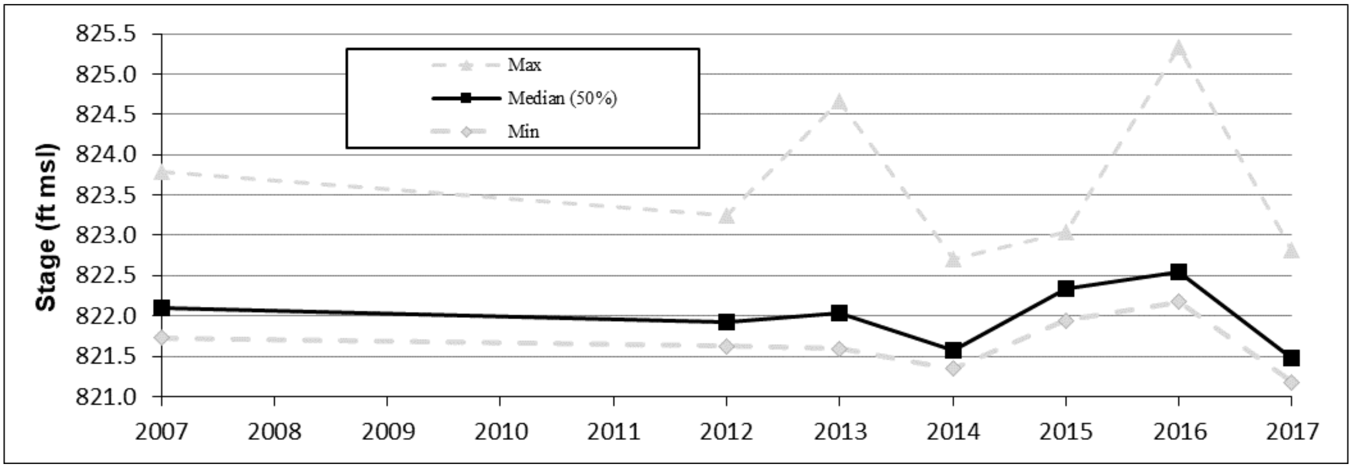
Summary of All Monitored Years

Percentiles	2007	2012	2013	2014	2015	2016	2017
Min	821.73	821.63	821.60	821.34	821.95	822.17	821.18
2.5%	821.77	821.69	821.63	821.38	821.98	822.20	821.26
10.0%	821.84	821.77	821.73	821.42	822.02	822.27	821.31
25.0%	821.95	821.80	821.78	821.45	822.26	822.46	821.40
Median (50%)	822.10	821.93	822.04	821.57	822.34	822.54	821.48
75.0%	822.32	822.04	824.67	821.82	822.46	822.61	821.59
90.0%	822.49	822.19	824.67	821.98	822.56	822.70	821.69
97.5%	822.63	822.33	824.67	822.19	822.61	822.81	821.82
Max	823.79	823.25	824.67	822.70	823.04	825.33	822.81

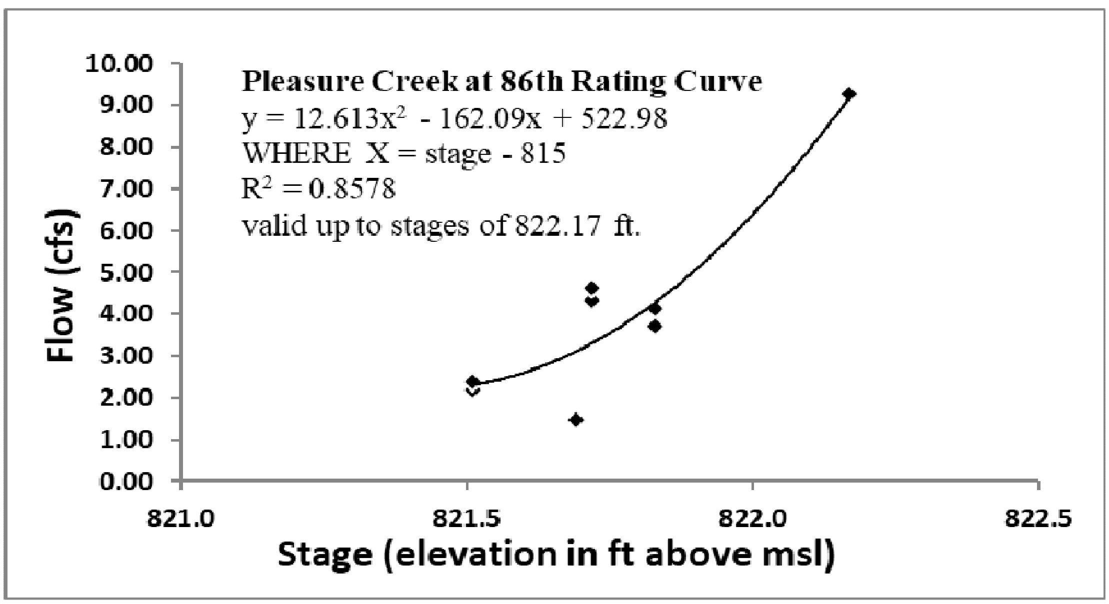
PLEASURE CREEK

at 86th Ave, Coon Rapids

Summary of All Monitored Years



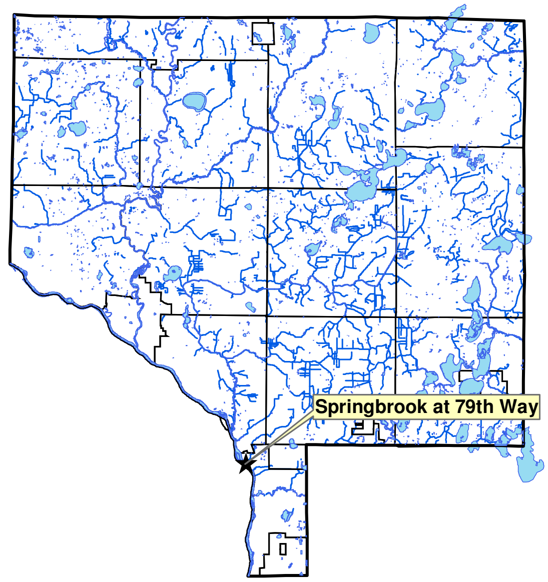
Rating Curve (2013)



SPRINGBROOK

at 79th Way, Fridley

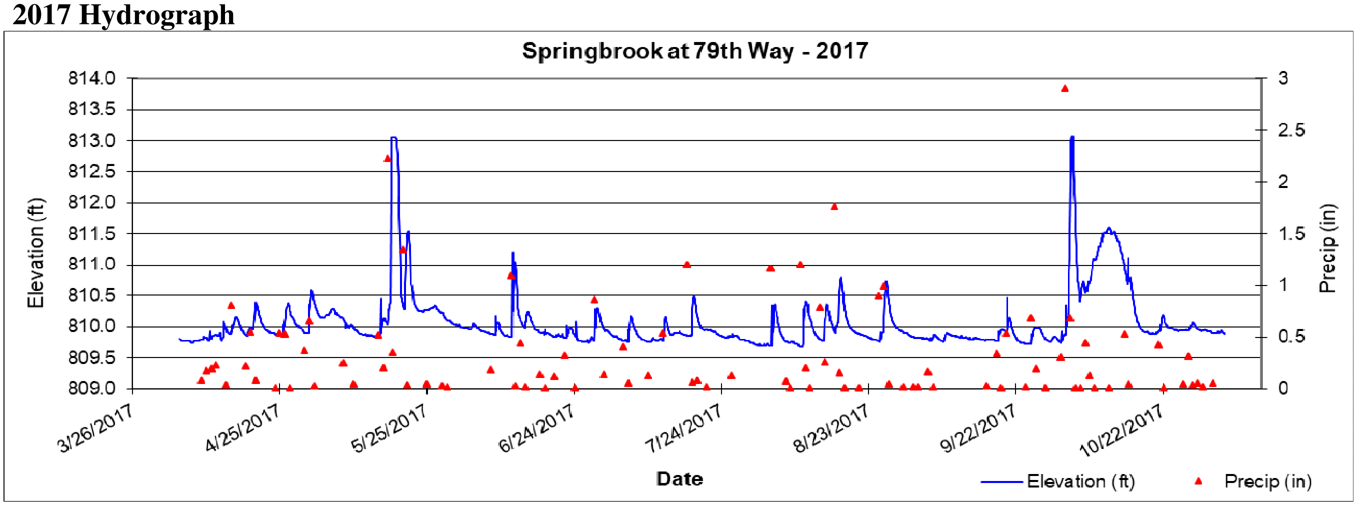
Notes



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.

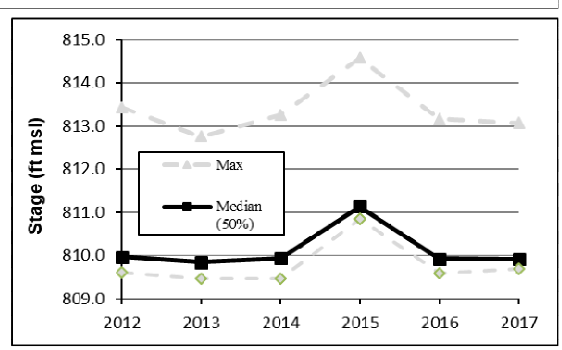
Springbrook at 79th Way was monitored for the first time in 2012. The stream is flashy, with water levels that increase dramatically following rainfall and quickly recede thereafter. This occurs despite the possible dampening effect of the stream flowing through the Springbrook Nature Center impoundment just upstream. For example, in 2017 water levels rose 2.66 feet in 4 hours after a 2.23-inch rain in May, and 3.2 feet in 30 hours after 3.59 inches of rain in October. An additional aspect which makes this site unique is its proximity to the Mississippi River. Influence of the river occurred in 2012-2014 when the river water levels rose to such an elevation that backflowing 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 maximum water level is still unknown. No rating curve exists for this site.

2017 Hydrograph



Summary of All Monitored Years

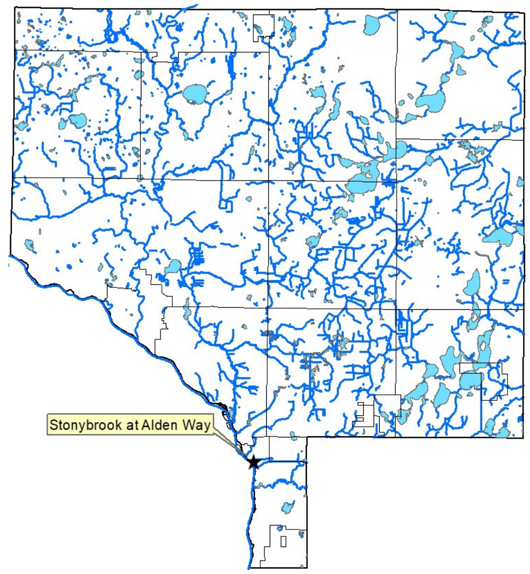
Percentiles	2012	2013	2014	2015	2016	2017
Min	809.62	809.47	809.46	810.85	809.59	809.69
2.5%	809.65	809.54	809.63	810.91	809.67	809.72
10.0%	809.69	809.60	809.66	810.96	809.74	809.78
25.0%	809.76	809.67	809.72	811.04	809.79	809.83
Median (50%)	809.97	809.84	809.93	811.13	809.93	809.91
75.0%	810.29	810.08	811.62	811.30	810.13	810.10
90.0%	811.24	810.71	812.99	811.73	810.50	810.41
97.5%	812.87	812.17	813.18	812.63	811.28	811.51
Max	813.43	812.76	813.25	814.57	813.16	813.07



STONYBROOK

at Alden Way, Fridley

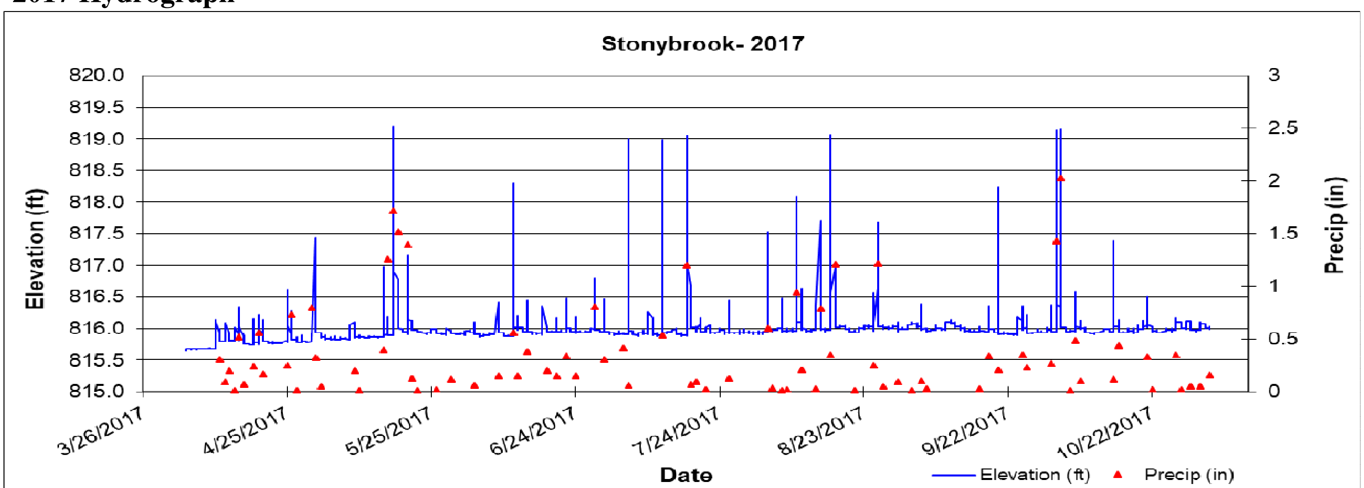
Notes



Stonybrook is a small waterway that drains a small subwatershed in western Fridley. The stream's contributing area starts about one mile east of the Mississippi River as a storm sewer, with most of the conveyance system being subterranean in nature. The last 1/3 of the one-mile watershed is an open, deeply cut channel that descends 50 feet to the Mississippi River. The sampling site is located about 250 feet upstream of the confluence with the Mississippi River, just east of Alden Way. The creek is only about 10 feet wide and 6 inches deep during baseflow conditions at the sampling site.

Not surprisingly, given its surrounding land use, size, and channelized characteristics, Stonybrook has extremely flashy reactions to rain events, with virtually instantaneous spikes and plummets of stage. 2017 was the first year in which stage was recorded for Stonybrook. The standard water level recording interval of 2 hours was used from April into June, until it became apparent that stage fluctuations were being missed. Stage was recorded every half hour from June 19 until the equipment was collected in November. Stage ranged 3.55 feet through 2017. Stage rose over three feet within the hour of most rain events exceeding one inch.

2017 Hydrograph

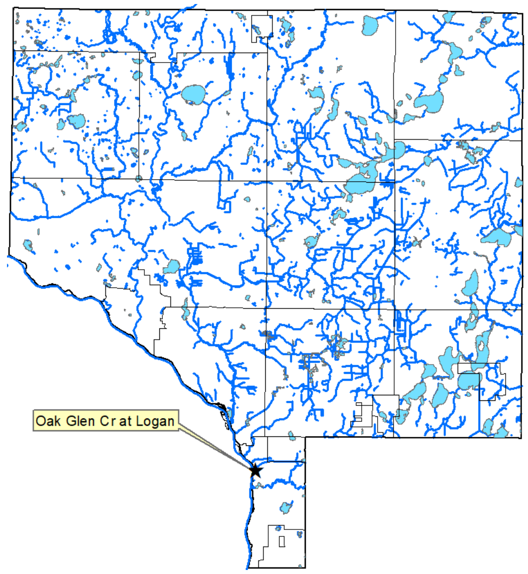


Percentiles	2017
Min	815.65
2.5%	815.80
10.0%	815.91
25.0%	815.93
Median (50%)	815.96
75.0%	816.00
90.0%	816.07
97.5%	816.30
Max	819.20

Oak Glen Creek

at Logan Parkway, Fridley

Notes

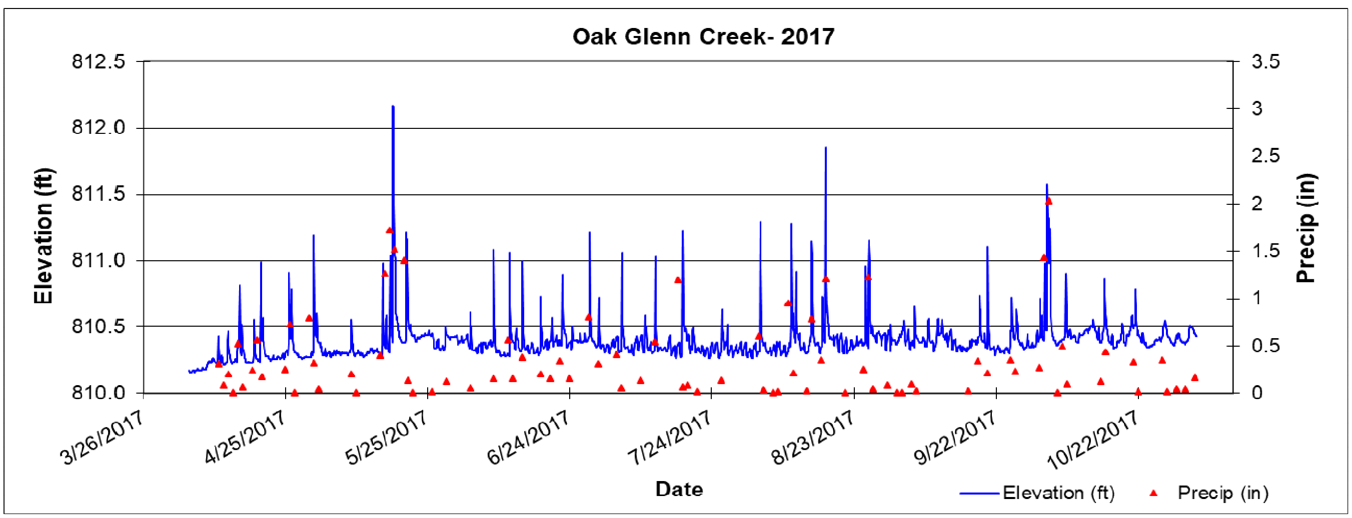


Oak Glen Creek is a small waterway that drains its own subwatershed directly to the Mississippi River. The Oak Glen subwatershed is 119 acres of mostly commercial development and storm sewer. The subwatershed boundaries are Highway 65 to the east, Osborne Road to the north and 71st Avenue to the south. The creek exists as an open channel for approximately 1,200 feet between East River Road and the Mississippi River. The channel is deeply cut and narrow, descending about 50 feet to the River.

2017 was the first year in which Oak Glen Creek was monitored for stage. The sampling site was located about 500 feet upstream of the confluence with the Mississippi. Upstream of this site, in 2017, a stormwater pond just east of East River Road was excavated to a larger and deeper size, and an iron enhanced sand filter bench was installed.

Due to its size and watershed characteristics, the creek reacts very quickly to rain events. It only fluctuated about 2 feet total over the year (2.02 ft.) compared to nearby Stonybrook's 3.55 feet. A 1.72 inch rain event on May 17, 2017 caused the stage to rise 1.78 feet and descend back down 1.13 feet all over just 6 hours.

2017 Hydrograph



Percentiles	2017
Min	810.15
2.5%	810.23
10.0%	810.28
25.0%	810.31
Median (50%)	810.37
75.0%	810.42
90.0%	810.49
97.5%	810.74
Max	812.17

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, total phosphorus and *E. coli* bacteria.

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

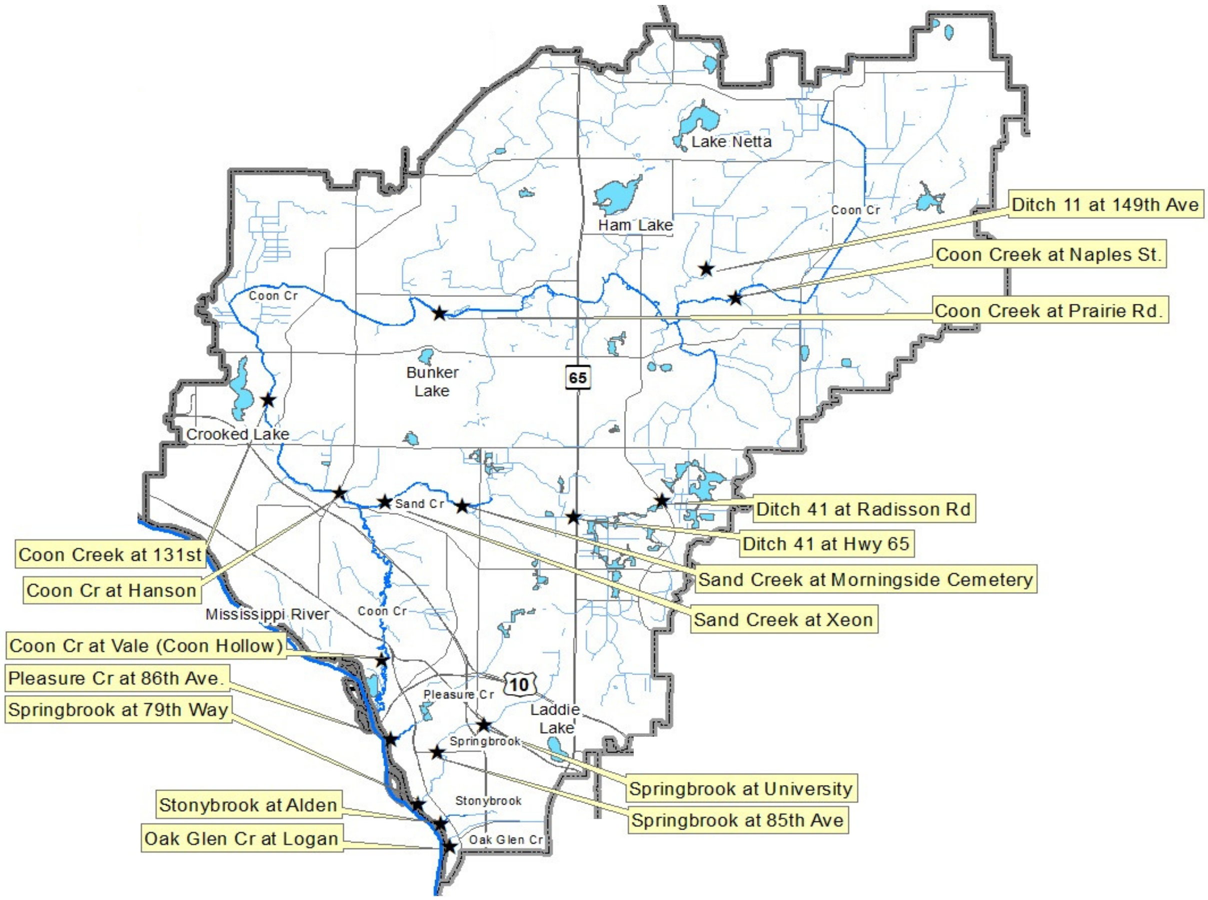
Locations:

Stream	Location	City
Ditch 11	149th Ave.	Ham Lake
Coon Creek	Naples St.	Ham Lake
Coon Creek	Prairie Rd.	Andover
Coon Creek	131st Ave.	Coon Rapids
Coon Creek	Hanson Blvd	Coon Rapids
Coon Creek	Coon Hollow	Coon Rapids
Stonybrook	Alden Way	Fridley
Oak Glen Cr	Logan Pkwy.	Fridley

Stream	Location	City
Ditch 41	Radisson Rd.	Blaine
Ditch 41	Highway 65	Blaine
Sand Creek	Morningside	Coon Rapids
Sand Creek	Xeon Street	Coon Rapids
Pleasure Cr.	86th Ave.	Coon Rapids
Springbrook	University	Blaine
Springbrook	85th Ave.	Fridley
Springbrook	79th Way	Fridley

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

Coon Creek Watershed 2017 Stream Water Quality Monitoring Sites



Median pollutant concentrations for waterways in the Coon Creek Watershed District. The reader is warned that differing amounts of sampling have been done at each stream. Also, in some cases, the extreme measurements are more important than the median values presented. Please see detailed results from each stream for more insight. The numbers shown are medians of all readings from all sites within the subwatershed. Values on top are baseflow median values; values on bottom are storm flow median values. All data through 2017 is included for the individual creeks.

Differences between baseflow and storm flow conditions illustrate the effect that storm runoff has on the water quality of each of the subwatersheds. Large increases in pollutant concentrations in individual subwatersheds during storm events shows where additional stormwater treatment is needed within the watershed.

Baseflow Median / Storm flow Median	**Springbrook Creek sub watershed**	**Pleasure Creek sub watershed**	**Sand Creek sub watershed**	**Coon Creek main stem**	**Stony Brook****	**Oak Glen Creek****	**Median for Anoka Co Streams all conditions**	**State Water Quality Standard**
Conductivity (mS/cm)	1.03	1.048	0.825	0.633	1.44	1.57	0.420	none
	0.724	1.149	0.753	0.520	1.08	1.34		
Chlorides* (mg/L)								860 - acute
								230 - chronic
Turbidity (NTU)	1.9	8	5.9	10	8.3	3.8	11.24	None
	10.2	18	10.0	20	6.7	5.1		
Total Suspended Solids (mg/L)	5	6	5	6	6	3	13.66	30
	8	15	7	16	7	11		
Total Phosphorus (µg/L)	83	56.5	53.5	81	76.5	38.5	126	100
	121	81.5	67.0	152	95.5	66.0		
Dissolved Oxygen (mg/L)	8.88	8.27	8.10	8.41	10.22	11.0		≥5
	8.33	8.58	7.76	7.34	9.22	8.67		
pH	7.81	8.08	7.76	7.77	7.72	7.91	7.59	6.5-8.5
	7.62	7.85	7.70	7.50	7.59	7.79		

**Chlorides not sampled in CCWD since 2012*

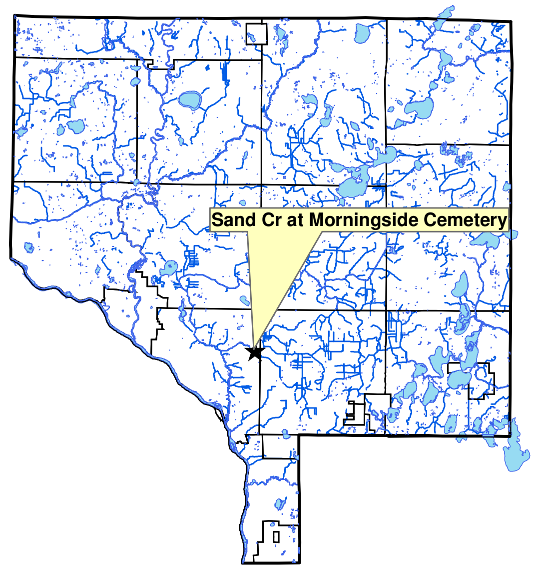
***Stonybrook and Oak Glen Creek only have one year of sampling data. True storm samples were missed due to the rapidity of conveyance through the systems. Medians presented do not reflect true storm flow water quality conditions.*

SAND CREEK

at Morningside Cemetery, Coon Rapids

Years Monitored

2017



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. Sand Creek at Morningside Cemetery is monitored because of its position between the cities of Blaine and Coon Rapids, which provides an estimate of the flow contributions from Blaine pending the development of a rating curve. In addition, the site is located immediately downstream of the confluence of Ditch 39 with Sand Creek.

This site has been monitored for storm and baseflow water quality using grab samples, as well as continuous hydrology, since 2010. That Data are presented elsewhere. Only continuous water quality monitoring with a sonde is presented in this section.

2017 was the first year in which continuous water quality was monitored during storm events in Sand Creek using a YSI EXO data sonde. The purpose of continuous water quality monitoring is to document water quality changes throughout a storm. This helps diagnose water quality problems and analyze differences in runoff from upper and lower parts of the watershed.

Methods

The site was monitored immediately before, during, and after storms with a YSI EXO data sonde. The sonde was suspended inside a PVC pipe with 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 during low flows. The sonde was programmed to take readings every 30 minutes. Readings included pH, salinity, specific conductance, temperature, dissolved oxygen, and turbidity. The sonde was calibrated before each deployment.

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

The YSI data sondes are deployed into the stream when a storm predicted to drop at least 0.5 inches of rain, and preferably greater, was forecasted. In some instances, water level was already high before the storm and remains high after the storm. At other times, predicted rain does not fall and we are monitoring baseflow conditions. In all instances, the YSI data sondes are left in the field for several days.

Water levels were continuously monitored throughout the open water season. An RDS Ecotone WM-40 water level monitoring device recorded water levels every two hours. This stream stage Data are presented with the water quality data. It would be preferable to present flow, but a rating curve does not exist for this site. To make graphs from all storms comparable, stage is displayed on a constant axis.

Precipitation data are provided with the water quality results. These data were taken from the datalogging rain gauge at Coon Rapids City Hall, which is approximately 1.67 miles southwest of the stream monitoring site.

A variety of storm sizes were analyzed. Rainfall during the monitored time periods ranged from 0.24 to 2.79 inches. The wide distribution is helpful in discerning the creek's response to different storms.

Only 2017 individual storm results are presented in this report. The individual storm results for other locations and previous years are available upon request from the Anoka Conservation District. Each year the findings of storm analyses 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.

Results and Discussion

Turbidity

- Turbidity Data are spotty for storm analysis in Sand Creek for 2017. Suspended debris got trapped in the sensor guard and affected measurements on multiple deployments.
- In general, there were very rapid turbidity increases at the beginning of storms, sometimes before stage even rose. These increases sometimes reached quite high levels, but turbidity levels also receded to low pre-storm levels very quickly (within hours).

Specific Conductance

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

Dissolved Oxygen

- The observed dissolved oxygen concentrations in Sand Creek generally were within the healthy range, >5mg/L.
- On two occasions, storm 4 and storm 2, dissolved oxygen temporarily dropped below 5 mg/L.

Temperature

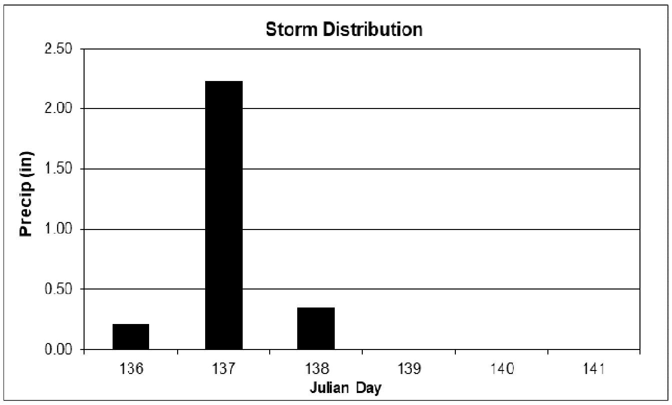
- Water temperature is generally not considered a concern in Sand Creek because there are no trout or other temperature sensitive resources.
- Cycles of day warming and night cooling are apparent in the data as well as high influxes of cooler storm runoff.

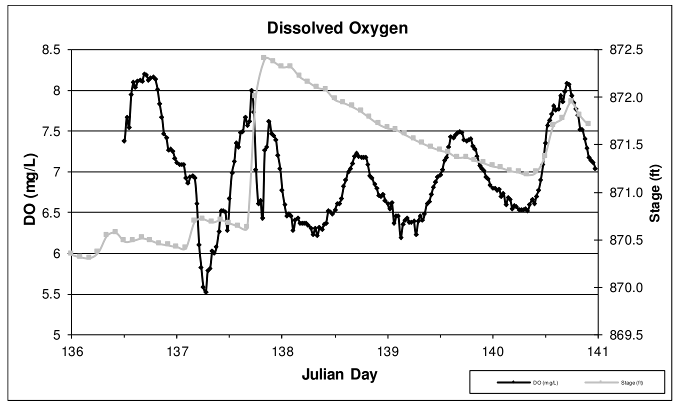
pH

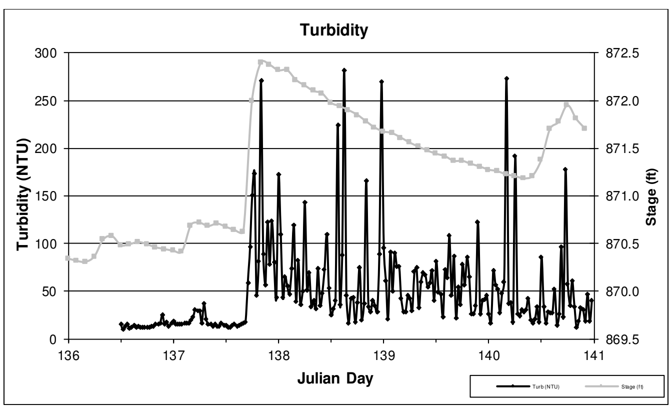
- pH is inversely related to water level in Sand Creek. When water level rises, pH declines. This is because rainwater has a lower pH than that of local shallow groundwater feeding baseflows.
- pH stayed within the desired range of 6.5 to 8.5 that is specified in state water quality standards and is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

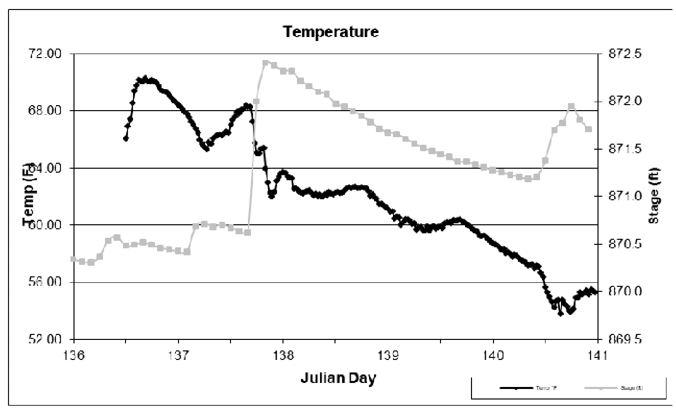
YSI Continuous Monitoring
Storm 1 - 2017

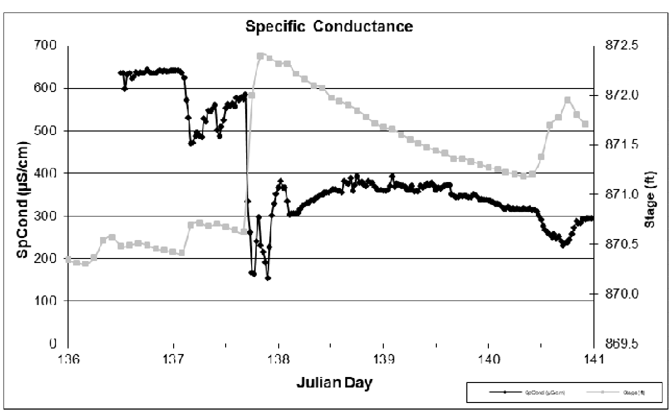
Sand Creek at Morningside Cemetery
<u>Storm Summary:</u>
Dates: 16 May 2017 (day 136) to 18 May 2017 (day 138)
Precipitation: 2.79 inches

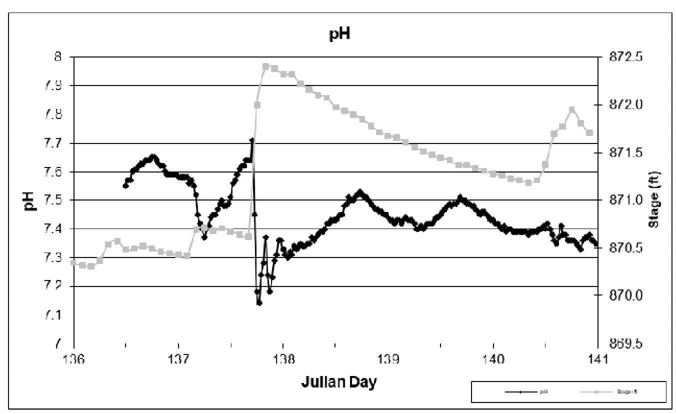








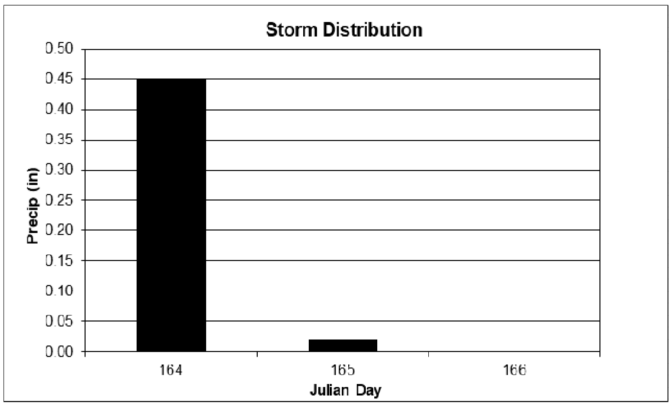


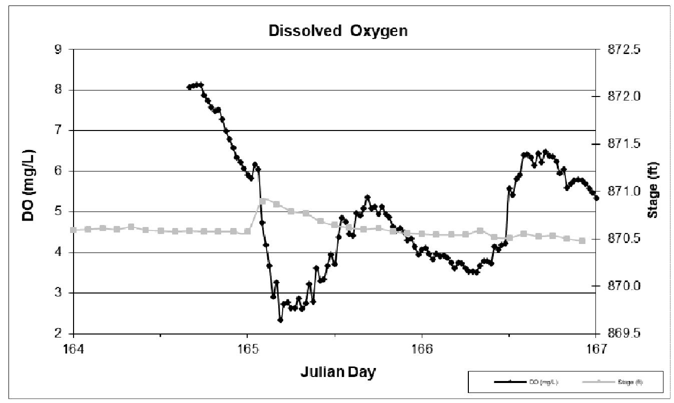


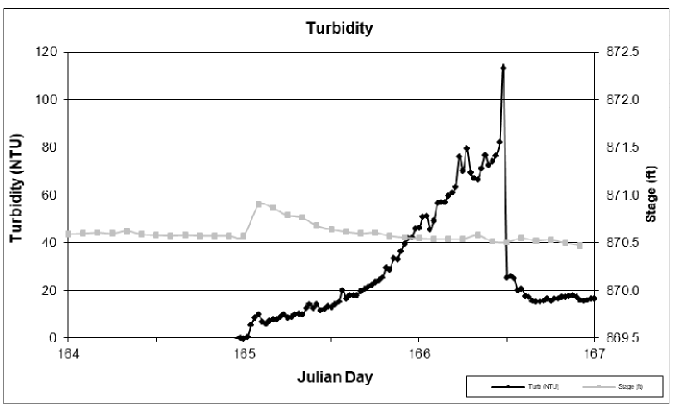
Note
Turbidity may not be reliable for this deployment. A bad calibration or debris in the probe may have affected equipment performance.

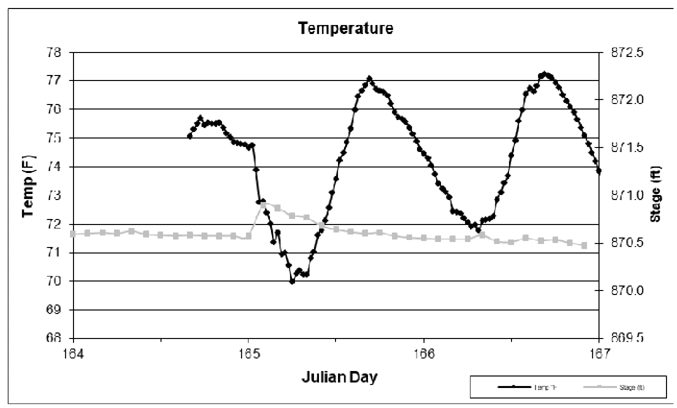
YSI Continuous Monitoring
Storm 2 - 2017

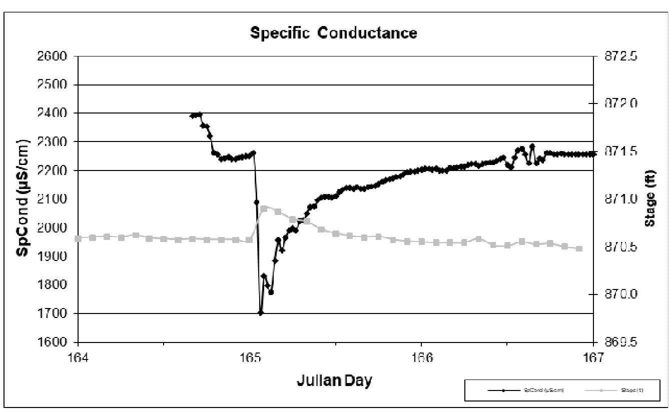
Sand Creek at Morningside Cemetery
<u>Storm Summary:</u>
Dates: 13 June 2017 (day 164) to 14 June 2017 (day 165)
Precipitation: 0.47 inches

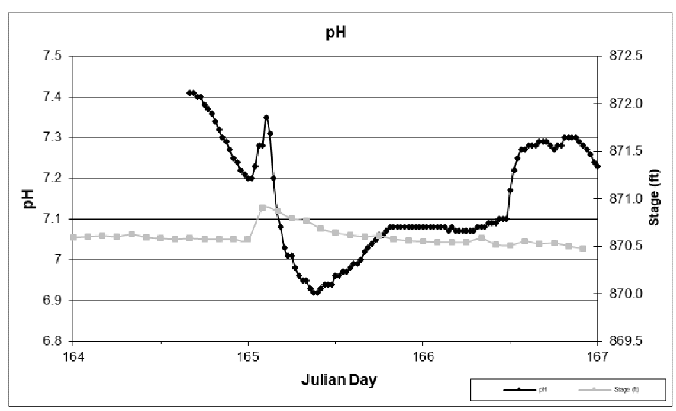








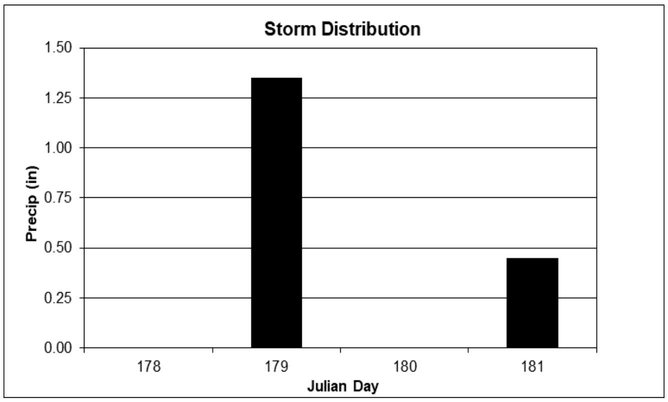


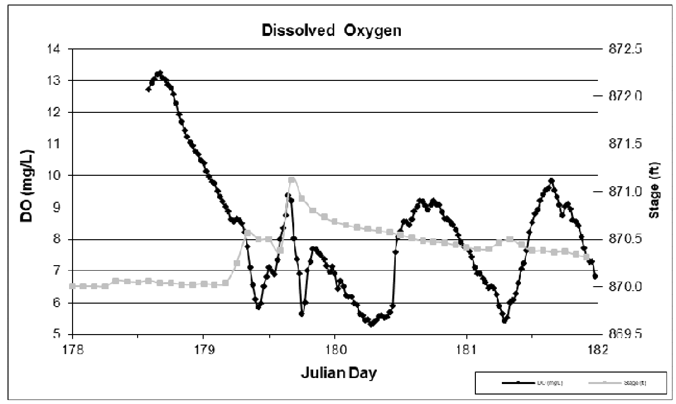


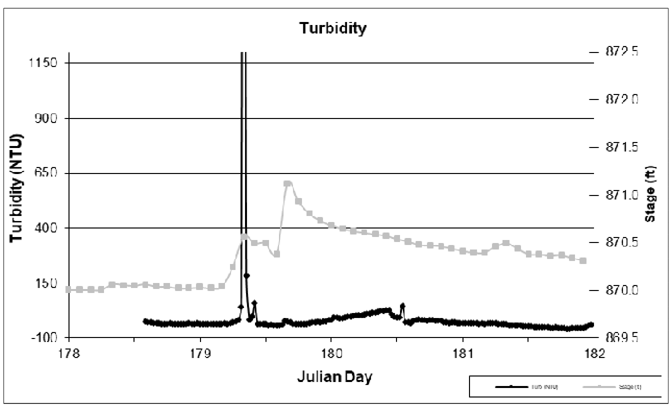
Note
Specific conductivity was very high on this deployment, but it appears to have fluctuated with the storm as usual. Levels are about double during this deployment compared to similar conditions at this site.

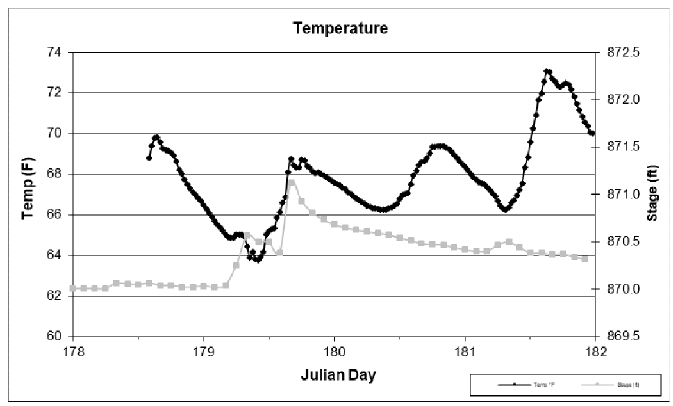
YSI Continuous Monitoring
Storm 3 - 2017

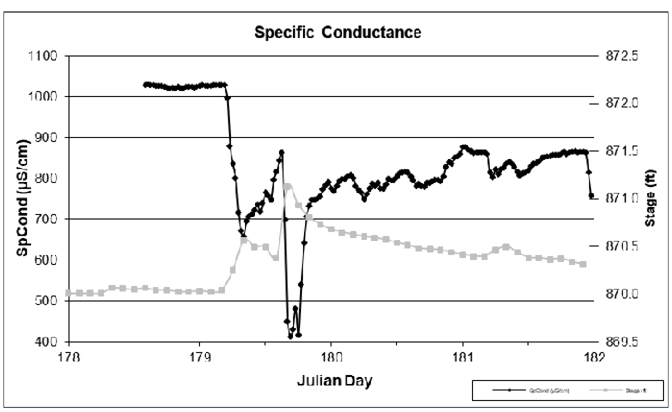
Sand Creek at Morningside Cemetery
<u>Storm Summary:</u>
Dates: 28 June 2017 (day 179) to 30 June 2017 (day 181)
Precipitation: 1.80 inches

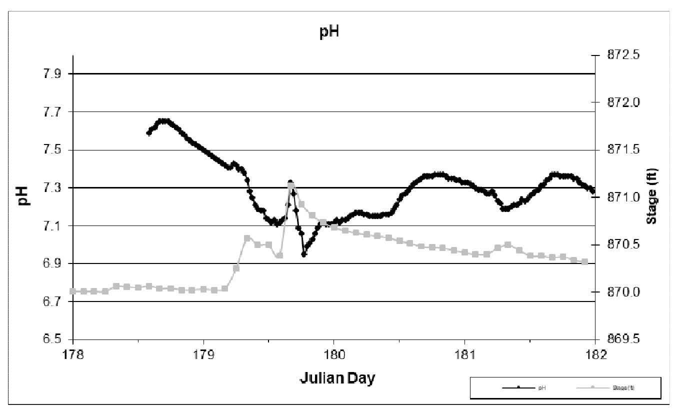








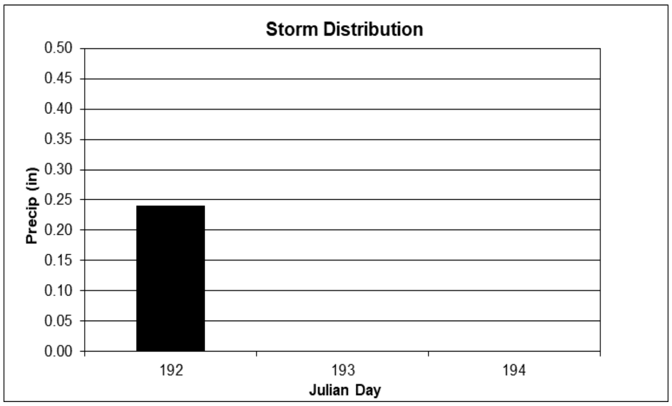


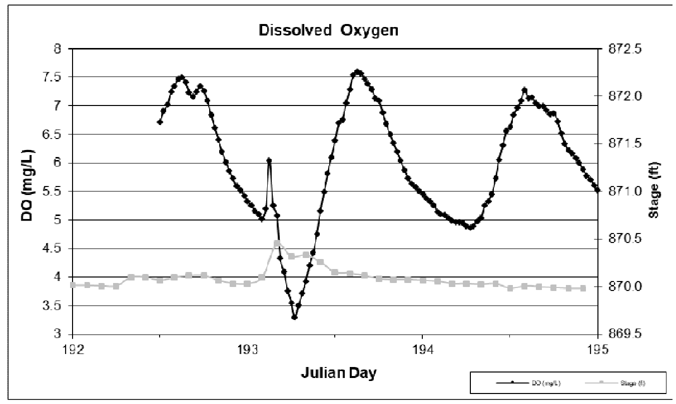


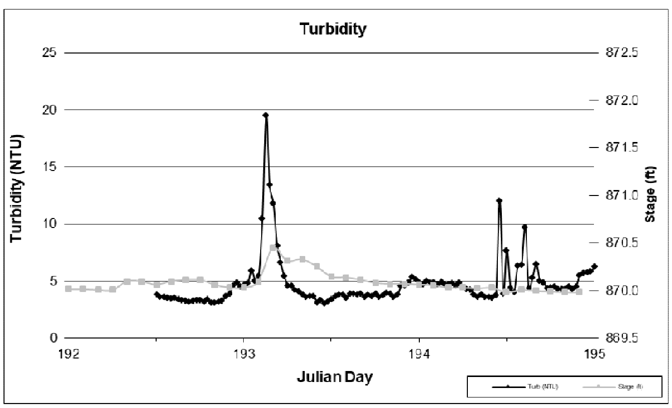
Note
Turbidity may not be reliable for this deployment. A bad calibration or debris in the probe may have affected equipment performance.

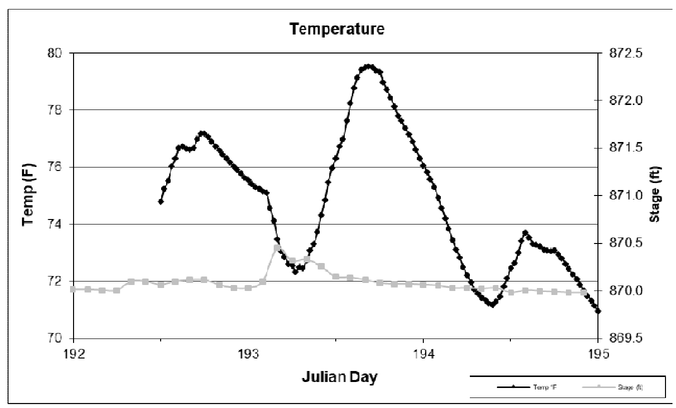
YSI Continuous Monitoring
Storm 4 - 2017

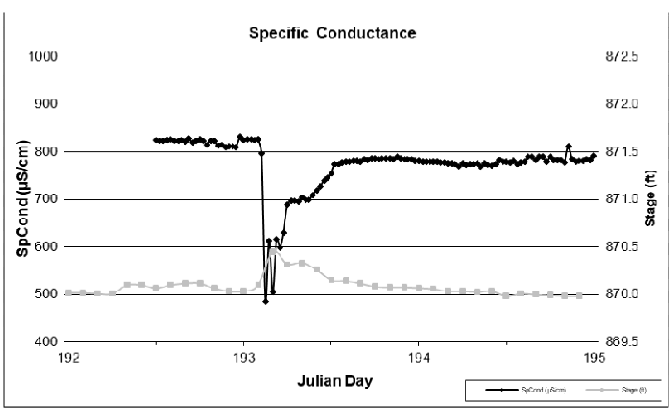
Sand Creek at Morningside Cemetery
<u>Storm Summary:</u>
Dates: 11 July 2017 (day 192)
Precipitation: 0.24 inches

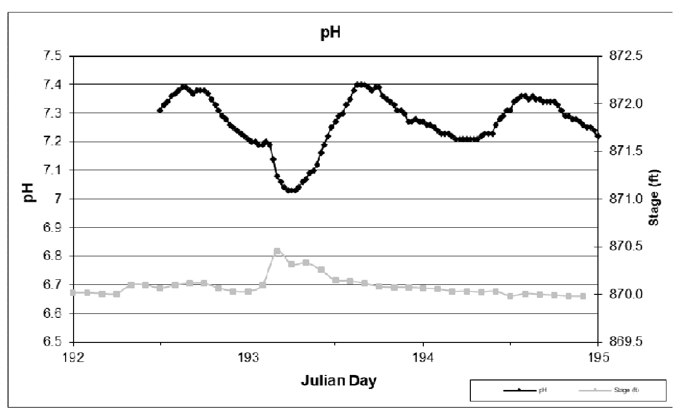






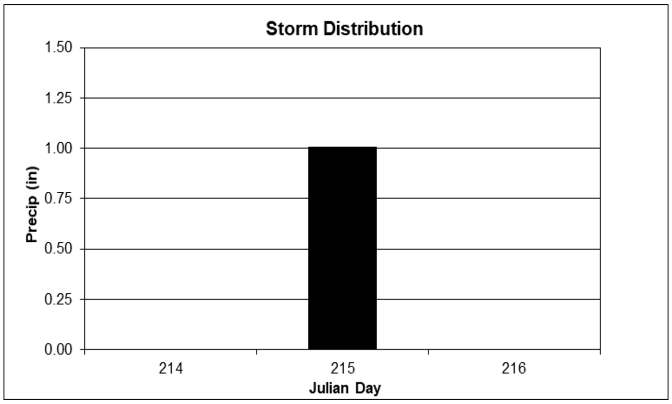


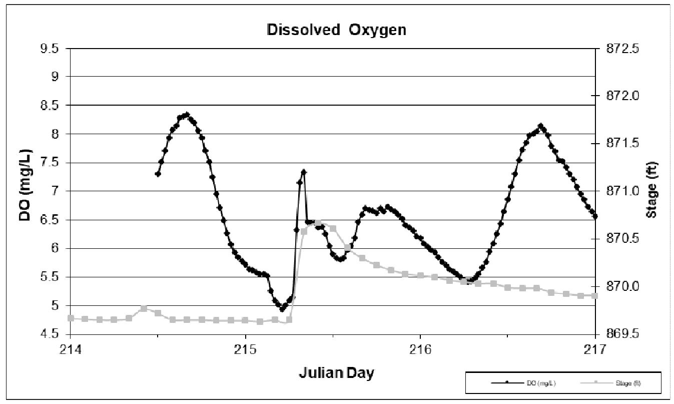


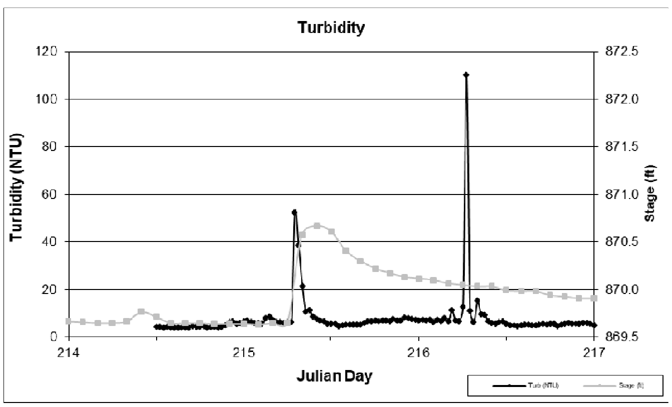


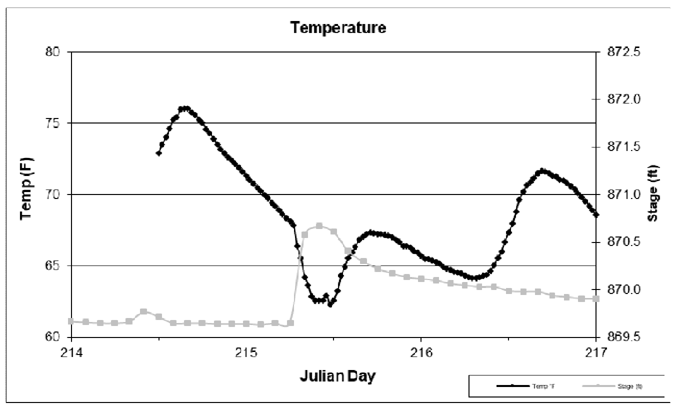
YSI Continuous Monitoring
Storm 5 - 2017

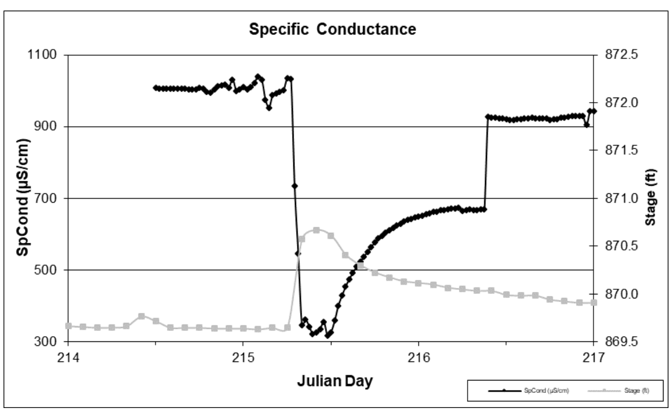
Sand Creek at Morningside Cemetery
<u>Storm Summary:</u>
Dates: 3 August 2017 (day 215)
Precipitation: 1.01 inches

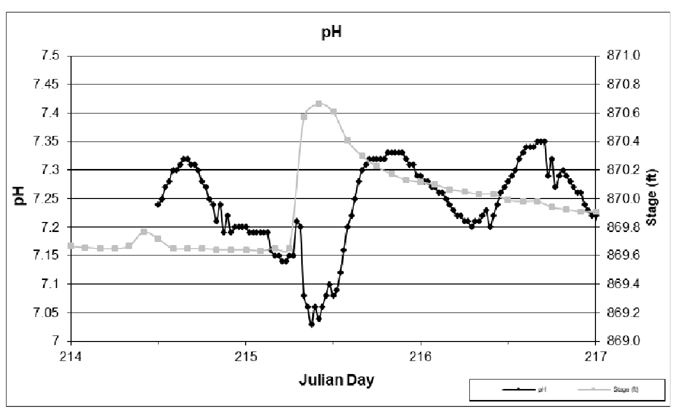












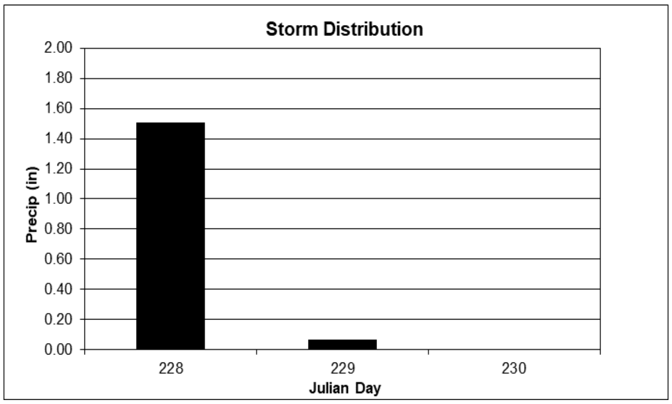
YSI Continuous Monitoring
Storm 6 - 2017

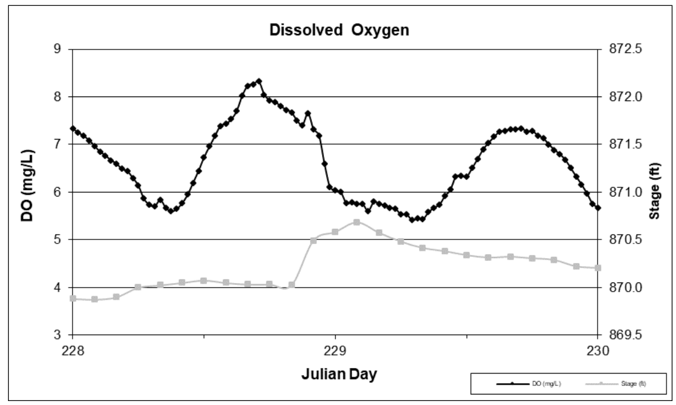
Sand Creek at Morningside Cemetery

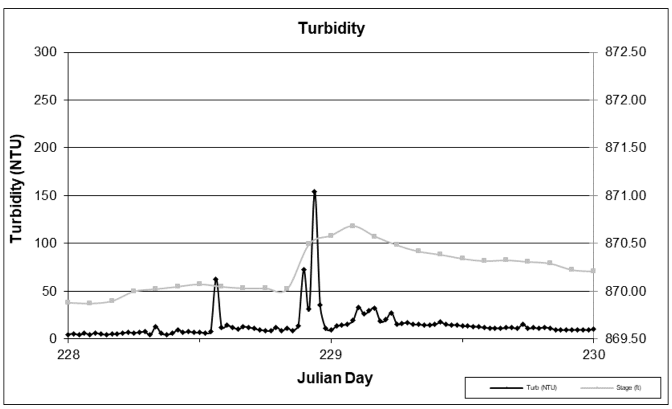
Storm Summary:

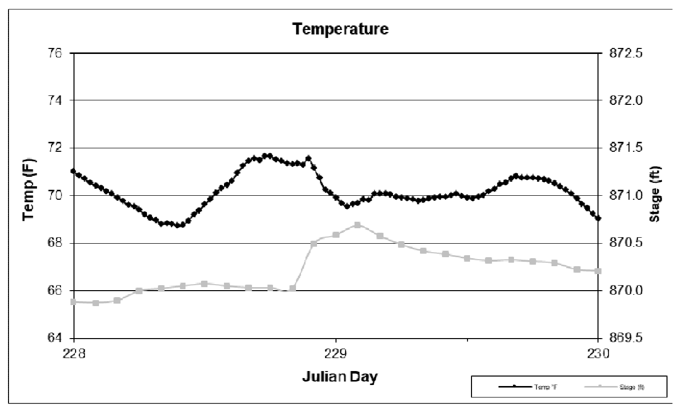
Dates: 16 August 2017 (day 228) to 17 August 2017 (day 229)

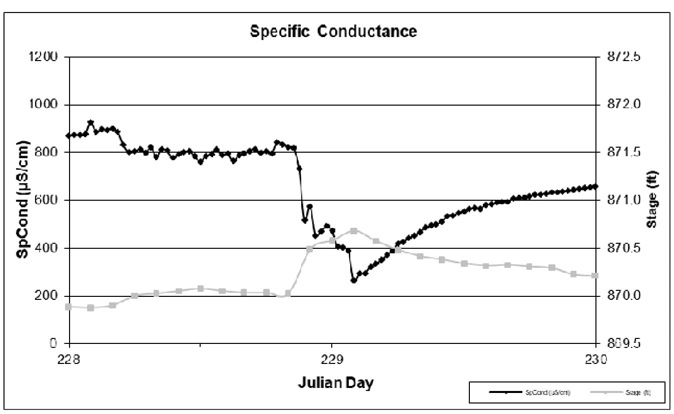
Precipitation: 1.58 inches

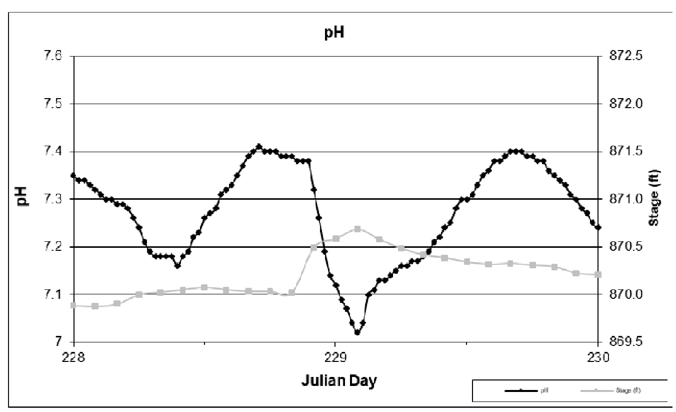












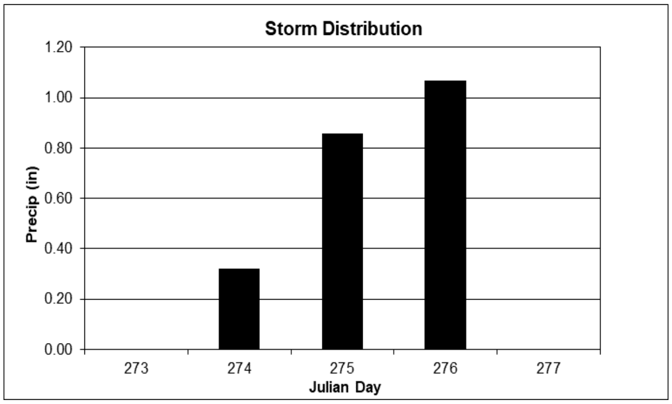
YSI Continuous Monitoring
Storm 7 - 2017

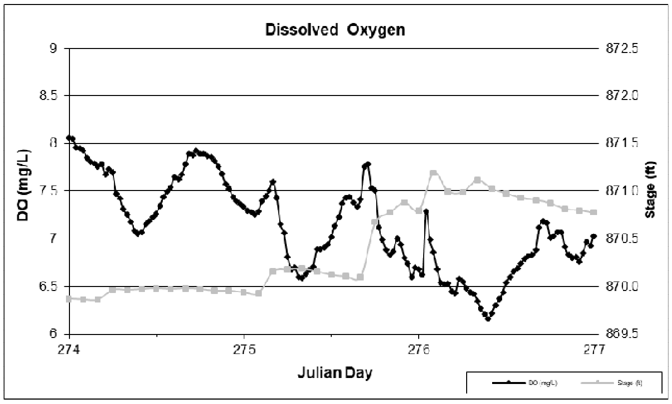
Sand Creek at Morningside Cemetery

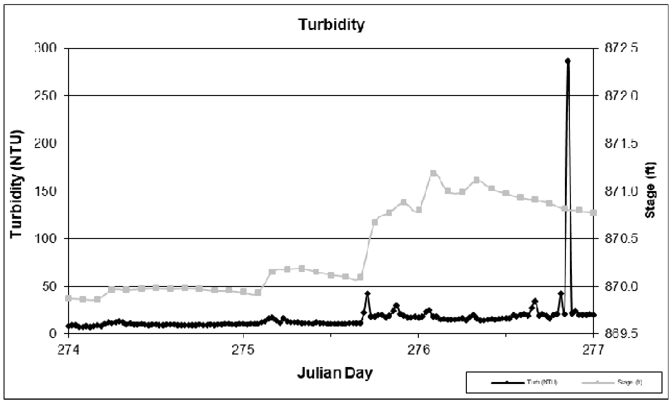
<u>Storm Summary:</u>

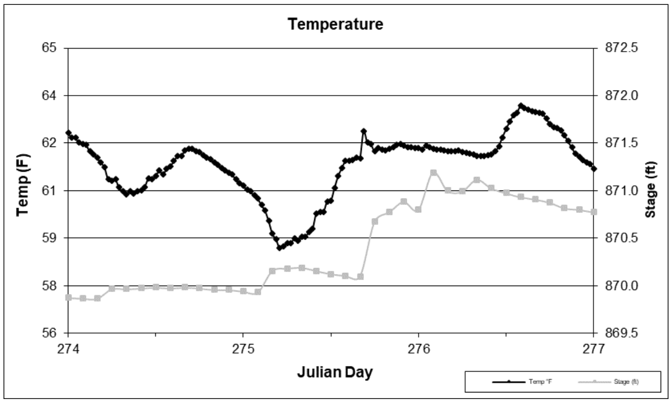
Dates: 1 October 2017 (day 274) to 3 October 2017 (day 276)

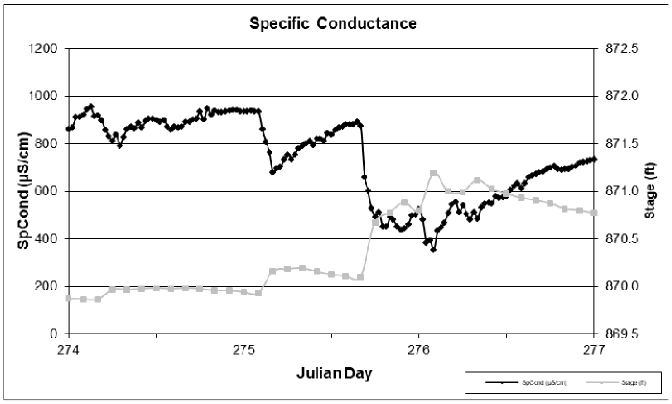
Precipitation: 2.25 inches

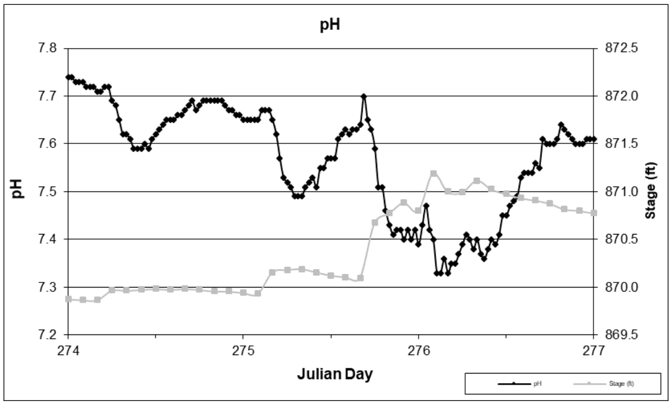












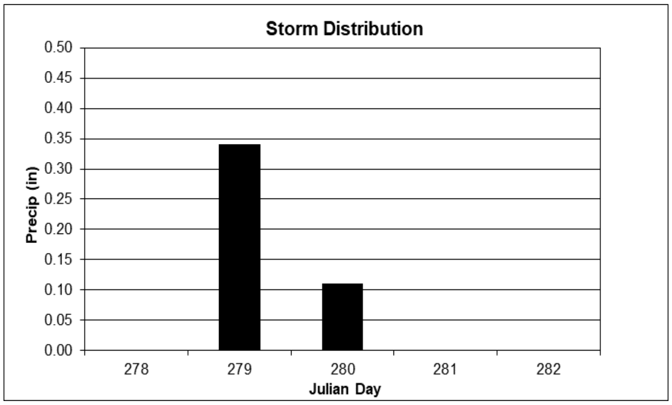
YSI Continuous Monitoring
Storm 8 - 2017

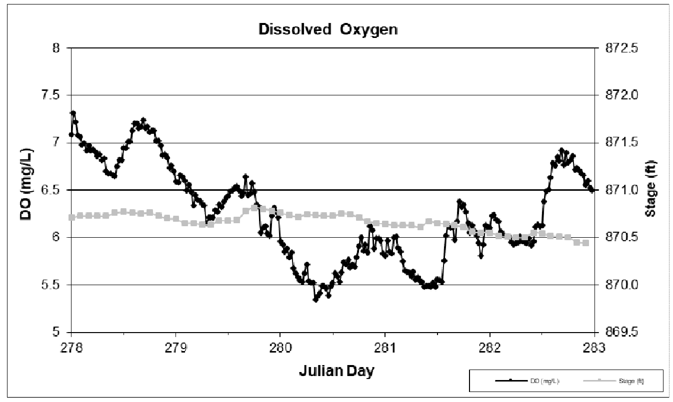
Sand Creek at Morningside Cemetery

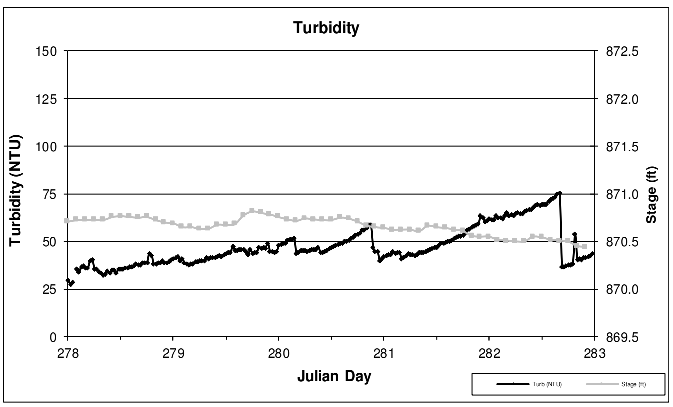
<u>Storm Summary:</u>

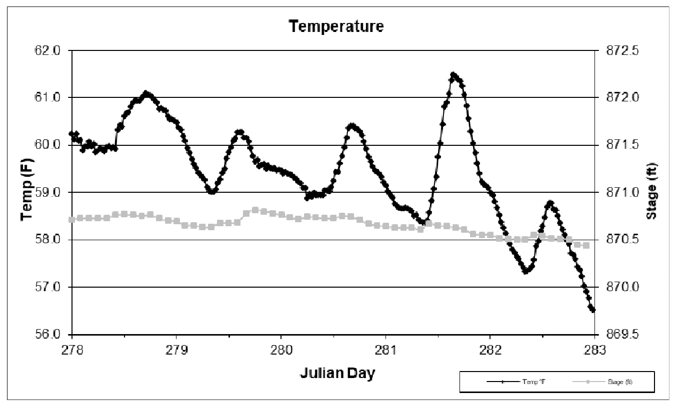
Dates: 6 October 2017 (day 279) to 7 October 2017 (day 280)

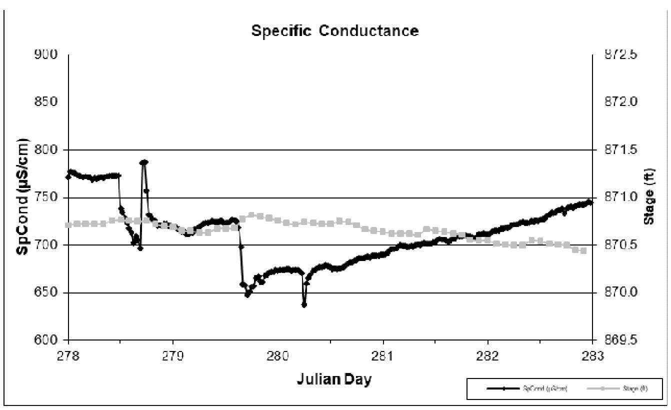
Precipitation: 0.45 inches

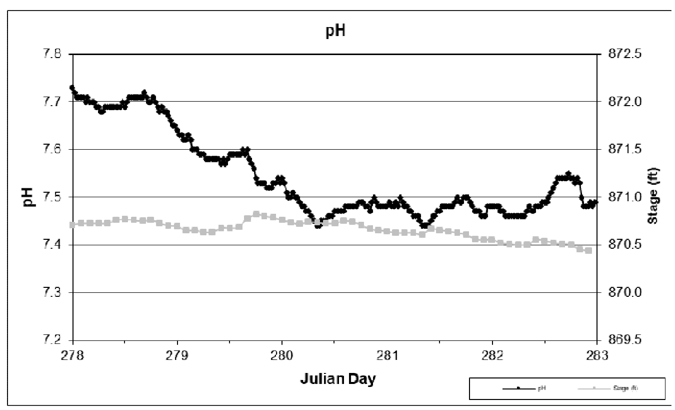












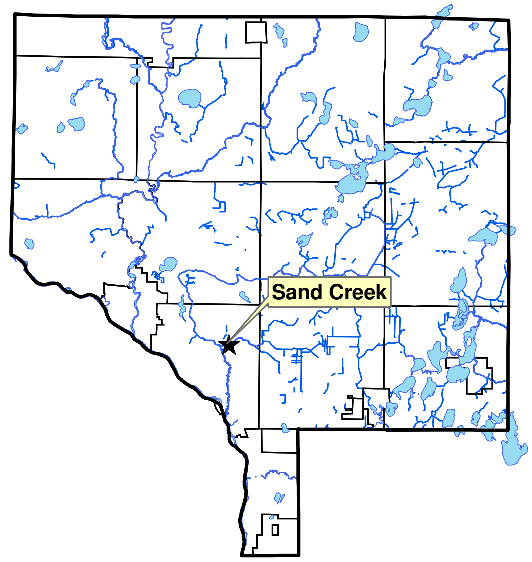
Sand Creek

at Xeon Street, Coon Rapids

Years Monitored

2017

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. The stream is about 15 feet wide and 3 feet deep at the monitoring site during baseflow.

Sand Creek at Xeon Street was selected for monitoring because it is immediately upstream of the confluence with Coon Creek. As the biggest tributary to Coon Creek, knowledge of water quality conditions in Sand Creek near the confluence is very important.

This site has been monitored for storm and baseflow water quality using grab samples, as well as continuous hydrology, since 2010. That Data are presented elsewhere. Only continuous water quality monitoring with a sonde is presented in this section.

2017 was the first year in which continuous water quality was monitored during storm events in Sand Creek using a YSI EXO data sonde. The purpose of continuous water quality monitoring is to document water quality changes throughout a storm. This helps 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.

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

Methods

The site was monitored immediately before, during, and after storms with a YSI EXO data sonde. The sonde was suspended inside a PVC pipe with 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 YSI data sondes are deployed into the stream when a storm predicted to drop at least 0.5 inches of rain, and preferably greater, was forecasted. In some instances, water level was already high before the storm and remains high after the storm. At other times, predicted rain does not fall and we are monitoring baseflow conditions. In all instances, the YSI data sondes are left in the field for several days.

Water levels were continuously monitored throughout the open water season. An RDS Ecotone WM-40 water level monitoring device recorded water levels every two hours. This stream stage Data are presented with the water quality data. It would be preferable to present flow, but the existing rating curve is only valid to stage elevation 859.76. Most of the storm flow stages are beyond this limit. Expanded rating curve development is needed at higher flows to refine this curve and make it useable for storm analysis. To make graphs from all storms comparable, stage is displayed on a constant axis.

Precipitation data are provided with the water quality results. These data were taken from the data logging rain gauge at Coon Rapids City Hall, which is approximately 1.67 miles southwest of the stream monitoring site.

A variety of storm sizes were analyzed. Rainfall during the monitored time periods ranged from 0.24 to 2.79 inches. The wide distribution is helpful in discerning the creek's response to different storms.

Only 2017 individual storm results are presented in this report. The individual storm results for other locations in Coon Creek Watershed District from previous sampling years are available upon request from the Anoka Conservation District. Each year the findings of storm analysis are reviewed and re-evaluated.

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

Results and Discussion

Turbidity

- Intense, rapid turbidity level increases are observed near the time that stage begins to rise from storm flows. These increases appear to be slightly less flashy at this site compared to the site upstream at Morningside Cemetery.
- Increases in turbidity can be quite high (>1000 NTU). These are associated with "first flushes" of stormwater across the land. When two storms occurred with relatively little time between them, the turbidity increases observed during the start of the second storm were often lower because there had been less time for filth to build up on the landscape since the last flush.

Specific Conductance

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

Dissolved Oxygen

- The observed dissolved oxygen concentrations in Sand Creek generally were within the healthy range, >5mg/L.
- Dissolved oxygen dropped to <5 mg/L only during storm 2 in mid-June 2017.

Temperature

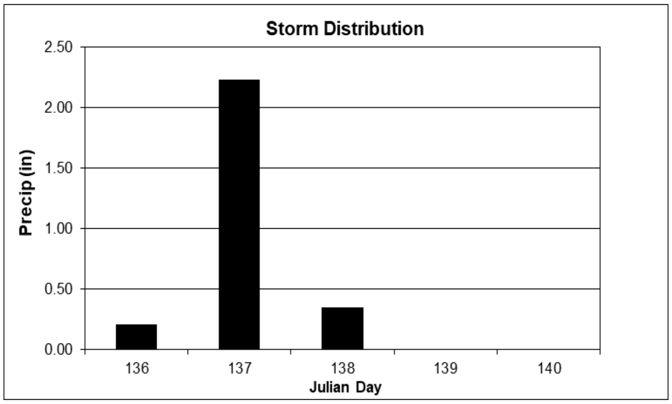
- Water temperature is generally not considered a concern in Sand Creek because there are no trout or other temperature sensitive resources.
- Cycles of day warming and night cooling are apparent in the data as well as high influxes of runoff resulting in cooling of the system.

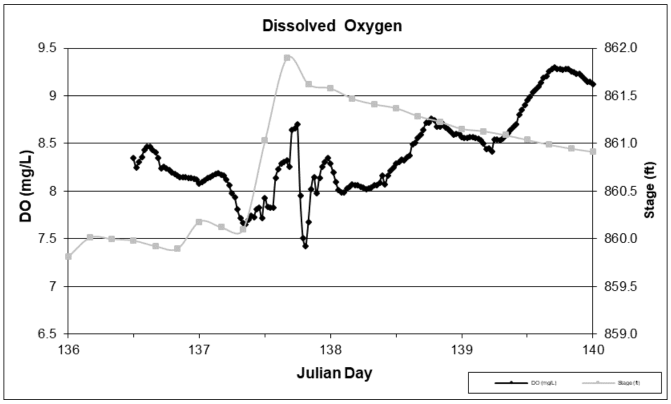
pH

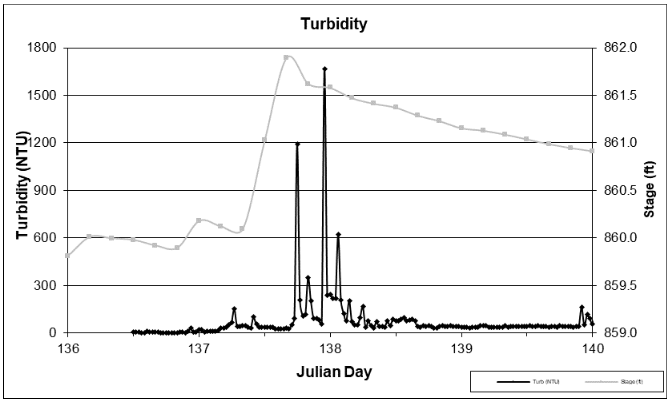
- pH is inversely related to water level in Sand Creek. When water level rises, pH declines. This is because rainwater has a lower pH than that of local shallow groundwater feeding baseflows.
- pH stayed within the desired range of 6.5 to 8.5 that is specified in state water quality standards and is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

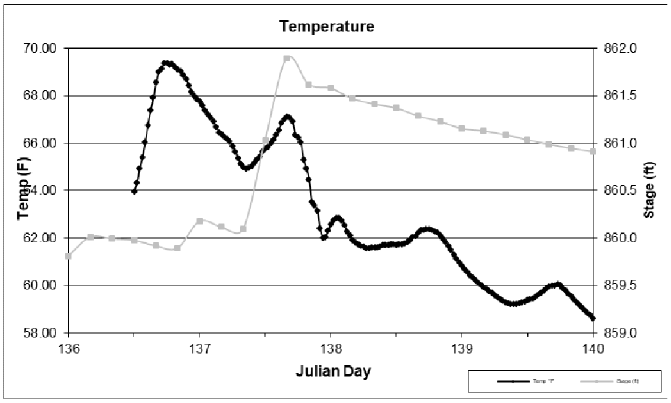
YSI Continuous Monitoring
Storm 1 - 2017

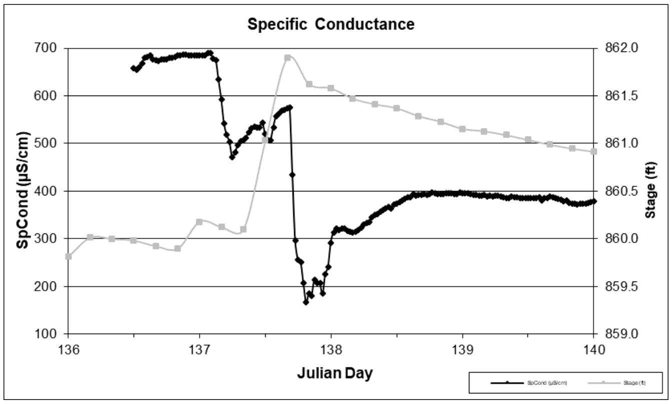
Sand Creek at Xeon Street
<u>Storm Summary:</u>
Dates: 16 May 2017 (day 136) to 18 May 2017 (day 138)
Precipitation: 2.79 inches

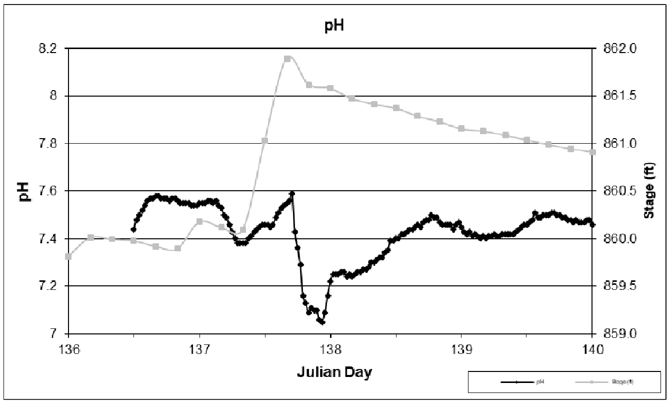












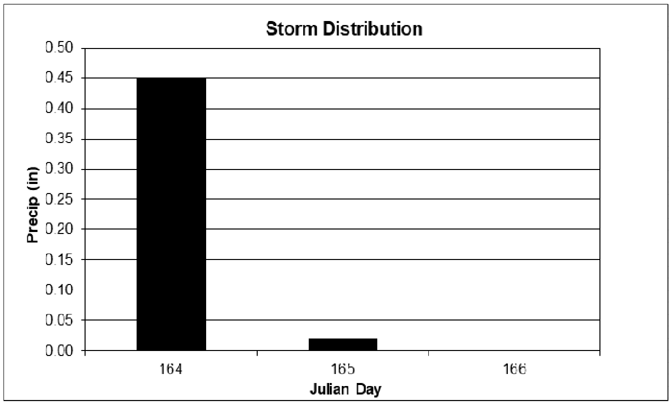
YSI Continuous Monitoring
Storm 2 - 2017

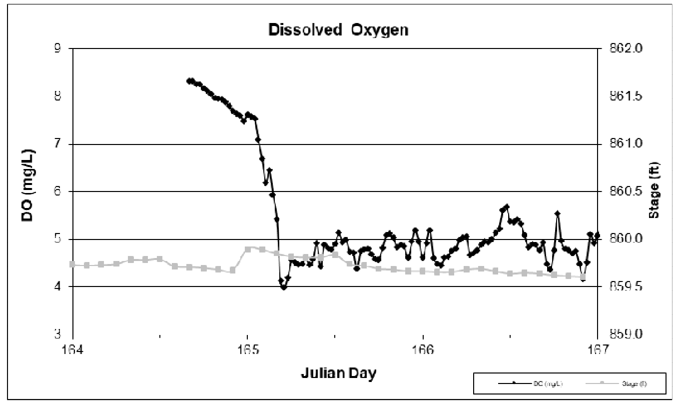
Sand Creek at Xeon Street

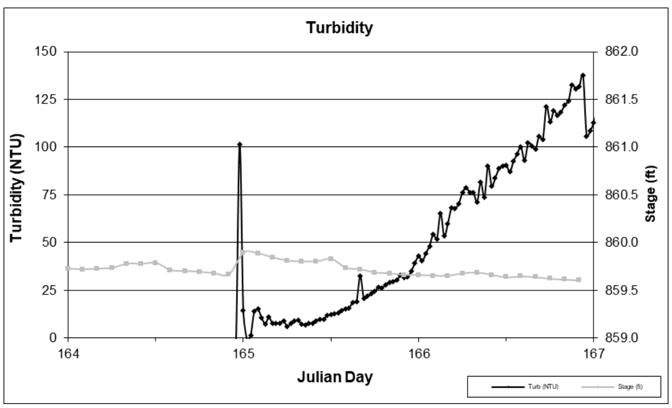
<u>Storm Summary:</u>

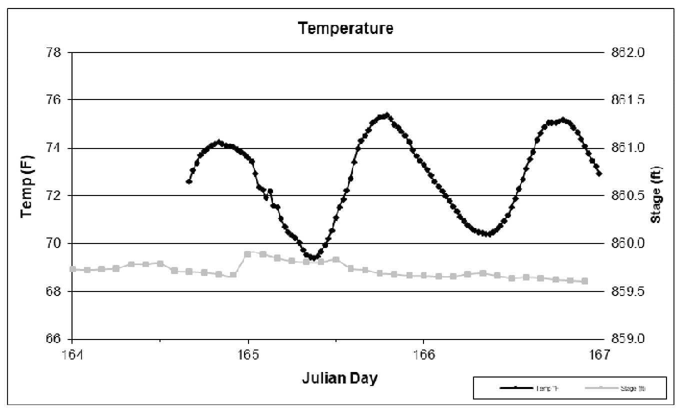
Dates: 13 June 2017 (day 164) to 14 June 2017 (day 165)

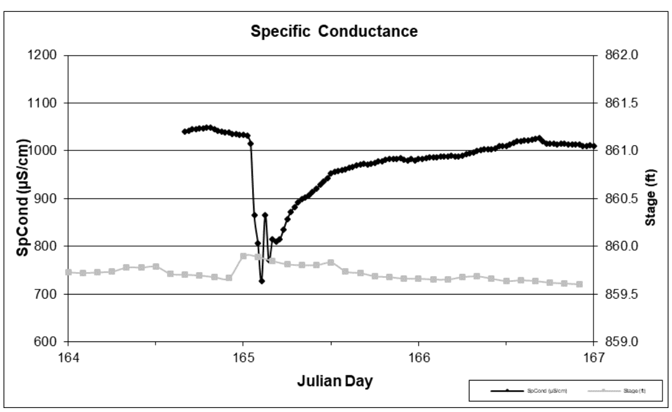
Precipitation: 0.47 inches

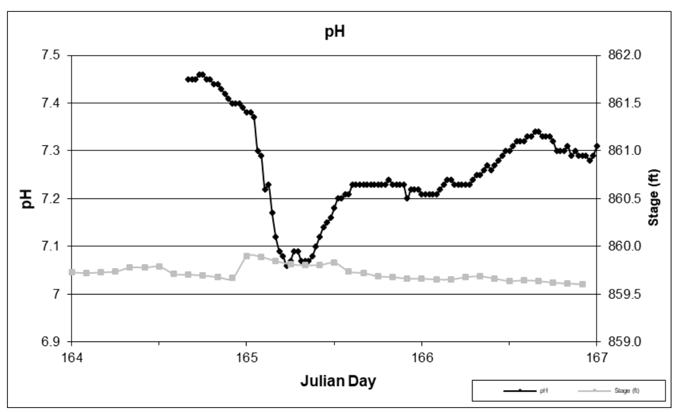












Note

Turbidity continued to rise throughout the deployment. It is likely that material was stuck in the sensor guard and continued to build up affecting the turbidity readings.

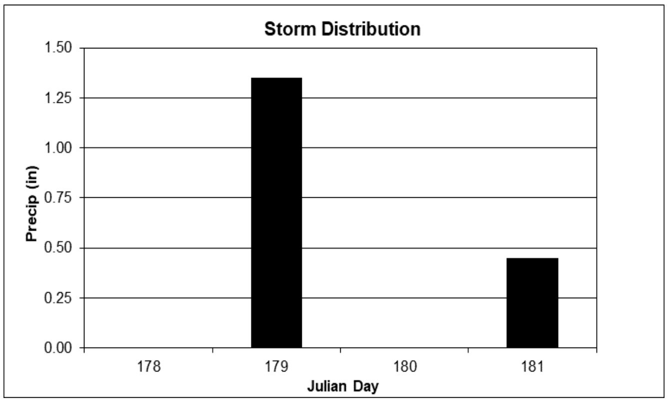
YSI Continuous Monitoring
Storm 3 - 2017

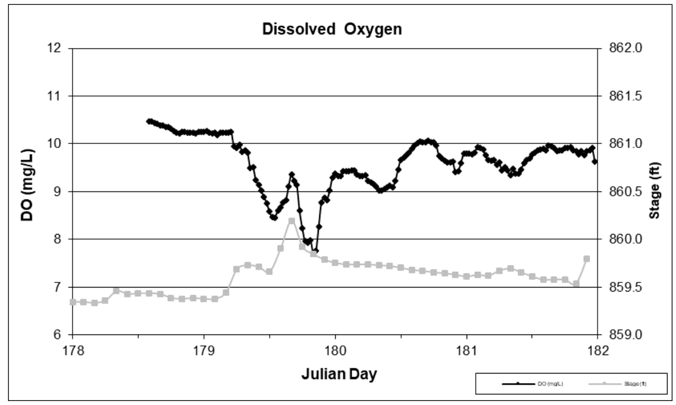
Sand Creek at Xeon Street

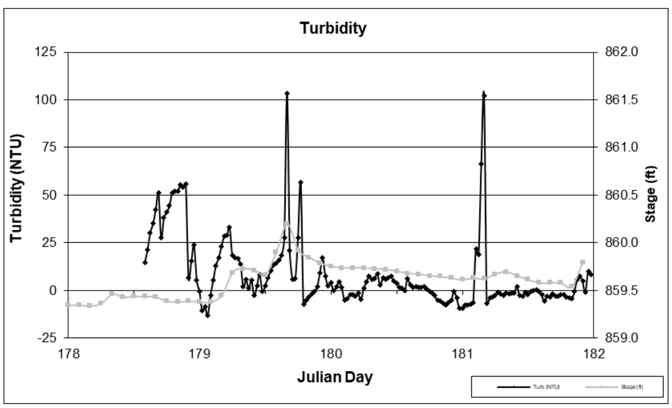
Storm Summary:

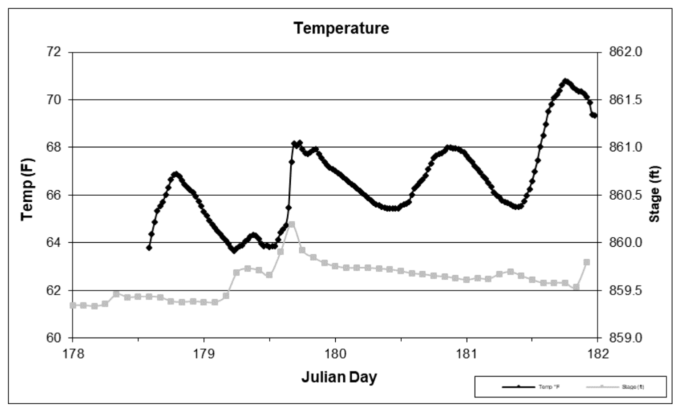
Dates: 28 June 2017 (day 179) to 30 June 2017 (day 181)

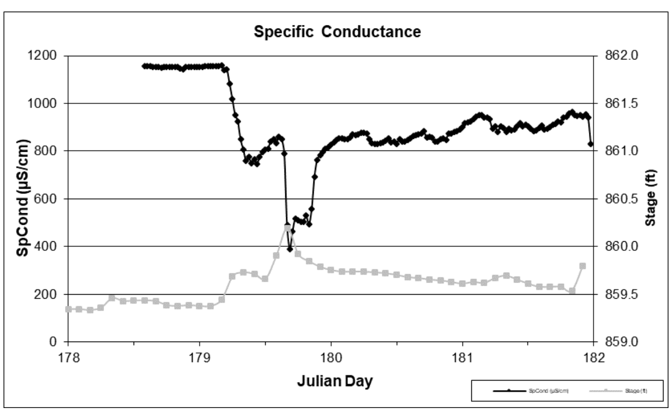
Precipitation: 1.80 inches

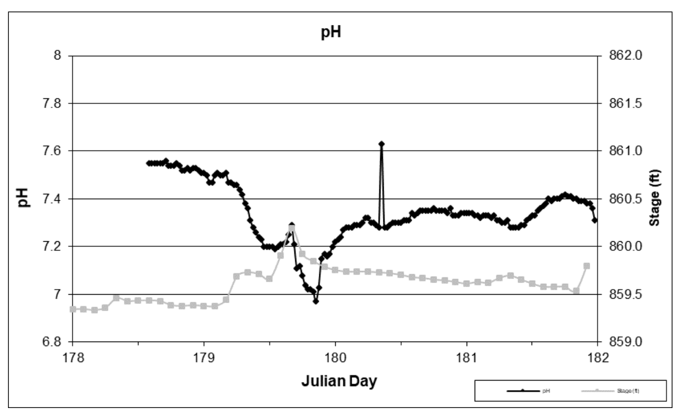










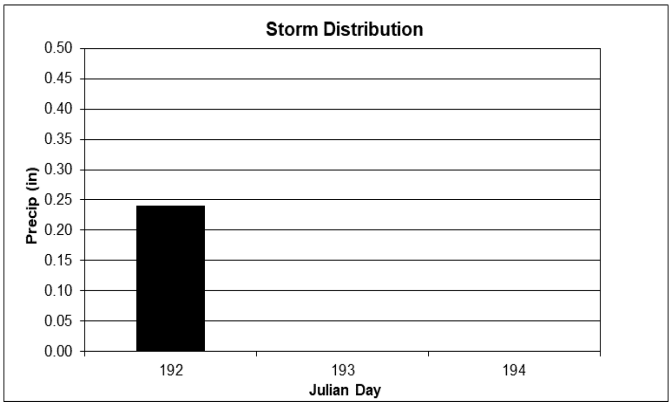


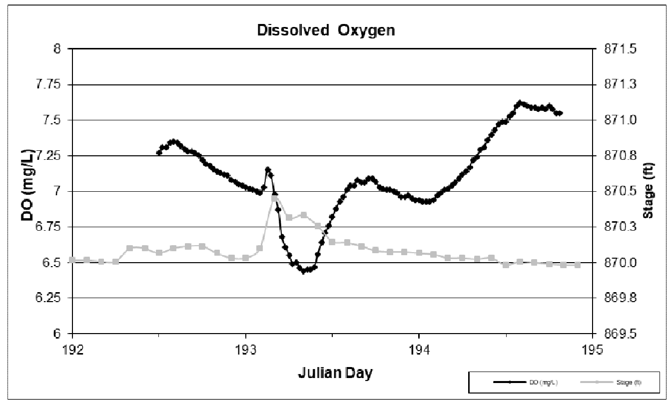
Note

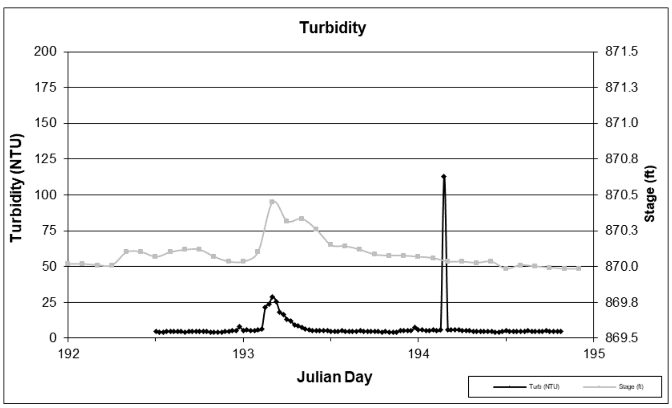
Turbidity may not be reliable for this deployment. A bad calibration at the zero point or debris in the probe may have affected equipment performance.

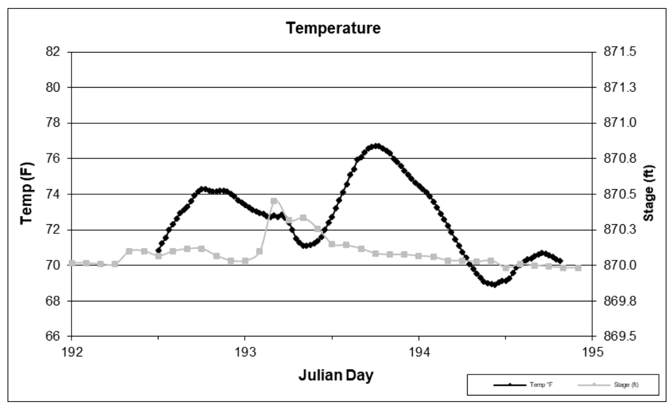
YSI Continuous Monitoring
Storm 4 - 2017

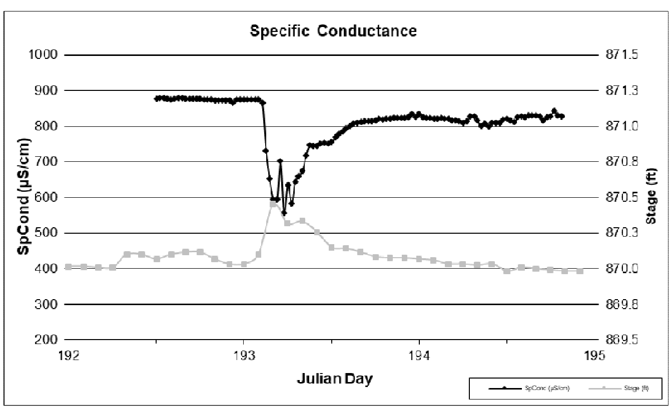
Sand Creek at Xeon Street
<u>Storm Summary:</u>
Dates: 11 July 2017 (day 192)
Precipitation: 0.24 inches

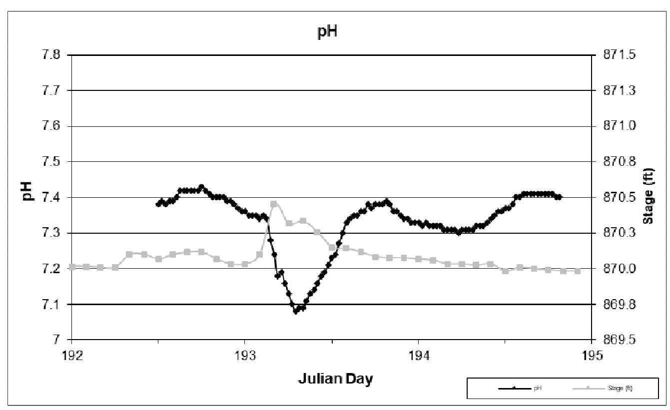












Note
Stage data from Sand Creek @ Morningside Cemetery for this deployment. Sensor at Xeon St. got wet inside.

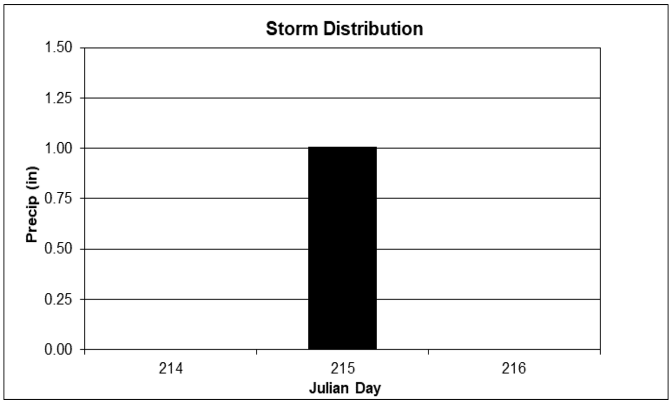
YSI Continuous Monitoring
Storm 5 - 2017

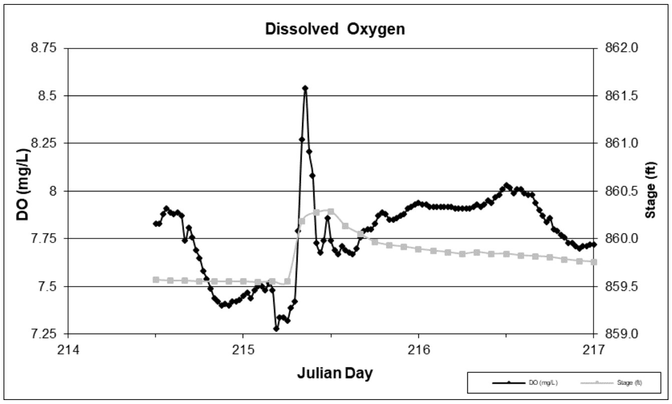
Sand Creek at Xeon Street

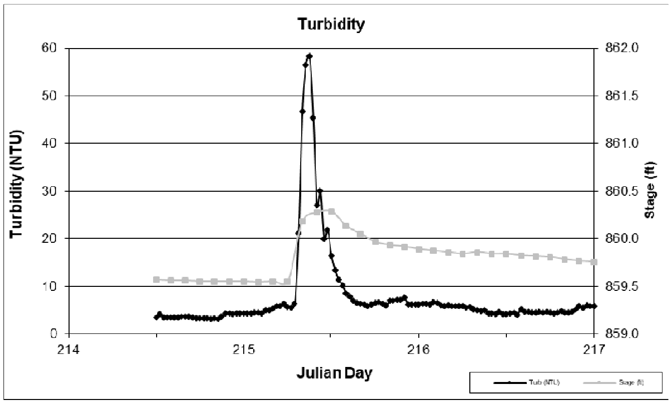
Storm Summary:

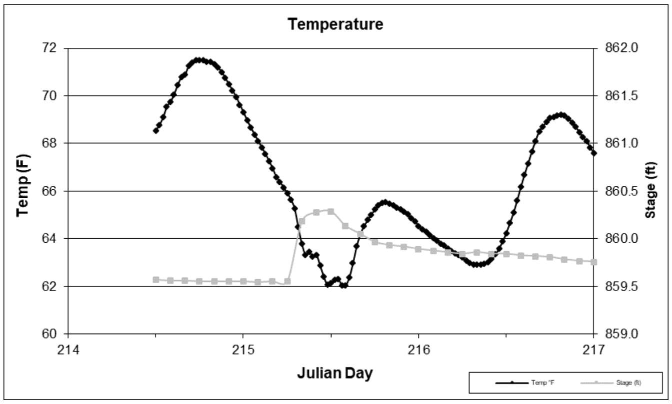
Dates: 3 August 2017 (day 215)

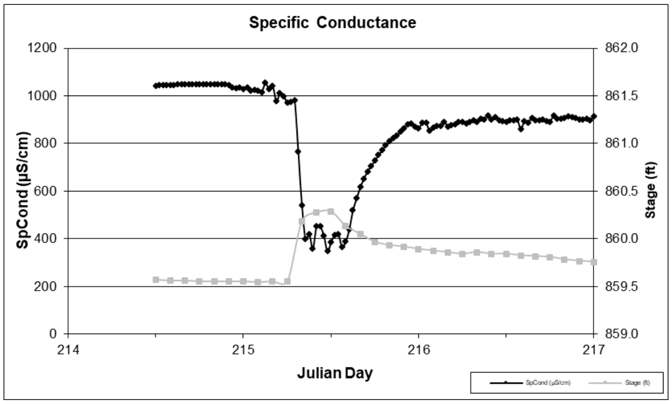
Precipitation: 1.01 inches

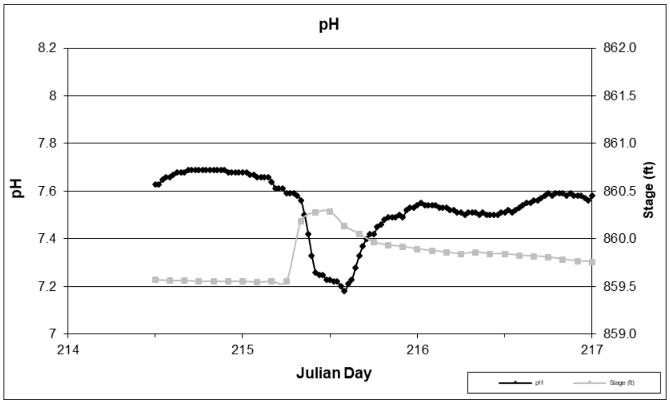












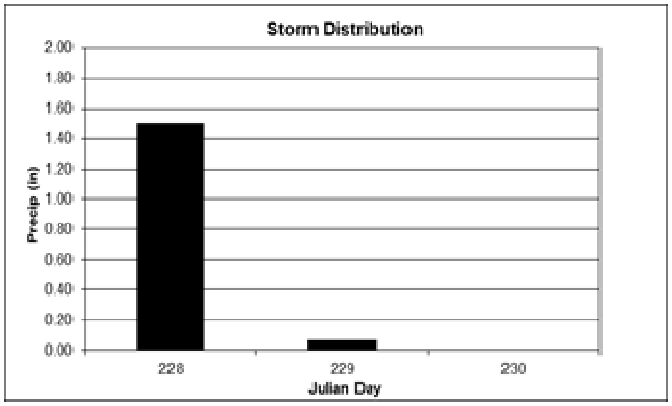
YSI Continuous Monitoring
Storm 6 - 2017

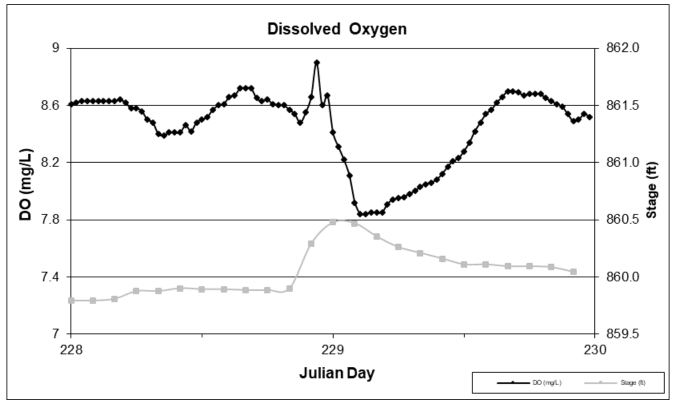
Sand Creek at Xeon Street

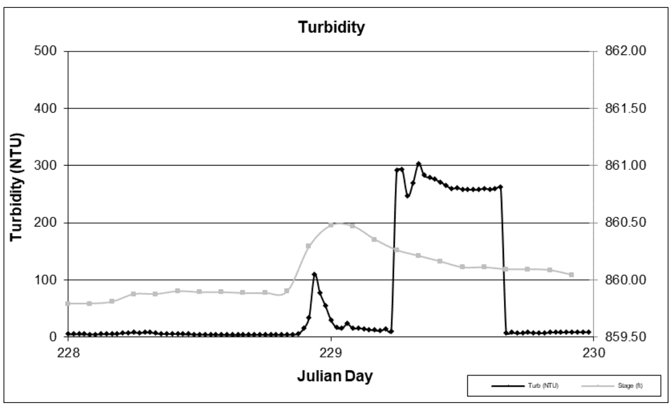
<u>Storm Summary:</u>

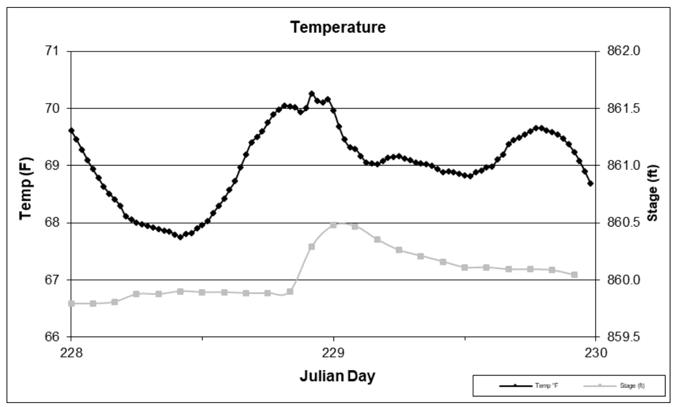
Dates: 16 August 2017 (day 228) to 17 August 2017 (day 229)

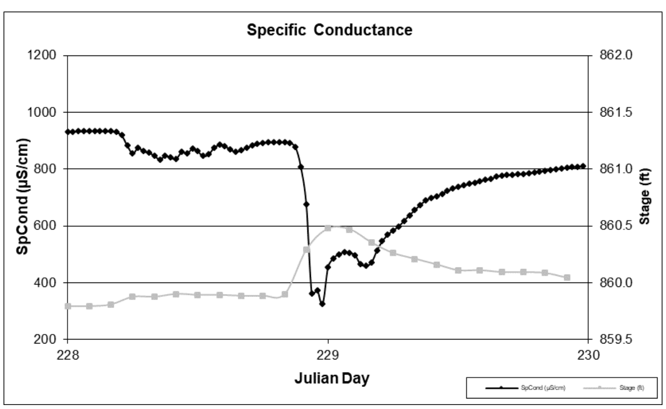
Precipitation: 1.58 inches

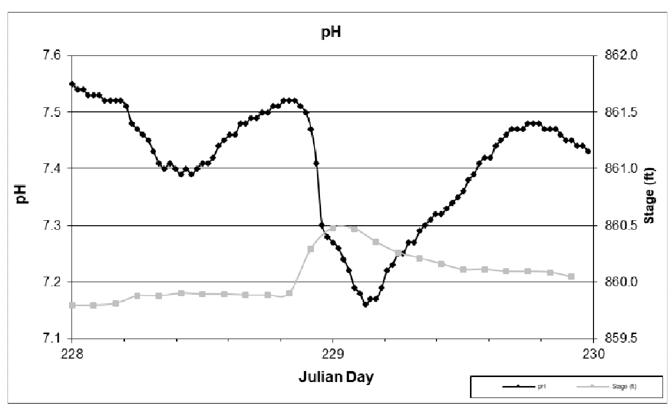












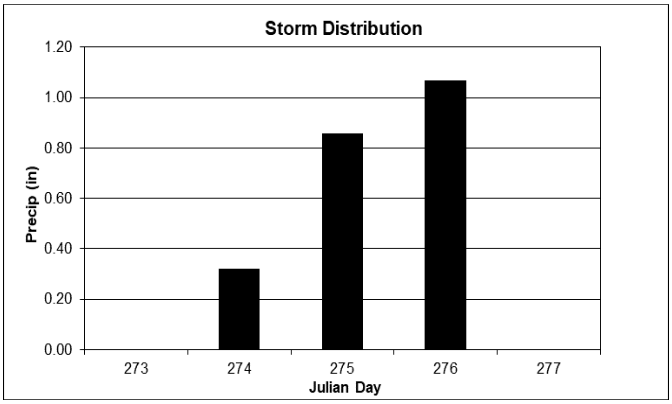
YSI Continuous Monitoring
Storm 7 - 2017

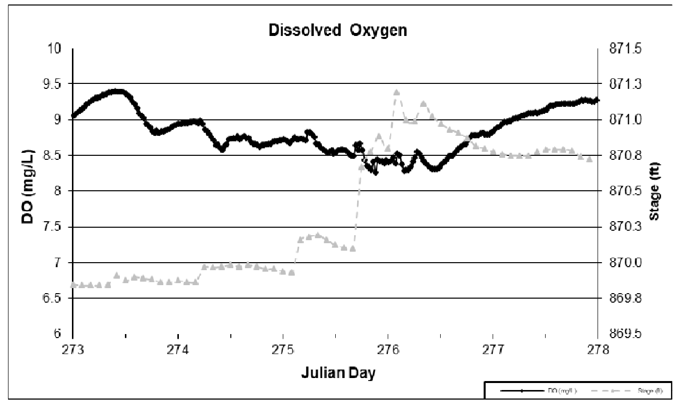
Sand Creek at Xeon Street

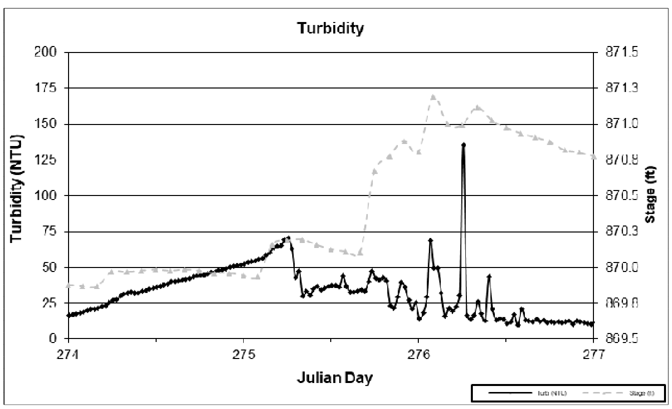
Storm Summary:

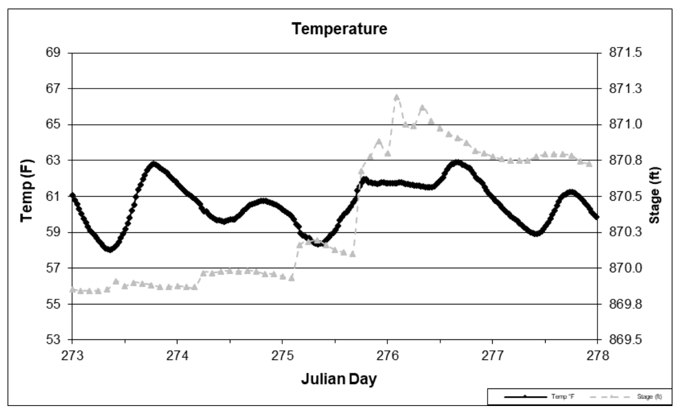
Dates: 1 October 2017 (day 255) to 3 October 2017 (day 257)

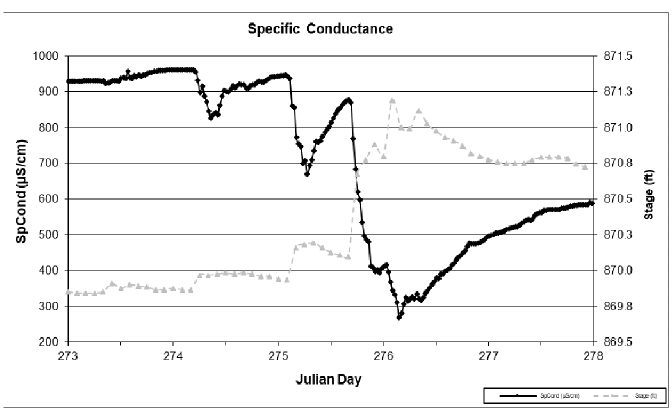
Precipitation: 2.25 inches

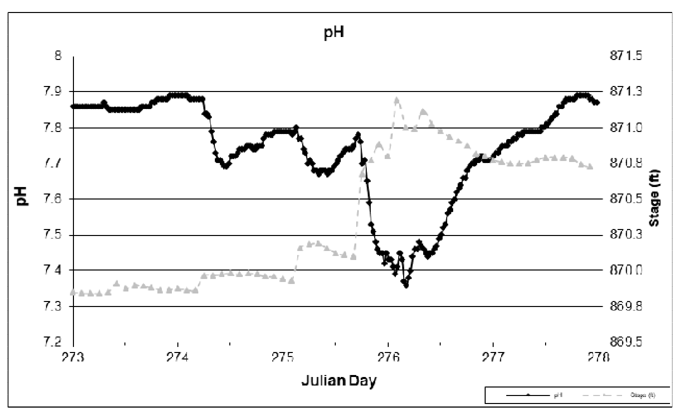












Note

Stage data from Sand Creek at Morningside Cemetery is used for this event. Sensor at Xeon Street got wet inside and was inaccurate.

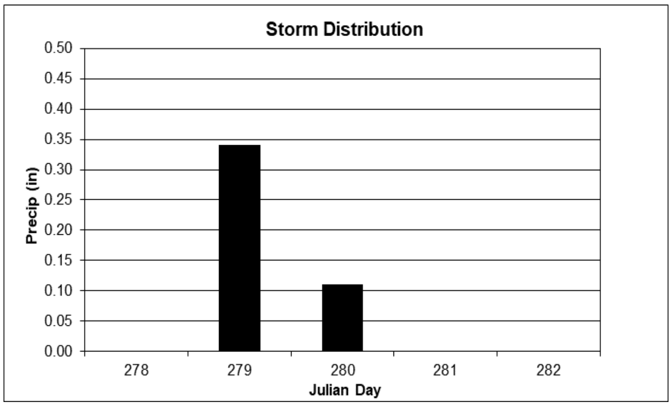
YSI Continuous Monitoring
Storm 8 - 2017

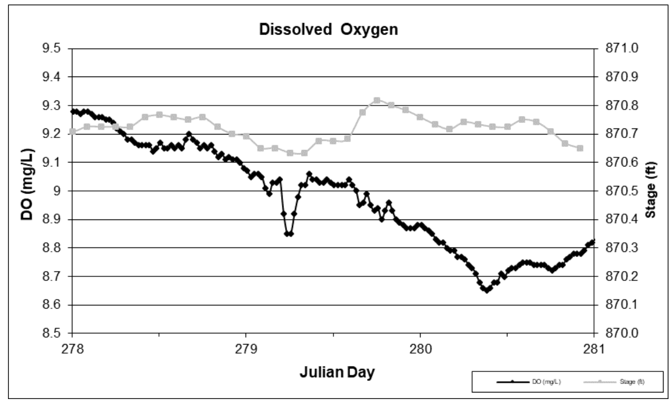
Sand Creek at Xeon Street

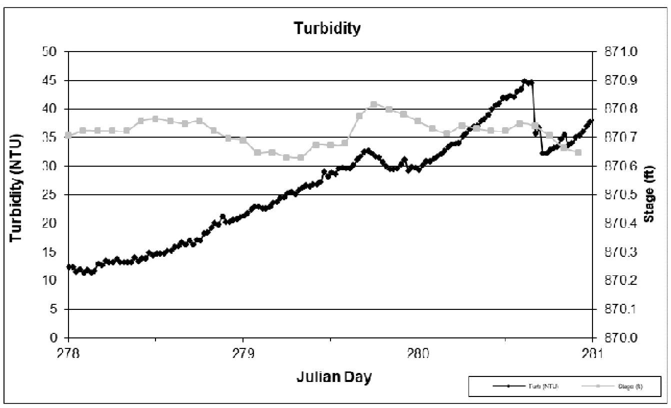
<u>Storm Summary:</u>

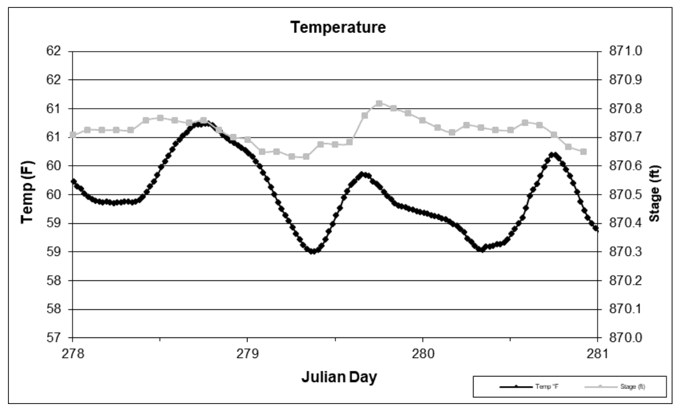
Dates: 6 October 2017 (day 279) to 7 October 2017 (day 280)

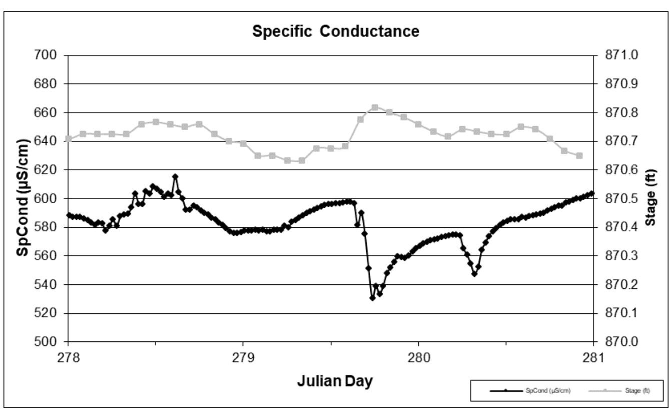
Precipitation: 0.45 inches

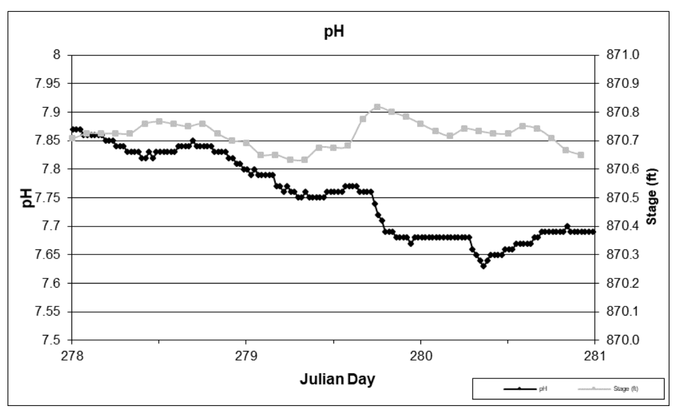












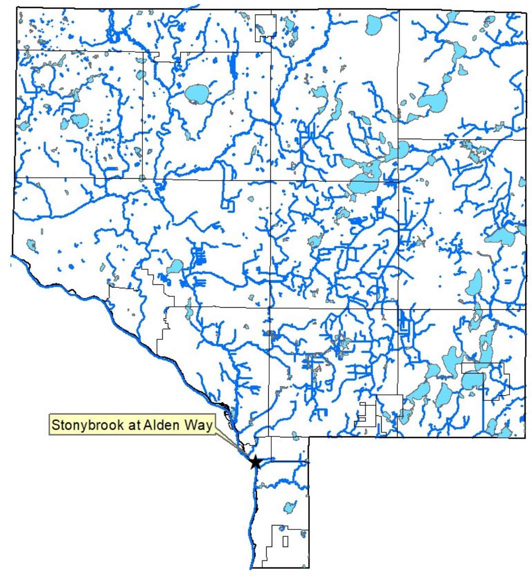
Note

Stage data from Sand Creek at Morningside Cemetery used for this event. Sensor at Xeon Street got wet inside and was inaccurate. Turbidity continuing to climb is may be the result of debris stuck in the sensor guard affecting readings.

YSI Continuous Stream Water Quality Monitoring

STONYBROOK

at Alden Way, Fridley



Years Monitored
2017

Background
Stonybrook is a small waterway that drains a mostly subterranean subwatershed in western Fridley. The stream's contributing area starts about one mile east of the Mississippi River as a storm sewer. The last 1/3 of the one-mile watershed is an open, deeply cut channel that descends 50 feet to the river. The sampling site is located about 250 feet upstream of the confluence with the Mississippi River, just east of Alden Way. The creek is only about 10 feet wide and 6 inches deep during baseflow conditions at the sampling site. Rain events frequently caused the stage to jump over 3 feet.

2017 was the first year in which continuous water quality was monitored during storm events in Stonybrook using a YSI EXO data sonde. The purpose of continuous water quality monitoring is to document water quality changes throughout storm events. This helps diagnose water quality problems and reflect differences in runoff from upper and lower parts of the watershed. Runoff from within the watershed passes the monitoring site quickly following a storm.

YSI EXO water quality sonde casing (taller) and an RDS continuous water level monitoring device in nearby Pleasure Creek. A staff gauge is shown in the middle.

Methods

Stonybrook was monitored with both continuous storm water quality and storm and baseflow grab samples. This site was newly added for all monitoring in 2017 to better understand conditions of smaller drainages in the Coon Creek Watershed District. Only continuous water quality monitoring of storms is presented in this section; grab sampling and hydrology data are presented elsewhere in this chapter.

The site was monitored immediately before, during, and after four storms with a YSI EXO data sonde. The sonde was suspended inside a PVC pipe with 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 YSI data sondes are deployed into the stream when a storm predicted to drop at least 0.5 inches of rain, and preferably greater, was forecasted. In some instances, water level was already high before the storm and remains high after the storm. At other times, predicted rain does not fall and we are monitoring baseflow conditions. In all instances, the YSI data sondes are left in the field for several days.

Water levels were continuously monitored throughout the open water season. An RDS Ecotone WM-40 water level monitoring device recorded water levels every two hours, until early June after which readings were taken every half hour. This stream stage Data are presented with the water quality data. It would be preferable to present flow, but a rating curve does not exist for this site. To make graphs from all storms comparable, stage is displayed on a constant axis.

Precipitation data are provided with the water quality results. These data were collected by a reliable, long-standing volunteer precipitation reader in Fridley, less than 2 miles southeast of the stream monitoring site.

Results and Discussion

Ideally, a variety of storm sizes would be analyzed. Monitored 2017 stormed ranged from 0.87 to 1.36 inches. This narrow distribution will not give a very good picture of the storm water quality for a variety of storm sizes, but it will provide good baseline data for a first sampling year at a new site.

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>

- Stonybrook was hydrologically flashy with intense turbidity increases, sometimes going from single digit turbidity to over 1000 NTU.
- During storms that consisted of two separated rainfalls, the turbidity increase during the second rainfall was much lower than during the first. This suggests "first flushes" of debris from the landscape is responsible for the initial, and most severe, 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>

- Dissolved oxygen levels were generally quite high, and only dipped below the state standard of 5 mg/L briefly during storm 4 in late September of 2017.
- Dissolved oxygen levels did not follow the diel oscillations typically observed in most streams and instead were correlated to movements in water stage. This is likely due to the fact that the system is so small, and increased water from storms rushes down the steep watershed turbulently, becoming aerated and causing dissolved oxygen to go up.

<u>Temperature</u>

- Water temperature is generally not considered a concern in Stonybrook because there are no trout or other temperature sensitive resources.
- Temperatures increased with water levels during three of four storms monitored in 2017. This dynamic is likely due to groundwater being the main contributor to the small level of baseflow in the stream. Storms then introduce large flushes of warmer surface runoff, raising the stream's temperature.

<u>pH</u>

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

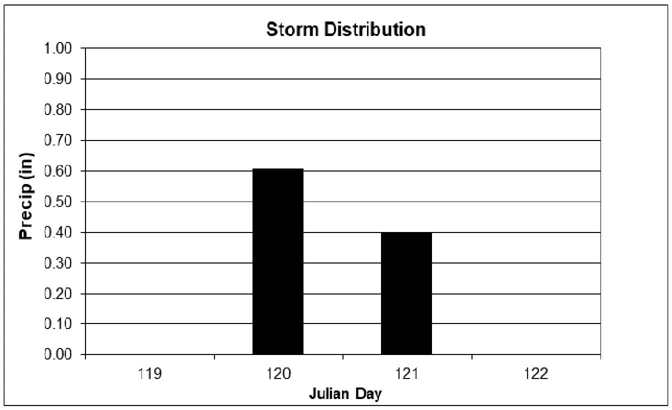
YSI Continuous Monitoring
Storm 1 - 2017

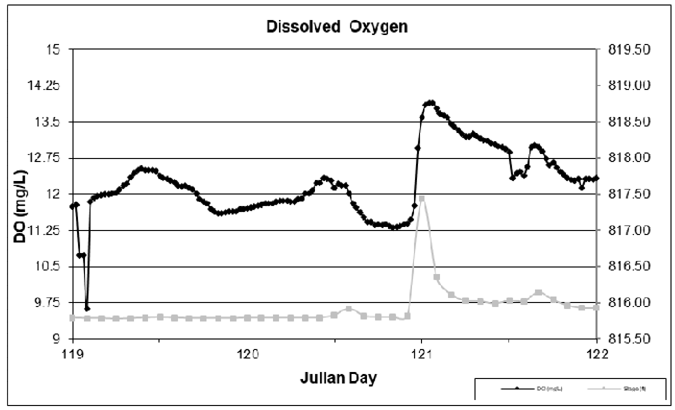
Stonybrook at Alden Way

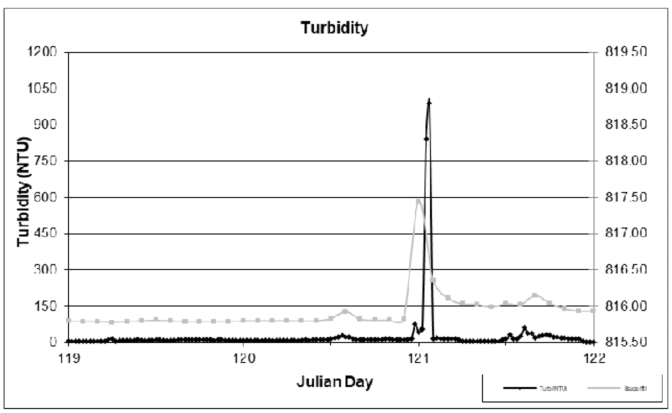
<u>Storm Summary:</u>

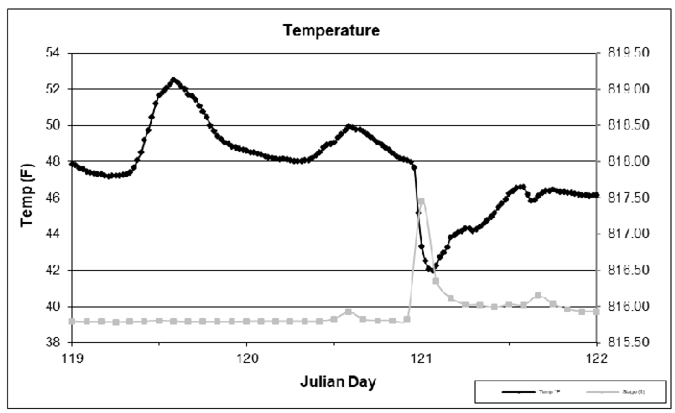
Dates: 30 April 2017 (day 120) to 1 May 2017 (day 121)

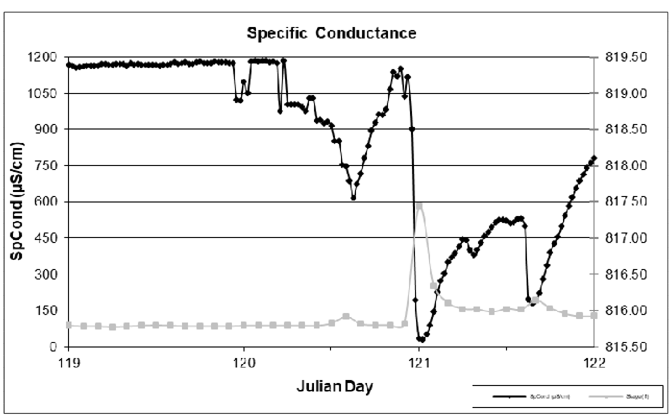
Precipitation: 1.01 inches

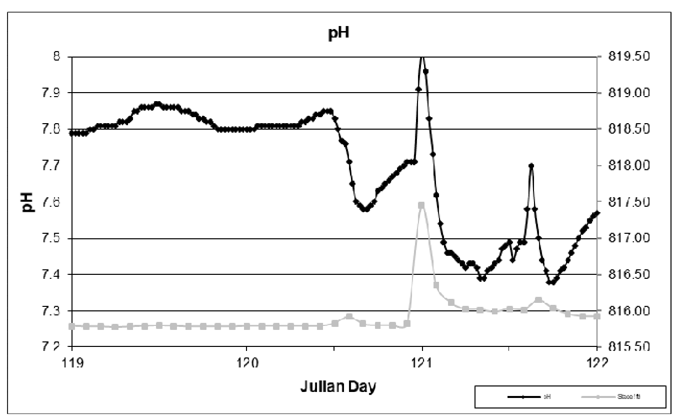












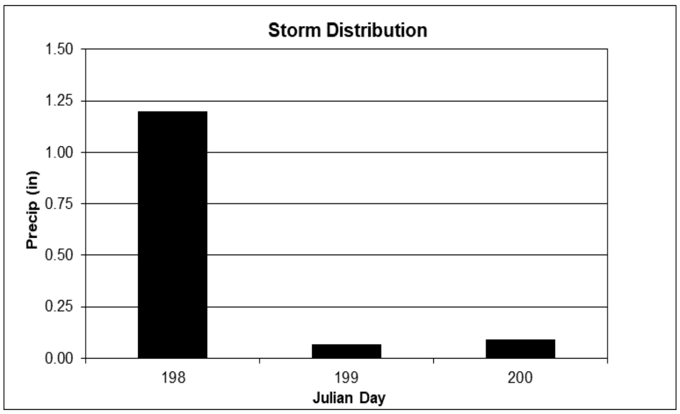
YSI Continuous Monitoring
Storm 2 - 2017

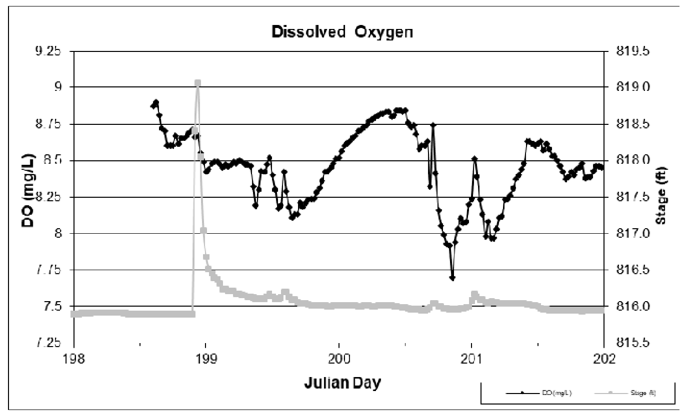
Stonybrook at Alden Way

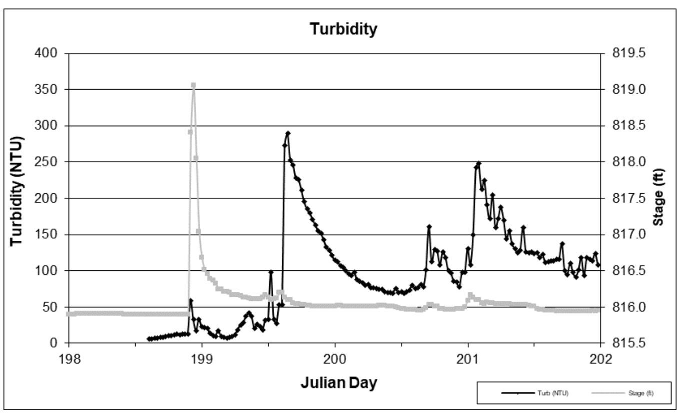
<u>Storm Summary:</u>

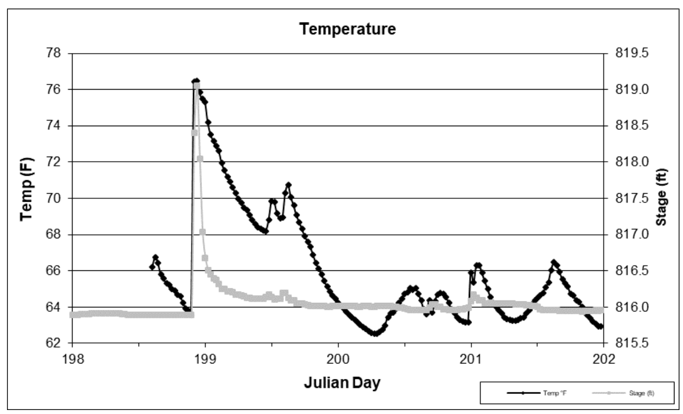
Dates: 17 July 2017 (day 198) to 19 July 2017 (day 200)

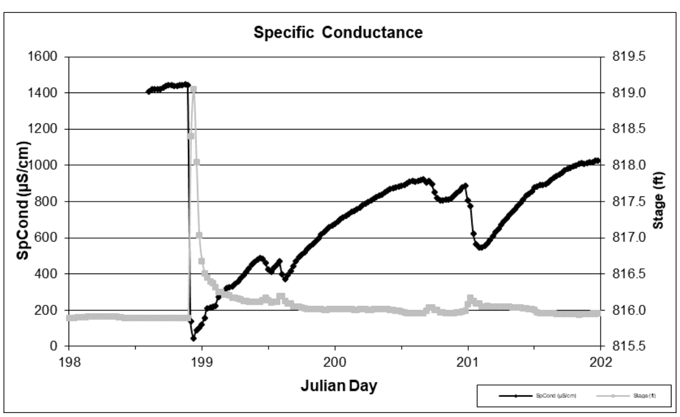
Precipitation: 1.36 inches

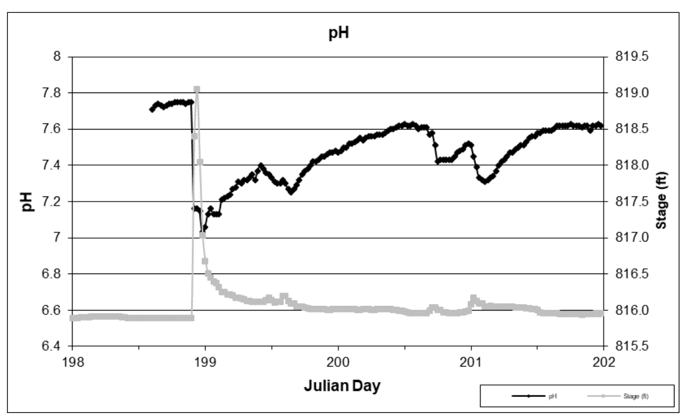












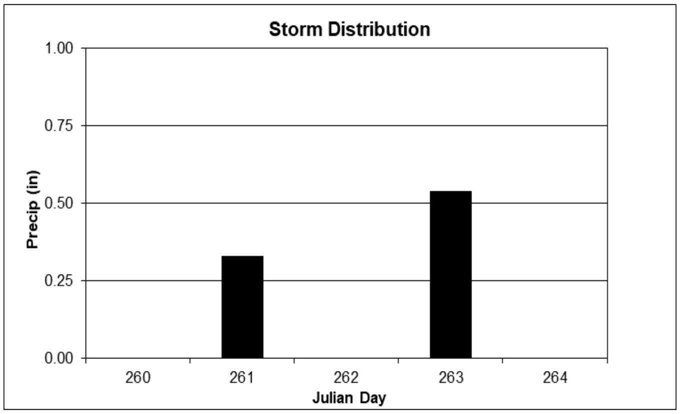
YSI Continuous Monitoring
Storm 3 - 2017

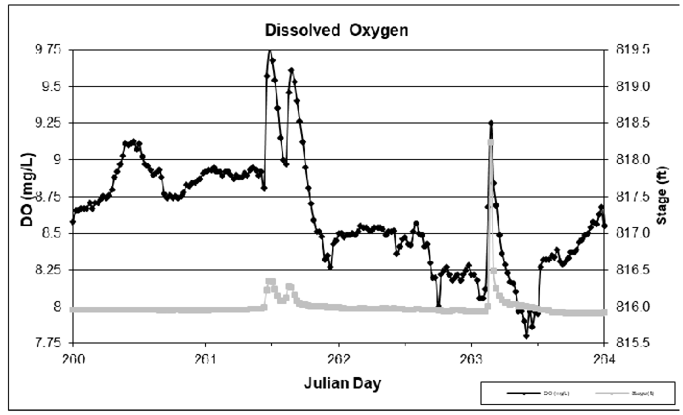
Stonybrook at Alden Way

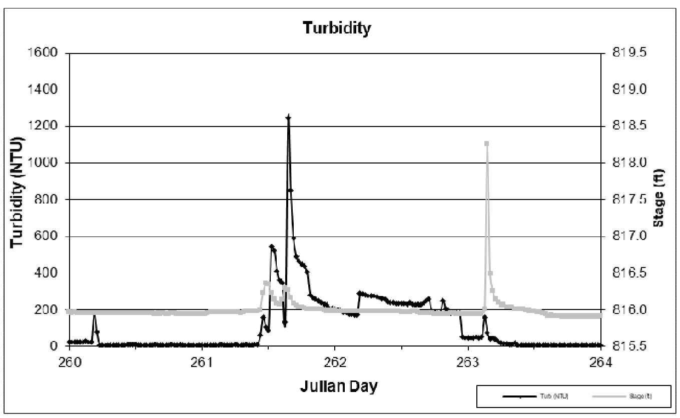
<u>Storm Summary:</u>

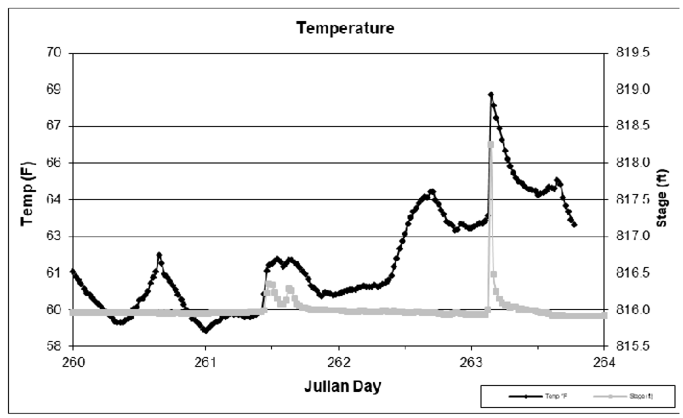
Dates: 18 September 2017 (day 261) to 20 September 2017 (day 263)

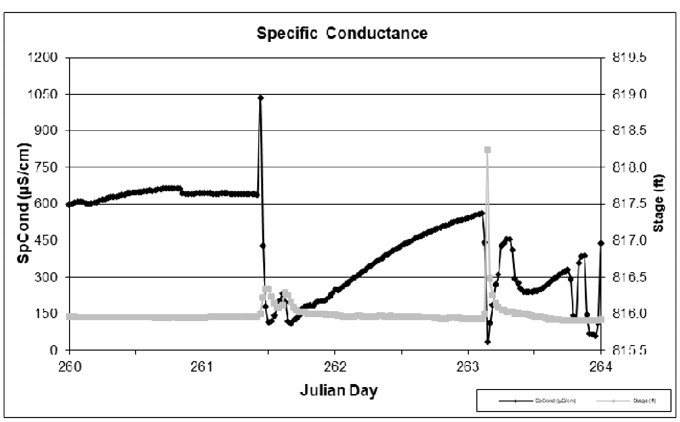
Precipitation: 0.87 inches

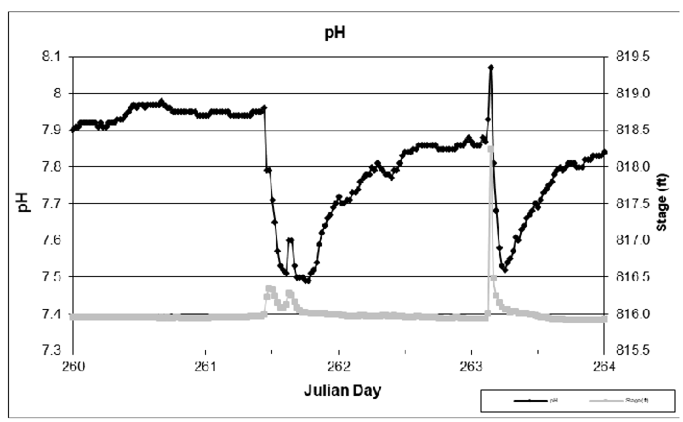












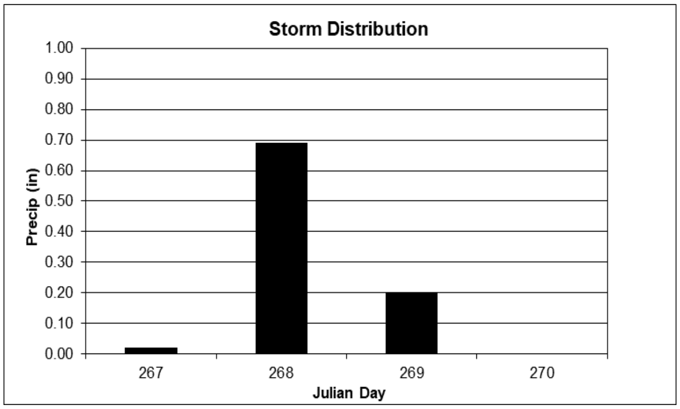
YSI Continuous Monitoring
Storm 4 - 2017

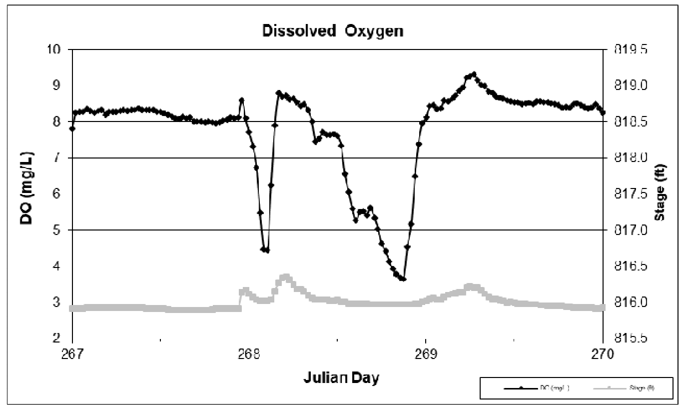
Stonybrook at Alden Way

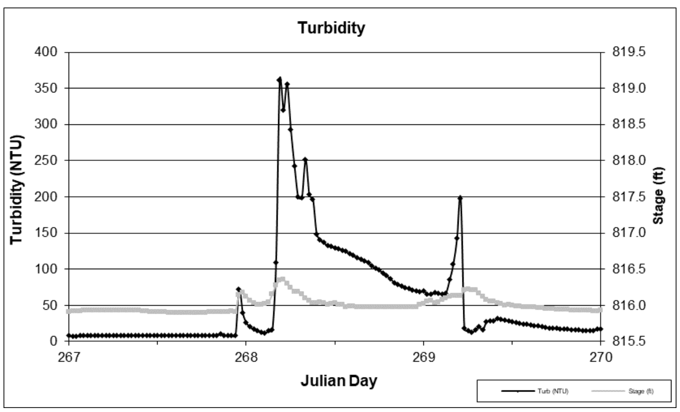
Storm Summary:

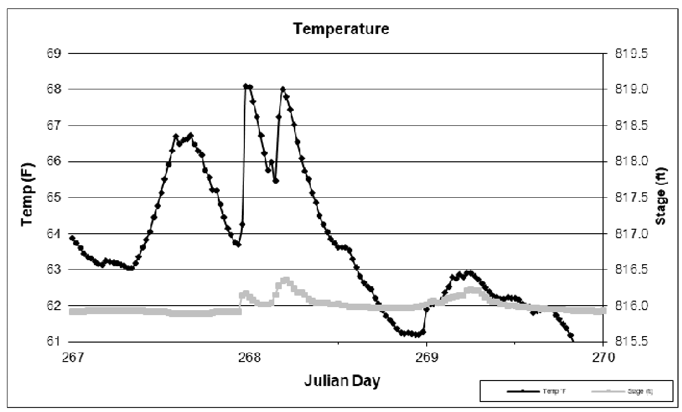
Dates: 24 September 2017 (day 267) to 26 September 2017 (day 269)

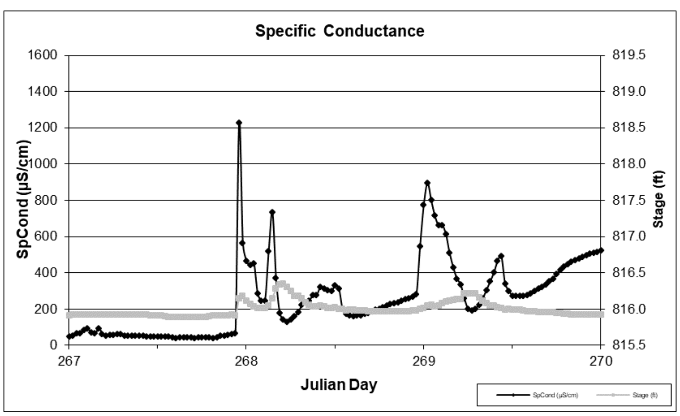
Precipitation: 0.91 inches

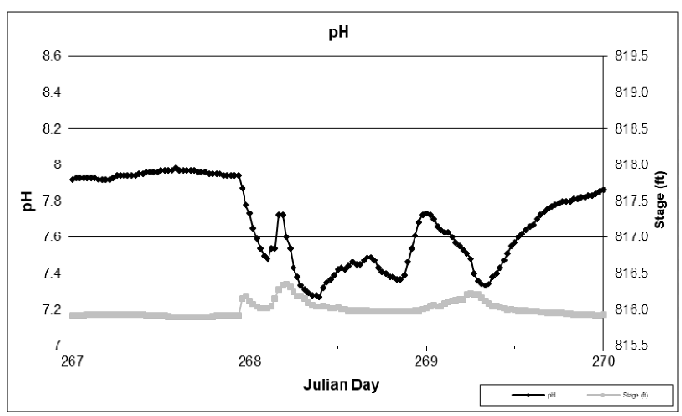








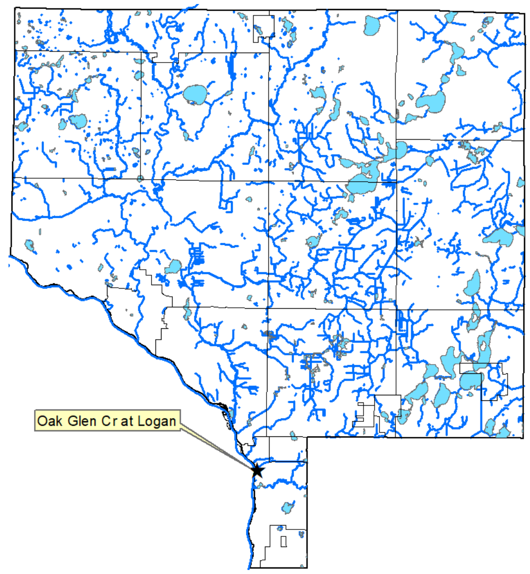




YSI Continuous Stream Water Quality Monitoring

OAK GLEN CREEK

at Logan Parkway, Fridley



Years Monitored

2017

Background

Oak Glen Creek is a small waterway that drains directly to the Mississippi River. The Oak Glen subwatershed is 119 acres of mostly commercial development and storm sewer. The subwatershed boundaries are Highway 65 to the east, Osborne Road to the north and 71st Avenue to the south. The creek exists as an open channel for approximately 1,200 feet between East River Road and the Mississippi River. The channel is deep cut and narrow, descending about 50 feet to the river. The sampling site is located about 500 feet upstream of the confluence with the Mississippi. A stormwater pond just east of East River Road was excavated to a larger and deeper size, and an iron enhanced sand filter bench was installed in the fall of 2017.

2017 was the first year in which continuous water quality was monitored during storm events in Oak Glen Creek using a YSI EXO data sonde. The purpose of continuous water quality monitoring is to document water quality changes throughout storm events. This helps diagnose water quality problems and reflect differences in runoff from upper and lower parts of the watershed. Runoff from the watershed passes the monitoring site quickly following a storm.

YSI EXO water quality sonde casing (taller) and an RDS continuous water level monitoring device in nearby Pleasure Creek. A staff gauge is shown in the middle.

Methods

Oak Glen Creek was monitored for both continuous storm water quality and storm and baseflow grab samples. This site was newly added for all monitoring in 2017 to better understand conditions of smaller drainages in the Coon Creek Watershed District where data was lacking, as well as to gather baseline data to assess the future effect of water quality projects being implemented in the watershed. Only continuous water quality monitoring of storms is presented in this section; grab sampling and hydrology data are presented elsewhere in this chapter.

The site was monitored immediately before, during, and after four storms with a YSI EXO data sonde. The sonde was suspended inside a PVC pipe with 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 YSI data sondes are deployed into the stream when a storm predicted to drop at least 0.5 inches of rain, and preferably greater, was forecasted. In some instances, water level was already high before the storm and remains high after the storm. At other times, predicted rain does not fall and we are monitoring baseflow conditions. In all instances, the YSI data sondes are left in the field for several days.

Water levels were continuously monitored throughout the open water season. An RDS Ecotone WM-40 water level monitoring device recorded water levels every two hours. This stream stage Data are presented with the water quality data. It would be preferable to present flow, but a rating curve does not exist for this site. To make graphs from all storms comparable, stage is displayed on a constant axis.

Precipitation data are provided with the water quality results. These data were collected by a very reliable, long-standing volunteer precipitation reader in Fridley, less than 2 miles southeast of the stream monitoring site.

Results and Discussion

Ideally, a variety of storm sizes would be monitored. Monitored 2017 storms ranged from 0.87 to 1.36 inches. This narrow distribution will not give a very good picture of the storm water quality for a variety of storm sizes, but it will provide good baseline data for a first sampling year at a new site.

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>

- Many storms caused multiple, brief turbidity increases of various intensities in Oak Glen Creek. It seems that particulate debris from different parts of the watershed are washed into the creek at different rates.
- Large initial turbidity increases in some storms happen as soon as the rain starts and before stream water levels begin to rise, suggesting a large amount of particulate debris immediately washing into the lower portions of the watershed. However, some of the secondary turbidity increases were actually larger, indicating debris washing in from further up in the watershed.

<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.
- Extremely high spikes in specific conductance (11,000+ µS/cm) are observed shortly after stream stage declines.

<u>Dissolved Oxygen</u>

- Dissolved oxygen levels were generally high, and never dropped below the state standard of 5 mg/L.
- Dissolved oxygen did display diel fluctuations indicating internal photosynthetic activity is occurring in the watershed.

<u>Temperature</u>

- Water temperature is generally not considered a concern in Oak Glen Creek because there is no trout or other temperature sensitive resource.

<u>pH</u>

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

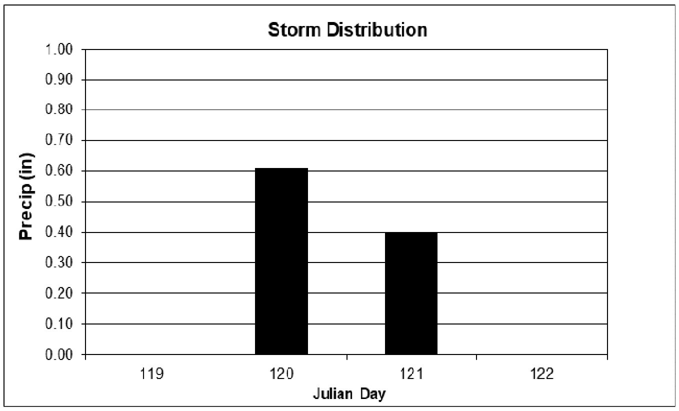
YSI Continuous Monitoring
Storm 1 - 2017

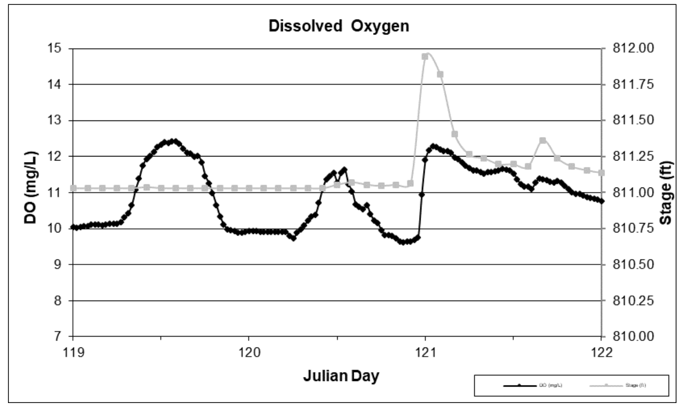
Oak Glen Creek at Alden Way

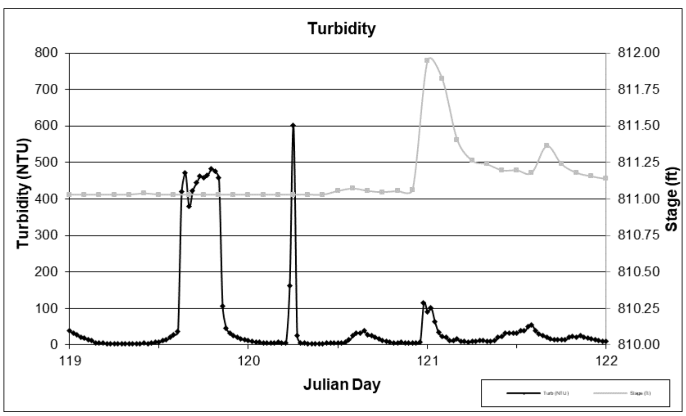
<u>Storm Summary:</u>

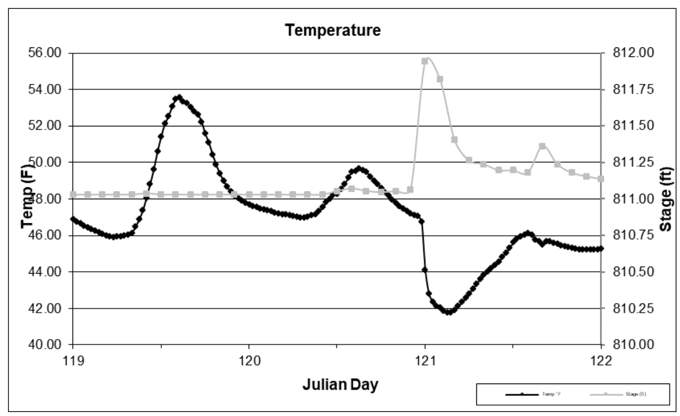
Dates: 29 April 2017 (day 120) to 1 May 2017 (day 121)

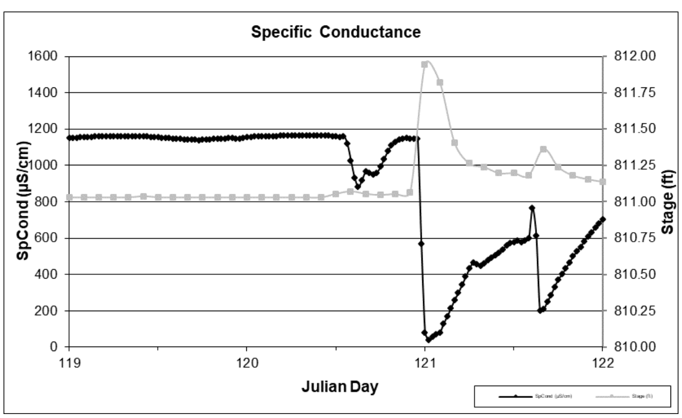
Precipitation: 1.01 inches

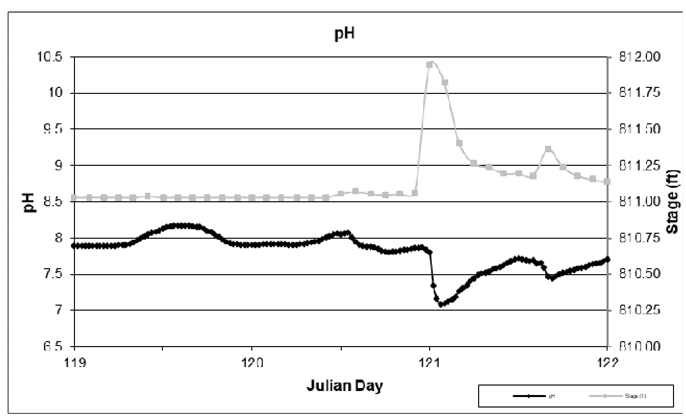












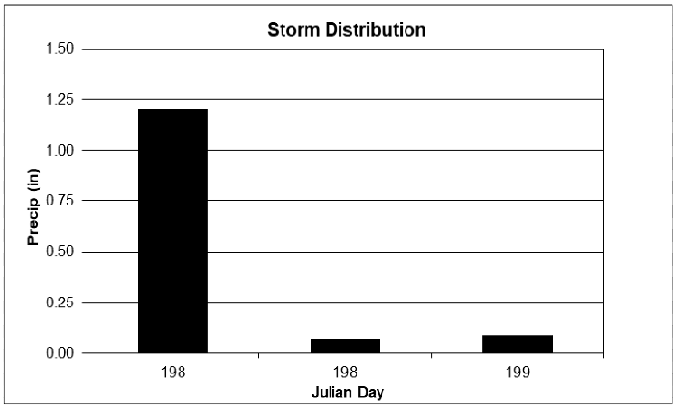
YSI Continuous Monitoring
Storm 2 - 2017

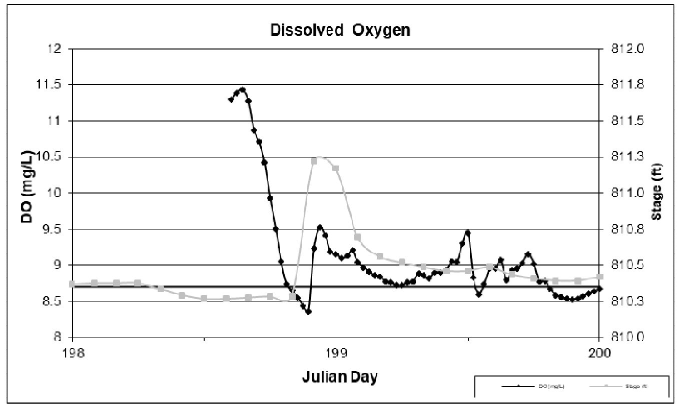
Oak Glen Creek at Alden Way

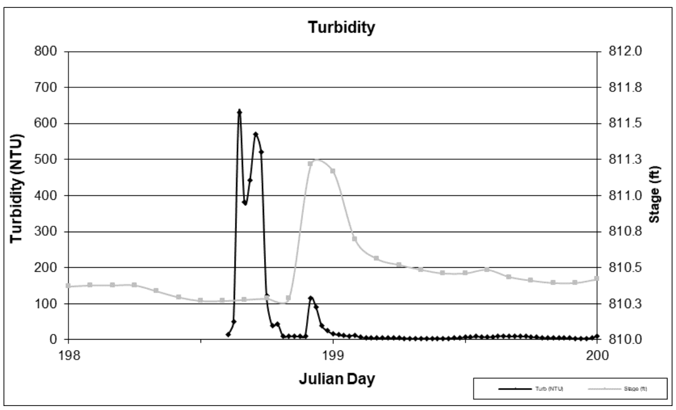
<u>Storm Summary:</u>

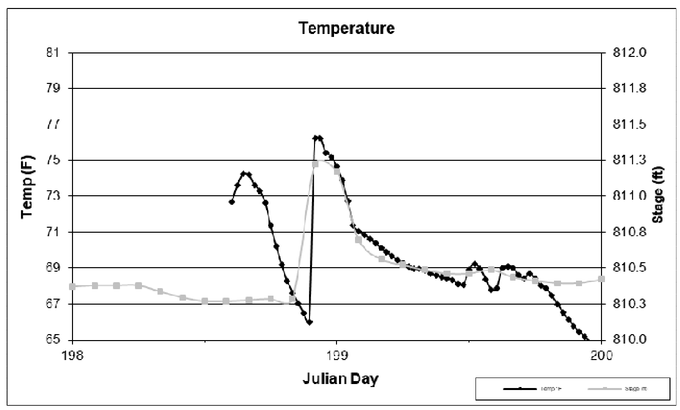
Dates: 17 July 2017 (day 198) to 19 July 2017 (day 200)

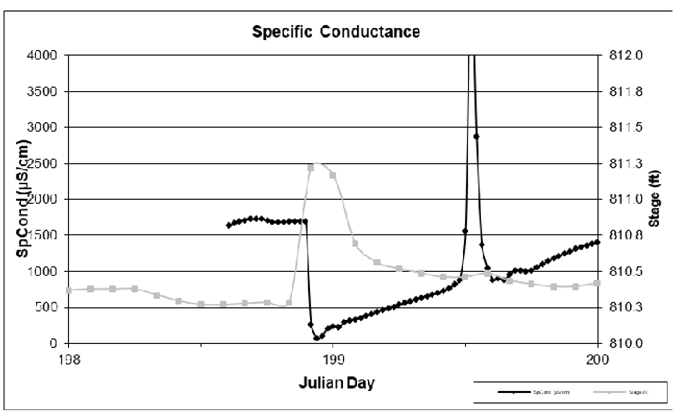
Precipitation: 1.36 inches

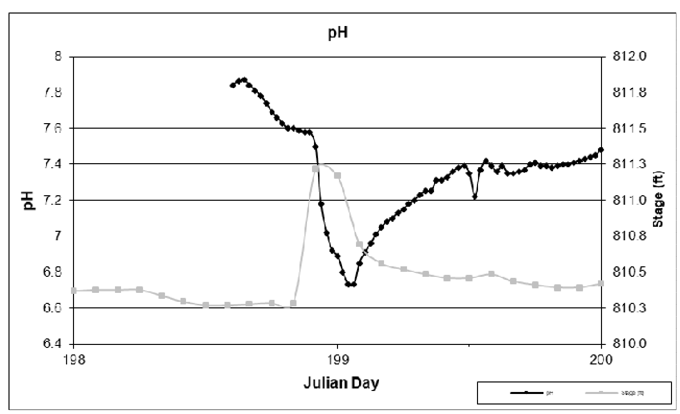






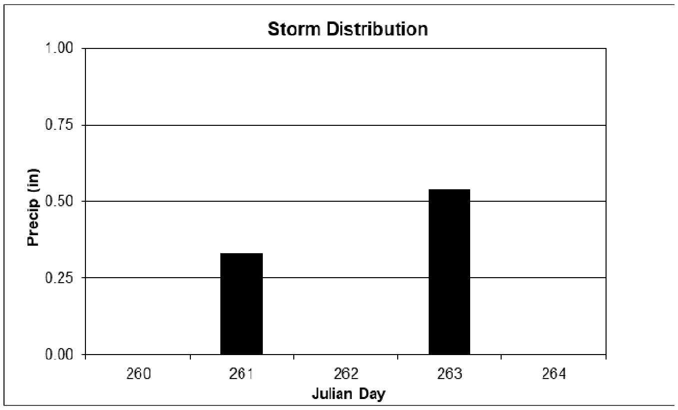


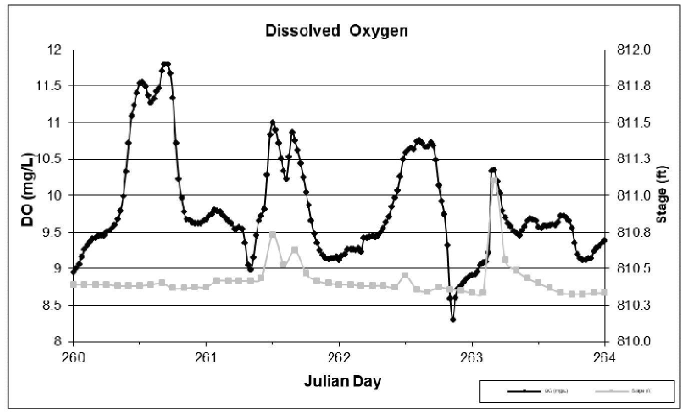


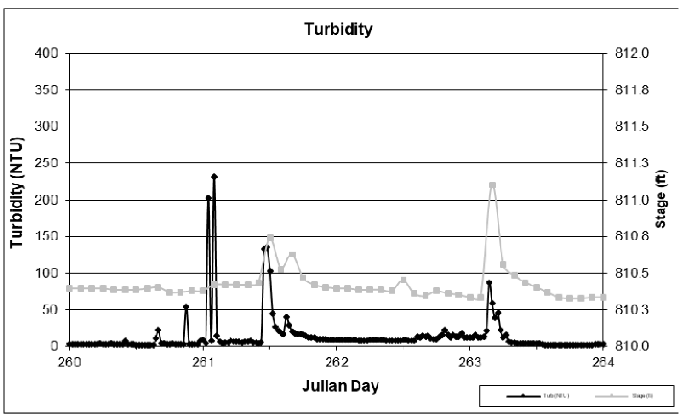


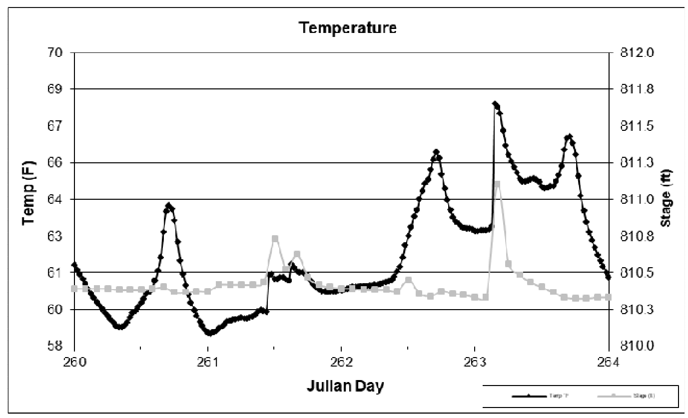
YSI Continuous Monitoring Storm 3 - 2017

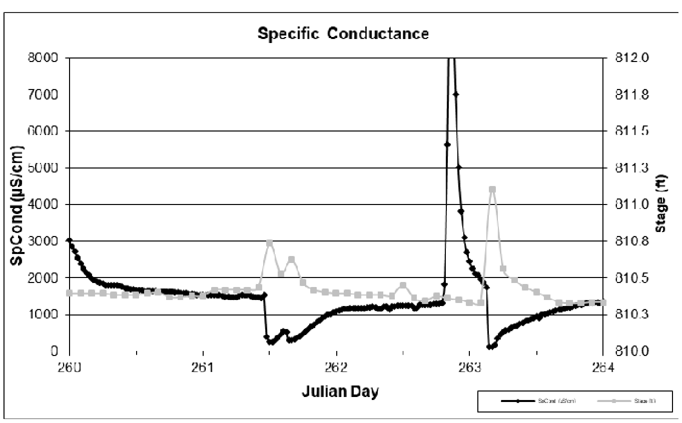
Oak Glen Creek at Alden Way
<u>Storm Summary:</u>
Dates: 18 September 2017 (day 261) to 20 September 2017 (day 263)
Precipitation: 0.87 inches

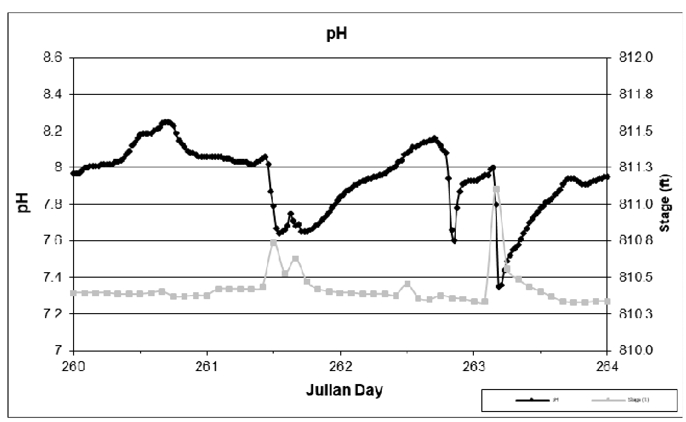












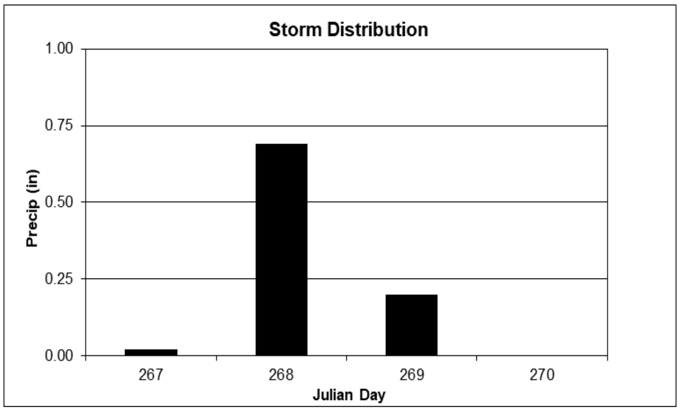
Note
Specific Conductivity peaked at over 11,000 µS/cm (off of the graph above), then plummets to 120 µS/cm within 4 hours as water levels began to rise again.

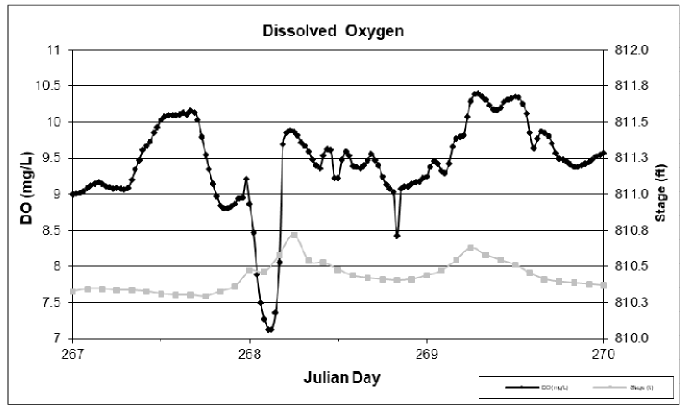
YSI Continuous Monitoring
Storm 4 - 2017

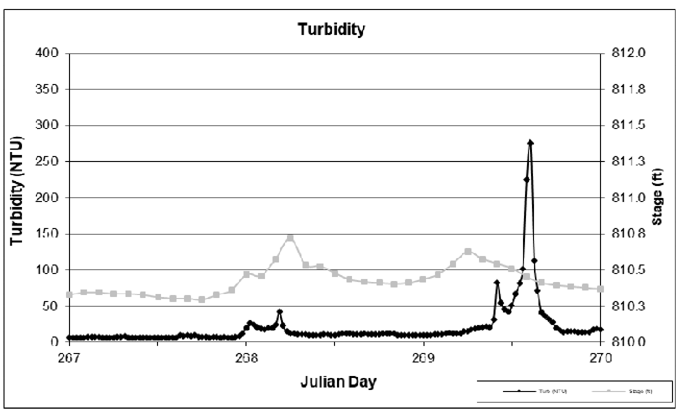
Oak Glen Creek at Alden Way

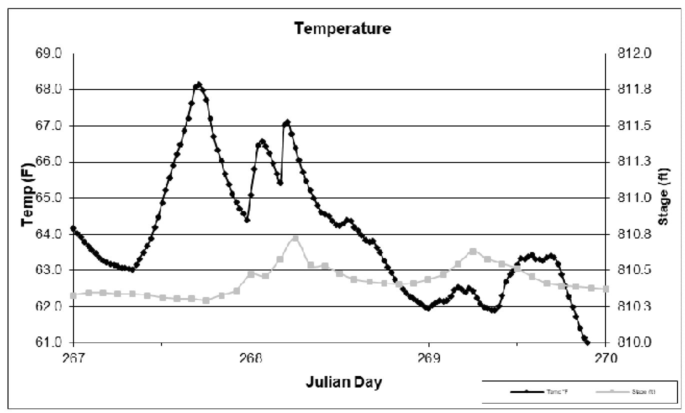
<u>Storm Summary:</u>

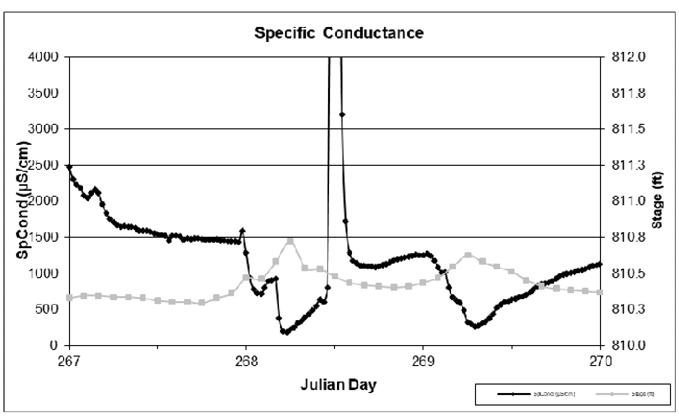
Dates: 24 September 2017 (day 267) to 26 August 2017 (day 269)
Precipitation: 0.91 inches

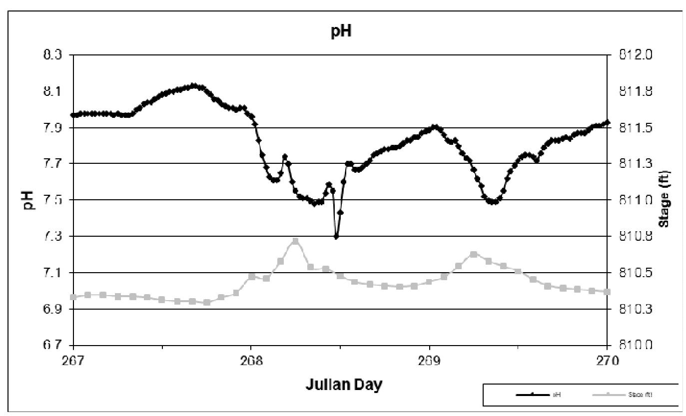












Note

Specific Conductivity dropped below 200 µS/cm when water rose, then shot to over 10,000 µS/cm (off of the graph above) when water levels receded.

Stream Water Quality Monitoring – Grab Sampling

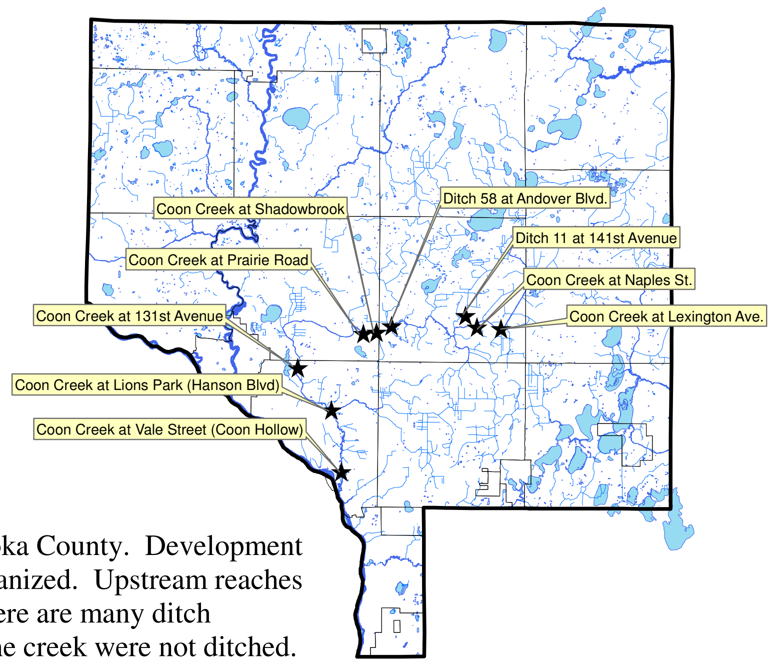
COON CREEK

Coon Creek at Lexington, Ham Lake	STORET SiteID = S007-539
Ditch 11 at 149st Avenue, Ham Lake	STORET SiteID = S007-541
Coon Creek at Naples Street, Ham Lake	STORET SiteID = S007-057
Ditch 58 at Andover Blvd, Ham Lake	STORET SiteID = S005-830
Coon Creek at Shadowbrook Townhomes, Andover	STORET SiteID = S004-620
Coon Creek at Prairie Road, Andover	STORET SiteID = S007-540
Coon Creek at 131st Avenue, Coon Rapids	STORET SiteID = S005-257
Coon Creek at Lions Park, Coon Rapids	STORET SiteID = S004-171
Coon Creek at Vale Street, Coon Rapids	STORET SiteID = S003-993

Years Monitored

Coon Cr at Lexington	2013-2016
Ditch 11 at 149st Ave	2013-**2017**
Coon Cr at Naples St	2012-**2017**
Ditch 58 at Andover Blvd	2013-2016
Coon Cr at Shadowbrook Townhomes	2007-2016
Coon Cr at Prairie Rd.	2013, **2017**
Coon Cr at 131st Ave	2010-**2017**
Coon Cr at Lions Park (Hanson Blvd)	2007-**2017**
Coon Cr at Vale St	2005-**2017**

Additional, intermittent data available at some other sites.



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 and is listed as an Impaired Water for *E. coli* bacteria and invertebrate biota.

Methods

Coon Creek was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were taken each year; half during baseflow and half following storms. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. In some years smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Eleven water quality parameters were tested. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009, transparency tube measurements were added and are reported to MPCA. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, and *E.coli* bacteria.

During every sampling event the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using continuous data logging gauges at selected sites. These data can be found in the hydrology section of this chapter.

Results and Discussion

This report includes data from all years and all sites to provide a broad overview of Coon Creek's water quality under a variety of conditions. Water quality assessments are based on upstream-to-downstream comparisons, a comparison of baseflow and storm conditions, and an overall assessment compared to other Anoka County streams and state water quality standards. Median results for each parameter at the furthest downstream site (Vale Street) are tabulated for comparison to state standards. All results for all years are graphed in box and whisker style plots. Following is a summary, including a management discussion:

- Dissolved pollutants, as measured by conductivity and chlorides, in Coon Creek were high compared to other Anoka County streams, and are highest near the outlet during baseflow conditions. Coon Creek was well below the state water quality standard for chlorides in 2012 (chlorides have not been sampled since) however, chloride was on a statistically significant climb from 2005-2012.

  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 levels are high during storms but lower during baseflow. Coon Creek did not exceed State impairment thresholds during baseflow conditions, but periodic exceedances of the 100 µg/L State standard did occur. During storm flow conditions, Coon Creek exceeded the State standard threshold over 90% of the time at Vale Street, and commonly at levels 3-7 times that standard. Phosphorus is slightly higher in downstream reaches than upstream, but certain upstream tributaries such as Ditch 11 were major phosphorus sources. It is possible that other small tributary ditches not sampled flowing through the northern portions of the watershed are large sources also.

  Management discussion: Phosphorus needs to be reduced in both the upper and lower watershed, though the sources are likely different. A major source upstream appears to be the agricultural land that Ditch 11 flows through. In the developed lower watershed, phosphorus is likely transported in concert with particulate debris from impervious surfaces and storm sewer systems. Efforts to trap and remove phosphorus from each of these major sources should be a management focus before Coon Creek is designated as impaired for nutrients. Furthermore, water quality monitoring at additional sites is recommended to determine the magnitude of phosphorus loading from tributaries that have not previously been sampled. It should also be noted that Coon Creek does have an established TMDL for phosphorus as it was identified as a primary stressor to the aquatic life impairment.

- Suspended solids and turbidity were lower upstream and during baseflow, but increased both during stormflows and moving downstream. During baseflow, suspended solids were generally below State standards, but increased drastically during storms, with a long-term median at Vale Street equaling the State water quality standard of 30 mg/L and 48% of storm samples exceeding that standard. Suspended solids are higher at all sites during storms, though the source likely differs in different parts of the watershed. Median turbidity levels approximately double during storms, and TSS concentrations triple, as compared to median baseflow concentrations. While bedload is a concern, continuous storm monitoring has shown that turbidity does not follow stream flow volumes, suggesting is it not the primary source.

  Management discussion: There are at least two sources of suspended solids and turbidity that seem to be impacting Coon Creek. These will require a variety of management techniques to address. First, suspended solids and turbidity are greatest during storms and in the lower, developed part of the watershed, suggesting that stormwater treatment is an important way to address this problem. Storms greater than one-inch produce the worst creek water quality, so practices aimed at reducing suspended solids and phosphorus entering the creek during those storms are especially important. Most stormwater practices were designed to treat storms up to one inch in size.

Secondly, there are likely near and in-stream sediment sources, like bedload and streambank erosion. High flows are a common aggravator of this type sediment source. We would anticipate near and in-stream sources to be impacting Coon Creek because much of it is ditched, and ditches generally have unstable banks. Soils in the watershed are highly erodible. Yet continuous monitoring of turbidity in previous years with a Hydrolab/YSI during storms and in the days after storms paints a more complex picture. Turbidity does rise quickly during storms (presumably runoff from the lower watershed). Turbidity then increases slowly and continuously after the storms (presumably sediment from the upper watershed). The Hydrolab/YSI found it was common for turbidity to increase for several days after a storm, even when flows were dropping. We would expect bedload and streambank erosion to increase with flow.

- pH and dissolved oxygen: pH levels remained within the range considered normal and healthy for streams in this area. All measurements were in the desired range of 6.5-8.5. Dissolved oxygen levels are poorer in the ditched upper portions of the watershed, especially in Ditch 11, but also in the main stem at Naples St. Neither pH nor DO are of particular concern watershed-wide however, with levels of both being quite healthy in most of the watershed.

- *E. coli* bacteria are high throughout Coon Creek, and an approved TMDL exists for the impairment. During baseflow, *E. coli* is periodically above the state standard thresholds, though not sampled frequently enough for threshold calculations, and this primarily occurs in the lower portion of the watershed. *E. coli* is generally low in the upper watershed during baseflow. During storms *E. coli* was much higher in all locations and is extremely high in the lower watershed.

  Management discussion: Because *E. coli* is pervasive in the environment, 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. Addressing sources of *E. coli* such as leaky septic systems, runoff from livestock operations, and domestic pet waste will be an important first step.

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, and other sources. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we use. It measures the electrical conductivity of water; pure water with no dissolved constituents has zero conductivity. Chlorides tests for chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community, however, it is also noteworthy that Coon Creek is upstream from the drinking water intakes on the Mississippi River for the Twin Cities. Note that chlorides have not been sampled since 2012.

The historical median conductivity in Coon Creek at Vale Street (furthest downstream site) is higher than the median for all other Anoka County streams (see table and figures below). The median conductivity in Coon Creek at Vale St. is 0.650 mS/cm compared to the countywide median of 0.420 mS/cm.

Dissolved pollutants were higher in downstream reaches of Coon Creek, where there is more impervious area (see figures below). Median conductivity increases gradually from upstream (0.437 mS/cm) to downstream (0.744 mS/cm) during baseflow conditions. Median conductivity (all years) for storm events shows a smaller, but positive difference between upstream and downstream, ranging from 0.411 to 0.518 mS/cm.

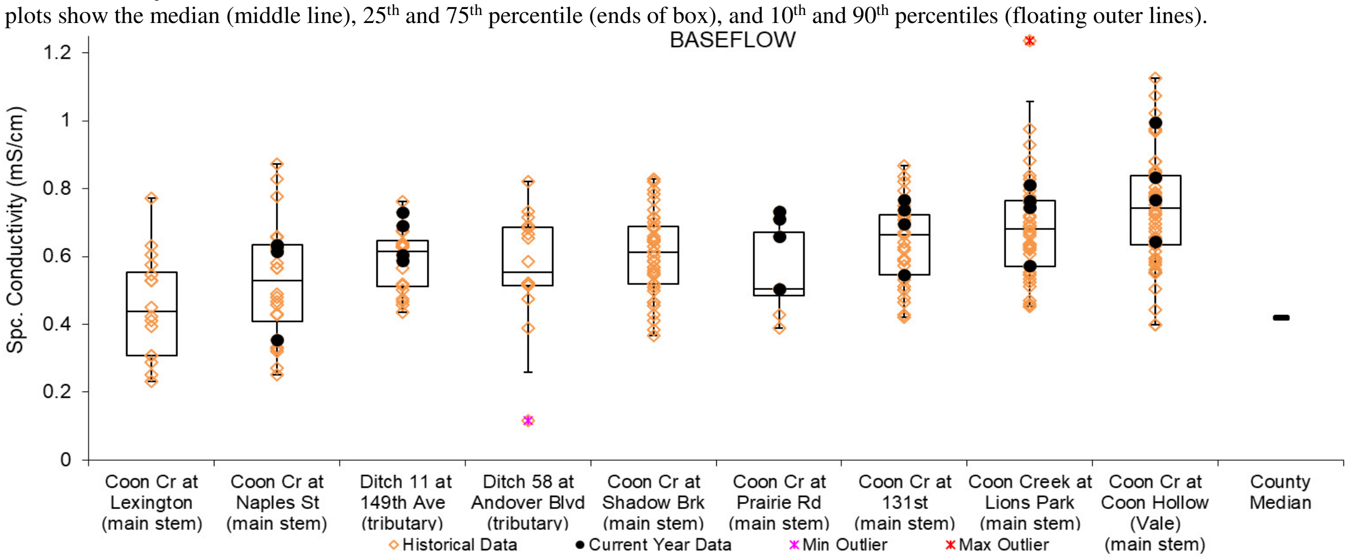
This lends some insight into the pollutant sources. If dissolved pollutants were only elevated during storms, stormwater runoff would be suspected as the primary contributor. Since dissolved pollutants are highest during baseflow, pollution of the shallow groundwater which feeds the stream during baseflow is suspected to be a primary contributor. In Coon Creek, especially further downstream, conductivity is higher during baseflow conditions, meaning the local groundwater is a significant source of dissolved pollutants. The increase in conductivity upstream to downstream also indicates that the pollution of the feeding groundwater system gets worse moving downstream.

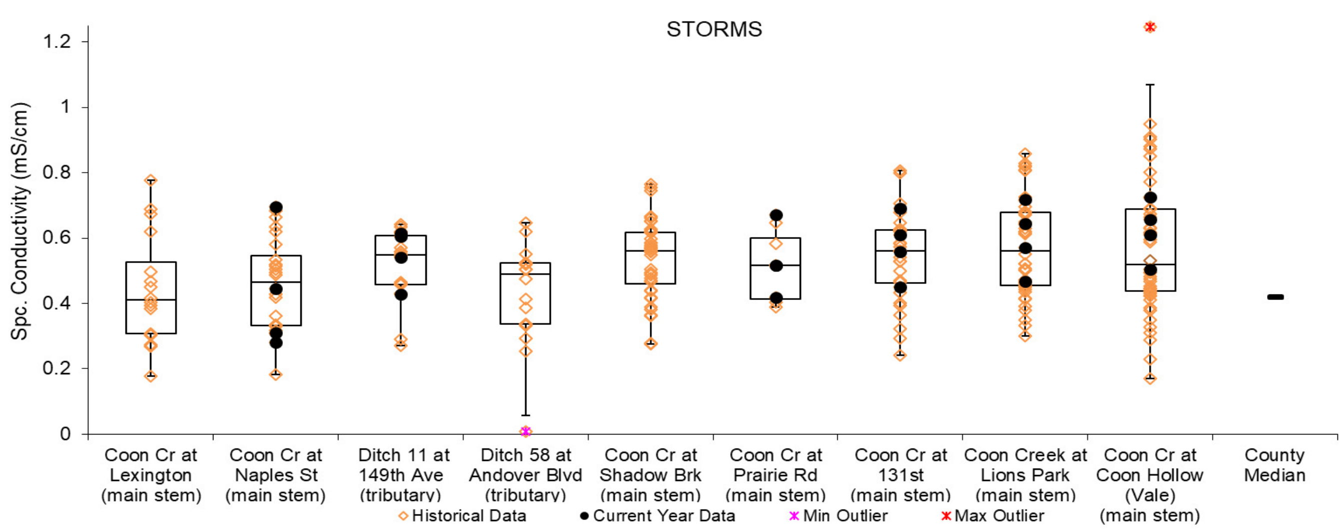
Storm flows dilute some of the pollutant load, making the increase from upstream to downstream much smaller. However, upstream median values during all conditions are still higher in Coon Creek than other Anoka County streams. Prevention measures to reduce conductivity (such as reduced road salting) should be a focus of management. Chloride sampling should also occur more regularly to verify the extent to which high conductivity is due to high chlorides.

Median conductivity and chlorides in Coon Creek Data are from Vale St for conductivity all years through 2017 and for chlorides all years through 2012.

	Conductivity (mS/cm)	Chlorides (mg/L)	State Standard	N
Baseflow	0.744	64.7	Conductivity – none	51
Storms	0.518	52.25	Chlorides 860 mg/L acute, 230 mg/L chronic	52
All	0.650	60.5		103
Occasions > state standard				0

Conductivity at Coon Creek Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Conductivity and Chloride Statistical Analysis

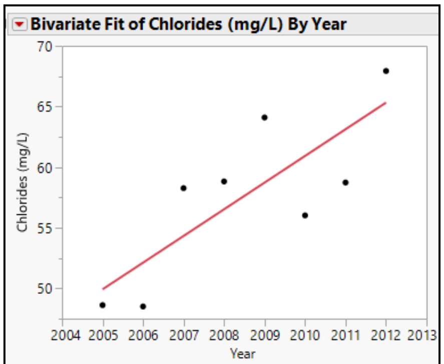
Conductivity increases from upstream to downstream in Coon Creek, and reaches high levels in the lower reaches of the watershed compared to other Anoka County streams. However, unlike many streams in Anoka County, conductivity does not seem to be trending upward on an annual average basis in Coon Creek through recent years when considering all samples and conditions. However, pairing conductivity data with chloride data collected from 2005-2012 offers up an interesting comparison. Chloride levels saw a statistically significant increase over those 8 years, $F_{1,6} = 10.65$, $p = 0.0172$. Conductivity saw a similar, statistically significant increase during that same period, but only following storm events. $F_{1,6} = 8.20$, $p = 0.0287$.

Avg. Annual Cond. and Cl all conditions – Vale

Year	Sp. Cond (mS/cm)	Chlorides (mg/L)
2005	0.421	48.63
2006	0.691	48.51
2007	0.728	58.28
2008	0.736	58.83
2009	0.679	64.10
2010	0.691	56.03
2011	0.619	58.74
2012	0.710	67.94
2013	0.609	
2014	0.689	
2015	0.705	
2016	0.627	
2017	0.717	

Baseflow conductivity actually seemed to decrease over that period, indicating that increasing chloride loading from stormwater runoff was driving conductivity up during storms, so much so that in 2012, average storm flow conductivity was higher than recorded baseflow conductivity, the only time ever. Since 2013, however, baseflow conductivity returned to elevated levels, indicating shallow aquifer contamination by salts that is diluted by lower conductivity storm water. This is the far more common relationship between storm and baseflow conductivity observed in Coon Creek and countywide.

Average Annual Chloride and Storm Cond Increases through 2012



Linear Fit

Linear Fit

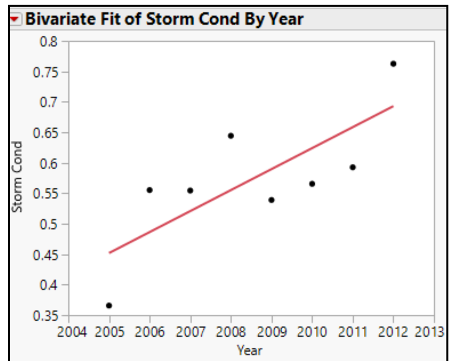
Chlorides (mg/L) = -4361.967 + 2.2004464*Year

Summary of Fit

RSquare	0.639563
RSquare Adj	0.57949
Root Mean Square Error	4.370515
Mean of Response	57.62969
Observations (or Sum Wgts)	8

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	203.36251	203.363	10.6465
Error	6	114.60841	19.101	Prob > F
C. Total	7	317.97092		0.0172*



Linear Fit

Linear Fit

Storm Cond = -68.583 + 0.0344314*Year

Summary of Fit

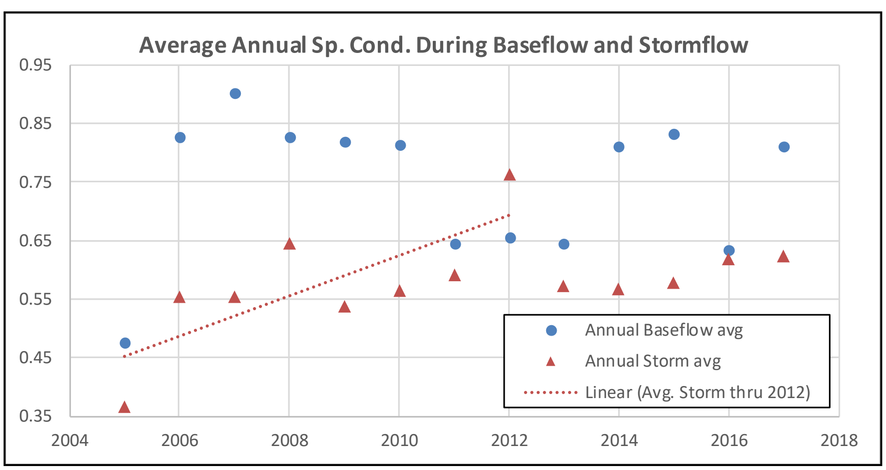
RSquare	0.577366
RSquare Adj	0.506927
Root Mean Square Error	0.07794
Mean of Response	0.572532
Observations (or Sum Wgts)	8

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.04979199	0.049792	8.1967
Error	6	0.03644787	0.006075	Prob > F
C. Total	7	0.08623985		0.0287*

Since chlorides have not been sampled in Coon Creek since 2012, it is impossible to know how that parameter has changed compared to swings in baseflow and storm flow conductivity in recent years. More samples of both parameters are necessary to determine any relationship between them and to track potentially continuing increases in chloride levels. CCWD has indicated plans to make chloride sampling a priority in the near future.

Average Annual Conductivity during storm and base flows



Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant and is usually the limiting factor for most algae growth in freshwater systems. Total phosphorus in Coon Creek was generally lower in the main stream during baseflow conditions and increases substantially during storms. The State TP water quality standard for streams is 100 µg/L, and Coon Creek eventually may be designated as impaired for exceeding it often, especially during storms. A TMDL for TP has already been established in Coon Creek to address the aquatic life impairment. Best management practices for this stream are needed to address stormwater phosphorus loading along the entire monitored stream length. A major source of TP into the upstream reaches of the system is Ditch 11, where high phosphorus concentrations are regularly observed.

During baseflow conditions, the six monitored Coon Creek sites had a composite median TP of 70.5 µg/L. Individually, however, Ditch 11 and the main stem at Lions Park had baseflow median concentrations of 163.5 and 134 µg/L respectively, both in exceedance of State standards. Near the outlet at Vale Street, 18 of 55 (33%) baseflow measurements, and of 47 of 52 (90%) of storm flow measurements taken since 2005 have been above 100 µg/L. Levels 3-7 times the state standard are frequently measured.

The tributary Ditch 11 appears to be a major source of TP in the upstream reaches of Coon Creek, and vastly exceeds the State water quality standards in every storm sample collected as well as 14 of 20 (70%) of baseflow samples. The composite average of 40 samples collected in Ditch 11 at 149th Avenue is more than double the State standard at 210 µg/L.

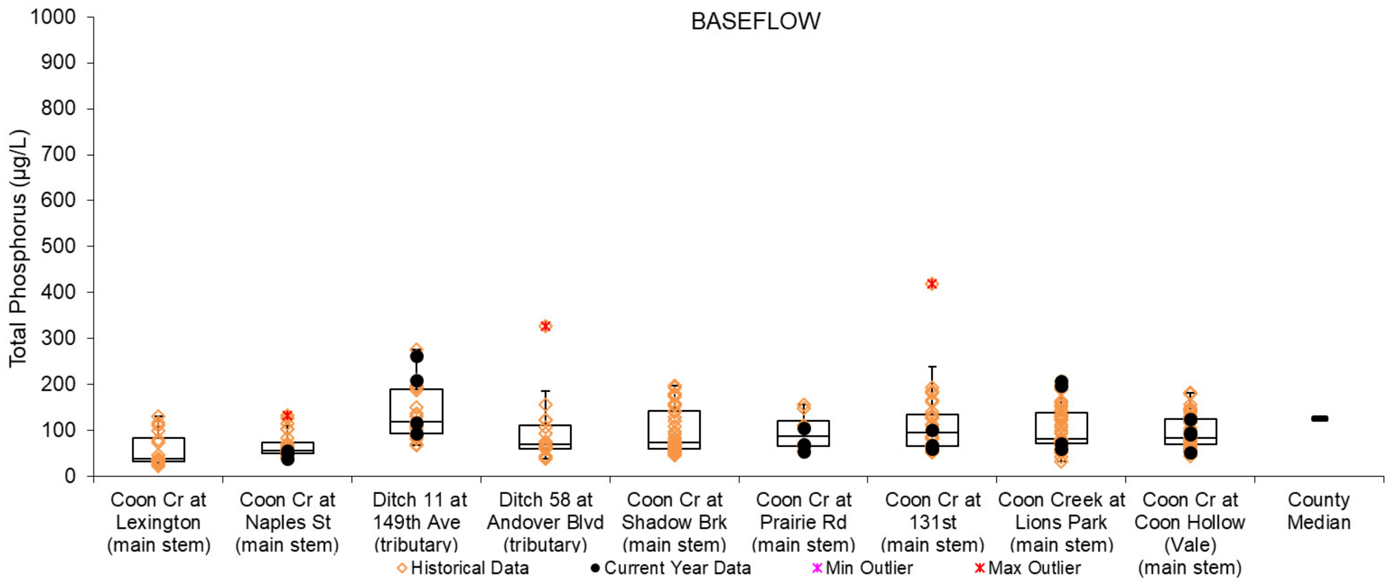
The dominant phosphorus source is likely different in upstream and downstream stream reaches. Upstream is less developed and any development has occurred more recently with more stringent stormwater treatment requirements. Here, mobilization of in-stream sediments and agricultural runoff are likely important phosphorus sources. Drained, organic wetland soils may be another source. Downstream parts of the watershed are fully developed, and some areas developed before modern-day stormwater treatment requirements. Here, flows are often higher and flashy, so mobilization of in-stream sediments may be important, but stormwater runoff from impervious surfaces is likely quite important.

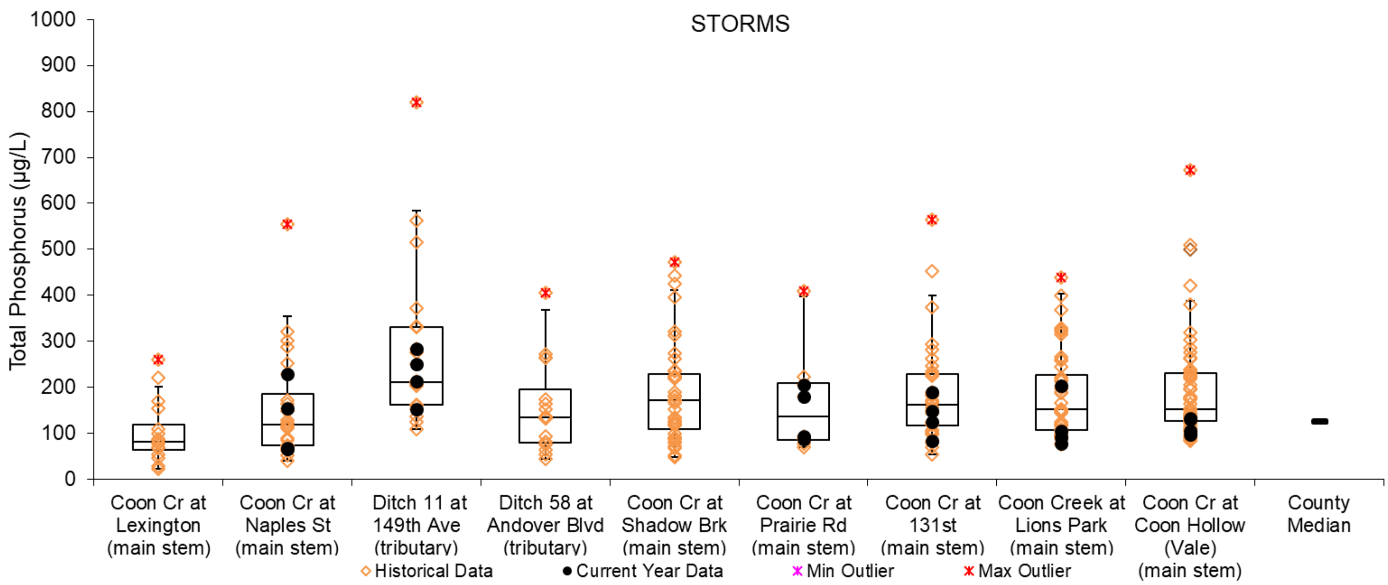
Phosphorus reduction needs to occur throughout the watershed. The highest priority should be addressing phosphorus from urban stormwater runoff in the lower portion of the watershed, and agricultural and drained wetland inputs in the upper watershed. These are likely the sources of other pollutants too, such as total suspended solids and *E. coli*.

Median total phosphorus in Coon Creek Data are from Vale St for all years through 2017.

	Total Phosphorus (µg/L)	State Standard	N
Baseflow	93	100	51
Storms	152		52
All	127		103
Occasions > state standard			65 (63%) (47 storms, 18 baseflow)

Total Phosphorus at Coon Creek Orange diamonds are historical data from previous years and black circles are 2017 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 dried 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 are generally lower upstream and increase dramatically during storms and in downstream reaches (see figures below). Presently, the State water quality standard allows TSS up to 30 mg/L and no more than 10% of turbidity samples should exceed 25 NTU. The stream often exceeds the state water quality standard at Vale Street during storms.

During baseflow conditions both turbidity and TSS are generally low in the upstream reaches and increase moving downstream. Median turbidity of all main stem samples collected through 2017 during baseflow from upstream to downstream range from 6 to 12 NTU, effectively doubling from Lexington Avenue to Vale Street. Median levels near the outlet are similar to the countywide median of 11 NTU for all Anoka streams. Median TSS of all main stem samples collected through 2017 during baseflow from upstream to downstream range from 5 to 9 mg/L, following the same trend as turbidity and almost doubling as well. These levels are lower than the countywide median for all Anoka streams of 13.6 mg/L, however. At Vale St. only 1 of 51 (2%) baseflow TSS measurements exceeded the water quality standard of 30 mg/L.

During storms, however, TSS and turbidity are elevated, and there is an even more dramatic increase from upstream to downstream reaches. Median turbidity during storms is about 2 times higher than during baseflow for individual sites, and once again doubles moving upstream to downstream from 12 to 26 NTU. Median TSS is proportionately even higher during storms with medians ranging from 8 to 30 mg/L moving upstream to downstream. This is approximately double at upstream sites compared to baseflow conditions, but triple at downstream sites. The long-term median TSS concentration during storm samples at Vale St. is right at the state water quality standard of 30 mg/L, and 48% of storm samples have exceeded that standard.

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 seem to increase proportionately throughout the watershed, the loading is likely not geographically isolated.

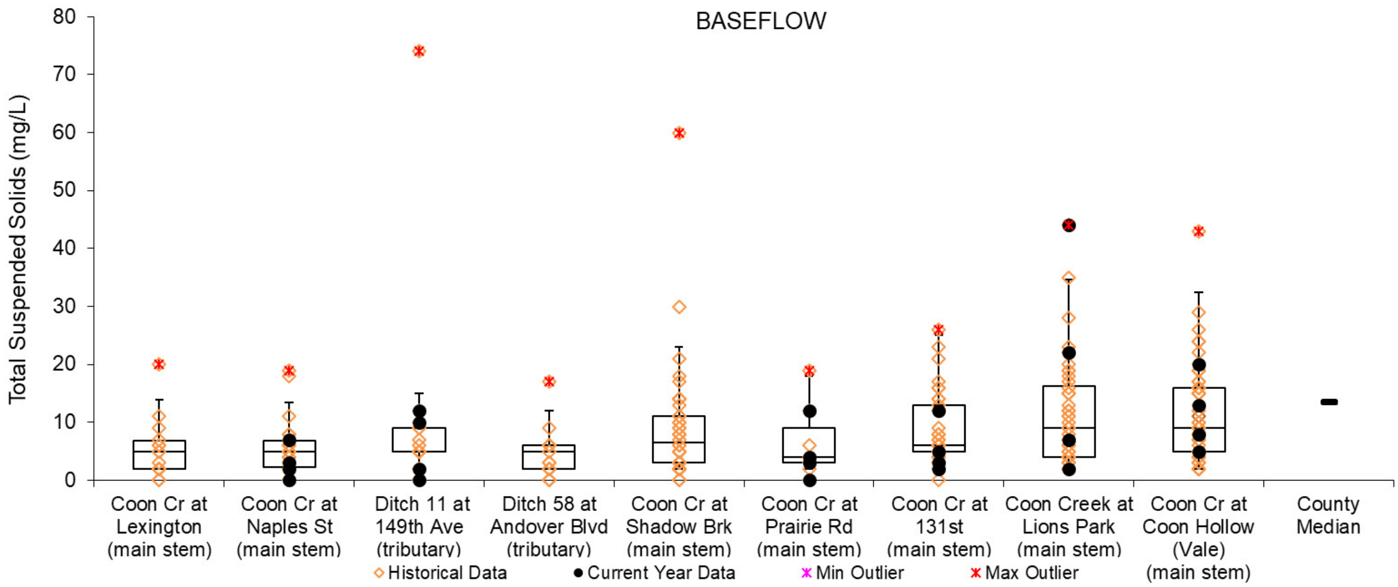
Research could be considered to determine the extent to which bed load sediment transport is contributing to high turbidity and TSS. It appears that it has the potential to be important. Instances of high suspended solids in the upper watershed, where land uses are rural residential and sod fields, is surprising given that these are not often large sources suspended solids. Near-channel and in-channel sources may be important in the upper watershed.

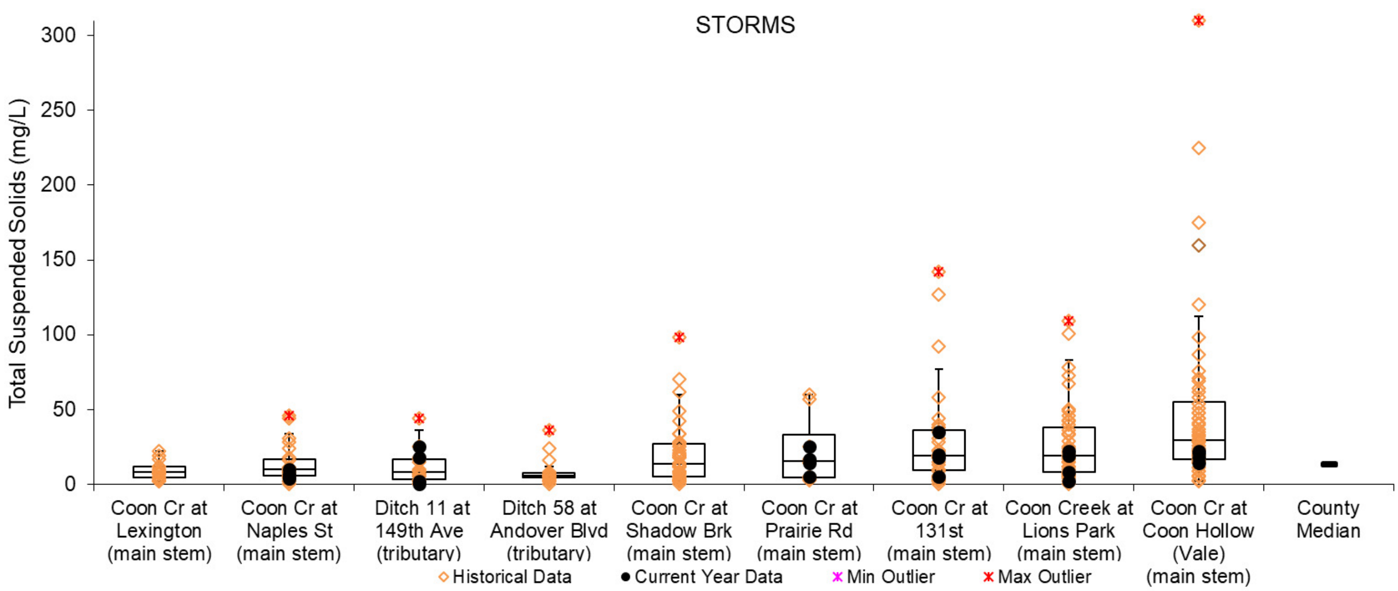
In the lower portions of the watershed continuous storm monitoring has found that turbidity does not increase as flow increases, as would be expected if bed load were dominant. Instead, it spikes immediately following rain commencement, indicating high loads of runoff contribution. This would also match the trend of increasing TSS and turbidity throughout the watershed moving downstream. Stormwater TSS capture and containment should be a management focus in the lower, more developed portions of the watershed.

Median turbidity and suspended solids in Coon Creek Data are from Vale St for all years through 2017.

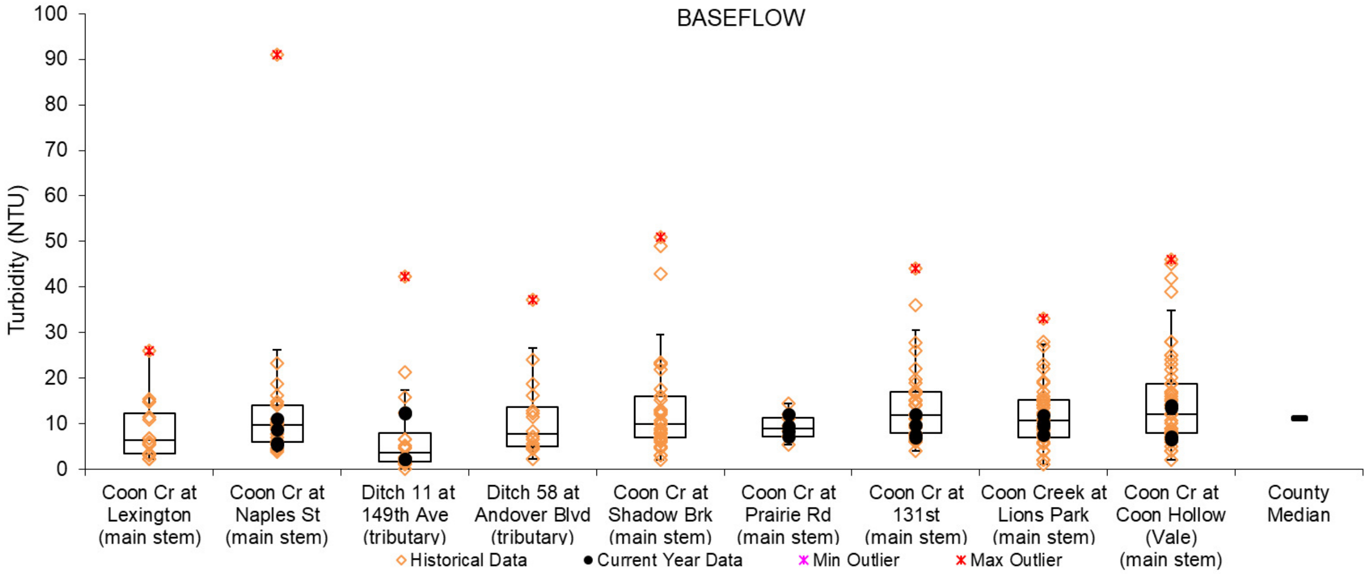
	Turbidity (NTU)	Total Suspended Solids (mg/L)	State Standard	N
Baseflow	12	9	30 mg/L TSS	51
Storms	26.3	29.5		52
All	19	16		103
Occasions > state TSS standard				26 (25 during storm flows)

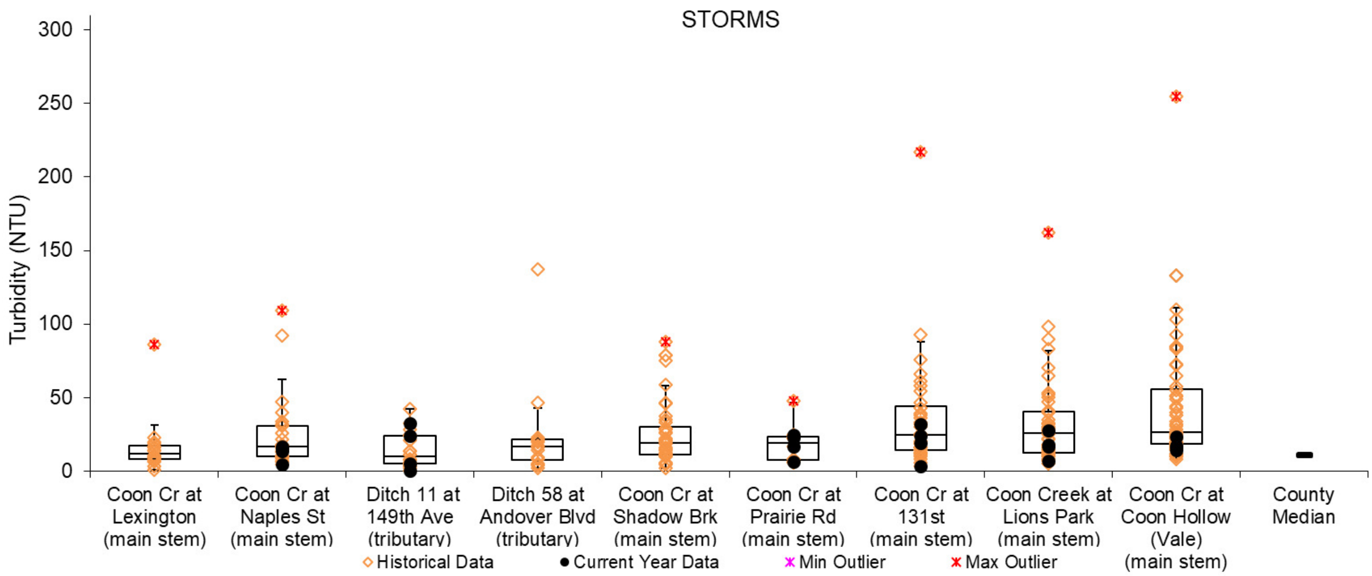
Total Suspended Solids at Coon Creek Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Coon Creek Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





pH

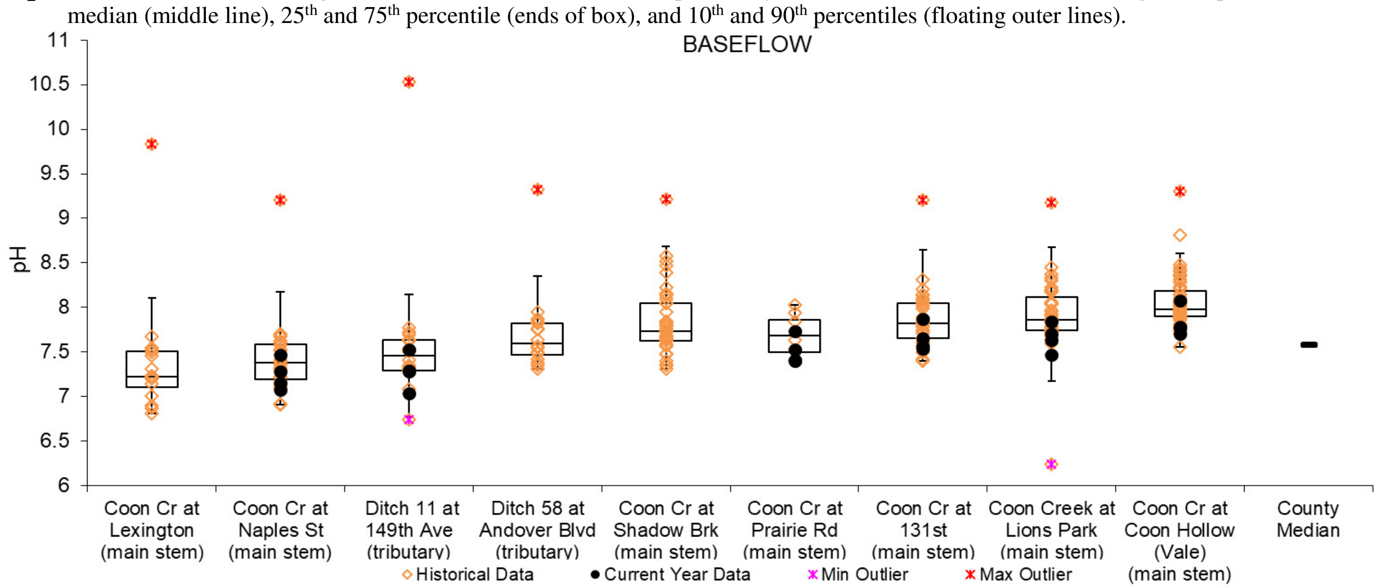
pH was within the state water quality standard range of 6.5-8.5 for all samples in 2017. While occasional readings outside of this range have occurred in previous years, none recently generate concerns. pH is slightly lower during storm events because rainfall has a lower pH and the creek serves as a stormwater conveyance for four cities.

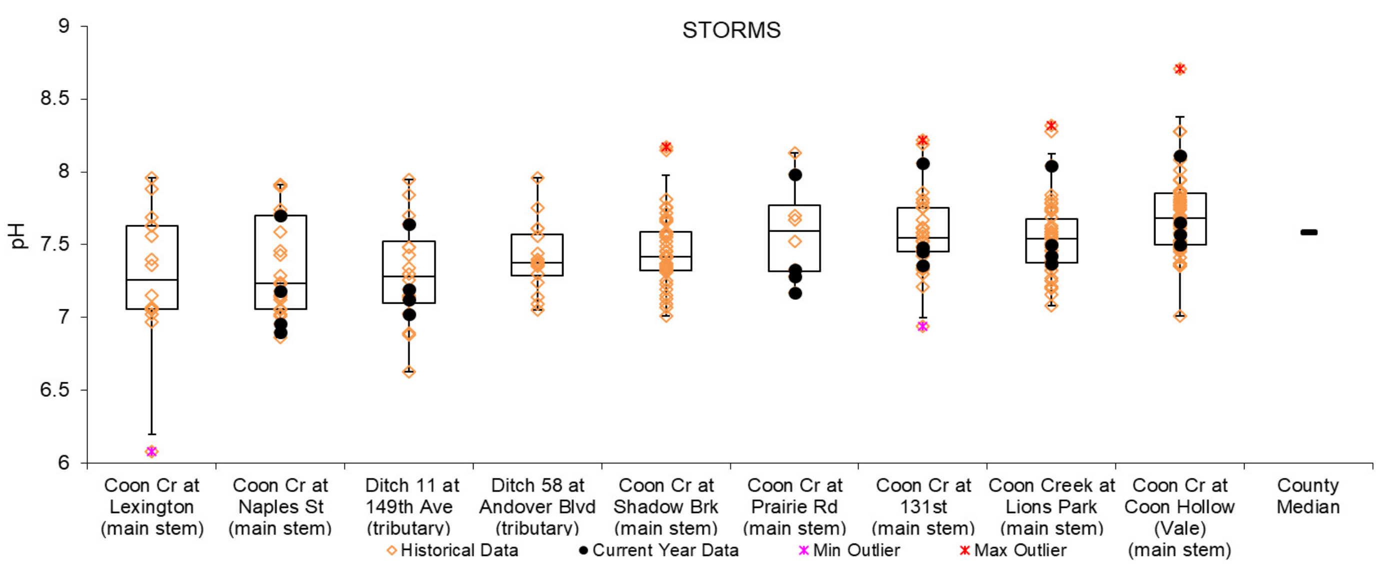
Median pH in Coon Creek Data are from Vale St for all years through 2017.

	pH	State Standard	N
Baseflow	7.98	6.5-8.5	51
Storms	7.68		48
All	7.87		99
Occasions outside state standard			1*

*A surprisingly high pH reading at each site during baseflow conditions in 2014 resulted in the outliers depicted below. This is a curious occurrence and may be due to a bad calibration of the equipment.

pH at Coon Creek Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





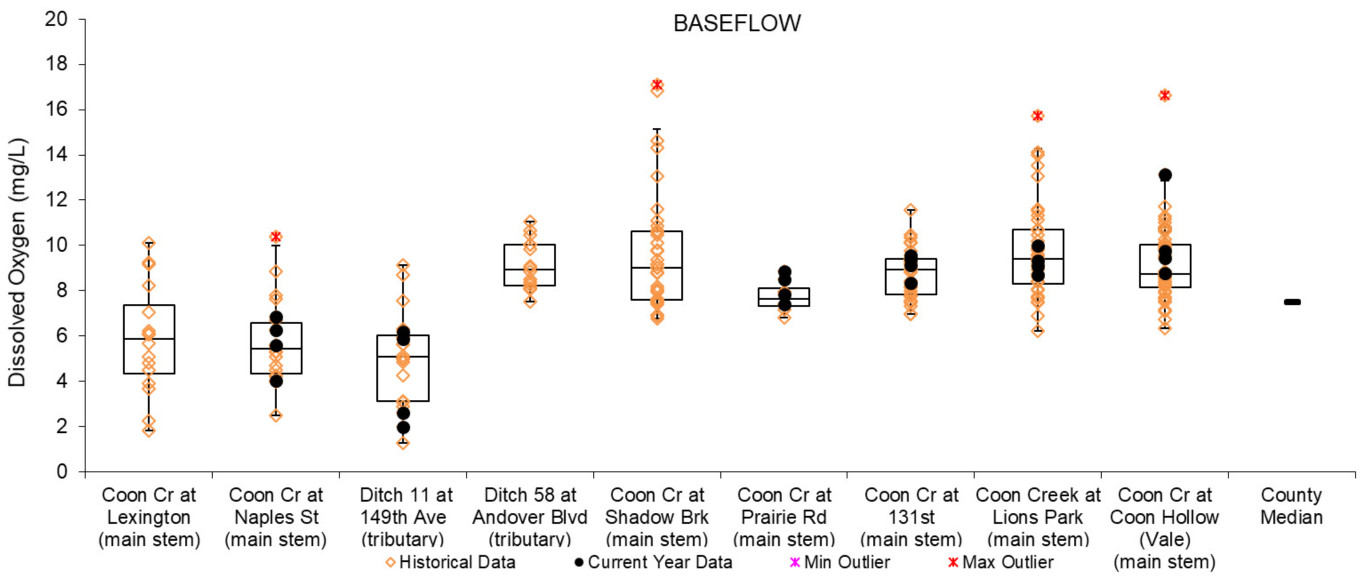
Dissolved Oxygen

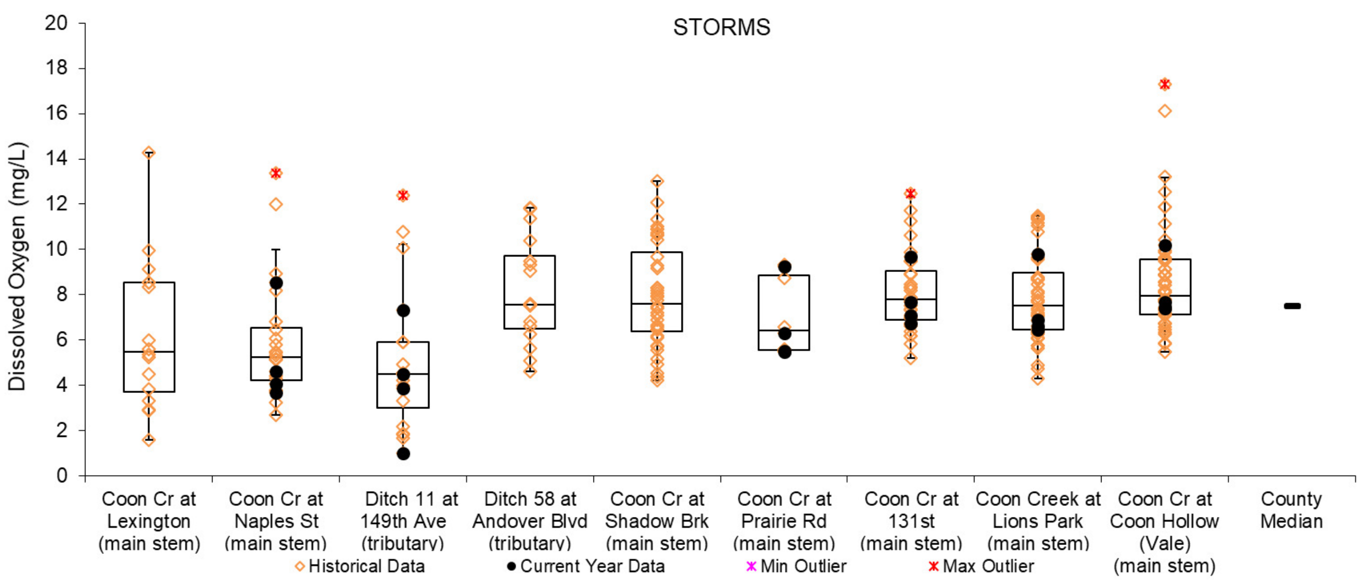
Low dissolved oxygen levels are generally not an issue in Coon Creek, especially in the downstream reaches. Observed low readings have all occurred in the upstream reaches of the main stem and Ditch 11. There is a marked increase in DO levels between these sites and the site near the Shadowbrook development. It is likely that DO is higher in the larger and more natural channel further downstream than the small ditched channels upstream. Coon Creek is impaired for invertebrate biota, but this may be more due to habitat than DO issues.

Median dissolved oxygen in Coon Creek Data are from Vale St for all years through 2017.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.73	5 mg/L daily minimum	44
Storms	8.10		46
All	8.57		90
Occasions <5 mg/L			

Dissolved oxygen at Coon Creek Orange diamonds are historical data from previous years and black circles are 2017 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 bacteria found in the feces of warm-blooded animals. *E. coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets *E. coli* standards for contact recreation (swimming, etc.). A stream is designated as "impaired" if 10% of measurements in a calendar month are >1260 colonies in the units of most probable number (MPN) per 100 milliliters of water, or if the geometric mean of five samples taken within 30 days is greater than 126 MPN.

Sampling by the MPCA has found Coon Creek is exceeds State standards for *E. coli* bacteria. Data collected by local agencies to date are not sufficient to re-calculate if the MPCA standards are met or exceeded. We took samples throughout the summer, often with only 1-2 samples 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. But other examinations of the data presented below verify that *E. coli* abundance is high.

During baseflow conditions, *E. coli* were generally low in the upper Coon Creek system but tended to be higher in the lower watershed. Median *E. coli* for all years at sites moving upstream to downstream ranged from 34 to 136 MPN during baseflow conditions. Though the sampling frequency requirements were not met, bacteria levels during baseflow generally fell below the 126 MPN state water quality standard in the upper watershed. During 2017, however, baseflow results in Coon Creek at Naples Street and in Ditch 11were strikingly high during baseflow conditions in July and September. These samples were each the two highest ever recorded at these sites. In the three furthest downstream sites (131st, Lions Park, and Vale St.) long-term median results are all higher than the 126 MPN geometric mean standard, suggesting that this standard is likely exceeded for at least portions of the year. Coon Creek is listed as impaired for *E. coli* in these reaches, and a TMDL study has been approved.

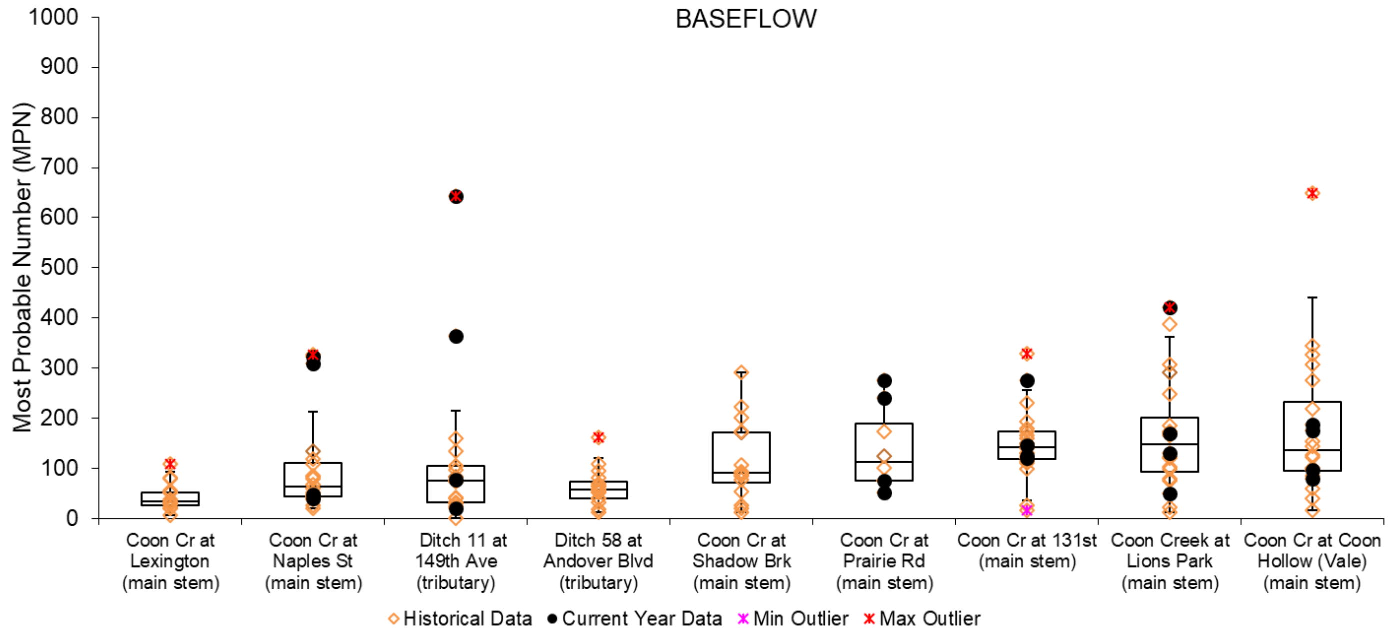
During storms, *E. coli* were significantly higher and more variable (note the difference in Y axis scales in the graphs below). A large part of this variability is likely due to the intensity and phenology of each storm and when the storm the sampling took place. Median *E. coli* during storms from upstream to downstream range from 236 to 922 MPN, showing a sharp increase in lower portions of the watershed.

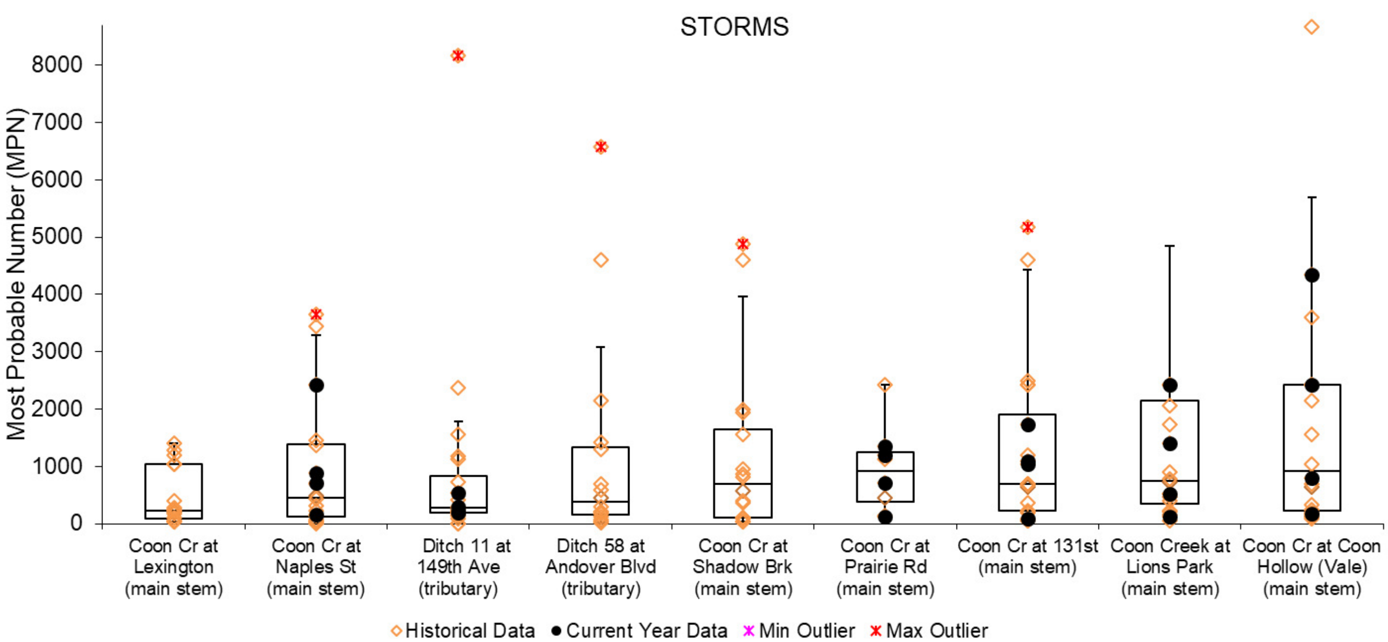
Though the sampling frequency requirements are again not met, bacteria levels during storms continue to grossly exceed the 126 MPN State water quality standard with every storm sample collected in 2017 at all sites being higher. The average of 24 *E. coli* samples collected in the three most downstream sites in 2017 during all conditions was 756 MPN, after counting two samples exceeding the reporting limit (2420) as the reporting limit.

Median *E. coli* in Coon Creek Data are from Vale St. 2013-2017.

	E. coli **(MPN)**	**State Standard**	**N**
Baseflow	136	Monthly Geometric Mean >126	20
Storms	922		20
All	234		40
Occasions >126 MPN		Monthly 10% average >1260	11 baseflow (55%), 19 storm (95%)
Occasions >1260 MPN			0 baseflow, 9 storm (45%)

***E. coli* at Coon Creek** Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





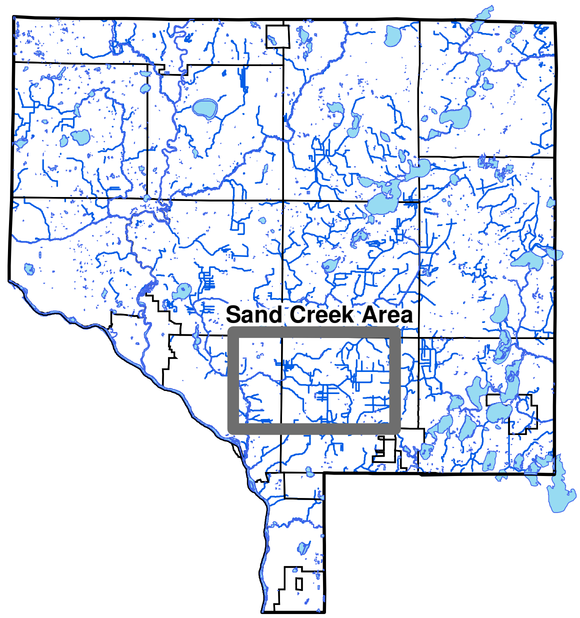
Stream Water Quality Monitoring – Grab Sampling

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-**2017**
Sand Cr (Ditch 41) at Highway 65	2009-**2017**
Sand Cr at Happy Acres Park	2009
Ditch 60 at Happy Acres Park	2009
Sand Cr at University Avenue	2008
Ditch 39 at University Avenue	2009
Sand Cr at Morningside Cemetery	2010-**2017**
Sand Cr at Xeon Street	2007-**2017**



Background

Sand Creek is the largest tributary to Coon Creek. It drains suburban residential, commercial and retail areas throughout northeastern Coon Rapids and western Blaine. In upper portions of the watershed (upstream of Hwy 65), the creek flows through a network of man-made ponds and lakes which serve stormwater treatment and aesthetic purposes. These areas were developed recently, after 1995. Farther downstream there are no in-line ponds and developments are older, with many preceding stormwater regulations. A number of ditched tributaries exist throughout the watershed, and many reaches of Sand Creek itself have been ditched.

Sand Creek drains into Coon Creek, which then drains into 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 is impaired for *E. coli* and invertebrate biota downstream of Morningside Memorial Gardens.

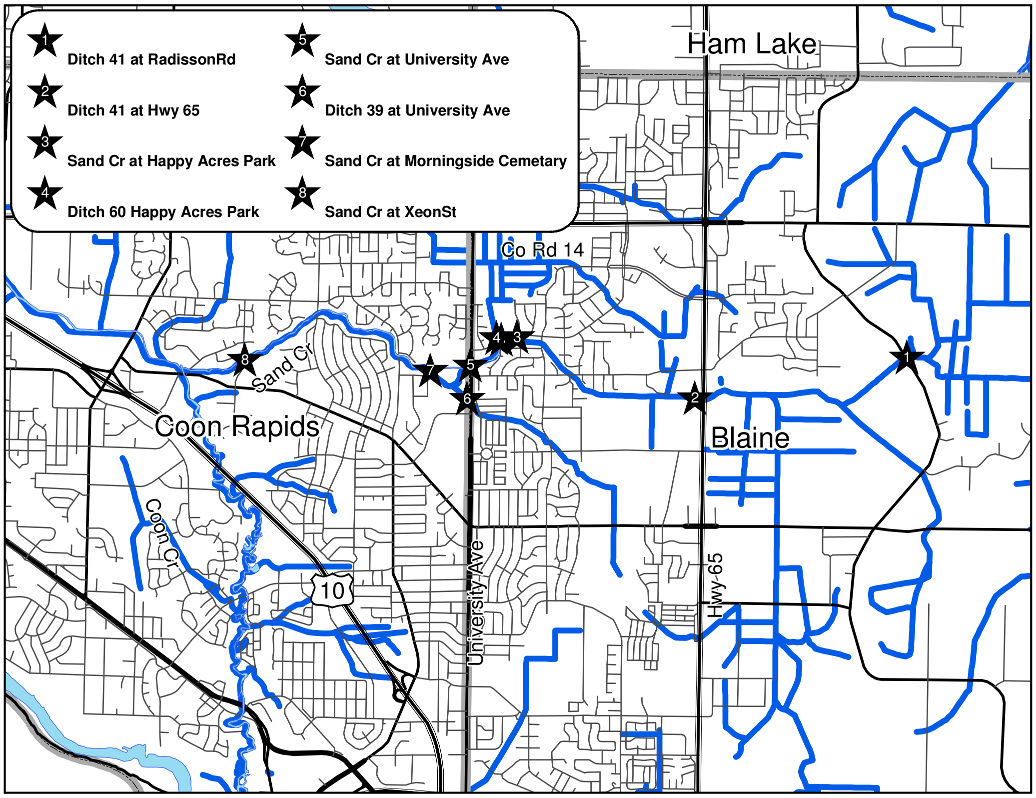
Methods

Sand Creek was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were taken each year; half during baseflow and half following storms. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. In some years smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Eleven water quality parameters were tested. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009, transparency tube measurements were added and are reported to MPCA. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, and E.*coli* bacteria.

During every sampling the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using electronic continuous data logging gauges at the Morningside Cemetery and Xeon Street stream crossing (farthest downstream).

Sand Creek Monitoring Sites



Results and Discussion

This report includes data from all years and all sites to provide a broad overview of Sand Creek's water quality under a variety of conditions. Water quality assessments are based on upstream-to-downstream comparisons, a comparison of baseflow and storm conditions, and an overall assessment compared to other Anoka County streams and state water quality standards. Median results for each parameter at the furthest downstream site (Xeon St.) are tabulated for comparison to state standards as near the confluence as possible. All results for all years are graphed in box and whisker style plots. Following is a summary, including a management discussion:

- Dissolved pollutants, as measured by conductivity and chlorides, are higher in Sand Creek than other streams in Anoka County, including Coon Creek. There is a slight decrease from upstream to downstream. Readings for conductivity are markedly higher during baseflow than storms, indicating pollutants migrating through the shallow water table are a large source to the stream. Chlorides, a likely component of conductivity, were last monitored in 2012 but should be considered for monitoring again. Chlorides can be elevated due to road deicing salts and other factors.

  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 is low in Sand Creek compared to other streams in the region but on occasion it exceeds the State standard of 100 µg/L, particularly during storm flows at the furthest downstream site (Xeon St.).

Phosphorus concentrations do increase upstream to downstream indicating loading is occurring throughout the watershed. Targeting phosphorus in Sand Creek could be an effective management practice to reduce the high phosphorus levels in the lower reaches of Coon Creek after the confluence.

Management discussion: Some stormwater treatment retrofits, including stormwater pond and network of rain gardens installed in 2012 and other practices like them, will be helpful in lowering storm-related phosphorus in Sand Creek. These projects will have a beneficial effect on Coon Creek downstream which has even higher phosphorus.

- <u>Suspended solids and turbidity</u> are low in Sand Creek, with the exception of occasional higher readings during storms further downstream. Median TSS is low compared to the state water quality standard of 30 mg/L.

  Management discussion: Because TSS approaches state standards during storms, and because it flows into Coon Creek, which has high suspended solids concentrations, continued efforts should be made to lower these pollutants in Sand Creek. Projects that target TSS and phosphorus reduction are usually similar and would likely have a large benefit on Coon Creek downstream.

- <u>pH and dissolved oxygen</u> remain within the range considered normal and healthy for streams in this area.
- <u>*E. coli* bacteria</u> are high throughout Sand Creek during storms, and the problem increases downstream. One deviation from the upstream-to-downstream trend it that *E. coli* declines sharply just before Highway 65, presumably due to treatment in ponds just upstream.

  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, and other sources. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we use. It measures the electrical conductivity of water; pure water with no dissolved constituents has zero conductivity. Chlorides are a common cause of high conductivity. The most common chloride salt source locally is road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community, however, it is also noteworthy that Coon Creek is upstream from the drinking water intakes on the Mississippi River for the Twin Cities. Chlorides have not been sampled since 2012.

Sand Creek dissolved pollutant levels are approaching double the level typically found in Anoka County streams, and are consistently higher than Coon Creek main stem levels. Considering all sites for all years under all conditions, median conductivity in Sand Creek is higher than the median for all Anoka County streams (0.794 mS/cm compared to 0.420 mS/cm for the county overall) with the highest levels observed in the upstream portions of the subwatershed.

It's not surprising that Sand Creek, which lies in a suburban area, would have higher dissolved pollutant concentrations than the county-wide median. The county spans rural to urban areas. Sand Creek's upper watershed has an abundance of current and retired sod farms, where a variety of chemicals 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 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), although there is a slight decline in long-term median values moving upstream to downstream. This suggests dissolved pollutant concentrations in all parts of the watershed are similar with upstream portions contributing more. Though each sampling site has large ranges in data during both storm and baseflow conditions, average annual conductivity in Sand Creek does not appear to be rising.

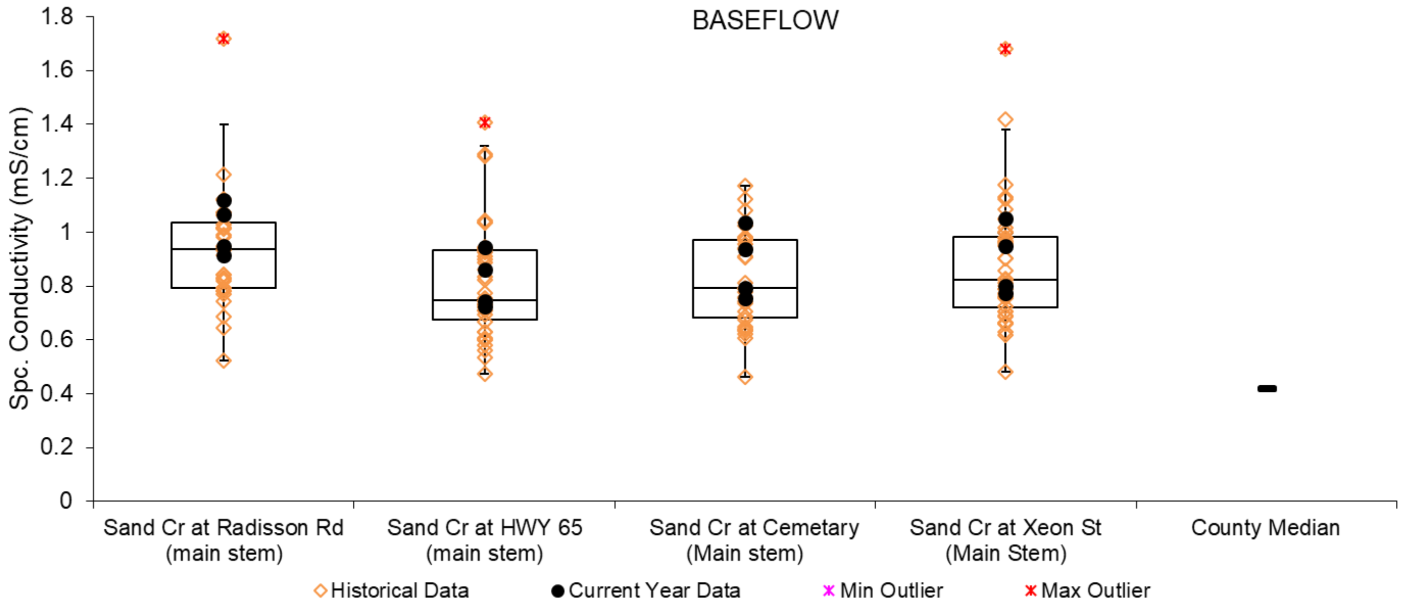
Dissolved pollutants are lower during storms than during baseflow conditions. Dissolved pollutants can easily infiltrate into the shallow groundwater that feeds streams during baseflow, causing continuous high levels of conductivity. If road runoff was the primary dissolved pollutant source, then readings would be higher during storms. When chlorides were monitored at Xeon Street during baseflow the median levels were 18% higher than during storms. 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 should be a high priority.

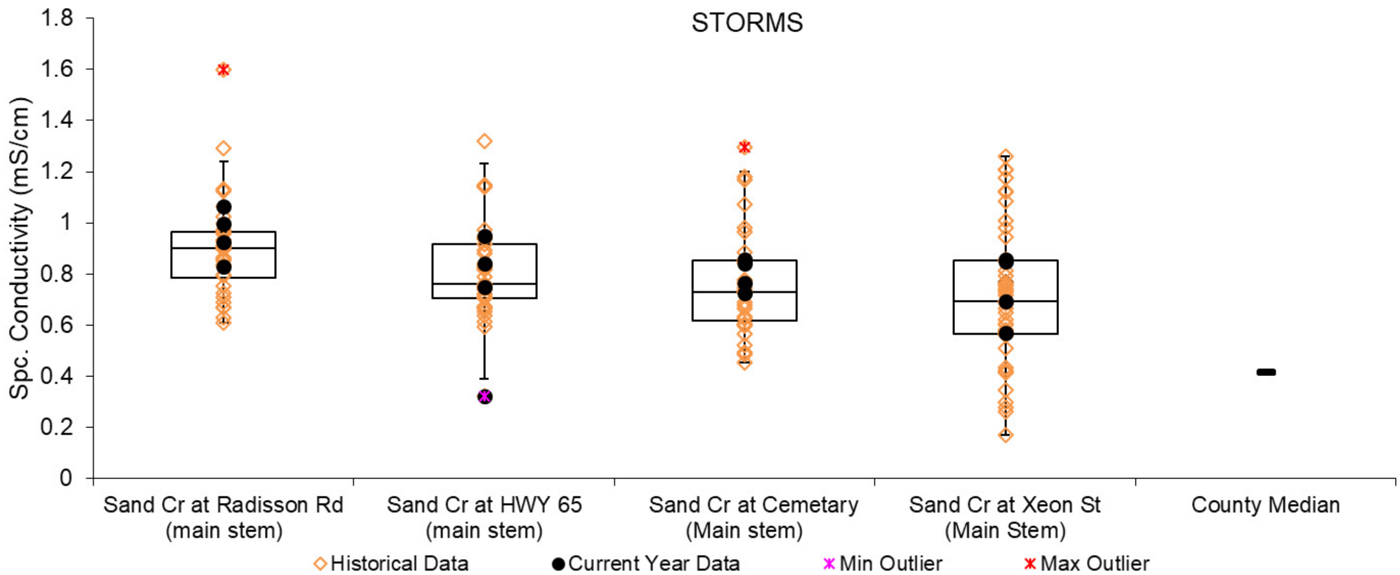
Sand Creek has higher concentrations of dissolved constituents as indicated by conductivity than does Coon Creek. Both creeks were monitored just before they join (Coon Cr at Lions Park and Sand Cr at Xeon). Across all years monitored, Sand Creek's median conductivity is 18% higher than Coon Creek (0.741 vs 0.629 mS/cm) before this junction. Sand Creek's median chlorides when last monitored were 42% higher than Coon Creek (74 vs 52 mg/L).

Median conductivity and chlorides in Sand Creek Data are from Xeon St for conductivity all years through 2017, for chlorides all years through 2012.

	Conductivity (mS/cm)	**Chlorides (mg/L)**	**State Standard**	**N (Cond.)**
Baseflow	0.823	75	Conductivity – none	44
Storms	0.693	63.45		44
All	0.741	71.65	Chlorides 860 mg/L acute, 230 mg/L chronic	88
Occasions > state standard				0

Conductivity at Sand Creek Orange diamonds are historical data from previous years and black circles are 2017 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

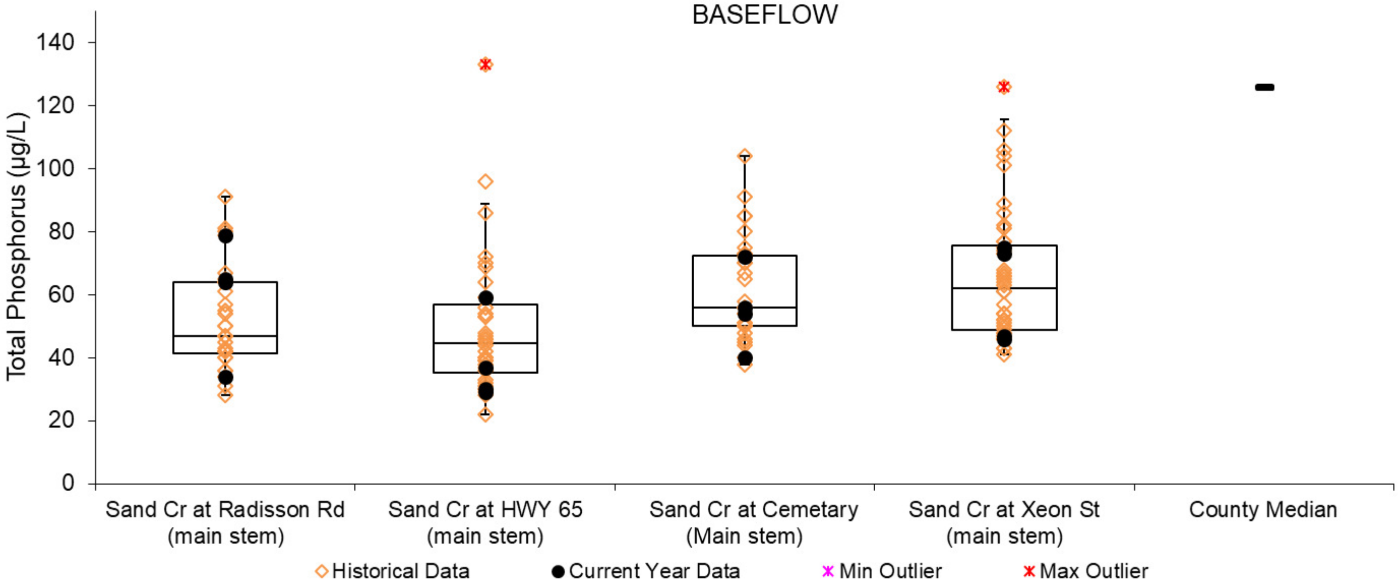
Total phosphorus (TP) is a common nutrient pollutant and is the limiting factor for most algae growth. TP is low in Sand Creek (see table and figures below). Median TP in Sand Creek at Xeon (all years) is 62 µg/L during baseflow and 89 µg/L during storm events. Both are below the median for Anoka County streams (126 µg/L) and below the water quality standard of the MN Pollution Control Agency (100 µg/L).

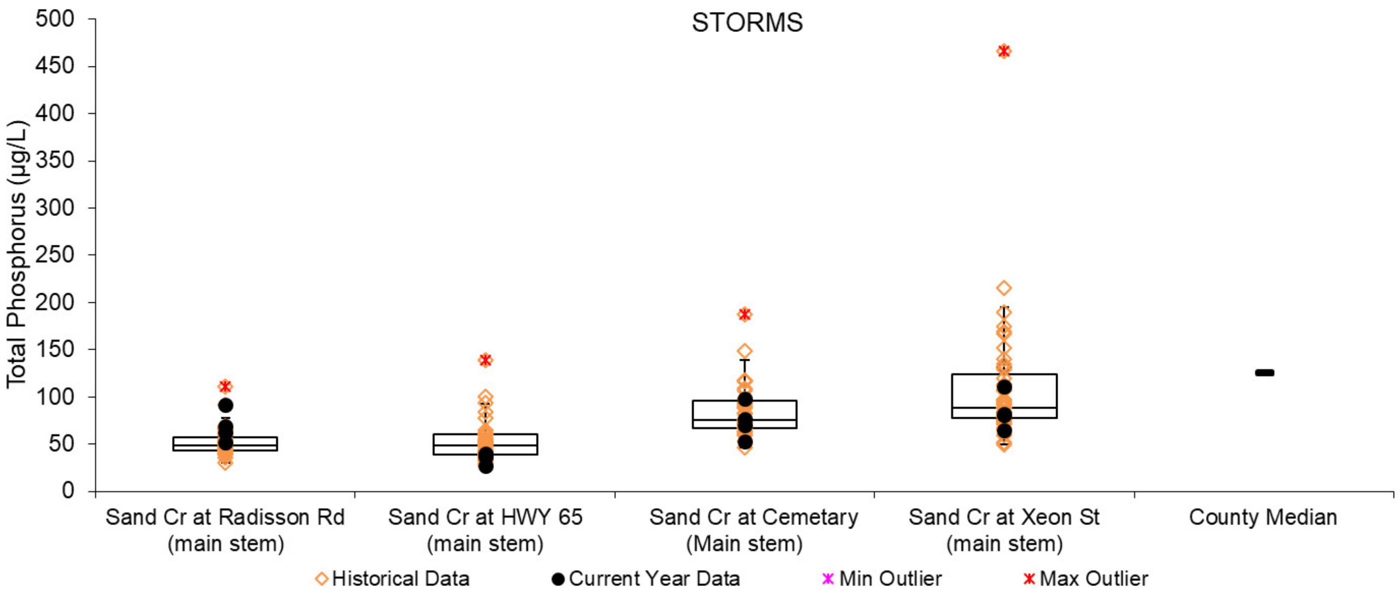
While generally low, Sand Creek phosphorus levels have occasionally exceeded State standards. While the median phosphorus level is below, the stream at Xeon Street exceeds that State standard of 100 µg/L in 37% of storm samples and 11% of the time at baseflow. Phosphorus loading occurs throughout the Sand Creek watershed with median concentrations increasing upstream to downstream during both baseflow and storm flow conditions. Retrofitting stormwater treatment for improved phosphorus capture should continue to be a focus of management throughout the watershed. Decreasing phosphorus in Sand Creek will help reduce the high levels in downstream reaches of Coon Creek.

Median total phosphorus in Sand Creek Data are from Xeon St for all years through 2017.

	Total Phosphorus (µg/L)	State Standard*	N
Baseflow	62	100	44
Storms	89		43
All	77		87
Occasions > state standard			16 (37%) storm 5 (11%) baseflow

Total phosphorus at Sand Creek Orange diamonds are historical data from previous years and black circles are 2017 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 are both measure solid particles in the water. TSS measures these particles by weighing materials filtered out of the water. Turbidity measures the diffraction of a beam of light sent though the water sample and is most sensitive to large particles.

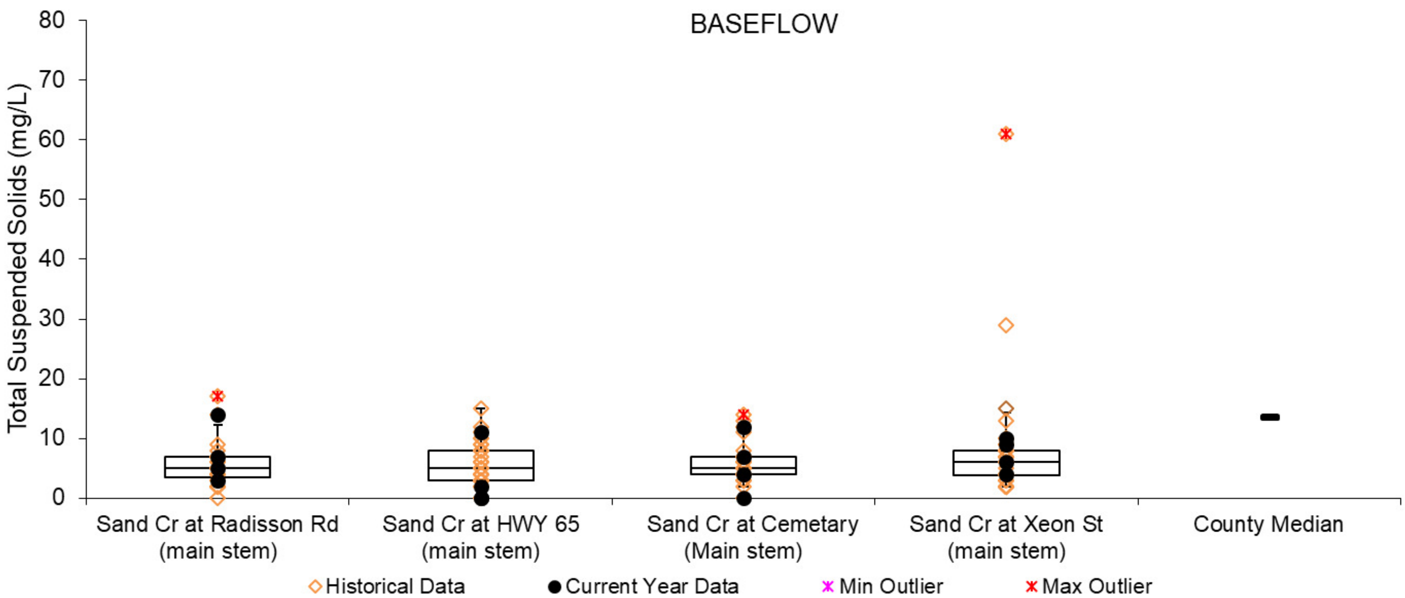
TSS and turbidity are reasonably low in Sand Creek, with the exception of occasional higher readings during storms at Xeon Street (farthest downstream). At Xeon Street, median TSS (all years) during baseflow is 6 mg/L, but it is 12 mg/L during storms. Both are low compared to the State water quality standard of 30 mg/L, but that standard was exceeded in six individual samples (7%) historically. None of these exceedances occurred in 2017.

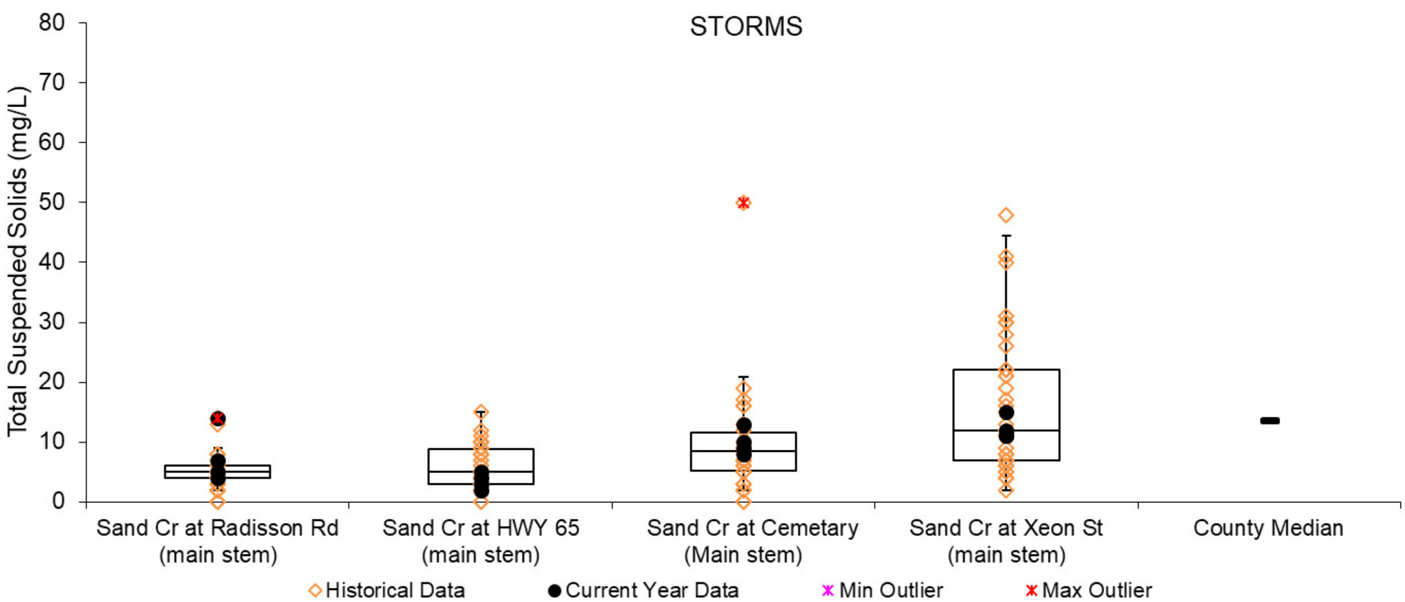
Since it does occasionally approach the water quality standard, and because it flows into Coon Creek which has high suspended solids, efforts should be made to lower these pollutants in Sand Creek. This particulate pollution would likely be reduced through efforts to curb phosphorus loading, which should already be a focus of management.

Median turbidity and suspended solids in Sand Creek Data are from Xeon St for all years through 2017.

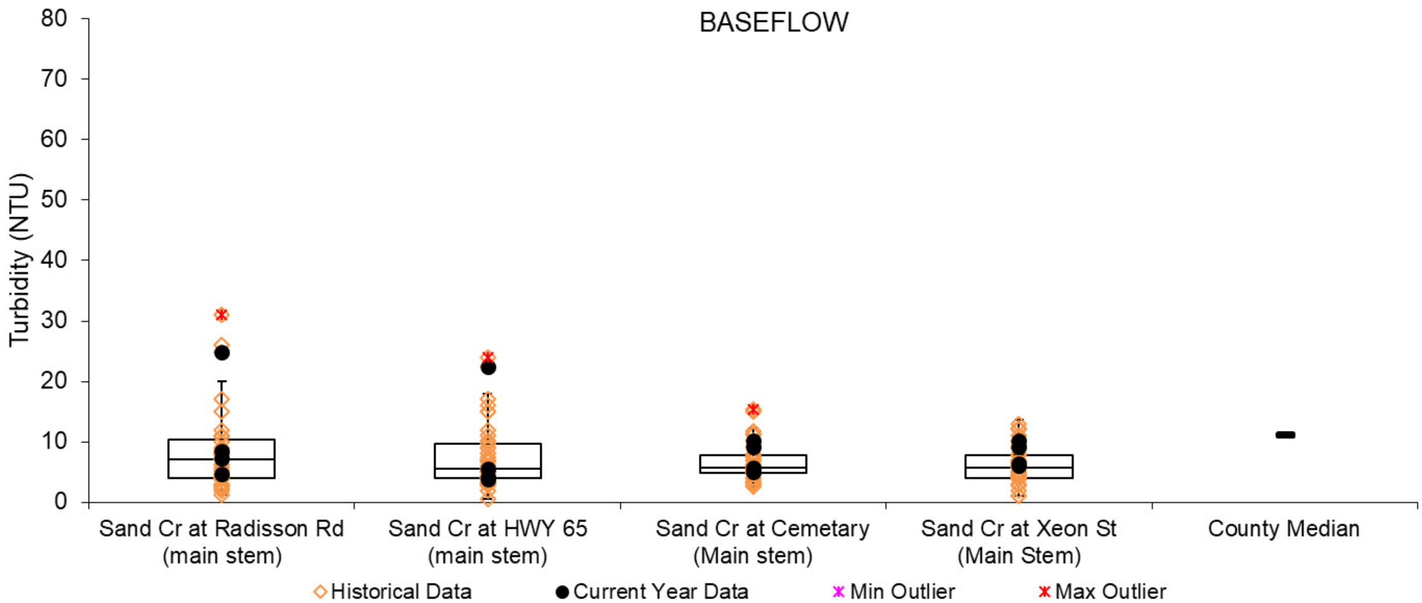
	Turbidity (NTU)	Total Suspended Solids (mg/L)	State Standard	N
Baseflow	5.8	6.0	30 mg/L TSS	44
Storms	12.0	12.0		44
All	8.9	7.5		88
Occasions > state TSS standard				5 (11%) storm 1 (2%) baseflow

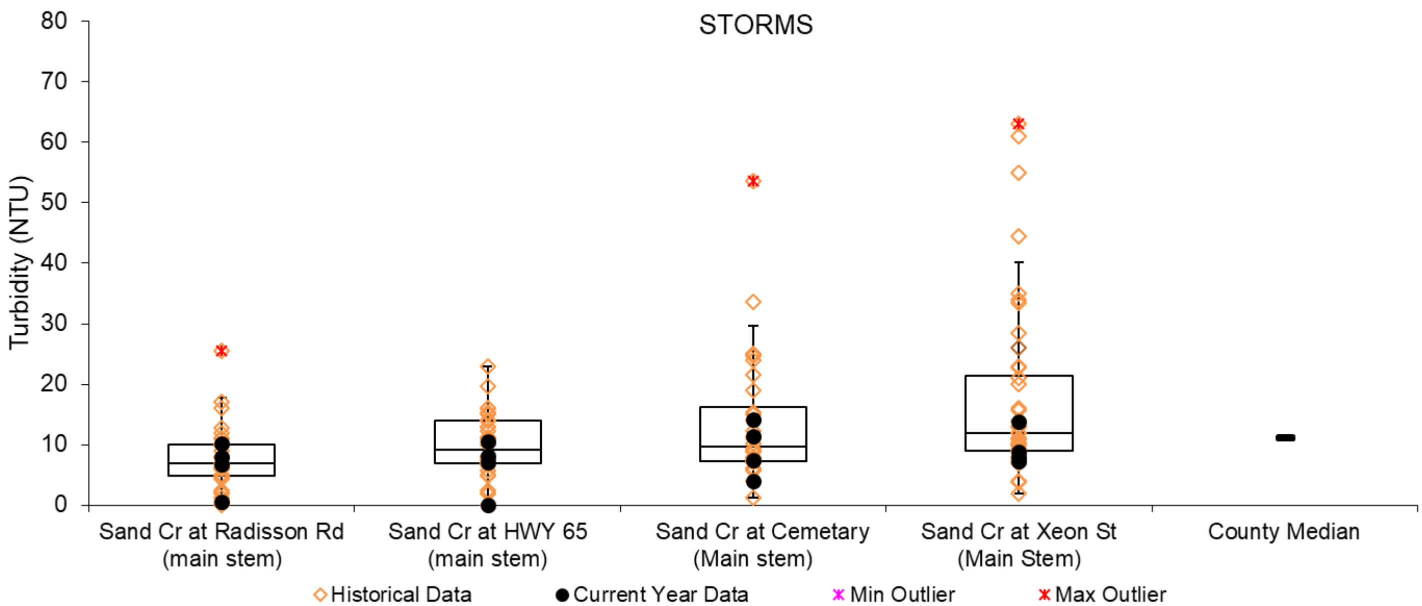
Total suspended solids at Sand Creek Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Sand Creek Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





pH

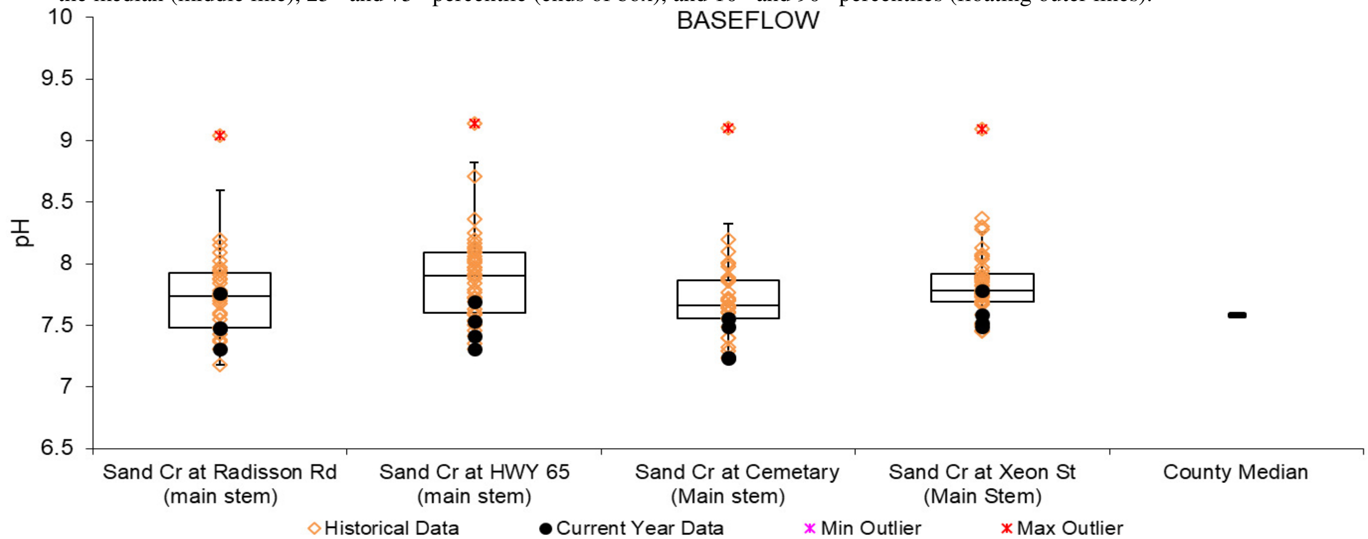
Sand Creek pH remained within the acceptable range at all sites and during all conditions. Similar to Coon Creek, one result from 2014 during baseflow conditions was a high outlier at all sites, and is likely due to a poor calibration of the sampling equipment. The median for all conditions at Xeon was 7.73. The Minnesota Pollution Control Agency water quality standards set a range for pH to remain between 6.5 and 8.5. pH is lower during storms because rainwater has a lower pH.

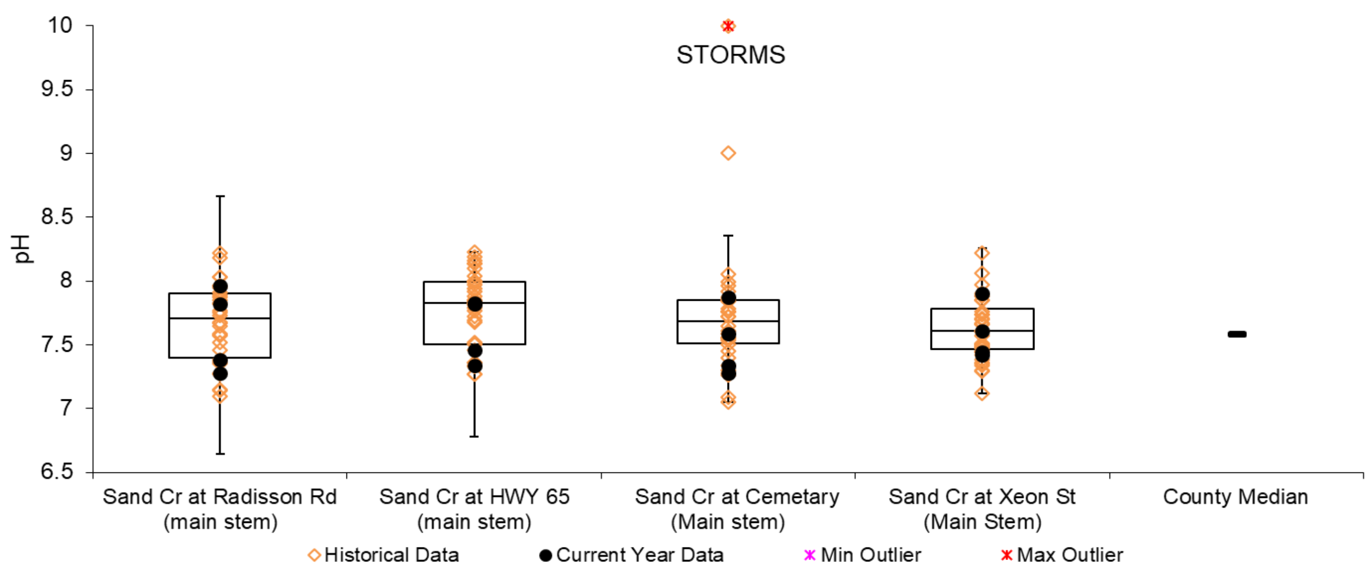
Median pH in Sand Creek Data are from Xeon St for all years through 2017.

	pH	State Standard	N
Baseflow	7.78	6.5-8.5	39
Storms	7.60		38
All	7.73		77
Occasions outside state standard			1*

*Questionable result

pH at Sand Creek Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





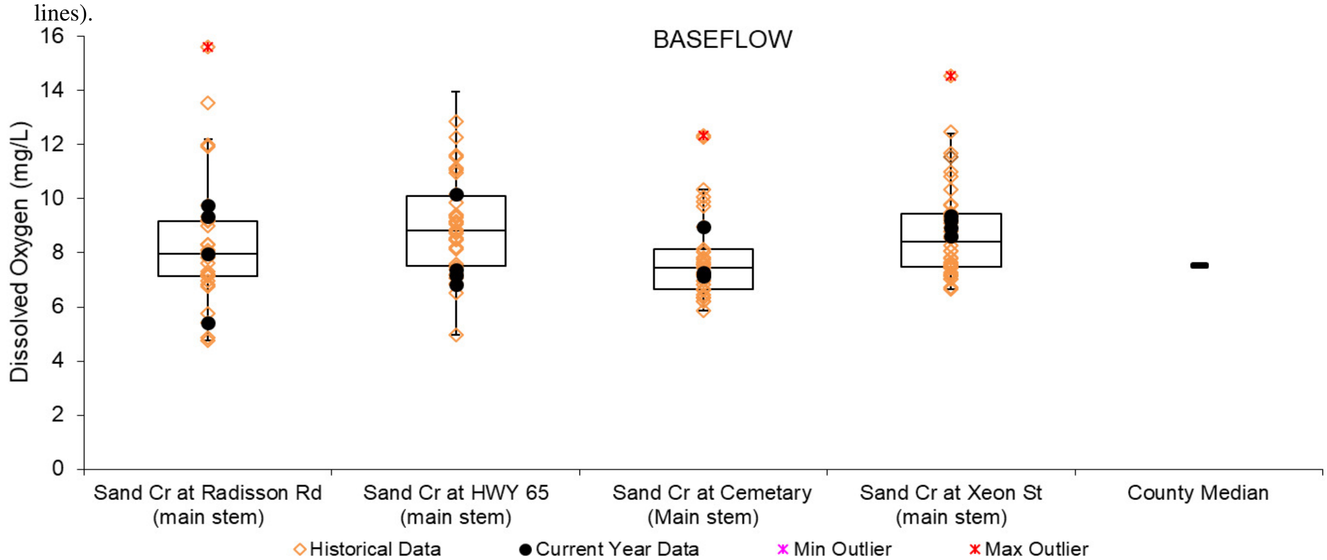
Dissolved Oxygen

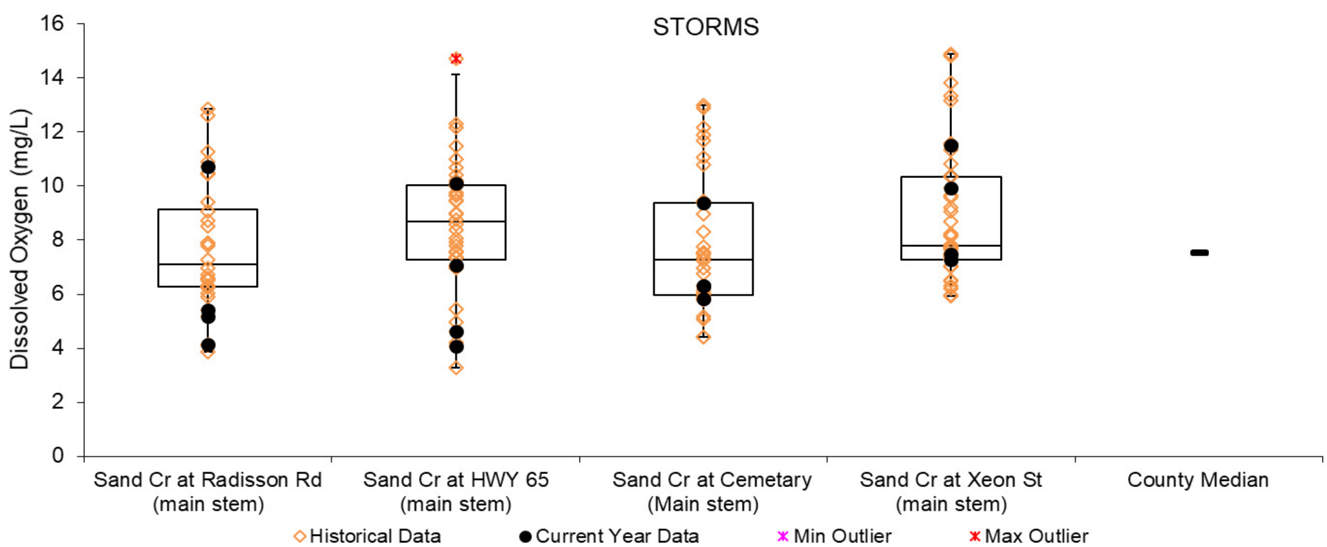
Dissolved oxygen (DO) is essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO falls below 5 mg/L. Low DO can be a result of organic pollution, the decomposition of which consumes oxygen. Dissolved oxygen is always high in lower reaches, and has never been recorded below 5 mg/L at Xeon St. However, on ten occasions across all monitored years at other upstream sites DO dropped below 5 mg/L. Overall, there are no significant management concerns about dissolved oxygen levels in Sand Creek, but it will continue to be monitored.

Median dissolved oxygen in Sand Creek. Data are from Xeon St for all years through 2017.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.41	5 mg/L daily minimum	40
Storms	7.78		44
All	8.10		84
Occasions <5 mg/L			0

Dissolved Oxygen at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2017 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 bacteria found in the feces of warm-blooded animals. *E. coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets *E. coli* standards for contact recreation (swimming, etc.). A stream is designated as "impaired" if 10% of measurements in a calendar month are >1260 colonies in the units of most probable number (MPN) per 100 milliliters of water, or if the geometric mean of five samples taken within 30 days is greater than 126 MPN.

Sampling by the MPCA has found Sand Creek is exceeds State standards for *E. coli* bacteria. Data collected by local agencies to date are not sufficient to re-calculate if the MPCA standards are met or exceeded. We took samples throughout the summer, often with only 1-2 samples 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. But other examinations of the data presented below verify that *E. coli* abundance is high.

During all conditions, *E. coli* was similarly high at all monitoring sites except the site at Highway 65. There was consistently a sharp decrease in *E. coli* between Radisson Road and Highway 65, and a sharp return to high levels by Morningside Memorial Gardens Cemetery. Presumably, this is due to treatment by ponds just upstream of Highway 65.

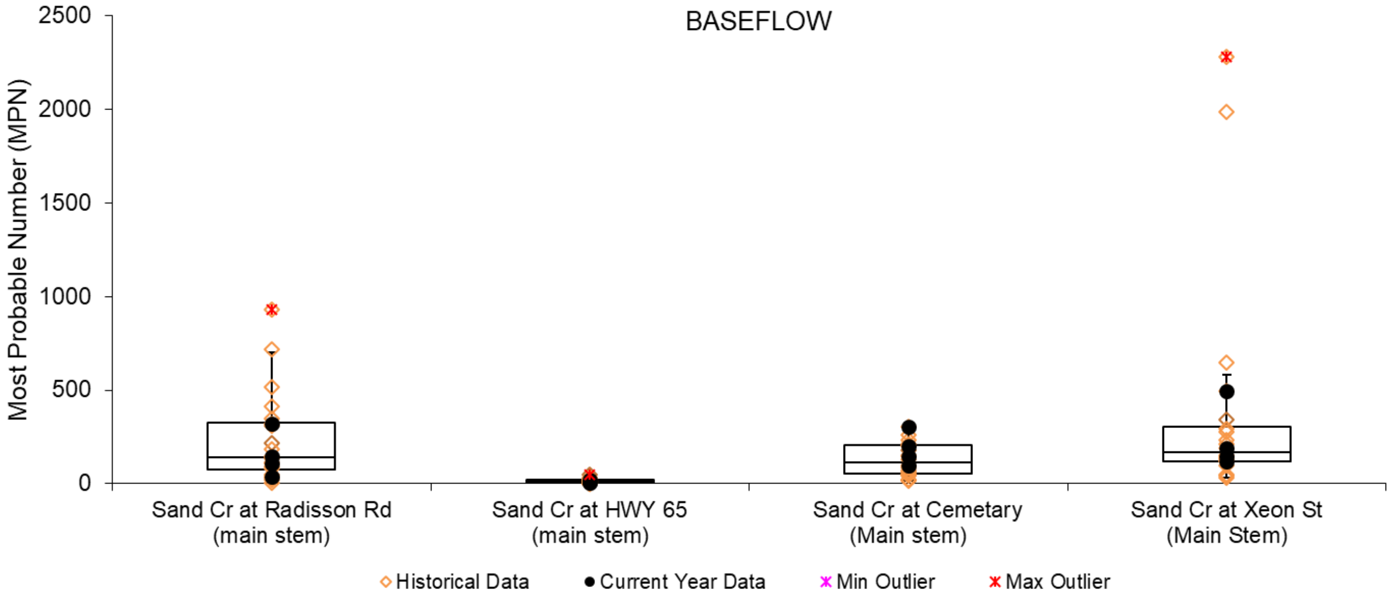
During storms, *E. coli* was significantly higher and more variable, and there is an increase from upstream to downstream (Morningside Cemetery site median= 339 MPN, Xeon Street site median= 609 MPN). As with baseflow conditions, there was a sharp decline between Radisson Road and Highway 65 with the long term median dropping from 345 to 43 MPN for those two sites. The median increases back up to 339 MPN at the next site downstream - Morningside Cemetery.

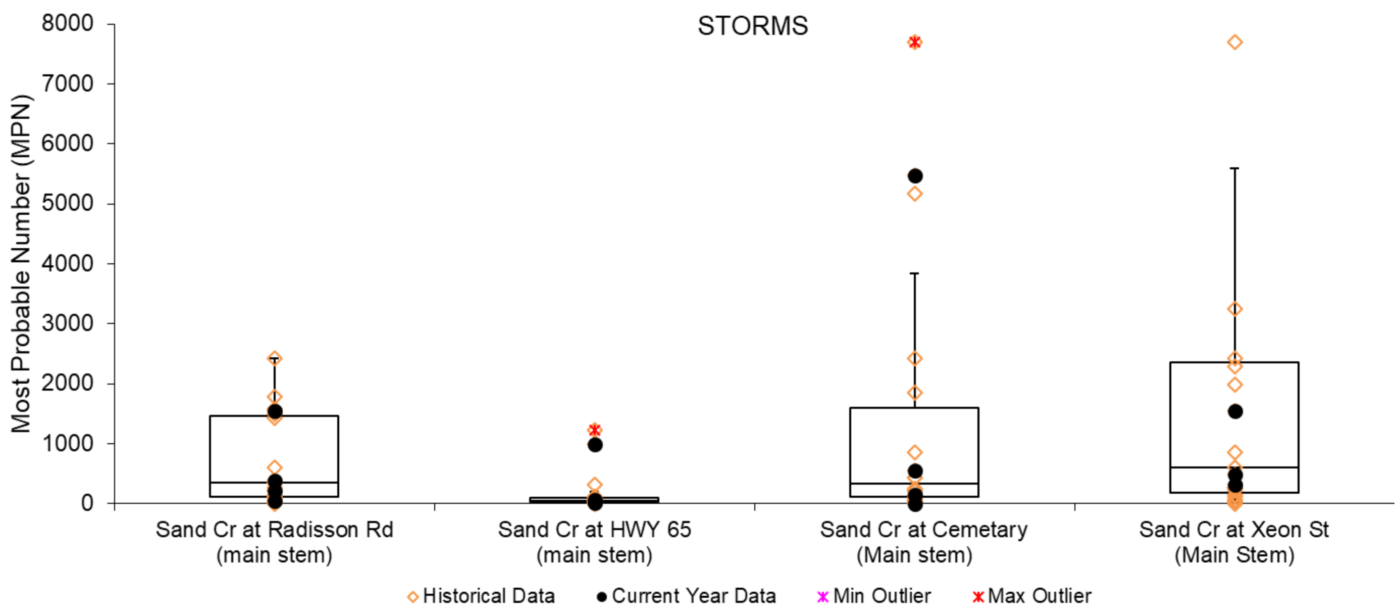
Aside from the sharp decline in *E. coli* near Highway 65, levels are generally high in Sand Creek and should remain a focus of management effort. Further study is needed to determine the cause of low *E. coli* at Highway 65 given that the sites upstream and downstream have much higher *E. coli*. Management efforts should consider focusing between Highway 65 and Morningside Memorial Gardens where a large increase occurs.

Median *E. coli* in Sand Creek. Data are from Xeon St. for all years through 2017.

	***E. coli* (MPN)**	**State Standard**	**N**
Baseflow	88.5	Monthly Geometric Mean >126	20
Storms	609		20
All	127.4		40
Occasions >126 MPN **Occasions >1260 MPN**		Monthly 10% average >1260	14 (70%) baseflow, 15 (75%) storm 2 (10%) baseflow, 8 (40%) storm

***E. coli* at Sand Creek.** Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating lines).





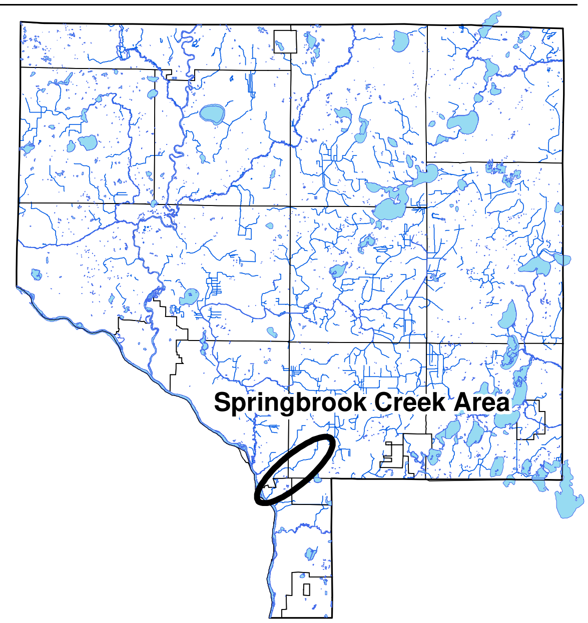
Stream Water Quality Monitoring – Grab Sampling

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-**2017**
Springbrook at 85th Avenue 2013-**2017**
Springbrook at 79th Way 2012-**2017**



Other sites around the Springbrook Nature Center were monitored on a few occasions in the early 2000s but are not included in this report.

Background

Springbrook is a small waterway draining an urbanized and highly modified subwatershed. The watershed includes portions of the Cities of Blaine, Coon Rapids, Spring Lake Park and Fridley. Several tributaries and 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 support came from a MN Pollution Control Agency grant and the City of Fridley. During that effort, several projects to better treat stormwater and rehabilitate the nature center impoundment were initiated. Water quality monitoring at that time produced little data, but enough to indicate sizable water quality and hydrology problems existed. More recently, the Coon Creek Watershed District has renewed a monitoring program and is planning water quality improvement projects.

Springbrook Creek is listed as "impaired" by the MN Pollution Control Agency for excessive *E. coli* bacteria and poor invertebrate biota. New standards (Tiered Aquatic Life Standards) currently under development will likely take into consideration the fact that the creek is a public ditch and therefore will likely lower aquatic life expectations, at least in some reaches. While recent monitoring Data are insufficient to officially assess Springbrook for other impairments, the data to date suggest that other impairment designations are possible in the future.

Methods

Springbrook Creek was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were taken each year; half during baseflow and half following storms. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. In some years smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Eleven water quality parameters were tested. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009, transparency tube measurements were added and are reported to MPCA. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, and E.*coli* bacteria.

During every sampling event, the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using an electronic continuous data logging device at 79th Way, shortly before the outlet to the Mississippi River.

Results and Discussion

Springbrook Creek has some prominent water quality concerns. While it is currently listed as impaired by the State for *E. coli* bacteria and invertebrate biota, monitoring data suggests that other impairments exist. Chlorides, phosphorus, and suspended solids all approach or exceed state standards at least occasionally.

Following is a parameter-by-parameter summary and management discussion:

- Dissolved pollutants, as measured by conductivity and chlorides, are high in Springbrook Creek. Conductivity has reached four times the median for Anoka County streams in past years, while chlorides have reached nine times the county median when measured in past years. The long-term conductivity median is more than double that of all streams Anoka County-wide. Both parameters are high during storms and baseflow conditions, but consistently higher conductivity is recorded during baseflow. On one of eight past monitoring occasions the state chronic standard for chlorides was exceeded.

  Management discussion: Dissolved pollutants enter the stream both directly through surface runoff and also by infiltrating into the shallow groundwater that feeds the stream during baseflow. A variety of sources appear to be likely, including road deicing salts and road runoff. Preventing their release into the environment is important because they are not easily removed.

- Phosphorus is moderate to high in Springbrook Creek. Phosphorus is highest during storm events and lower during baseflow. During baseflow, phosphorus concentrations decrease from upstream to downstream, indicating effective removal in wetlands and stormwater treatment practices. During storm flows, it appears these practices are overwhelmed, and phosphorus levels do not decrease from upstream to downstream. Storm flow samples frequently exceed State standards, but this stream has not yet been designated as "impaired" though a TMDL for TP has been established to address the aquatic life impairments.

  Management discussion: Additional treatment within the stormwater conveyance system is suggested to help reduce a phosphorus below State water quality standards and prevent a future "impairment" designation. This will also help reduce the loading into the Mississippi River.

- Suspended solids and turbidity are quite low in Springbrook during baseflow, but increase moving downstream during storms.

  Management discussion: Additional treatment within the stormwater conveyance system will help reduce suspended solids, which will in turn reduce storm flow phosphorus concentrations.

- pH and dissolved oxygen are with the range considered normal and healthy for streams in this area.

- *E. coli* bacteria are high in Springbrook Creek during storm events.

  Management discussion: Because *E. coli* is pervasive in the environment 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 and chlorides are measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial sources, agricultural chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we use. It measures the electrical conductivity of water; pure water with no dissolved constituents has zero conductivity. Chloride monitoring measures for chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community; however, it is also noteworthy that Springbrook Creek discharges into the Mississippi River just upstream from drinking water intakes for the Twin Cities.

Springbrook dissolved pollutant levels are multi-fold higher than the concentrations typically found in Anoka County streams and approaching levels that impact stream biota. The long-term median conductivity in Springbrook at 79th Way is 0.920 mS/cm, more than double the median for all Anoka County streams of 0.420 mS/cm. Median conductivity at 79th Way (all years) was high during storm events (0.863 mS/cm) and even higher during baseflow conditions (1.013 mS/cm).

Chlorides, when sampled, were nine times higher than the average of other Anoka County streams. The Springbrook median for chlorides at 79th Way (all years) was 159 mg/L compared to 17 mg/L for other Anoka County streams. Median chlorides during storms (216 mg/L) 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.

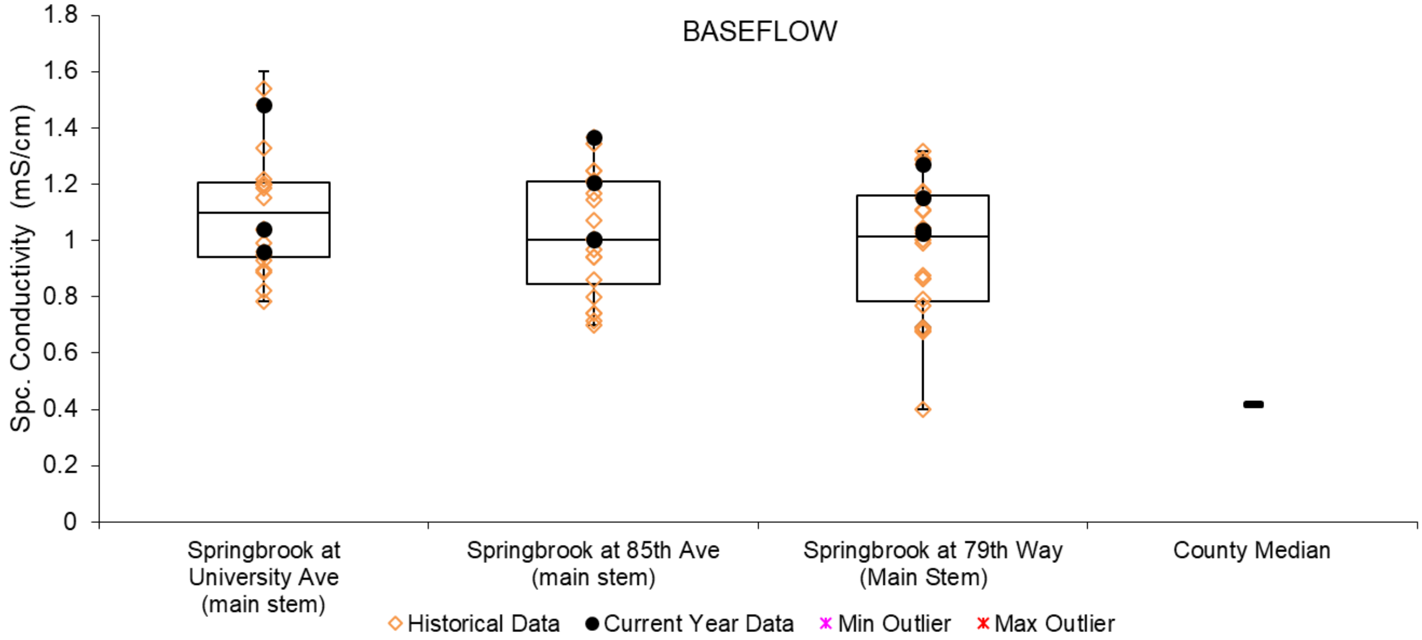
Springbrook's high dissolved pollutants are lower during storm flows, suggesting that the local shallow groundwater is a source. Road deicing salts are an often-cited contributor when similar conditions are found elsewhere in the region. Greater road densities and a long history of road salting contribute to high chlorides. Chlorides are persistent in the environment and not effectively broken down by stormwater treatment or time. They migrate into the shallow groundwater that feeds the stream during baseflow. Still, during storm flows Springbrook also carries high concentrations of dissolved pollutants, suggesting that runoff from impervious surfaces directly to the stream is also problematic.

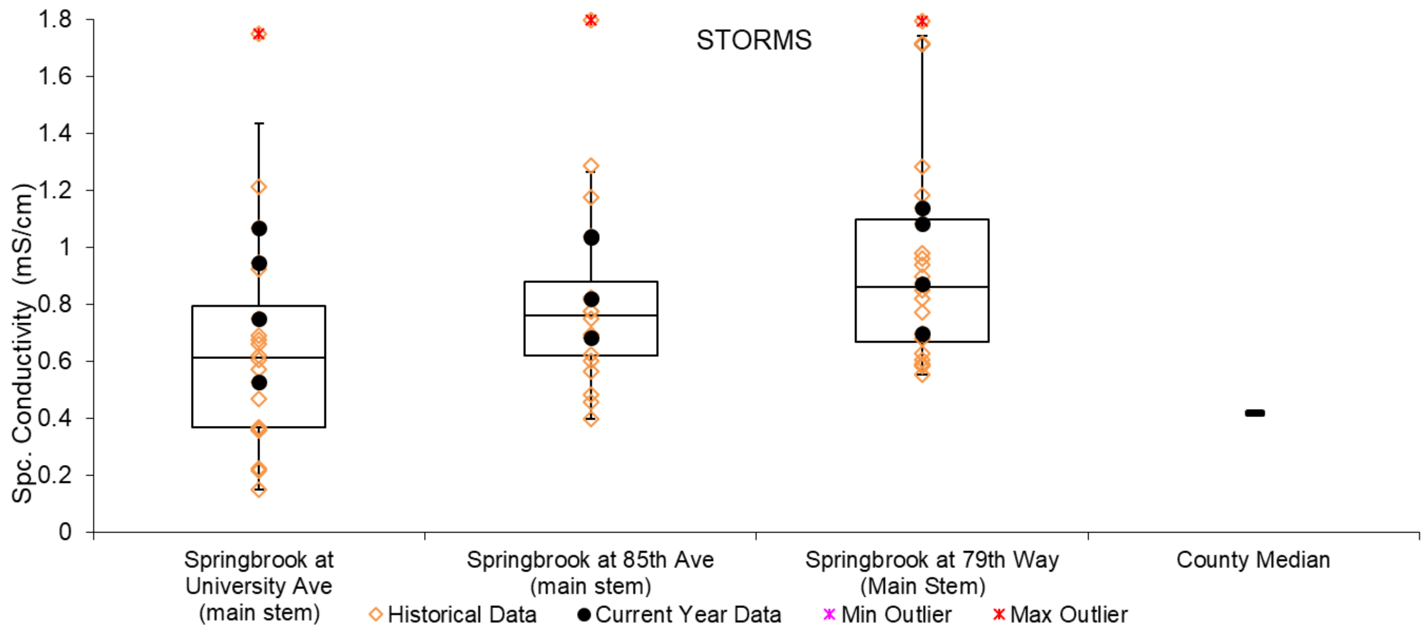
Dissolved pollutants are especially difficult to manage once in the environment. They are not removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also risk contaminating groundwater. Filtration practices with specialized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

Median conductivity and chlorides in Springbrook Creek. Data are from 79th Way for conductivity all years through 2017, for chlorides all years through 2012.

	Conductivity (mS/cm)	Chlorides (mg/L)	State Standard	N
Baseflow	1.013	129	Conductivity – none Chlorides 860 mg/L acute, 230 mg/L chronic	24
Storms	0.863	216		24
All	0.920	159		48
Occasions exceeding standard- Chloride				0

Conductivity at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2017 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 and is the limiting factor for most algae growth. Springbrook Creek often exceeds, but does not grossly exceed, the State water quality standard of 100 µg/L during stormflows at all sites and during baseflow conditions in the upstream sites. Baseflow phosphorus was lower than during storms.

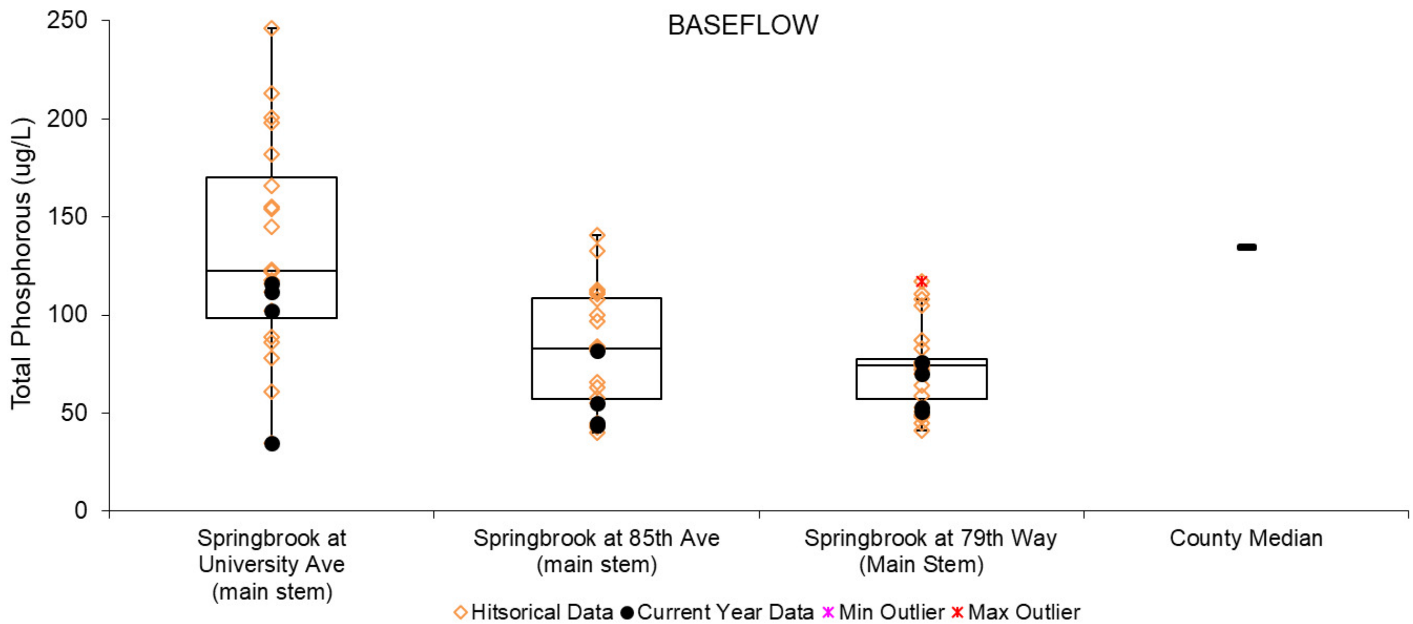
It is interesting to note that there was a marked decrease in baseflow total phosphorus moving from upstream to downstream. Long-term median concentrations at the three sites were 122.5, 83, and 74.5 µg/L respectively. This suggests that water quality projects and practices are doing a good job of removing phosphorus from the system throughout the watershed. A likely treatment source is the large wetland complex of the Springbrook Nature Center, although a decrease is also occurring between the two sites prior. Overall, the system is doing a decent job of treating baseflow total phosphorus concentrations to levels below state standards.

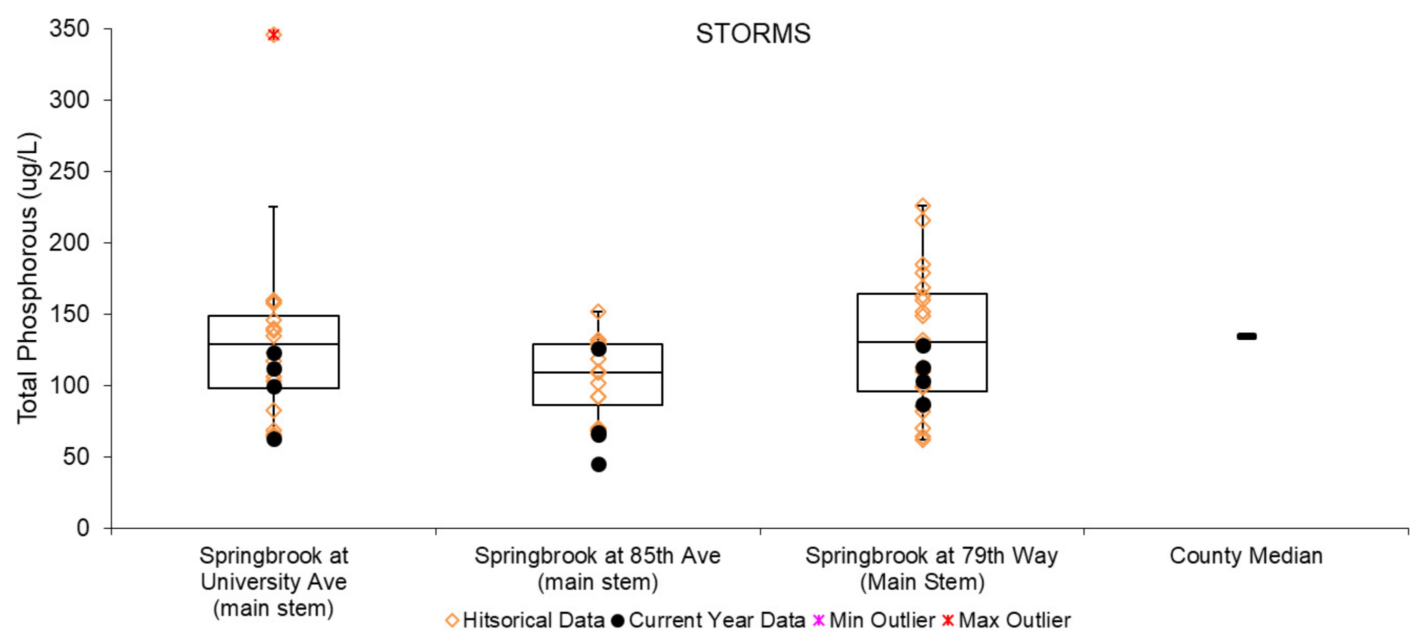
During storms, however, there was no decrease in total phosphorus concentrations moving upstream to downstream. Generally, it appears that the nature center wetlands and other practices are undersized or overwhelmed by the volume of water or pollutants produced by the watershed. Adding additional treatment capacity is advised, but the limited available space can make this a challenge.

Median total phosphorus in Springbrook Creek. Data are from 79th Way for all years through 2017.

	Total Phosphorus (µg/L)	State Standard	N
Baseflow	75	100	24
Storms	120.5		24
All	86.5		48
Occasions > state standard			4 (17%) Baseflow 16 (67%) storm

Total phosphorus at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2017 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 most sensitive to large particles. Suspended solids are important because they carry other pollutants, affect water appearance and clarity, and can harm stream biota.

TSS and turbidity in Springbrook Creek were both low during baseflow and higher during storms. The highest observed TSS in 2017 was 71 mg/L at 79th Way. TSS exceeded the 30 mg/L State standard at 79th Way four times since 2012, and all were during storms.

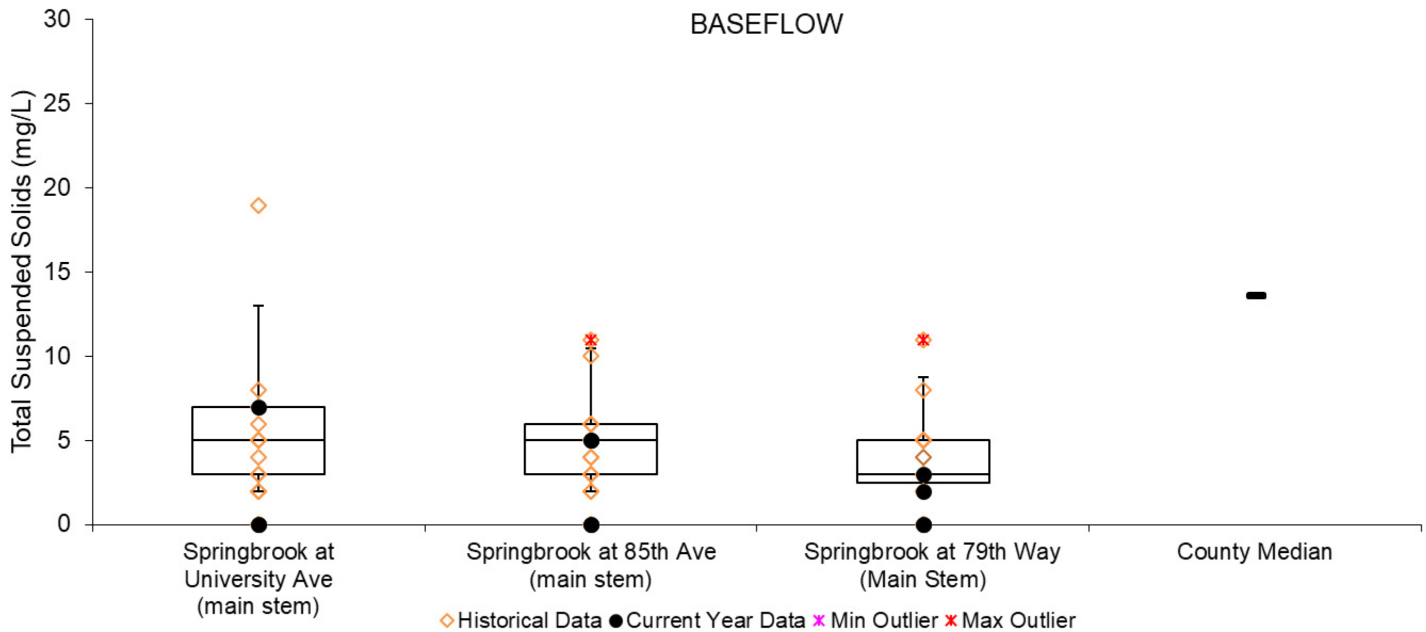
Based on long-term median concentrations, TSS does not increase moving upstream to downstream during baseflow conditions but does during storm flows. The long-term (all years) median TSS concentrations moving upstream to downstream were 3, 9, and 16 mg/L, respectively. The similarity of TSS among sites during baseflow suggests that internal loading of the system through bank erosion and bed suspension is minimal. The largest likely contributor of TSS in Springbrook Creek is solids transported by stormwater conveyances from impervious surfaces.

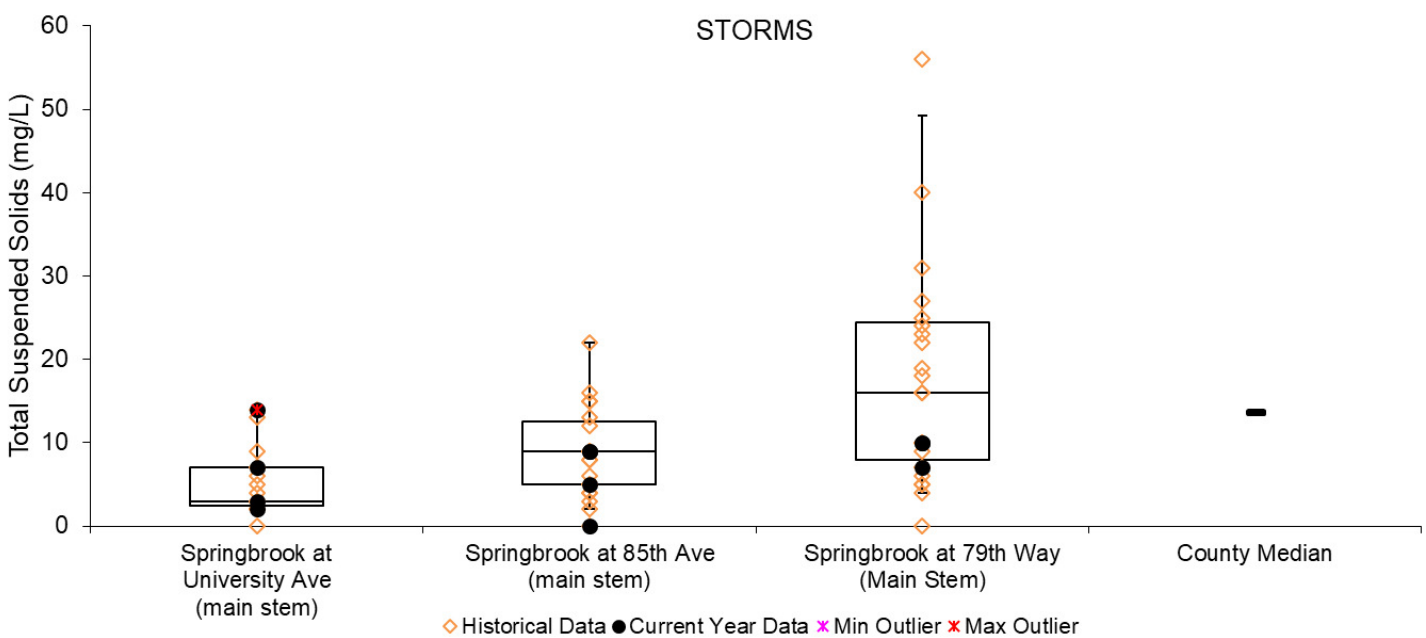
During baseflow conditions, turbidity is similarly low, only exceeding 5 NTU twice at 79th Way since 2012. Turbidity does however increase during storm flows and follows the same trend of increasing downstream. The long-term median storm flow turbidity at each site is 5.8, 10.6, and 14 NTU respectively from upstream to downstream. This indicates the same pollutant loading of downstream stormwater as TSS indicated.

Median turbidity and suspended solids in Springbrook Creek. Data are from 79th Way for all years through 2017.

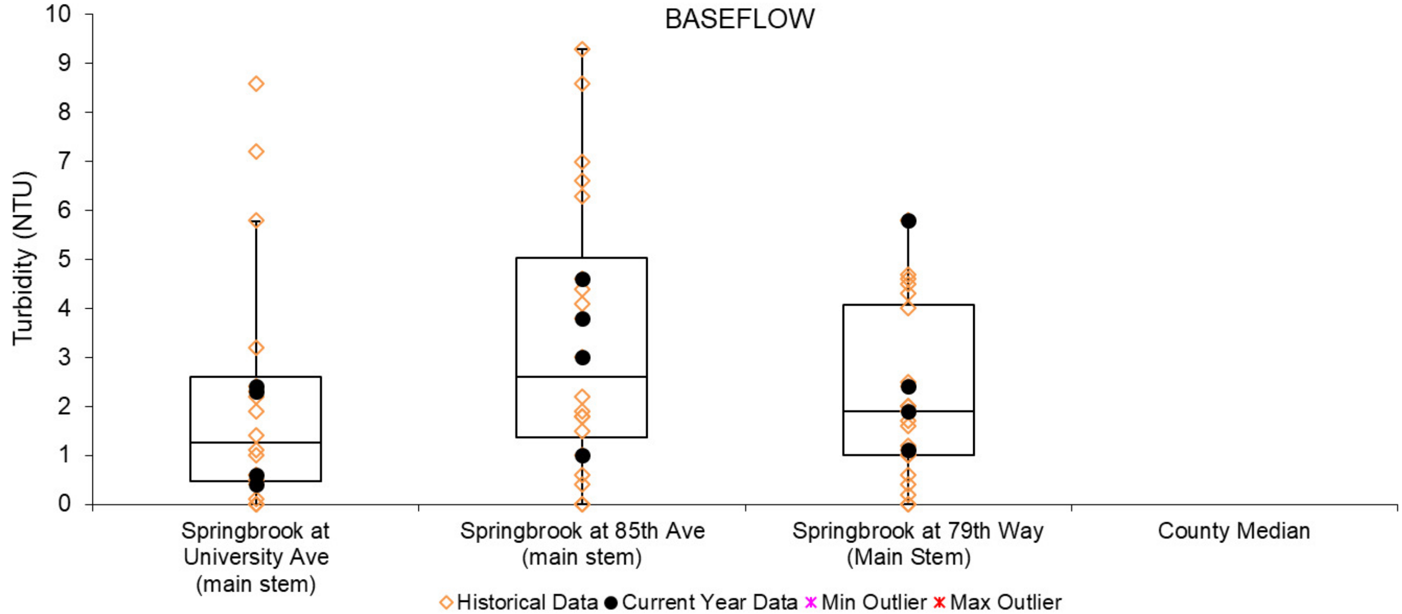
	Turbidity (NTU)	Total Suspended Solids (mg/L)	State Standard	N
Baseflow	1.9	3	30 mg/L TSS	24
Storms	14	16		24
All	4.65	6		40
Occasions > state TSS standard				0 baseflow 4 (17%) storm

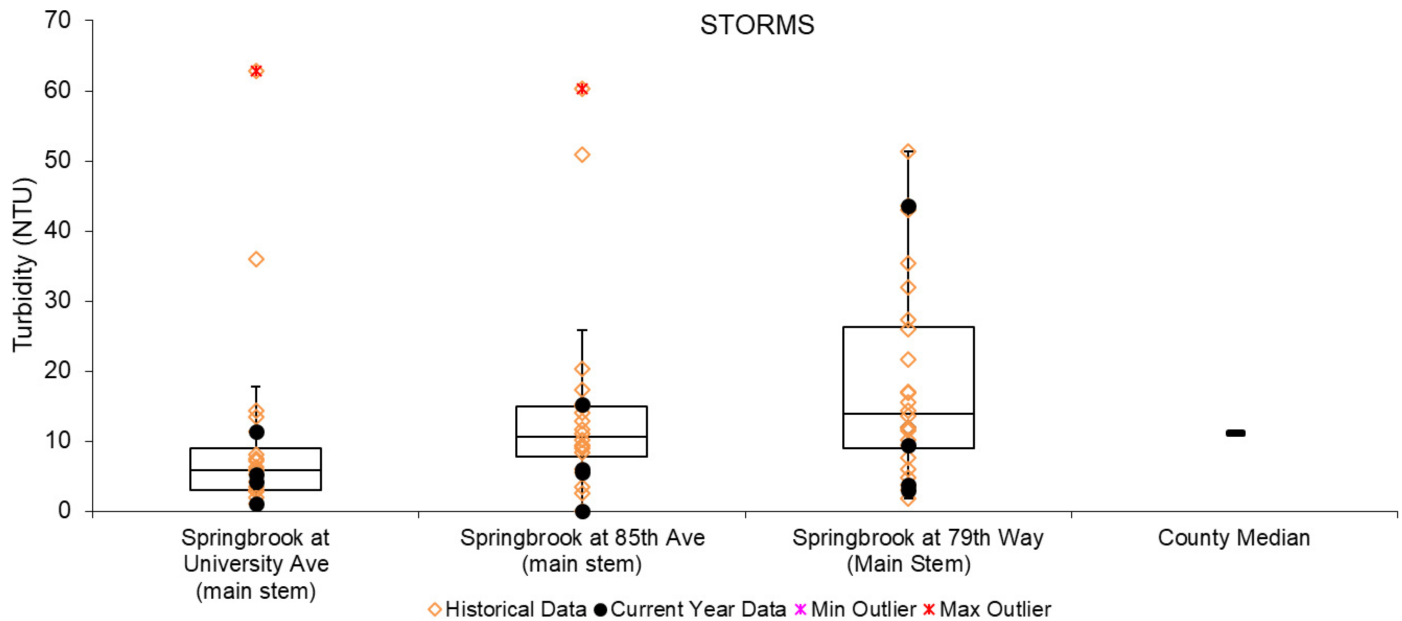
Total suspended solids at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





pH

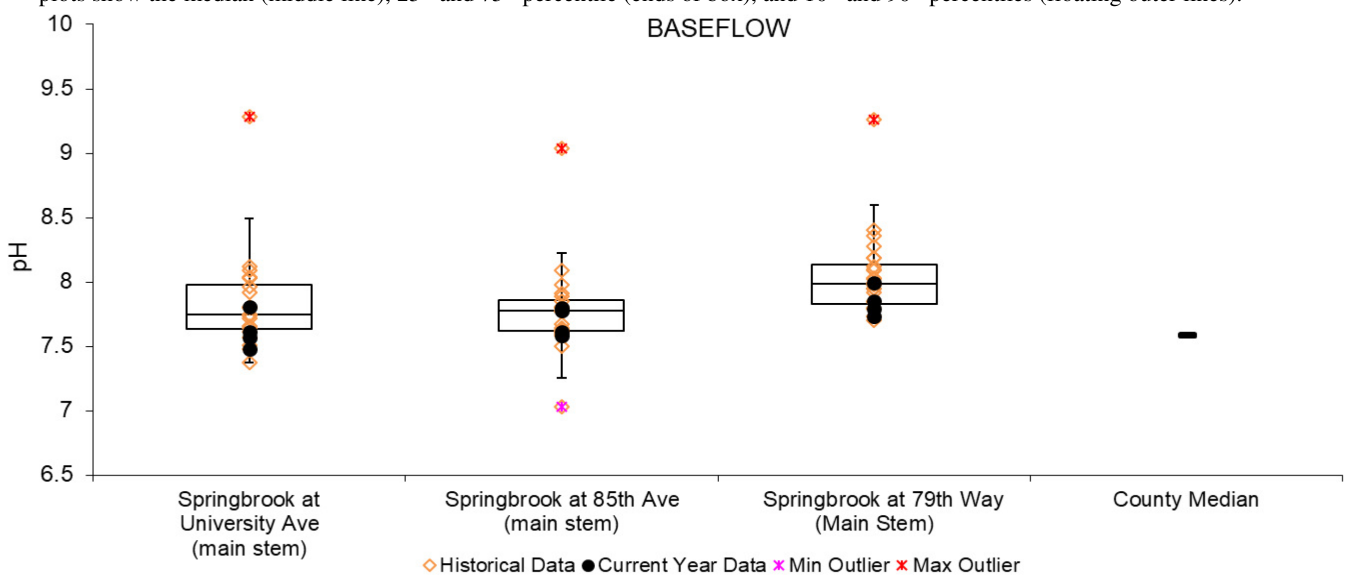
Springbrook Creek maintains healthy pH levels within the State water quality standard range of 6.5-8.5. Two exceedances of the acceptable range have occurred, but neither is a management concern. One of those exceedances was in September 2017 and likely attributable to a bad sensor calibration given that all sites monitored that day with the same instrument were far above their normal range.

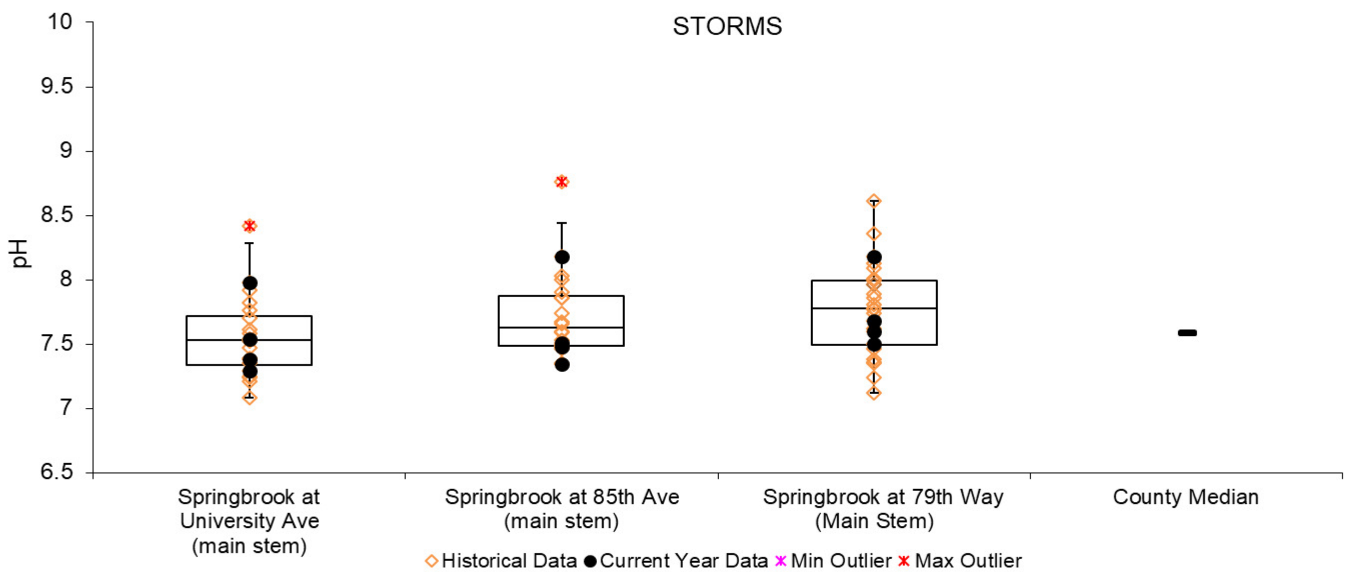
Median pH in Springbrook Creek. Data are from 79th Way for all years through 2017.

	pH	State Standard	N
Baseflow	8.0	6.5-8.5	24
Storms	7.78		24
All	7.91		48
Occasions outside state standard			2*

**one result questionable*

pH at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





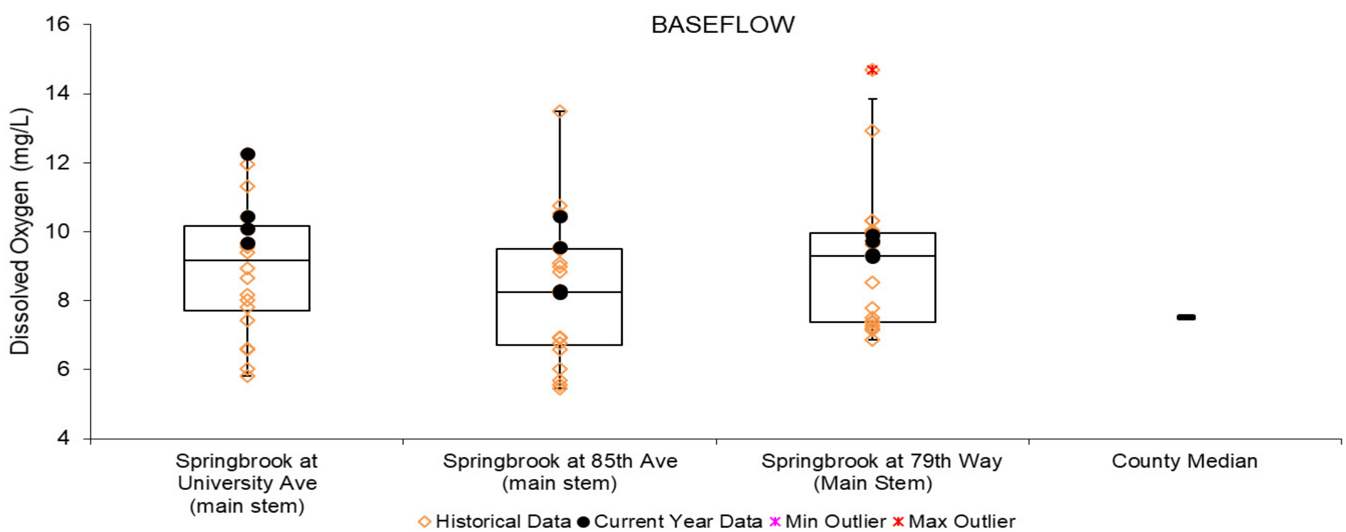
Dissolved Oxygen

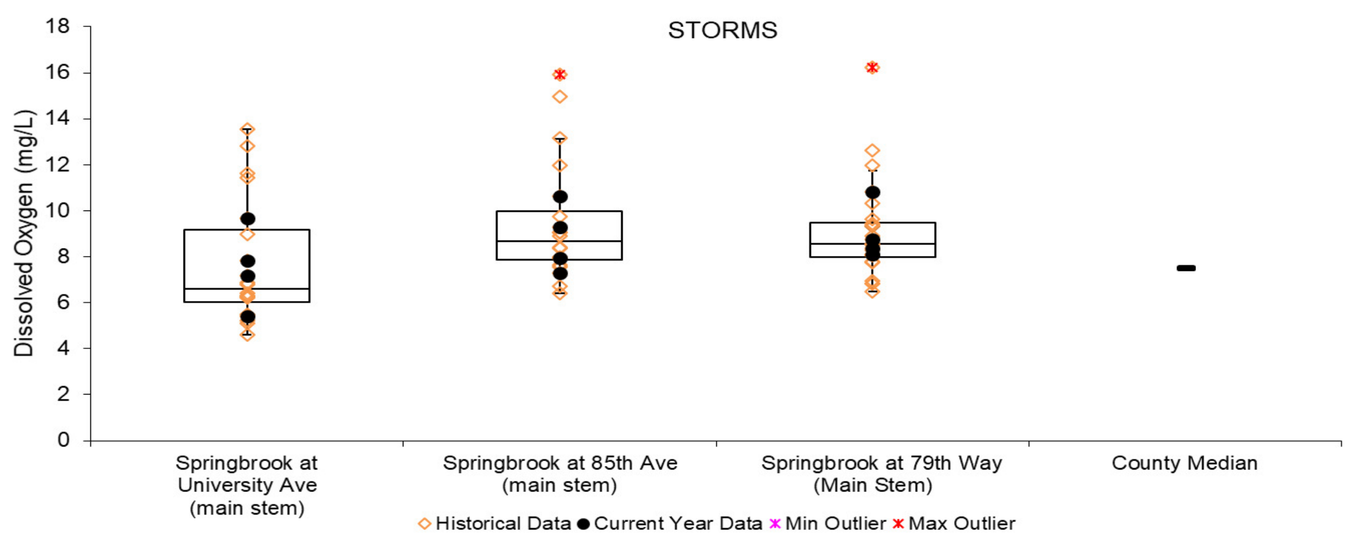
Dissolved oxygen (DO) is essential for aquatic life. Fish, invertebrates, and other aquatic life suffer if DO falls below the state standard of 5 mg/L. Low DO can be the result of organic pollution, the decomposition of which consumes oxygen. DO concentrations in Springbrook Creek were generally high and in a healthy range. There have been a few instances since 2012 at the furthest upstream site (University Ave.) that have been below or near the standard, but DO is not a concern in general in Springbrook Creek.

Median dissolved oxygen in Springbrook Creek. Data are from 79th Way for all years through 2017.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	9.29	5 mg/L daily minimum	22
Storms	8.56		24
All	8.66		46
Occasions <5 mg/L			0

Dissolved Oxygen at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2017 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 bacteria found in the feces of warm-blooded animals. *E. coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets *E. coli* standards for contact recreation (swimming, etc.). A stream is designated as “impaired” if 10% of measurements in a calendar month are >1260 colonies in the units of most probable number (MPN) per 100 milliliters of water, or if the geometric mean of five samples taken within 30 days is greater than 126 MPN.

Sampling by the MPCA has found Springbrook Creek is exceeds State standards for *E. coli* bacteria. Data collected by local agencies to date are not sufficient to re-calculate if the MPCA standards are met or exceeded. We took samples throughout the summer, often with only 1-2 samples 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. But other examinations of the data presented below verify that *E. coli* abundance is high.

E. coli levels during baseflow are generally near the chronic standard of 126 MPN in all sites, but in 60 baseflow samples taken at all sites since 2013, *E. coli* has never approached the acute standard of 1260 MPN. Half of the samples taken at 79th Way during baseflow conditions have exceeded 126 MPN.

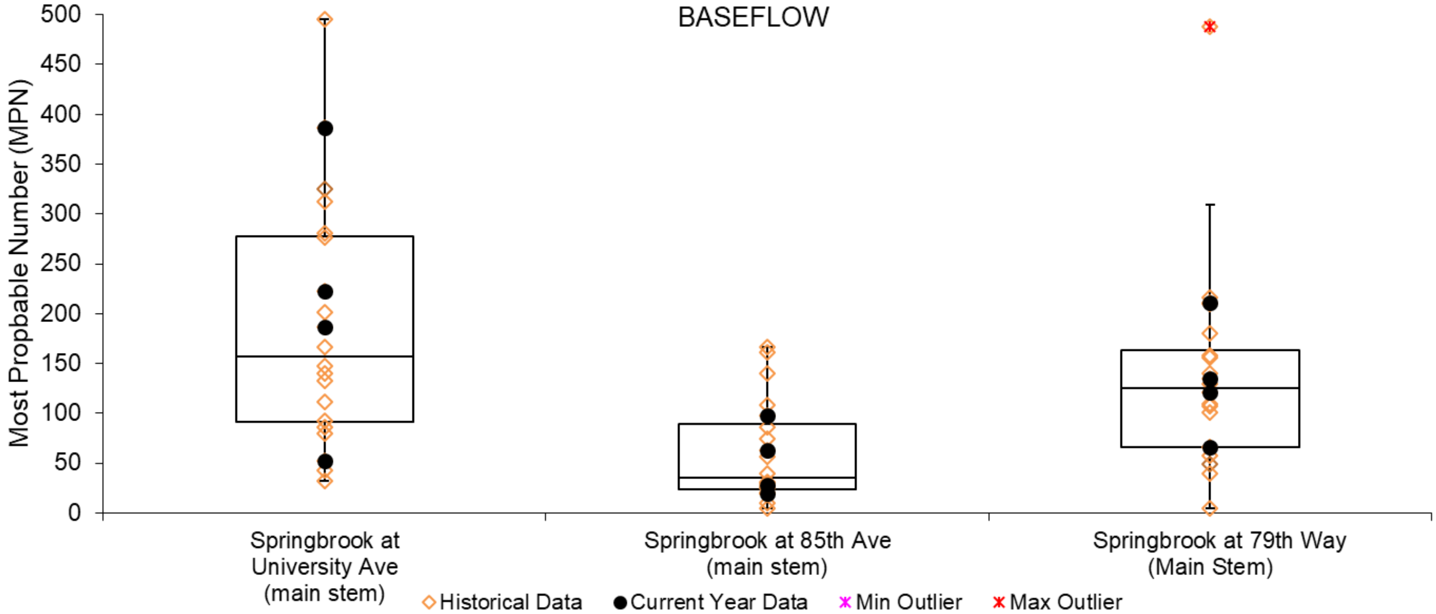
Interestingly, during baseflow conditions the median *E. coli* level at 85th Avenue (35.5 MPN) is about 1/5 of that at University Avenue (157.5 MPN). It seems that the ponds and wetlands between University Avenue and 85th Avenue sites are providing some level of baseflow treatment. Levels tend to rebound again between 85th Avenue and 79th Way, however.

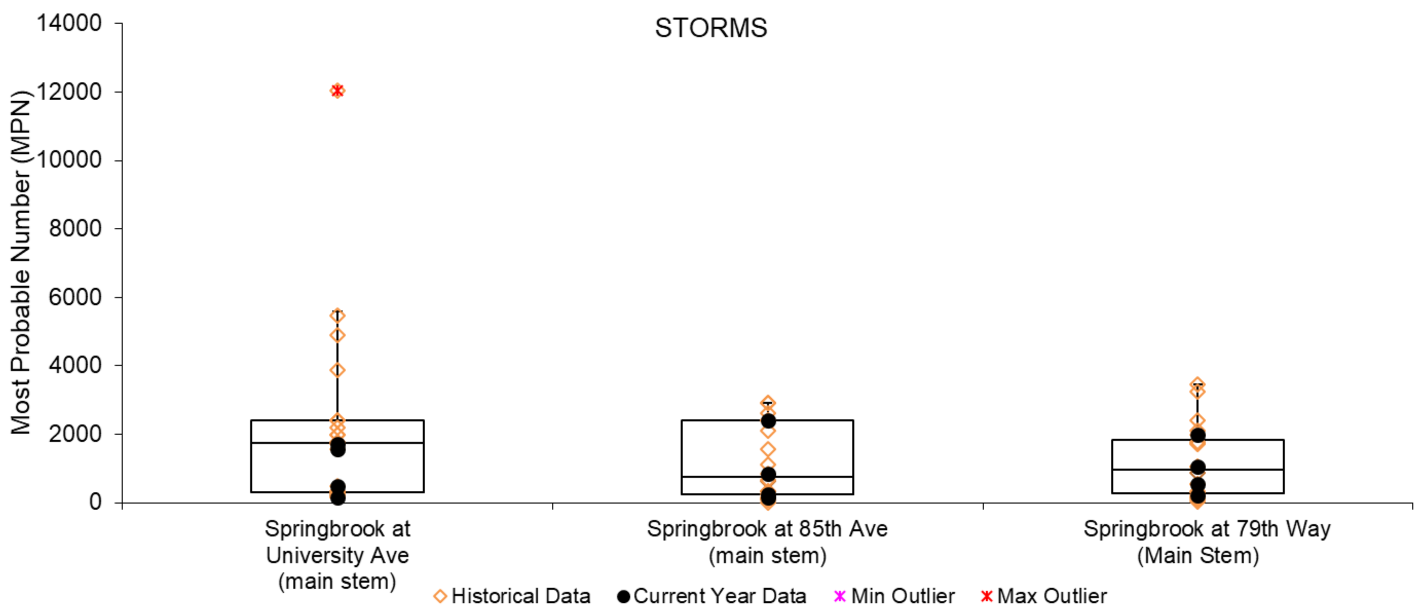
During storms *E. coli* is significantly higher (note the difference in scale on the charts below), but the same pattern remains with the middle site (85th Ave.) having much lower levels than University Avenue. Median *E. coli* during storms for all years from upstream to downstream are 1756, 765, and 956.2 MPN, respectively. These levels are all quite high, and 90% of storm samples collected at 79th Way have exceeded 126 MPN/100ml. Almost half of the samples collected at 79th way during storms have exceeded the acute standard of 1260 MPN.

Median *E. coli* in Springbrook Creek. Data are from 79th Way for 2013-2017

	***E. coli* (MPN)**	**State Standard**	**N**
Baseflow	125	Monthly Geometric Mean >126	20
Storms	956		20
All	195		40
Occasions >126 MPN		Monthly 10% average >1260	10 (50%) baseflow, 18 (90%) storm
Occasions >1260 MPN			0 baseflow, 8 (40%) storm

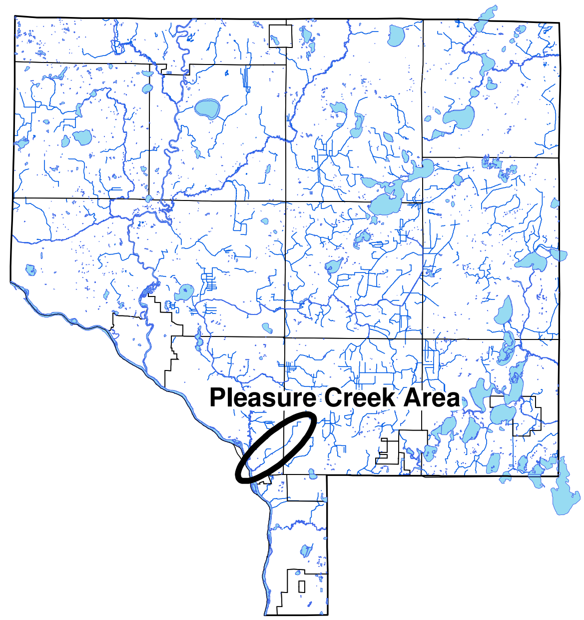
***E. coli* at Springbrook.** Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





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-**2017** 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 near the outlet to the Mississippi River 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, and particularly *E. coli*. In 2009, monitoring moved even farther upstream to further diagnose pollutant sources. In 2012 monitoring was moved back to the lower portions of the watershed to continue overall water quality assessment near the outfall.

Pleasure Creek is listed as an impaired water by the MN Pollution Control Agency for invertebrate biota and *E. coli* bacteria. New Tiered Aquatic Life Use (TALU) standards currently under development will likely take into consideration the fact that the creek is a public ditch and therefore has lower aquatic life expectations, at least in some reaches.

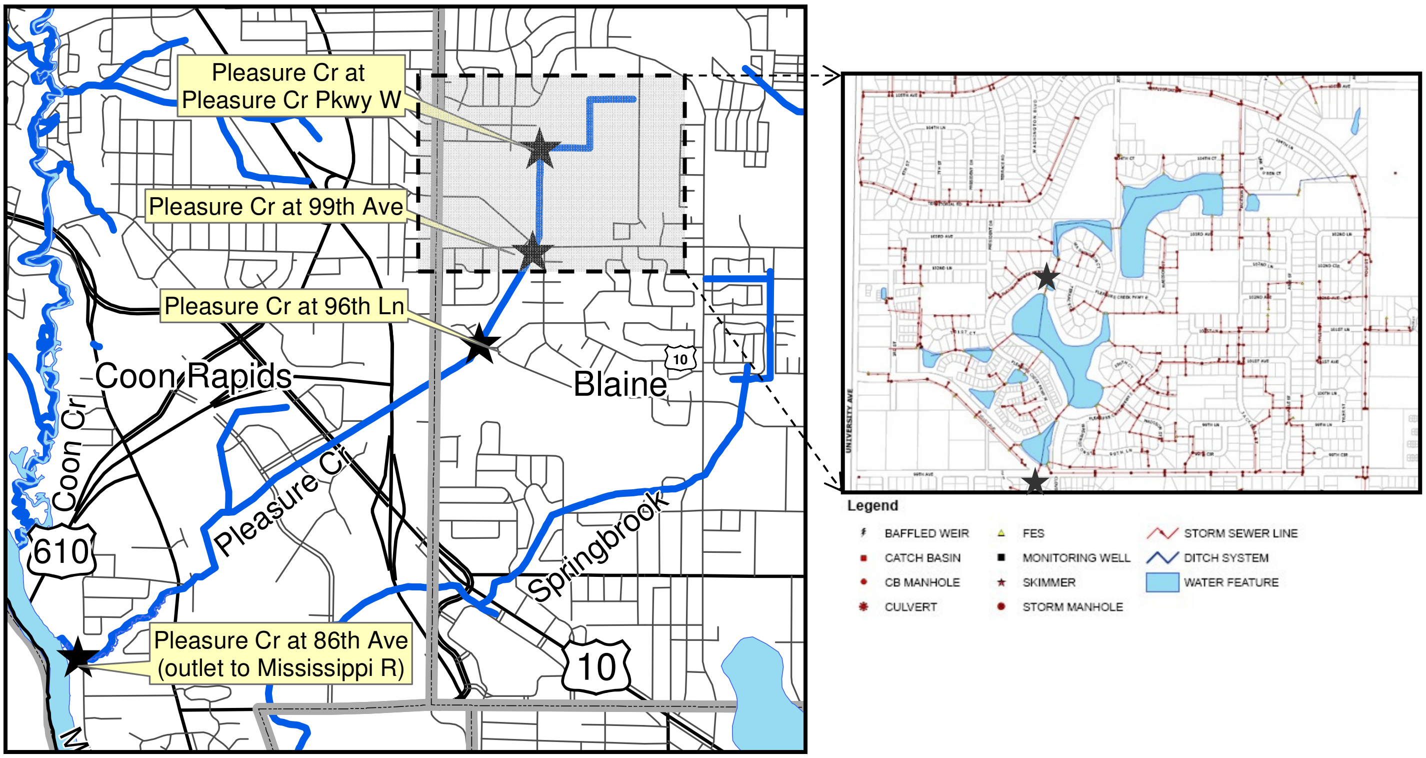
Methods

Pleasure Creek was monitored during both storm and baseflow conditions by grab samples. Eight water quality samples were taken each year; half during baseflow and half following storms. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. In some years, particularly during drought, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Eleven water quality parameters were tested. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Beginning in 2009, transparency tube measurements were added and are reported to MPCA. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, chlorides, hardness, and sulfate. Hardness and sulfate were monitored only in 2012. Chlorides have not been monitored since 2012.

During every sampling event, the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using an electronic data logging device at the 86th Avenue stream crossing (farthest downstream).

Pleasure Creek Monitoring Sites



Results and Discussion

Pleasure Creek has some prominent water quality concerns. Pleasure Creek currently listed as impaired by the State for poor invertebrate biota and high *E. coli*, a TMDL exists for these impairments.

The following is a parameter-by-parameter summary and management discussion:

- <u>Dissolved pollutants</u>, as measured by conductivity and chlorides, are high in Pleasure Creek, much higher than most other Anoka County streams. At Pleasure Creek, and many other streams, the highest conductivity readings on record for individual sampling sites have been observed in recent years, indicating a regional problem that is likely worsening.

  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 appears 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> is generally 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 µg/L. Long-term median levels remain much lower in Pleasure Creek than other Anoka County streams.

  Management discussion: Additional treatment within the stormwater conveyance system would help reduce peak storm flow phosphorus concentrations, and limit state standard exceedances.

- <u>Suspended solids and turbidity</u> were both low during baseflow and higher during storms, but overall appear better than State standards. The most robust existing stormwater treatment is upstream of East River Road. Any new treatment might target the neighborhoods downstream of that point.

Management discussion: Additional treatment within the stormwater conveyance system, particularly downstream of East River Road, would help but is probably a lower priority than other area streams where these pollutants are higher.

- pH and dissolved oxygen have recently been within the range considered normal and healthy for streams in this area. In previous years (2002-2009), however, multiple samples did not conform to state standards for either parameter.
- *E. coli* bacteria are high, and problematic throughout Pleasure Creek, especially during storm events. Investigative monitoring has been done, and a TMDL has been approved. Stormwater runoff and stormwater ponds themselves are likely sources of the bacteria, but identifying sources can be very difficult.

  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 and Chlorides

Conductivity and chlorides are measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial sources, agricultural chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we use. It measures electrical conductivity of the water; pure water with no dissolved constituents has zero conductivity. Chlorides tests measure for chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community; however it is also noteworthy that Pleasure Creek discharges into the Mississippi River just upstream from drinking water intakes for the Twin Cities.

Conductivity and chlorides in Pleasure Creek are high. Median conductivity for all years and conditions at the 86th Ave site is 1.066 mS/cm. By comparison, the median for all streams in Anoka County is 0.420 mS/cm. The median conductivity for storm flow samples at Pleasure Creek is even higher at 1.149 mS/cm. 2017 readings for both storm and baseflow conditions were near the upper reach of the site's long term range, as has been the case for the last couple of sampling seasons. There is no state water quality standard for conductivity, but these extremely high readings are indicative of high levels of dissolved pollutants.

Chlorides are a common dissolved pollutant, most often associated with road deicing salts. Chlorides have not been monitored since 2012, but those results are still instructive. Chlorides increased at the downstream site even more dramatically than conductivity. Median chlorides (all years) at three upstream sites were 70, 71, and 67 mg/L (upstream to downstream). At the downstream site (86th Ave.) median chloride concentrations were 159 mg/L, more than double. The median for all streams in Anoka County is 13.3 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.

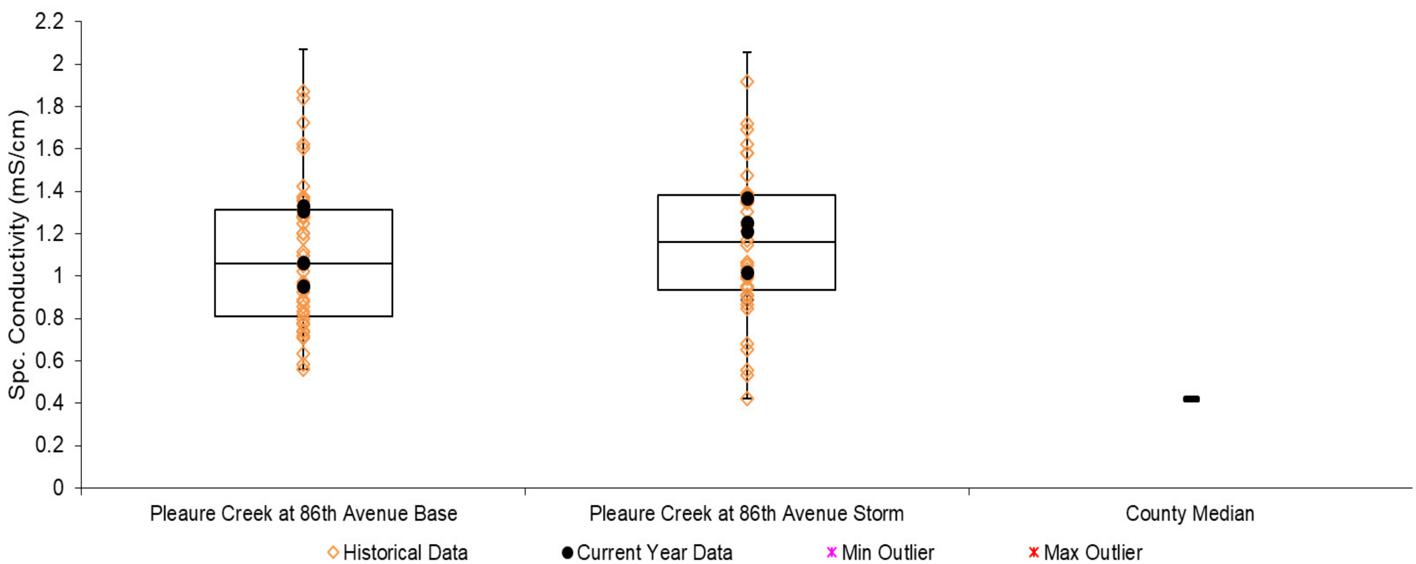
Both conductivity and chlorides are slightly higher during storms than baseflow conditions. This is the opposite of most other area streams. At those other streams road deicing salt infiltration to the shallow water table that feeds stream base flows is an often-suspected source. This same problem may be occurring at Pleasure Creek, as evidenced by high baseflow conductivity, however storm runoff directly to the stream has even higher dissolved pollutants.

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

Median conductivity and chlorides in Pleasure Creek at 86th Ave. for conductivity all years through 2017, for chlorides all years through 2012.

	Conductivity (mS/cm)	Chlorides (mg/L)	State Standard	N
Baseflow	1.048	146.5	Conductivity – none Chlorides 860 mg/L acute, 230 mg/L chronic	47
Storms	1.149	178		39
All	1.066	158.5		86

Conductivity at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



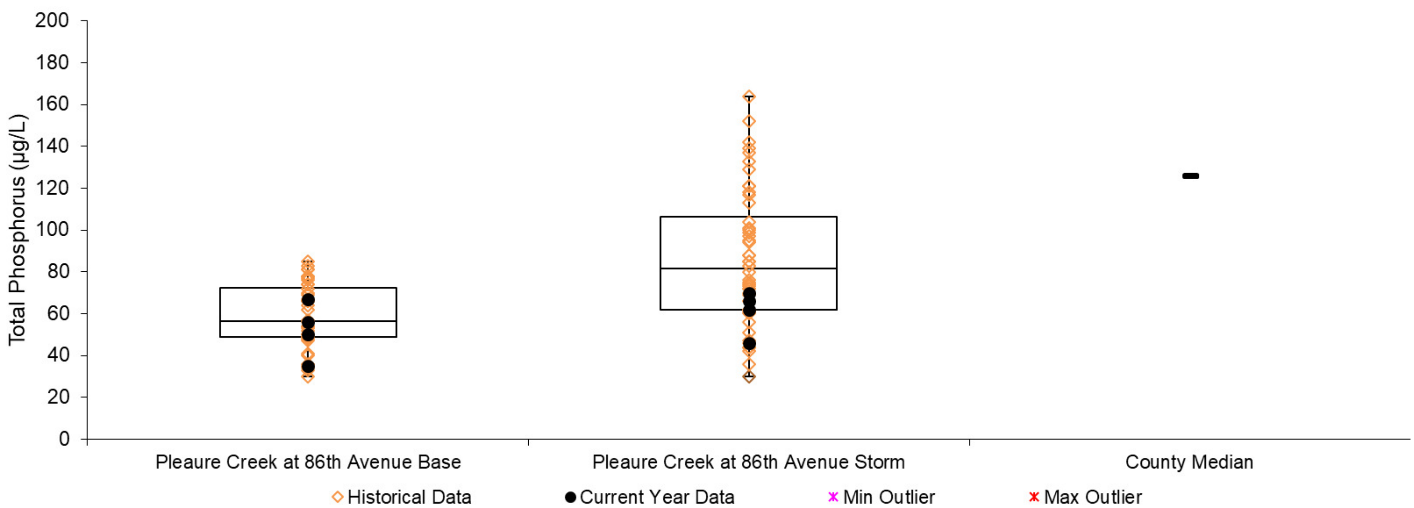
Total Phosphorus

Total phosphorus (TP) is a common nutrient pollutant and is the limiting factor for most algae growth. TP is generally low in Pleasure Creek during baseflow and slightly higher during storms. In all conditions, TP is much lower than other streams in Anoka County with a composite median of 69.5 µg/L compared to the overall countywide median of 126 µg/L. The MN Pollution Control Agency has a state standard of 100 µg/L. Pleasure Creek has exceeded this standard during 29% of storm samples, but never at baseflow conditions.

Median TP in Pleasure Creek. Data are from the 86th Avenue site and all years through 2017.

	Total Phosphorus (µg/L)	State Standard	N
Baseflow	56.5	100	40
Storms	81.5		48
All	69.5		88
Occasions > state standard			0 baseflow 14 (29%) storms

Total phosphorus at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2017 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 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 most sensitive to large particles. Suspended solids are important because they carry other pollutants, affect water appearance and clarity, and can harm stream biota.

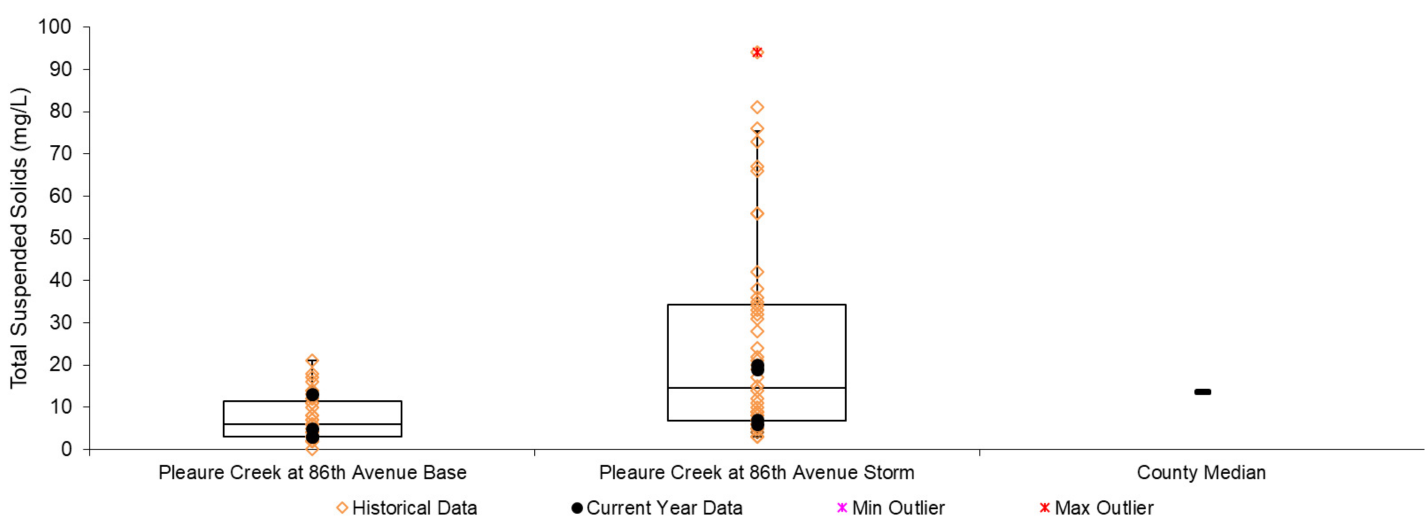
TSS and turbidity are both generally low during baseflow conditions and higher during storms. The MN Pollution Control Agency State standard for TSS is 30mg/L in this region. Near the outfall to the Mississippi River, Pleasure Creek exceeds this standard 33% of the time during storms, but rarely approaches it during baseflow conditions. Storm results vary widely, as storm conditions are highly variable.

The low baseflow turbidity and TSS potentially reflect the effectiveness of large stormwater ponds just upstream of East River Road. Increases in both parameters during some storms, particularly larger storms, is not unexpected for any stream. Additional stormwater treatment around and downstream of East River Road would likely be most helpful at improving water quality in Pleasure Creek because treatment upstream of that location is already more robust.

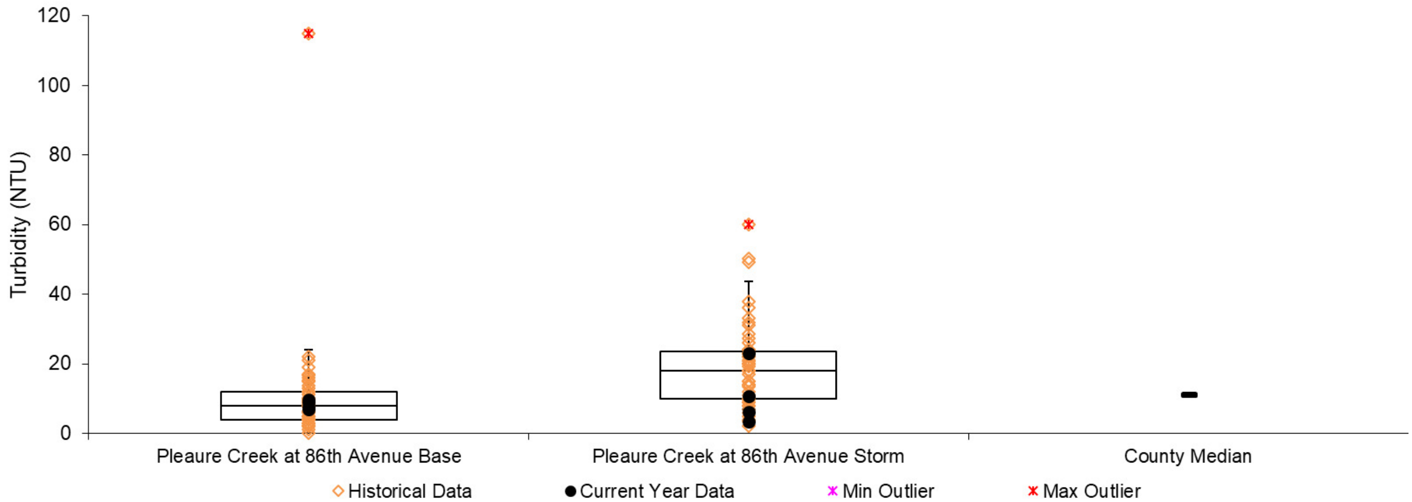
Median turbidity and suspended solids in Pleasure Creek. Data are from the 86th Avenue site and all years through 2017.

	Turbidity (NTU)	Total Suspended Solids (mg/L)	State Standard	N
Baseflow	8	6	30 mg/L TSS	40
Storms	18	14.5		48
All	11	9		88
Occasions > state TSS standard				0 baseflow 16 (33%) storm

Total suspended solids at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Turbidity at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



pH

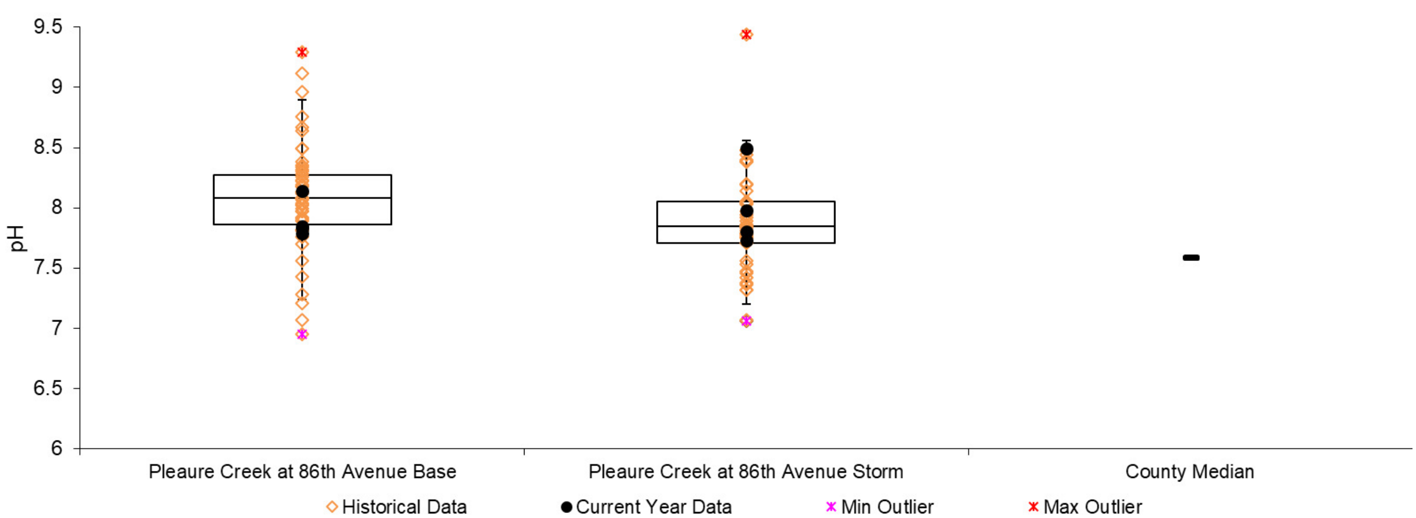
Pleasure Creek pH has remained within the state water quality standard of 6.5-8.5 since 2012, except for one exceedance occurring during a questionable measurement in 2014. From 2002-2009, however, there were 6 exceedances out of 55 samples, or 11%. These exceedances seem to have subsided in recent years, but one storm sample in 2017 was 8.49, just under the upper limit.

Median pH in Pleasure Creek. Data are from the 86th Avenue site and all years through 2017.

	pH	State Standard	N
Baseflow	8.08	6.5-8.5	54
Storms	7.85		49
All	7.97		103
Occasions outside state standard			7*

*One occasion in 2014 questionable

pH at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Dissolved Oxygen

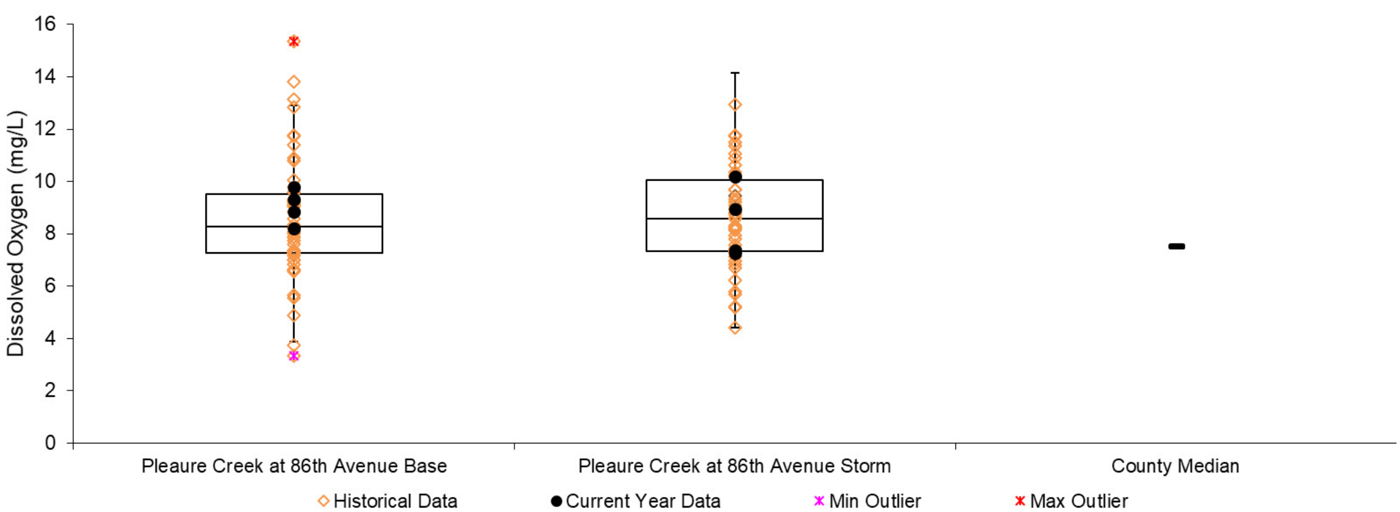
Dissolved oxygen (DO) is essential for aquatic life. Fish, invertebrates, and other aquatic life suffers if DO falls below 5 mg/L. Low DO can be a result of organic pollution, the decomposition of which consumes oxygen.

Dissolved oxygen in Pleasure Creek is generally high and within the acceptable range. No instances of DO <5mg/L have been measured since 2009.

Median dissolved oxygen in Pleasure Creek. Data are from the 86th Avenue site and all years through 2017.

	Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.27	5 mg/L daily minimum	50
Storms	8.58		50
All	8.46		100
Occasions <5 mg/L			4

Dissolved Oxygen at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



E. coli Bacteria

E. coli is bacteria found in the feces of warm-blooded animals. *E. coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets *E. coli* standards for contact recreation (swimming, etc.). A stream is designated as "impaired" if 10% of measurements in a calendar month are >1260 colonies in the units of most probable number (MPN) per 100 milliliters of water, or if the geometric mean of five samples taken within 30 days is greater than 126 MPN.

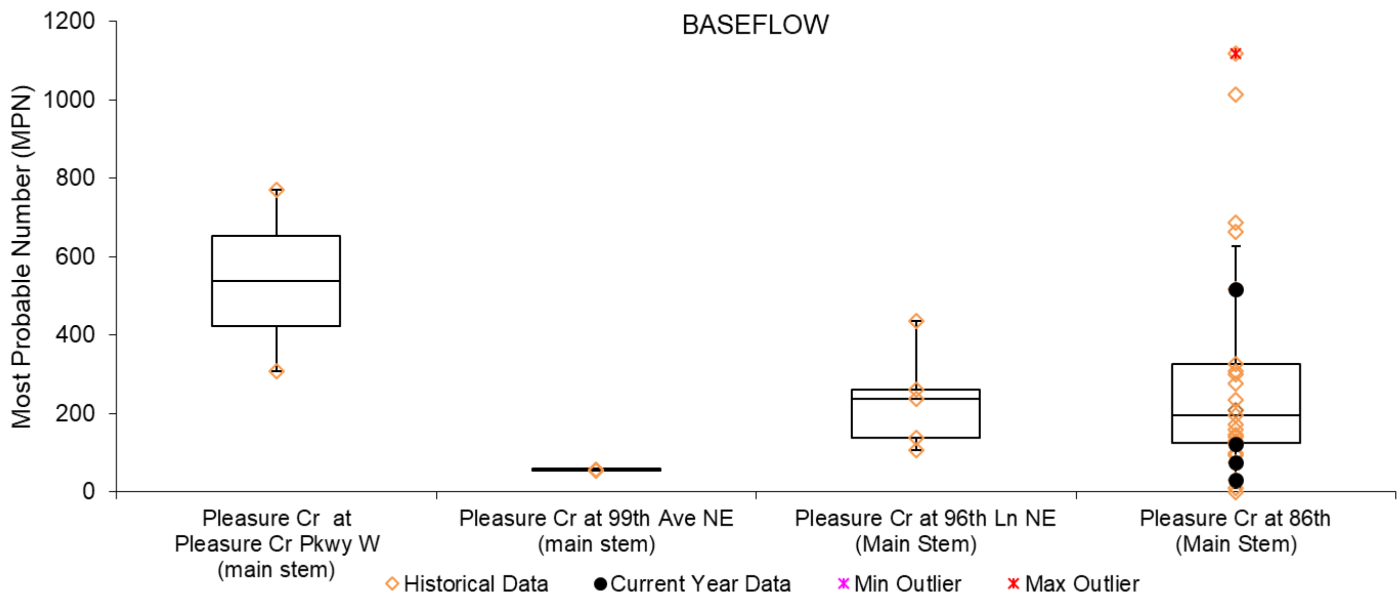
Pleasure Creek exceeded both criteria during extensive monitoring about a decade ago. The creek is listed as impaired for excessive *E. coli* by the State and a TMDL has been approved. High *E. coli* persists today, so people should be wary about contact and inadvertent consumption of Pleasure Creek water. Study around 2010 concluded likely bacteria sources include headwaters storm water ponds and storm water runoff from sources throughout the watershed.

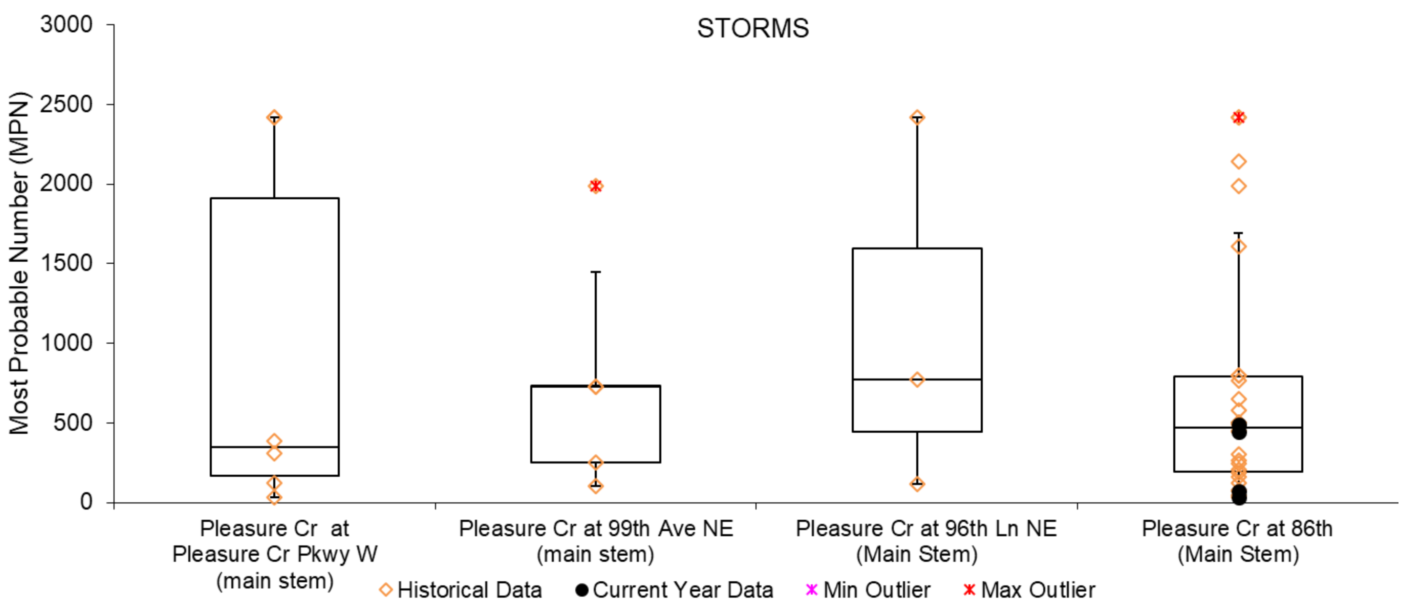
E. coli measurements collected in 2017 ranged greatly, with two very low samples and two very high samples collected during both storm and baseflow conditions. The baseflow median at 86th Avenue of 196 MPN/100mL was higher than the state chronic standard of 126 MPN/100mL (note this standard is a minimum 5 samples in 30 days geometric mean). The storm event median of 468 MPN/100mL greatly exceeds the state standard value. , The composite median measurement of more 300 MPN/100mL is more than double the State standard.

Median *E. coli* in Pleasure Creek. Data are from the 86th Avenue site only, all data through 2017.

	***E. coli* (MPN)**	**State Standard**	**N**
Baseflow	196	Monthly Geometric Mean >126	26
Storms	468		26
All	300		52
Occasions >126 MPN **Occasions >1260 MPN**		Monthly 10% average >1260	17 baseflow, 19 storm 0 baseflow, 5 storm

***E. coli* at Pleasure Creek.** Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



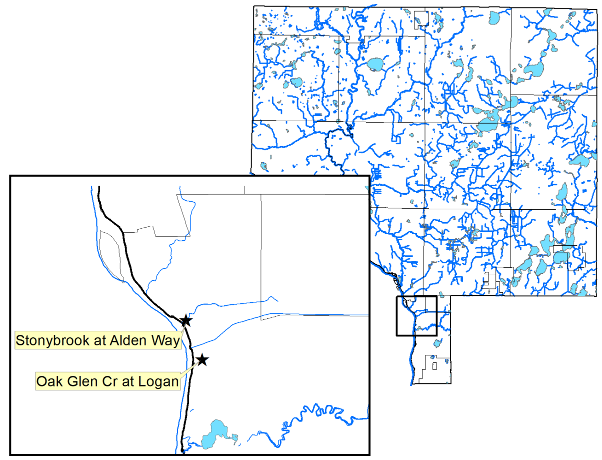


OAK GLEN CREEK AND STONYBROOK

Oak Glen Creek at Logan Parkway
Stonybrook at Alden Way

Years Monitored

Oak Glen Creek at Logan Parkway 2017
Stonybrook at Alden Way 2017



Background

Stonybrook is a small waterway that drains a mostly subterranean subwatershed in western Fridley. The stream's contributing area starts about one mile east of the Mississippi River as a storm sewer. The last 1/3 of the one-mile watershed is an open, deeply cut channel that descends 50 feet to the River. The sampling site is located about 250 feet upstream of the confluence with the Mississippi River, just east of Alden Way. The creek is only about 10 feet wide and 6 inches deep during baseflow conditions at the sampling site. Rain events frequently caused the stage to jump over 3 feet.

Oak Glen Creek is a small waterway that drains its own subwatershed directly to the Mississippi River. The Oak Glen subwatershed is 119 acres of mostly commercial development and storm sewer. The subwatershed boundaries are Highway 65 to the east, Osborne Road to the north and 71st Avenue to the south. The creek exists as an open channel for approximately 1,200 feet between East River Road and the Mississippi. The channel is extremely deeply cut and narrow, descending about 50 feet to the river. The sampling site is located about 500 feet upstream of the confluence with the Mississippi. A stormwater pond just east of East River Road was excavated to a larger and deeper size, and an iron enhanced sand filter bench was installed in the fall of 2017.

Methods

Both streams were monitored during storm and baseflow conditions by grab samples. Eight water quality samples were taken each year; half during baseflow and half following storms. Storms were generally defined as one-inch or more of rainfall in 24 hours or a significant snowmelt event combined with rainfall. In cases, especially during drought years, smaller storms were sampled because of a lack of larger storms. All storms sampled were significant runoff events.

Eleven water quality parameters were tested. Parameters tested with portable meters included pH, conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus and total suspended solids. During every sampling event, the water level (stage) was recorded using a staff gauge surveyed to sea level elevations. Stage was also continuously recorded using an electronic continuous data logging device.

Results and Discussion

2017 was the first year either of these streams was monitored, and some major water quality concerns were found. Dissolved pollutants as measured by conductivity do not have a state water quality standard, but both of these streams are higher than any other stream ever monitored in Anoka County. Additionally, phosphorus and *E. coli* levels are very high in Stonybrook in particular, and suspended solids and turbidity have very large spikes in both streams during storms.

Following is a parameter-by-parameter summary and management discussion:

- Dissolved pollutants, as measured by conductivity, at Stonybrook and Oak Glen Creek are the highest of any Anoka County stream. Chloride sampling in subsequent years is recommended to gain a sense of the extent to which road deicing salts may be a contributor.

  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 are likely, including road deicing salts and road runoff. Preventing their release into the environment is important because they are not easily removed.

- Phosphorus levels appear to be fairly low in Oak Glen Creek and high in Stonybrook. Stonybrook total phosphorus exceeded the state standard of 100 µg/L on two of four storms sampled and had a storm median of 95.5 µg/L. Storms had higher phosphorus than baseflow conditions.

  Management discussion: Efforts to reduce the input of phosphorus into the small watershed of Stonybrook should be considered.

- Suspended solids and turbidity were a mixed bag of high and low results in 2017. In combination with other observations and continuous datalogging sonde measurements, it is likely that both streams have high TSS and turbidity during storms. Because both streams rise and fall so quickly in response to storms, true representative storm samples were not collected at these sites in 2017, and some additional strategizing needs to be done to effectively monitor these streams in the future.

  Management discussion: Early indications show a large need to capture and treat stormwater in these small watersheds which potential convey large quantities of material proportional to the size of the streams. Automated sampling gear, or special grab sampling trips to these streams should be considered to capture storm flows before they recede.

- pH and dissolved oxygen were within the range considered normal and healthy for streams in this area in both streams. Neither of these parameters should be of concern at this point.

- *E. coli* bacteria are a potential problem in Oak Glen Creek and are clearly a significant problem at Stonybrook. More intensive sampling and calculations based on the state water quality standards may be in order.

  Management discussion: With additional monitoring, it is likely that these two streams will be found to exceed State water quality standards for *E. coli*. 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 and chlorides are measures of a broad range of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial sources, agricultural chemicals, and others. Metals, hydrocarbons, road salts, and others are often of concern in a suburban environment. Conductivity is the broadest measure of dissolved pollutants we use. It measures the electrical conductivity of water; pure water with no dissolved constituents has zero conductivity. Chlorides measures for chloride salts, the most common of which are road de-icing chemicals. Chlorides can also be present in other pollutant types, such as wastewater. These pollutants are of greatest concern because of the effect they can have on the stream's biological community; however, it is also noteworthy that both Oak Glen Creek and Stonybrook discharge into the Mississippi River just upstream from drinking water intakes for the Twin Cities.

Conductivity measured in Oak Glen Creek and Stonybrook in 2017 were the highest conductivity levels measured in any stream ever in Anoka County. Oak Glen Creek had slightly higher readings than Stonybrook. The median level for each creek exceeded 1 mS/cm. While these median values are exceptionally high for the local area, a look at some individual sample results is worse. The highest reading recorded in Oak Glen Creek was 2.46 mS/cm. Stonybrook had a reading of 1.49 mS/cm. There is no state standard for conductivity in streams, but these values are indicative of high levels of specific dissolved pollutant levels for which State standards may exist. Chlorides are one such constituent.

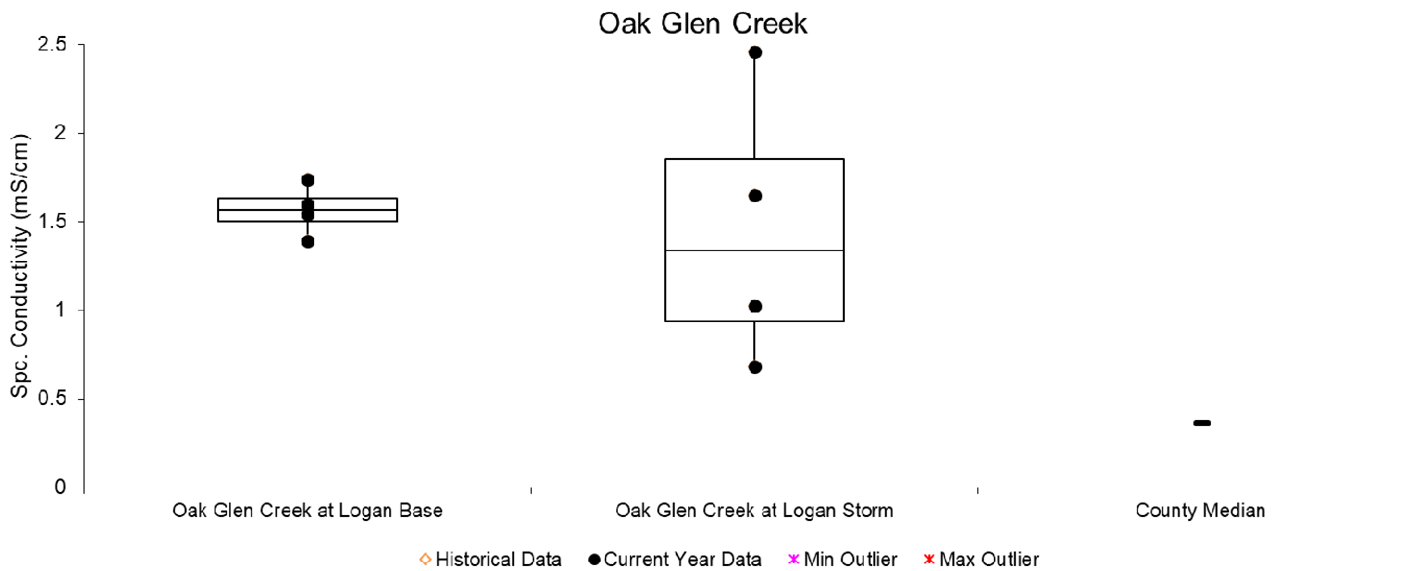
Both of these stream's watersheds are small and urbanized. The area has a long history of road de-icing chemical application, and these salts are an often-cited cause of water quality problems elsewhere in the metropolitan area. These pollutants readily dissolve into the water and infiltrate into the local water table where they feed baseflows in area streams. They do not break down over time.

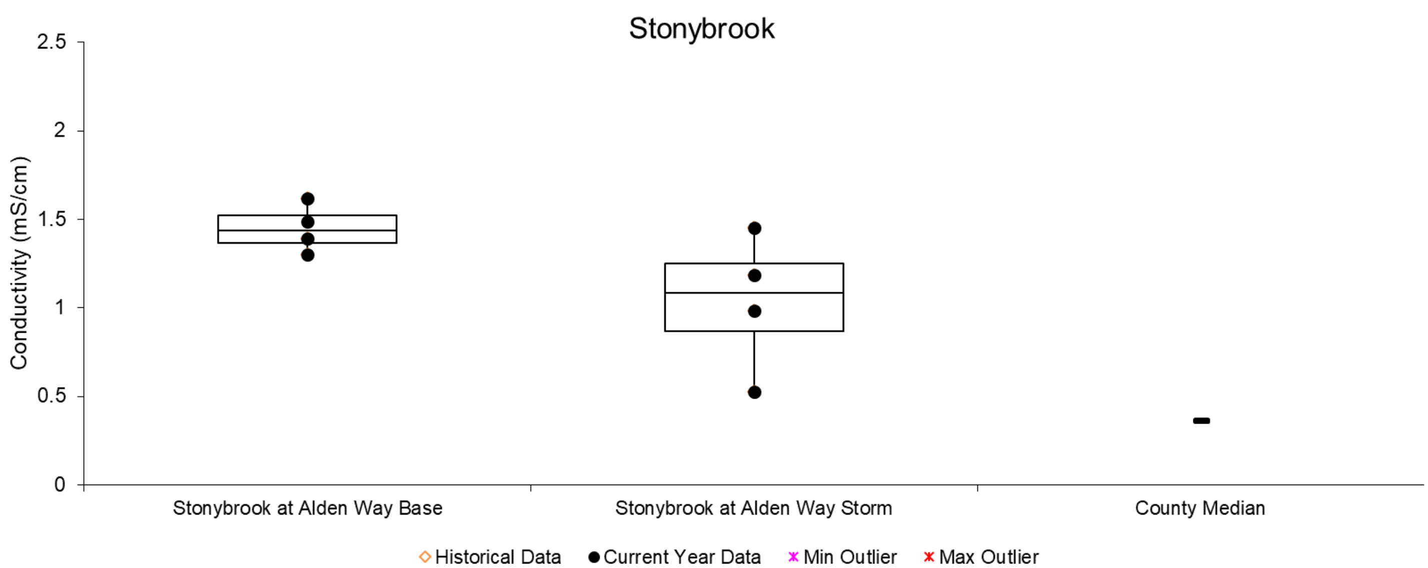
Dissolved pollutants are especially difficult to manage once in the environment. They are not removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also risk contaminating groundwater. The first approach to dissolved pollutant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

Median conductivity in Oak Glen Creek and Stonybrook. Data has only been collected from each site in 2017.

	Oak Glen Creek Conductivity (mS/cm)	Stonybrook Conductivity (mS/cm)	N (each site)
Baseflow	1.57	1.44	4
Storms	1.34	1.08	4
All	1.57	1.35	8

Conductivity at Oak Glen Creek and Stonybrook. Orange diamonds are historical data from previous years and black circles are 2017 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

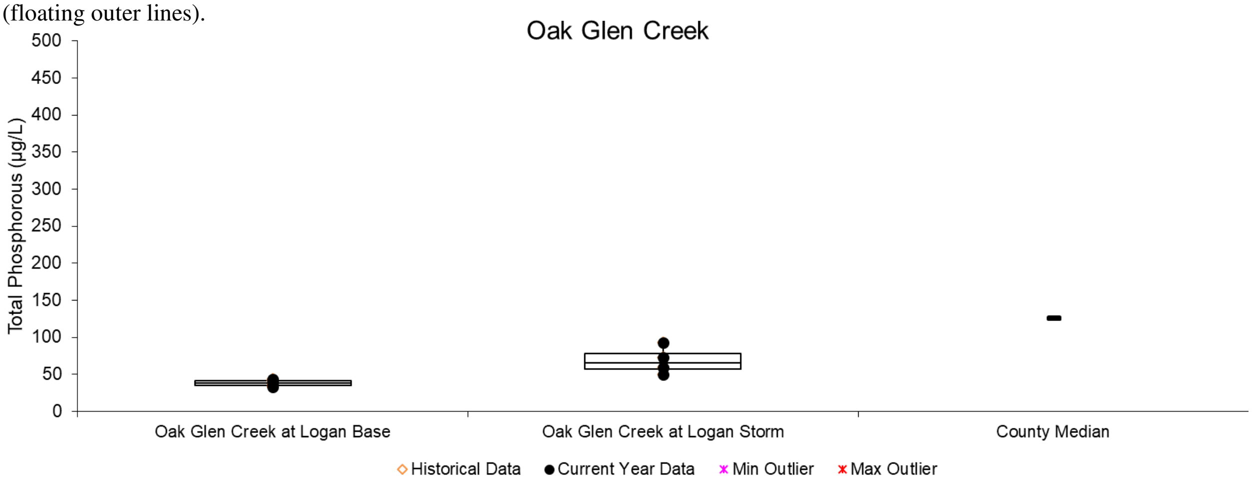
Total phosphorus (TP) is a common nutrient pollutant and is the limiting factor for most algae growth. The MN Pollution Control Agency has a phosphorus standard for streams of 100µg/L. In 2017, TP levels were low in Oak Glen Creek, the highest of which was 93 µg/L during a September storm.

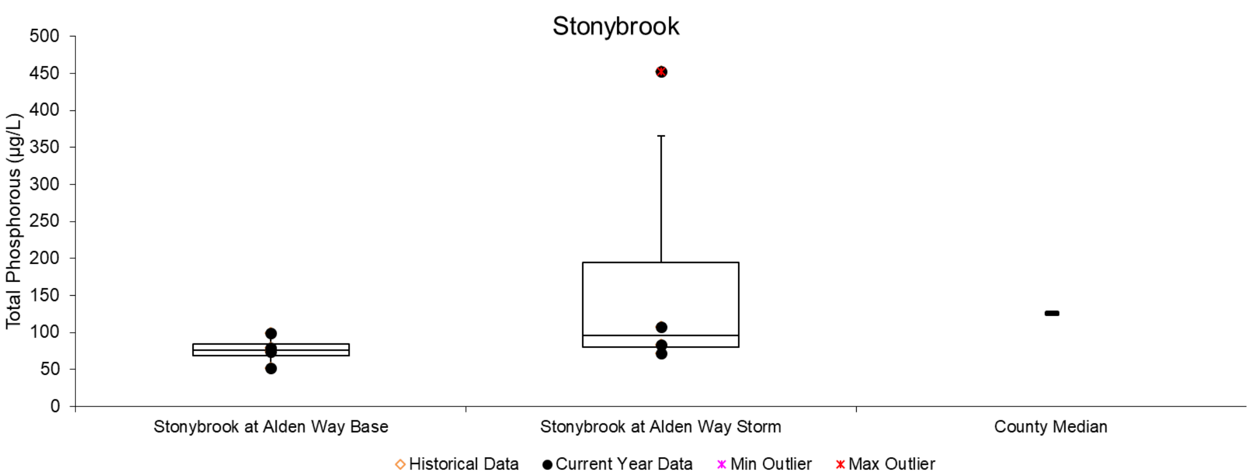
Stonybrook had higher TP levels, exceeding the State standard twice during four storms, one of which was over 4 times the standard at 453 µg/L. The median of the four storm samples in Stonybrook is very close to the standard as well at 95.5 µg/L.

Median total phosphorus in Oak Glen Creek and Stonybrook. Data has only been collected from each site in 2017.

	Oak Glen Creek Total Phosphorus (µg/L)	Stonybrook Total Phosphorus (µg/L)	State Standard	N (each site)
Baseflow	38.5	76.5	100	4
Storms	66	95.5		4
All	46.5	81		8
Occasions > state standard				
Oak Glen Creek				0
Stonybrook				2, both storms

Total phosphorus at Oak Glen Creek and Stonybrook. Orange diamonds are historical data from previous years and black circles are 2017 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 is measured 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 most sensitive to large particles. Suspended solids are important because they carry other pollutants, affect water appearance and clarity, and can harm stream biota.

Both streams had fairly low TSS and turbidity during baseflow conditions, with Oak Glen Creek having lower marks than Stonybrook. It is unclear at this point how much storms affect TSS and turbidity because the flashy hydrology prevented sampling during the middle of storm flow conditions, and only four samples were taken at each site.

Of the four storms sampled at each site, TSS and turbidity were only markedly elevated on the May 1, 2017 storm. During that storm, Oak Glen Creek had a TSS concentration of 25 mg/L and a turbidity of 21 NTU. Stonybrook had a TSS concentration of 292 mg/L, almost ten times the state water quality standard of 30 mg/L, and a turbidity of 195 NTU. However, anecdotal evidence by staff visits to these sites during, or shortly after rain events that were not sampled, even very small events, the water in Stonybrook appeared to be an opaque black.

It is highly likely that true storm samples for these sites were never collected in 2017 and that the storm surge passes through within hours, or even minutes, of the initiation of rainfall. Luckily, four storms were also monitored with YSI EXO data sondes, the data from which can be found earlier in this chapter. Turbidity levels during those deployments spiked to over 600 NTU in Oak Glen Creek and over 1,000 NTU in Stonybrook. These levels vastly exceed those measured in either stream during storm sample collection suggesting that these true storm flows were missed. Continued sampling at these sites will have to be based on a much shorter time frame than traditional sampling of much larger systems.

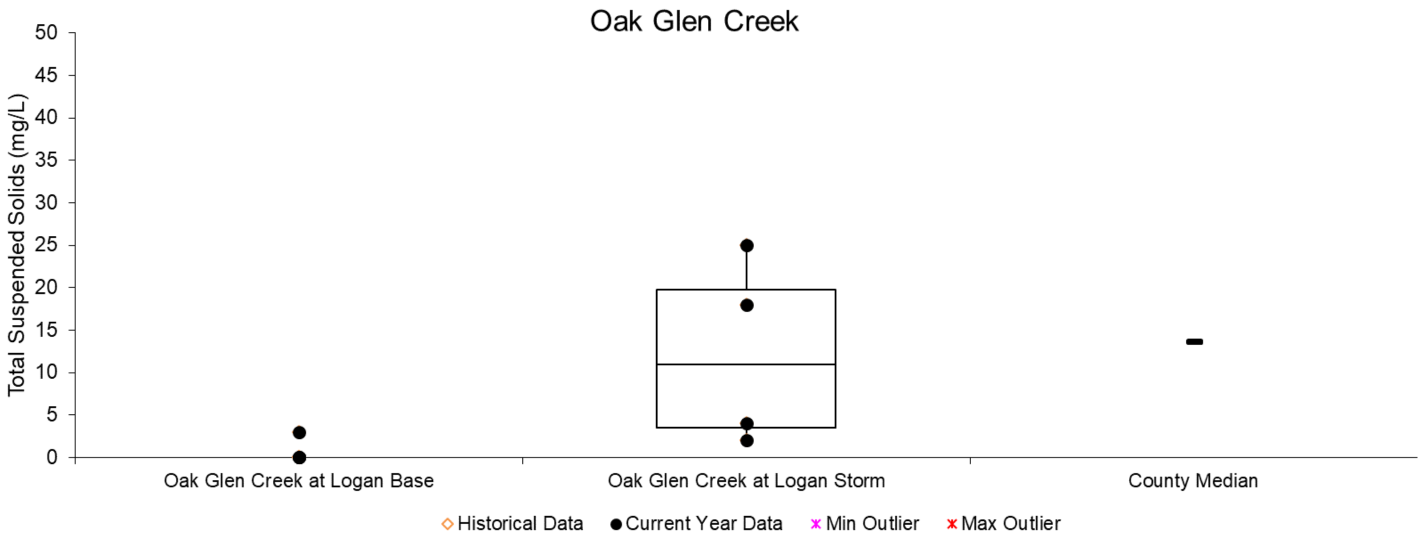
The gross exceedance of State TSS standards by Stonybrook in one storm sample collected, paired with field notes from other visits, and turbidity readings from data sonde storm deployments suggests that extreme swings in TSS occur often in this stream, and it’s likely that most any rain event that causes runoff in the watershed causes an exceedance of this standard. This is also potentially true for Oak Glen based on continuous storm turbidity readings, but these observations were not made in the field, nor by samples collected.

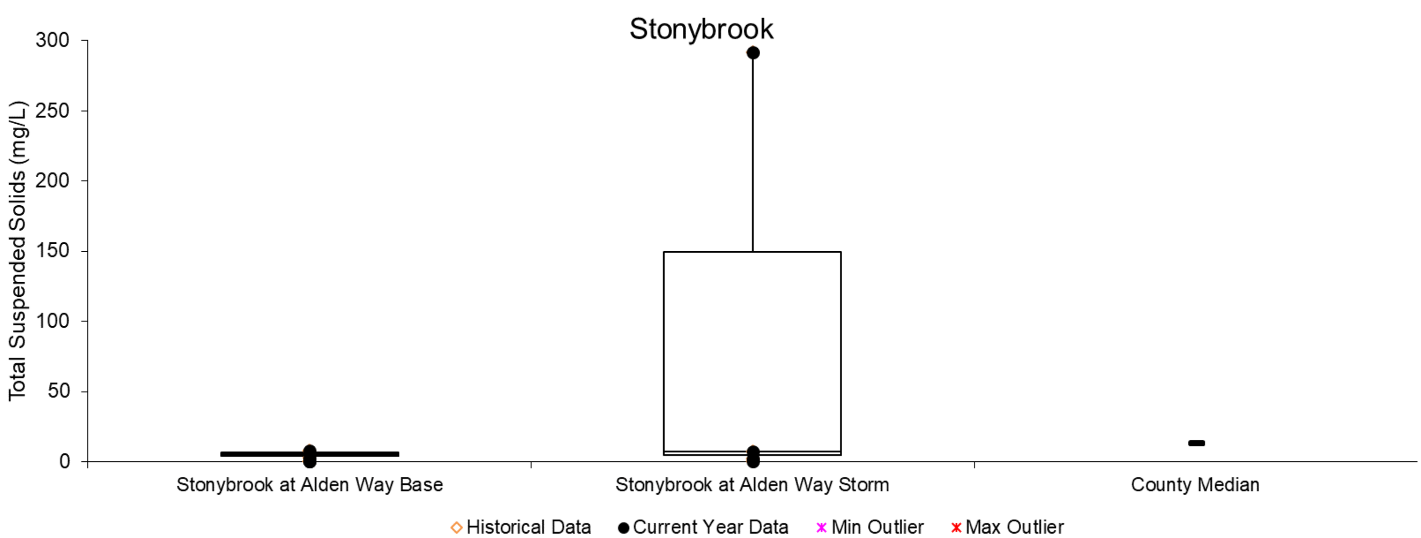
Median turbidity and suspended solids in Oak Glen Creek and Stonybrook. Data has only been collected from each site in 2017.

Oak Glen Creek	Turbidity (NTU)	Total Suspended Solids (mg/L)	State Standard	N
Baseflow	3.8	<2	30 mg/L TSS	4
Storms	5	11		4
All	4.7	2.5		8
Occasions > state TSS standard				0

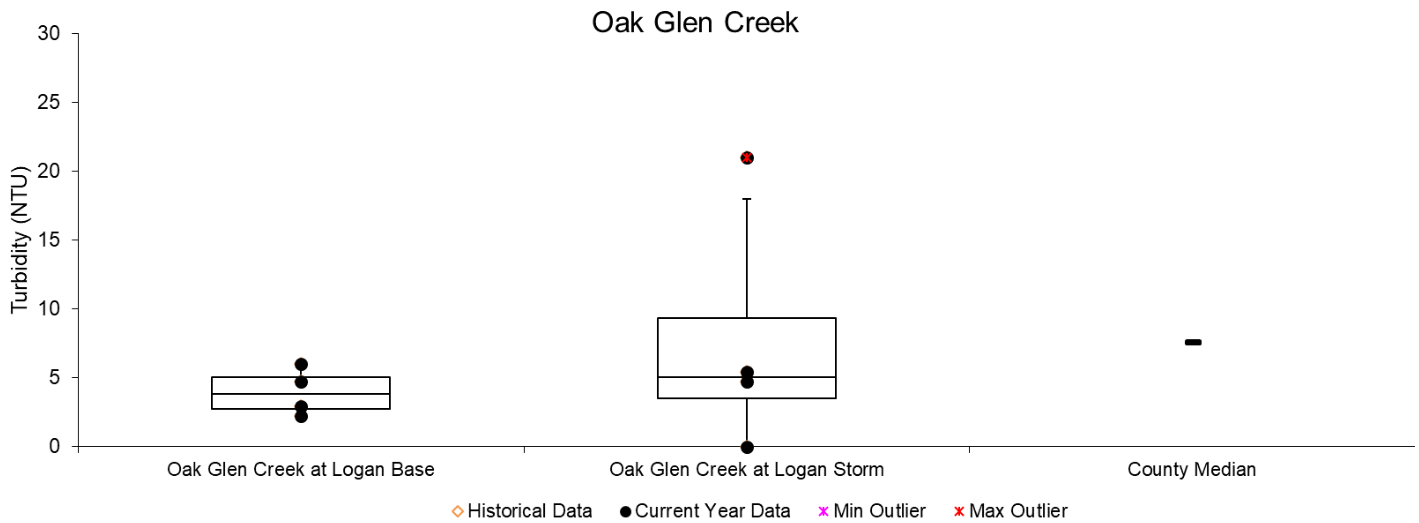
Stonybrook	Turbidity (NTU)	Total Suspended Solids (mg/L)	State Standard	N
Baseflow	8.3	2.5	30 mg/L TSS	4
Storms	6.7	4.5		4
All	7	2.5		8
Occasions > state TSS standard				1

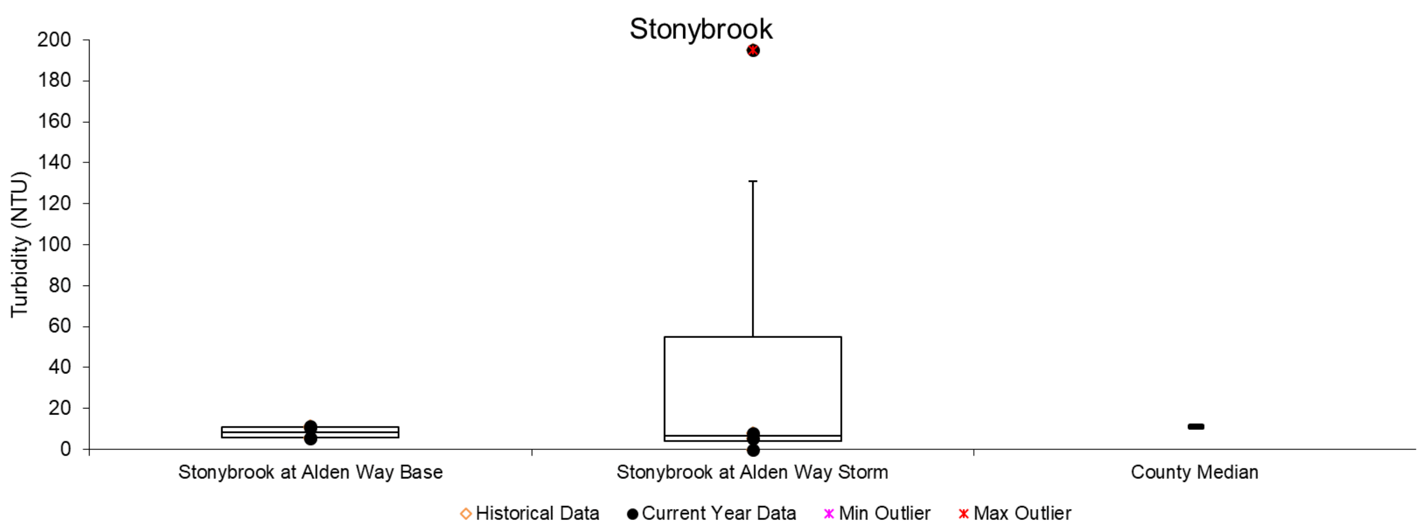
Total suspended solids at Oak Glen Creek and Stonybrook. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Turbidity at Oak Glen Creek and Stonybrook. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





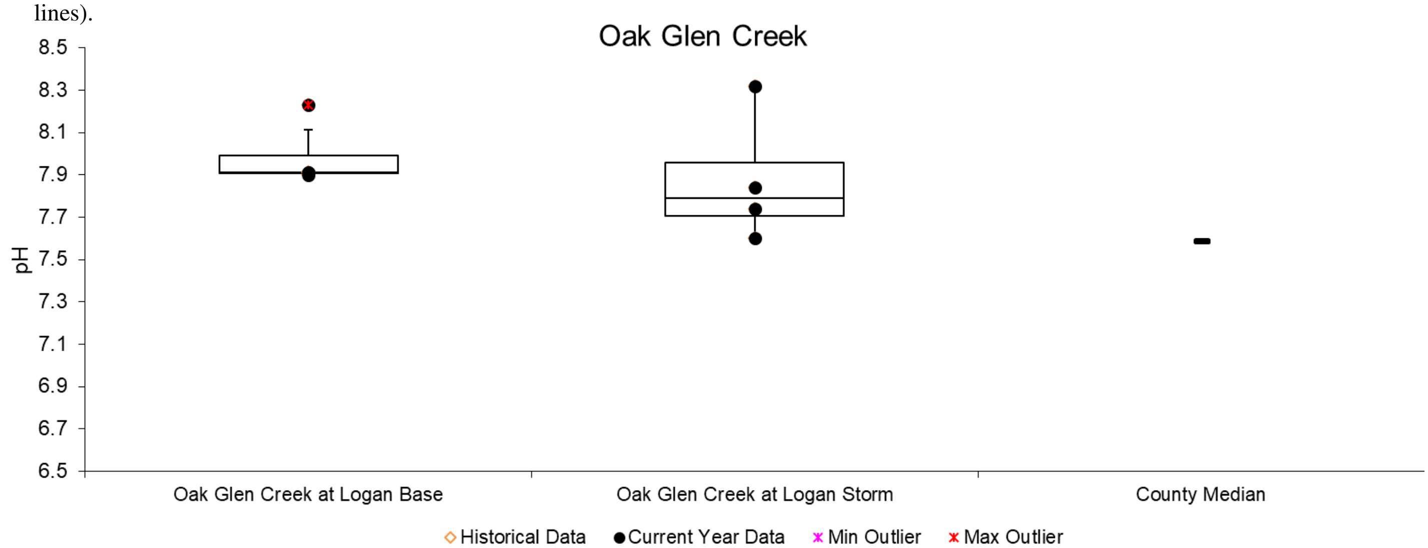
pH

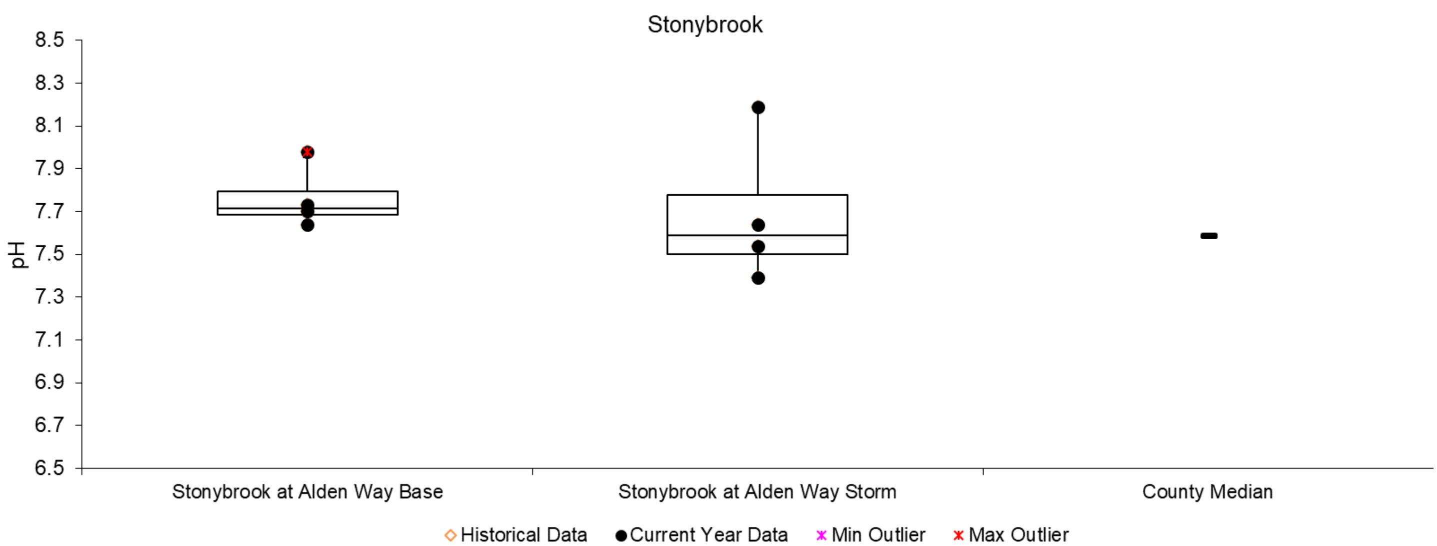
In 2017 pH levels were stable and within the healthy range for both Oak Glen Creek and Stonybrook. These sites both showed a similar slight decline in pH during storm flows due to the slight acidity of rainfall compared to ambient water. The Minnesota Pollution Control Agency water quality standards set the range for pH to remain between 6.5 and 8.5. These sites were additionally monitored continuously during four storm events with YSI EXO data sondes. Neither of these streams gave cause for concern with this particular parameter.

Median pH in Oak Glen Creek and Stonybrook. Data has only been collected from each site in 2017.

	Oak Glen Creek pH	Stonybrook pH	State Standard	N (each site)
Baseflow	7.91	7.715	6.5-8.5	4
Storms	7.79	7.59		4
All	7.905	7.67		8
Occasions outside state standard				0

pH at Oak Glen Creek and Stonybrook. Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





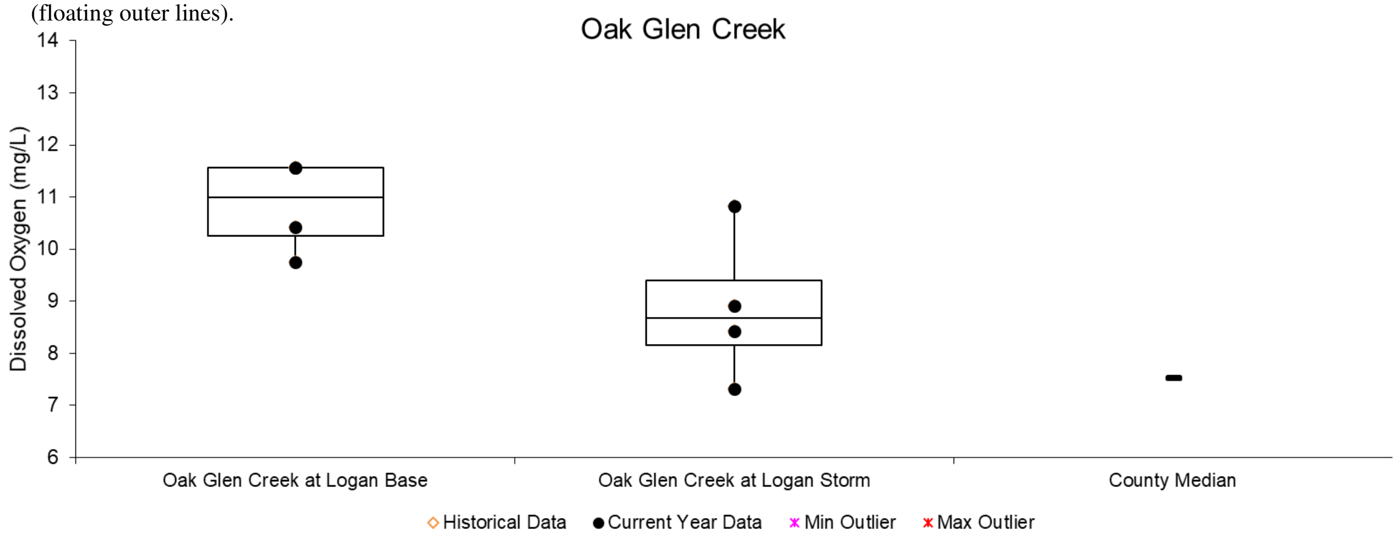
Dissolved Oxygen

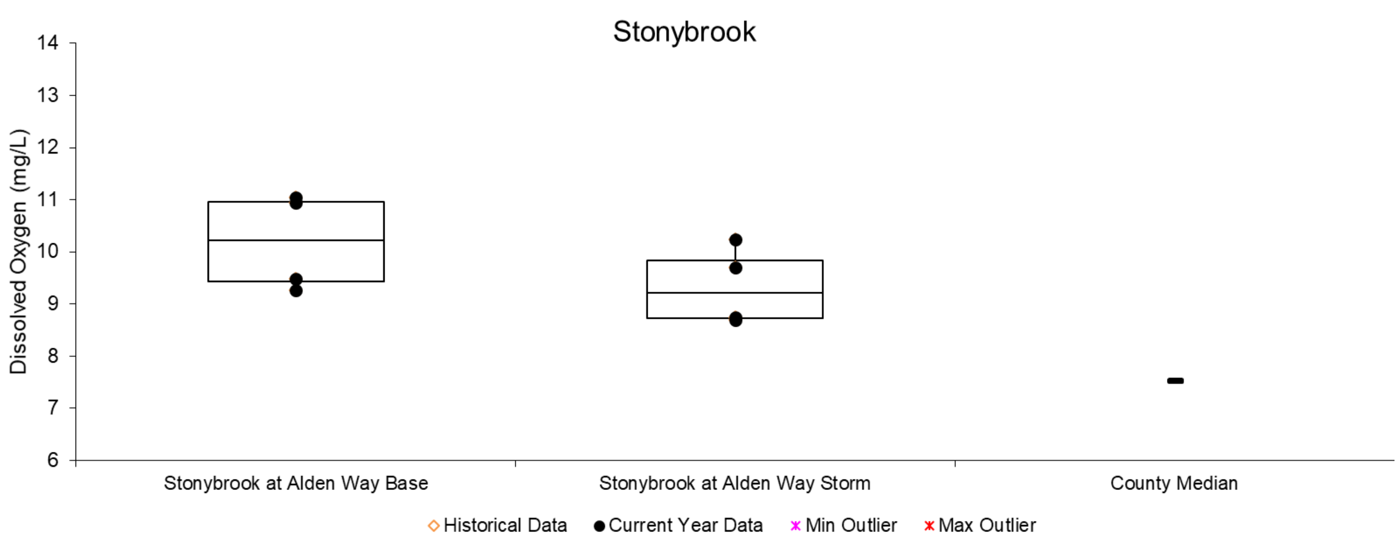
Initial sampling in 2017 showed dissolved oxygen (DO) concentrations to be healthy and stable in both streams. During sample collection, neither stream approached the state standard level of <5 mg/L, and both had median values about double that concentration. Pairing this data with the continuous storm sampling of DO using a YSI EXO data sonde during four storm events shows quite high concentrations rarely dropping below 8 mg/L in both streams. The only exception was a very brief drop to about 4 mg/L in Stonybrook during one storm deployment. This extremely short dip in concentrations is not concerning at this point.

Median dissolved oxygen in Oak Glen Creek and Stonybrook. Data has only been collected from each site in 2017.

	Oak Glen Creek Dissolved Oxygen (mg/L)	Stonybrook Dissolved Oxygen (mg/L)	State Standard	N (each site)
Baseflow	11.0	10.22	5 mg/L daily minimum	4
Storms	8.67	9.22		4
All	10.01	9.60		8
Occasions <5 mg/L				0

Dissolved Oxygen at Oak Glen Creek and Stonybrook. Orange diamonds are historical data from previous years and black circles are 2017 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 bacteria found in the feces of warm-blooded animals. *E. coli* is an easily measureable indicator of all pathogens that are associated with fecal contamination. The Minnesota Pollution Control Agency sets *E. coli* standards for contact recreation (swimming, etc.). A stream is designated as "impaired" if 10% of measurements in a calendar month are >1260 colonies in the units of most probable number (MPN) per 100 milliliters of water, 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 perform other examinations of the data, however.

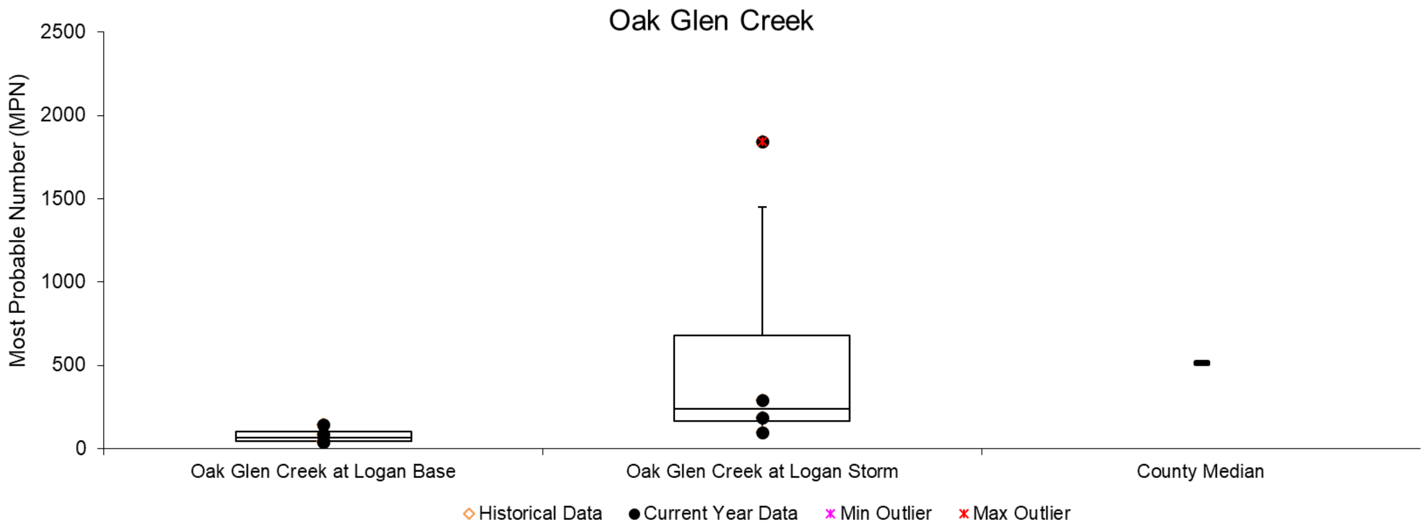
Initial sampling of these streams in 2017 indicates that *E. coli* may be an issue in Oak Glen Creek. Oak Glen Creek generally had levels below the chronic standard of 126 MPN and a baseflow median at about half that standard. Three of four storm samples, however exceeded 126 MPN. One very high reading of 1842 MPN, exceeding the acute standard of 1260 MPN, was collected. The overall median remained below the chronic standard in Oak Glen Creek.

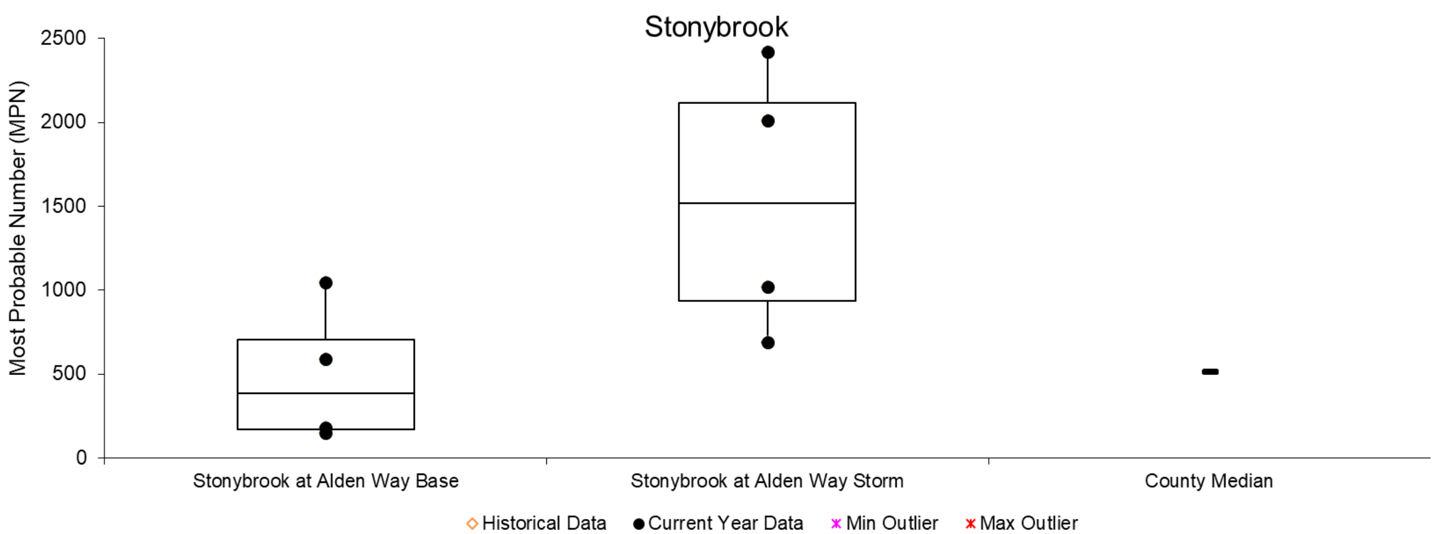
Stonybrook *E. coli* levels were concerning in the eight samples collected in 2017. All eight samples in both storm and baseflow conditions exceeded the chronic 126 MPN standard with the baseflow median being three time that standard at 386 MPN. Worse, half of the storm samples exceeded the acute 1260 MPN standard with the four-storm sample median also exceeding this mark at 1516 MPN.

Median *E. coli* in Oak Glen Creek and Stonybrook. Data has only been collected from each site in 2017.

	Oak Glen Creek *E. coli* (MPN)	**Stonybrook *E. coli* (MPN)**	**State Standard (MPN)**	**N (each site)**
Baseflow	65	386	Monthly Geometric Mean >126 Monthly 10% average >1260	4
Storms	238	1516.5		4
All	120.5	855		8
Occasions >126 MPN	3 (75%) storm, 1 (25%) base	8 (100%)		
Occasions >1260 MPN	1 (25%) storm, 0 base	2 (50%) storm 0 baseflow		

***E. coli* at Oak Glen Creek and Stonybrook.** Orange diamonds are historical data from previous years and black circles are 2017 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Wetland Hydrology

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

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

Locations: Bannochie Wetland, SW of Main St and Radisson Rd, Blaine

Bunker Wetland, Bunker Hills Regional Park, Andover

(middle and edge of Bunker Wetland are monitored)

Camp Three Wetland, Carlos Avery WMA on Camp Three Road, Columbus Township

Ilex Wetland, City Park at Ilex St and 159th Ave, Andover

(middle and edge of Ilex Wetland are monitored)

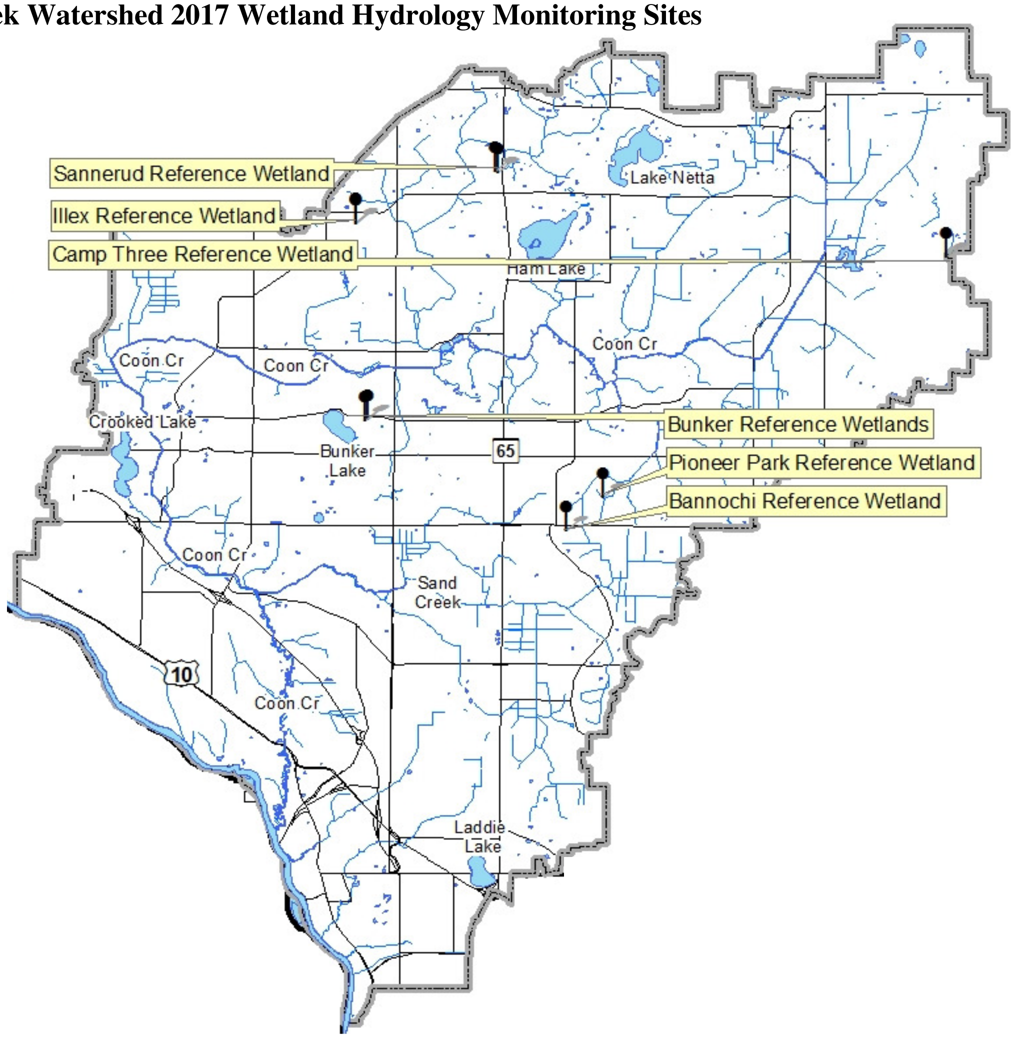
Pioneer Park Wetland, Pioneer Park off Main St., Blaine

Sannerud Wetland, W side of Hwy 65 at 165th Ave, Ham Lake

(middle and edge of Sannerud Wetland are monitored)

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

Coon Creek Watershed 2017 Wetland Hydrology Monitoring Sites

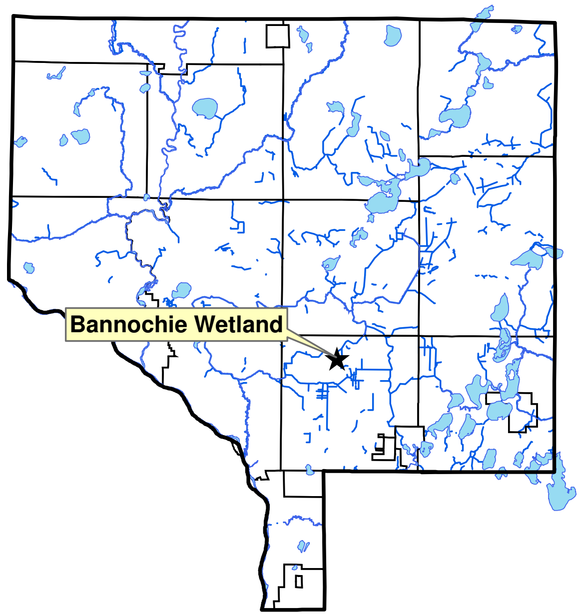


Wetland Hydrology Monitoring

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	-

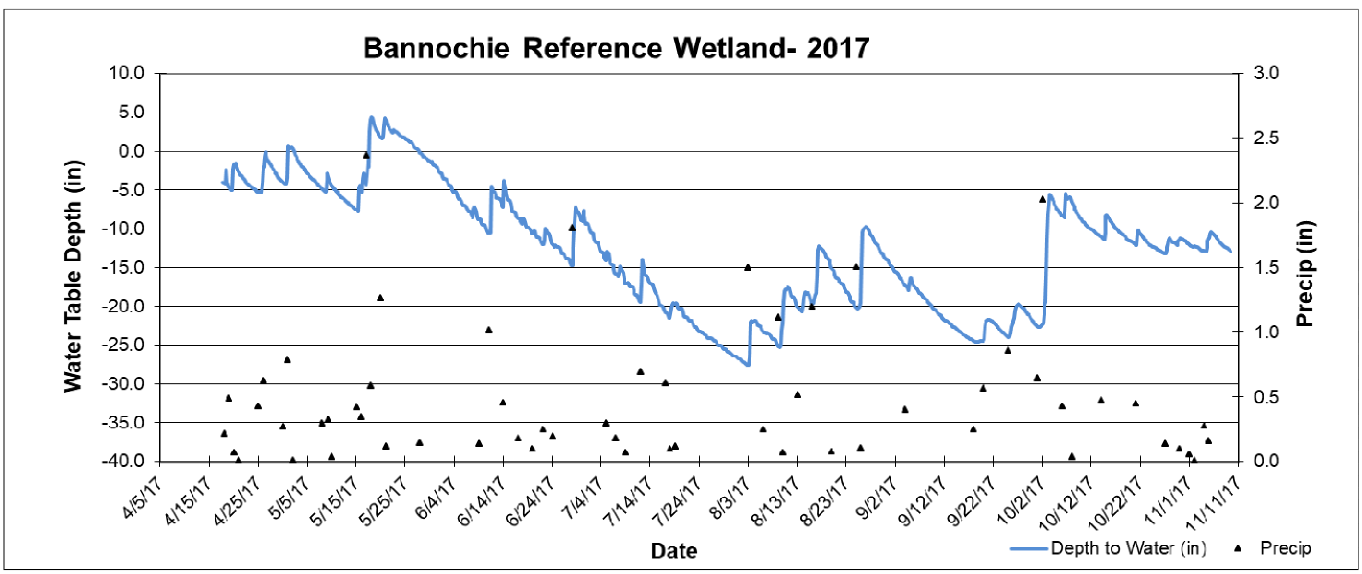
Surrounding Soils: Rifle and some Zimmerman fine sand

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.

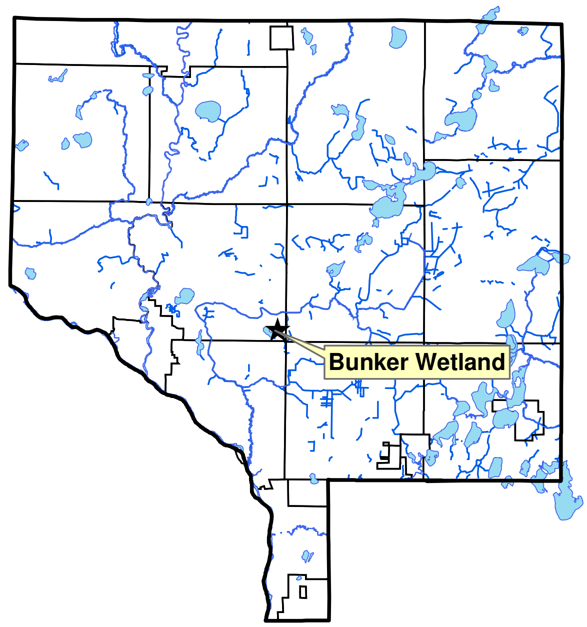
2017 Hydrograph



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	-

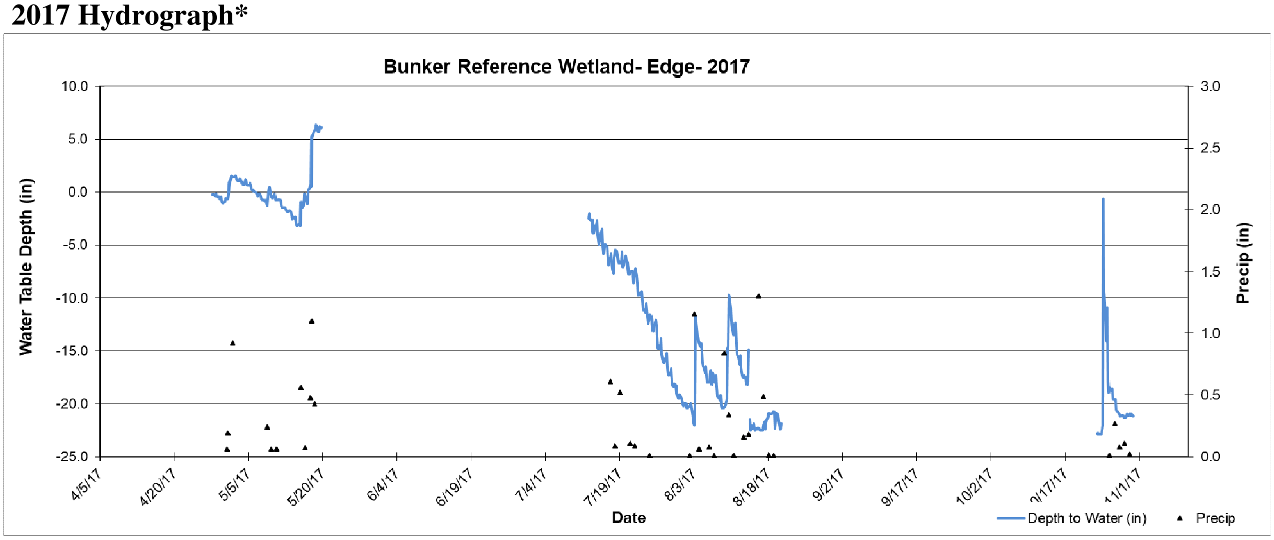
Surrounding Soils: Zimmerman fine sand

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.

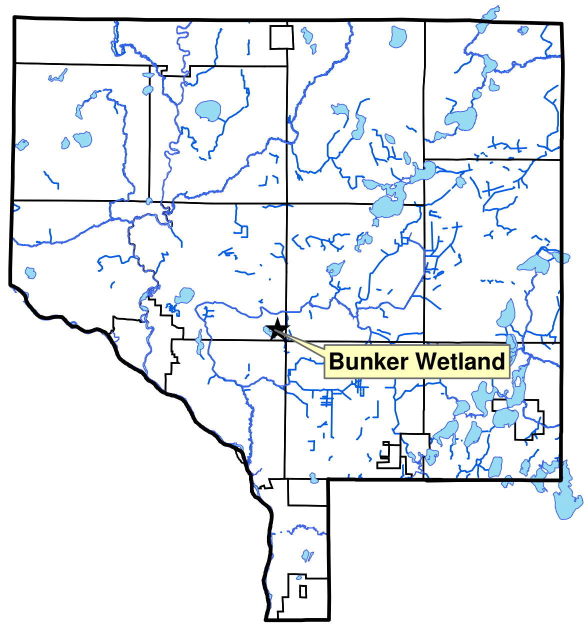
2017 Hydrograph*



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	-

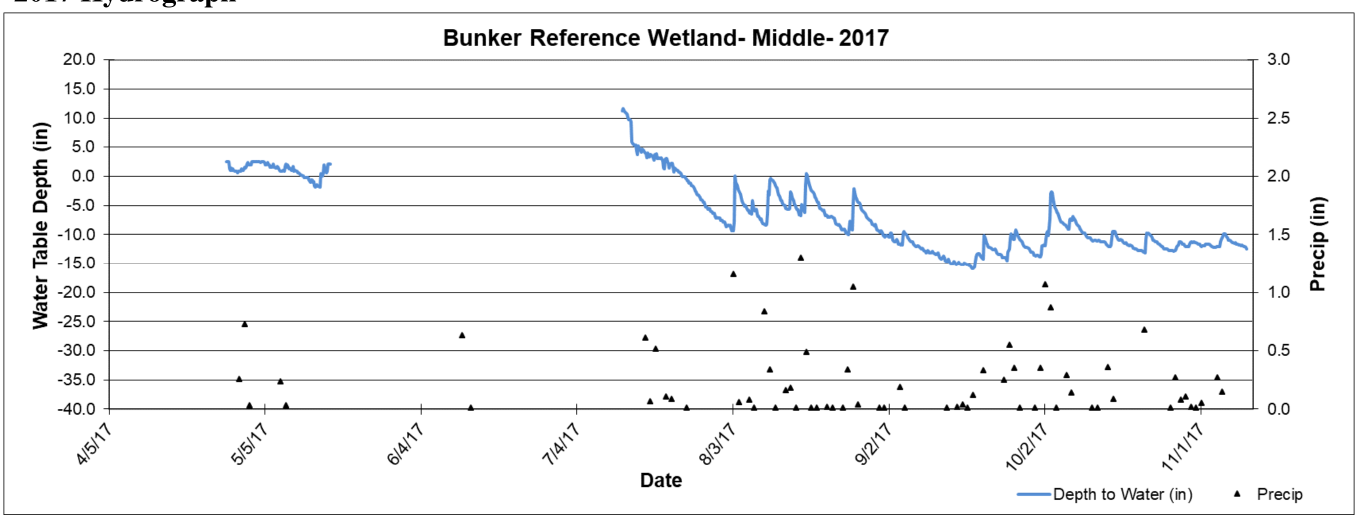
Surrounding Soils: Zimmerman fine sand

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.

2017 Hydrograph*



*Both of these data loggers got flooded out by very high standing water. It is highly probable that the road construction project on Bunker Lake Blvd. was the cause. Missing Data are due to that flooding out, and later, equipment malfunction at the Edge site. These sites will be a high priority for new equipment in 2018.

Wetland Hydrology Monitoring

CAMP THREE REFERENCE WETLAND

Carlos Avery Wildlife Management Area, Columbus Township

Site Information

Monitored Since: 2008

Wetland Type: 3

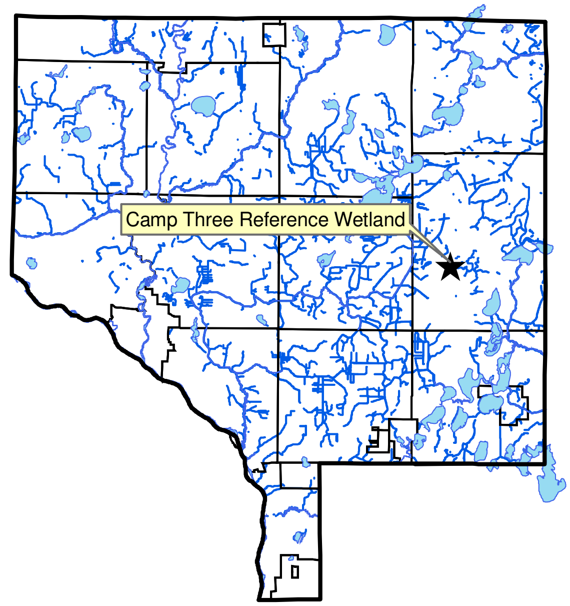
Wetland Size: Part of complex > 200 acres

Isolated Basin? No

Connected to a Ditch? Yes

Soils at Well Location: Markey Muck

Horizon	Depth	Color	Texture	Redox
A	0-4	N2/0	Mucky Fine Sandy Loam	-
A2	4-13	10yr 3/1	Fine Sandy Loam	20% 5yr 5/6
Bg1	13-21	10yr 5/1	Fine Sandy Loam	2% 10yr 5/6
Bg2	21-39	10yr 5/1	Fine Sandy Loam	5% yr 5/6
Bg3	39-55	10yr 5/1	Very Fine Sandy Loam	10% 10yr 5/6



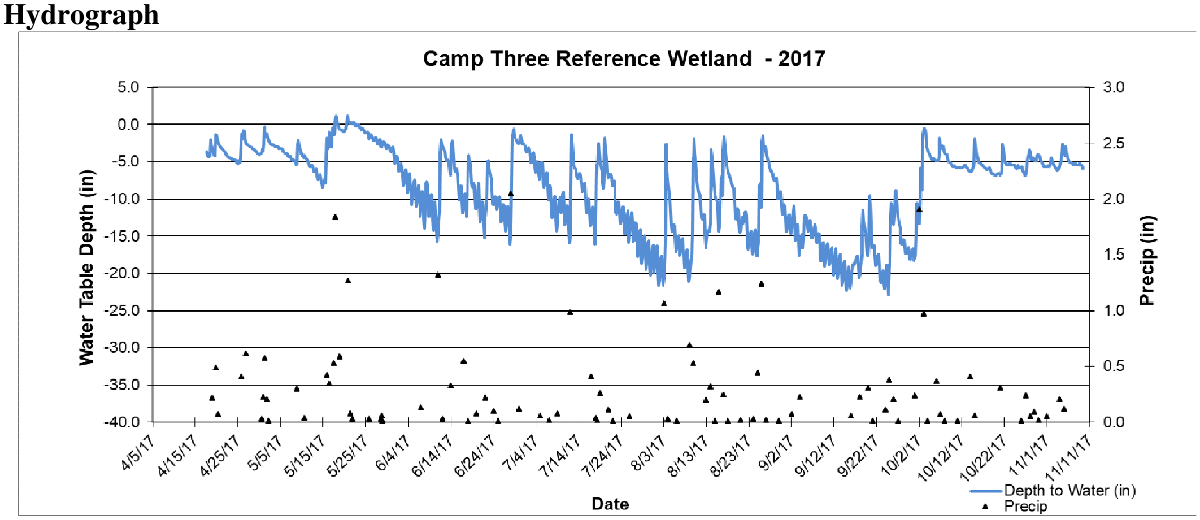
Surrounding Soils: Zimmerman Fine Sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Populus tremuloides (T)	Quaking Aspen	30
Acer negundo (S)	Boxelder	30
Acer rubrum (T)	Red Maple	10

Other Notes: This well is located at the wetland boundary. It maintained a consistent water level of -26 inches throughout summer 2008. This may have been due to water control structures elsewhere in the Carlos Avery Wildlife Management Area.

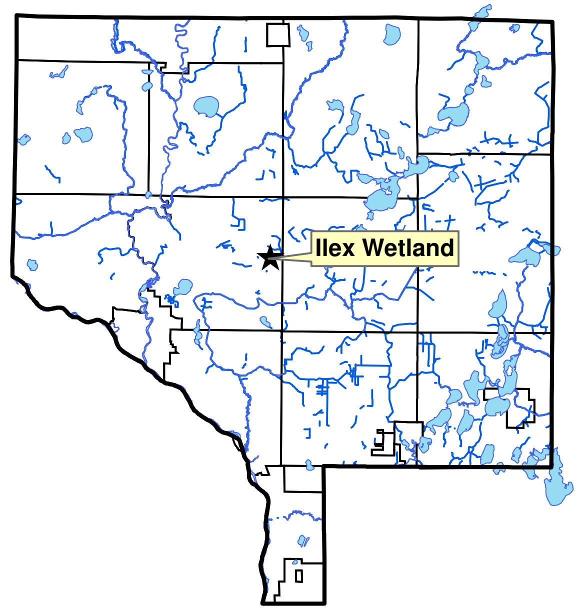
2017 Hydrograph



ILEX REFERENCE WETLAND - EDGE

City Park at Ilex St and 159th Ave, Andover

Site Information



Monitored Since: 1996

Wetland Type: 2

Wetland Size: ~9.6 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-10	10yr2/1	Fine Sandy Loam	-
Bg	10-14	10yr4/2	Fine Sandy Loam	-
2Ab	14-21	N2/0	Sandy Loam	-
2Bg1	21-30	10yr4/2	Fine Sandy Loam	-
2Bg2	30-45	10yr5/2	Fine Sand	-

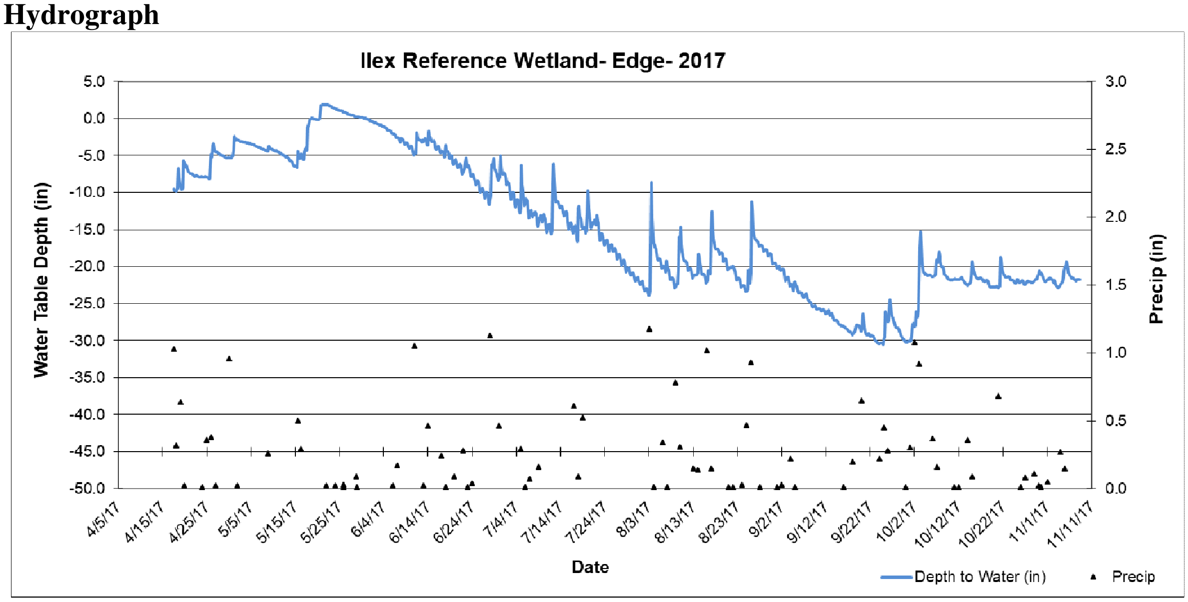
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Solidago gigantia	Giant Goldenrod	20
Populus tremuloides (T)	Quaking Aspen	20
Rubus strigosus	Raspberry	10

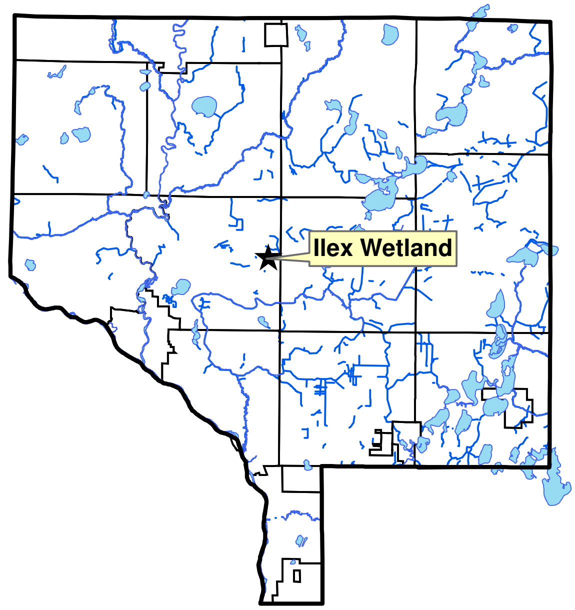
Other Notes: This well is located at the wetland boundary. In 2000-2005 the water table was only once within 15 inches of the surface and seldom within 40 inches. This prompted us to re-delineate the wetland and move the well down-gradient to the new wetland edge at the beginning of 2006. As a result, water levels post-2005 are not directly comparable to previous years.

2017 Hydrograph



Ilex Reference Wetland - MIDDLE

City Park at Ilex St and 159th Ave, Andover



Site Information

Monitored Since: 2006

Wetland Type: 2

Wetland Size: ~9.6 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa	0-9	N2/0	Organic	-
Bg1	9-19	10yr4/2	Fine Sandy Loam	-
Bg2	19-45	10yr5/2	Fine Sand	-

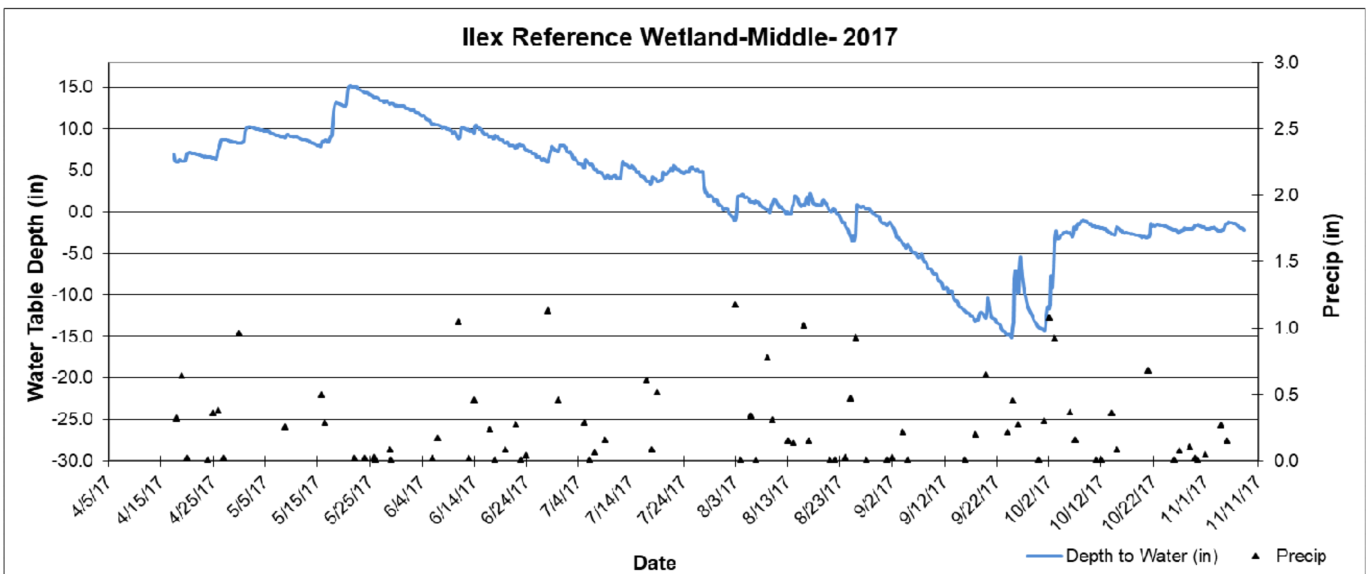
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	80
Typha angustifolia	Narrow-leaf Cattail	40

Other Notes: This well is located near the middle of the wetland basin.

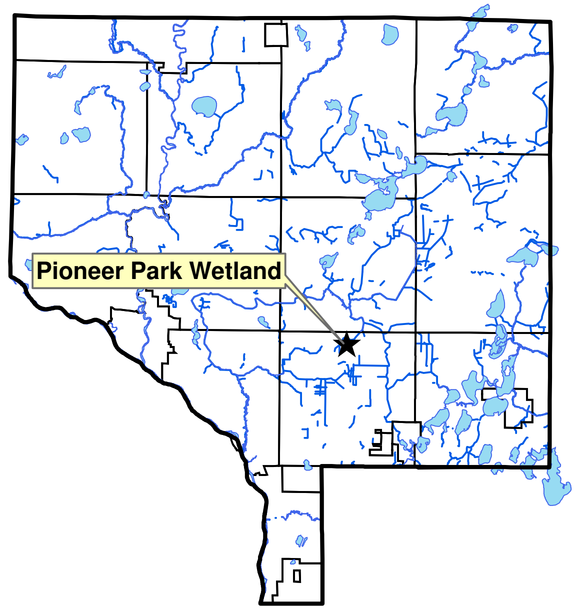
2017 Hydrograph



Wetland Hydrology Monitoring

PIONEER PARK REFERENCE WETLAND

Pioneer Park N Side of Main St. E of Radisson Road, Blaine



Site Information

Monitored Since: 2005

Wetland Type: 2

Wetland Size: Undetermined. Part of a large wetland complex.

Isolated Basin? No

Connected to a Ditch? Not directly.Wetland complex has small drainage ways, culverts, & nearby ditches.

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
Oa1	0-4	10yr 2/1	Sapric	-
Oa2	4-8	N 2/0	Sapric	-
AB	8-12	10yr 3/1	Mucky Sandy Loam	-
Bw	12-27	2.5y 5/3	Loamy Sand	-
Bg	27-40	2.5y 5/2	Loamy Sand	-

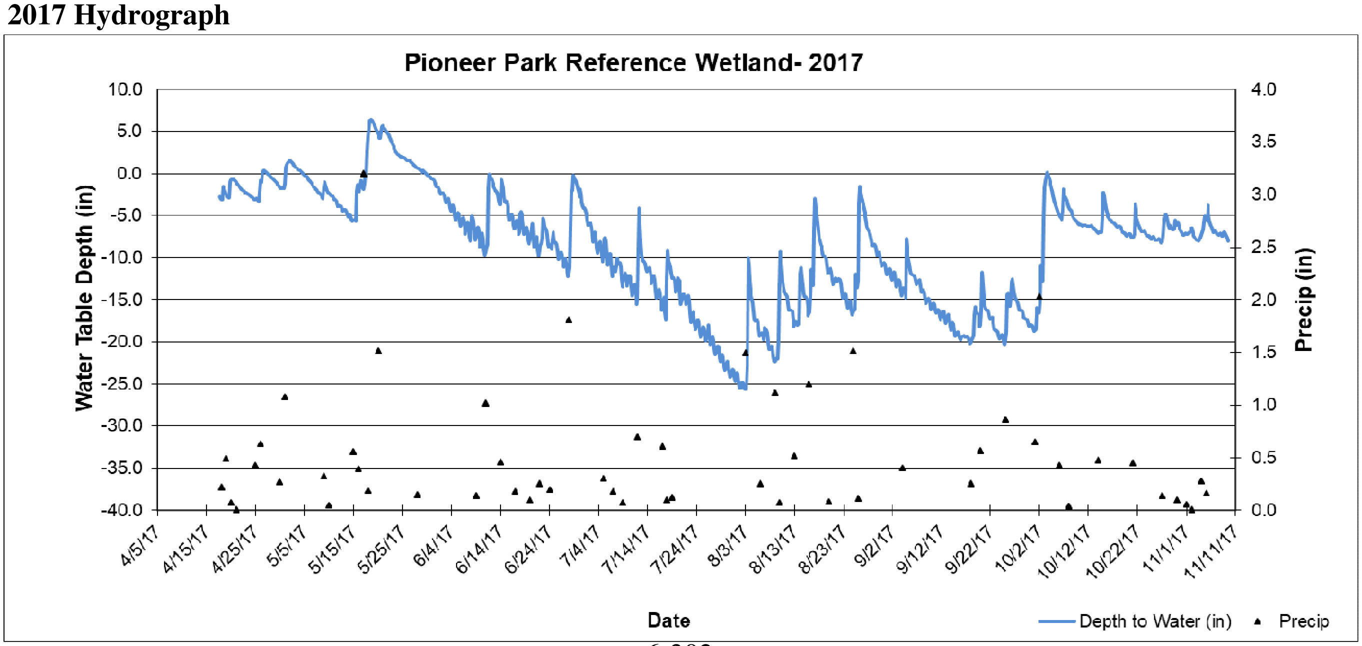
Surrounding Soils: Rifle and loamy wet sand.

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Carex lacustris	Lake Sedge	20
Fraxinus pennsylvanica (T)	Green Ash	30
Rhamnus frangula (S)	Glossy Buckthorn	20
Ulmus americana (T)	American Elm	20
Populus tremuloides (S)	Quaking Aspen	20
Urtica dioica	Stinging Nettle	10

Other Notes: This well is located within the wetland, not at the edge. City of Blaine surveyed calibration line 6-2013. Elevation = 897.366 (NGVD 29)

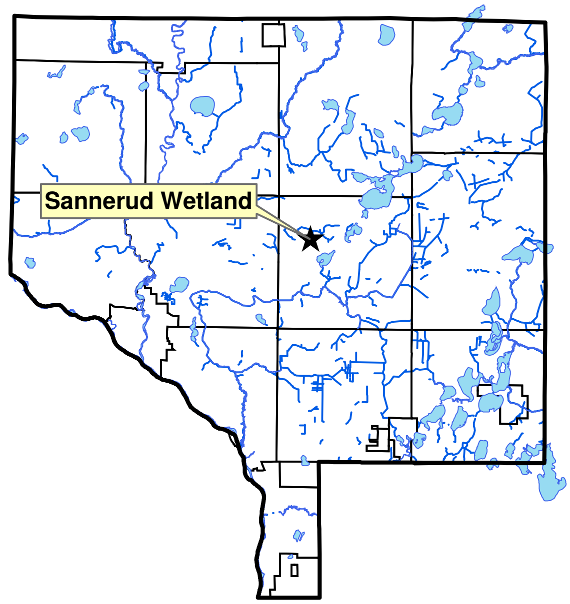
2017 Hydrograph



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	-

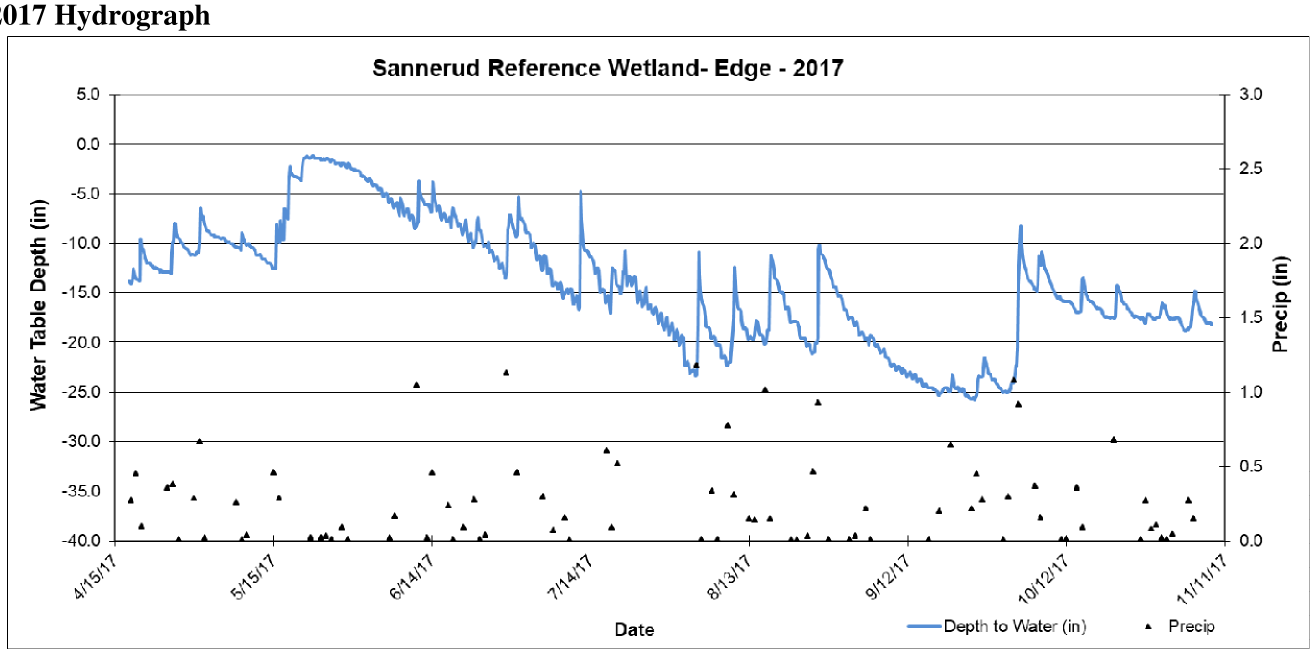
Surrounding Soils: Zimmerman and Lino.

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.

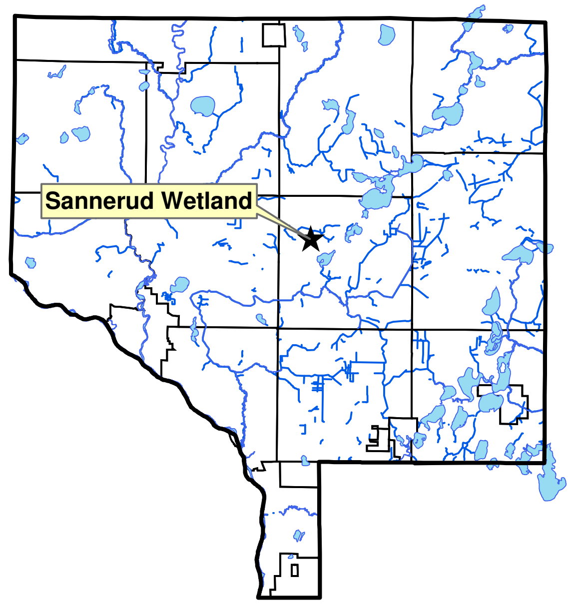
2017 Hydrograph



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	-

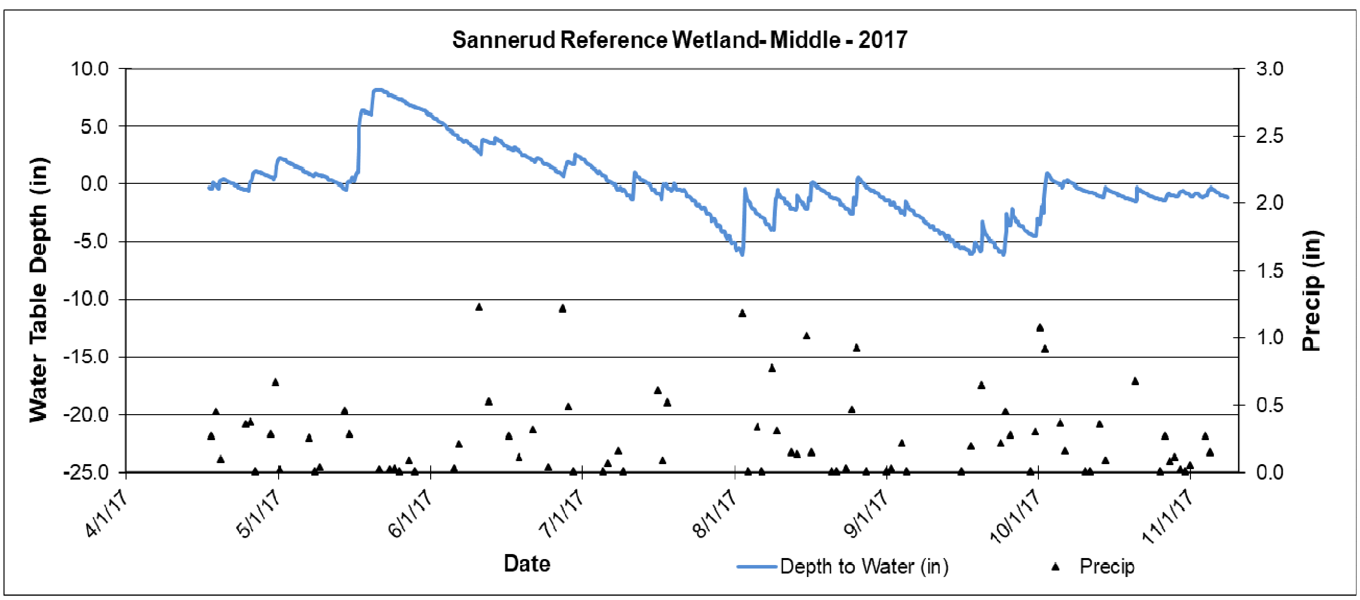
Surrounding Soils: Zimmerman and Lino.

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.

2017 Hydrograph



Reference Wetland Analyses

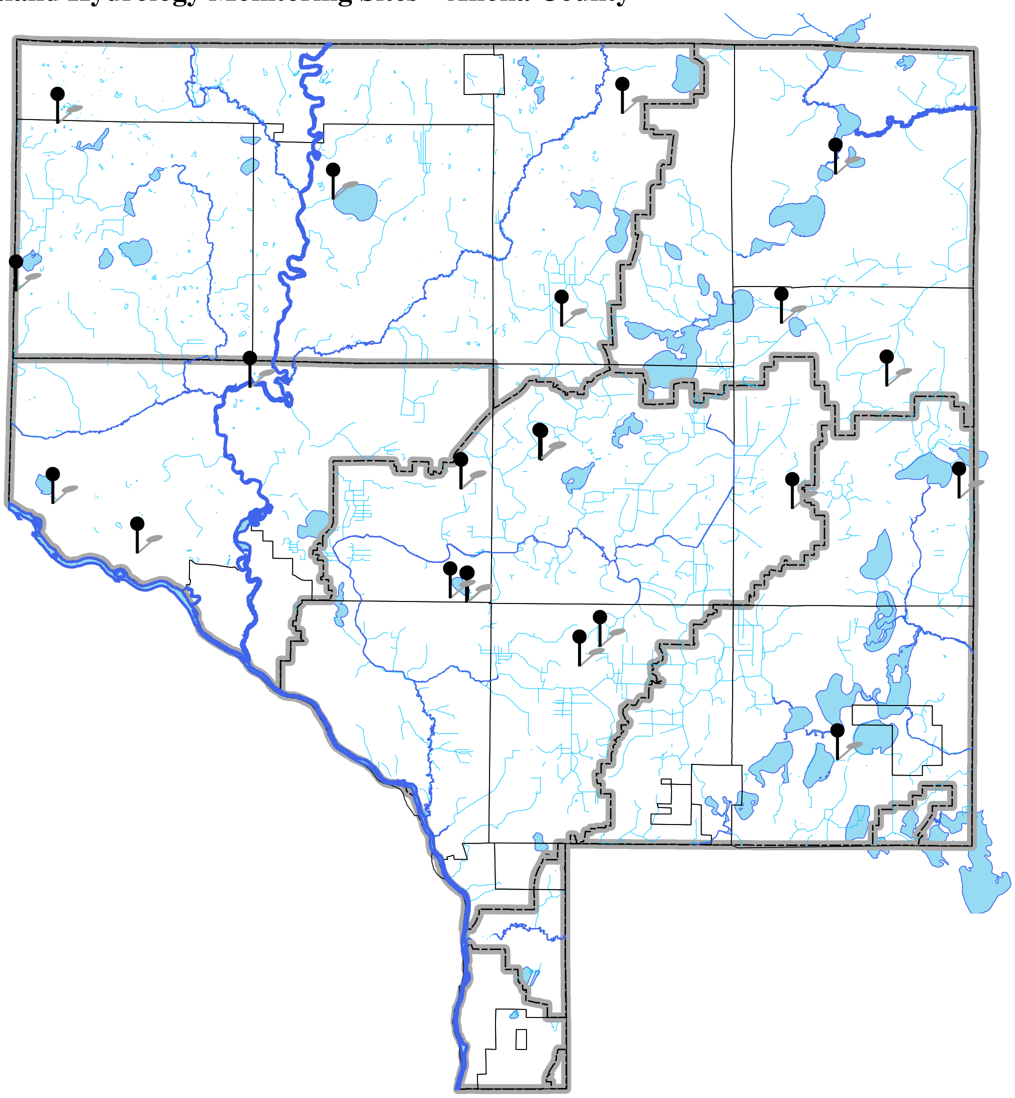
Description: This section includes analyses of wetland hydrology data of 22 reference wetland sites collected at 19 locations. Shallow groundwater levels at the edge of these wetlands are recorded every four hours. Many have been monitored since 1996. These analyses summarize this enormous multi-year, multi-wetland dataset. In the process of doing this analysis, a database summarizing all of these 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.

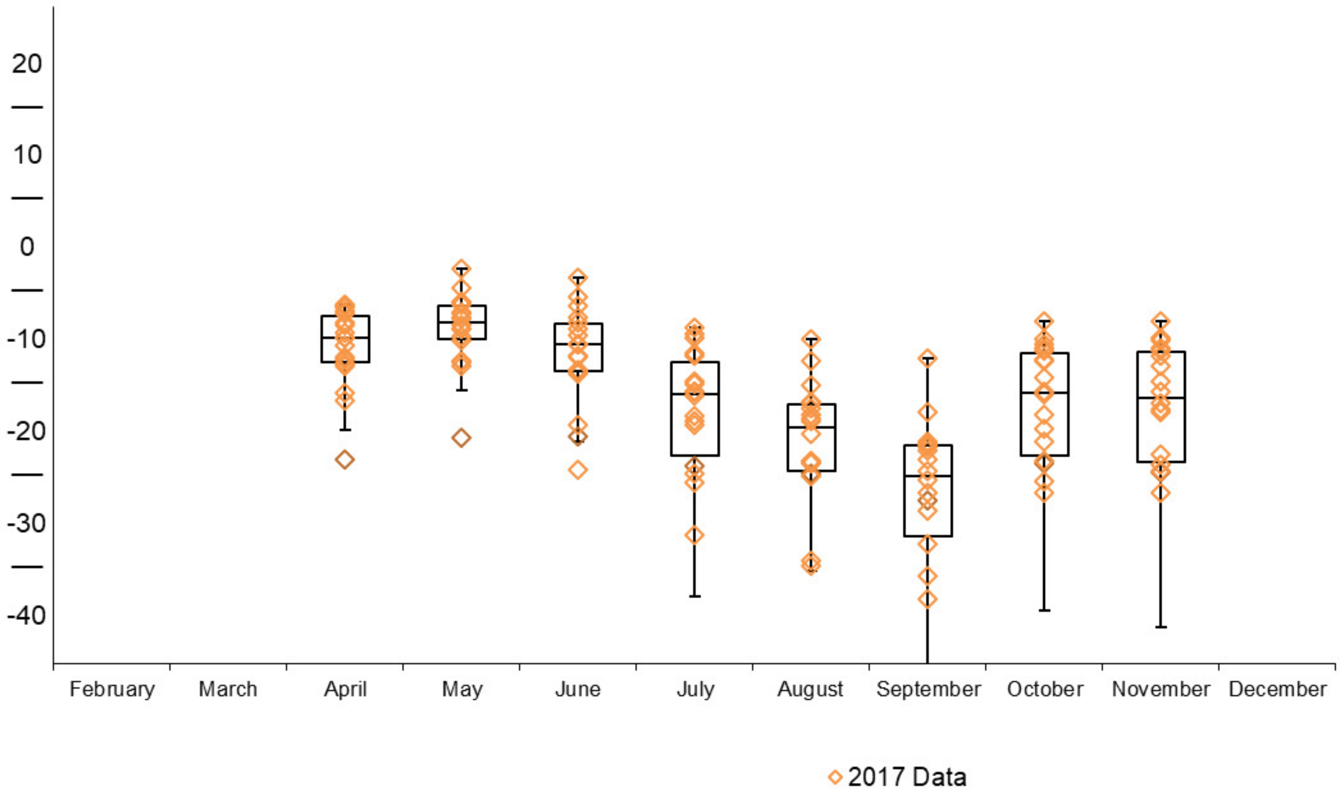
Locations: All 23 reference wetland hydrology monitoring sites in Anoka County.

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



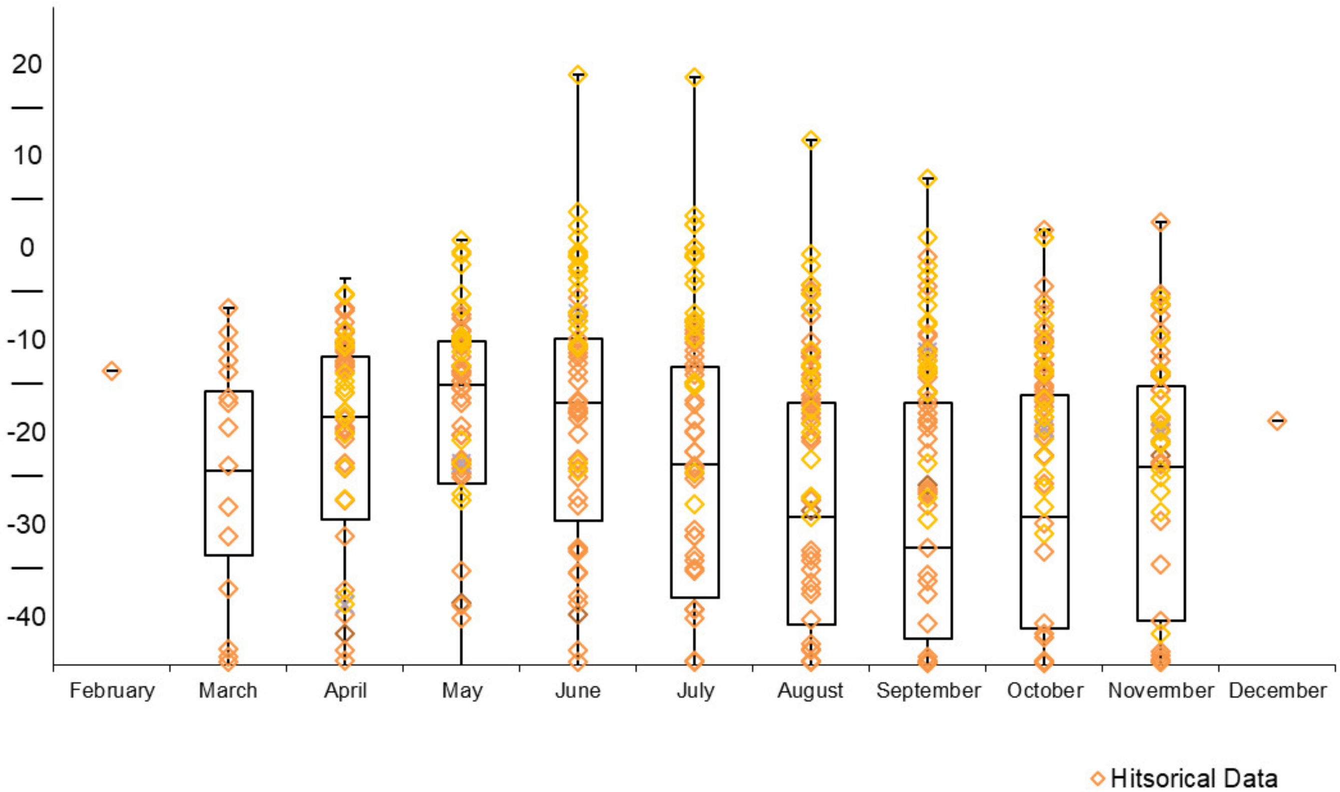
2017 Reference Wetland Water Levels Summary: Each marker represents the median depth to the water table at the edge of one reference wetland for a given month in 2017. The quantile boxes show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (floating horizontal 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	-18.2	-11.3	-7.8	-5.3	-2.9	-1.9	-1.7
5	-15.9	-8.0	-5.4	-3.6	-1.9	-1.0	2.2
6	-19.3	-14.9	-8.8	-5.9	-3.8	-1.5	1.1
7	-41.8	-22.4	-17.8	-11.2	-7.8	-5.1	-4.1
8	-41.8	-29.1	-19.4	-14.8	-12.3	-9.5	-5.4
9	-42.7	-35.7	-26.3	-19.9	-16.7	-15.4	-7.4
10	-41.9	-20.9	-17.8	-11.1	-6.8	-5.8	-3.5
11	-41.9	-20.3	-18.4	-11.6	-6.7	-5.4	-3.4

1996-2017 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 2017. 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	-34.2	-24.5	-13.6	-7.1	-3.5	1.2
5	-41.6	-32.3	-20.7	-10.2	-5.5	-2.1	5.3
6	-50.5	-36.6	-24.7	-12.0	-5.2	0.2	22.9
7	-67.9	-39.6	-32.8	-18.6	-8.2	-2.5	22.6
8	-50.3	-40.1	-35.7	-24.2	-12.1	-4.6	15.9
9	-48.8	-40.4	-37.2	-27.4	-12.1	-5.3	11.8
10	-45.0	-40.1	-36.0	-24.2	-11.2	-5.5	6.4
11	-46.9	-40.0	-35.3	-18.9	-10.3	-4.5	7.2
12	-14.0	-14.0	-14.0	-14.0	-14.0	-14.0	-14.0

Discussion:

The purpose of reference wetland Data are to help ensure that wetlands are accurately identified by regulatory personnel, as well as to aid understanding of shallow groundwater hydrology. State and federal laws place restrictions on filling, excavating, and other activities in wetlands. Commonly, citizens wish to do work in an area that is sometimes, or perhaps only rarely, wet. Whether this area is a wetland under regulatory definitions is often in dispute. Complicating the issue is that conditions in wetlands are constantly changing—an area that is very wet and clearly wetland at one time may be completely dry only a few weeks later (dramatically displayed in the graphs above). As a result, regulatory personnel look at a variety of factors, including soils, vegetation, and current moisture conditions. Reference wetland data provide a benchmark for comparing moisture conditions in dispute, thereby helping assure accurate regulatory decisions. Likewise, it allows us to compare current shallow water levels to the range of observed levels in the past; this is useful for purposes ranging from flood prediction to drought severity indexing. The analysis of reference wetland Data are a quantitative, non-subjective tool.

The simplest use of the reference wetland data in a regulatory setting is to compare water levels in the reference wetlands to water levels in a disputed area. The graphics and tables above are based upon percentiles of the water levels experienced at known wetland boundaries. The quantile boxes in the figures delineate the 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentiles. Water table depths outside of the box have a low likelihood of occurring, or may only occur under extreme circumstances such as extreme climate conditions or in the presence of anthropogenic hydrologic alterations. If sub-surface water levels in a disputed area are similar to those in reference wetlands, there is a high likelihood that the disputed area is a wetland.

This approach can be refined by examining data from only the year of interest and only certain wetland types. This removes much of the variation that is due to climatic variation among years and due to wetland type. Substantial variation in water levels will no doubt remain among wetlands even after these factors are accounted for, but this exercise should provide a reasonable framework for understanding what hydrologic conditions were present in known wetlands during a given time period.

Water table levels are recorded every 4 hours at all 23 reference wetlands (except during winter), and the raw water level data are available through the Anoka Conservation District.

Aquatic Invasive Species Early Detection Surveys

Description: AIS early detection surveys are conducted twice annually on four lakes within Coon Creek Watershed District (CCWD). ACD conducts a meandering boat survey on each lake in early and late summer. During the surveys, ACD staff weave between the shoreline and maximum rooting depth around the entire lake. In lakes shallow enough for plants to root throughout, meanders are made from shoreline to shoreline. Invasive aquatic vegetation is searched for from the boat and using a weed rake. Any new infestations to each lake are noted and CCWD staff are notified.

Purpose: To detect new AIS in CCWD lakes

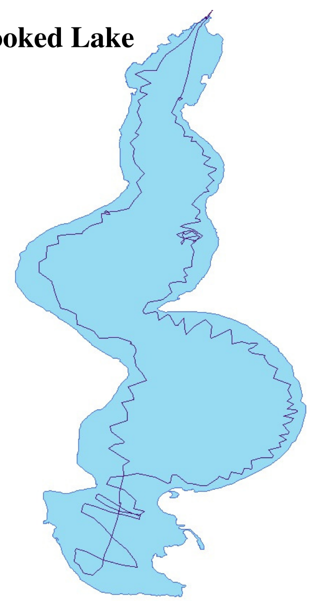
Locations:

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

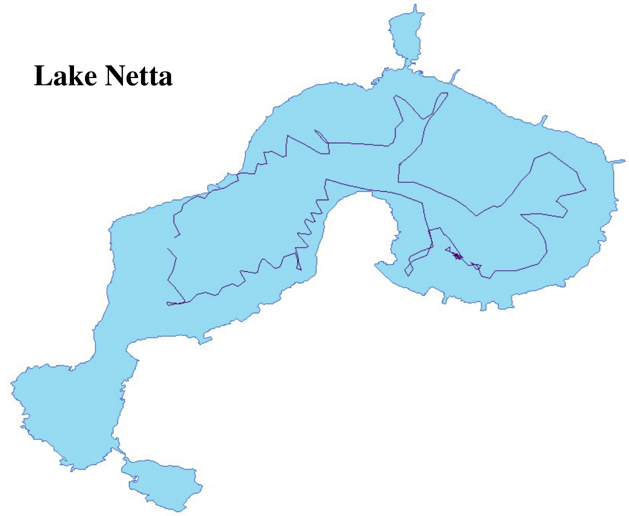
Results: Surveys were conducted on 5/25/2017 and 9/13/2017. No new infestations were discovered in 2017.

Meandering boat tracks in each lake from 9/13/2017 survey. Lakes are not depicted to scale.

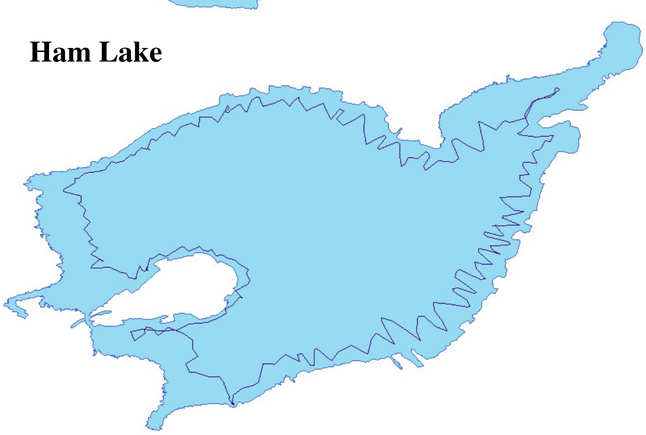
Crooked Lake



Lake Netta



Ham Lake



Laddie Lake

Oak Glen Creek Pond Expansion and IESF Retrofit

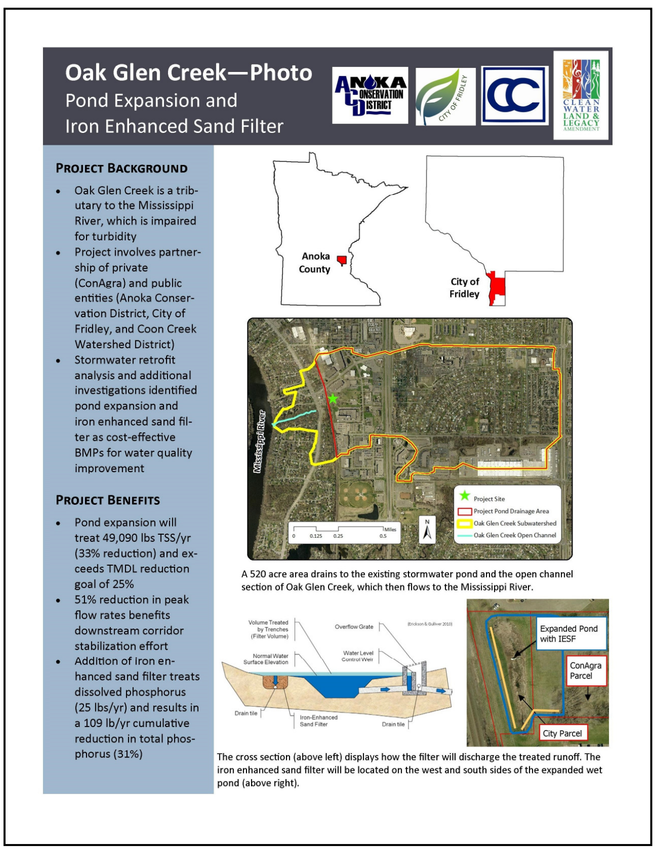
Description: In partnership with the City of Fridley and Coon Creek Watershed District, the Anoka Conservation secured a Clean Water Fund Grant to expand a stormwater pond in the Oak Glen Creek sub-watershed, and install an Iron Enhanced Sand Filter (IESF) bench. The small sub-watershed drains directly to a portion of the Mississippi River that is designated as impaired for excessive nutrients and turbidity. The pond is located near the bottom of the sub-watershed, receiving water from 90% of the total drainage. The pond expansion and IESF will reduce sediment discharge by Oak Glen Creek to the Mississippi by 49,090 pounds (33%) annually, exceeding the TMDL reduction goal of 25%. Additionally, the project will remove 109 pounds of total phosphorus (31%) per year.

This project will additionally reduce peak discharge rates by 51%, bolstering a previous project completed in 2013 that stabilized a ¼-mile segment of creek that was washing out considerable portions of the 20-30 foot cliffs it flows through on its descent to the Mississippi.

Purpose: Reduce phosphorus and sediment delivery to an impaired section of the Mississippi River from the Oak Glen Creek sub-watershed.

Results: The expanded pond will reduce sediment delivery to the Mississippi River by 49,090 lbs/year and phosphorus delivery by 84 lbs/year. The IESF will reduce phosphorus by an additional 25 lbs/year resulting in 109 lbs/year of phosphorus reduction annually.

Project Grant Application Photo



IESF Installation and Completion photos

Financial Summary

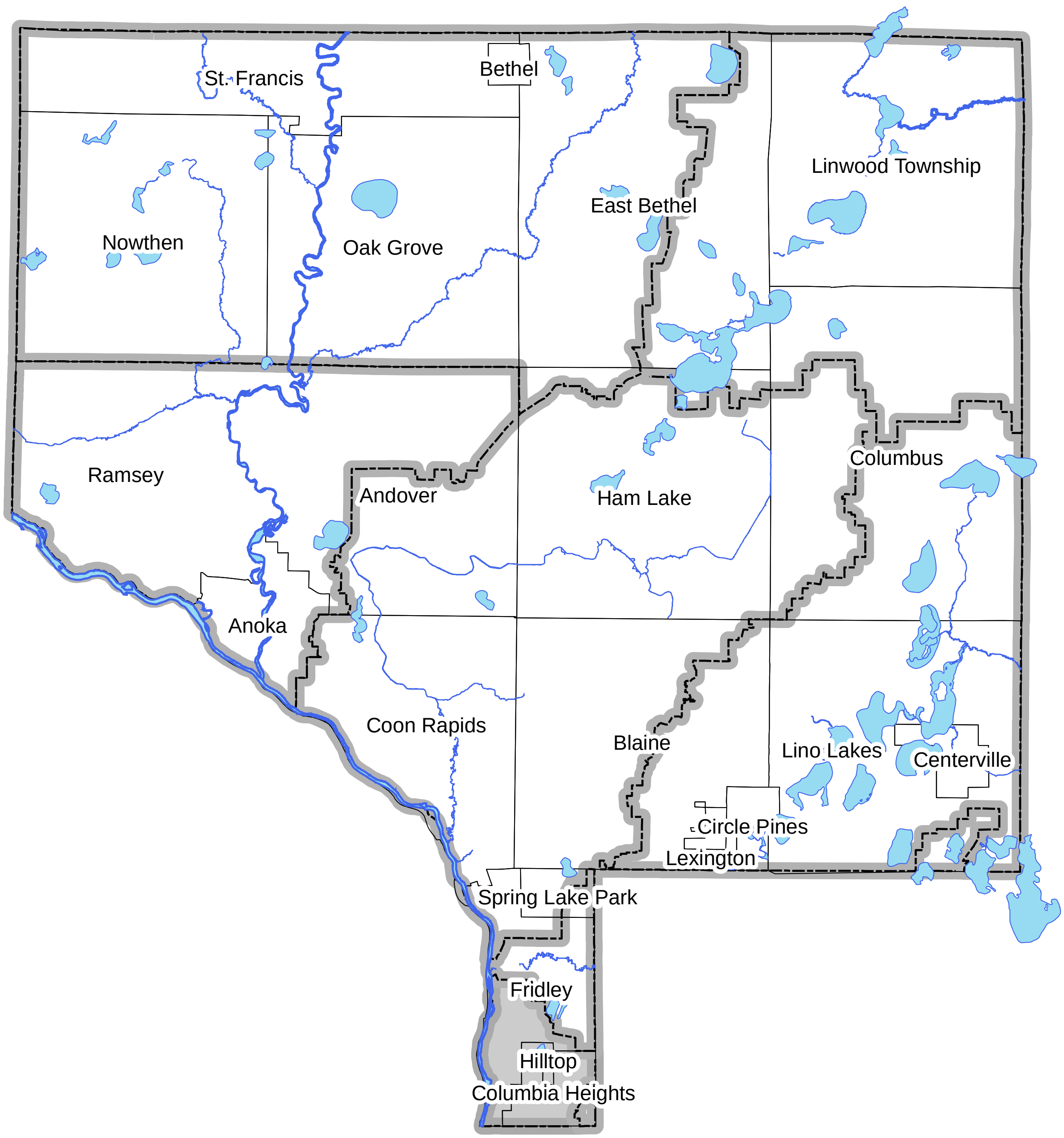
ACD accounting is organized by program and not by customer. This allows us to track all of the labor, materials and overhead expenses for a program, such as our lake water quality monitoring program. We do not, however know specifically which expenses are attributed to monitoring which lakes. To enable 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 Precip". Likewise, all reference wetland work, including monitoring, analysis, and vegetation mapping, are grouped as "Reference Wetlands".

Coon Creek Watershed Financial Summary

Coon Creek Watershed	County, City, SWCD Asst (no charge)	Volunteer Precip	CCWD Precip	Reference Wetlands	DNR Groundwater Wells	Lake Levels	Lake Water Quality	Stream Levels	Stream Water Quality	CCWD YSI/Hydrolab	Oak Glen Pond/IESF	AIS CCWD Early Detection	Total
Revenues													
CCWD			5551	4875		1200	5250	5850	#####	4200		1067	59455
State - Other					490						517780		518270
MPCA													0
DNR OHF													0
DNR CPL													0
BWSR Cons Delivery	1377				517								1894
BWSR Capacity Staff													0
BWSR Capacity Direct													0
BWSR Cost Share													0
BWSR Cost Share TA													0
BWSR Local Water Planning		365					247	1669		1082		745	4108
Metro ETA & NPEAP											1855		1855
Metro AWQCP													0
Regional/Local											11500		11500
Anoka Co. General Services	1109										2055		3165
County Ag Preserves/Projects													0
Service Fees													0
Investment Dividend													0
Rents													0
Product Sales													0
TOTAL	2487	365	5551	4875	1007	1200	5497	7519	31462	5282	533190	1812	600246
Expenses-													
Capital Outlay/Equip	61	16	309	116	69	48	211	211	483	211	184	53	1973
Personnel Salaries/Benefits	2244	299	3736	3316	803	1160	3464	6067	9671	4379	12244	1569	48950
Overhead	88	20	334	250	71	68	235	477	679	315	416	80	3034
Employee Training	10	1	31	28	5	6	26	49	52	36	62	8	314
Vehicle/Mileage	28	5	81	101	17	22	72	170	228	109	122	34	989
Rent	56	11	196	176	42	42	173	274	434	220	214	68	1904
Project Installation											517780		517780
Project Supplies		12	49	41		13	1317	312	6188	11			7943
McKay Expenses													0
TOTAL	2487	365	4737	4027	1007	1359	5497	7560	17734	5282	531022	1812	582887
NET	0	0	814	848	0	-159	0	-41	13728	0	2168	0	17359

Mississippi Watershed



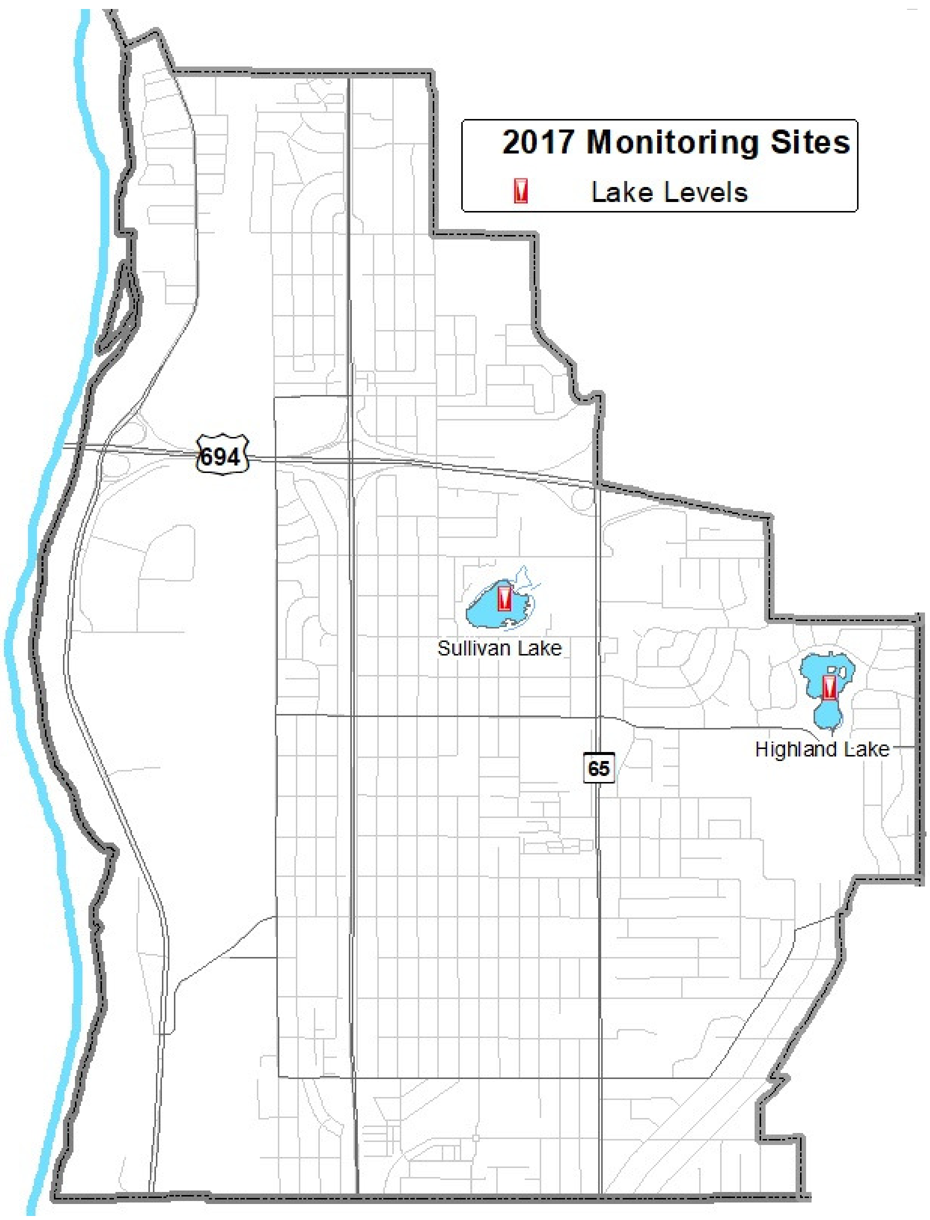
Contact Info: Mississippi Watershed Management Organization
www.mwmo.org
612-465-8780

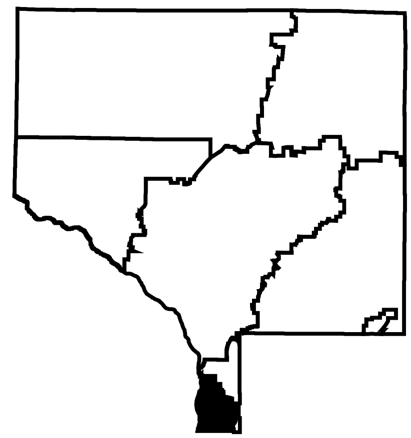
Anoka Conservation District
www.AnokaSWCD.org
763-434-2030

MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

Monitoring	Partners	Page
Lake Levels	ACD, MNDNR, volunteers	7-314
Financial Summary		7-315
Recommendations		7-315

ACD = Anoka Conservation District, MNDNR = Minnesota Department of Natural Resources,
MWMO = Mississippi Watershed Management Organization, ACAP = Anoka County Ag Preserves





Lake Levels

Description: Weekly water level monitoring in lakes. These data, as well as all additional historical data are available on the Minnesota DNR website using the “LakeFinder” feature (www.dnr.mn.us.state\lakefind\index.html).

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

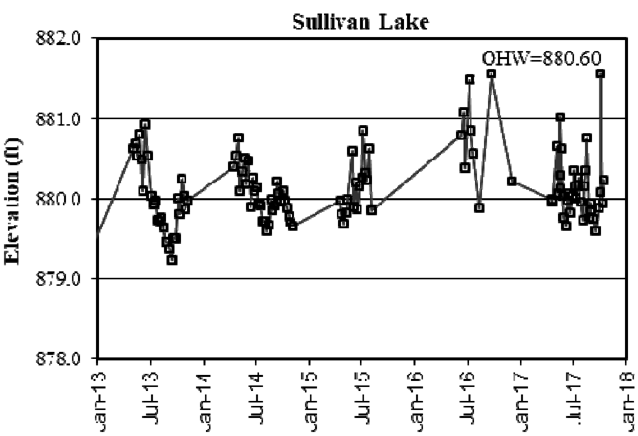
Locations: Sullivan/Sandy Lake

Highland Lake

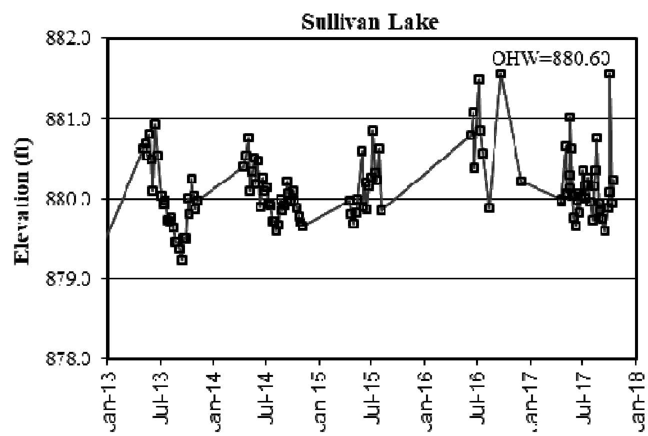
Results: Lake levels were measured 35 times at each lake April through October of 2017. Sullivan Lake water levels fluctuate widely, routinely bouncing by half a foot in response to rainfall and fluctuating just under 2 feet (1.96’) over 2017. Sullivan Lake experiences these fluctuations because it receives a large amount of storm water relative to its size, and its outlet releases water in all but the lowest water conditions. Highland Lake fluctuated very little only ranging 0.57 ft. total throughout the season.

Raw lake level data for all sites and all years can be downloaded from the Minnesota DNR website using the "LakeFinder" tool. Ordinary High Water Levels (OHW), the elevation below which a DNR permit is needed to perform work, are listed for each lake on the graph below.

Sullivan/Sandy lake levels last 5 years



Sullivan/Sandy Lake Levels 1999-2017



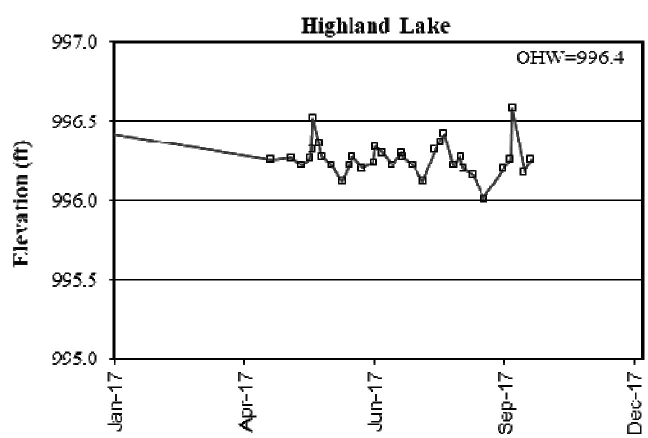
Sullivan/Sandy Lake level 5 year summary

Year	Average	Min	Max
2013	880.00	879.23	880.93
2014	880.05	879.60	880.76
2015	880.14	879.69	880.85
2016	880.76	879.88	881.56
2017	880.13	879.60	881.56
5-year	880.13	879.23	881.56

Highland Lake level 2016-2017 summary

Year	Average	Min	Max
2016	996.40	996.24	996.75
2017	996.27	996.01	996.58

Highland Lake levels 2016-2017



Financial Summary

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MWMO 2017 Financial Summary

Mississippi WMO	Lake Levels	Total
Revenues		
MWMO	600	600
State - Other		0
MPCA		0
DNR OHF		0
DNR CPL		0
BWSR Cons Delivery		0
BWSR Capacity Staff		0
BWSR Capacity Direct		0
BWSR Cost Share		0
BWSR Cost Share TA		0
BWSR Local Water Planning		0
Metro ETA & NPEAP		0
Metro AWQCP		0
Regional/Local		0
Anoka Co. General Services		0
County Ag Preserves/Projects		0
Service Fees		0
Investment Dividend		0
Rents		0
Product Sales		0
TOTAL	600	600
Expenses-		
Capital Outlay/Equip	19	19
Personnel Salaries/Benefits	464	464
Overhead	27	27
Employee Training	2	2
Vehicle/Mileage	9	9
Rent	17	17
Project Installation		0
Project Supplies	5	5
McKay Expenses		0
TOTAL	544	544
NET	56	56

Recommendations

- Continue to monitor levels on Highland and Sullivan Lakes.
- Periodically monitor water quality on Highland and Sullivan Lakes.
- Investigate storm water conveyances draining to both Highland and Sullivan Lake and determine ways to incrementally improve the water that reaches them.