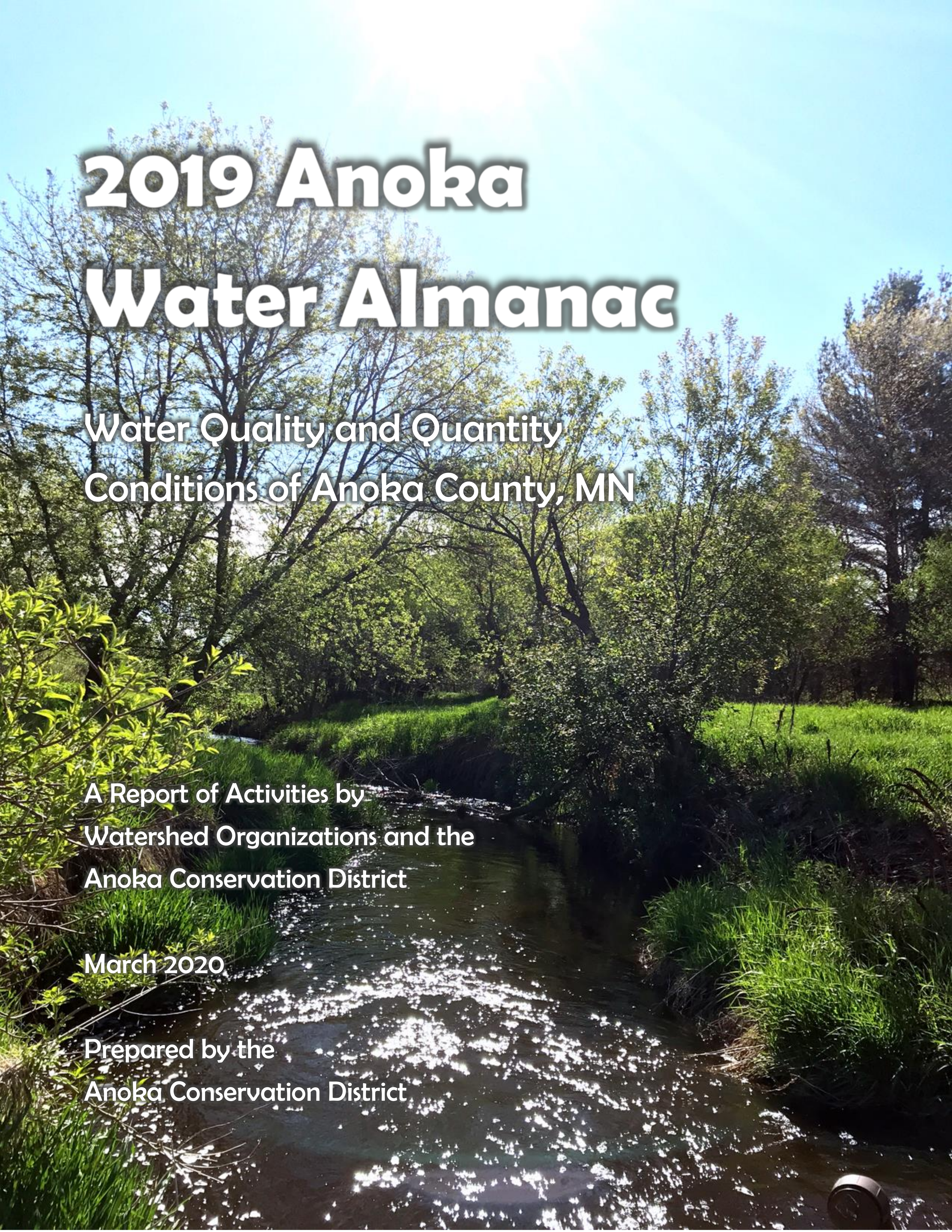


2019 Anoka Water Almanac

Water Quality and Quantity Conditions of Anoka County, MN

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

March 2020

Prepared by the
Anoka Conservation District

2019 ANOKA WATER ALMANAC

Water Quality & Quantity Conditions of Anoka County, Minnesota

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

March 2020

Prepared by:
Kris Larson
Water Resource Technician
1318 McKay Drive NE, Suite 300
Ham Lake, MN 55304
(763) 434-2030
Kris.Larson@AnokaSWCD.org

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

EXECUTIVE SUMMARY AND ORGANIZATION OF THIS REPORT

This report summarizes water resources management and monitoring work done as a cooperative effort between the Anoka Conservation District (ACD) and watershed districts or watershed management organizations. 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.

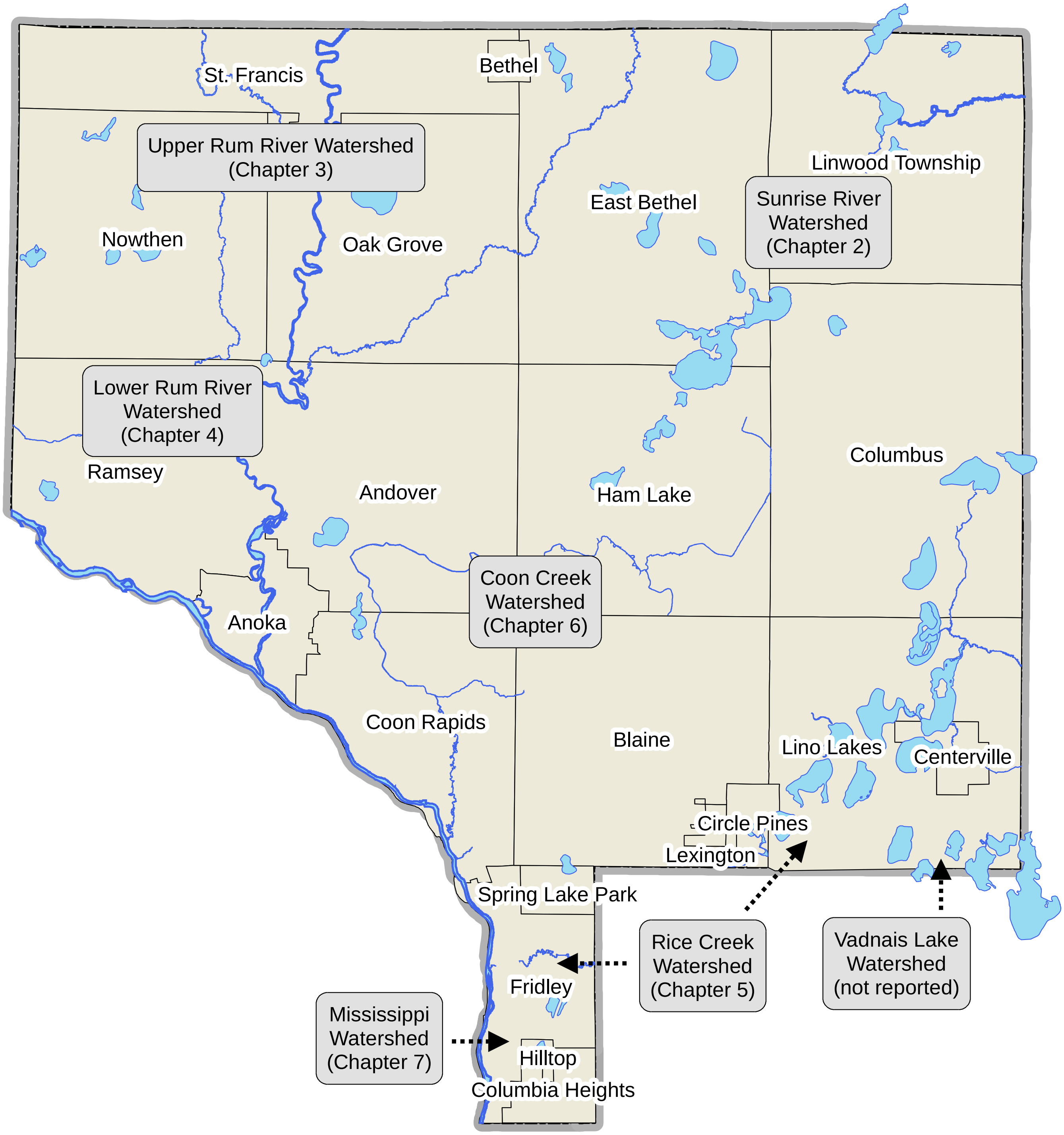
The water resource management and monitoring work reported here include:

- 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 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 2018. 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 2018 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 2018 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.

TABLE OF CONTENTS

Chapter 1 – Primer



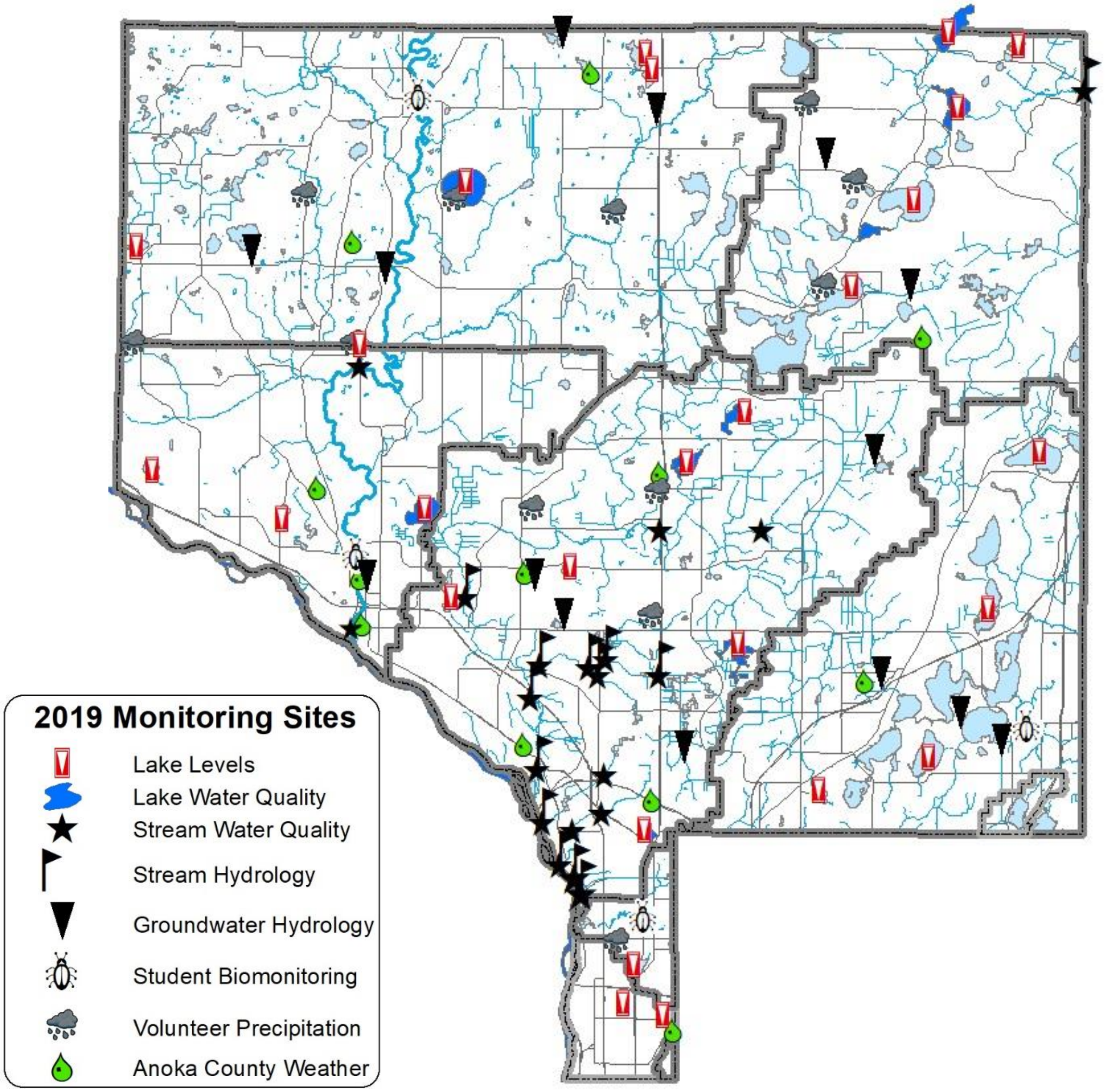
Contact Info: Anoka Conservation District
www.AnokaSWCD.org
763-434-203

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.

2019 Water Monitoring Sites



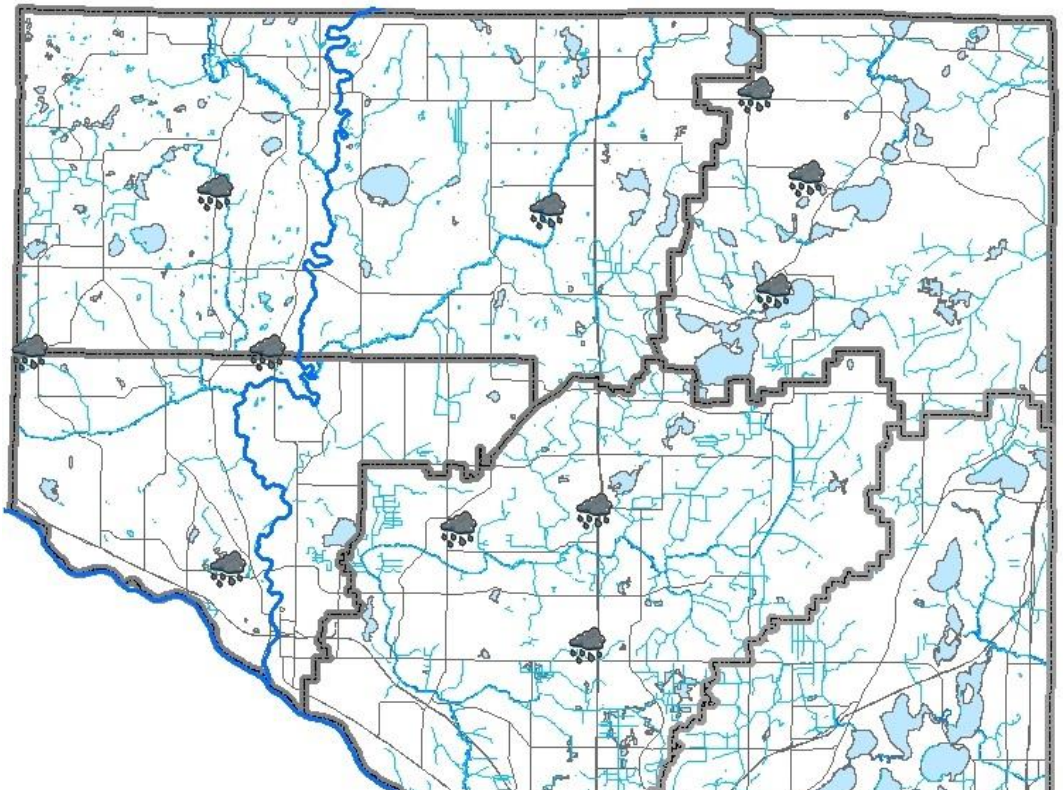
Precipitation

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 13 rain gauges countywide, which are monitored by volunteers, including one at the ACD office. The volunteer-operated stations are cylinder-style rain gauges located at the volunteer's home. Total rainfall is read daily. 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. One volunteer reader was inactive in 2019.

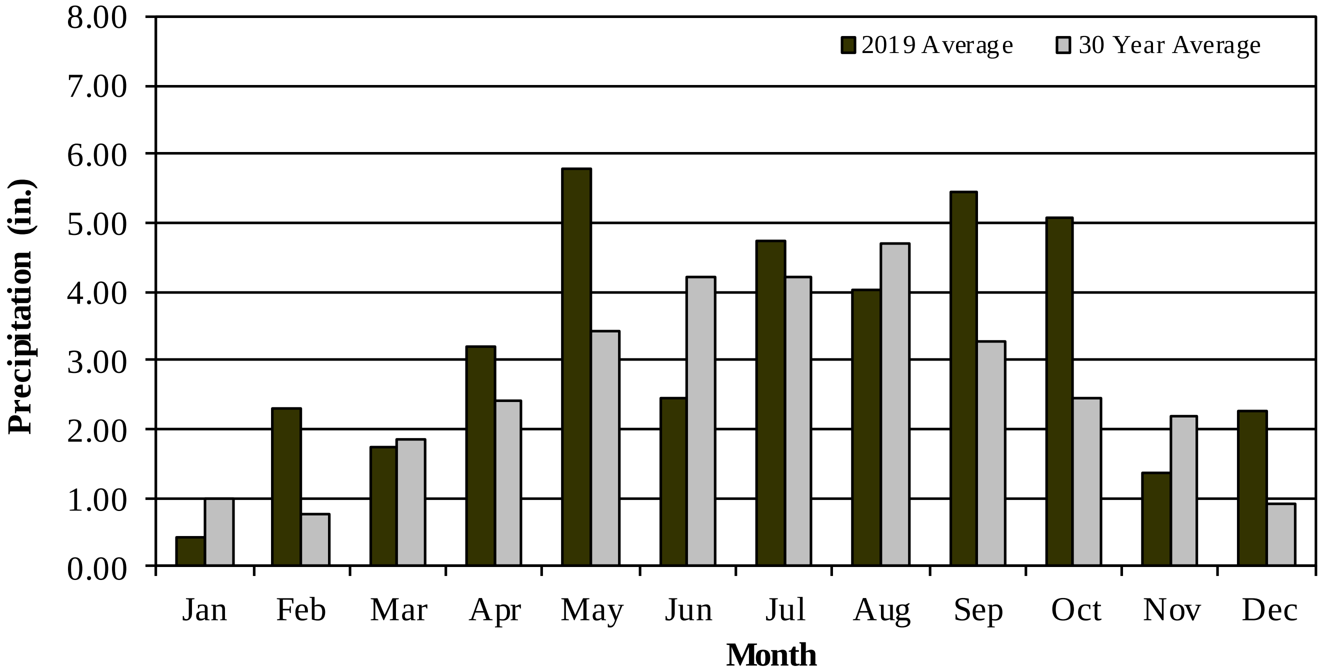
2019 Precipitation Monitoring Sites



Tipping bucket rain gauge.

Cylinder rain gauge.

2019 Anoka County Average Monthly Precipitation (average of all sites)



2019 Anoka County Monthly Precipitation at Each Monitoring Site

Location or Volunteer	City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total	Growing Season (May-Sept)
BYRG, DNR, and NWS data															
30N 24W 3 DNR	Fridley	0.51	2.60	2.12	3.79	5.76	2.51	5.39	5.25	5.11	5.07	1.70	2.30	42.11	24.02
30 24 14 BYRG	Fridley	0.48	2.52	2.15	3.84	6.12	2.75	5.39	5.36	4.94	5.12	1.68	2.22	42.57	24.56
32 22 14 BYRG	Columbus	0.39	2.46	1.66	3.71	5.59	2.04	5.16	3.83	5.36	4.78	1.4	2.59	38.97	21.98
32 24 23 NWS	Andover	0.46	2.30	1.81	3.73	6.13	2.29	4.72	4.58	5.09	5.37	1.43	2.26	40.17	22.81
34N 23W 36 BYRG	East Bethel													0.00	0.00
Cylinder rain gauges (read daily)															
N. Myhre	Andover	0.50	2.45	1.83	3.38	6.30	2.16	4.43	4.44	3.60	7.22	1.35	2.45	40.11	20.93
J. Rufsvold	Burns				3.03	5.35	2.91	4.19	3.31	4.54	5.51			28.84	20.30
J. Arzdorf	Blaine				2.52	7.33	2.78	5.62	6.61	6.03	5.47			36.36	28.37
P. Arzdorf	East Bethel				3.83	5.94	2.45	3.90	3.35	6.45	5.40			31.32	22.09
A. Mercil	East Bethel	0.14	1.10	1.32	2.83	3.44	2.04	4.08	3.11	5.48	3.89	0.82	1.84	30.09	18.15
K. Ackerman	Fridley	0.4	2.35	2.20	4.00	6.41	3.36	5.30	5.22	4.76	4.94	2.26	2.06	43.26	25.05
B. Myers	Linwood				2.37	3.31	1.67	3.39	2.38	7.16	3.53			23.81	17.91
B. Barkhoff	Nowthen				1.79	7.43	3.35	4.79	2.69	6.20				26.25	24.46
S. Mizell	Ramsey													0.00	0.00
ACD Office	Ham Lake				3.16	6.48	2.07	5.33	4.13	5.58	5.09			31.84	23.59
Y. Lyrenmann	Ramsey				2.86	6.32	3.08	4.92	3.88	4.47	3.86	0.35		29.74	22.67
T. Isaacson						4.89	2.06	5.05	3.37	5.51	5.31			26.19	20.88
S. LeMay	East Bethel	0.50	2.58	0.87		5.61	1.88	4.08	2.73	6.68	5.54			30.47	20.98
2019 Average	County-wide	0.42	2.30	1.75	3.20	5.78	2.46	4.73	4.02	5.44	5.07	1.37	2.25	38.78	22.42
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

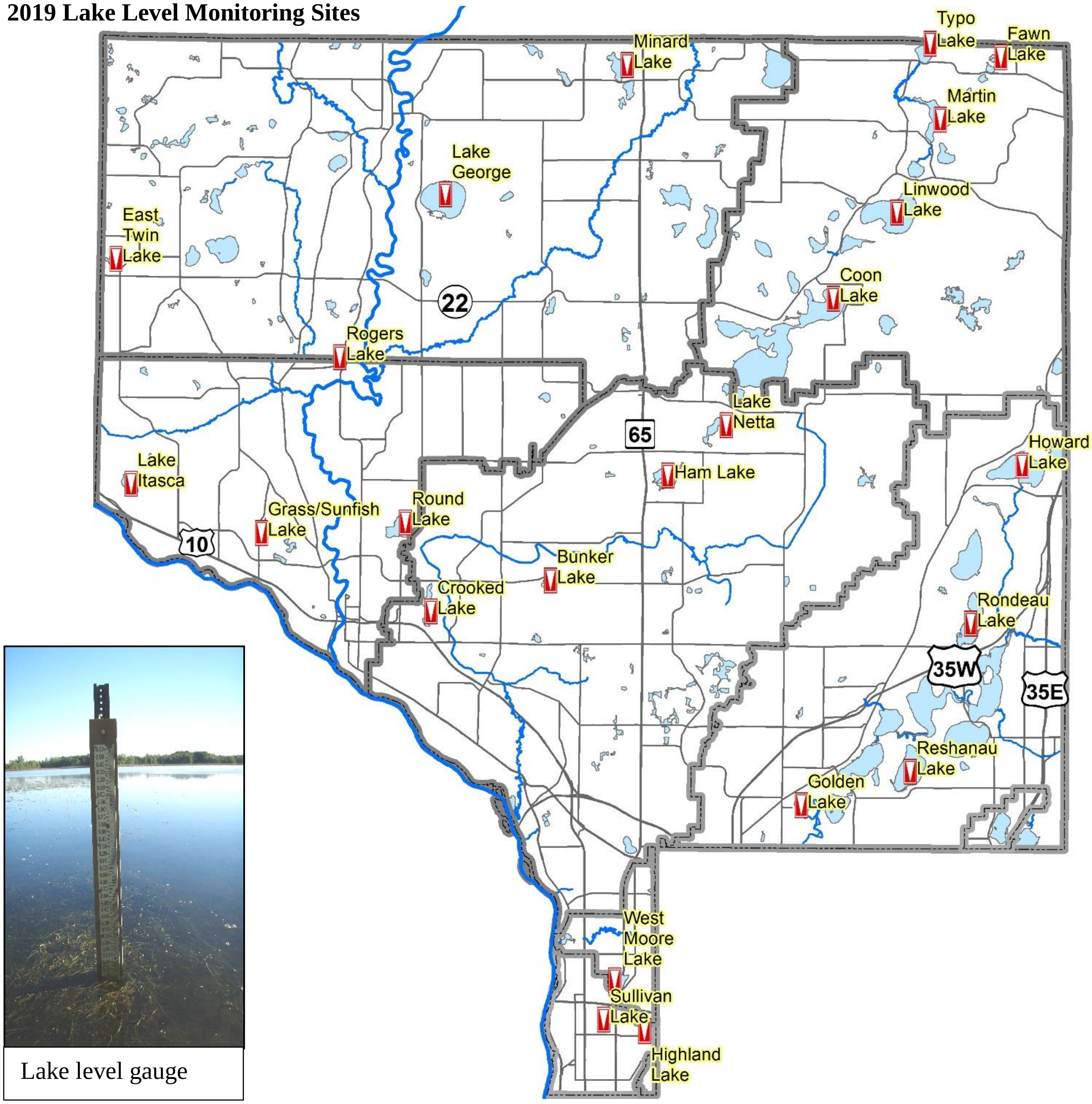
Lake Levels

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 25 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.

2019 Lake Level Monitoring Sites



Lake level gauge

Stream Hydrology

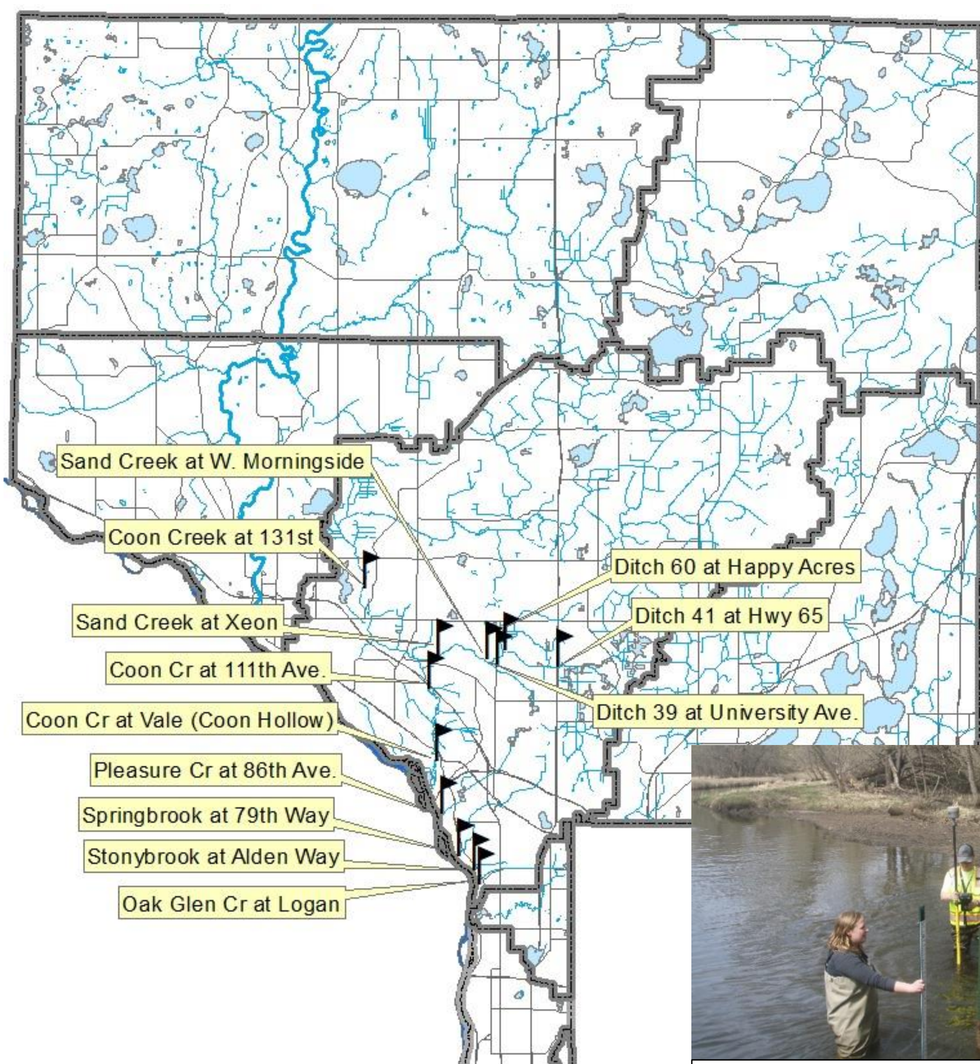
Hydrology is the study of water quantity and movement. Records of the quantity of water flowing in a stream helps engineers and natural resource managers better understand the effects of rain events, land development and storm water management. This information is also often paired with water quality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

The ACD monitored hydrology at 12 stream sites in 2019. Each site is equipped with an electronic gauge that records water levels every hour, except for two sites where levels were recorded every 15 minutes. 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, including 3 new rating curves developed this year. 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.

2019 Stream Hydrology Monitoring Sites



Stream gauge setup.

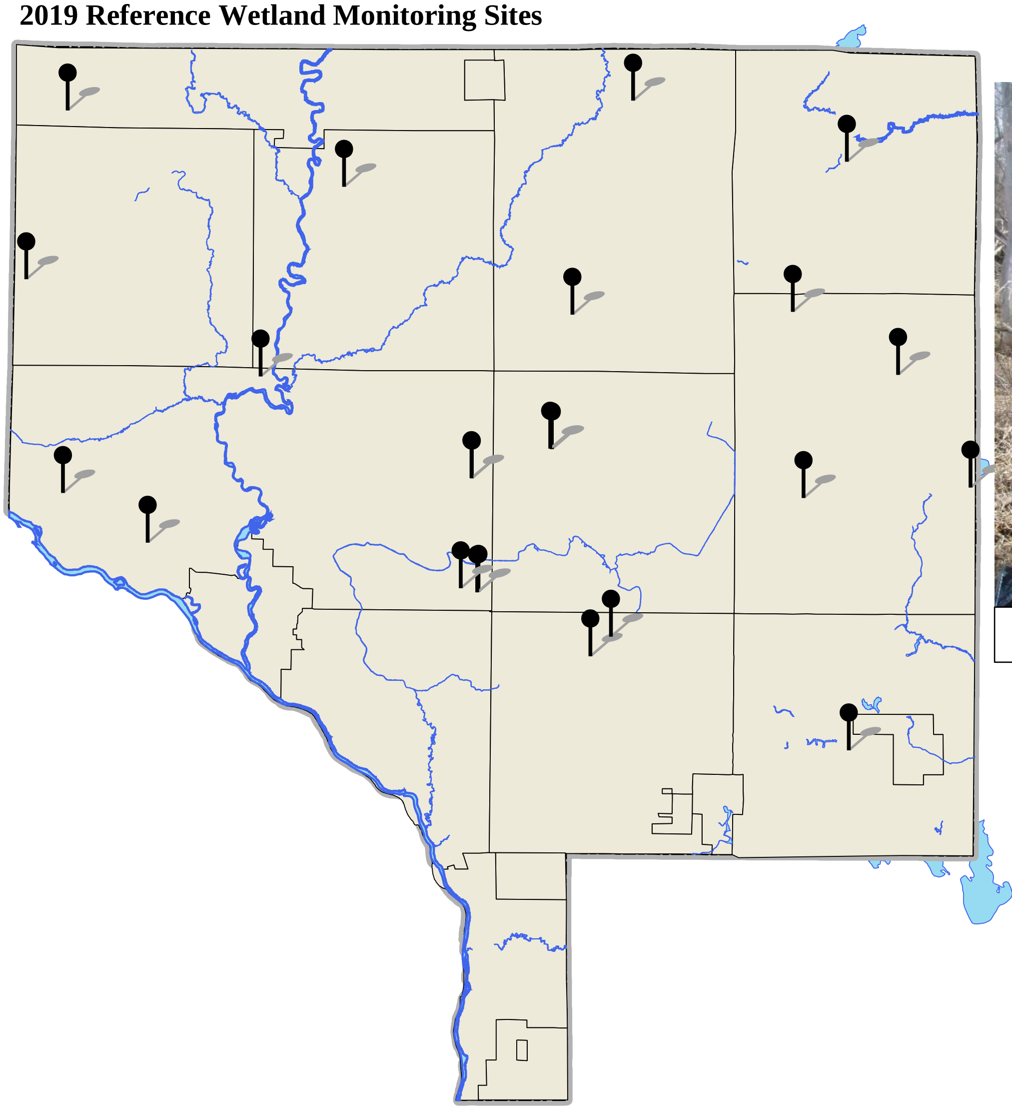
Wetland Hydrology

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, especially at the surface. 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 and wetland data can help speak to this.

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.

2019 Reference Wetland Monitoring Sites



Wetland gauge deploy.

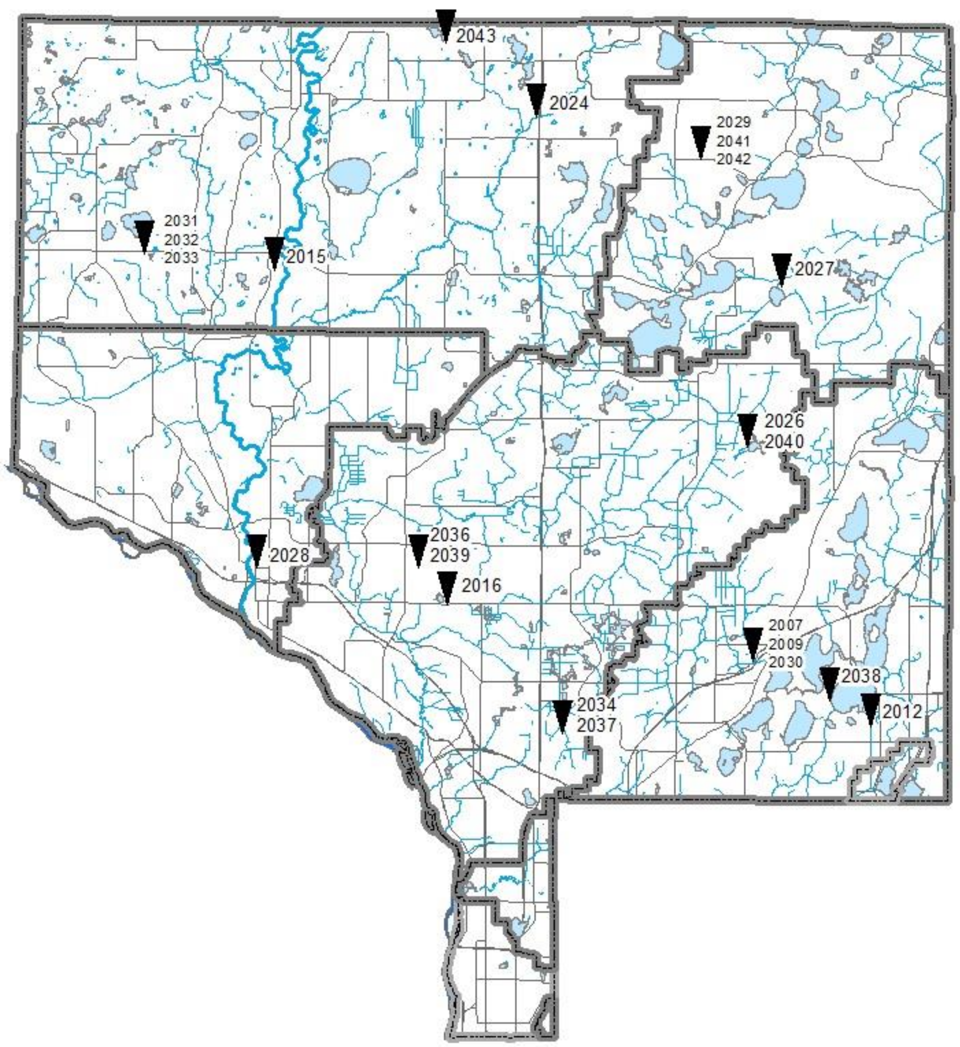
Groundwater Hydrology

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 23 wells in Anoka County and to download continuous loggers quarterly. 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 statewide and national databases that aid 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

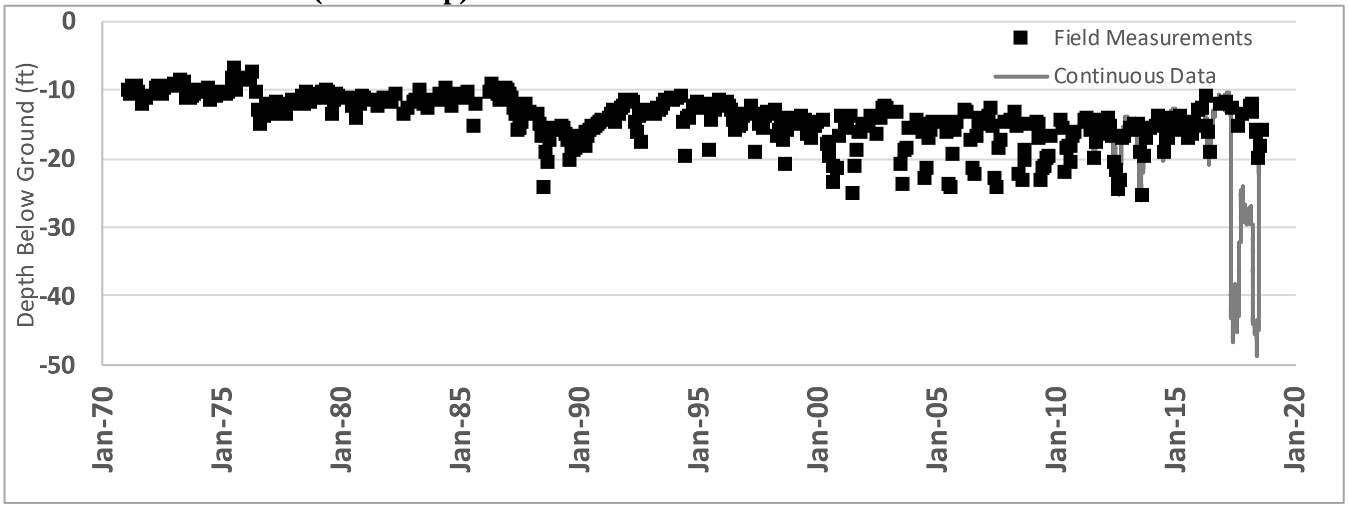
These deep groundwater wells are not as sensitive to precipitation as other hydrologic systems such as wetlands and streams, but rather respond to longer term trends.

The charts on the following pages show groundwater levels hand measured by ACD through 2018 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.

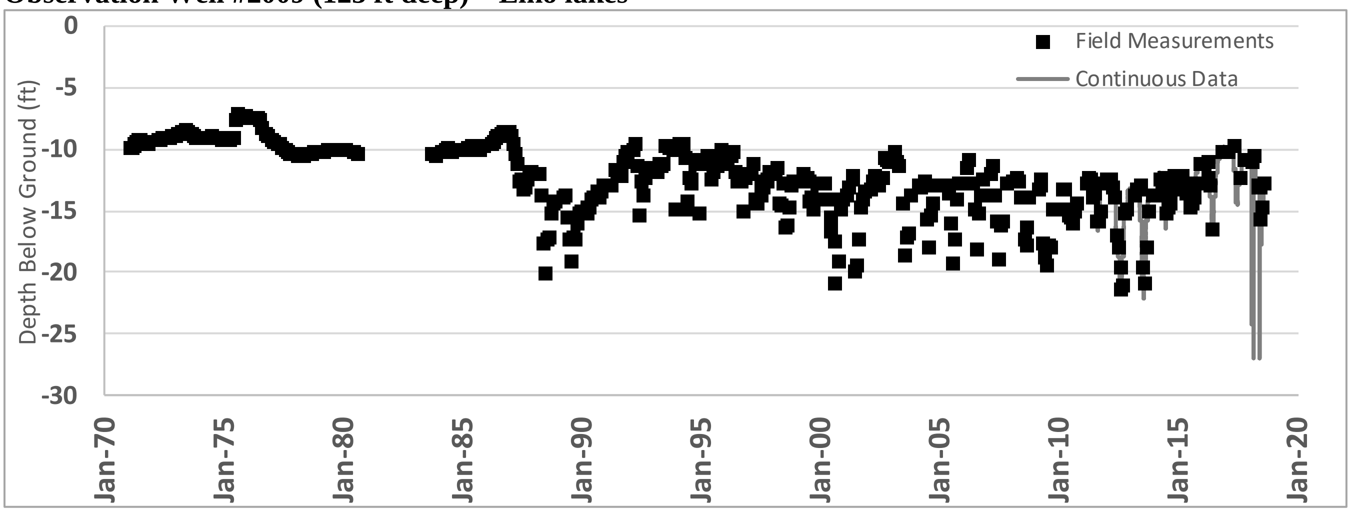
2019 Groundwater Observation Well Sites and Well ID Numbers



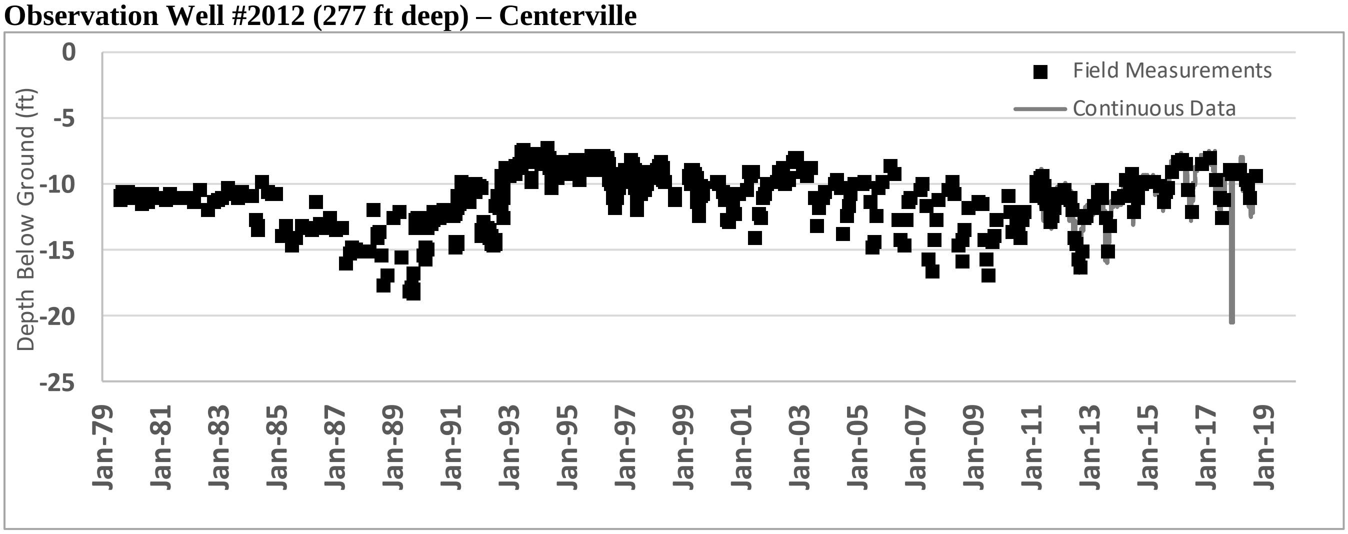
Observation Well #2007 (270 ft deep)—Lino Lakes



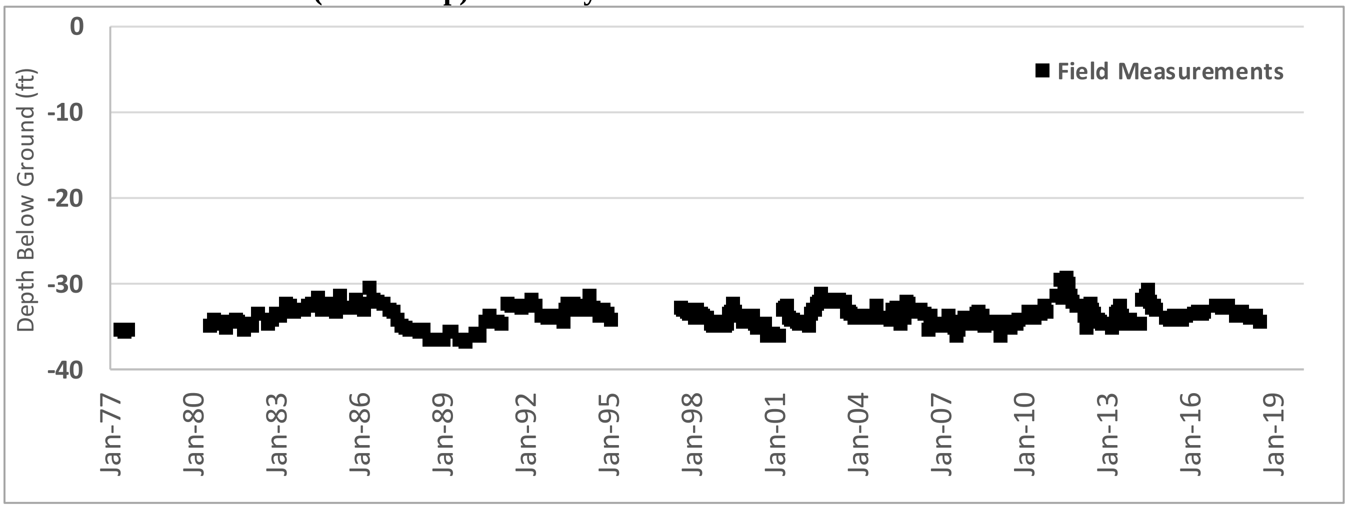
Observation Well #2009 (125 ft deep)—Lino lakes



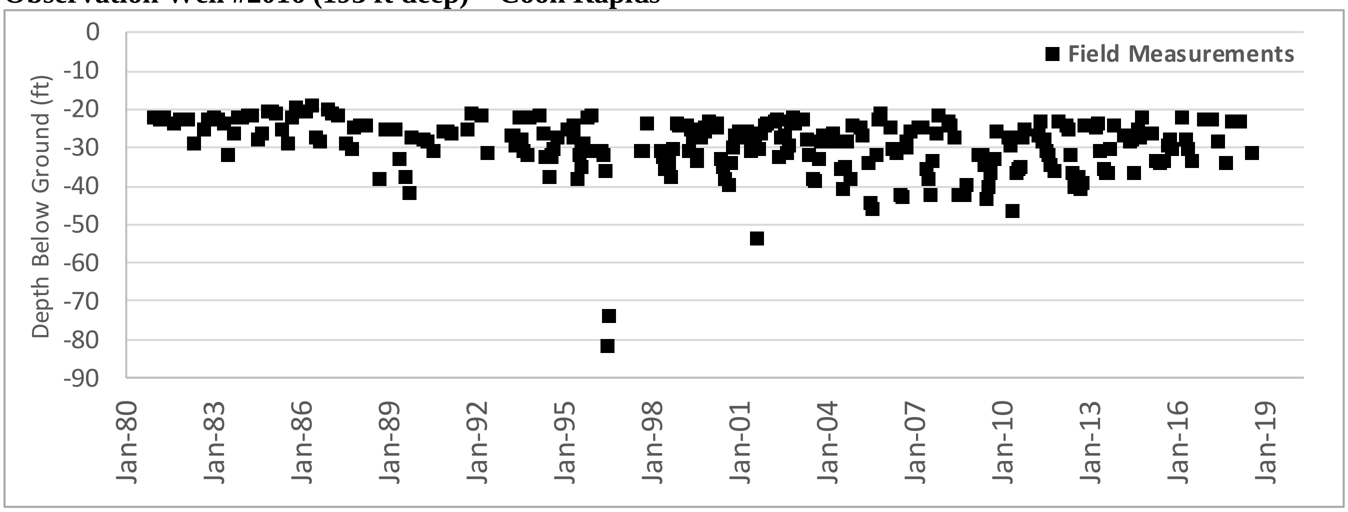
Observation Well #2012 (277 ft deep) – Centerville



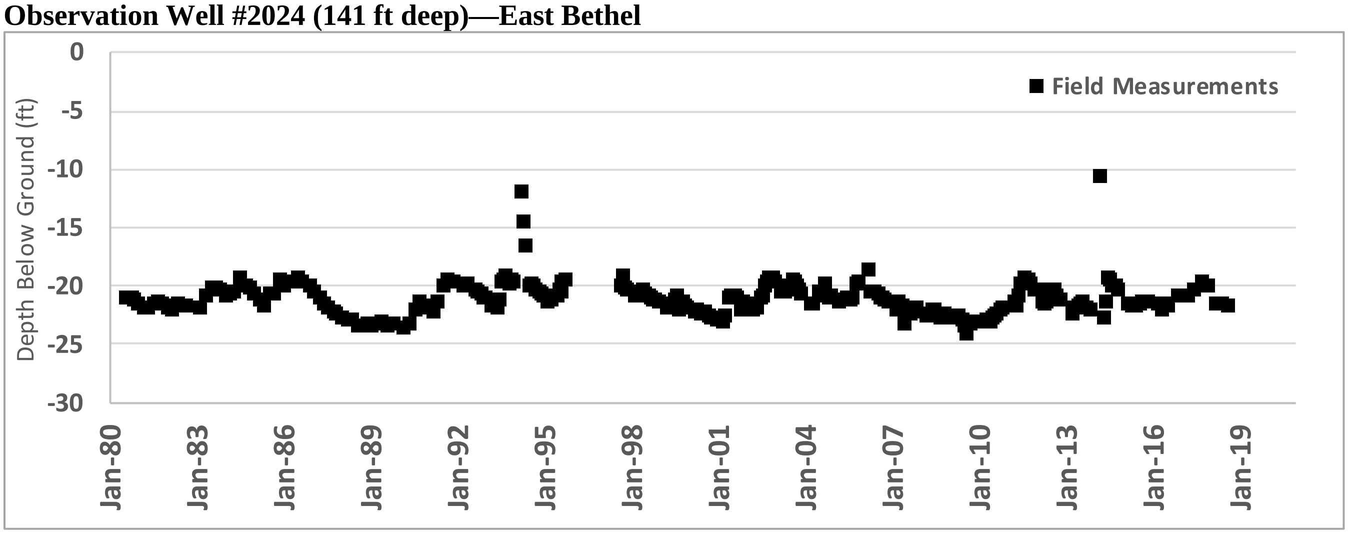
Observation Well #2015 (280 ft deep)—Ramsey



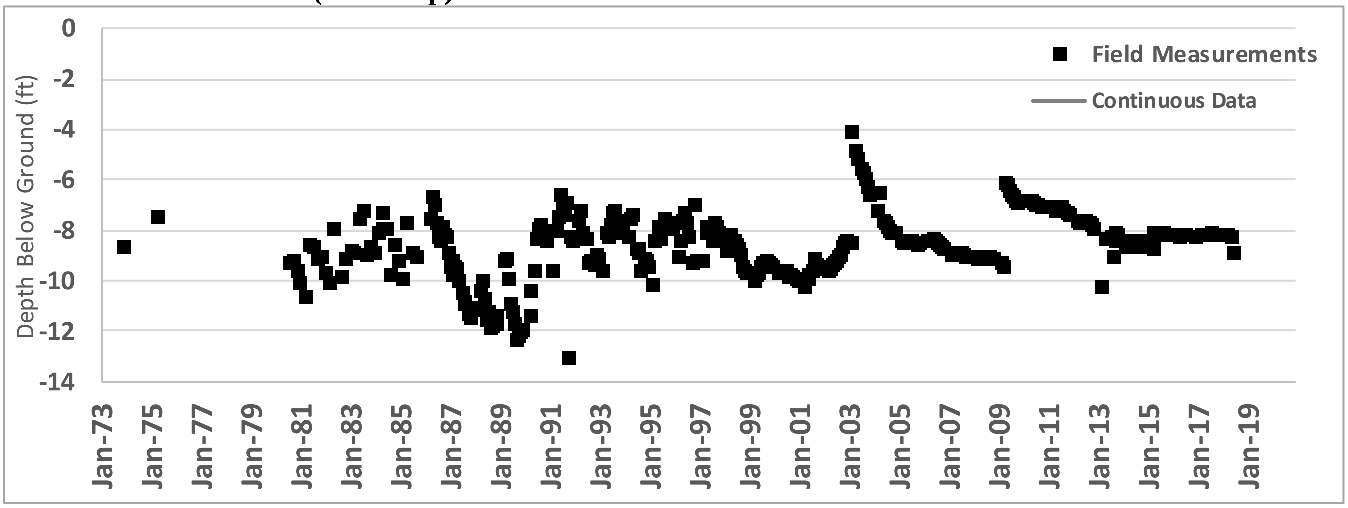
Observation Well #2016 (193 ft deep)—Coon Rapids



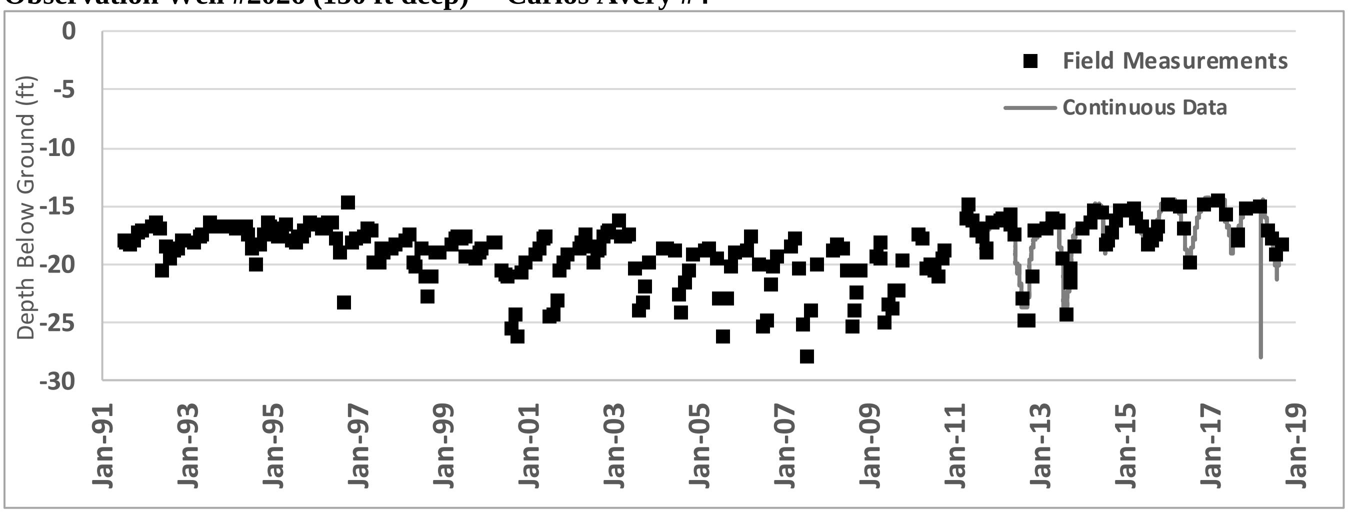
Observation Well #2024 (141 ft deep)—East Bethel



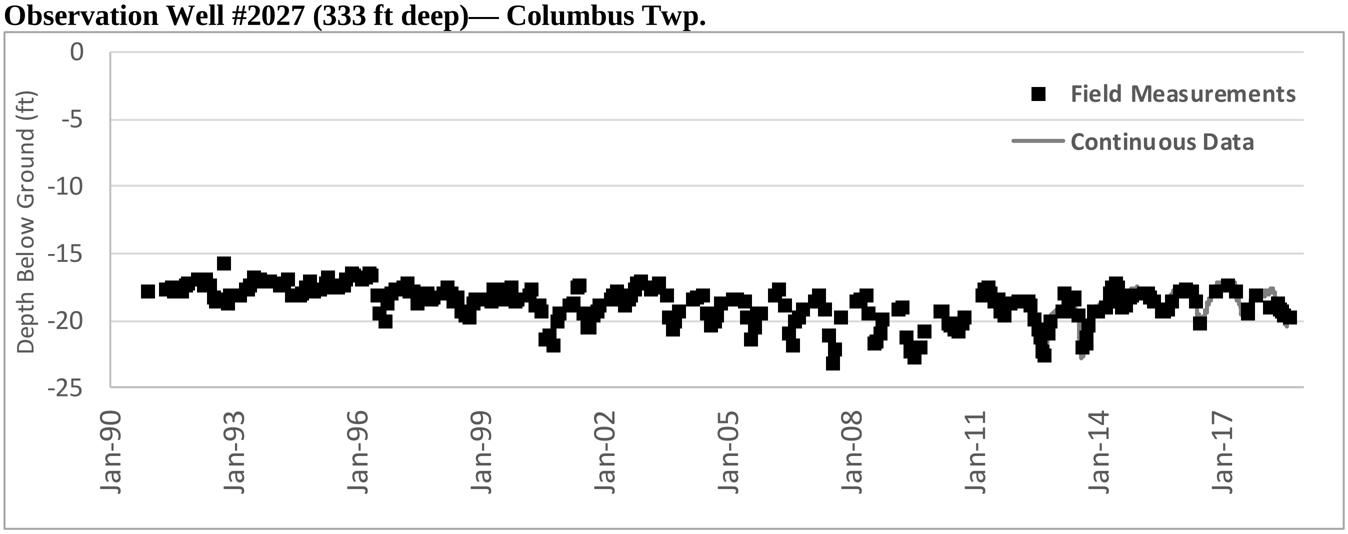
Observation Well #2025 (21 ft deep)—Bethel



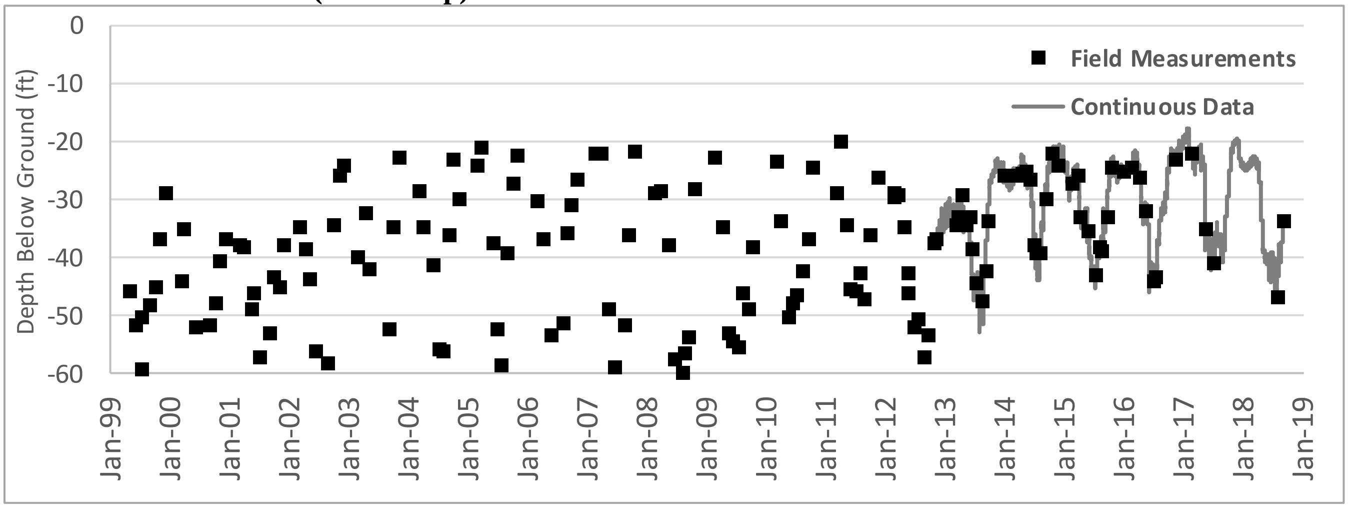
Observation Well #2026 (150 ft deep)— Carlos Avery #4



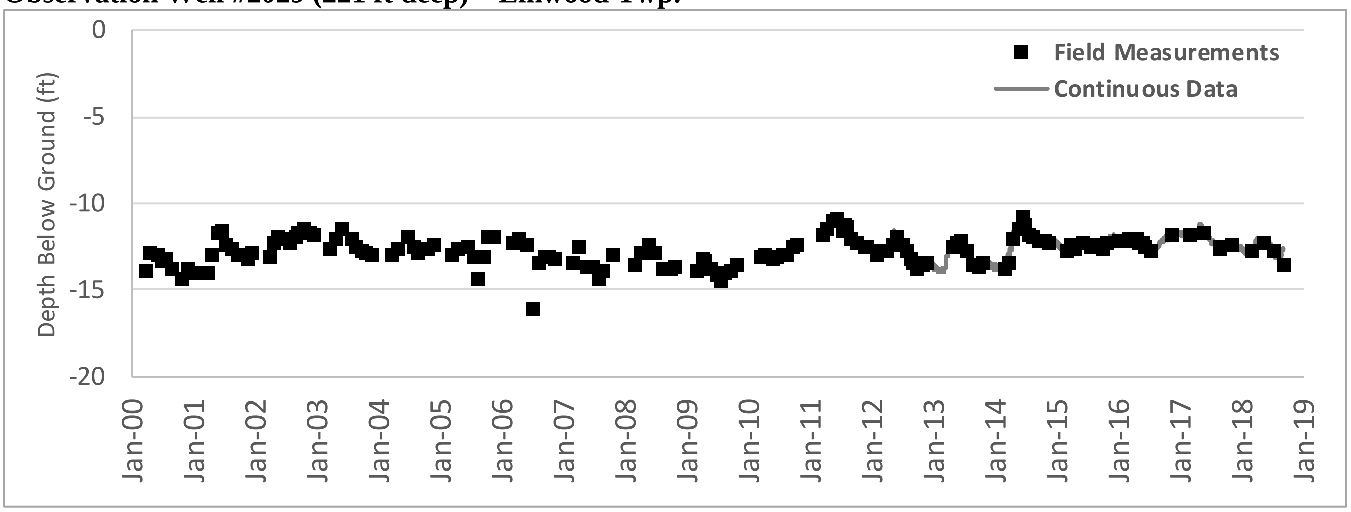
Observation Well #2027 (333 ft deep)— Columbus Twp.



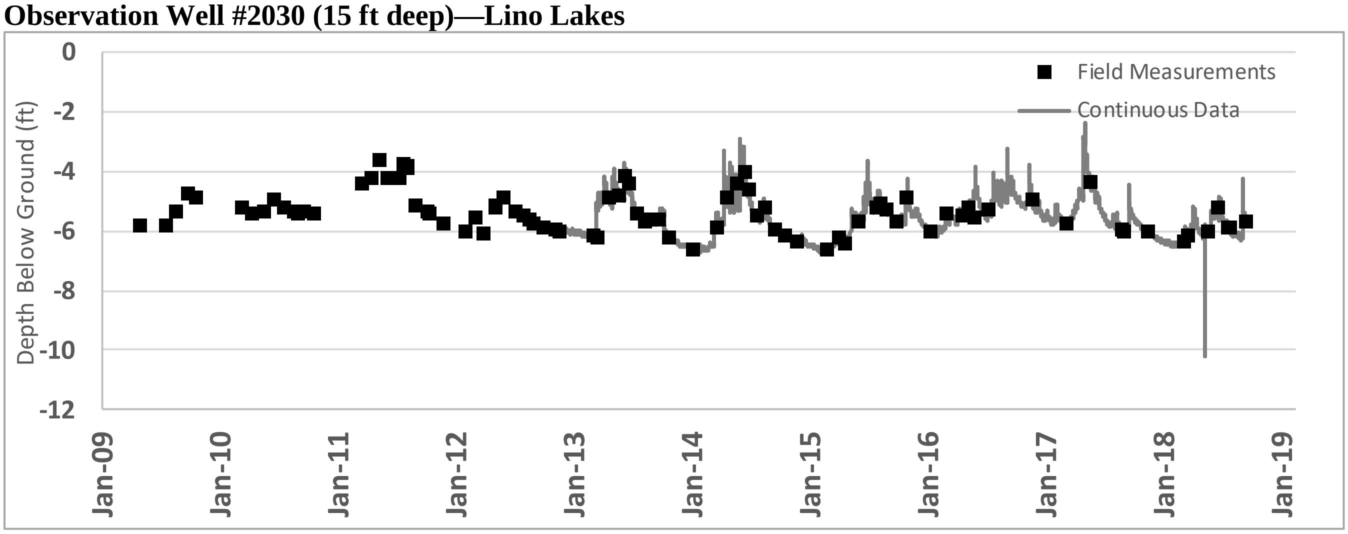
Observation Well #2028 (510 ft deep)—Anoka



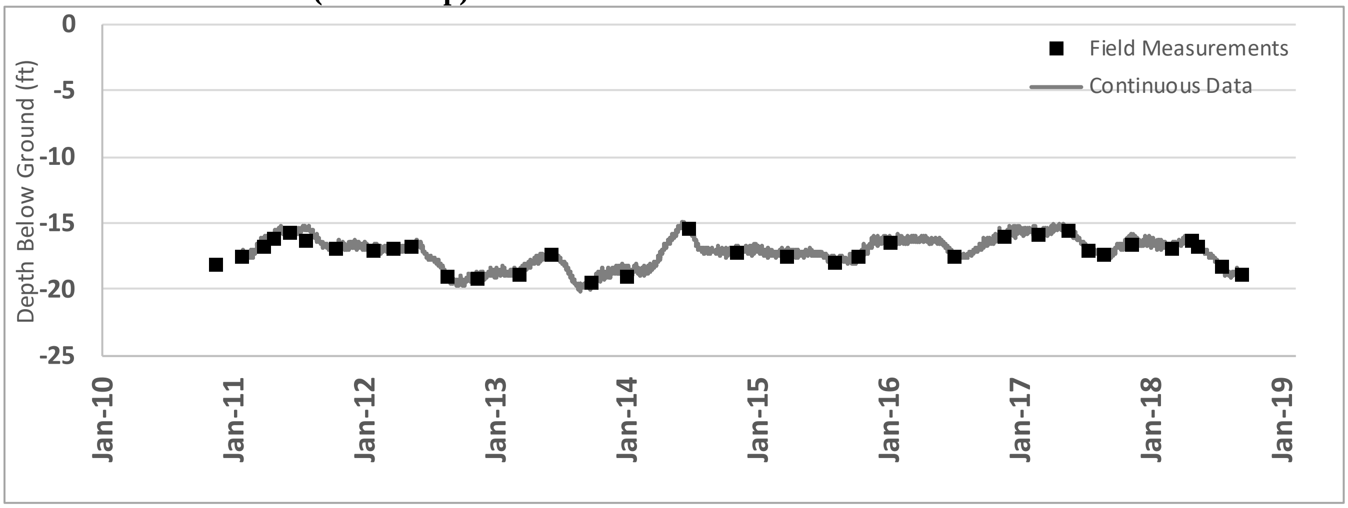
Observation Well #2029 (221 ft deep)—Linwood Twp.



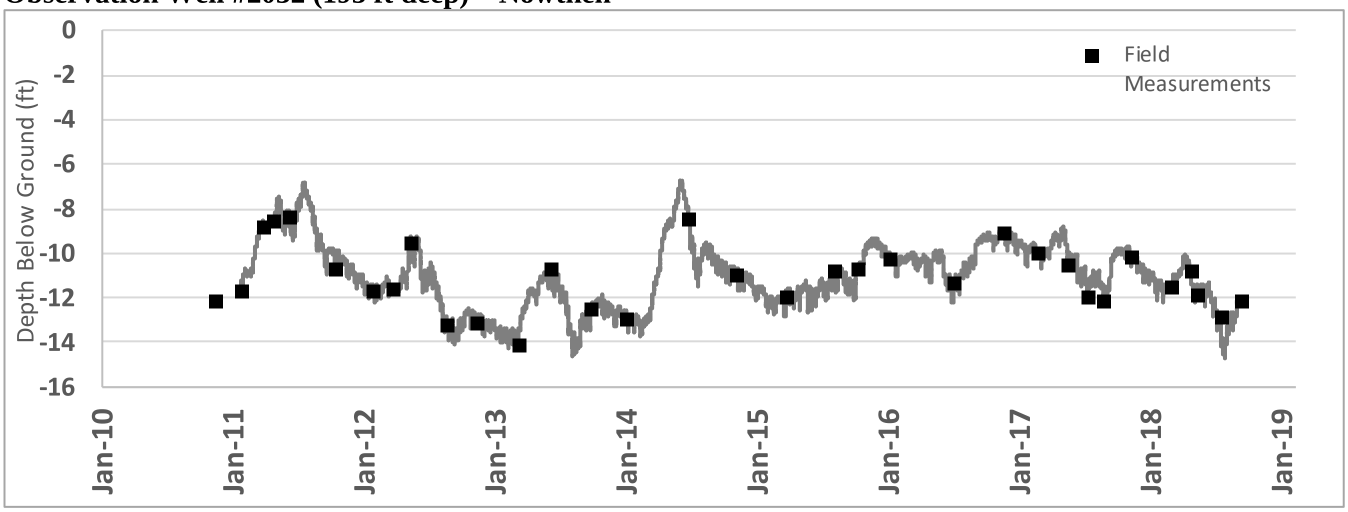
Observation Well #2030 (15 ft deep)—Lino Lakes



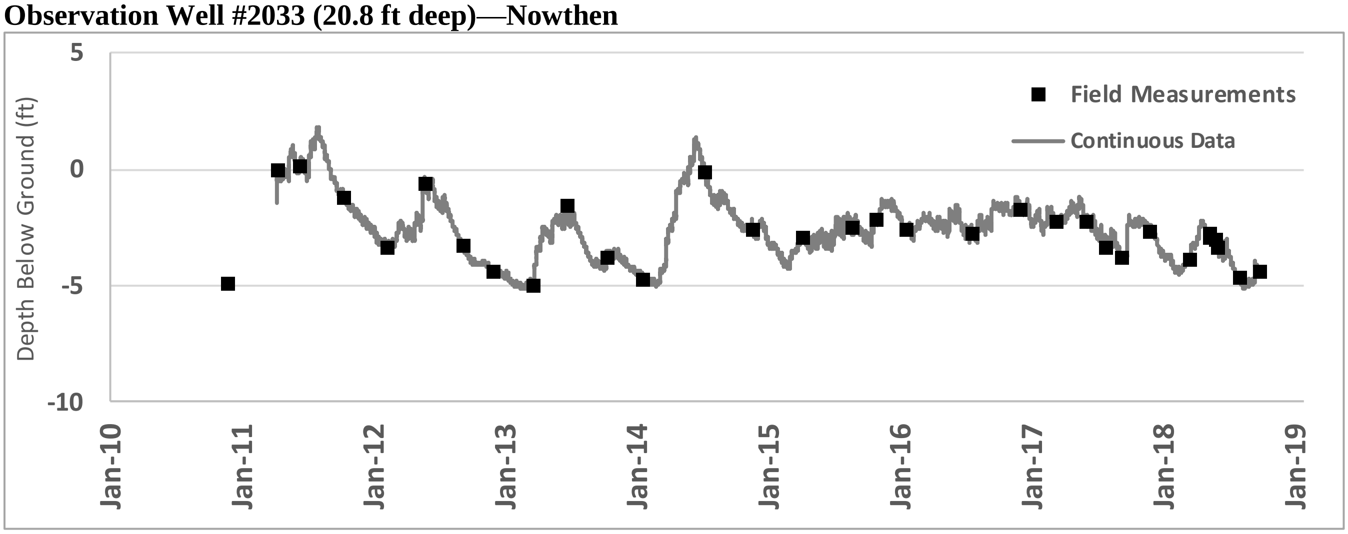
Observation Well #2031 (410 ft deep)—Nowthen



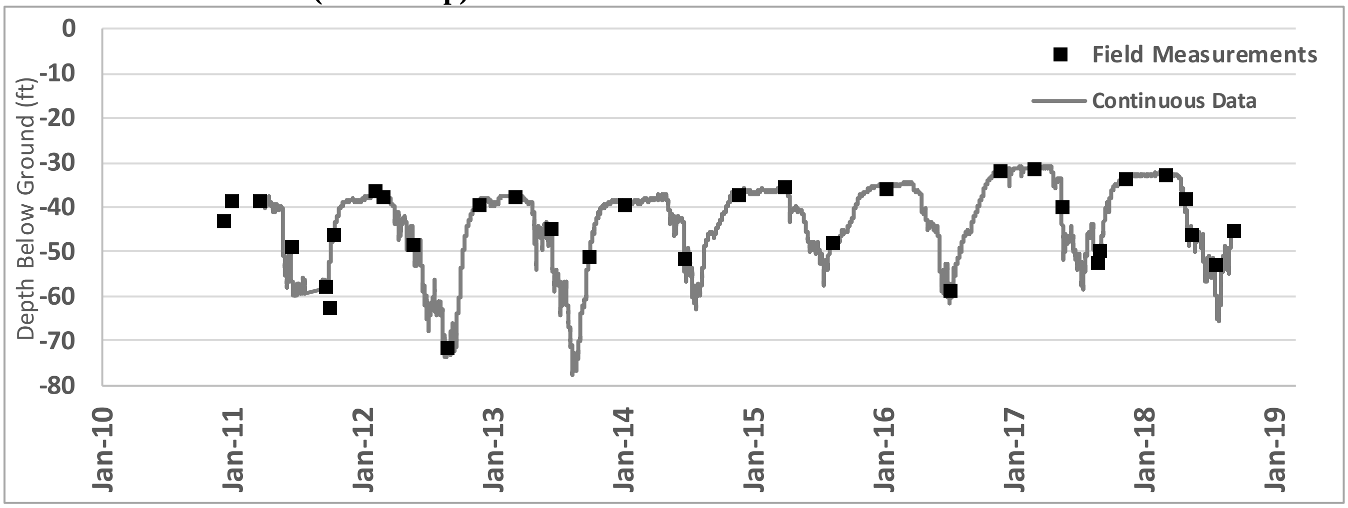
Observation Well #2032 (195 ft deep)—Nowthen



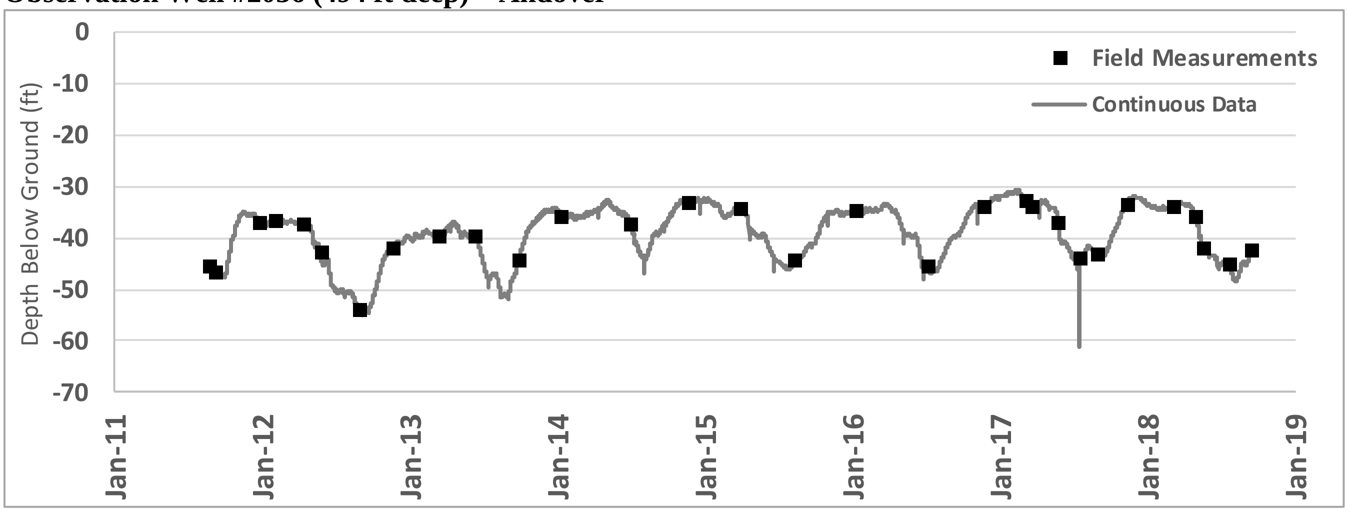
Observation Well #2033 (20.8 ft deep)—Nowthen



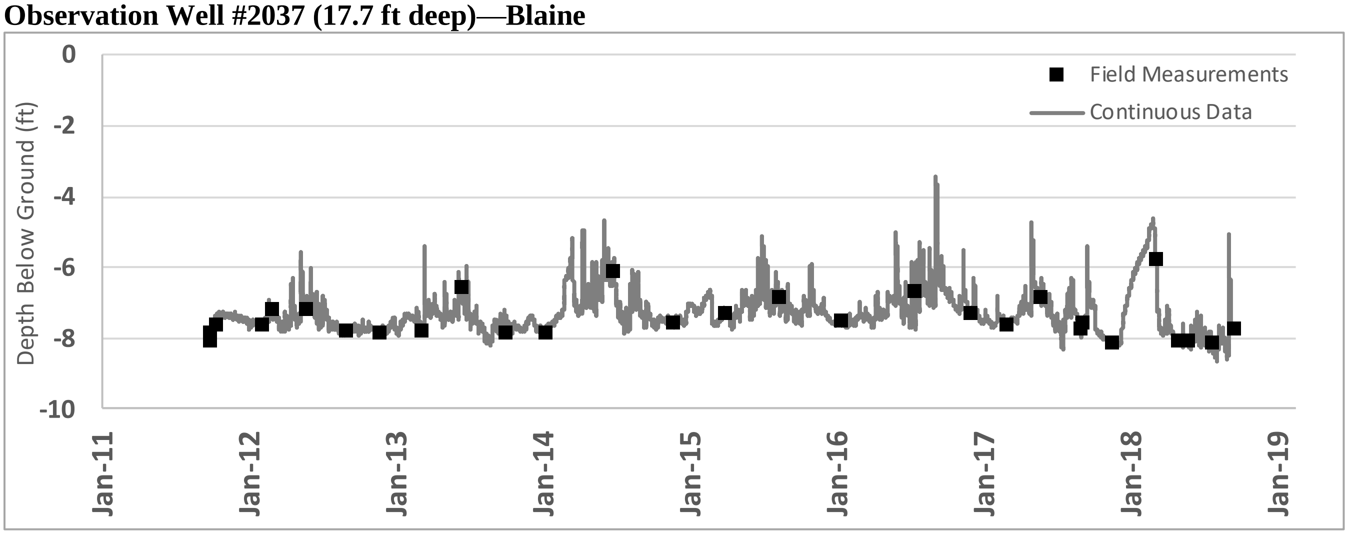
Observation Well #2034 (222 ft deep)—Blaine



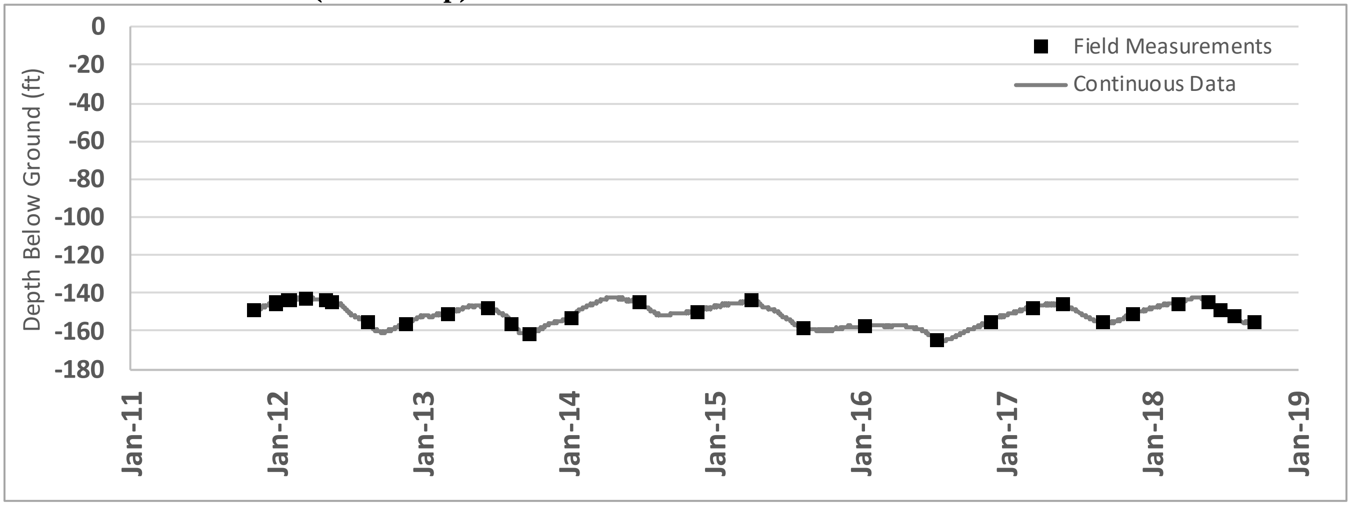
Observation Well #2036 (494 ft deep)—Andover



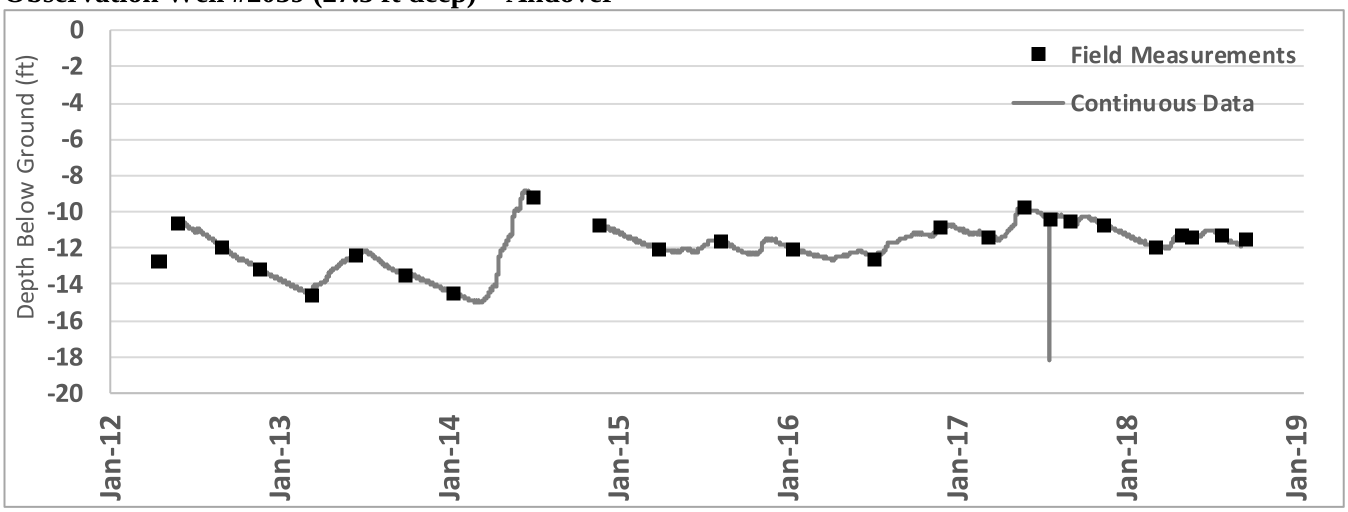
Observation Well #2037 (17.7 ft deep)—Blaine



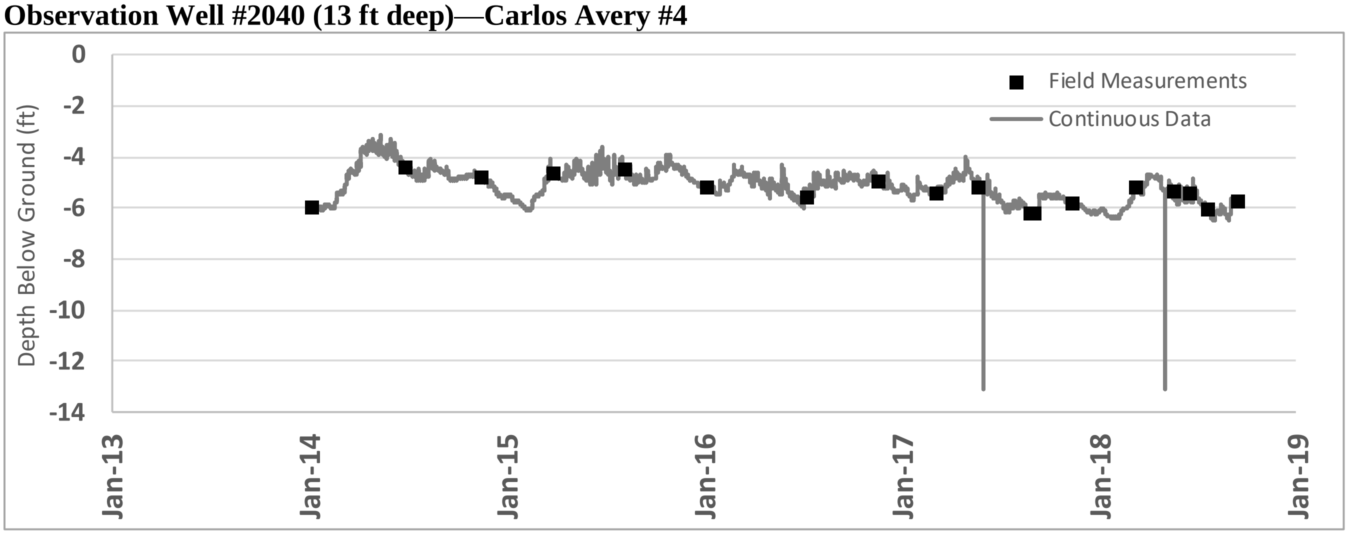
Observation Well #2038 (810 ft deep)—Lino Lakes



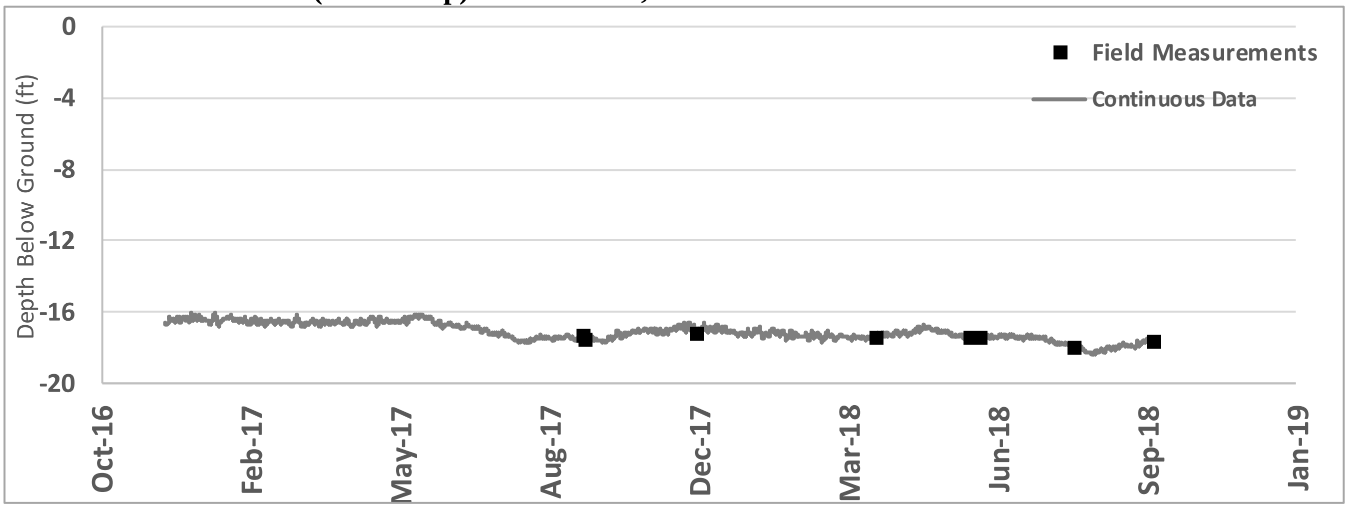
Observation Well #2039 (27.5 ft deep)—Andover



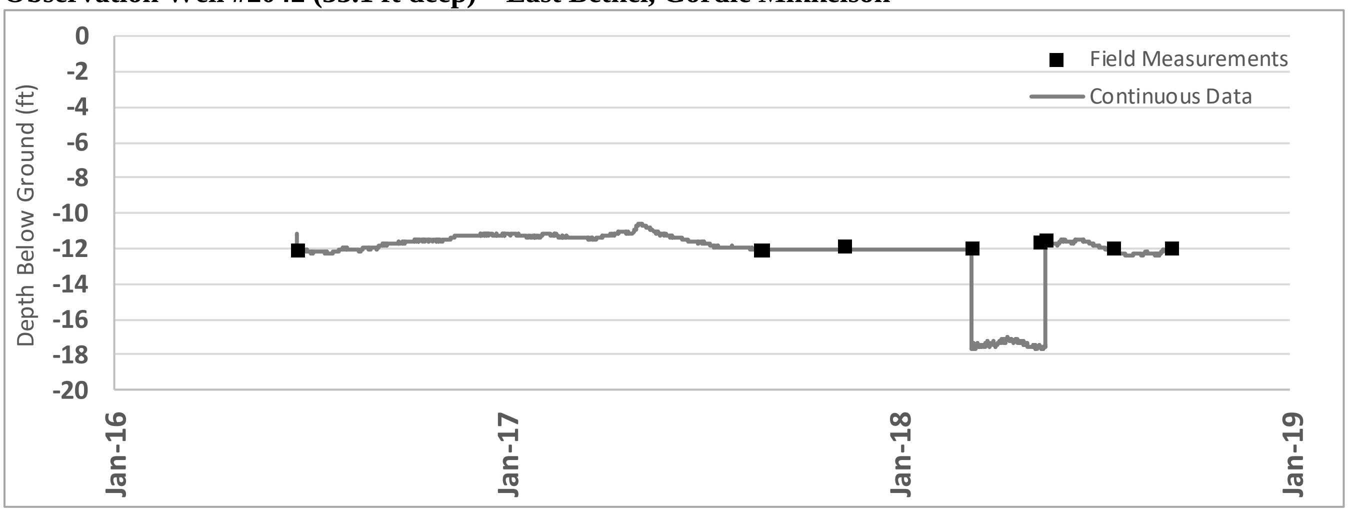
Observation Well #2040 (13 ft deep)—Carlos Avery #4



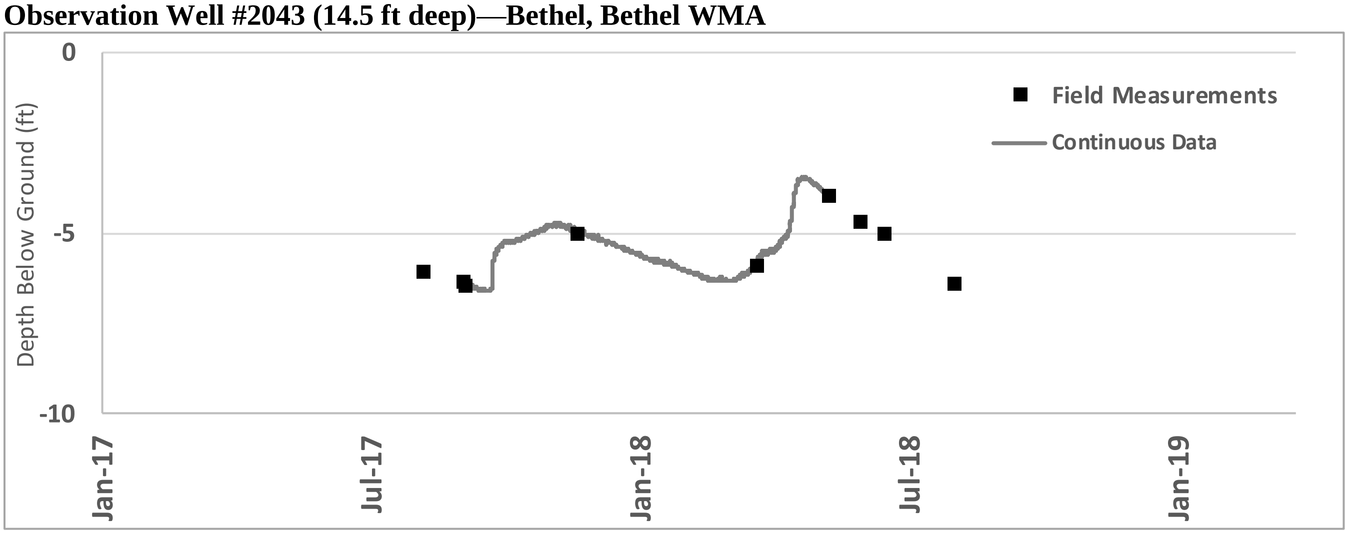
Observation Well #2041 (340 ft deep)—East Bethel, Gordie Mikkelson



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



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

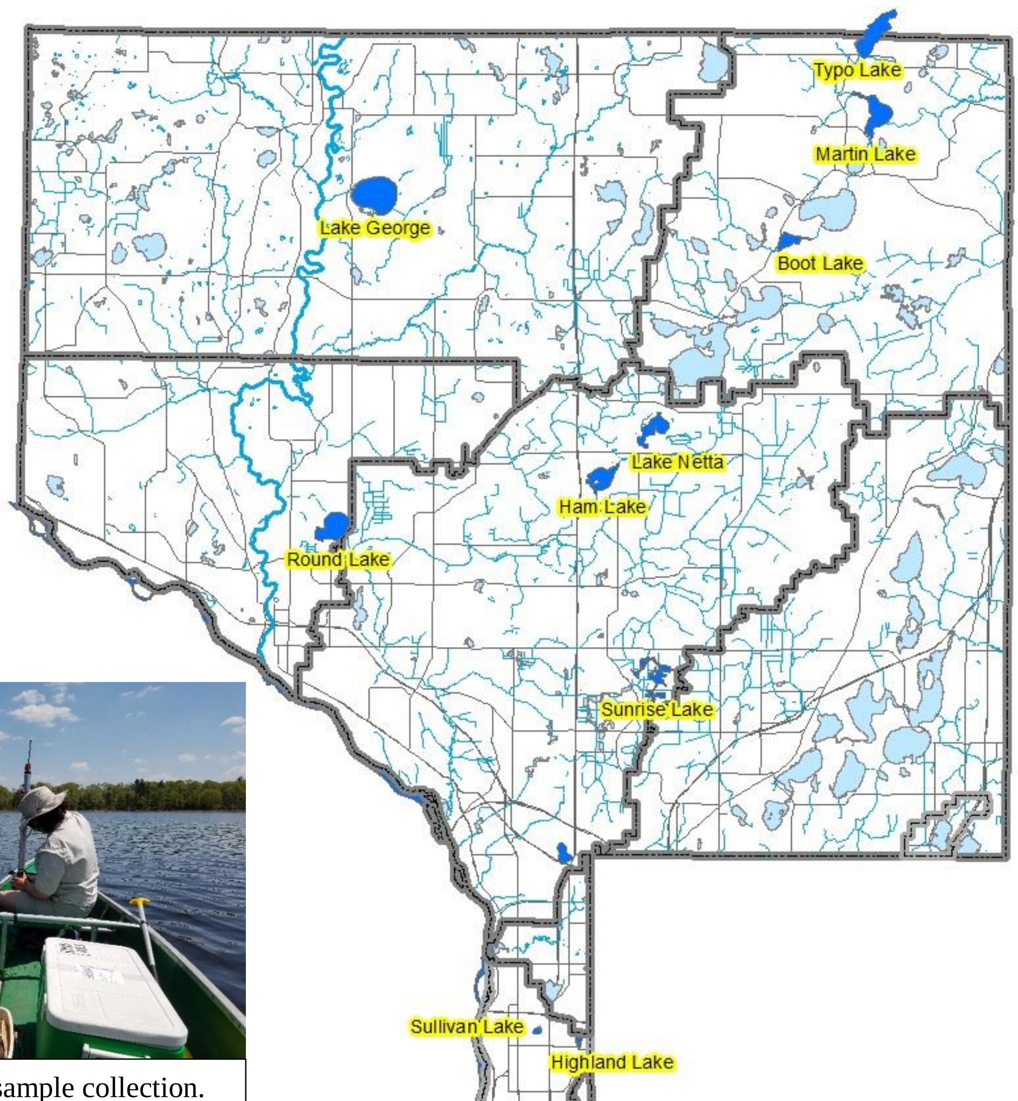


Lake Water Quality

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.

2019 Lake Water Quality Monitoring Sites



Lake water quality sample collection.

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 (RMB Labs) for total phosphorus and chlorophyll-a. Sample bottles are provided by the laboratory. Total phosphorus sample bottles contain the preservative sulfuric acid (H_2SO_4), while bottles for chlorophyll-a analysis do not require preservative. Brown or foil-wrapped bottles are used for chlorophyll-a to prevent light from entering the bottles. 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 Carlson's Trophic State Index and the Metropolitan Council's lake quality grading system 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 whether 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 $\geq$7). The pH of a lake will fluctuate daily and seasonally due to algal photosynthesis, runoff, and other factors.

Specific 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 (i.e. road salt), agricultural runoff, or 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 is a measurement of the quantity of salts dissolved 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 for deep lakes 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 (25th to 75th percentile) of the reference lakes for the North Central Hardwood Forest ecoregion. This provides a range of values that represent the central tendency of the reference lakes' water quality.

Q- What 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 transparency. 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 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, below). 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 Carlson's Trophic State Index?

A- Carlson's Trophic State Index (see figure below) uses a number calculated with the lakes Secchi transparency, phosphorus, and chlorophyll-a readings 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:

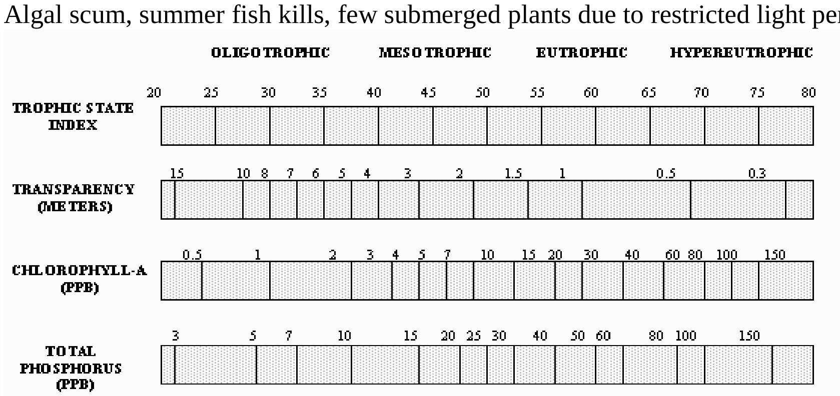
TSI- Overall Trophic State Index.
TSIP- Trophic State Index for Phosphorus.
TSIS- Trophic State Index for Secchi transparency.
TSIC- Trophic State Index for the inorganic part of algae, Chlorophyll-a.

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 is set at < 40 μg/L in deep lakes and <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	1999
Boot																				
Cenaiko																		B	A	A
Centerville		C		C					D											
Coon (East Bay)					C					C	C	C		C	C	C		B	B	A
Coon (West Bay)																				
Crooked				C		C				C					B	C	B	B	B	
East Twin	A	B		C						B						B		A	B	A
Fawn									B									A	B	A
Fish																				
George	A	A	A		A					A								A	B	A
George Watch		F	D	D		D		D	D	F	D	F					F	D	F	D
Golden						D	C	D	F	F	F	F		D			C	D	C	C
Ham					C									A	B		A	A	B	
Highland																				D
Howard										F	F	F							F	D
Island				C																
Itasca																			A	B
Laddie	D													A	B	B			B	B
Linwood	B	C		C						C					C			C	C	C
Lochness																				
Martin				D														D	D	C
Minard																				
E. Moore	C	C	C	C	C	B	C	C							C				C	B
W. Moore	C	C	F	C	B	C	F	C												B
Mud														B						B
Netta																		B	C	A
Peltier				D										D	F	D	D	D	D	D
Pickerel																B		A	A	B
Reshanau																				
Rogers																			C	
Round																			B	A
Sullivan (Sandy)														D	D	D		D	D	D
Sunfish/Grass																				
Sunrise																				
Typo														F	F	F		F	F	F

YEAR →	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Boot																			C	B
Cenaiko	A	B	A	A	A	A	A	A	B	B	B	B	B						A	
Centerville	C	C		C	C	A														
Coon (East Bay)	B	C	B		C	C	C	B	A	B	B	B	B	B	A		B		A	
Coon (West Bay)											A		A		B		A		A	
Crooked	B		B	B		B	B		B	B		B	A		A	A		B	A	
East Twin	A		A			A			A			A		A				A		
Fawn	A	A			A		A		A		A		A			A			A	
Fish																			A	
George	A		A			B			B			B		B	B	A	A	B	A	A
George Watch	D	F	D	D	F	D	F	F	D	D	D	D	F					D		
Golden	C	D	D	D	D	C	C	C	C	C	C									
Ham	C	C			B	B		B	A		B	B		A	A		B	B		B
Highland	D	D	F	F	F	F	F	F									F			F
Howard	D																			
Island				B	B	C	C	B	B	C	C	C	C							
Itasca	B																			
Laddie	B	B	B	B	B	B			B			B					A	B		B
Linwood	C	C		C		C		C	C	C			C			C			C	
Lochness								A	B		B	C	C					C		
Martin	D	D		D		D		D	D	D			D		C	C	C	C	C	C
Minard														A	A					
E. Moore	B	C	C	C		C														
W. Moore	B	C	C	C		C														
Mud	C																			
Netta		B		A	A		B	B		B	A		A	A		A	A		A	A
Peltier	D	F	F	D	D	D	F	D												
Pickerel	C										A	C		B	A					
Reshanau							D	D	D	D	D	D	D							
Rogers	C			B			D		B	B										
Round	B			A		B		C		C	C		A		A		A			A
Sullivan (Sandy)	D	D	F	D	D	D								D			D			D
Sunfish/Grass													B	B			B	A	B	
Sunrise																			B	C
Typo	F	F		F		F		F		F			F		D	F	F	F	F	D

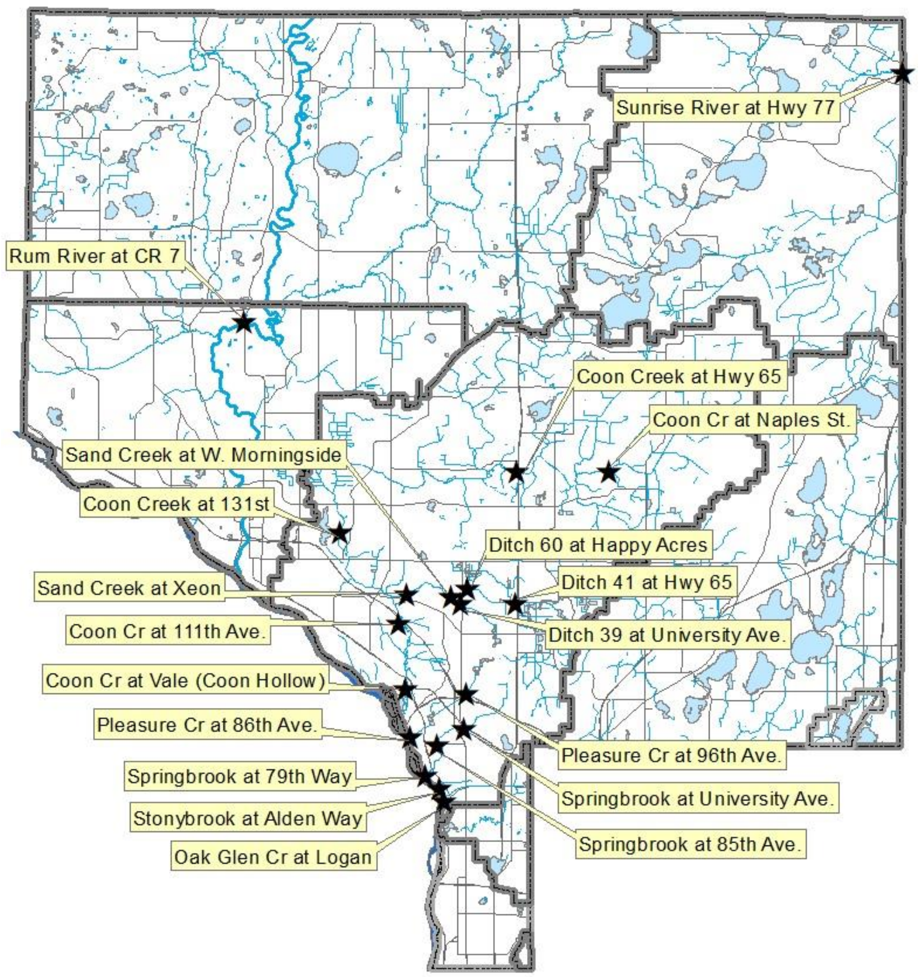
Stream Water Quality – Chemical Monitoring

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 2018 was conducted at five Coon Creek system sites, five Sand Creek system sites, three Springbrook Creek sites, two Pleasure Creek sites, and one site each in the Rum River, Sunrise River, Stonybrook, and Oak Glen Creek. Additionally, the ACD continued a cooperative effort with the Metropolitan Council for monitoring of the Rum River at the Anoka Dam as part of the Metropolitan Council's Watershed Outlet Monitoring Program (WOMP). Those data are housed with the Metropolitan Council, and methodologies are available upon request from either organization.

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

2019 Chemical Stream Water Quality Monitoring Sites



Stream water quality sample collection.

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. Stream sampling is performed using a Hydrolab Quanta multi-probe in the stream and concurrently collecting grab samples for laboratory analysis.

Each stream sample was tested for the following parameters:

- pH;
- Dissolved Oxygen (DO);
- Turbidity;
- Specific Conductivity;
- Temperature;
- Salinity;
- Total Phosphorus (TP);
- Total Suspended Solids (TSS);
- 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 RMB Environmental Laboratory. Sample bottles are provided by the laboratory, along 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 Tube Transparency- Transparency is directly related to the amount of algae and suspended solids in the water column. A Secchi tube is a 1 m long tube marked at 1 cm intervals with a white and black disk on a string within it. The tube is filled with water and the disk is drawn upward until it is just visible than lowered until it just disappears. The midpoint between these points is the Secchi transparency

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 stream as impaired if it has >100 µg/L average summertime phosphorous.

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.

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:

RMB Environmental Laboratories (RMB) conducted the laboratory analysis. RMB has a comprehensive QA/QC program, which is available by contacting them directly. The ACD followed field protocols supplied by RMB including keeping samples on ice, avoiding sample contamination and delivering samples to the lab within 24 hours of sampling. Sample bottles are provided by RMB lab 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	0.389	0.298	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.

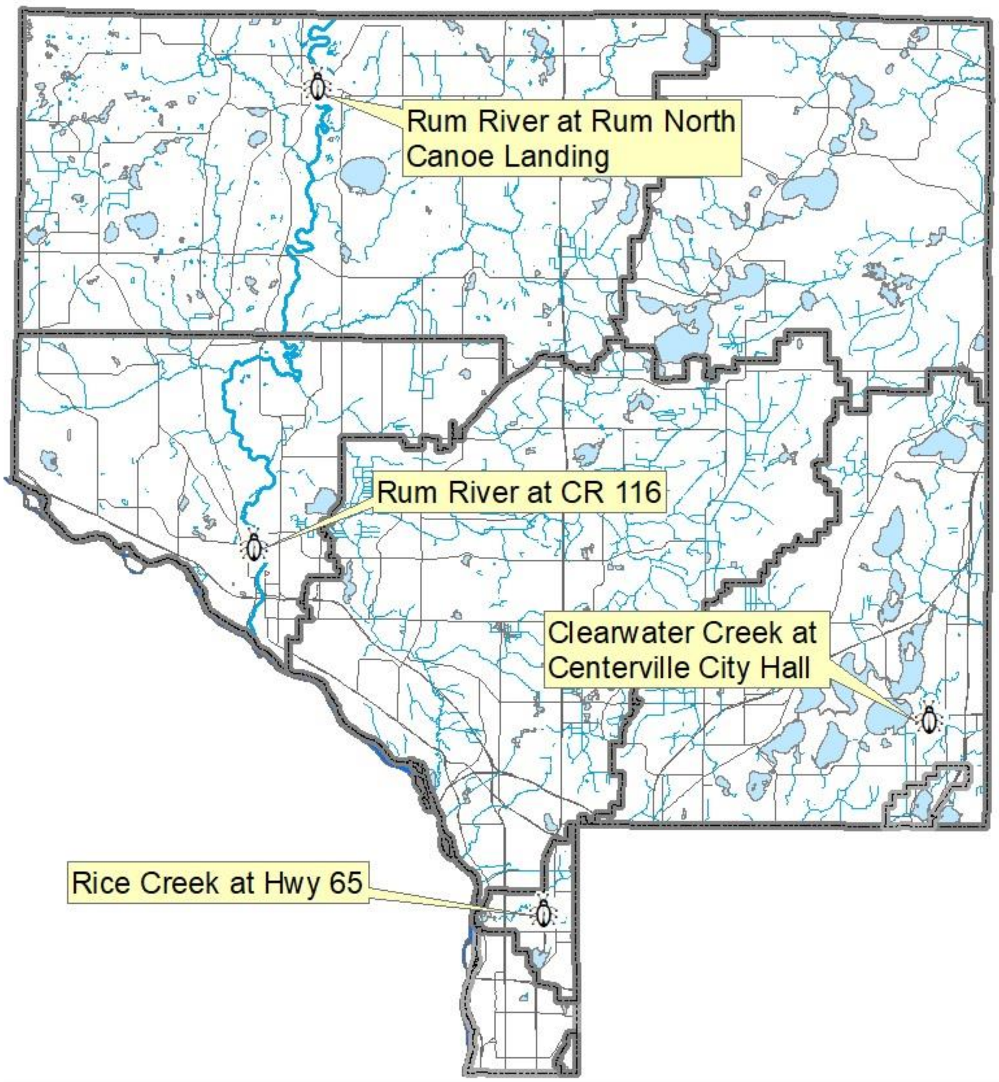
Stream Water Quality – Biological Monitoring

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 2019 there were approximately 190 students from four high schools who monitored four stream sites. Since 2000, over 5,372 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.

2019 Biological Stream Water Quality Monitoring Sites



Biomonitoring Methods

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

Biomonitoring Indices

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

Taxa Richness and Composition Measures

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

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

Tolerance and Intolerance Metrics

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

Key to interpreting the Family Biotic Index (FBI)

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

Population Attributes Metrics

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

% 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).

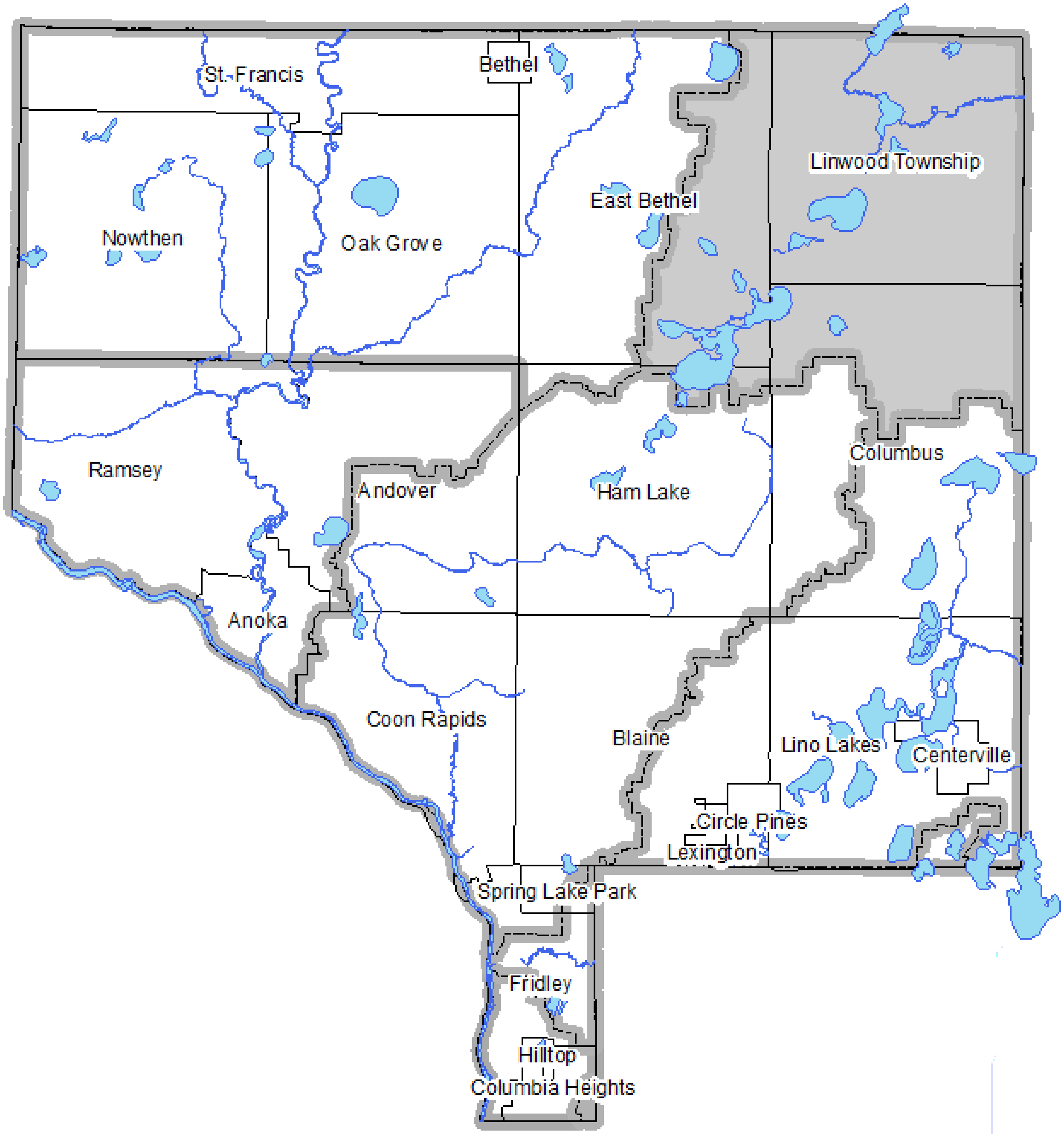
Sites

In 2019, high school classes from Anoka, Totino Grace, St. Francis, and Forest Lake ALC with ACD staff supervision sampled four sites for benthic macroinvertebrates and identified each organism captured to family level. Information on sampling results from individual sites can be found in the corresponding WMO chapter for that stream.

2019 Biomonitoring Sites and Corresponding Monitoring Groups

Monitoring Group	Stream
Anoka High School	Rum River (south)
Forest Lake Area Learning Center	Clearwater Creek
Totino Grace High School	Rice Creek
St. Francis High School	Rum River (north)

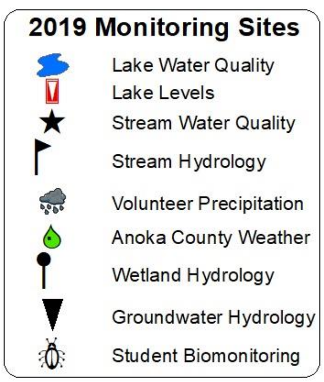
Chapter 2: Sunrise River Watershed

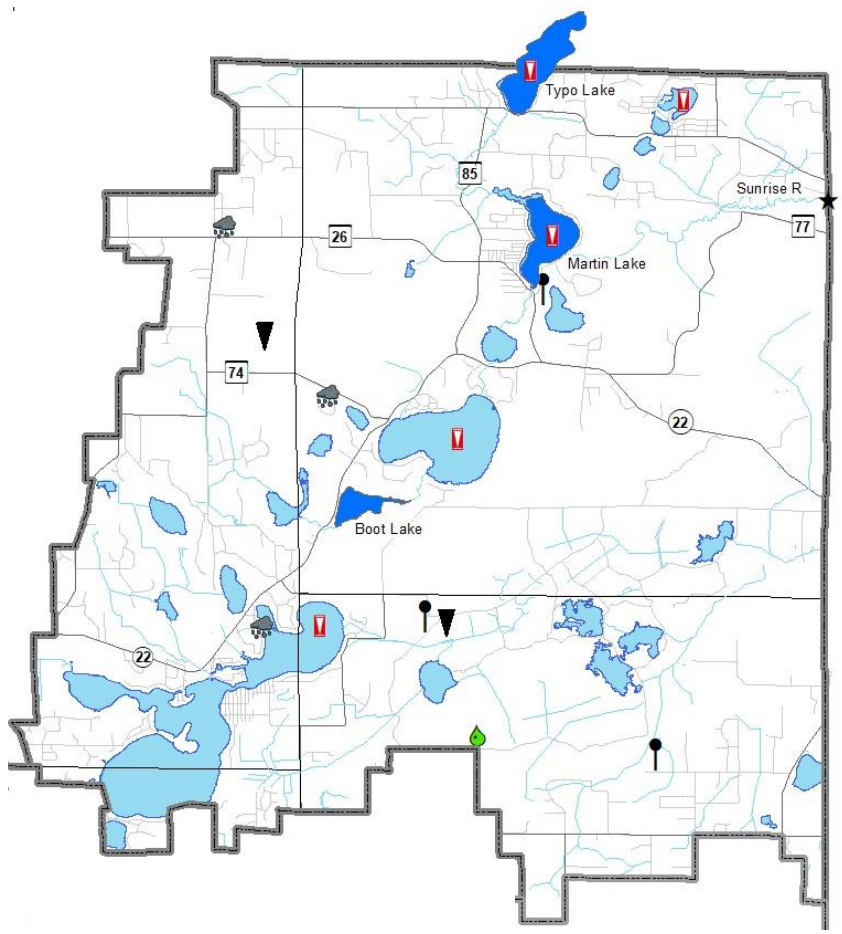


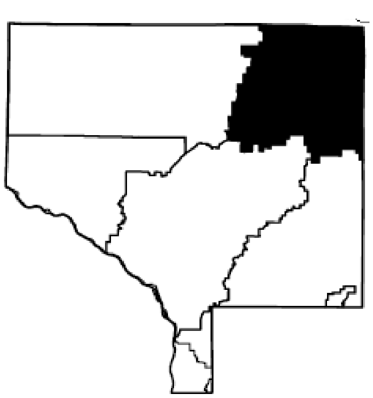
Prepared by the Anoka Conservation District

Chapter 2: Sunrise River Watershed

Table of Contents







Lake Level Monitoring

Partners: SRWMO, ACD, MN DNR, local volunteers

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).

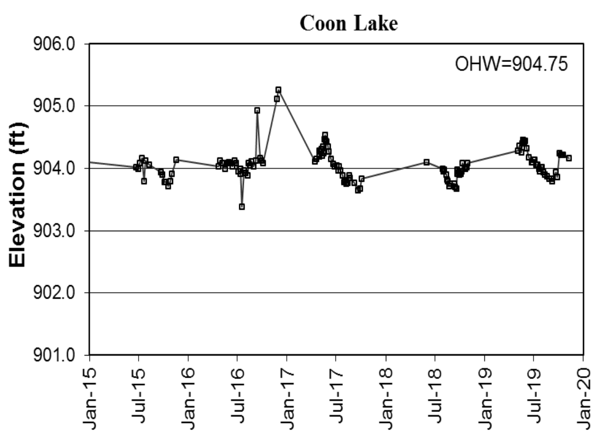
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

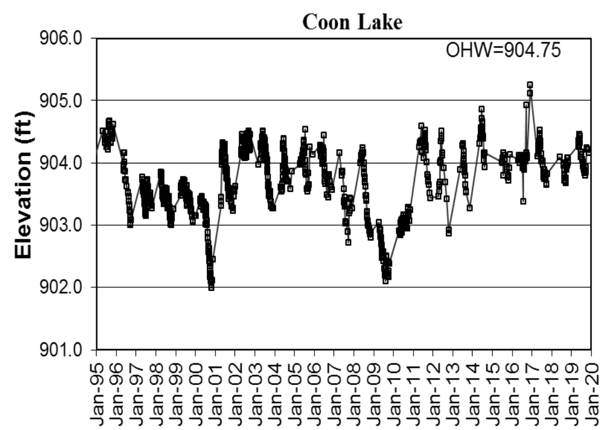
Results: Lake gauges were installed by the Anoka Conservation District and surveyed by the MN DNR. In 2019, lakes followed the expected pattern of high levels in the spring, declining levels through the summer and then water levels beginning to rebound in the fall. Coon Lake and Fawn Lake both had higher water levels than in 2018 but only fluctuated 0.5 ft. throughout the season. Typo Lake and Martin Lake had the highest recorded levels in the past five years. Water levels on both lakes fluctuated widely throughout the season (Typo: 1.96 ft., Martin: 1.5 ft.). It's notable that 2019 had the greatest precipitation total of any recorded year (data goes back to 1871) in the Twin Cities metro.

All lake level data can be downloaded from the MN DNR website's LakeFinder feature (https://www.dnr.state.mn.us/lakefind/index.html). 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.

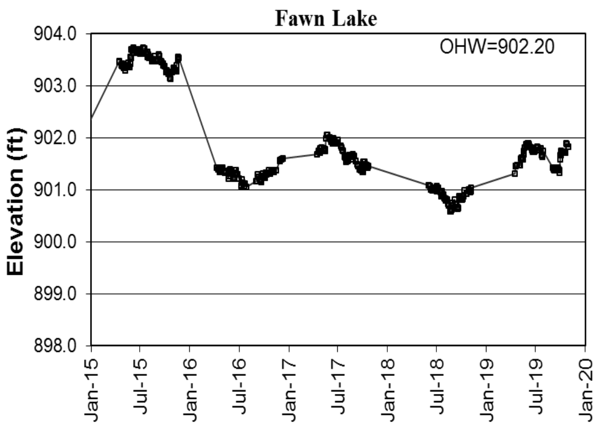
Coon Lake Levels – last 5 years



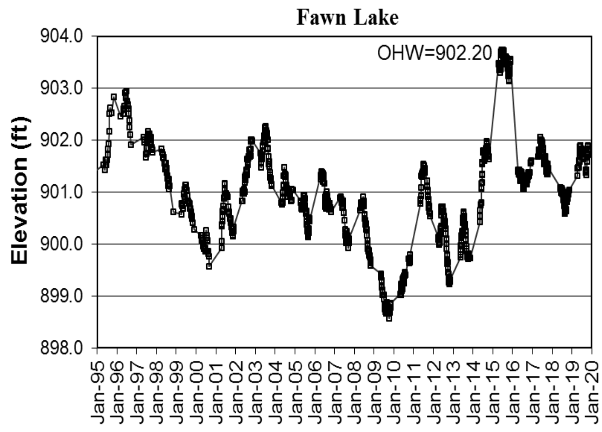
Coon Lake Levels – last 25 years



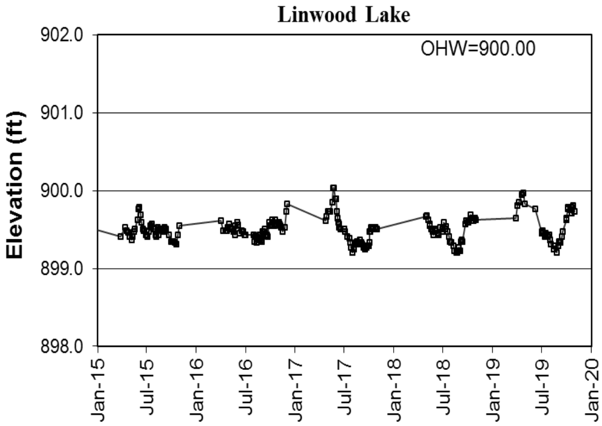
Fawn Lake Levels – last 5 years



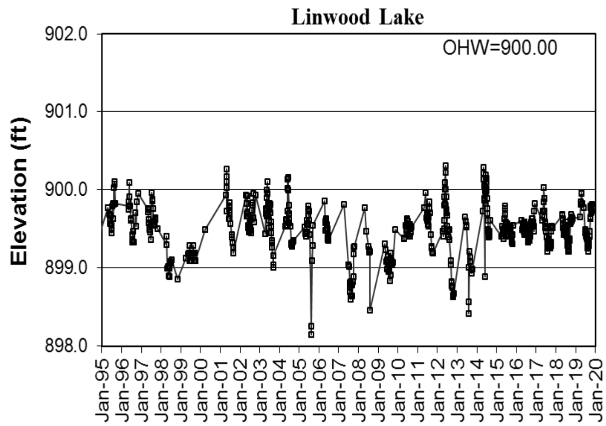
Fawn Lake Levels – last 25 years



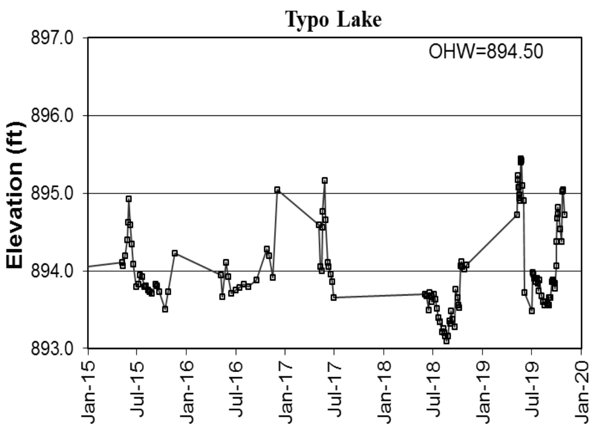
Linwood Lake Levels – last 5 years



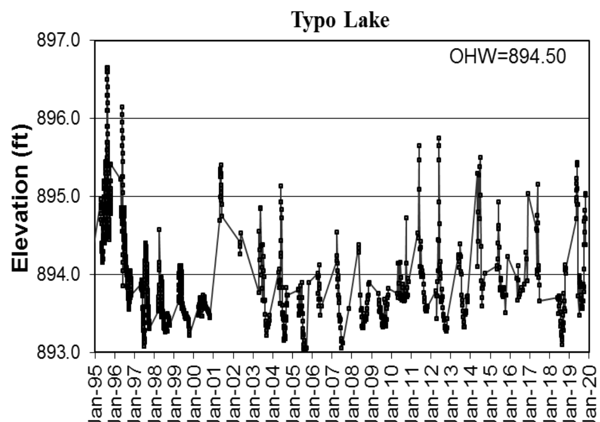
Linwood Lake Levels – last 25 years



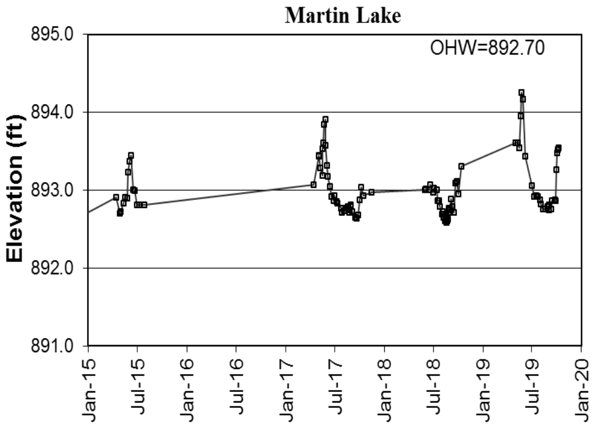
Typo Lake Levels – last 5 years



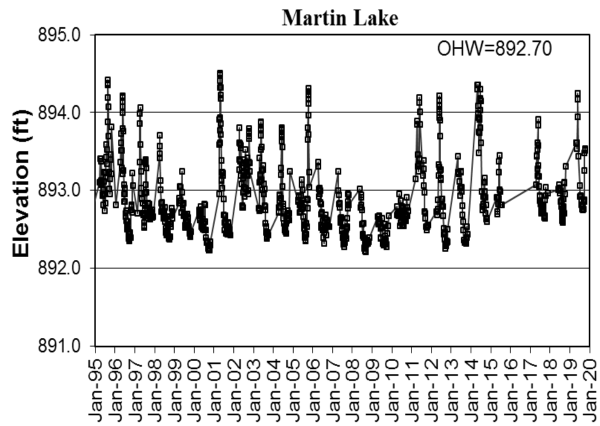
Typo Lake Levels – last 25 years



Martin Lake Levels – last 5 years



Martin Lake Levels – last 25 years



Lake Water Quality

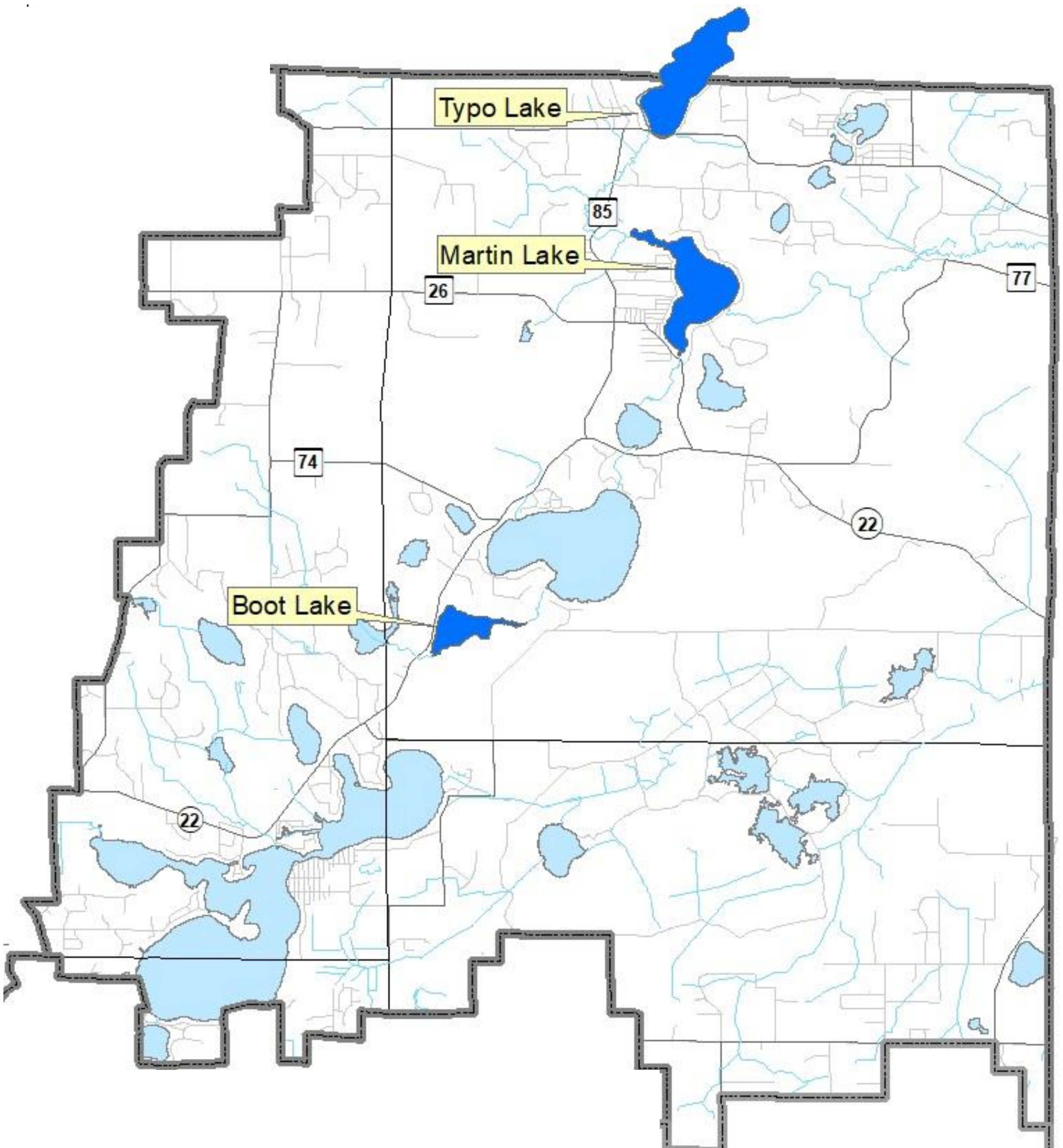
Description: May through September, every-other-week, monitoring is conducted for the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, specific conductivity, pH, and salinity.

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

Locations: Boot, Typo, and Martin Lakes

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 Minnesota Pollution Control Agency (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.

2019 Sunrise River Watershed Lake Water Quality Monitoring Sites



BOOT LAKE
LINWOOD TOWNSHIP LAKE ID # 02-0028

Background

Boot Lake is located in the northeast portion of Anoka County and has a surface area of 92 acres. While nearly all of the lake is shallow with aquatic vegetation growing to the surface, there is one area with a depth of 23 ft. (7 m) where water quality monitoring occurs.

Boot Lake is within a Scientific and Natural Area (SNA) owned and administered by the Minnesota Department of Natural Resources. The Boot Lake SNA is 660 acres and includes the entire lake as well as the undeveloped shoreline. Access, including for ACD to conduct water quality monitoring, requires a special permit from the MN DNR.

Boot Lake has one primary stream inlet and one outlet. The inlet drains upstream lands that include undeveloped, sod fields and large-lot residential usage. The outlet stream goes to Linwood Lake.

Boot Lake was selected as a new monitoring site in 2018 for two reasons. First, Boot Lake is a contributing water source to Linwood Lake which is impaired for excess nutrients. Monitoring Boot Lake's water quality allows us to determine whether Boot Lake is degrading Linwood Lake's water quality. Secondly, Boot Lake is relatively undisturbed, and it is desirable to see what types of water quality conditions are in a rare, undeveloped lake in Anoka County.

2019 Results

Boot Lake's nutrient levels are typical of shallow lakes in the area. Average phosphorus levels in 2019 were 43.3 µg/L, average chlorophyll-a was 6.6 µg/L, and average Secchi transparency was 5.5 ft. (1.7 m). These are better than the state water quality standard for shallow lakes (total phosphorus <60 µg/L, chlorophyll-a <20 µg/L, Secchi transparency >1m), and earns Boot Lake an overall B letter grade on Met Council's grading scale for metro area lakes. This is an improvement from the C letter grade Boot Lake received in 2018. Boot Lake supports a rich plant community, and the lake attracts abundant waterfowl.

Trend Analysis

2019 was only second year of water quality monitoring for Boot Lake. Trend analysis is not yet possible. The earliest data about the lake is from a 1979 a resource inventory was completed for assessment of the site as a potential Scientific and Natural Area. The inventory did not include water quality monitoring.

Discussion

While Boot Lake is not subject to many of the potential negative impacts that occur on unprotected and/or developed lakes, its water quality is far from the pristine condition one might expect. Viking Boulevard runs near the western shore of the lake and may directly contribute pollutants. The contributing subwatershed includes some agriculture and scattered residential housing, which may also affect water quality in Boot Lake. Finally, in-lake nutrients can contribute to algal growth.

ACD monitored the water quality of the inlet to Boot Lake at Viking Boulevard in 2001 and 2003. Average total phosphorus in the inlet across both years was 117 µg/L, which is typical for the area but does exceed the state water quality standard of 100 µg/L, and is likely contributing to the nutrient load into Boot Lake.

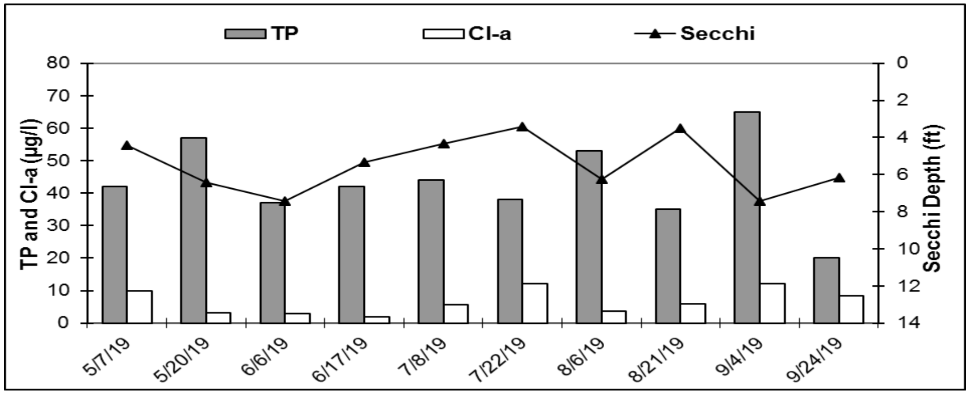
Carp can negatively impact lake water health, though their population appears low in Boot Lake. This is significant because carp reduction is a management goal for Linwood Lake. Boot Lake could be a source of carp, or spawning area for them. Dead common carp were observed in 2018 when ACD staff were monitoring water quality. Also in 2018 a trap netting survey for carp was done in Boot Lake but none were caught.

Boot Lake's impact on Linwood Lake downstream appears neutral, as its nutrient concentrations are similar. However, efforts to improve impaired Linwood Lake should be made with Boot Lake in mind. It often makes sense to manage the whole watershed, and especially upstream contributing waters.

Boot Lake

Linwood Township Lake ID # 02-0028

2019 Results



2019 Median

pH		7.73
Specific Conductivity	mS/cm	0.255
Turbidity	NTU	5.4
D.O.	mg/l	9.14
D.O.	%	107.8
Temp.	°F	71.1
Salinity	%	0.12
Cl-a	µg/L	5.7
T.P.	µg/l	42
Secchi	ft	4.76

Historical Report Card

Year	TP	Cl-a	Secchi	**Overall**
2018	C	B	C	**C**
2019	C	A	C	**B**
State Standards	60 ug/L	20 ug/L	>3.3 ft	

2019 Water Quality Data

	Units	R.L.*	5/7/2019	5/20/2019	6/6/2019	6/17/2019	7/8/2019	7/22/2019	8/6/2019	8/21/2019	9/4/2019	9/24/2019	Average	Min	Max
Time:			9:40	10:00	9:15	9:15	9:00	9:00	9:25	9:15	9:15	9:30			
pH		0.1	7.93	7.89	8.13	7.74	8.29	7.51	7.53	7.44	7.53	7.72	7.8	7.44	8.29
Specific Conductivity	mS/cm	0.01	0.218	0.239	0.215	0.234	0.250	0.272	0.286	0.261	0.275	0.260	0.3	0.22	0.29
Turbidity	NTU	1	N/A	0.02	0.20	2.60	5.40	4.300	0.00	3.60	2.10	2.20	2.3	0.00	5.40
D.O.	mg/l	0.01	10.32	9.29	9.00	8.83	11.28	8.01	8.76	8.84	10.36	14.10	9.9	8.01	14.10
D.O.	%	100	102.1	82.1	108.5	107.6	144.6	97.6	108.0	102.8	114.0	160.6	112.8	82.10	160.60
Temp.	°C	0.1	14.10	12.17	22.27	21.17	25.87	23.91	24.57	22.86	20.01	19.57	20.7	12.17	25.87
Temp.	°F	0.1	57.4	53.9	72.1	70.1	78.6	75.0	76.2	73.1	68.0	67.2	69.2	53.91	78.57
Salinity	%	0.01	0.10	0.11	0.10	0.11	0.12	0.13	0.14	0.13	0.13	0.12	0.1	0.10	0.14
Cl-a	µg/L	1	9.90	3.20	2.80	1.8	5.6	12.2	3.7	5.8	12.1	8.5000	6.6	1.80	12.20
T.P.	mg/l	0.005	0.042	0.057	0.037	0.042	0.044	0.038	0.053	0.035	0.065	0.020	0.0	0.02	0.07
T.P.	µg/l	5	42	57	37	42	44	38	53	35	65	20	43.3	20.00	65.00
Secchi	ft		4.41	6.41	7.41	5.33	4.33	3.41	6.3	3.5	7.4	6.2	5.5	3.41	7.41
Secchi	m		1.3	2.0	2.3	1.6	1.3	1.0	1.9	1.1	2.3	1.9	1.7	1.04	2.26
Physical			1.0	1.0	1.0	1.0	2.0	2.0	1.0	2.0	2.0	2.0	1.5	1.00	2.00
Recreational			2.0	1.0	2.0	1.0	3.0	3.0	2.0	3.0	2.0	2.0	2.1	1.00	3.00

*reporting limit

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, and 28% wetlands, with the remainder being forested or grassland. Typo Lake is on the MPCA's list of impaired waters for excess nutrients.

2019 Results

In 2019 Typo Lake had poor water quality compared to other lakes in this region (NCHF Ecoregion), receiving an overall F letter grade. Average total phosphorus (TP) was 175.0 µg/L, which was an increase from the 2018 average of 160.3 µg/L. While total phosphorus levels continue to far exceed the 60 µg/L state standard, average concentrations appear to be staying well below averages from a decade ago (353.0 µg/L in 2009).

Chlorophyll-a (Cl-a) levels in 2019 averaged 74.4 µg/L. Though this is an increase from previous years, it is below the historical average for the lake of 110.3 µg/L. This is still many times higher than the state standard for Cl-a in shallow lakes of 20 µg/L.

Average Secchi transparency in 2019 was 1.5 feet, which is the second-highest average on record. In 2007 and 2009 a Secchi disk could be seen only 5-6 inches below the surface, on average. Transparency has improved throughout the last decade, but still remains poorer than the state standard for shallow lakes transparency of 1 meter (3.3 feet).

Trend Analysis

Nineteen years of water quality monitoring have been conducted by the MPCA (1993, '94, and '95) and the Anoka Conservation District (1997-2001, '03, '05, '07, '09, '12, 2014-2019). Overall, water quality has improved from 1993 to 2019 (excluding high nutrient outlier years 2007 and 2009) in a statistically significant way (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2, 14}=7.79$, $p=0.01$). 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 showing a statistically significant decline ($p=0.001$). A superficial look at graphs of these parameters suggests that total phosphorus is generally stable between 150 µg/L and 250 µg/L without a long-term trend. Secchi transparency in recent years is similar to averages from the early 1990s, an improvement from the late 1990s-2010. The major driver of improved water quality is decreasing Cl-a concentrations.

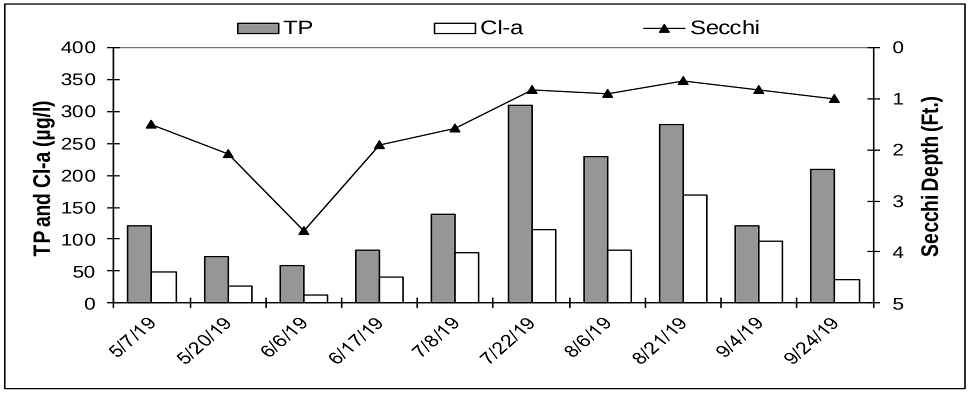
Discussion

Typo Lake, along with Martin Lake downstream was 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 forth lake rehabilitation strategies. Some factors impacting water quality in Typo Lake include rough fish, ditched wetland west of the lake, and lake sediments. Recent work has included installation of carp barriers (completed in 2016), carp removals (2017-19, to be continued in 2020), and a feasibility study of ditched wetland restorations upstream of Typo Lake (2018). The feasibility study was completed in early 2018 and identified 4 potential projects along Ditch 20 upstream of Type Lake. It also recommends that dredging of Ditch 20 not occur. Current shoreline conditions on Typo Lake were inventoried during a 2019 shoreline survey. This inventory will assist in identifying future lakeshore projects. For more information on these projects, contact the Anoka Conservation District.

TYPO LAKE

LINWOOD TOWNSHIP, LAKE ID # 30-0009

2019 Results



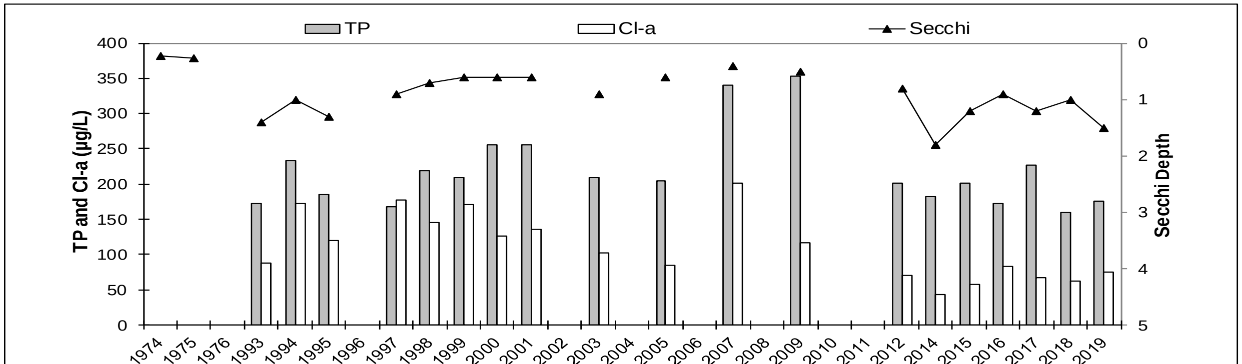
2019 Median Values

pH		8.46
Specific Conductivity	mS/cm	0.284
Turbidity	NTU	98.8
D.O.	mg/l	10.96
D.O.	%	114.95
Temp.	°F	71.6
Salinity	%	0.13
Cl-a	µg/L	63.55
T.P.	µg/l	130
Secchi	ft	1.25

Historical Report Card

Year	TP	Cl-a	Secchi	**Overall**
1974			F	**F**
1975			F	**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**
2018	F	D	F	**F**
2019	F	D	F	**F**
State Standards	60 ug/L	20 ug/L	>3.3 ft	

Historic Annual Averages



2019 Water Quality Data

		Date	2/1/2019	2/15/2019	5/7/2019	5/20/2019	6/6/2019	6/17/2019	7/8/2019	7/22/2019	8/6/2019	8/21/2019	9/4/2019	9/24/2019			
		Time	16:30	16:30	11:30	11:30	10:50	10:40	10:45	10:30	10:50	10:15	10:25	10:45			
	Units	R.L.*													Average	Min	Max
pH		0.1			8.71	8.12	8.43	8.50	8.58	8.51	7.73	8.39	8.30	8.61	8.39	7.73	8.71
Specific Conductivity	mS/cm	0.01			0.236	0.264	0.255	0.301	0.349	0.320	0.333	0.285	0.283	0.270	0.290	0.236	0.349
Turbidity	FNRU	1			N/A	20.20	10.10	30.50	45.7	98.50	99.10	109.00	105.00	101.00	65	10	109
D.O.	mg/l	0.01	16.91	12.57	12.01	10.36	9.22	8.94	16.68	13.75	5.24	11.56	10.30	15.03	11.59	5.24	16.91
D.O.	%	1	130.0	92.0	118.3	96.0	111.6	103.4	204.1	165.9	65.9	136.2	110.9	162.9	121.3	65.9	204.1
Temp.	°C	0.1			13.64	10.98	23.07	20.93	26.06	23.86	24.93	23.20	19.35	19.60	20.67	10.98	26.06
Temp.	°F	0.1			56.6	51.8	73.5	69.7	78.9	74.9	76.9	73.8	66.8	67.3	69.2	51.8	78.9
Salinity	%	0.01			0.11	0.12	0.12	0.14	0.17	0.16	0.11	0.14	0.13	0.13	0.1	0.1	0.2
Cl-a	µg/l	1			49.10	26.50	11.90	40.00	78.00	115.00	83.30	169.00	97.20	36.10	74.4	11.9	169.0
T.P.	mg/l	0.005			0.120	0.072	0.059	0.083	0.140	0.310	0.230	0.280	0.120	0.210	0.175	0.059	0.310
T.P.	µg/l	5			120	72	59	83	140	310	230	280	120	210	175	59	310
Secchi	ft	0.1			1.50	2.08	3.58	1.91	1.58	10.00	0.9	0.7	0.8	1.0	2.6	0.7	10.0
Secchi	m	0.1			0.5	0.6	1.1	0.6	0.5	3.0	0.3	0.2	0.3	0.3	0.8	0.2	3.0
Physical					3.0	3.0	3.0	3.00	3.00	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Recreational					3.0	3.0	3.0	3.00	4.00	3.0	3.0	3.0	4.0	4.0	3.3	3.0	4.0

*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 remaining 82% 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 MPCA's list of impaired waters for excess nutrients.

2019 Results

In 2019 Martin Lake had a C letter grade. During 2016-2018 the lake had a pattern of declining phosphorus levels, including a record low of 53.1µg/L in 2018. In 2019 total phosphorus levels were higher, averaging 64.1 µg/L. Even though total phosphorus levels were higher in 2019, they are better than the average of 92.7 µg/L during 1997-2015 or even higher. 2019 was the wettest year on record for the area, and increased runoff from the watershed may have played a role in higher 2019 phosphorus.

In 2019, chlorophyll-a averaged 32.8 µg/L, an increase from the 2018 average of 27.6 µg/L. Cl-a levels have been on a fairly steady incline since 2014 which had the lowest recorded average of 15.5 µg/L. While the 5-year (2015-2019) average (26.5 µg/L) has been much lower than the 2005-2009 average (108.3 µg/L), it remains above the impairment standard of 14 µg/L.

Average Secchi transparency was 3.3 feet in 2019, an improvement from the historical average of 2.9 feet for the lake. Secchi transparency remains about 30% below the State impairment threshold of 4.6 feet. The ACD staff continues to note green water during late summer months.

Trend Analysis

Nineteen years of water quality data have been collected by the MPCA (1983), Metropolitan Council (1998, 2008), and the ACD (1997, 1999-2001, 2003, 2005, 2007, 2009, 2012-2019). 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 poor, water quality in Martin Lake has shown an improvement from 1983 to 2019 that is statistically significant (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth; $F_{2, 15}$=5.26, p <0.02). This is especially true for the last decade. Further examination of the data shows that while TP and Secchi transparency have not changed in the long-term since 1983, chlorophyll-a has shown a statistical decrease (p <0.01) over this time. Water quality in Martin Lake declined through the late 1990s and reached its worst in 2007. In the nine years sampled since 2007, both TP and Secchi transparency have improved on a statistically significant basis (TP p <0.01, Secchi p <0.01).

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 sources 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.

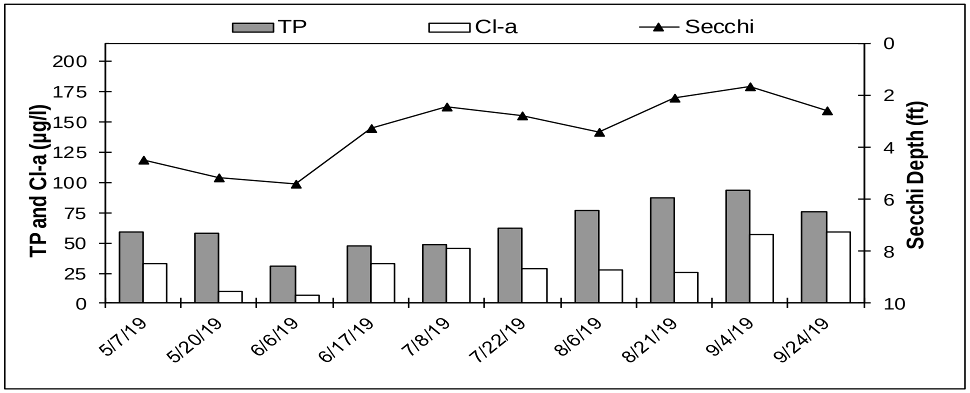
Upstream of Typo Lake, a feasibility study was completed in early 2018 regarding restoration of ditched wetlands (Ditch 20). This study identified 4 potential projects and also recommends that dredging of Ditch 20 not occur.

Carp removals and other management efforts are taking place in 2017-2020 and additional stormwater retrofits are planned in 2020-2021. Current shoreline conditions on Martin Lake were inventoried during a 2019 shoreline survey. This inventory will assist in identifying future lakeshore projects. Recent water quality monitoring results suggest these management approaches are improving conditions in these lakes, but reaching goals will require additional effort and time.

MARTIN LAKE

LINWOOD TOWNSHIP, LAKE ID # 30-0009

2019 Results



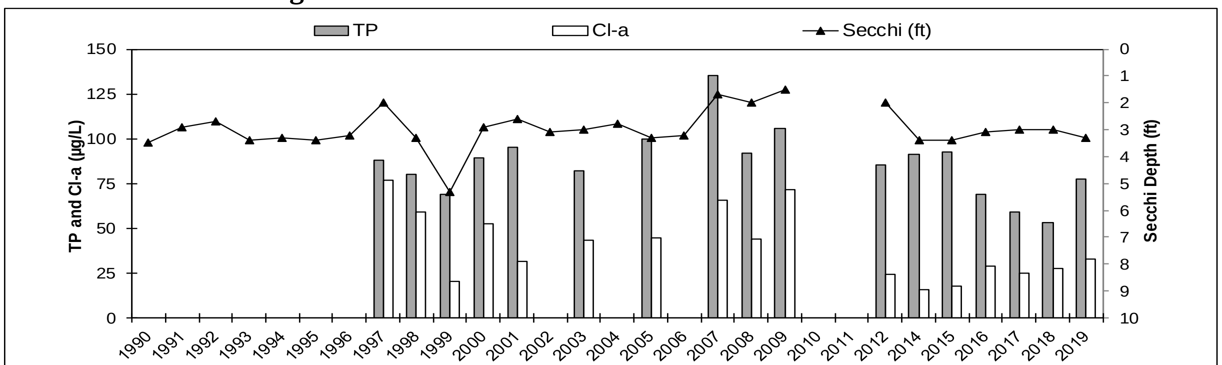
2019 Median Values

pH		8.04
Specific Conductivity	mS/cm	0.315
Turbidity	NTU	17
D.O.	mg/l	10.85
D.O.	%	125.55
Temp.	°F	70.5
Salinity	%	0.14
Cl-a	µg/L	31.1
T.P.	µg/l	60.5
Secchi	ft	3.3

Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1996			D	**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**
2018	C	C	D	**C**
2019	C	C	D	**C**
State Standards	40 ug/L	14 ug/L	>4.6 ft	

Historic Annual Averages



2019 Water Quality Data

	Units	R.L.*	5/7/2019	5/20/2019	6/6/2019	6/17/2019	7/8/2019	7/22/2019	8/6/2019	8/21/2019	9/4/2019	9/24/2019	Average	Min	Max
Time:			10:45	10:30	9:50	9:50	10:00	9:50	10:10	9:45	9:50	10:10			
pH		0.1	8.20	7.80	7.95	8.07	8.38	8.02	8.39	7.97	7.79	8.25	8.08	7.79	8.39
Specific Conductivity	mS/cm	0.01	0.285	0.299	0.272	0.290	0.332	0.363	0.360	0.334	0.340	0.299	0.317	0.272	0.363
Turbidity	FNRU	1	N/A	4.40	2.10	17.00	21.40	13.50	12.30	22.60	27.00	35.60	16.11	2.10	35.60
D.O.	mg/l	0.01	13.33	8.56	8.95	9.72	12.18	10.21	14.08	10.46	11.24	16.14	11.49	8.56	16.14
D.O.	%	1	125.7	83.3	105.7	112.6	156.5	125.4	178.9	124.7	127.5	172.5	131.3	83.3	178.9
Temp.	°C	0.1	12.72	13.09	21.94	20.82	25.71	25.18	25.91	23.85	20.31	20.14	21.0	12.7	25.9
Temp.	°F	0.1	54.9	55.6	71.5	69.5	78.3	77.3	78.6	74.9	68.6	68.3	69.7	54.9	78.6
Salinity	%	0.01	0.13	0.14	0.13	0.14	0.16	0.17	0.10	0.16	0.16	0.14	0.14	0.10	0.17
Cl-a	ug/L	1	33.20	10.10	7.00	33.40	46.00	29.00	27.90	25.20	56.60	59.10	32.8	7.0	59.1
T.P.	mg/l	0.005	0.059	0.058	0.031	0.048	0.049	0.062	0.077	0.087	0.094	0.076	0.064	0.031	0.094
T.P.	ug/l	5	59	58	31	48	49	62	77	87	94	76	64.1	31	94
Secchi	ft	0.1	4.50	5.16	5.41	3.25	2.41	2.75	3.4	2.1	1.7	2.6	3.3	1.7	5.4
Secchi	m	0.1	1.4	1.6	1.6	1.0	0.7	0.8	1.0	0.6	0.5	0.8	1.0	0.5	1.6
Physical			1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.0	2.0
Recreational			1.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	1.0	3.0

*reporting limit

Stream Water Quality

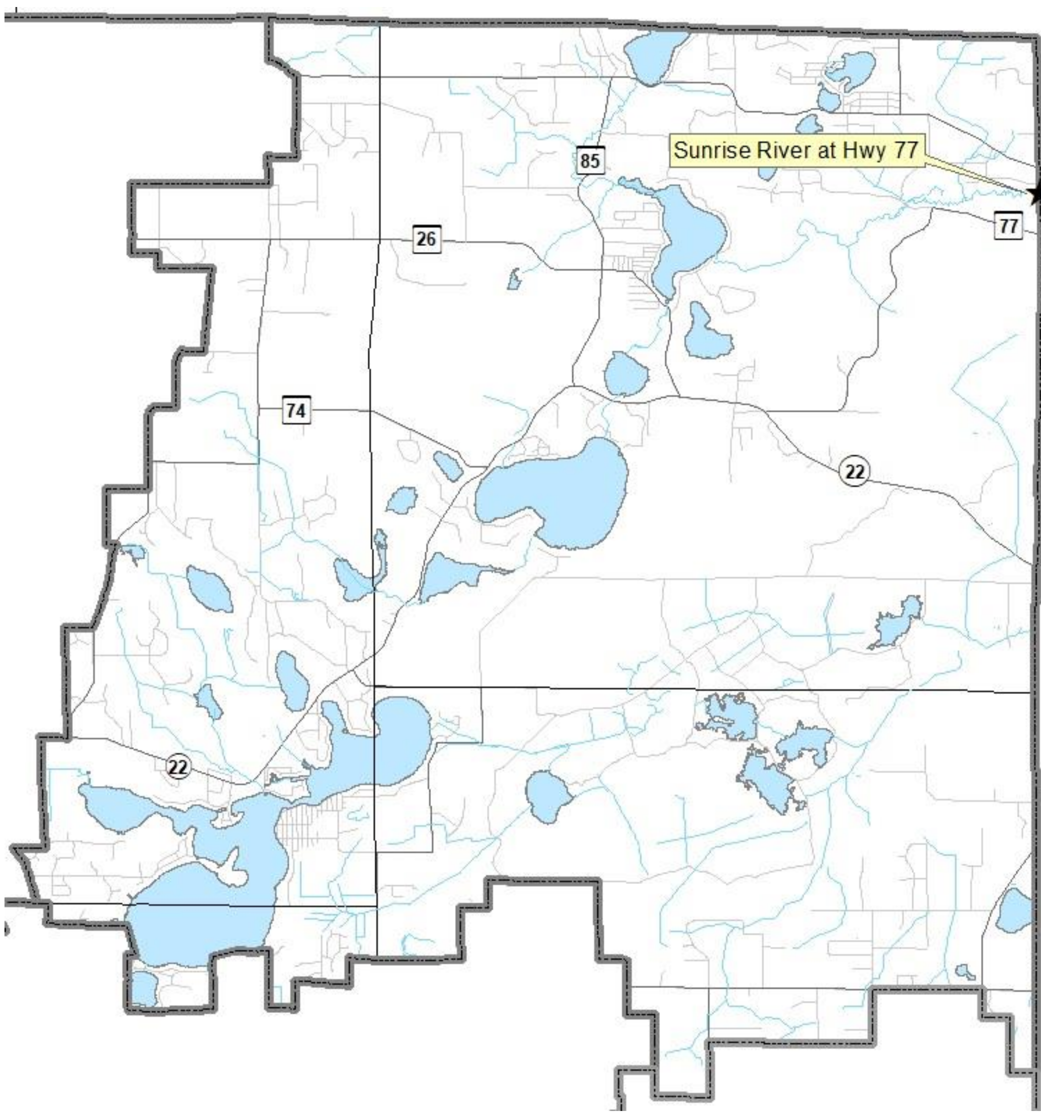
Description: In 2019 and 2020, the Sunrise River water quality monitoring site at Highway 77 is being monitored using funds from a MPCA Surface Water Assessment Grant (SWAG). Stream water quality was monitored on twelve occasions in 2019, including five grab samples. The selected site is at the furthest downstream limit of the Sunrise River Watershed Management Organization's jurisdictional area, and the Anoka County border. Parameters monitored include water level, pH, specific conductivity, turbidity, chlorides, transparency, dissolved oxygen, total phosphorus, and total suspended solids.

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

Location: Sunrise River at Hwy 77

Results: Results are presented on the following pages.

2019 Sunrise River Watershed Stream Water Quality Monitoring Sites



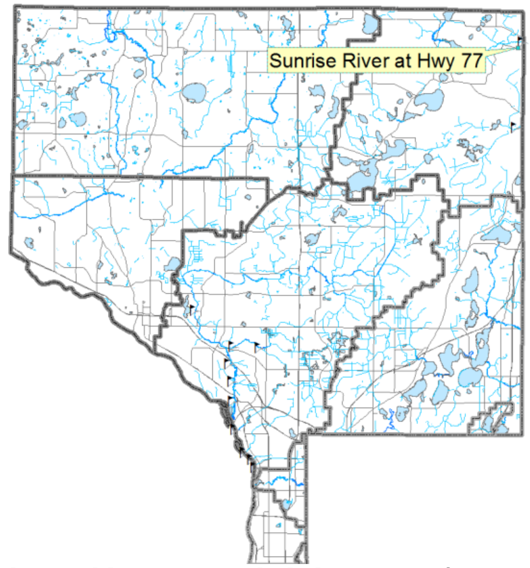
Stream Water Quality Monitoring

SUNRISE RIVER AT HWY 77

Near Fawn Lake Dr. NE, Linwood Township

STORET SiteID = S001-424

Years Monitored
2001, 2003, 2006, 2012, 2015, 2018, 2019



Background
This monitoring site is near the bottom of the Sunrise River Watershed in Anoka County, at the Chisago County border. Upstream, this river drains through Boot, Linwood, Island, Martin, and Typo Lakes. The Sunrise River Watershed Management Organization historically monitors this site because it is where the river leaves their jurisdiction. Additionally, monitoring is considered important because this portion of the river is impaired for aquatic life with turbidity identified as a stressor. This site is included in the MN Pollution Control Agency's Cycle II Monitoring for the Lower St. Croix Watershed which began in 2019 and will run through 2020. A TMDL study was completed in 2013.

Methods
The river was monitored on 12 occasions. All monitoring during 2019 was completed during baseflow conditions. Parameters tested with portable meters included pH, specific conductivity, turbidity, temperature, dissolved oxygen, and salinity. Parameters tested by water quality grab samples sent to a state-certified lab included total phosphorus, chlorides, and total suspended solids. Grab samples were taken and analyzed by a laboratory at the beginning of each month monitored.

Summarized Results
Summarized water quality monitoring findings and management implications include:

- Specific conductivity was below the county median of 0.420 mS/cm. The median specific conductivity was 0.362 mS/cm. The median specific conductivity for all years at this site is 0.306 mS/cm. For management considerations see chlorides.
- Chlorides were measured at this site in all years, except 2015. In 2019, the median chloride concentration was 17.2 mg/L. The median for all years at this site is 15.65 mg/L and the countywide median is 13.29 mg/L which are both well below the state standard of 230 mg/L
  Management discussion: Road deicing salts are a concern region-wide. Chlorides are measurable in area streams year-round, including in the Sunrise River. While chloride levels may be low compared to state standards, excessive salt use should be avoided.
- Suspended solids and turbidity levels were similar in 2019 compared to other years monitored. The 2019 median TSS concentration was 12.0 mg/L, a decrease from 20.1 mg/L in 2018. The median for all years at this site is 17 mg/L. These levels are higher than most other Anoka County streams, but still below the state standard of 30 mg/L TSS.
  Management discussion: Efforts to reduce suspended material in upstream lakes will help decrease turbidity and suspended solids throughout the Sunrise River.
- Phosphorus has fluctuated above and below the water quality standard for the Central River Nutrient Region of ≤100 µg/L. The 2019 median for TP was 72.0 ug/L, which was much lower than the 2018 median of 101.5 ug/L. The median TP for all years at this site is 87 µg/L.
  Management discussion: Management in upstream lakes will help reduce phosphorus in the river.
- pH was within the range considered normal and healthy for streams in this area. The median pH was 7.56.
- Dissolved oxygen (DO) was typically within the range considered normal and healthy at the time of sample collection.

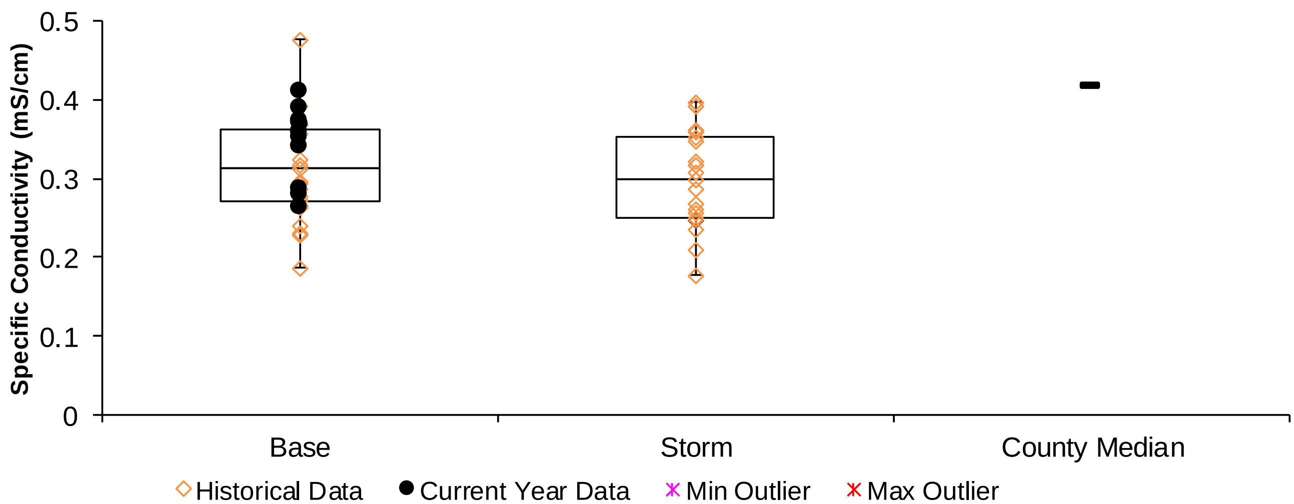
Below the data are presented and discussed for each parameter in greater detail. Management recommendations will be included at the conclusion of this report.

Specific conductivity

Specific conductivity and chlorides are measures of dissolved pollutants. Dissolved pollutant sources include urban road runoff, industrial chemicals, and others. Metals, hydrocarbons, and road salts are often of concern in a suburban environment. Specific conductivity is the broadest measure of dissolved pollutants we use. It measures electrical conductivity of water standardized for temperature; pure water with no dissolved constituents has zero specific conductivity.

Specific conductivity was acceptably low in the West Branch of the Sunrise River. Median specific conductivity for 2019 was 0.362 mS/cm. Some of the highest specific conductivity samples were observed in 2019 but the median for the site was lower than the median for Anoka County streams (0.420 mS/cm). Specific conductivity has historically been lower during storms, suggesting that stormwater runoff contains fewer dissolved pollutants than the surficial water table that feeds the river during baseflow. Increased specific conductivity levels during baseflow conditions has been observed in many Anoka County streams. This has been studied leading to the determination that the largest contributor to rising specific conductivity levels is road deicing salts that have infiltrated into the shallow aquifer.

Specific conductivity during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

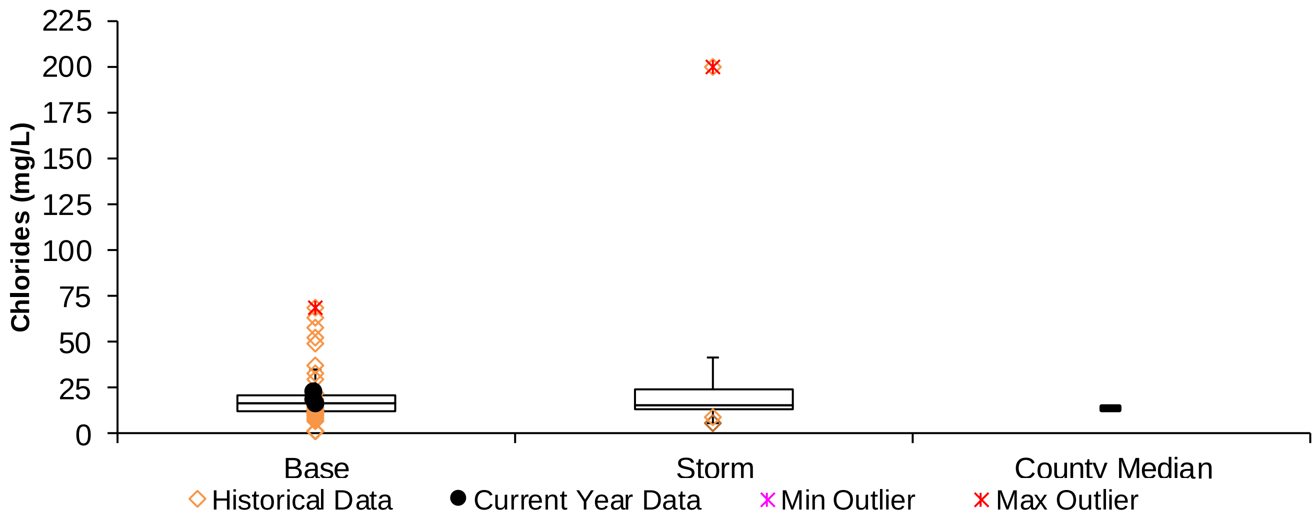


Chlorides

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 concern because of the effect they can have on the stream's biological community. Specific Conductivity data, reported above, is commonly used as an indicator for chlorides, with higher specific conductivity generally corresponding to higher chlorides.

Chlorides in the West Branch of the Sunrise River are higher than the median for Anoka County (13.29 mg/L). In 2019 the median chloride concentration was 17.2 mg/L, slightly less than in 2018 and well below the state standard of 230 mg/L. A waterbody is considered impaired if two or more samples exceed the state standard in a three-year period. This mirrors the pattern seen in specific conductivity with higher readings during baseflow conditions and further supports the finding that road deicing salts seeping into the shallow aquifer are a primary cause of higher baseflow chloride and specific conductivity readings.

Chlorides during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Turbidity and Total Suspended Solids (TSS)

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

It is important to note that suspended solids can come from sources within the river itself or outside of the river from the contributing watershed. Sources from the watershed include soil erosion, road sanding, and others. In-stream sources of TSS include riverbank erosion and movement of the river bottom. Finally, algae from the river and upstream lakes contribute to suspended solids.

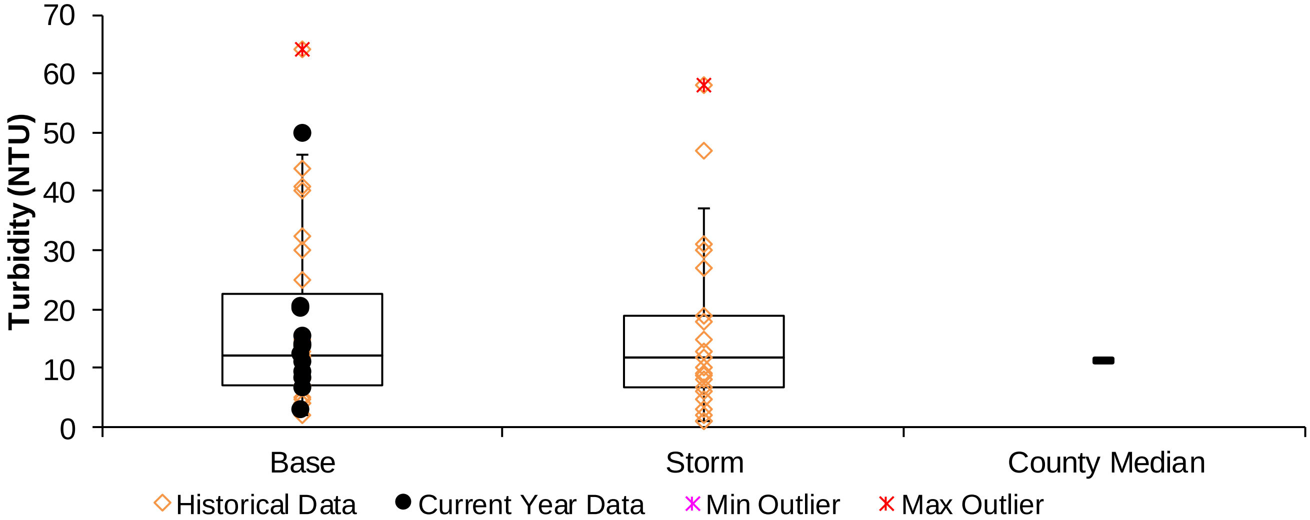
Turbidity is no longer used to determine if a stream is impaired. Instead, total suspended solids is used. Turbidity is still a helpful and easy to measure parameter. Generally, turbidity below 25 NTU is acceptable; previously this was the State's standard. When that standard was in place a stream was impaired if it exceeded this value on three occasions and at least 10% of all sampling events. Including all years of data, the West Branch of the Sunrise River has exceeded 25 NTU on 14 of 60 sampling occasions (23%). Turbidity decreased in 2019, with only one of twelve samples surpassing the state standard (8.3%) at 49.7 NTU.

The most obvious source of turbidity is algae from upstream lakes. Three upstream lakes are impaired for excess nutrients and high algae. They include Linwood, Martin, and Typo Lakes. The river sampling site is 3 miles downstream from Martin Lake. The area between the lake and sampling site is wide floodplain fringe and forest with little human impact that would not be expected to add much sediment to the river. Therefore, efforts to reduce suspended material in the river should focus on the upstream lakes. It is also worth noting that this section of the river has unconsolidated bottom material which can re-suspend and contribute to turbidity.

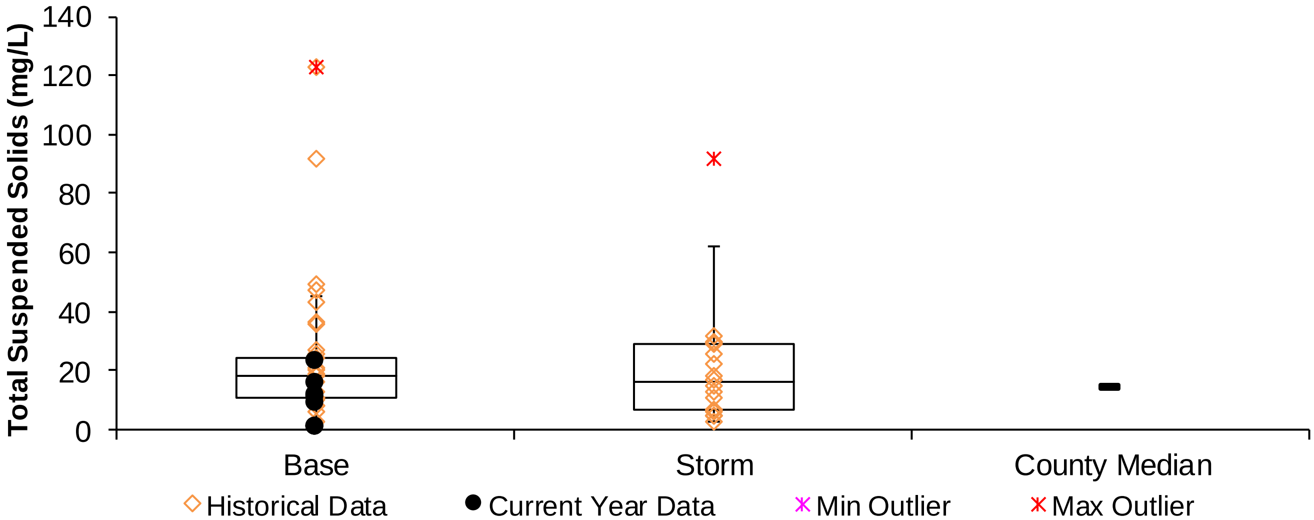
Total suspended solids in the West Branch of the Sunrise River has exceeded the State standard for this region. The standard is no more than 10% of samples exceeding 30 mg/L during April 1-September 30. Over all years monitored the West Branch exceeded the standard on 17% of sampling occasions (9 of 53).

In 2019 total suspended solid levels decreased compared to 2018 and no samples exceeded the standard. In 2019, unlike previous years, all samples were taken during baseflow. Other years of sampling included storm events. This suggests that storm runoff may contribute suspended solids, in addition to the algae coming from upstream lakes. It's also important to recognize that the unconsolidated river bottom sediments may contribute to high TSS, especially during times of higher flow. There it little land runoff to this river downstream of Martin Lake.

Turbidity during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2019 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 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

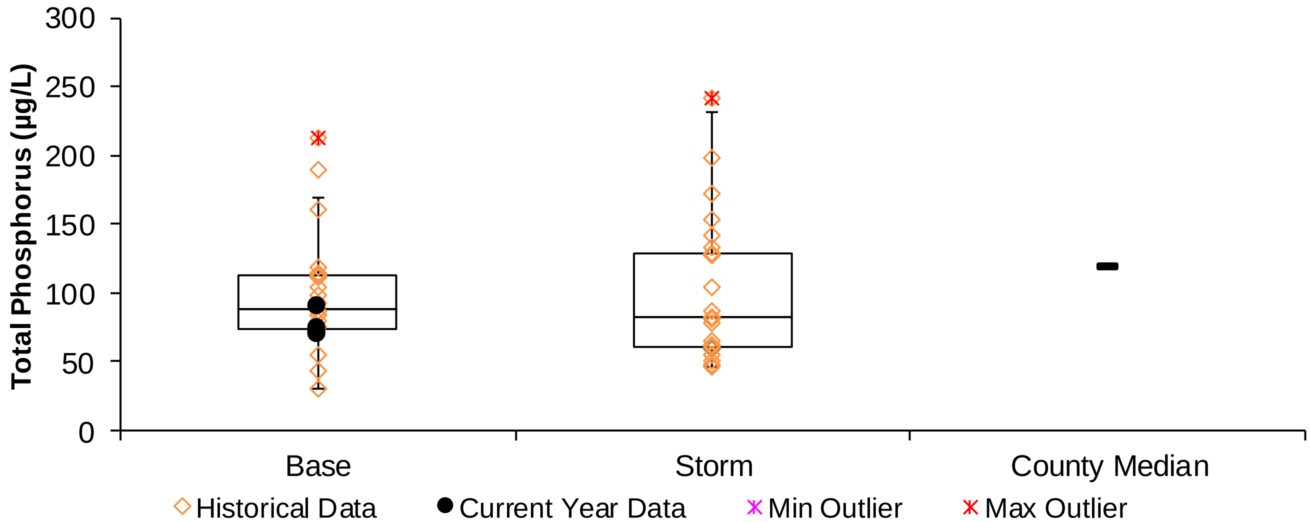


Total Phosphorus

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. Total phosphorus (TP) in the West Branch of the Sunrise River often exceeds the state standard of 100 µg/L. In 2019 the median phosphorus concentration was 72.0 ug/L and did not exceed the state standard in any of the five sampling events. This was a decrease from the 2018 median of 101.5 ug/L The median phosphorus concentration in the West Branch of the Sunrise River across all years monitored is 87.0 µg/L. Over all years sampled, 21 of 53 samples (39%) have exceeded the standard of 100 µg/L. There has generally not been a large difference between storm and baseflow TP concentrations, though all 2019 sampling occurred during baseflow conditions. This likely contributed to a lower median concentration.

These phosphorus levels are common for the area. In the case of the West Branch of the Sunrise River phosphorus levels are, at least in part, reflective of conditions of Martin Lake located 3 miles upstream from the sampling site. Martin Lake is impaired for excess phosphorus, with a summertime average of 79.2 µg/L over the last 10 years. Water quality improvements to Martin Lake will benefit the river downstream. Recent upstream projects including carp barriers, carp harvests, and stormwater retrofits, coincide with improved conditions in upstream lakes, but those benefits are not yet apparent in the West Branch of the Sunrise River.

Total phosphorus during baseflow and storm conditions. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



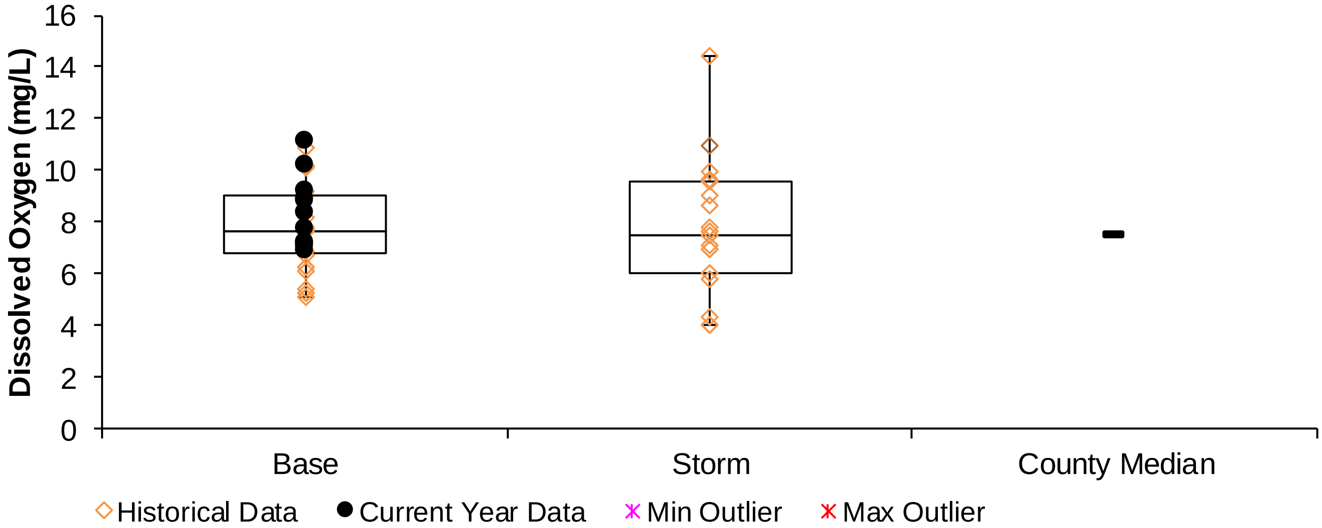
Dissolved Oxygen

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

For the West Branch of the Sunrise River there are two datasets to consider. First, spot measurements were taken with the other water quality monitoring described in this report. Dissolved oxygen has been found at less than 5 mg/L on three out of 52 occasions. All were during storm events, occurring in 2003, 2012 and 2015. In 2019, there were no instances of DO dipping below 5 mg/L, but sampling did not occur in early morning, or during storms flows.

The second data set is around-the-clock DO measurements for eight days in 2012 by the MPCA. They found DO dipped below 5 mg/L every morning. The river has been designated as impaired for poor fish and invertebrate communities. Although it is not listed as impaired for DO specifically, low DO concentration occurring each morning in this stream is a likely stressor on these organisms.

Dissolved oxygen results during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

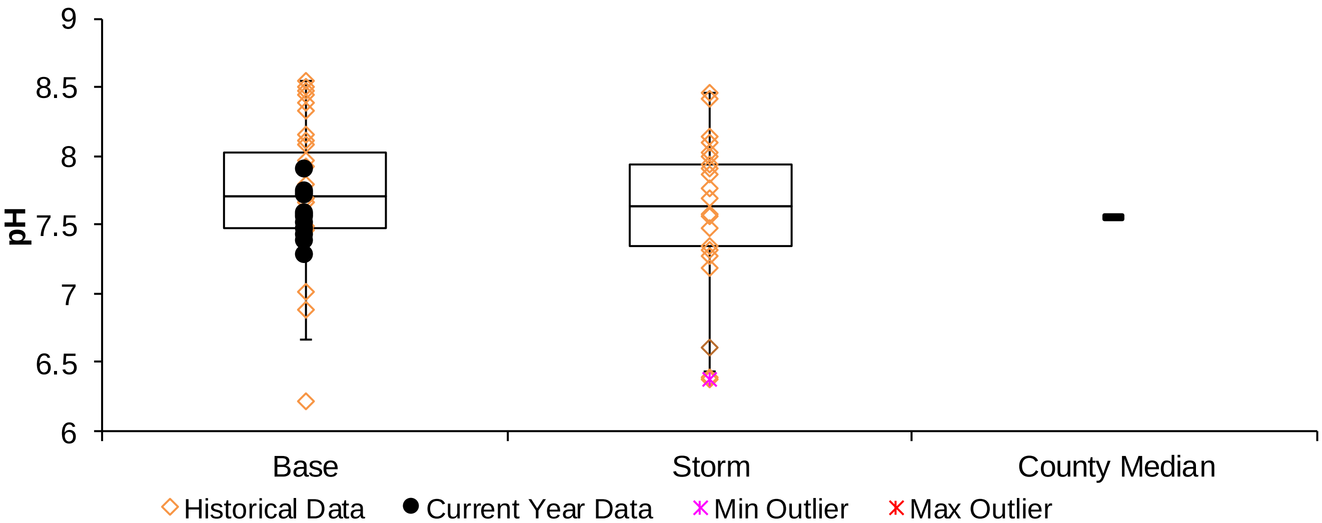


pH

pH refers to the acidity of the water. The MPCA's water quality standard is for pH to be between 6.5 and 8.5. The West Branch of the Sunrise River is regularly within this range (see figure below). It often has slightly higher pH than other streams because of the impact of algal production in upstream lakes.

It is interesting to note that pH is generally lower during storms than during baseflow. This is because the pH of rain is typically lower (more acidic). While acid rain is a longstanding problem, its effect on this aquatic system is small. In 2018, there was one occurrence of sub-standard pH in October when pH was 5.66. This is not overly concerning. pH was within the normal range (7.28 to 7.90) for all samples in 2019.

pH results during baseflow and storm conditions Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Recommendations

Water quality in the West Branch of the Sunrise River is lower than ideal. A Total Maximum Daily Load (TMDL) study was completed in 2013 to determine impairments of this river. The study found that aquatic life in this river was struggling with turbidity identified as the main stressor. Low dissolved oxygen may also be a stressor contributing to aquatic life impairment. At this time, it appears that many of the issues in the river would be best addressed with water quality improvement projects targeted at upstream lakes. These lakes are likely the main sources of nutrients and suspended solids in this river.

Dissolved oxygen is not low in the lakes, however, and low nighttime levels in the river may be related to decomposition occurring in the large wetland floodplain. With regards to water quality improvements in the lakes, there are a number of ongoing projects including carp removals in Typo and Linwood lakes. For more information, see the Martin and Typo Lake Carp Removal section of the 2019 Water Almanac.

Wetland Hydrology

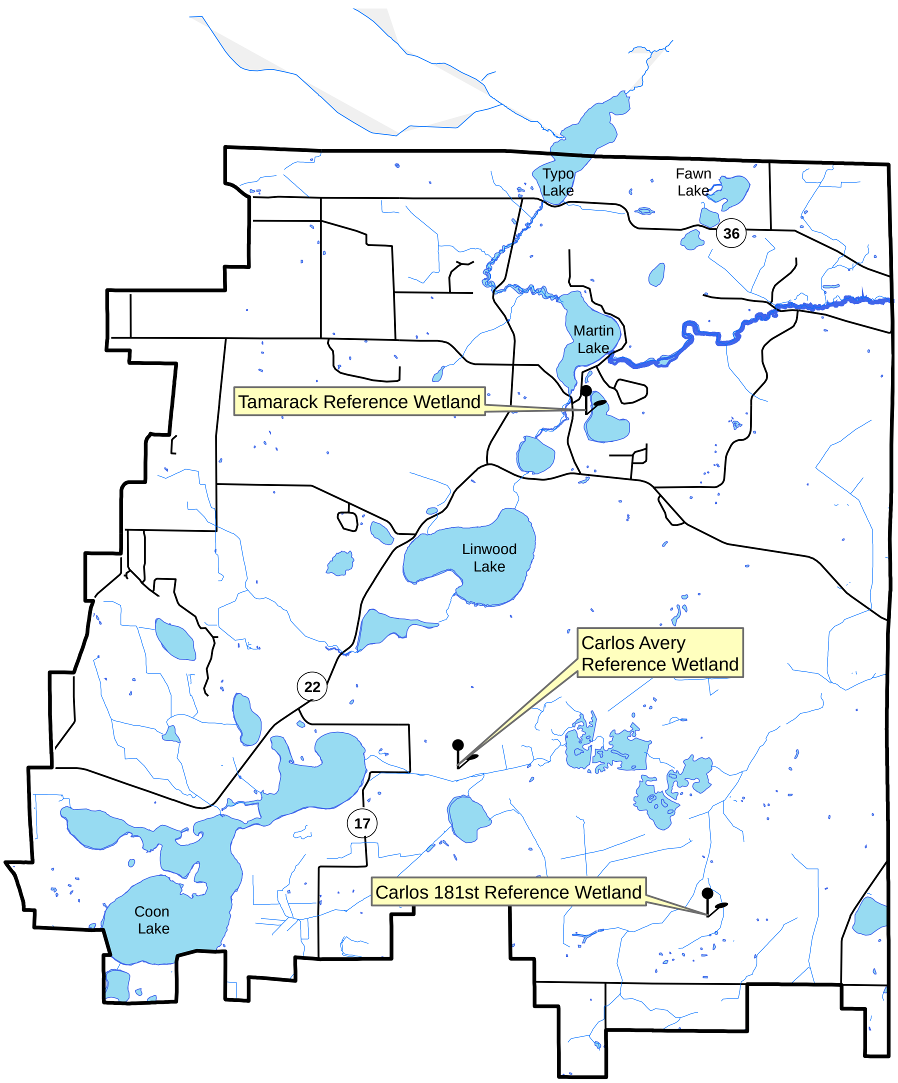
Description: Continuous groundwater level monitoring at a wetland boundary. Countywide, the ACD maintains a network of 23 wetland hydrology monitoring stations.

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.

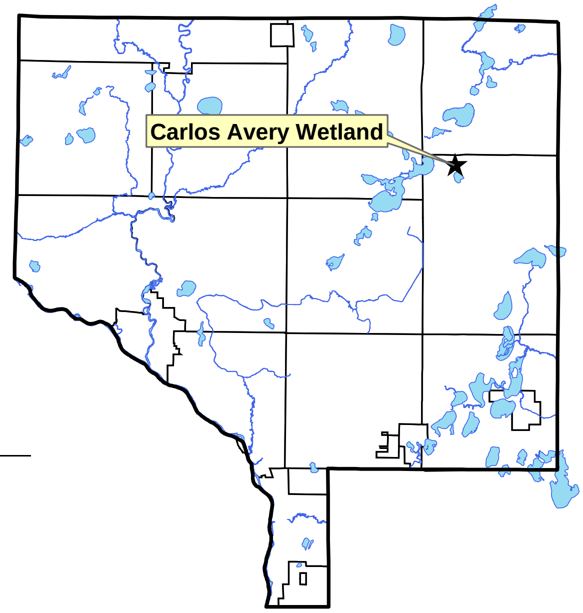
2019 Sunrise River Watershed Wetland Hydrology Monitoring Sites



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

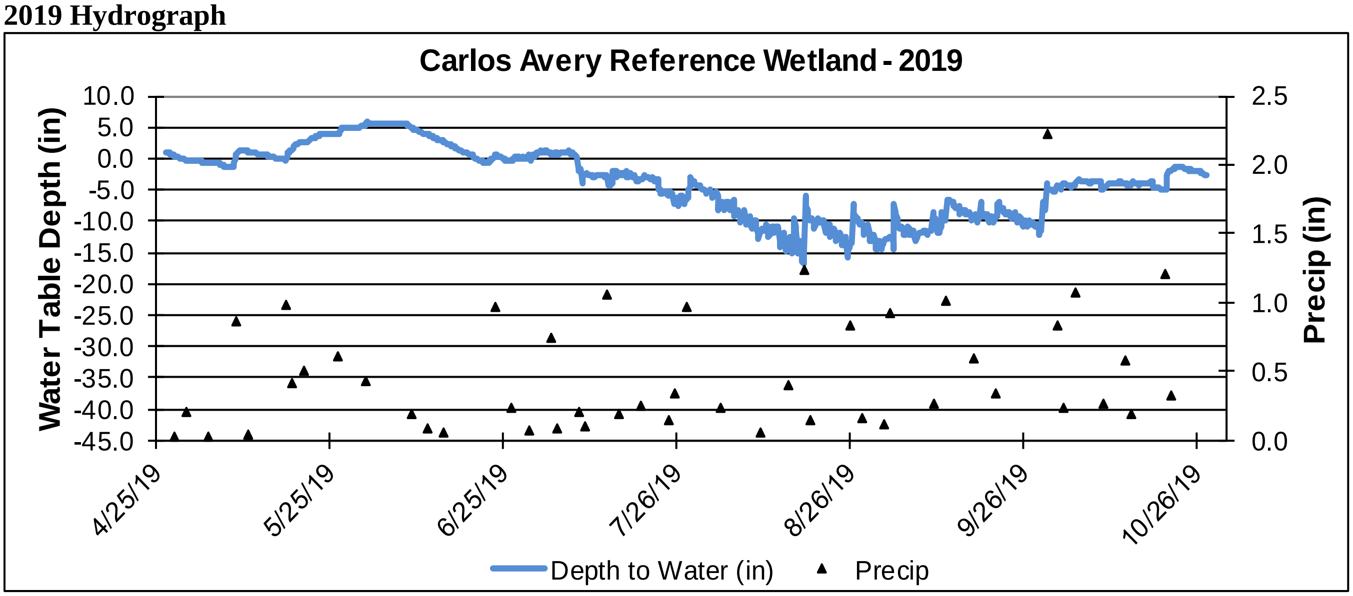
Surrounding Soils: Lino loamy fine sand

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.

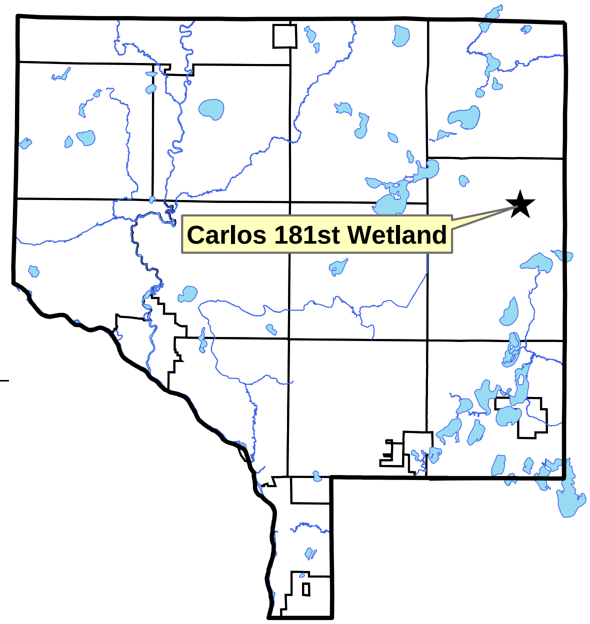
2019 Hydrograph



Wetland Hydrology Monitoring

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	-

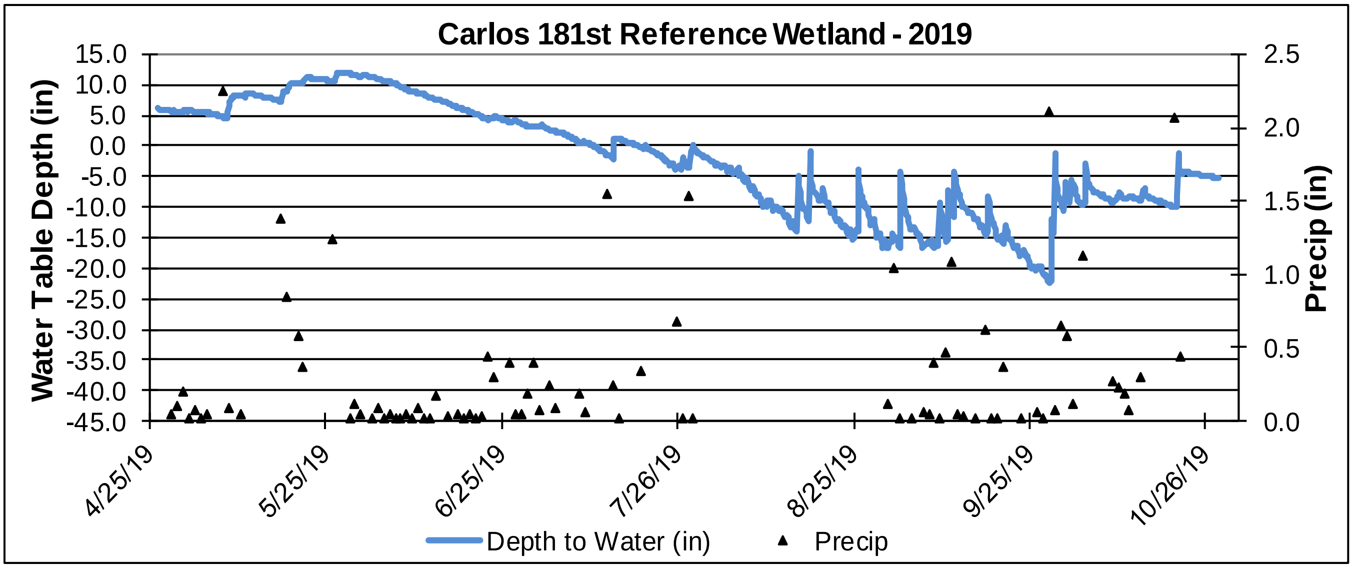
Surrounding Soils: Soderville fine sand

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

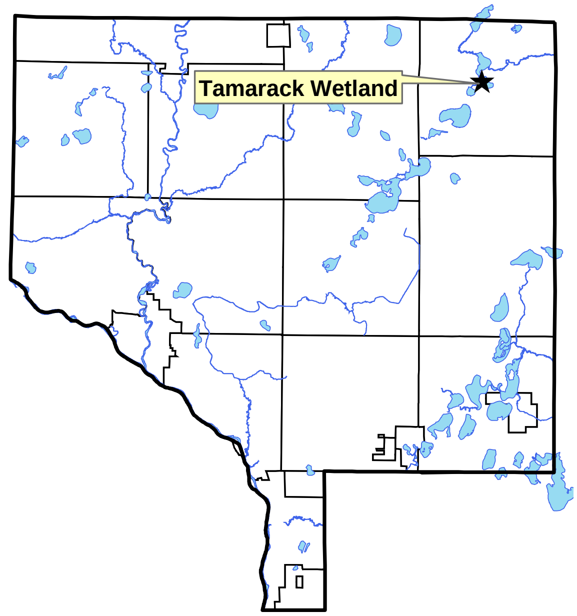
Other Notes: The site is owned and managed by the MN DNR. Access is from 181st Avenue.

2019 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	-

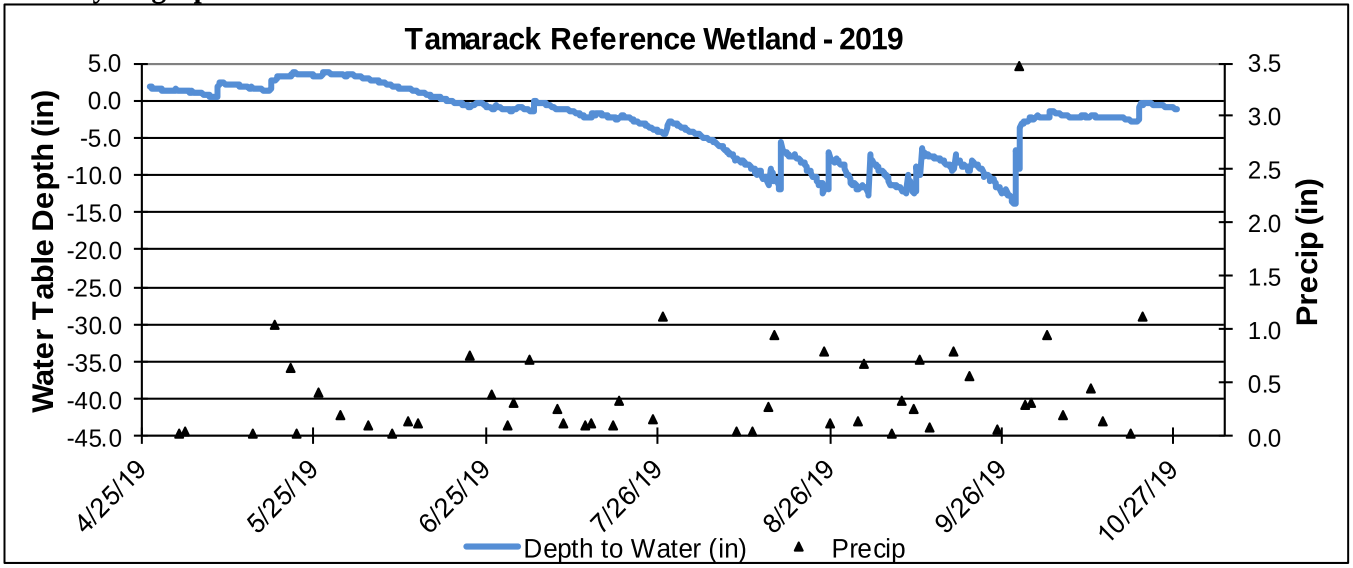
Surrounding Soils: Sartell fine sand

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.

2019 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 cost sharing of the materials needed for a project. The landowner is responsible for some expenses. 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 Expense – Gunnink Coon Lakeshore	-	$1,148.40
2019 SRWMO Contribution		$ 0.00
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 both water quality and 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 2017-2019 carp were actively removed from the lakes. Additionally, a detailed assessment of the carp population, age structure, and spawning history is being completed. A long-term management plan for carp was prepared in 2019.

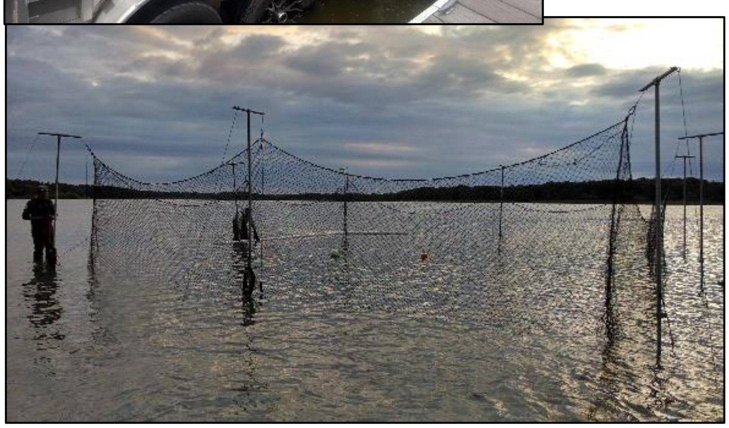
Purpose: To improve water quality in Typo and Martin Lakes, as well as downstream waterways.

Location: Typo and Martin Lakes

Results: In 2019 the following work was completed:

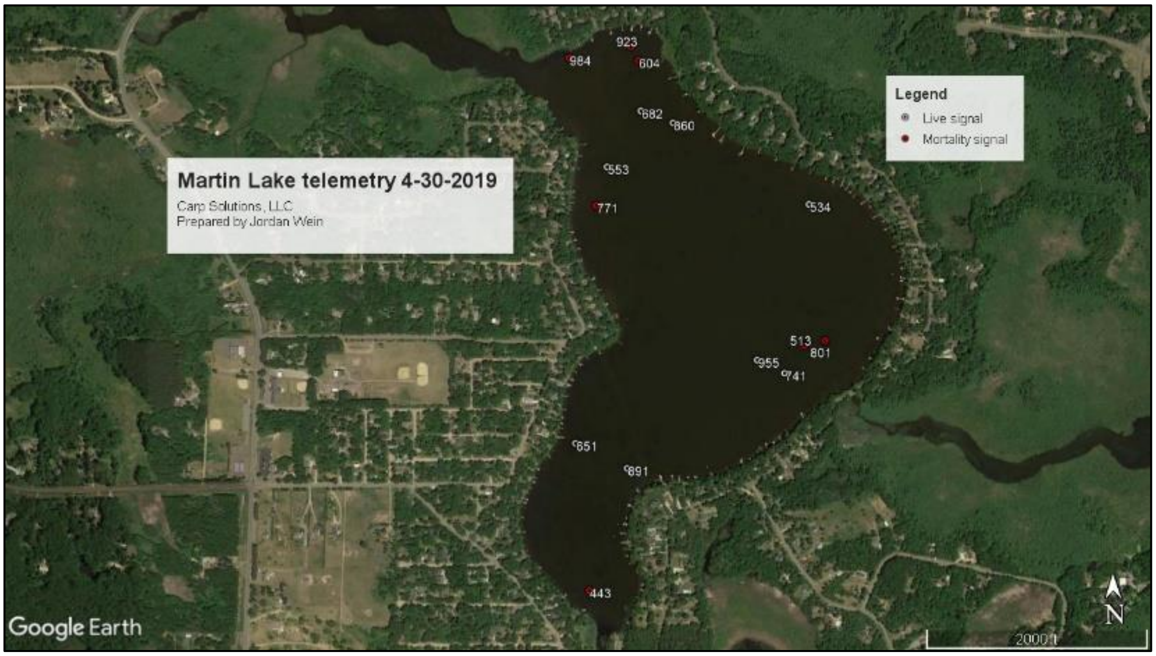
- Radio telemetry monitoring of carp in Typo and Martin Lakes.
- 1,863 carp were removed from Martin Lake and 999 carp were removed from Typo Lake. Total three-year total of carp removed from these lakes is now 11,879.
- Completed a long term carp management plan.
- Fully expended and closed the DNR Conservation Legacy Program grant for this project.
- Secured a new State Clean Water Fund grant to fund carp removals in 2020-2022, bringing these lakes, plus Linwood Lake, to carp density goals.
- Presented results at the annual Martin Lakers Association meeting.

Volunteers and Carp Solutions LLC staff with carp removed at Martin Lake. 40 carp were implanted with radio loggers, 20 each from 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 multiple sites each in Typo and Martin Lake for a total of 24 nettings on 7 different days from June through October, 2019.

Martin and Typo Lake Carp Removal Project continued



Example Telemetry Map from April 30, 2019. Radio tagged carp are periodically located to help determine seasonal movements that can direct management, such as when and where to attempt carp harvests.

First place 2019 Martin Lakers Association boat parade float. The float celebrated carp removal to improve lake water quality.

Linwood Lake Carp Population Study

Description: Linwood Lake has relatively poor water quality, modestly worse than state water quality standards. The lake often has a green or brown tinge to it. Carp are a major cause of poor water quality in Typo and Martin Lake, and the goal of this study was to determine how much of a role carp play in causing poor water quality in Linwood Lake.

Purpose: Estimate carp abundance and population age structure; identify likely carp nursery sites; map carp movement using radio telemetry

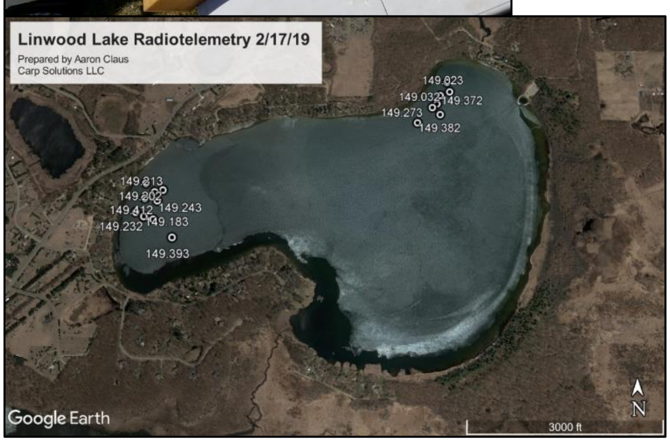
Location: Linwood Lake

Results: A "Linwood Lake Carp Management Feasibility Assessment" was completed by Carp Solutions LLC and the Anoka Conservation District. Work included electrofishing surveys to determine carp populations, box netting surveys for young carp in Linwood and Boot Lakes, determining the age structure and recruitment history of the carp population, radio tracking 20 tagged carp, and a cost-benefit comparison of options available to improve lake water quality. The resulting data was used to develop management recommendations.

In summary, the study found that Linwood Lake has a carp density of 98 lbs/ac, which is only modestly above the threshold of 89 lbs/ac, above which carp significantly affect lake health. The carp population is relatively young; 56% are age 7 or younger. Because the population is near goals but seems prime to increase substantially, preventive carp removals were recommended. This carp management feasibility study was used to successfully apply for a State Clean Water Fund to do the recommended management.

The full feasibility study report is available from the Anoka Conservation District.

Surgical implantation of a radio tracking device in a carp at Linwood Lake.



Map of carp radio tracking showing aggregations in Linwood Lake.

Annual Education Publication

Description: An annual newsletter article about the SRWMO is required by MN Rules 8410.010 subpart 4, and included 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 2019 the SRWMO contracted with the ACD to prepare its annual education publication. This year's newsletter was used to update the public on the priorities in the then-draft SRWMO Watershed Management Plan. The article shown below or an abbreviated version was published in community newsletters.

Education Material Produced for 2019

Full Length Version

The next 10 years for local water resources...

The Sunrise River Watershed Management Organization (SRWMO) is finalizing its new 10-year watershed management plan in 2019.

Priorities include:

⇒ Lake and stream water quality projects. Goals include improving Linwood, Martin and Typo Lakes which are designated by the State as "impaired" due to excessive nutrients and algae. Others, like Coon Lake, are major recreational hubs where protecting already good water quality is a priority. Projects will include common carp management, stormwater treatment, agricultural projects and others.

⇒ Grants to landowners. Where cost effective projects can be done on private property to improve the community's water, we'll help with the cost. Common projects are lakeshore buffers and rain gardens.

⇒ Monitor lakes and streams. Detecting water quality trends early is a key to successful management. Waterbodies are monitored for nutrients and other common pollutants that affect fish and recreation.

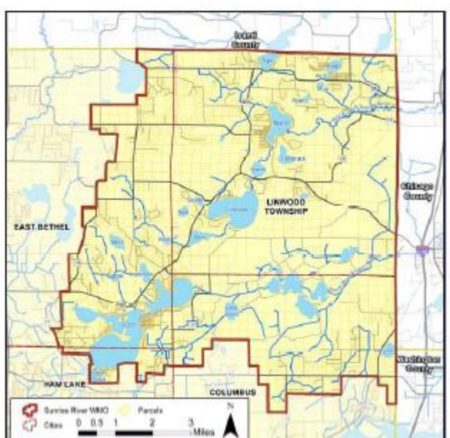
⇒ Secure funding. The SRWMO area is richer in water than money. A goal is to continue securing grants for >50% of expenses.

⇒ Public outreach. Our lakes and streams reflect what we all do on the land. We'll work with residents to find ways that we can all help our lakes and streams.

⇒ Other topics including aquatic invasive species, septic systems, development, regional coordination, stormwater, groundwater, chlorides from road deicing salts, drainage, habitat and others.

The draft 10-year watershed management plan will be finalized by December 2019. This plan updated every 10 years. Plan materials can be obtained at www.SRWMO.org or by calling Jamie Schurbon at 763-434-2030 ext. 12. Comments are welcomed.

The SRWMO is a partnership of the cities of Ham Lake, East Bethel, Columbus and Linwood Township charged with managing water resources on a watershed level.



Map of the SRWMO which includes Linwood Township and portions of Columbus, East Bethel and Ham Lake.

SRWMO Website

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

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

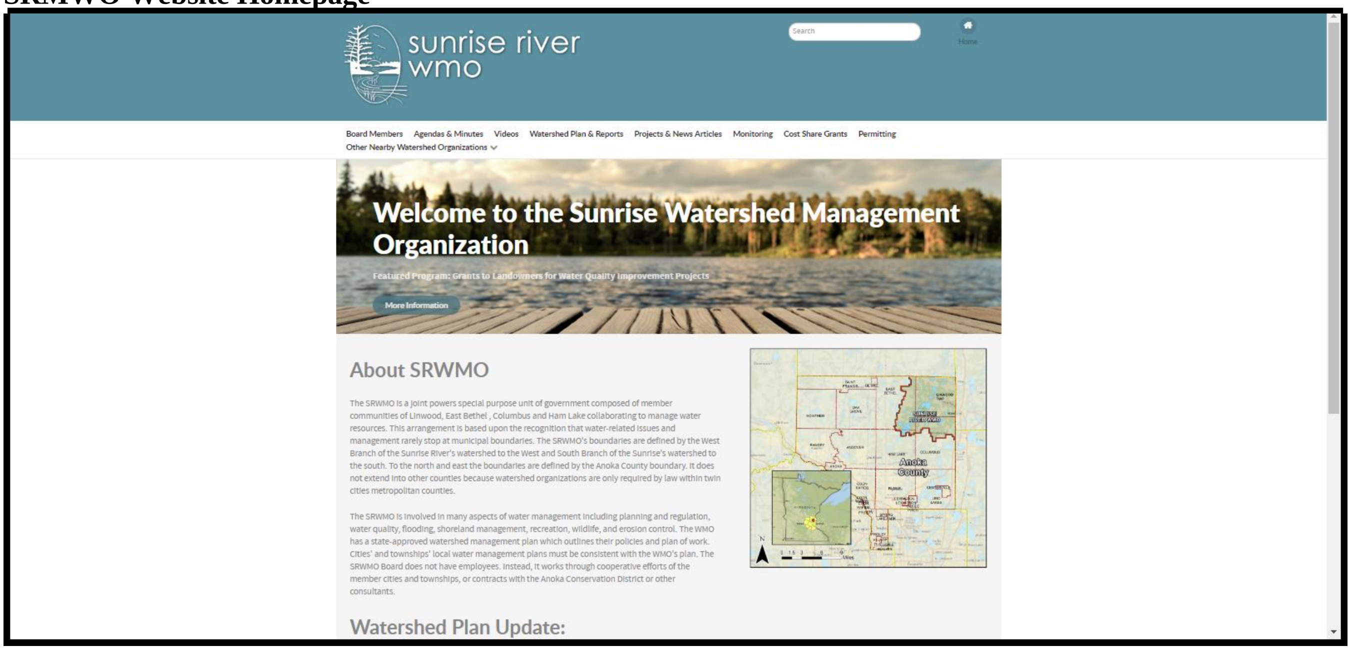
Location: www.SRWMO.org

Results: In 2019 routine SRWMO website updates were performed. The new website includes:

- Directory of board members,
- Meeting minutes and agendas,
- Watershed management plan and annual reports,
- Descriptions of work that the organization is directing,
- Highlighted projects,
- Informational videos,
- Maps of the URRWMO.

The website is regularly updated throughout the year.

SRMWO Website Homepage



Grant Searches and Applications

Description: The Anoka Conservation District (ACD) partners with the SRWMO for 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 2019 the SRWMO pursued several grants and positioned itself for others. They included:

1. **A competitive State Clean Water Fund grant was secured for $148,000 for carp management in Linwood, Martin and Typo Lakes.** The Anoka Conservation District was the grant applicant and fiscal agent. The SRWMO is a critical partner and the largest source of grant matching funds.
2. **A MPCA grant for $40,000 was secured to fix up failing septic systems** for low-income homeowners. The Anoka Conservation District holds this grant, which must be used county-wide. At least one septic system in the SRWMO at Martin Lake is anticipated to be fixed using this grant.
3. **A MPCA grant for $5,102 to monitor water quality in the West Branch of the Sunrise River at County Road 77.** Monitoring this site is a priority for the SRWMO because it is one of two major discharge points from the SRWMO.
4. **The SRWMO positioned itself for 2020 Watershed Based Implementation Funds**. This non-competitive State grant funds projects in the SRWMO Watershed Management Plan, the Lower St. Croix One Watershed One Plan (1W1P) and a few other eligible plans. The SRWMO positioned itself for these funds by participating in the 1W1P process and updating the SRWMO Watershed Management Plan. Funding amounts will be decided in 2020 and every two years thereafter.

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 CLP	$ 35,770
2014 Martin and Typo Lake Carp Barriers, sites 1,3,4	MN DNR CLP	$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 CLP	$ 99,000
2017 Septic System Fix Up Fund*	MPCA	$ 23,040
2018 Watershed Based Funding	BWSR WBF	$156,750
2018 Septic System Fix Up Fund*	MPCA	$ 27,055
2019 Septic System Fix Up Fund*	MPCA	$ TBD
2019-20 Surface Water Monitoring Grant, Sunrise R	MPCA	$ 5,102
2019 Sunrise River Chain of Lakes Carp Mgmt	BWSR CWF	$148,000
	TOTAL	$1,010,087

*Septic system fix up funds are available county-wide. Only the amount used in the SRWMO is reported.

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

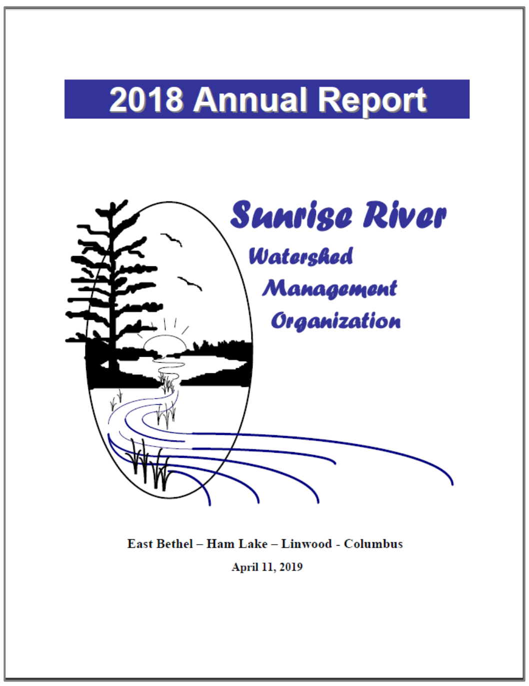


Table of Contents

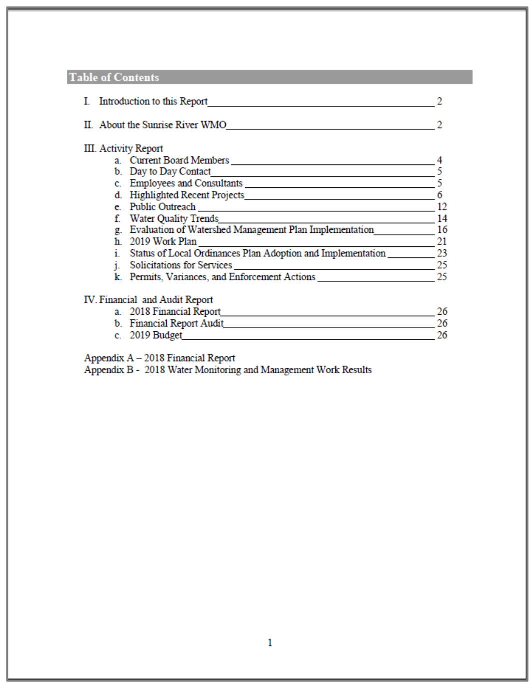


Table of Contents

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 2019 administrative assistance provided to the SRWMO by the Anoka Conservation District included:

- Prepared board meeting packets. Facilitated meetings and meeting planning.
- Fielded questions from board members on a variety of issues affecting the SRWMO.
- Represented the SRWMO at staff level meetings of the Lower St. Croix One Watershed One Plan.
- Prepared a draft 2020 budget for the SRWMO and subsequent revisions.
- Addressed questions arising from the City of Ham Lake's desire to modify how costs of the SRWMO are split amongst member communities.
- Reviewed all four SRWMO member communities' local water plans and facilitated approvals by the SRWMO.
- Prepared requests for proposals for 2020 water monitoring and management.
- Fielded permitting questions from the county highway department and builders.
- Prepared a display for community events staffed by the SRWMO board.
- Reviewed and edited meeting minutes.
- Wrote meeting minutes when the Recording Secretary was absent.

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 2019 Financial Summary

Sunrise River Watershed	Volunteer Precip	DNR Groundwater Wells	Wetland Levels	Lake Levels	Lake Water Quality	Stream Water Quality - W Branch Sunrise	Lakeshore Condition Inventory	Linwood Lake Carp Mgmt Feasbility Study	Planning	1W1P Lower St. Croix Planning	SRWMO Admin/Reporting/Grants	Mikkelson WMA Buckthorn Treatment	Carp Management	Mikkelson WMA Prairie Restoration	Coon & Martin Lakes Retrofits	Website	Education/Newsletter	Lakeshore Outreach	Outreach Collaborative	Total
Revenues																				
SRWMO			1950	1500	5475			884	9225		6745		3575		4308	645	500			34806
State - Other		344						3840							5220			50	4332	13785
DNR OHF												11083								11083
DNR CPL													12946	2835						15781
BWSR Capacity Staff							3775													3775
BWSR Local Water Planning					668															668
Regional/Local						2591				3771									273	6635
Anoka Co. General Services	429	597	79		130	1639			2215	9319	701		3472	5		1251	52	60	743	20690
County Ag Preserves/Projects					1102															1102
Service Fees								1086				1580	11400						23	14089
TOTAL	429	941	2029	1500	7376	4230	3775	5810	11440	13089	7446	12663	31394	2840	9527	1896	552	110	5371	122416
Expenses-																				
Capital Outlay/Equip	0	2	2	1	13	8	1	3	15	17	12	4	11	2	13	2			5	112
Personnel Salaries/Benefits	408	868	1739	1231	4967	3249	6353	1711	10122	13283	7326	10860	3883	872	10278	1325	459	49	3354	82338
Overhead	23	47	85	67	251	141	314	100	685	698	386	807	181	37	482	82	44	2	189	4623
Employee Training	2	3	6	5	13	13	43	5	30	64	31	40	12	3	59	5	1	0	13	347
Vehicle/Mileage	5	11	24	16	71	47	74	22	113	166	94	104	57	13	132	16	3	1	42	1011
Rent	18	44	74	53	261	145	162	87	534	516	312	517	195	39	336	65	26	2	151	3538
Program Participants													20196							20196
Program Supplies	9		126		1756	914		3942	66			829	7036	1953		458			474	17562
TOTAL	466	976	2056	1374	7332	4518	6948	5870	11566	14743	8160	13160	31571	2919	11299	1952	534	54	4228	129727
NET	-37	-35	-27	126	44	-288	-3173	-60	-126	-1654	-715	-498	-178	-79	-1772	-56	18	56	1143	-7310

Recommendations

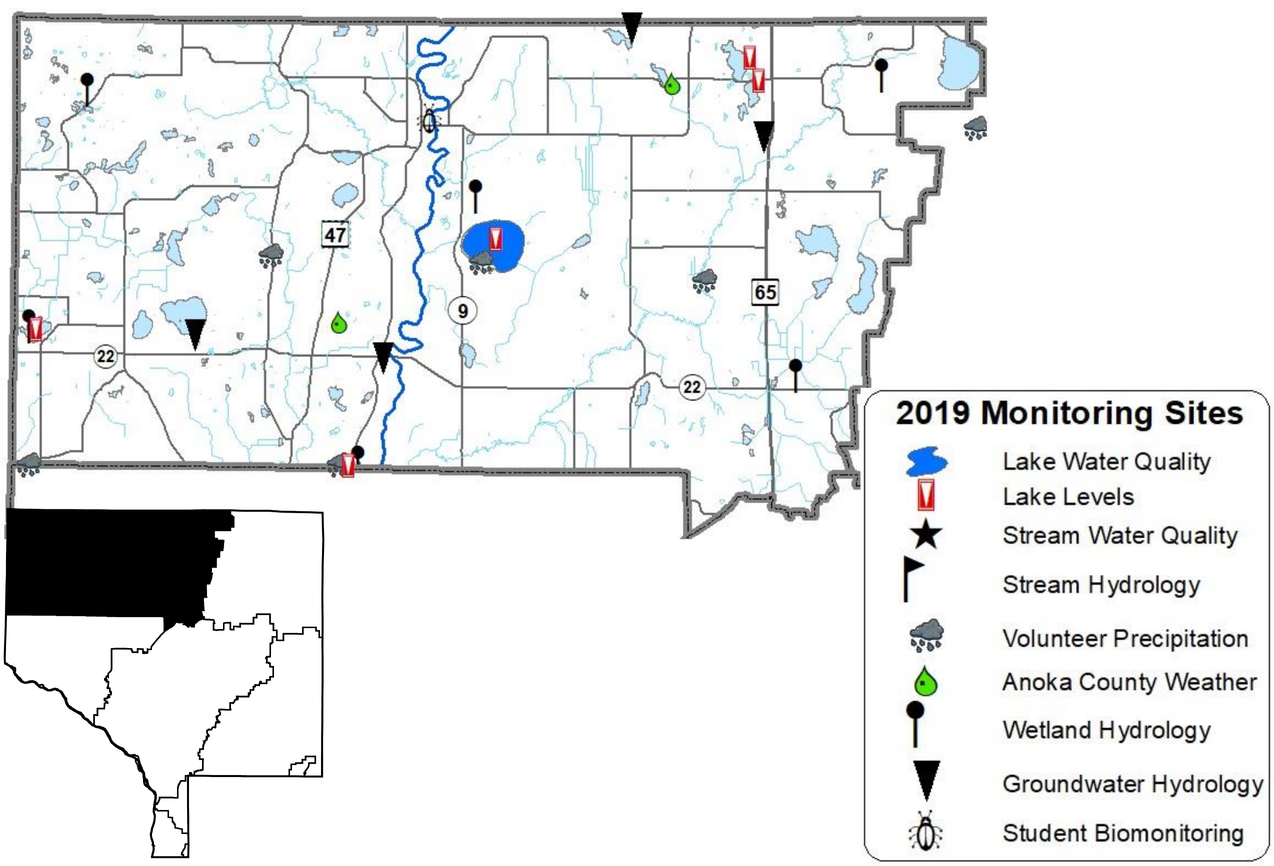
- **Implement the SRWMO Waterhed Management Plan that was approved in 2019.** The plan reflects the latest science and includes schedules for various projects.
- **Continue engaging in the Lower St. Croix One Watershed, One Plan process** to ensure SRMWO priorities are reflected. This is necessary to ensure access to future Watershed Based Funding grants.
- **Continue carp removals at Martin and Typo Lakes and begin carp management at Linwood Lake.** A State Clean Water Fund grant will support this work in 2020-2022.
- **Collaborate with the Anoka County Outreach Coordinator.** This new position in 2018 seeks efficiency and consistent messaging across many cities and natural resources agencies.
- **Continue installation of stormwater retrofits around Coon and Martin Lakes** where completed studies have identified and ranked projects.
- **Update the SRWMO joint powers agreement** to address out of date material and the lack of a dispute resolution mechanism.
- **Continue prioritizing strategic water quality monitoring** to assess baseline conditions, diagnose problems and determine the effectiveness of new water quality projects. The data help with strategically implementing grant funds and local funds to provide the largest water quality benefit possible at the lowest cost.
- **Create a new SRWMO display for use at community events.** This projects is planned and budgeted for in 2020.
- **Encourage development of septic system point of sale ordinances.** Columbus has such an ordinance. East Bethel and Linwood are developing it in 2020 with assistance from the Anoka Conservation District. Ham Lake is not interested at this time.
- **Promote Septic System Fix Up Grants to landowners,** particularly in shoreland areas.
- **Bolster lakeshore landscaping education efforts.** The SRWMO Watershed Management Plan sets a goal of three lakeshore restorations per year. Lakeshores were mapped in 2019 by the Anoka Conservation District so that future outreach can be targeted

Chapter 3: Upper Rum River Watershed

Prepared by the Anoka Conservation District

Chapter: 3 Upper Rum River Watershed

Table of Contents



Lake Levels

Partners: URRWMO, ACD, MN DNR, volunteers

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

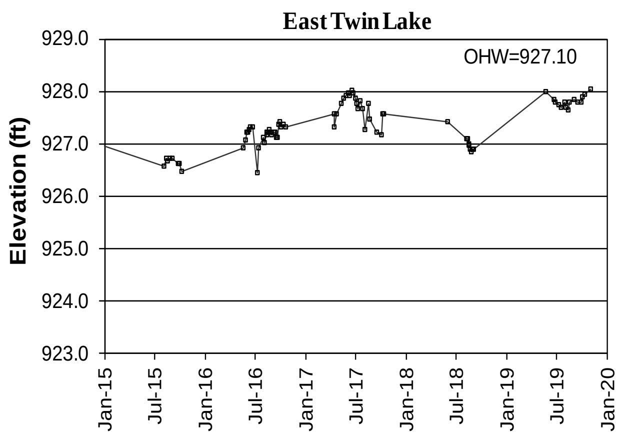
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

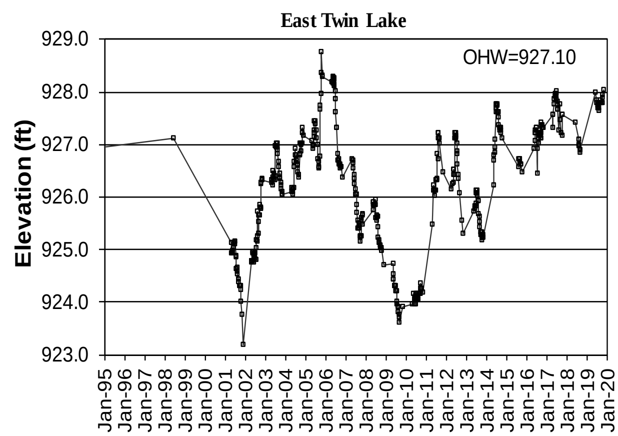
Results: Lake levels were measured by volunteers throughout the 2019 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes generally followed the expected trend of increasing water levels in spring and early summer and declining levels by mid-summer. Lakes generally experienced rebounding water levels starting in mid-September. Overall lake levels were near average though some were higher and some were lower.

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. All lakes monitored were lower than the OHW for much of the monitoring season.

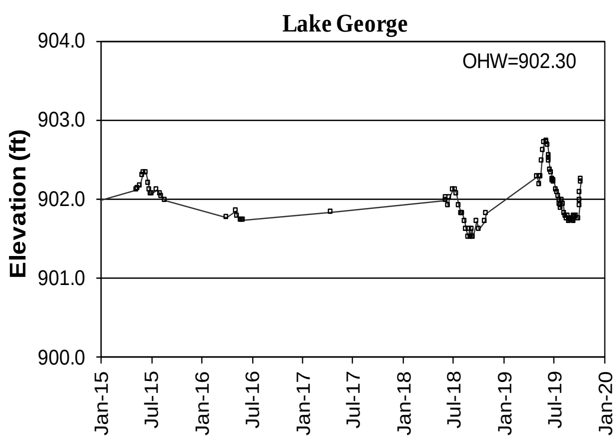
East Twin Lake Levels – last 5 years



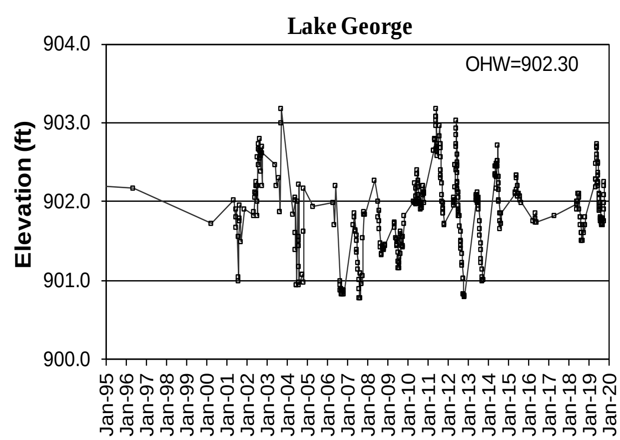
East Twin Lake Levels – last 25 years



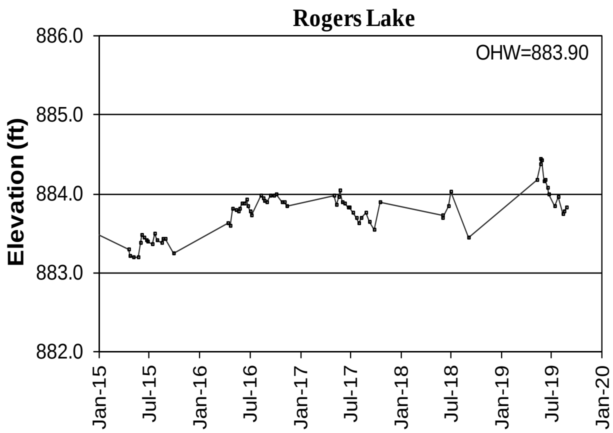
Lake George Levels– last 5 years



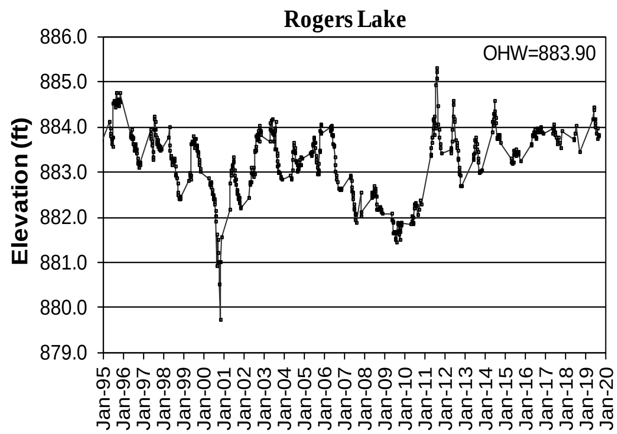
Lake George Levels – last 25 years



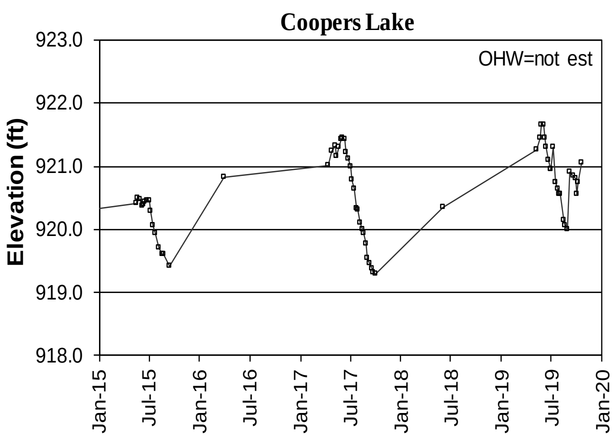
Rogers Lake Levels – last 5 years



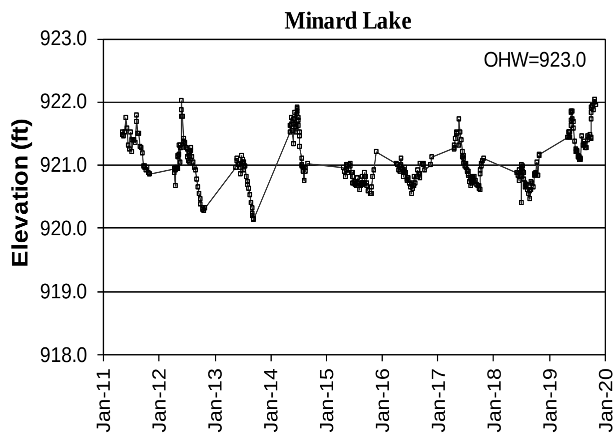
Rogers Lake Levels – last 25 years



*Coopers Lake Levels – last 5 years



Minard Lake Levels – last 9 years



Lake Water Quality

Partners: ACD, Lake George LID

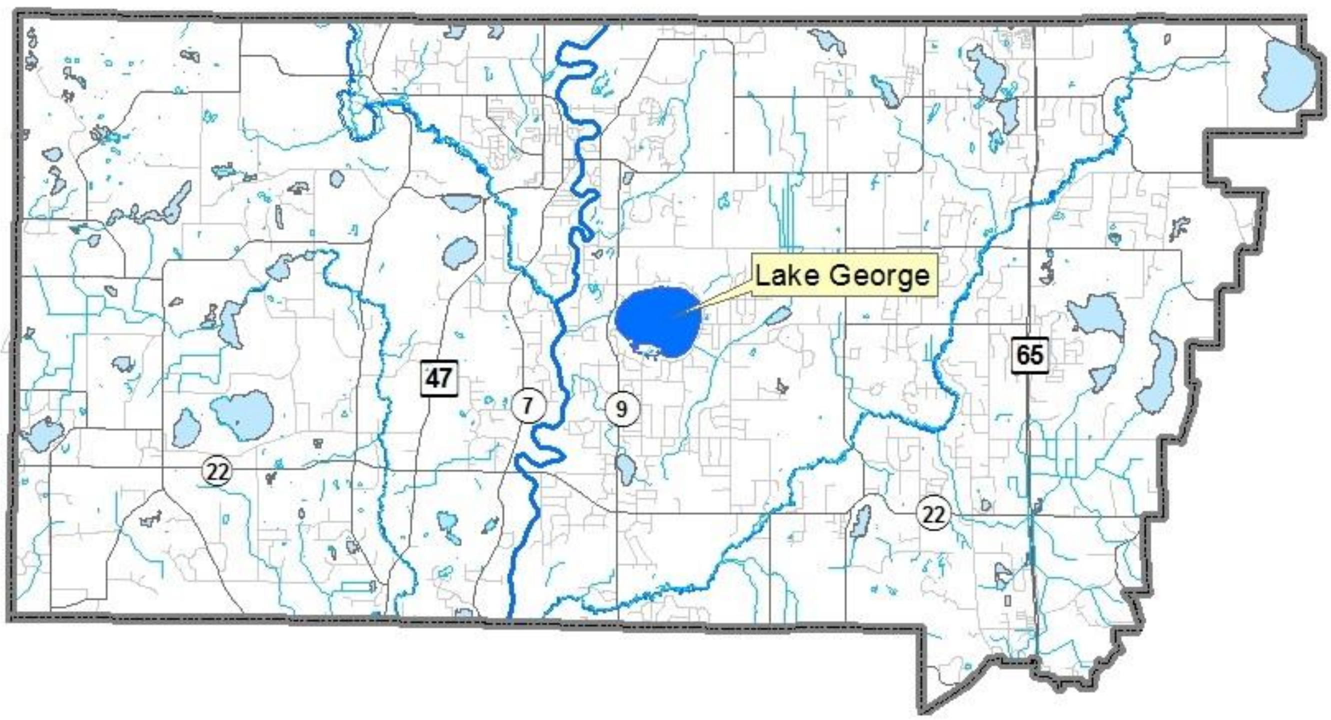
Description: May through September, every-other-week, monitoring is conducted for the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, Specific Conductivity, pH, and salinity.

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

Locations: Lake George

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

Upper Rum River Watershed Lake Water Quality Monitoring Sites



Lake George
City of Oak Grove, Lake ID # 02-0091

Background

Lake George is located in north-central Anoka County. The lake has a surface area of 535 acres with a maximum depth of 32 feet (9.75 m). Public access is from Lake George County Park on the lake's north side, where there is both a swimming beach and boat launch. About 70% of the lake is surrounded by homes; the remainder is county parkland. The watershed is mostly undeveloped or vacant, with some residential areas, particularly on the lakeshore and in the southern half of the watershed. Two invasive 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.

2019 Results

In 2019, Lake George had excellent water quality for this region of the state (NCHF Ecoregion), receiving an overall A letter grade, but Secchi transparency individually earned a B grade. These results are similar to what was recorded before 2009, when the majority of monitoring years scored an A letter grade.

Results for individual water quality parameters varied. Total phosphorus in 2019 averaged 21.4 µg/L, and is the lowest recorded average since 2005. Secchi transparency was high early in the season, but dropped to a low of 5.3 feet in early September. Average Secchi transparency was 8.7 feet, which was poorer than 2018. Chlorophyll-a (Cl-a) averaged 7.3 µg/L, which was similar to the last 5 years. Cl-a, TP and transparency were all poorest in early September, but throughout the season all three parameters were better than the State water quality standard for deep lakes in this region (<40 µg/L TP, <14 µg/L Cl-a, and >1.4 m (4.6 ft.) Secchi transparency).

Although Lake George water quality remains better than state standards and good for a metro-county lake, simply adhering to these standards isn't the goal for such an important water body. Decline of Lake George's Secchi transparency has been a cause for concern in recent years with a now twenty-year trend of decline bearing out in statistical analyses. The residents, managers, and users of Lake George are collectively looking for ways to reverse that decline and to maintain the very good water quality that all who utilize this prized lake have come to value.

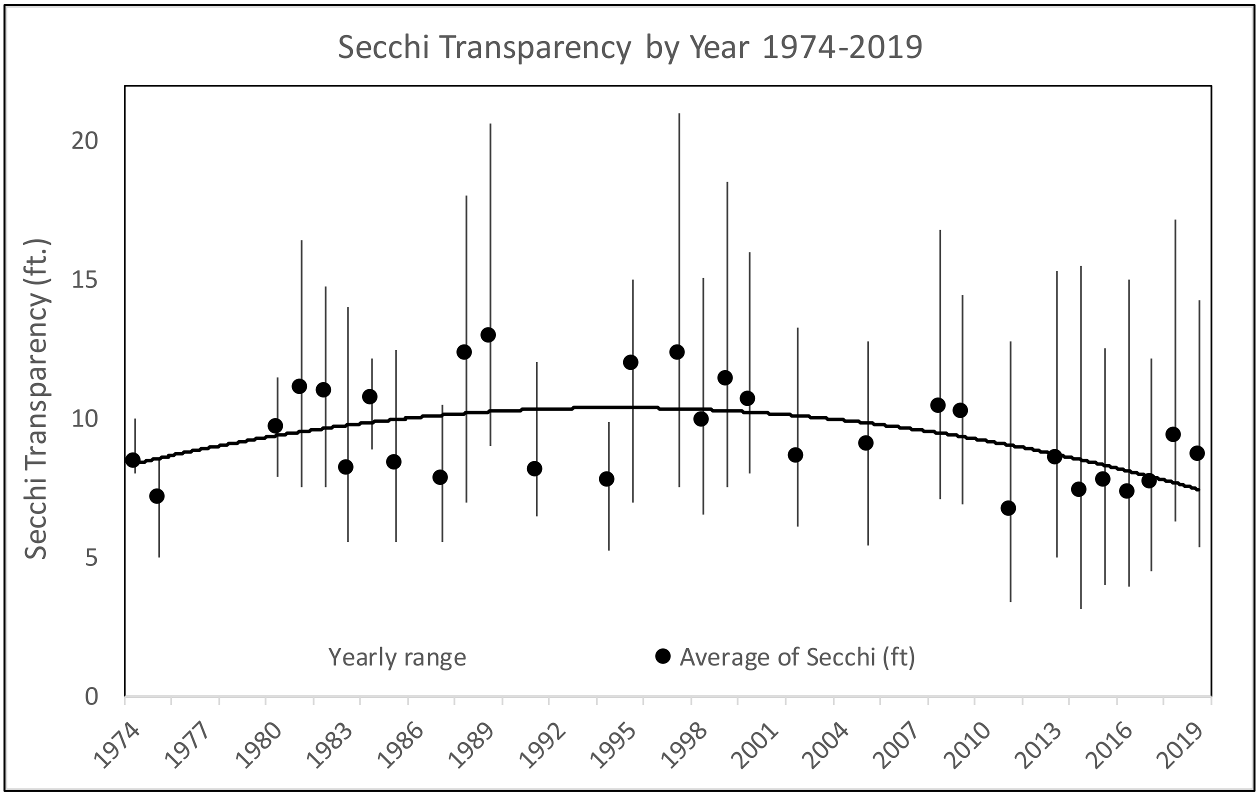
Trend Analysis

Thirty 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- 2019). A broad 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 transparency, $F_{2,19}$=1.21, p=0.31). When parameters are isolated for individual analysis, there is no significant change in Chlorophyll-a. However, during this period there is a statistically significant trend of declining Secchi transparency (one-way ANOVA $F_{1,22}$= 15.09, p=<0.01). This trend is particularly apparent from the mid-1990s to 2017. When sampling years' 1995-2017 are isolated declining Secchi transparency again shows a strong statistically significant decline (one-way ANOVA $F_{1,14}$=10.92, p=<0.01). We also find a statistically significant trend of increasing TP during this period (one-way ANOVA $F_{1,14}$=5.55, p=<0.05)

Lake George

CITY OF OAK GROVE, LAKE ID # 02-0091

Lake George Secchi transparency trend: Includes years with partial datasets not covering all open water months. Those years are excluded from ACD's statistical analysis and graphs later in the document.



Discussion

Lake George remains one of the clearest of the Anoka County lakes, but its trend of declining Secchi transparency since the mid-1990s has caused concern. Lake George is a highly valued lake due to its recreational opportunities and ecological quality. The lake has a large park, many lakeshore homes, and a notably diverse plant community (most metro area lakes have 10-12 different aquatic plant species; Lake George is home to 24).

In 2018 a special study of this lake titled "Lake George Water Quality Improvement Assessment" was completed. Work from 2016-2018 included intensive monitoring of tributaries, modeling, and evaluation of projects to correct transparency declines. The work focused on the watershed, and a "phase 2" study of in-lake processes may occur in the future. The study was funded by the Lake George Improvement District, Lake George Conservation Club, Anoka Conservation District, and a State Clean Water Fund grant.

CLEAN WATER LAND & LEGACY AMENDMENT

The aforementioned study provides some insight into the causes of transparency decline. While a number of factors may play a role in transparency declines, an increase in the average amount of precipitation falling is the most significant driver identified. Water Years (Oct. 1 – Sept. 30) that are wetter than the 100-year 90th percentile result in increased volumes of runoff and nutrients into the lake from surrounding tributaries, and the lake has poorer clarity in those years, or in immediately subsequent years.

These "wet" years were more frequent during the period that lake transparency has declined. Six out of sixteen years from 2001 to 2017 were "wet" with water year precipitation above the historical 90th percentile, with 1999 reaching just under the 90th percentile mark. Additionally, four of these six wet years occurred during the sustained low Secchi transparency period of 2010 through 2017.

Water year precipitation returned to normal levels in 2017 and 2018, causing a temporary rebound in average Secchi transparency during the most recently monitored years. The 2019 calendar year was the wettest on record. Secchi results in 2019 were only slightly poorer than the improved 2018 results, but that average was likely skewed by much higher readings earlier in the season, with poorer readings later. If the relationship between precipitation and Secchi holds true, 2020 results may show even further decline in Secchi clarity driven by the heavy rainfall throughout 2019.

There is concern that climate change and increased runoff from development in the watershed will drive poorer water quality in Lake George into the future. Among the recommendations of the 2018 study are replacing the deteriorating Ditch 19 weir just east of Lake George which is an important hydrological control for the lake. The weir was replaced in early 2020. This work offers modest benefits of reduced nutrient delivery to the lake in wet years, and the broader benefits of restoring lake hydrology and enhancing game fish spawning opportunities. Other actions include agricultural best practices, an iron-enhanced sand filter, public education, lakeshore restorations, enhanced stormwater standards for new developments in the lakeshed and others. While certain tributary subwatersheds do generate more nutrients than others, and therefore deserve special consideration for projects, it is also noted that some of these subwatersheds drain through large wetlands with some apparent pollutant removal ability which must be considered when siting projects. Projects nearest the lake are favored because they treat a larger upstream area and don't duplicate treatment that might already be provided by certain wetlands.

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 one of special concern and deemed vulnerable. Lack of aquatic habitat and near-shore development disturbances were indicated as stressors.

Two exotic invasive plants are present in Lake George, curly-leaf pondweed and Eurasian water milfoil. The Lake George Improvement District works 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.

Historical Summertime Mean Values

Agency	MC	MC	MC	MC	MC	MC	ACD	MC	ACD	ACD	ACD
Year	1980	1981	1982	1984	1989	1994	1997	1998	1999	2000	2002
TP	22.5	22.0	22.3	24.4	24.3	25.4	17.4	27.5	21.1	16.3	19.9
Cl-a	7.3	7.1	7.0	9.5	4.5	6.9	13.2	7.8	5.6	5.8	5.2
Secchi (m)	3.1	3.4	3.4	3.3	3.9	2.4	3.6	2.7	3.5	2.8	2.6
Secchi (ft)	10.2	11.2	11.0	10.8	12.9	7.8	11.7	9.0	11.4	10.7	8.6
Carlson's Trophic State Indices											
TSIP	49	49	49	50	50	51	45	52	48	44	47
TSIC	50	50	50	53	45	50	56	51	48	48	47
TSIS	44	42	43	43	40	48	42	45	42	45	46
TSI	48	47	47	49	45	49	48	49	46	46	47

Lake George Water Quality Report Card

Year	1980	1981	1982	1984	1989	1994	1997	1998	1999	2000	2002
TP	A	A	A	B	B	B	A	B	A	A	A
Cl-a	A	A	A	A	A	A	B	A	A	A	A
Secchi	A	A	A	A	A	B	A	B	A	B	B
Overall	**A**	**A**	**A**	**A**	**A**	**B**	**A**	**B**	**A**	**A**	**A**

Agency	ACD	ACD	MC	MC	ACD	ACD	ACD	ACD	ACD	ACD	ACD
Year	2005	2008	2009	2011	2013	2014	2015	2016	2017	2018	2019
TP	26.0	23.0	26.2	29.0	30.3	25.5	21.4	28.4	23.3	22.5	21.4
Cl-a	5.4	6.4	7.0	12.4	6.1	6.4	2.7	7.8	5.7	6.8	7.3
Secchi (m)	2.8	3.2	2.9	1.8	2.6	2.2	2.6	2.3	2.4	2.9	2.64
Secchi (ft)	9.1	10.4	9.5	6.7	8.6	7.4	8.7	7.4	7.7	9.4	8.67
Carlson's Trophic State Indices											
TSIP	51	49	51	53	53	51	48	52	50	49	48
TSIC	47	49	50	55	48	49	40	51	48	49	50
TSIS	45	43	45	52	46	49	46	48	48	45	46
TSI	48	47	49	53	49	49	45	50	48	48	48

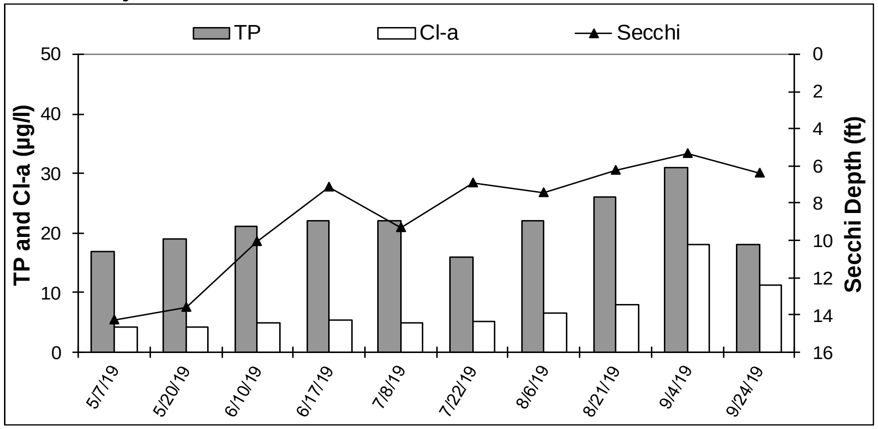
Lake George Water Quality Report Card

Year	2005	2008	2009	2011	2013	2014	2015	2016	2017	2018	2019
TP	B	B	B	B	B	B	A	B	B	A	A
Cl-a	A	A	A	B	A	A	A	A	A	A	A
Secchi	B	A	B	C	B	B	B	B	B	B	B
Overall	**B**	**A-**	**B**	**B**	**B**	**B**	**A**	**B**	**B**	**A**	A

Lake George

CITY OF OAK GROVE, LAKE ID # 02-0091

2019 Daily Results



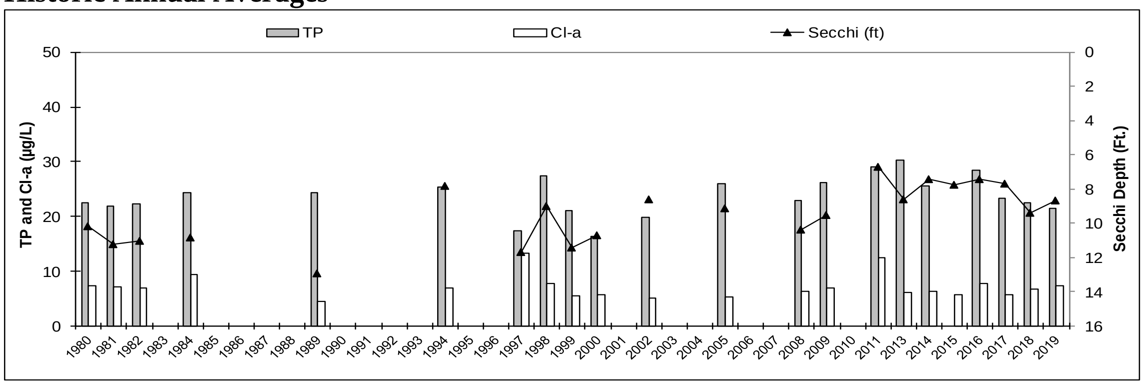
2019 Median Values

pH		8.25
Specific Conductivity	mS/cm	0.23
Turbidity	NTU	2.7
D.O.	mg/l	11.365
D.O.	%	126.15
Temp.	°F	70.772
Salinity	%	0.11
Cl-a	µg/L	5.25
T.P.	µg/l	21.4
Secchi	ft	7.29

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**
2018	A	A	B	**A**
2019	A	A	B	**A**
State Standards	40 ug/L	14 ug/L	>4.6 ft	

Historic Annual Averages



Lake George
2019 Water Quality Data

	Units	R.L.*	Date: 5/7/2019	5/20/2019	6/10/2019	6/17/2019	7/8/2019	7/22/2019	8/6/2019	8/21/2019	9/4/2019	9/24/2019			
			Time: 12:20	12:45	9:20	11:45	11:30	11:15	11:45	11:15	11:30	11:45			
			Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.48	8.09	7.71	8.17	8.34	8.18	8.46	8.34	8.05	8.31	8.21	7.71	8.48
Specific Conductivity	mS/cm	0.01	0.225	0.236	0.243	0.219	0.234	0.241	0.238	0.211	0.217	0.199	0.226	0.199	0.243
Turbidity	NTU	1	N/A	0.00	2.30	4.30	1.00	2.100	0.00	4.40	4.10	3.10	2.15	0	4
D.O.	mg/l	0.01	11.89	9.67	8.44	8.98	11.67	10.16	11.75	11.36	11.37	11.62	10.69	8.44	11.89
D.O.	%	1	116.4	95.0	98.4	105.8	150.4	127.3	151.7	129.9	125.0	131.1	123.1	95.0	151.7
Temp.	°C	0.1	13.20	13.29	21.69	21.39	26.61	25.84	26.95	24.08	20.66	20.81	21.5	13.2	27.0
Temp.	°F	0.1	55.8	55.9	71.0	70.5	79.9	78.5	80.5	75.3	69.2	69.5	70.6	55.8	80.5
Salinity	%	0.01	0.11	0.11	0.12	0.10	0.11	0.12	0.11	0.10	0.10	0.10	0.11	0.10	0.12
Cl-a	µg/L	1	4.30	4.3	4.9	5.3	4.8	5.2	6.5	7.9	18.0	11.3	7.3	4.3	18.0
T.P.	mg/l	0.005	0.017	0.019	0.021	0.022	0.022	0.016	0.022	0.026	0.031	0.018	0.021	0.016	0.031
T.P.	µg/l	5	17	19	21	22	22	16	22	26	31	18	21.40	16	31
Secchi	ft		14.3	13.6	10.1	7.2	9.3	6.9	7.4	6.3	5.3	6.4	8.67	5.3	14.3
Secchi	m		4.3	4.1	3.1	2.2	2.8	2.1	2.3	1.9	1.6	2.0	2.6	1.6	4.3
Physical			1.0	1.0	1.0	1.0	1.0	1.0	1	1.0	1	1.0	1.0	1.0	1.0
Recreational			1.0	1.0	1.0	1.0	1.0	1.0	1	1.0	1	1.0	1.0	1.0	1.0

*reporting limit

2019 Aquatic Invasive Vegetation Mapping

Lake George
City of Oak Grove, Lake ID # 02-0091

Partners: Lake George LID, Lake George Conservation Club, MNDNR

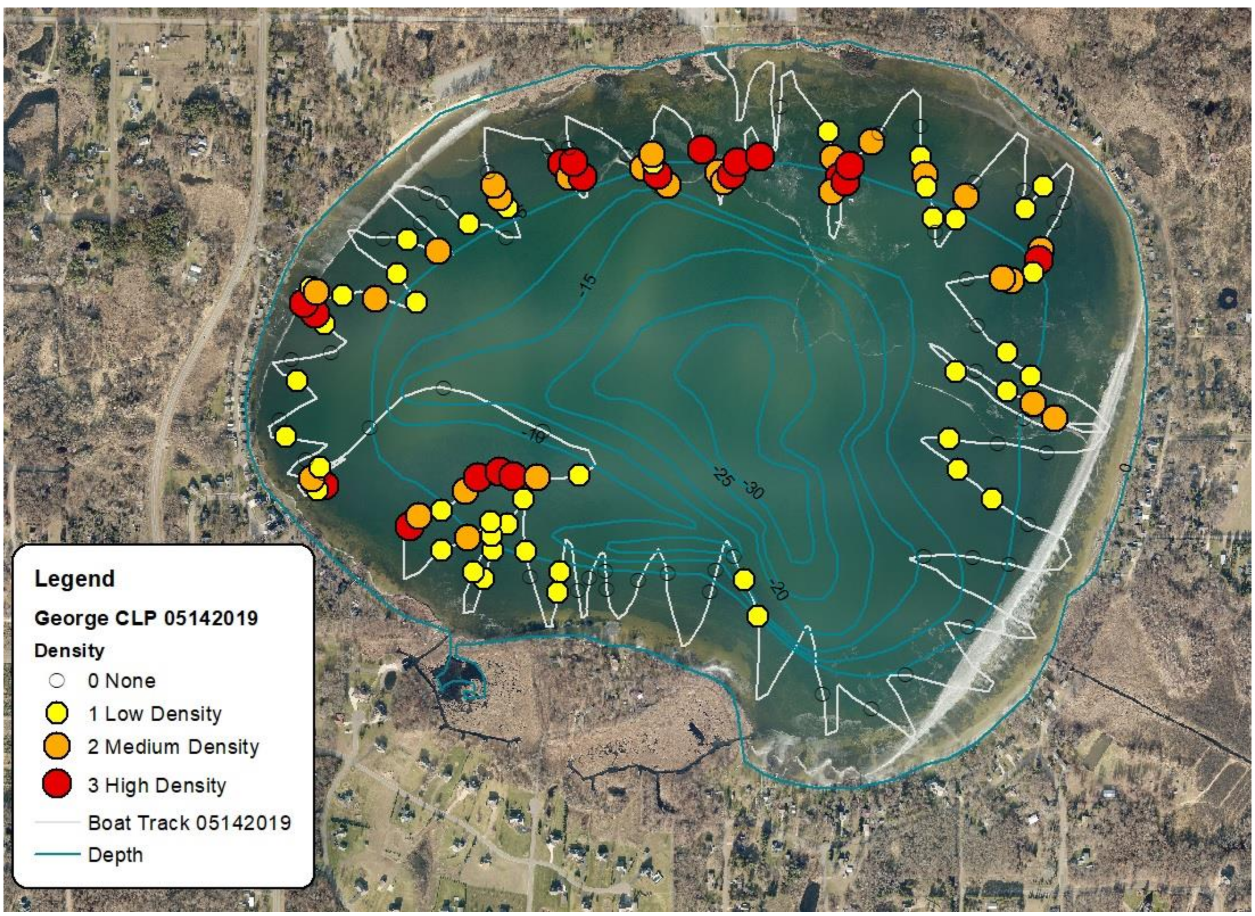
Description: The Anoka Conservation District (ACD) was contracted by the Lake George Lake Improvement District (LID) to conduct an aquatic invasive vegetation delineation.

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.

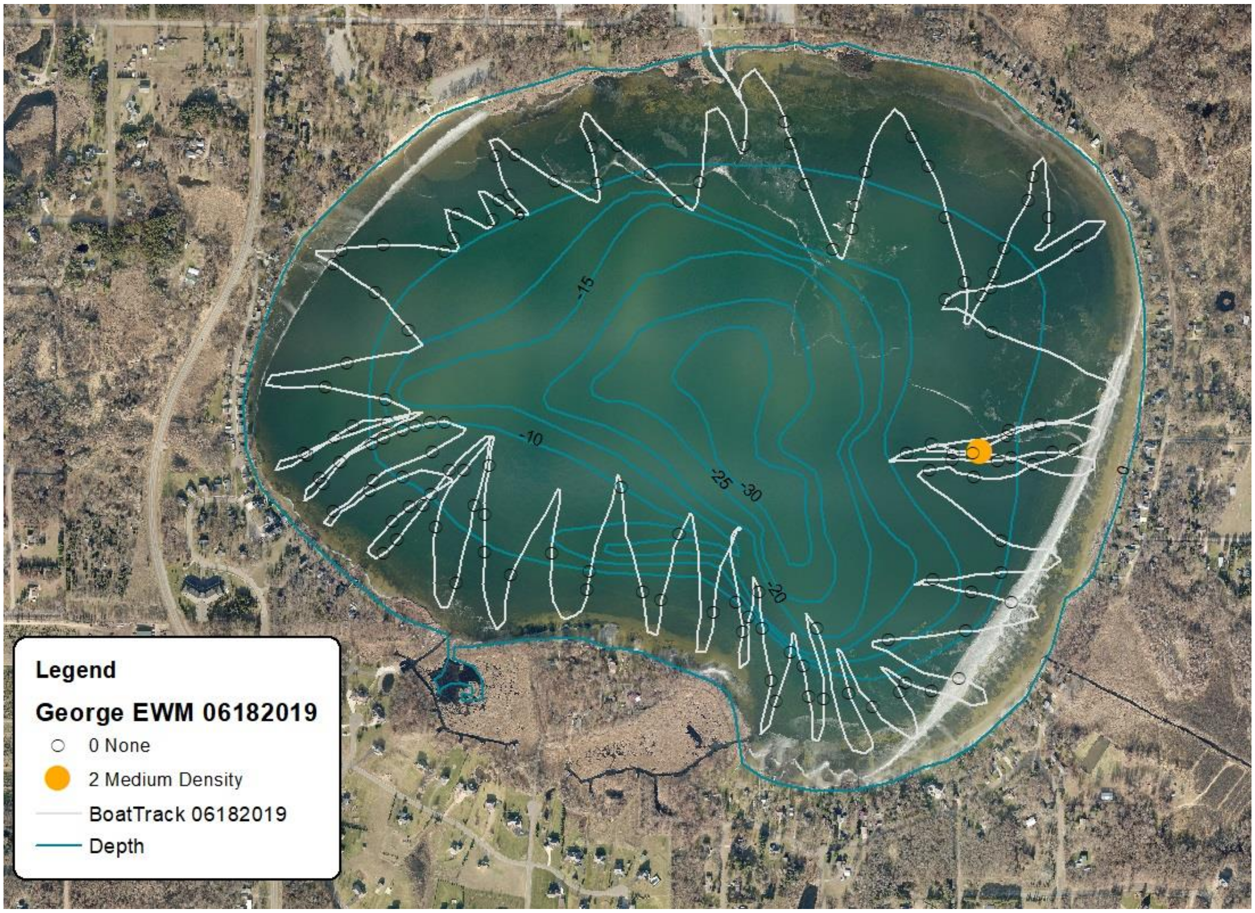
Locations: Lake George

Results: Maps presented below were delivered to the MN DNR and Lake George Improvement District within 48 hours of the field surveys. These survey points were reviewed by the MNDNR and herbicide treatment was approved for curly-leaf pondweed on 120.3 acres of Lake George. No treatment of Eurasian watermilfoil occurred in 2019 due to low densities.

May 14, 2019 Lake George Curly Leaf Pondweed (CLP) survey



June 18, 2019 Lake George Eurasian Water Milfoil (EWM) Survey



Stream Water Quality – Biological Monitoring

Partners: St. Francis American Legion Post #622

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 at Rum River North County Park

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

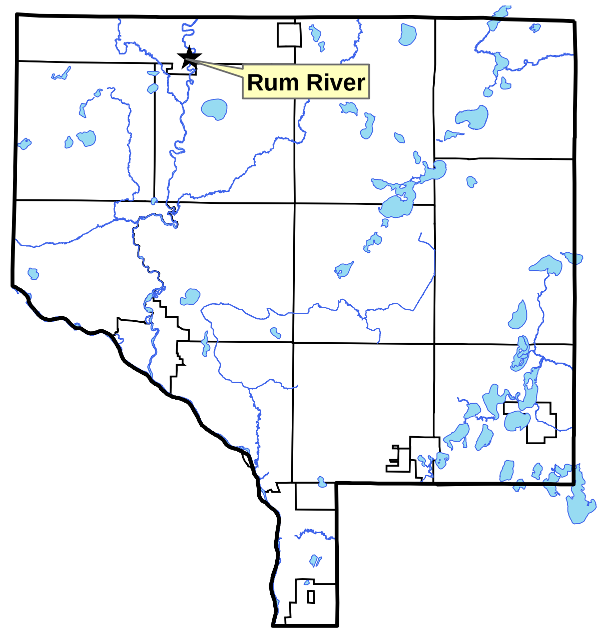
Population Attributes Metrics

% 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

at Rum River North County Park, St. Francis



Last Monitored

By St. Francis High School in 2019

Monitored Since

2000

Student Involvement

40 students in 2019, approximately 1,375 since 2000

Background

The Rum River originates from Lake Mille Lacs, and flows south through western Anoka County where it joins the Mississippi River in the City of Anoka. Other than the Mississippi, this is the largest river in the county. In Anoka County the river has both rocky riffles as well as pools and runs with sandy bottoms. The river's condition is generally regarded as excellent. Portions of the Rum in Anoka County have a state "scenic and recreational river" designation.

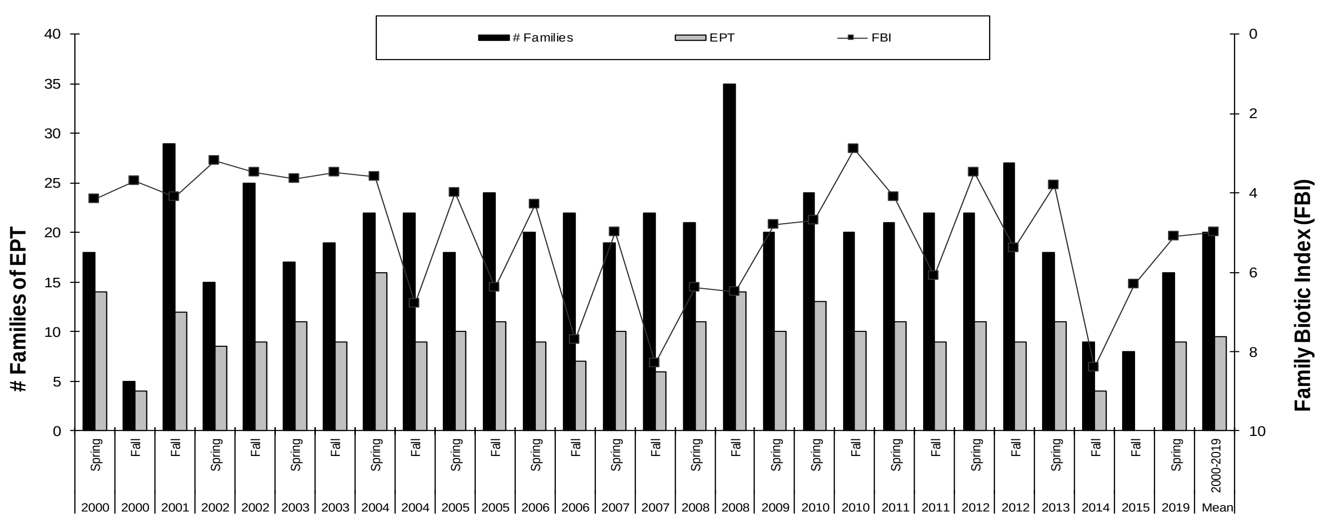
The sampling site is in Rum River North County Park. This site is typical of the Rum in northern Anoka County, having a rocky bottom with numerous pool and riffle areas.

Results

St. Francis High School classes monitored the Rum River in the spring of 2019, with ACD oversight and funding from the St. Francis American Legion. Results for 2019 are similar to results in most previous years. By contrast, the most recent previous years of 2014 and 2015 had invertebrate captures that indicated a poor ecological condition. In 2019 captures indicated a moderate-to-healthy ecological condition despite high water levels and fast flows which typically lower sampling success the students.

Multiple years should cumulatively be considered when interpreting biomonitoring data. Water levels, weather, site conditions and differences in class sizes and student capabilities can all contribute to different results in any one year. Based on the multi-year dataset it appears that Rum River ecological health at this site is good.

Summarized Biomonitoring Results for Rum River North County Park, St. Francis (samplings by St. Francis High School and Crossroads Schools in 2002-2003 are averaged)



Biomonitoring Data for Rum River at Rum River North County Park, St. Francis

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

Table of most recent five years

Year	2012	2013	2014	2015	2019	Mean
Season	Fall	Spring	Fall	Fall	Spring	2000-2019
FBI	5.4	3.8	8.4	6.3	5.1	5.0
# Families	27	18	9	8	16	20.0
EPT	9	11	4	0	9	9.6
Date	27-Sep	20-May	24-Oct	22-Jul	19-May	
Sampled By	SFHS	SFHS	SFHS	4-H	SFHS	
Sampling Method	MH	MH	MH	MH	MH	
Mean # Individuals/Rep.	333	247.5	219	23	139	
# Replicates	1	2	1	1	1	
Dominant Family	veliidae	Baetiscida	Corixidae	Cambaridae	Siphlonuridae	
% Dominant Family	13.8	34.7	86.3	34.8	32.4	
% Ephemeroptera	34.2	54.1	3.7	0	46	
% Trichoptera	4.2	6.3	0.5	0.0	0	
% Plecoptera	11.1	30.3	2.3	0	18	

Discussion

Historically, both chemical and biological monitoring indicate the good water quality of this river. Poorer results in 2014 and 2015 may reflect varying site and sampling conditions rather than a shift in the biological community. Habitat is ideal for a variety of stream life, and includes a variety of substrates, plenty of woody snags, riffles, and pools. Taxa that are extremely sensitive to pollution are still being collected. Water chemistry monitoring done at various locations on the Rum River throughout Anoka County indicates that water quality is also good. Continued biological monitoring is recommended both as an education program and for long-term ecological condition monitoring.

Wetland Hydrology

Partners: URRWMO, ACD

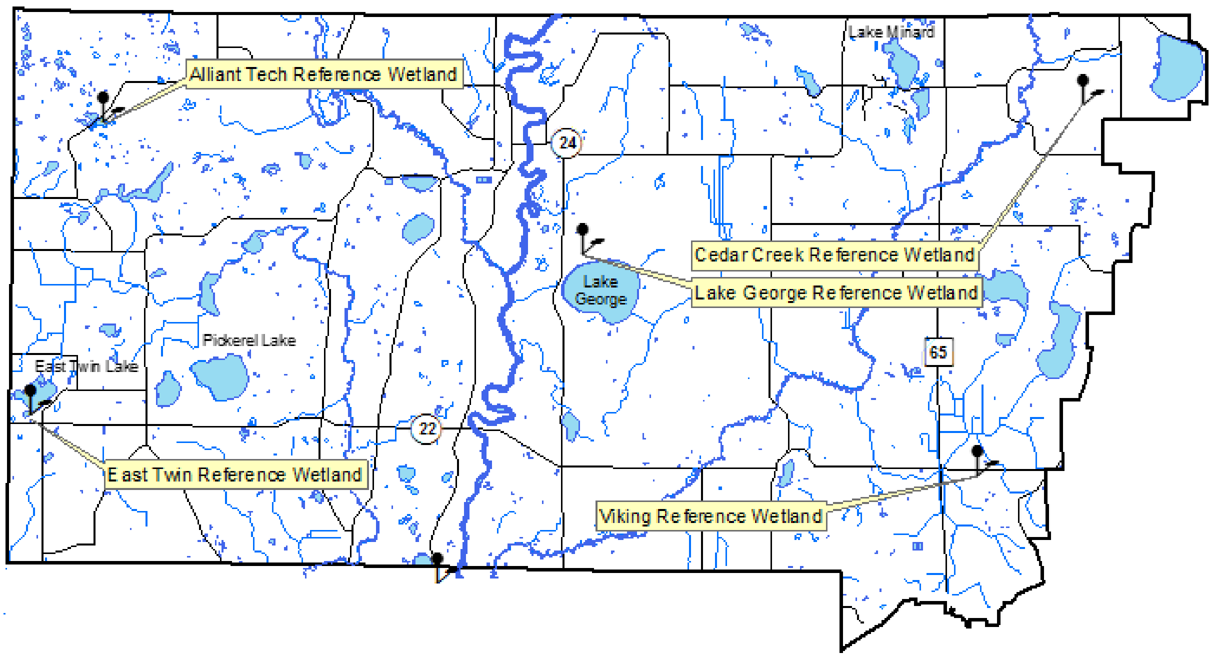
Description: Continuous groundwater level monitoring at a wetland boundary, to a depth of 40 inches. Countywide, the ACD maintains a network of 23 wetland hydrology monitoring stations.

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

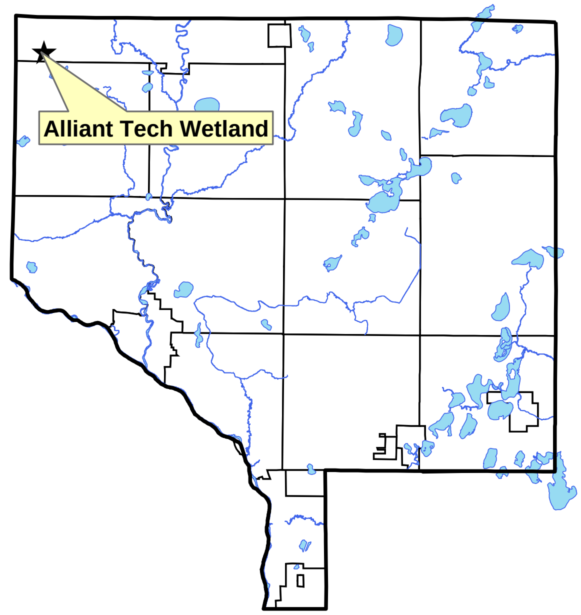
Results: See the following pages. Raw data and updated graphs can be downloaded from www.AnokaNaturalResources.com using the Data Access Tool.

Upper Rum River Watershed Wetland Hydrology Monitoring Site



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	-

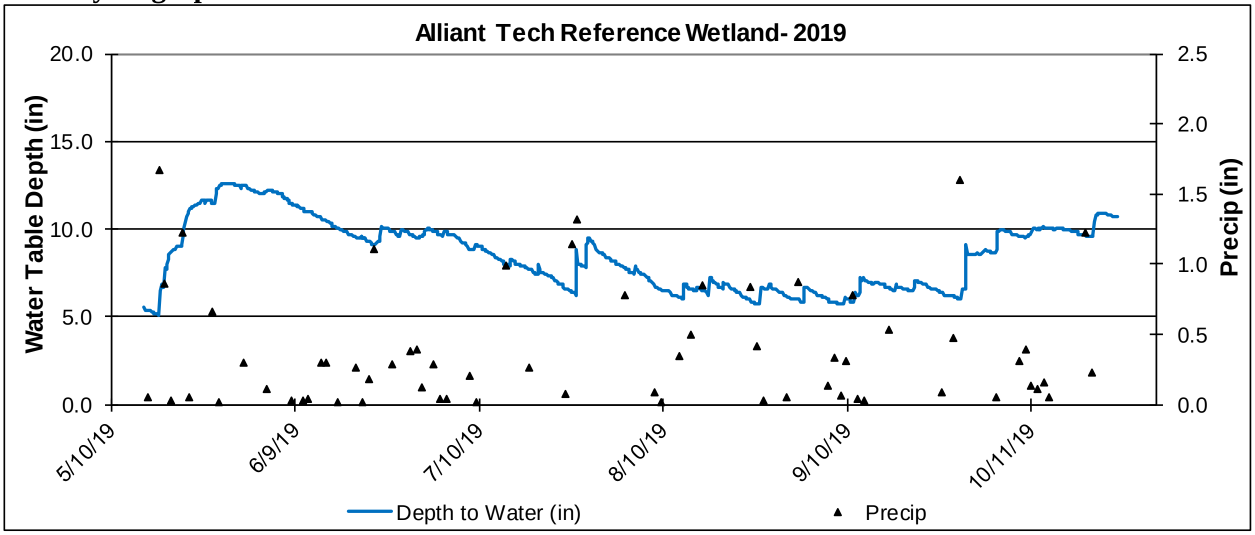
Surrounding Soils: Emmert

Vegetation at Well Location:

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

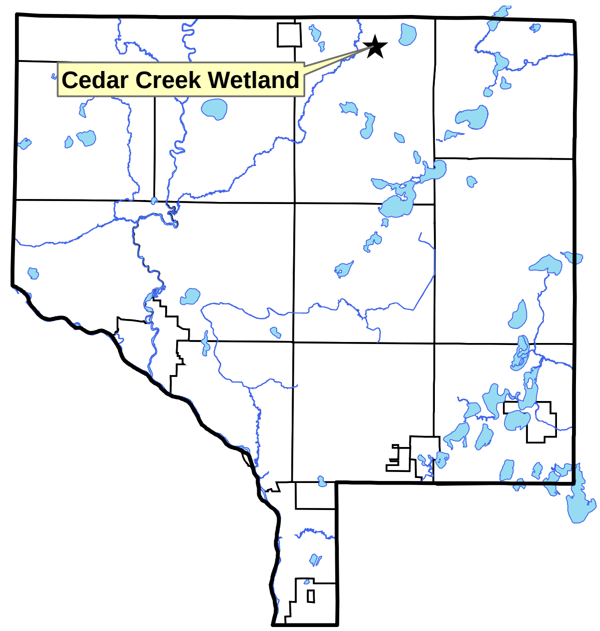
Other Notes: This wetland lies next to the highway, in a low area surrounded by hilly terrain. It holds water throughout the year, and has a beaver den.

2019 Hydrograph



CEDAR CREEK REFERENCE WETLAND

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



Site Information

Monitored Since: 1996

Wetland Type: 6

Wetland Size: unknown, likely >150 acres

Isolated Basin? No

Connected to a Ditch? No

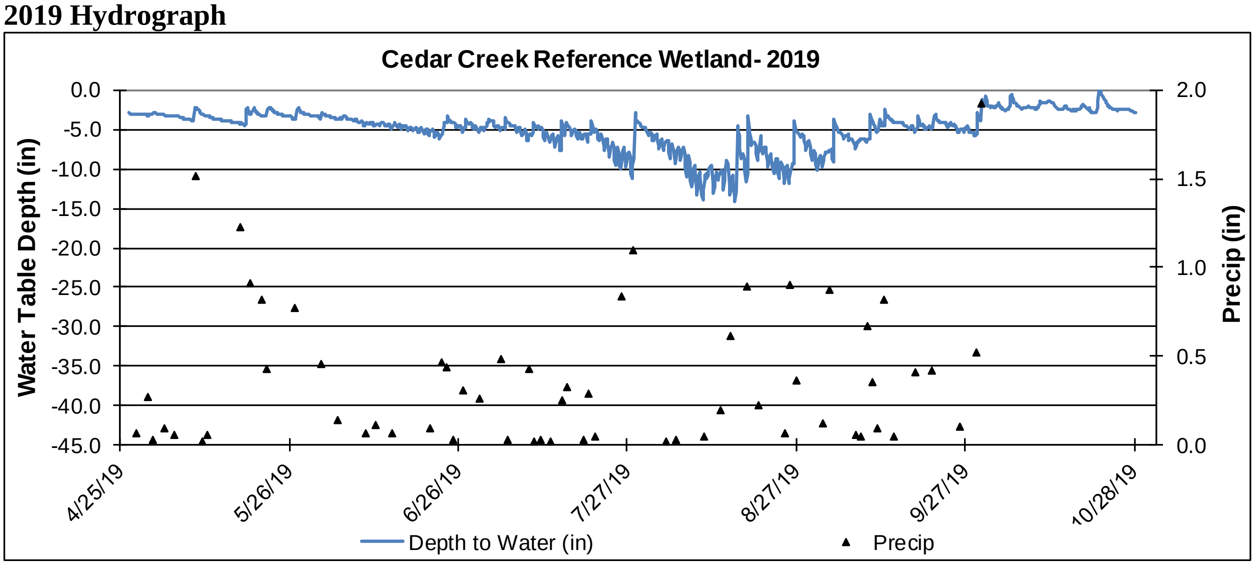
Soils at Well Location: not yet available

Surrounding Soils: Zimmerman

Vegetation at Well Location: not yet available

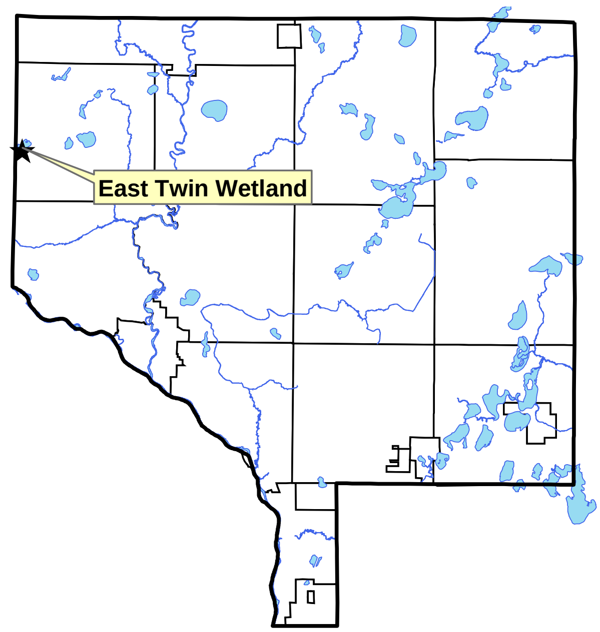
Other Notes: The Cedar Creek Ecosystem Science Reserve, where this wetland is located, is a University of Minnesota research area. Much of this area, including the area surrounding the monitoring site, is in a natural state. This wetland probably has some hydrologic connection to the floodplain of Cedar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

2019 Hydrograph



East Twin Reference Wetland

Twin Lake City 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	-

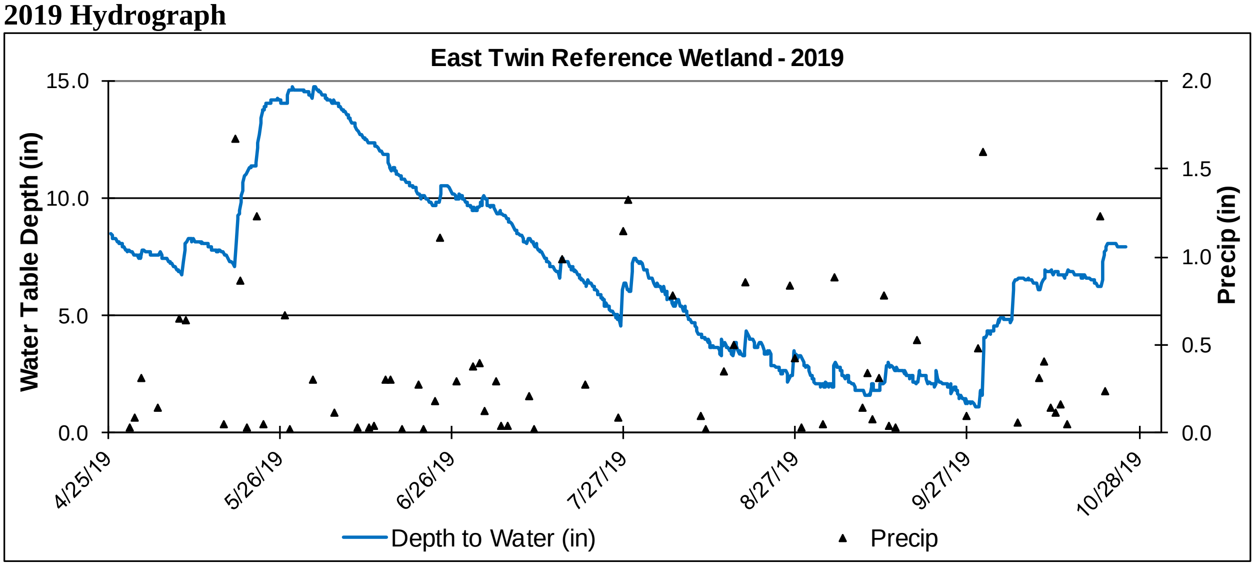
Surrounding Soils: Lake Beach, Growton and Heyder fine sandy loams

Vegetation at Well Location:

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

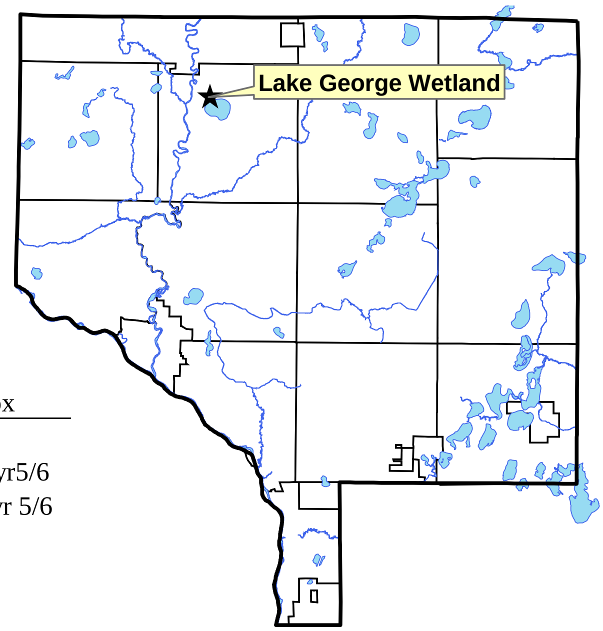
Other Notes: This wetland is located within Twin Lakes City Park, and is only 180 feet from the lake itself. Water levels in the wetland are influenced by lake levels.

2019 Hydrograph



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

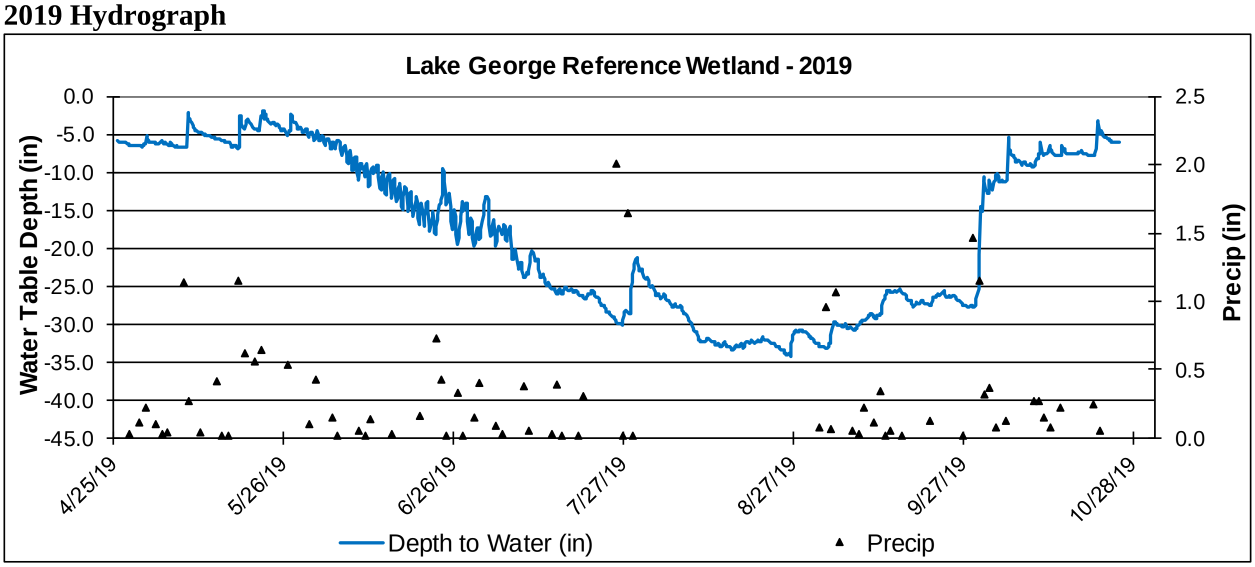
Surrounding Soils: Lino loamy fine sand and Zimmerman fine sand

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.

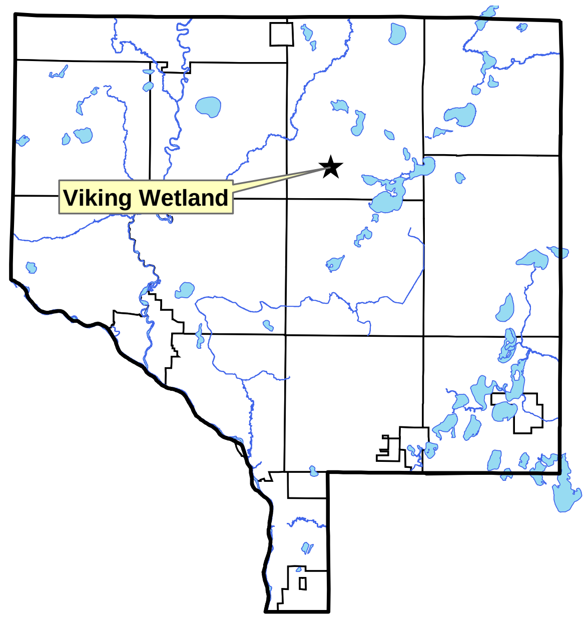
2019 Hydrograph



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

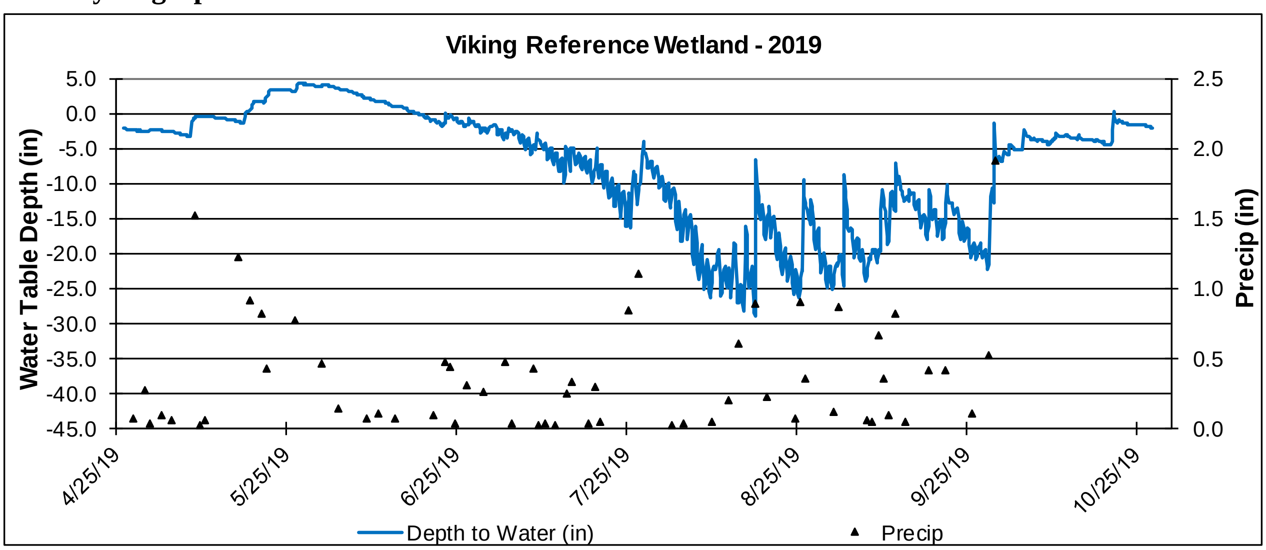
Surrounding Soils: Zimmerman fine sand

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).

2019 Hydrograph



Rum River Bank Stabilization

Partners: LRRWMO, URRWMO, ACD, MN DNR Conservation Partners Legacy Grant, Lessard-Sams Outdoor Heritage Council grant, landowners

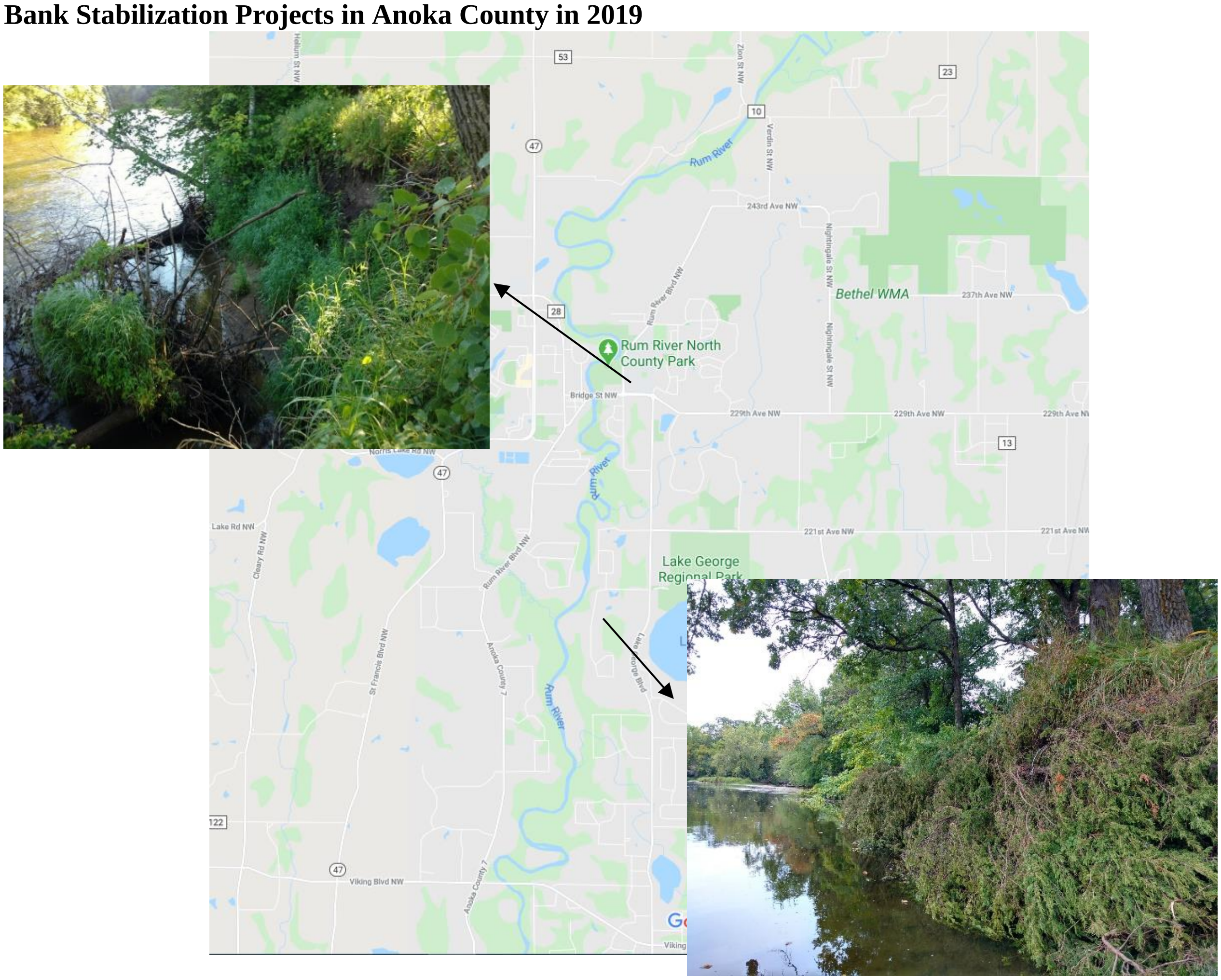
Description: 6 riverbank stabilization projects were installed on the Rum River in Anoka and Isanti Counties in 2019. At these sites, cedar tree revetments and willow stakes were used to stabilize eroding banks. The projects were installed with labor from Conservation Corps Minnesota (CCM) work crews. Funding for the 5 revetments installed in Anoka County came from the Conservation Partners Legacy Grant Program from the Outdoor Heritage Fund, a Clean Water Fund CCM crew labor grant, the URRWMO and LRRWMO, and landowner contributions. Funding for 1 additional revetment 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 to reduce sediment loading in the Rum River, as well as to reduce the likelihood of much larger and more expensive corrective projects in the future.

Location: Rum River Central Regional Park, Rum River North County Park, 3 residential properties in Anoka County, and the River Bluff Preserve in Isanti County

Results: Stabilized 650 linear feet of riverbank on the Rum River in Anoka and Isanti Counties.

Bank Stabilization Projects in Anoka County in 2019



Rum River Bank Erosion Grants

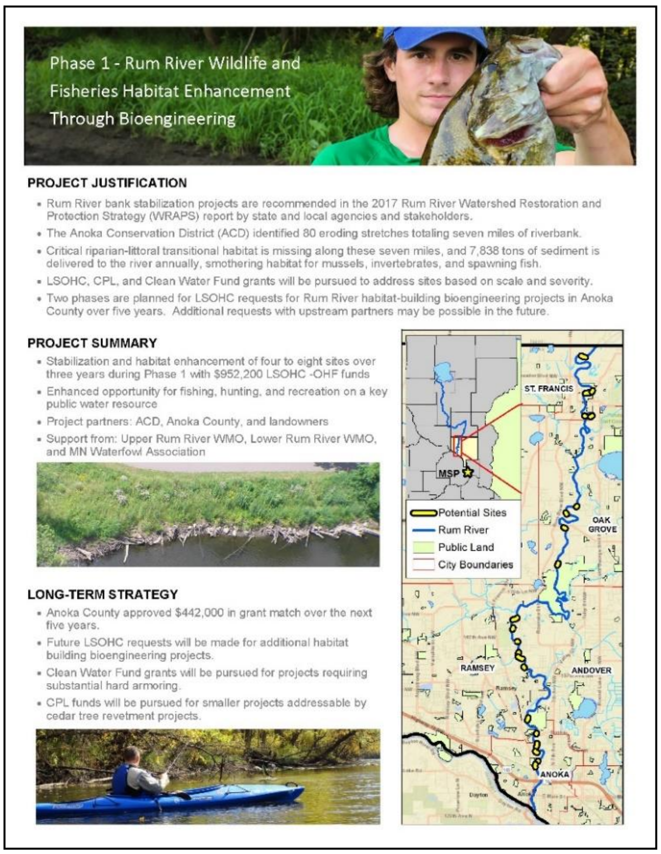
Partners: ACD, Anoka County Parks, LRRWMO, URRWMO

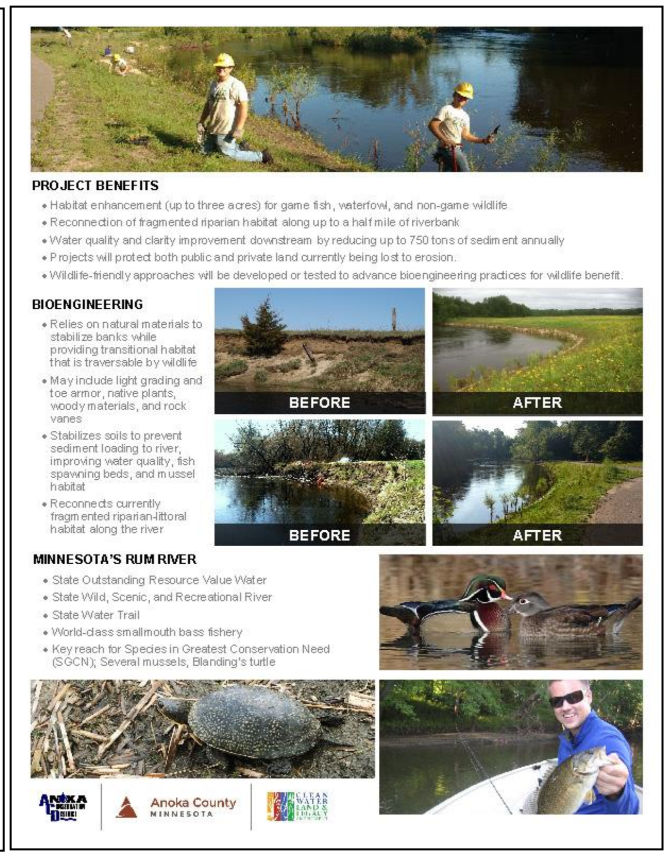
Description: The Anoka Conservation District (ACD) prepared an inventory of Rum River bank erosion using 360° photos of the riverbanks of the Rum throughout Anoka County. The photos are available through Google Maps using the Street View feature. An inventory report identifying 80 stretches of riverbank with moderate to very severe erosion is available on ACD's website. Estimated project cost and annual sediment load reduction to the river were calculated. ACD used this inventory to apply for grant funding for stabilization projects to correct some of these eroding banks. These applications, and matching money from Anoka County and the Rum River WMOs resulted in $1.4 Million to be used over the next three years for stabilization projects.

Purpose: To identify and prioritize riverbank stabilization sites and be used by ACD and other entities to pursue grant funds to restore or stabilize eroding stretches of Rum Riverbank.

Location: Rum River conveyance throughout Anoka County

Results: Inventory of 80 stretches of moderate to very severe erosion on banks of the Rum River. $1.4 Million has been secured so far in grant and matching funds to implement stabilization projects.





Application illustration for the Lessard-Sams Outdoor Heritage Council to do Rum River stabilization projects utilizing bioengineering approaches. The LSOHC reccomended funding these projects at $952,000 over the next three years, which will be matched with $236,000 in local funds from Anoka County and the Upper and Lower Rum River WMOs.

URRWMO Website

Partners: URRWMO, ACD

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

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

Location: www.URRWMO.org

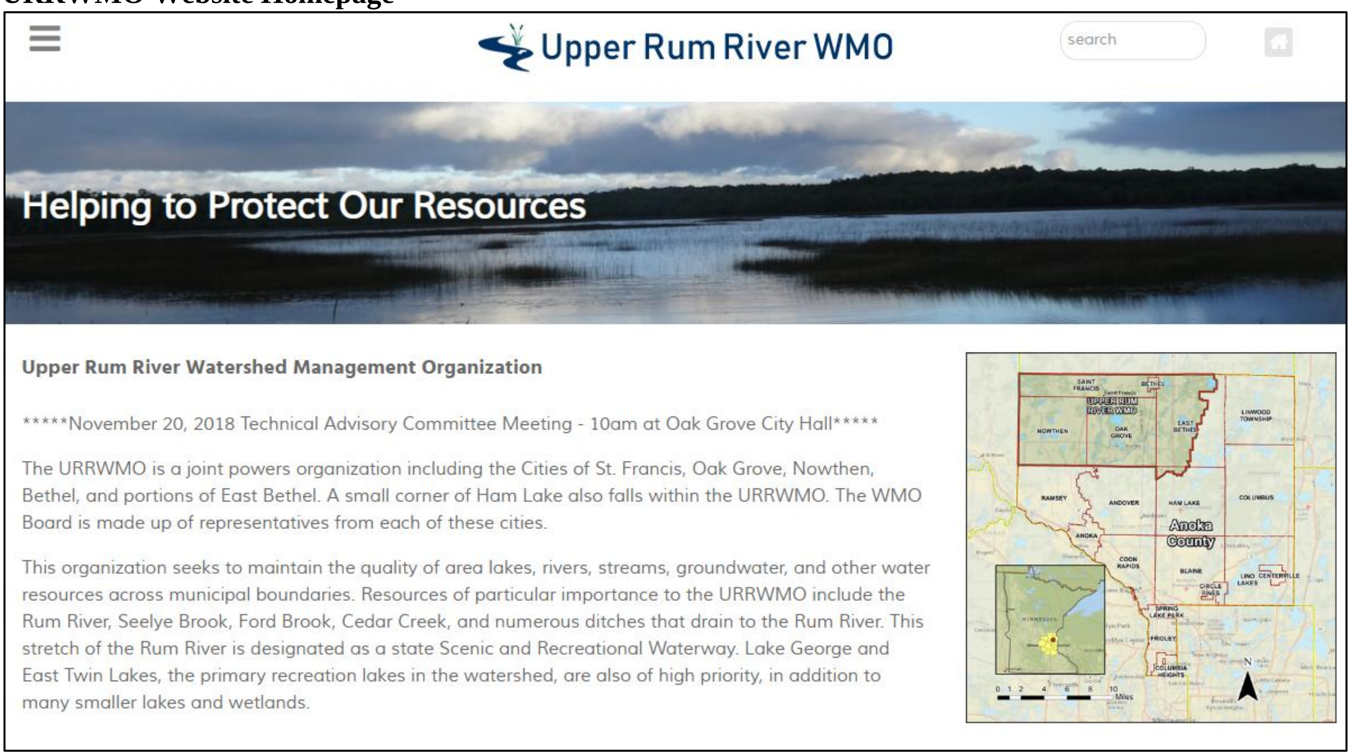
Results:

In 2019 routine SRWMO website updates were performed. The new website includes:

- Directory of board members,
- Meeting minutes and agendas,
- Watershed management plan and annual reports,
- Descriptions of work that the organization is directing,
- Highlighted projects,
- Informational videos,
- Maps of the URRWMO.

The website is regularly updated throughout the year.

URRWMO Website Homepage



URRWMO Annual Newsletter

Partners: URRWMO, ACD

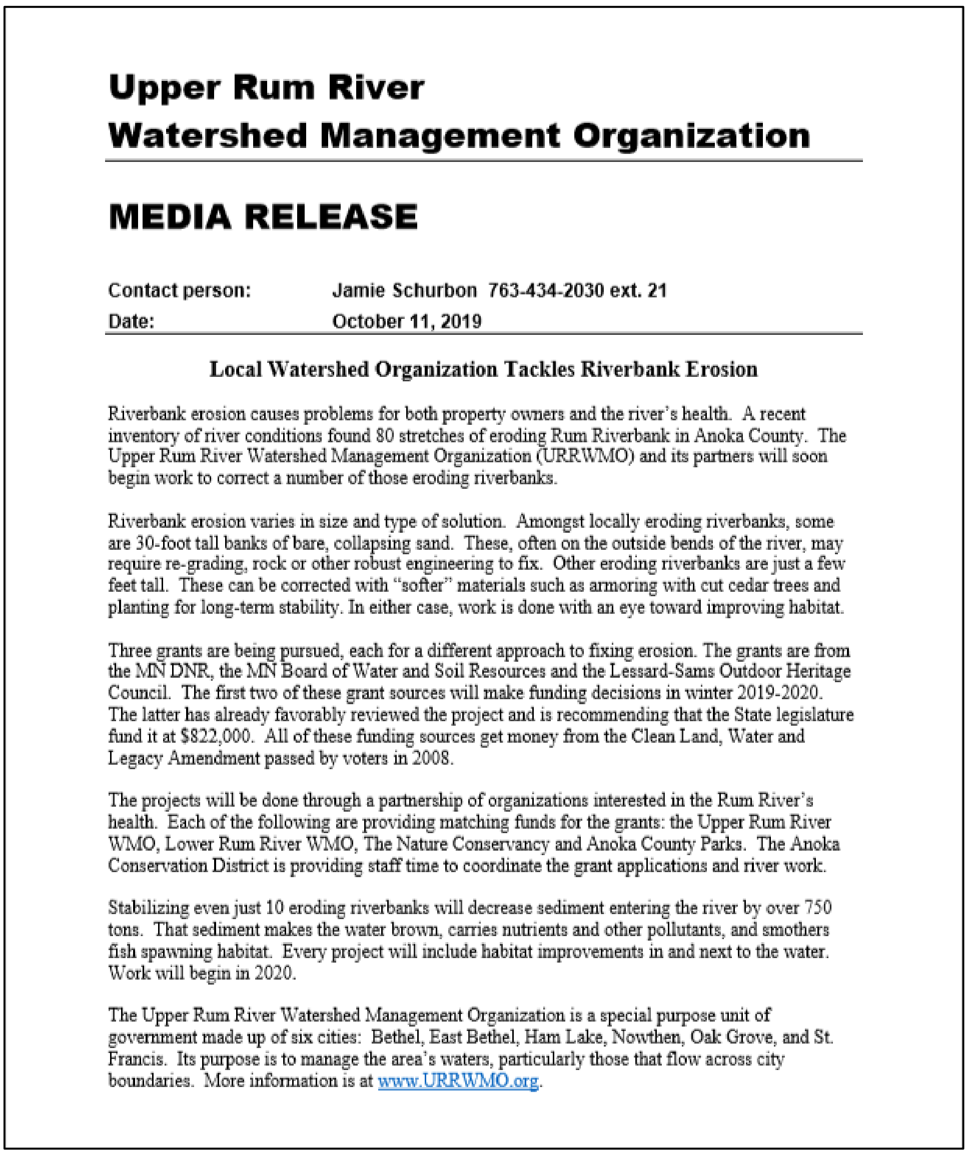
Description: The URRWMO Watershed Management Plan and state rules call for an annual URRWMO newsletter in addition to the WMO website. The URRWMO produces a newsletter article including information about the URRWMO, its programs, related educational information, and the URRWMO website address. This article 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."

2019 URRWMO Newsletter Article



Upper Rum River
Watershed Management Organization

MEDIA RELEASE

Contact person:	Jamie Schurbon 763-434-2030 ext. 21
Date:	October 11, 2019

Local Watershed Organization Tackles Riverbank Erosion

Riverbank erosion causes problems for both property owners and the river's health. A recent inventory of river conditions found 80 stretches of eroding Rum Riverbank in Anoka County. The Upper Rum River Watershed Management Organization (URRWMO) and its partners will soon begin work to correct a number of those eroding riverbanks.

Riverbank erosion varies in size and type of solution. Amongst locally eroding riverbanks, some are 30-foot tall banks of bare, collapsing sand. These, often on the outside bends of the river, may require re-grading, rock or other robust engineering to fix. Other eroding riverbanks are just a few feet tall. These can be corrected with "softer" materials such as armoring with cut cedar trees and planting for long-term stability. In either case, work is done with an eye toward improving habitat.

Three grants are being pursued, each for a different approach to fixing erosion. The grants are from the MN DNR, the MN Board of Water and Soil Resources and the Lessard-Sams Outdoor Heritage Council. The first two of these grant sources will make funding decisions in winter 2019-2020. The latter has already favorably reviewed the project and is recommending that the State legislature fund it at $822,000. All of these funding sources get money from the Clean Land, Water and Legacy Amendment passed by voters in 2008.

The projects will be done through a partnership of organizations interested in the Rum River's health. Each of the following are providing matching funds for the grants: the Upper Rum River WMO, Lower Rum River WMO, The Nature Conservancy and Anoka County Parks. The Anoka Conservation District is providing staff time to coordinate the grant applications and river work.

Stabilizing even just 10 eroding riverbanks will decrease sediment entering the river by over 750 tons. That sediment makes the water brown, carries nutrients and other pollutants, and smothers fish spawning habitat. Every project will include habitat improvements in and next to the water. Work will begin in 2020.

The Upper Rum River Watershed Management Organization is a special purpose unit of government made up of six cities: Bethel, East Bethel, Ham Lake, Nowthen, Oak Grove, and St. Francis. Its purpose is to manage the area's waters, particularly those that flow across city boundaries. More information is at www.URRWMO.org.

URRWMO 2018 Annual Reports to the State

Partners: URRWMO, ACD

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

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

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

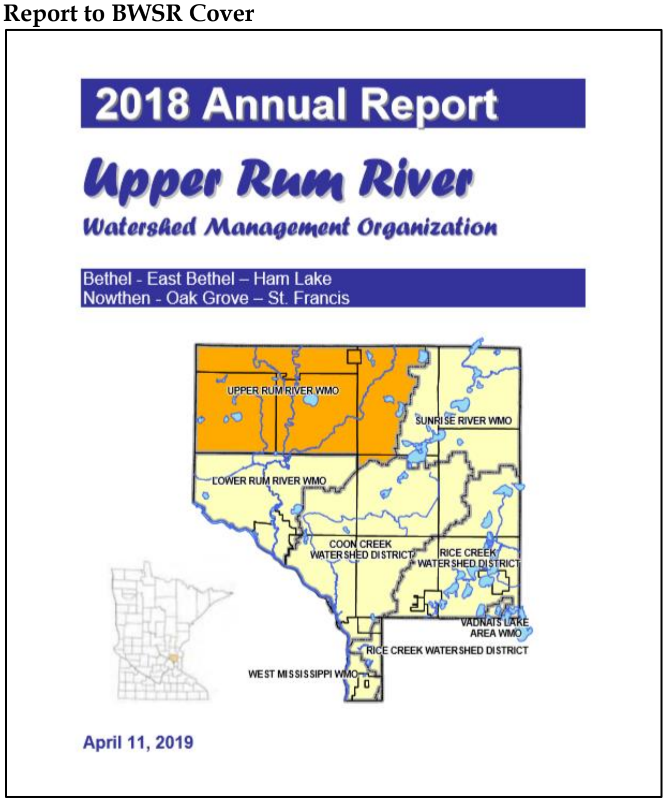
Locations: Watershed-wide

Results: The Anoka Conservation District assisted the URRWMO with preparation of a 2018 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,
- State Auditor's reporting forms through the State's SAFES website.

All were completed by the end of April 2019. The report to BWSR and financial report are available on the URRWMO website.

Report to BWSR Cover


2018 Annual Report

Upper Rum River

Watershed Management Organization

Bethel - East Bethel – Ham Lake
Nowthen - Oak Grove – St. Francis

April 11, 2019

Table of Contents

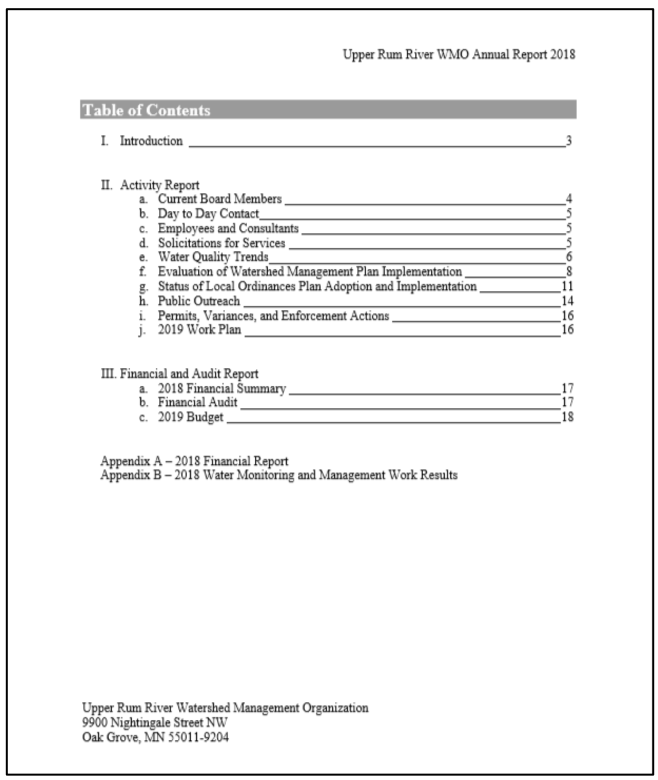

Upper Rum River WMO Annual Report 2018

Table of Contents

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

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.

2019 Upper Rum River Watershed Financial Summary

Upper Rum River Watershed	Volunteer Precip	DNR Groundwater Wells	Wetland Levels	Lake Levels	Lake Water Quality	Biomonitoring	AIS Lake George Mapping	Rum River Small Watersheds Grant	1W1P Rum River Planning	URRWMO Admin/Reporting/Grants	Beach Property Enhancement	Kern Property Enhancement	Burman WMA Restoration	Rum River Revetments	URRWMO Website	URRWMO Educ/Newsletter	Outreach Collaborative	Total
Revenues																		
URRWMO			1950	1240	1825					11360					665	1000		18040
State - Other		344															5767	6111
DNR OHF											3516		9285	935				13736
BWSR Local Water Planning					223													223
Regional/Local							1200		884					8754			364	11201
Anoka Co. General Services	571	597	132		43		56	160	4420		2149				1008		989	10125
County Ag Preserves/Projects					367	475								1862				2704
Service Fees						250						1868	5313	1149			31	8612
TOTAL	571	941	2082	1240	2459	725	1256	160	5304	11360	5665	1868	14599	12699	1673	1000	7151	70752
Expenses-																		
Capital Outlay/Equip	1	2	4	1	4	0			9	19	2	2	8	42	1		7	103
Personnel Salaries/Benefits	545	868	2898	1231	1656	1102	1228	146	4899	9634	3007	1696	11952	9591	1076	873	4465	56868
Overhead	31	47	141	67	84	68	53	12	271	481	244	105	580	404	69	44	252	2952
Employee Training	2	3	11	5	4	4	2	1	16	37	8	5	77	32	3	6	17	233
Vehicle/Mileage	7	11	40	16	24	13	20	1	64	131	27	21	144	146	13	10	56	743
Rent	23	44	124	53	87	47	56	7	238	435	165	85	337	511	55	22	202	2491
Program Participants														699				699
Program Supplies	13		209		585	80			64	122	2178	20	3858	566	484		631	8810
TOTAL	621	976	3426	1374	2444	1314	1360	167	5561	10859	5631	1933	16956	11991	1701	955	5630	72899
NET	-50	-35	-1345	-134	15	-589	-104	-7	-257	501	34	-65	-2358	708	-28	45	1522	-2146

Recommendations

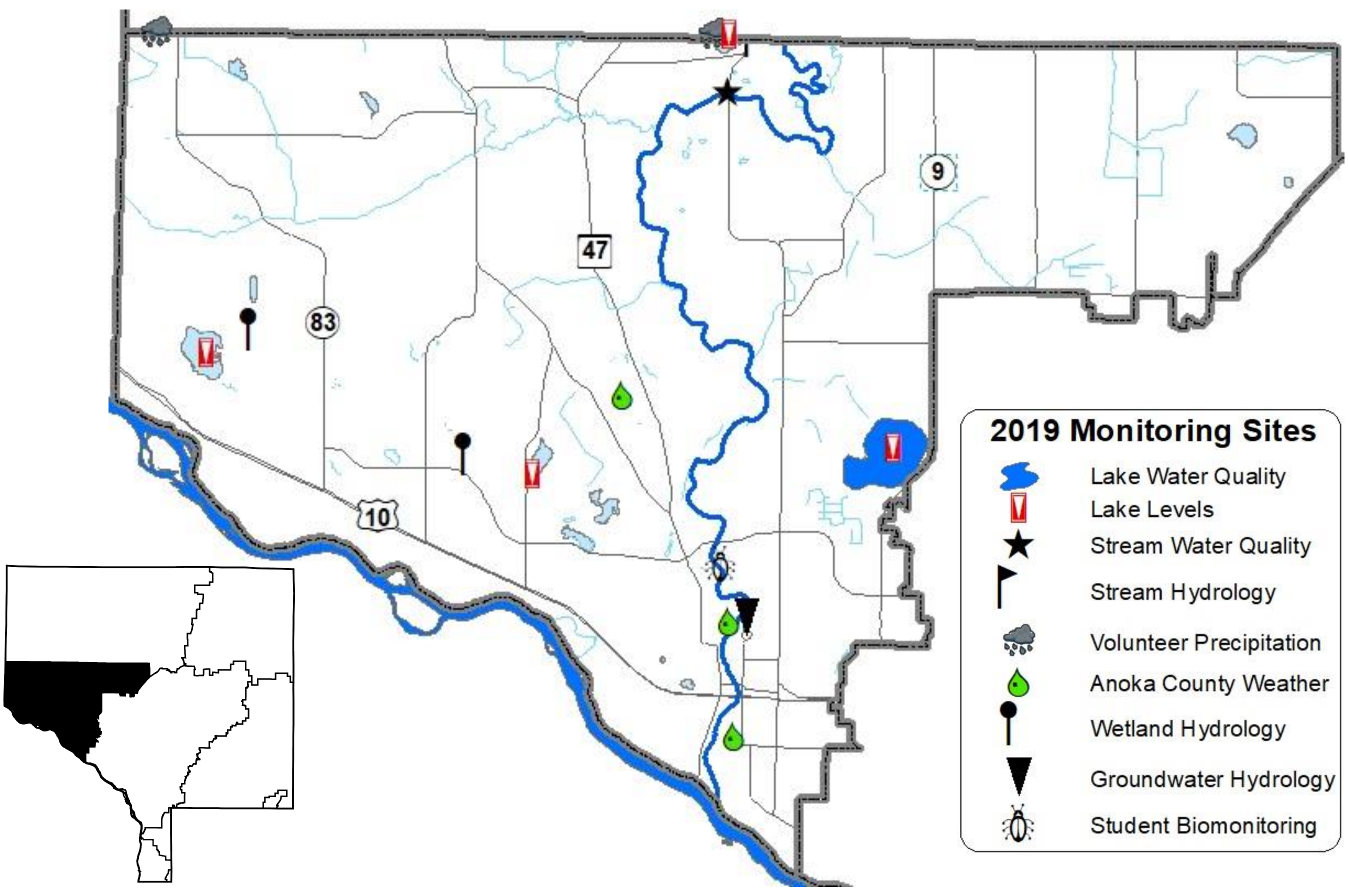
- **Participate in the Rum River One Watershed One Plan** process, resulting in prioritized management across the entire Rum River watershed.
- **Pursue projects that are in the URRWMO Watershed Management Plan**. This prioritized list was created by the URRWMO Technical Advisory Committee (TAC):
    1. Rum Riverbank stabilizations
    2. Anoka County Water Resources Outreach Collaborative
    3. (Tied) Stormwater retrofits for the Rum River and subwatershed assessments. Prioritized subwatershed assessment areas are: a) Pickerel Lake b) East Twin Lake c) Rum River direct drainage and d) City of Bethel periphery
    4. Lake George shoreline stabilizations
    5. Lake George iron-enhanced sand filter feasibility study
    6. Ditch 19 connector dredging
- **Bring projects to a construction-ready status** so they are positioned for State Watershed Based Implementation Funds. 10% match is needed for these grants.
- **Ensure stormwater treatment standards for new development result in no increase, and preferably a decrease, in phosphorus.** The Rum River is just below State standards for impairment and several tributaries exceed State nutrient standards. State MS4 stormwater treatment standards are aimed at maintaining water quality only, and it may be favorable to consider Minimum Impact Development Standards (MIDS) that are aimed at pollutant reductions.
- **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 practices that limit road deicing salt applications** while keeping roads safe. Streams throughout the URRWMO have increasing specific conductivity. Requiring municipal plow drivers to become certified through MN Pollution Control Agency deicing courses is recommended.
- **Periodically monitor chlorides in streams**. Monitoring every 3 years minimum is recommended.
- **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.

Chapter 4: Lower Rum River Watershed

Prepared by the Anoka Conservation District

Chapter 4: Lower Rum River Watershed

Table of Contents



Lake Level Monitoring

Partners: LRRWMO, ACD, MN DNR, volunteers

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).

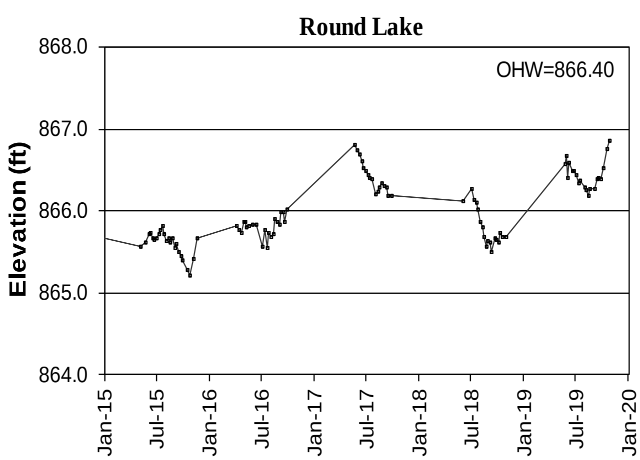
Purpose: To understand lake hydrology, including the impacts of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

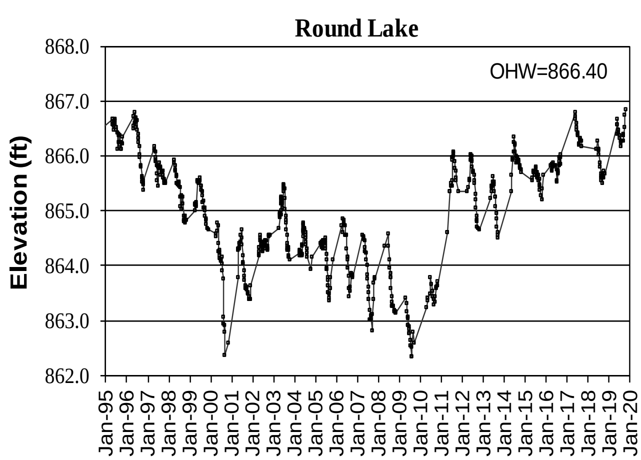
ults: Lake levels were measured by volunteers throughout the 2019 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. 2019 levels were higher than 2018 levels, and historical levels in general. Lake levels followed the expected pattern of higher levels in the spring with declining levels through summer. A wet summer, and very wet fall caused levels to drop less than usual into late summer, and then to increase dramatically through October. Most lakes ended the season at very high levels for the time of year. Sunfish Lake appears to be rising over the past 25 years with all of 2019 staying above the OHW. Round Lake has 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.

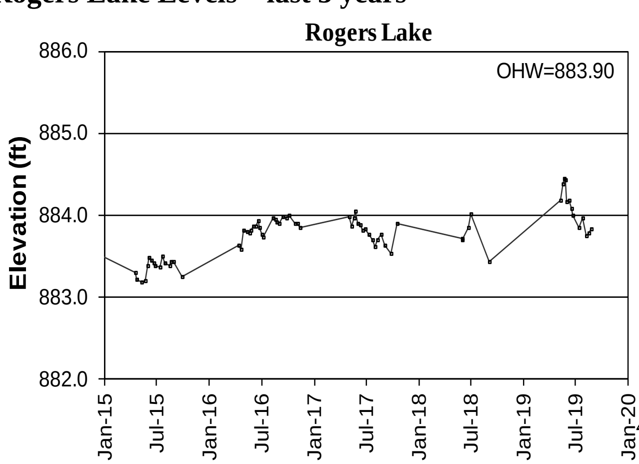
Round Lake Levels – last 5 years



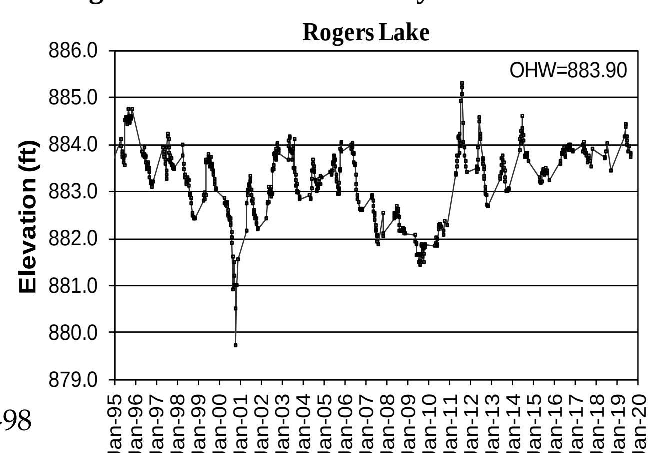
Round Lake Levels – last 25 years



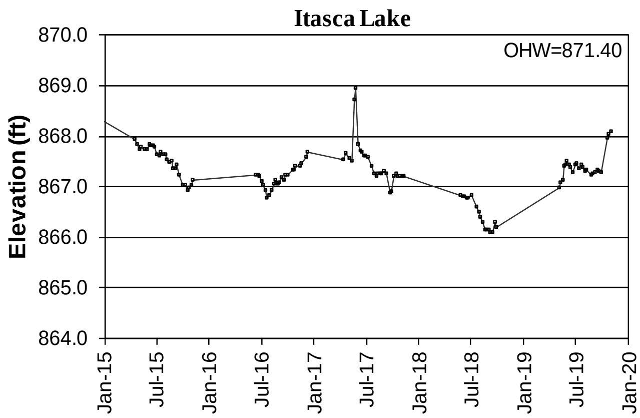
Rogers Lake Levels – last 5 years



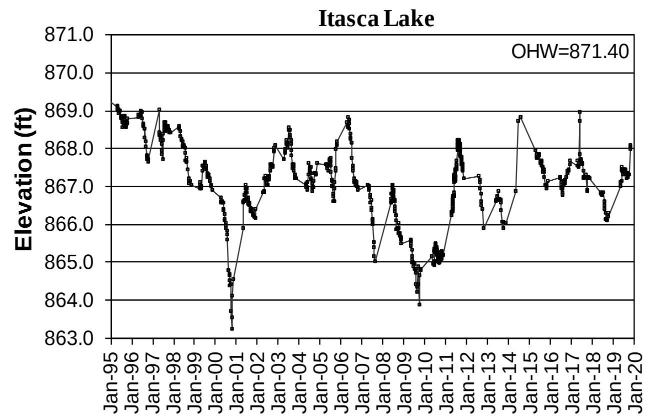
Rogers Lake Levels – last 25 years



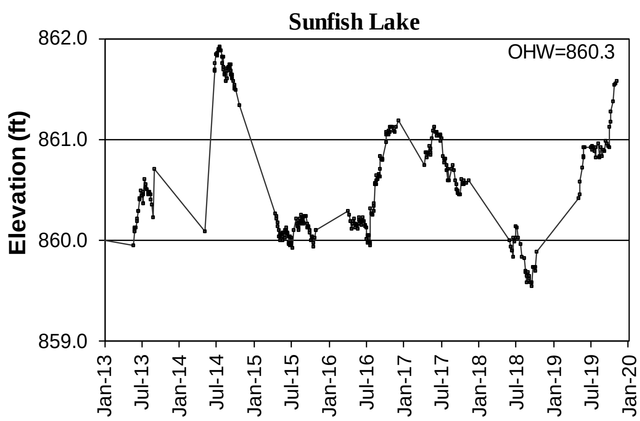
Itasca Lake Levels – last 5 years



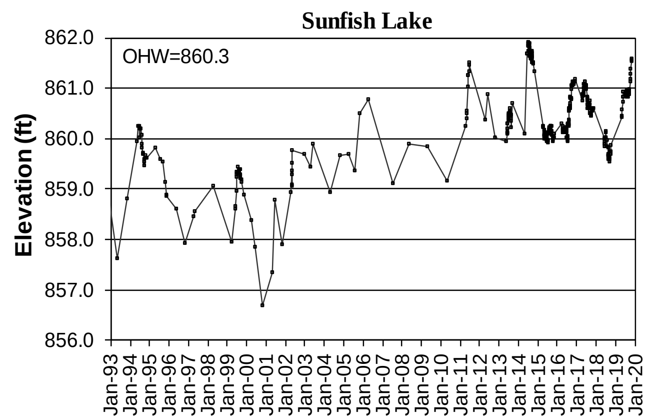
Itasca Lake Levels – last 25 years



Sunfish/Grass Lake Levels – last 5 years



Sunfish/Grass Lake Levels – last 25 years



Lake Water Quality

Partners: ACD, LRRWMO, Anoka County Ag Preserves Program

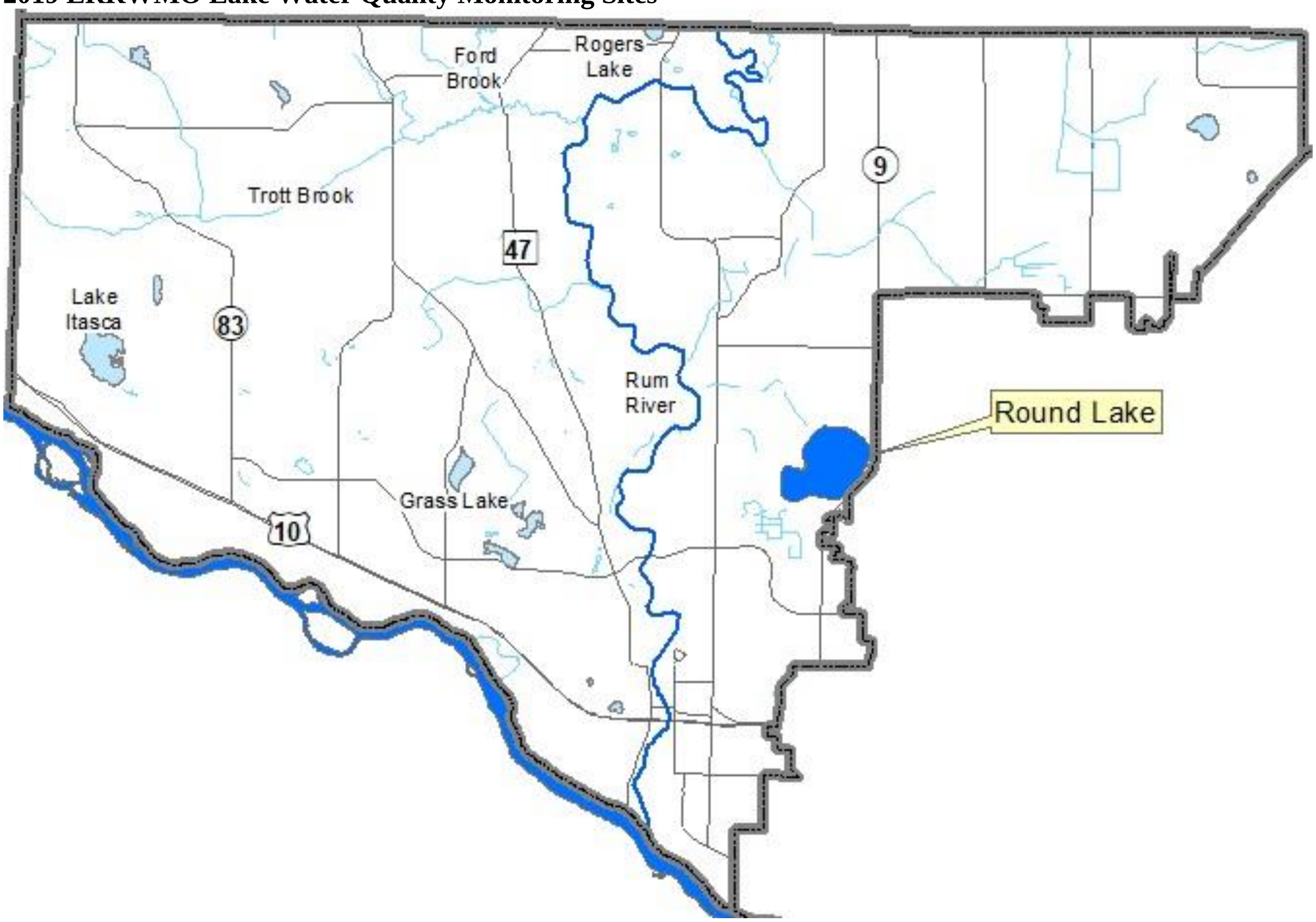
Description: May through September, every-other-week, monitoring is conducted for the following parameters: total phosphorus, chlorophyll-a, Secchi transparency, dissolved oxygen, turbidity, temperature, conductivity, pH, and salinity.

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

Locations: Round Lake

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.

2019 LRRWMO Lake Water Quality Monitoring Sites



Round Lake

City of Andover, Lake ID # 02-0089

Background

Round Lake is located in southwest Anoka County. It has a surface area of 220 acres and maximum depth of 19 feet, though the majority of the lake is less than 4 feet deep. The lake is surrounded by cattails and has submerged vegetation interspersed throughout the basin. This lake has a small watershed and is not subject to many of the negative impacts that occur on more developed lakes. Public access is from a dirt ramp on the lake's southeast side. Recreation is minimal primarily consisting of canoeing, kayaking, and wintertime fishing.

2019 Results

In 2019, Round Lake's water quality was very good compared with other lakes in this region (NCHF Ecoregion) receiving an overall A letter grade. The average of both total phosphorus (22.7 µg/L) and chlorophyll-a (5.1 µg/L) slightly increased from 2016, when the lake was last monitored. Both were still well below the state standards for shallow lakes (60 µg/L and 20µg/L respectively). Average Secchi transparency was 9.6 feet which is greater than the historical average of 8.5 feet. Phosphorus and algae concentrations were fairly consistent with a slight seasonal increase during July. Total phosphorus (29 µg/L), Cl-a (11.6 µg/L), and Secchi transparency (7.92 ft.), all had their poorest result during July. Even these "worst case" results during the middle of summer are quite good for a lake in this region and well within state standards for each parameter.

Trend Analysis

Twelve years of water quality monitoring has been conducted by the Anoka Conservation District (1998-2000, 2003, 2005, 2007, and 2009-2010, 2012, 2014, 2016-2019), which is a marginal number of years for trend analysis. In 2010, the results of the analysis indicated a significant trend of declining water quality across the years studied to that point (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,5} = 9.6065$, $p = 0.0194$). When the analysis is run on all data to date, including the exceptional water quality observed since 2012, no significant water quality changes are apparent ($F_{2,9} = 0.63$, $p = 0.55$). *). We examined each of the response variables separately using a one-way ANOVA to gain insight into which parameters could be influencing current water quality conditions. TP and Cl-a show non-significant downward trends, but lake level fluctuations are likely main drivers of TP and Cl-a concentrations in the lake due to dilution factors.*

Discussion

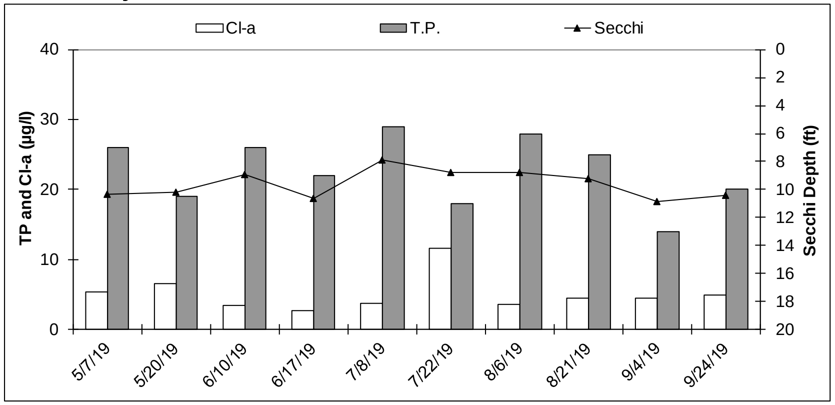
In 2019, exceptional water quality was observed in Round Lake for the fourth consecutive monitored year since 2012, earning the lake an A letter grade each year. There was growing concern about a trend toward poorer water quality, and continually falling lake levels from the mid-1990s through 2010. During this period, lake levels decreased by more than 4 feet on average. There was speculation that in-lake nutrient sources, driven by sediment mixing, were a contributor of phosphorus. During low water level conditions, there is more wind mixing due to shallow water depths, and in these years, there was also a conspicuous reduction of chara (a plant-like algae) carpeting the bottom. Since 2012, water levels have recovered substantially and water quality has dramatically improved. It does seem that low water levels in Round Lake have a correlation with poorer water quality.

The lake has few surface water inputs, so groundwater is important to lake hydrology. There have been concerns that local surficial groundwater levels, and hence the lake, are negatively impacted by a variety of causes including irrigation, residential groundwater use, and stormwater management. Groups including the MN DNR, ACD, watershed organizations, and cities have studied these potential causes. None has been found to cause lower-than-expected lake levels. Several lakes, including Round Lake and Bunker Lake, are potentially affected by groundwater overuse. Conservation of groundwater must become a regional and local priority as it will most likely become an increasing issue as development and population in the county continue to grow.

Round Lake

City of Andover, Lake ID # 02-0089

2019 Daily Results



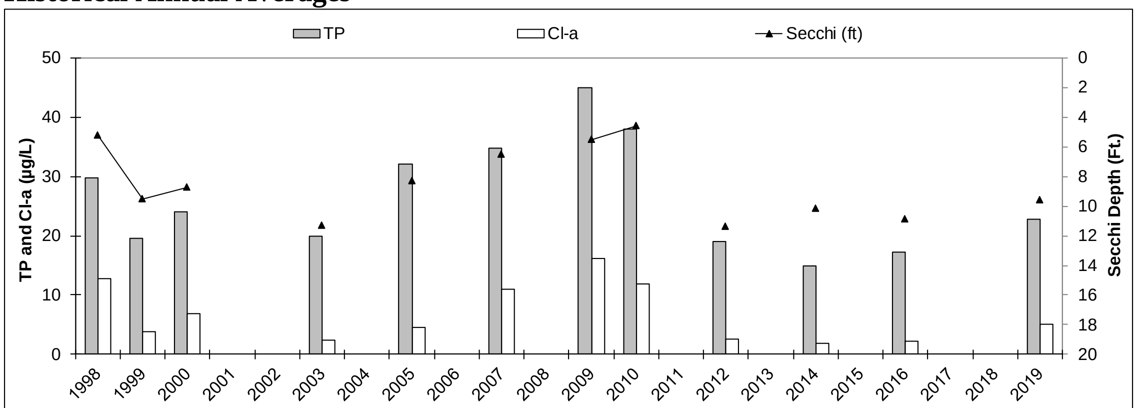
2019 Median Results

pH		8.11
Specific Conductivity	mS/cm	0.34
Turbidity	NTU	1.15
D.O.	mg/l	10.99
D.O.	%	128.2
Temp.	°F	71.84
Salinity	%	0.16
Cl-a	µg/L	5.1
T.P.	µg/l	23.5
Secchi	ft	2.96

Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1998	B	B	C	**B**
1999	A	A	B	**A**
2000	B	A	B	**B**
2003	A	A	A	**A**
2005	B	A	B	**B**
2007	C	B+	C	**C**
2009	C	B	C	**C**
2010	C	B	C	**C**
2012	A	A	A-	**A**
2014	A	A	A	**A**
2016	A	A	A	**A**
2019	A	A	B	**A**
State Standards	60 ug/L	20 ug/L	>3.3 ft	

Historical Annual Averages



Round Lake

2019 Water Quality Data

	Units	R.L.*	5/7/2019	5/20/2019	6/10/2019	6/17/2019	7/8/2019	7/22/2019	8/6/2019	8/21/2019	9/4/2019	9/24/2019			
		Time:	1:15	1:30	10:10	12:30	12:15	12:15	12:30	12:00	12:15	12:20			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.29	8.02	8.11	8.11	8.36	8.10	8.33	7.98	7.86	7.95	8.11	7.86	8.36
Specific Conductivity	mS/cm	0.01	0.363	0.376	0.336	0.313	0.324	0.348	0.350	0.324	0.335	0.316	0.339	0.313	0.376
Turbidity	FNRU	1	N/A	0.00	1.20	1.10	3.10	1.40	0.00	1.20	0.60	0.80	1	0	3
D.O.	mg/l	0.01	12.51	9.51	8.22	9.08	11.80	10.36	12.53	10.94	11.03	12.48	10.85	8.22	12.53
D.O.	%	1	126.6	93.0	96.5	105.7	152.4	130.2	134.3	129.8	122.6	146.6	123.8	93.0	152.4
Temp.	°C	0.1	15.15	13.12	22.11	22.16	26.60	25.65	26.89	23.92	20.58	20.45	21.7	13.1	26.9
Temp.	°F	0.1	59.3	55.6	71.8	71.9	79.9	78.2	80.4	75.1	69.0	68.8	71.0	55.6	80.4
Salinity	%	0.01	0.17	0.18	0.16	0.15	0.16	0.17	0.17	0.16	0.16	0.15	0.16	0.15	0.18
Cl-a	ug/L	0.5	5.4	6.5	3.4	2.7	3.7	11.6	3.6	4.5	4.4	4.9	5.1	2.7	11.6
T.P.	mg/l	0.010	0.026	0.019	0.026	0.022	0.029	0.018	0.028	0.025	0.014	0.020	0.023	0.014	0.029
T.P.	ug/l	10	26	19	26	22	29	18	28	25	14	20	22.7	14	29
Secchi	ft	0.1	10.33	10.16	8.92	10.66	7.92	8.75	8.8	9.3	10.8	10.4	9.6	7.9	10.8
Secchi	m	0.1	3.1	3.1	2.7	3.2	2.4	2.7	2.7	2.8	3.3	3.2	2.9	2.4	3.3
Physical			1	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	1.0	2.0	2.0	3.0	2.0	2.0	2.0	2.0	2.0	1.9	1.0	3.0

*reporting limit

Stream Water Quality - Chemical Monitoring

Partners: MPCA, ACD, LRRWMO

Description: Two sites on the Rum River were monitored in 2019. The locations of the river monitoring sites were located near the approximate upstream and downstream extents of the Lower Rum River Watershed. A site near the northern boundary of the Upper Rum River Watershed in St. Francis has been additionally monitored in previous years, but was not monitored in 2019. Monitoring near the southern extent of the Lower Rum Watershed was completed by the Metropolitan Council (Met Council) downstream of the Anoka Dam. Collectively, this data allows for an upstream to downstream water quality comparison within Anoka County, as well as within each watershed.

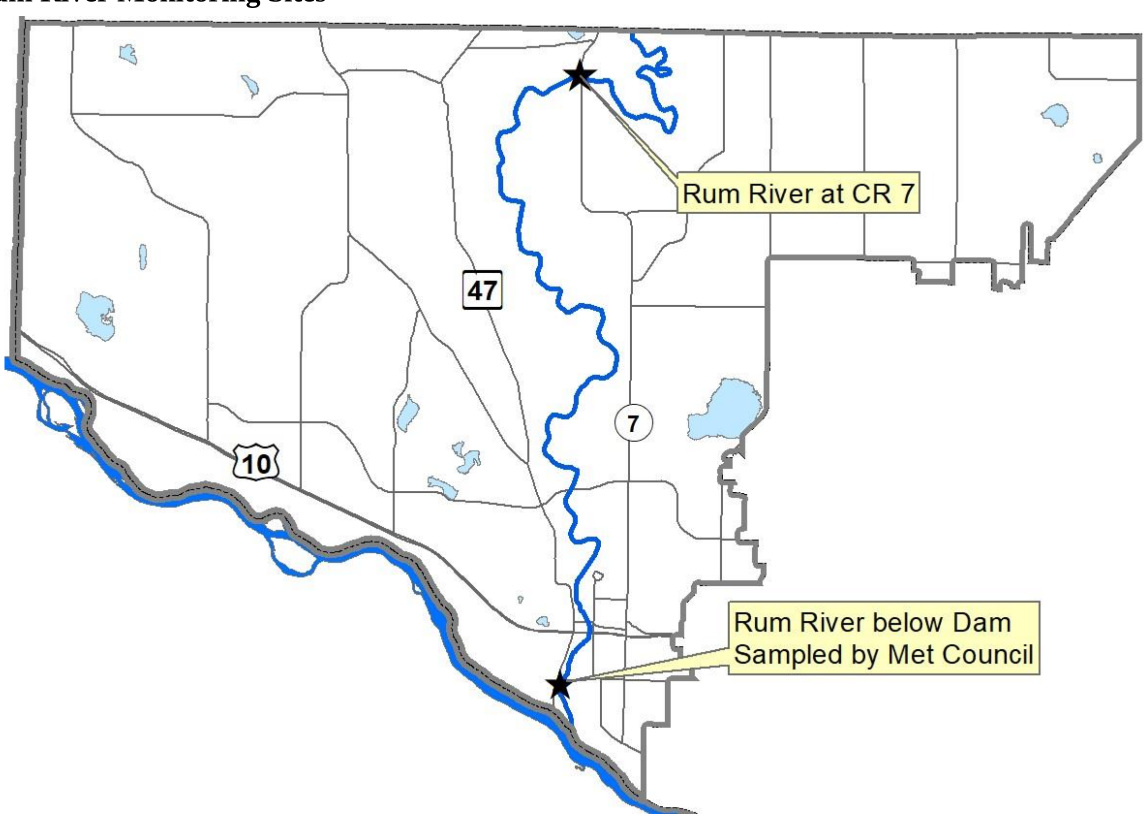
Monitoring by Anoka Conservation District occurred in May through October for each of the following parameters: total suspended solids, total phosphorus, Secchi tube transparency, dissolved oxygen, turbidity, chlorides, temperature, specific conductivity, pH, and salinity. Metropolitan Council monitoring occurred weekly March to October. The Met Council monitors all the parameters listed above, plus several more. Met Council monitoring data can be found on their Environmental Information Management Systems (EIMS) website (https://eims.metc.state.mn.us/). Data from both sources are summarized in this report.

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

Locations: **2019:** Rum River at County Road 7 (ACD), Rum River at Anoka Dam (Met Council)
Past: Rum River at County Road 24 (ACD)

Results: Results are presented on the following pages.

2019 Rum River Monitoring Sites



RUM RIVER

Rum River at Co. Rd. 24 (Bridge St), St. Francis	STORET Site ID = S000-066
Rum River at Co. Rd. 7 (Roanoke St), Ramsey	STORET Site ID = S004-026
Rum River at Anoka Dam, Anoka[1]	STORET Site ID = S003-183

[1]monitored by the Metropolitan Council

Years Monitored

At Co. Rd. 24 –	2004, 2009-2011, 2014-2018 (ACD)
At Co. Rd. 7 –	2004, 2009- 2011, 2014-2018, **2019** (ACD)
At Anoka Dam –	1996-2011(MC WOMP), 2015-2018, **2019** (Met Council)

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, and is heavily used for recreation. Subwatersheds that drain to the Rum in Anoka County include Seelye Brook, Ford Brook, Cedar Creek and Trott Brook. The Rum River watershed is quite large and extends to the north through most of Isanti and Mille Lacs Counties, and encompassing Lake Mille Lacs where it originates. The Rum River also has a West Branch tributary, which flows through portions of Morrison and Benton Counties.

Because its watershed is so large, the degree to which Rum River water quality improves or is degraded as it flows through Anoka County is hard to calculate, and is highly influenced by factors further upstream. 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 and exits Anoka County. Monitoring water quality at upstream sites has occurred only in more recent years. Water quality changes might be expected from upstream to downstream because predominant land use changes dramatically from forested and undeveloped upstream of Anoka County, rural residential in the upstream areas of Anoka County, and to suburban in the downstream areas.

Methods

In 2004, 2009-2011, and 2014-2019 monitoring was conducted to determine if Rum River water quality changes through Anoka County, and if so, generally where do these changes occur. The data is reported for all sites together for a more comprehensive analysis of the river from upstream to downstream.

In 2019, the river was monitored during both storm and baseflow conditions by taken grab samples at County Road 7, located at the top of the Lower Rum River Watershed. Eight water quality samples were taken; half during baseflow conditions and half following storm events. Storms are generally defined as one-inch or more of rainfall in 24 hours, or a significant snowmelt event combined with rainfall. In some years, particularly drought years, smaller storm events were used for sampling. Downstream of the Anoka Dam, the river was monitored by the Metropolitan Council using a different schedule. Data from six Met Council sampling events that occurred within 48 hours of an ACD monitoring event were included in the graphs and analysis below. County Road 24 (furthest upstream) was not sampled in 2019 but historical data is included in the analysis.

At County Road 7, parameters tested with portable meters included pH, specific conductivity, turbidity, temperature, salinity, and dissolved oxygen. Parameters tested by water samples sent to a state-certified lab included total phosphorus, total suspended solids, and chlorides. The Metropolitan Council monitored additional parameters at the Anoka Dam.

Water level and flow data are available 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 at all sites, and only similar dates that samples were collected in 2019. 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 available through the Minnesota Pollution Control Agency's EQuIS database (https://www.pca.state.mn.us/data/environmental-quality-information-system-equis).

Results Summary

This report includes data from 2019 and an overview of previous year's data. The following is a summary of results.

- Specific conductivity is an indicator of dissolved constituents. Specific conductivity in the Rum River is lower than other Anoka County streams. Specific conductivity generally increases mildly moving downstream. Average specific conductivity at County Road 7 in 2019 was 0.247 mS/cm.
- Chlorides averaged 9.36 mg/L at County Road 7 in 2019, which is low. As development continues in the Rum River watershed, efforts should include minimizing road deicing salt use and utilizing new water softening technology. Other streams near the Rum River do have significant high chlorides problems. The chronic State standard for chlorides is 230 mg/L which needs to be exceeded two or more times in a three-year period for a stream to be considered impaired.
- Phosphorus concentrations in the Rum River have a tendency to straddle the 100 µg/L State standard at ACD sampled sites. The site at County Road 7 averaged 86.6 µg/L and exceeded the standard on two sampling occasions in 2019, once during baseflow, and once after a storm event. Interestingly, concentrations below the Anoka Dam as measured by Met Council averaged just 56.8 µg/L. It is likely that the pool above the dam itself is providing settling treatment of water quality to the Rum River. These artificially low concentrations downstream of the dam do not minimize the reality that the Rum River is straddling the impairment threshold for phosphorus, and even small increases could cause the Rum River to be listed as impaired.
- Suspended solids and turbidity generally remained low in the Rum River in 2019 compared to State standards and to other Anoka County streams. Average turbidity was similar to previous years. ACD results garnered an eight-sample average of 8.55 NTU turbidity 8.22 mg/L TSS for 2019. Even lower turbidity and TSS concentrations measured by Met Council downstream of the Anoka Dam are likely due to settling in the pool created by the dam. Though suspended solids remain well under state impairment thresholds in the Rum, both TSS and turbidity show a moderate increase during storm events, and stormwater runoff mitigation should be a focus of management efforts, especially as other pollutants may be associated with suspended solids.
- Dissolved oxygen remained above the State standard of 5 mg/L in 2019 and previous monitored years. The lowest concentration recorded in 2019 was 6.58 mg/L at Rum River at C.R. 7. This was similar to the minimums recorded over the last several years.
- pH remained near neutral levels in the Rum River in 2019 after being elevated on some occasions in 2015 and 2017. pH should remain between 6.5 and 8.5 to support aquatic life and meet state water quality standards.

Below the data are presented and discussed for each parameter in greater detail. 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.

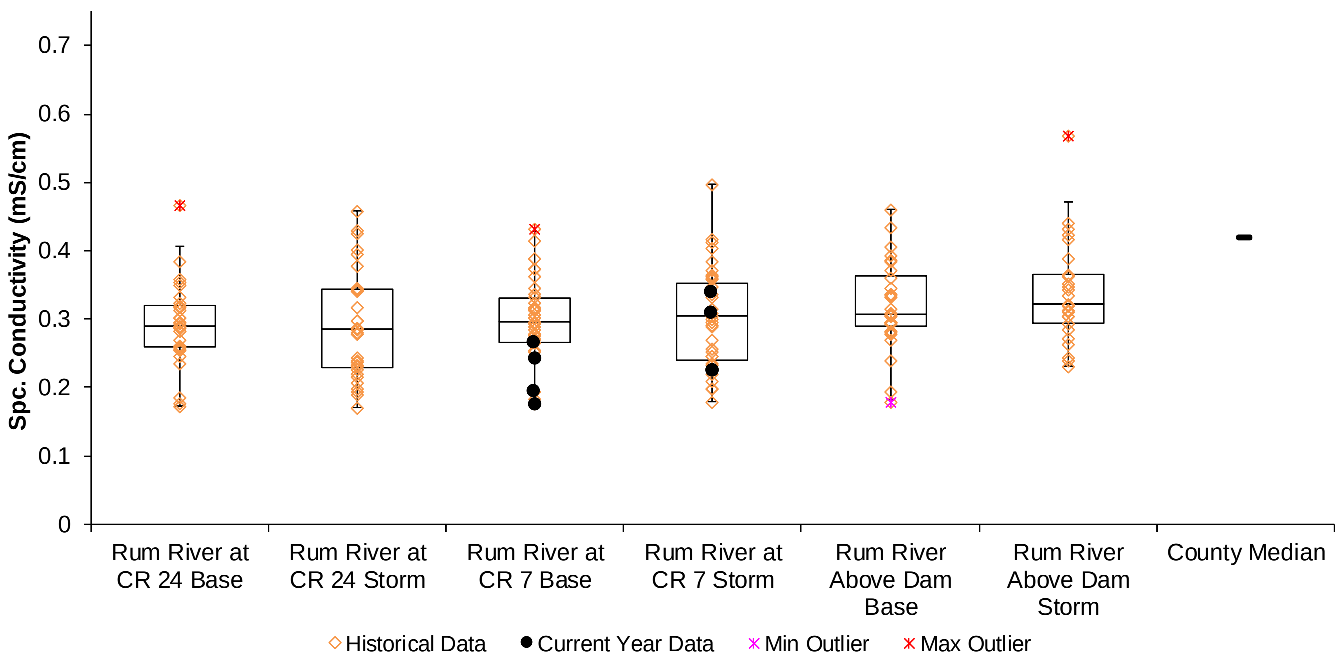
Specific Conductivity

Specific conductivity is an indicator of dissolved pollutants. Dissolved pollutant sources include road runoff and industrial chemicals, among many others. Metals, hydrocarbons, and road salts are often of concern in a suburban environment. Specific 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 specific conductivity.

Specific conductivity is acceptably low in the Rum River, but does show a tendency to increase slightly moving downstream. Conductivity is measured in different units by Met Council below the Dam than the units used by ACD above the dam. Because of this, the results cannot be compared for this parameter for that site. Average specific conductivity in 2019 (all conditions) was 0.247 mS/cm at County Road 7.This is lower than the historical median for Anoka County streams of 0.420 mS/cm. The 2019 maximum observed specific conductivity in the Rum River was 0.347 mS/cm at County Road 7 following a storm event.

Specific conductivity has historically been consistent between storm flow conditions and baseflow conditions in the Rum River. High baseflow specific conductivity has been observed in most other nearby streams and tributaries to the Rum. This occurrence has been studied extensively, and the largest cause has often been found to be road deicing salts that have infiltrated into the shallow aquifer. Water softening salts and geologic materials also contribute, but to a lesser degree. Many of these streams contribute to the Rum River.

Specific Conductivity during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

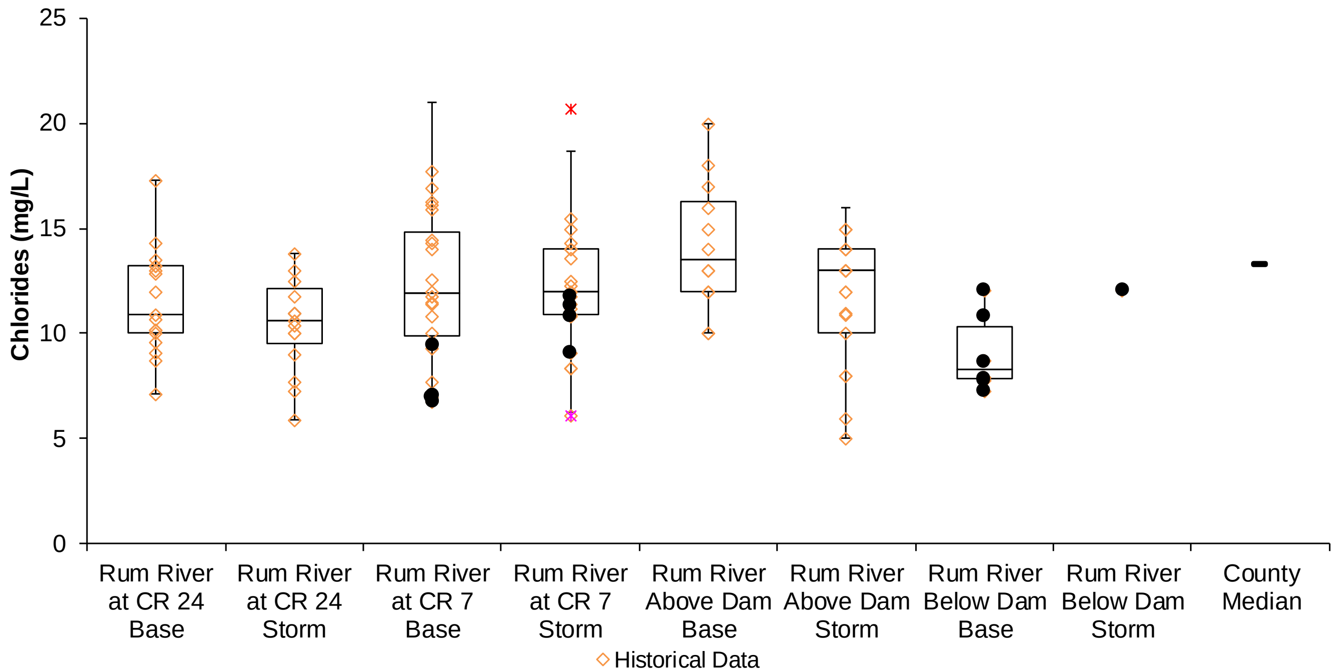


Chlorides

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 concern because of the effect they can have on the stream's biological community. They are also of concern in this case because the Rum River is upstream from the Twin Cities drinking water intakes on the Mississippi River. Specific Conductivity data, reported above, is commonly a reflection of chlorides, with higher specific conductivity generally corresponding to higher chlorides.

In 2019, water samples for chloride analysis were taken from the Rum River at C.R. 7 and below the Anoka Dam. At these locations, average chlorides concentrations were 9.2 mg/L and 9.54 mg/L respectively. Chloride concentrations in general in 2019 were on the low end of results gathered since 2004, but were slightly elevated during storm samples. May factors can contribute to variation in chloride concentrations year to year, not least of which is annual weather patterns that affect road salting. Practices like cities providing Smart Salt training to staff, improved water treatment process, and high efficiency water softeners can help reduce the chloride load to streams. Higher density housing and paved streets, and very snowy or icy winters can increase the chloride load to a stream. The chronic state water quality standards for chloride concentration in streams is 230 mg/L. The Rum has historically been well below that standard, and remains there in 2019.

Chlorides during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2019 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

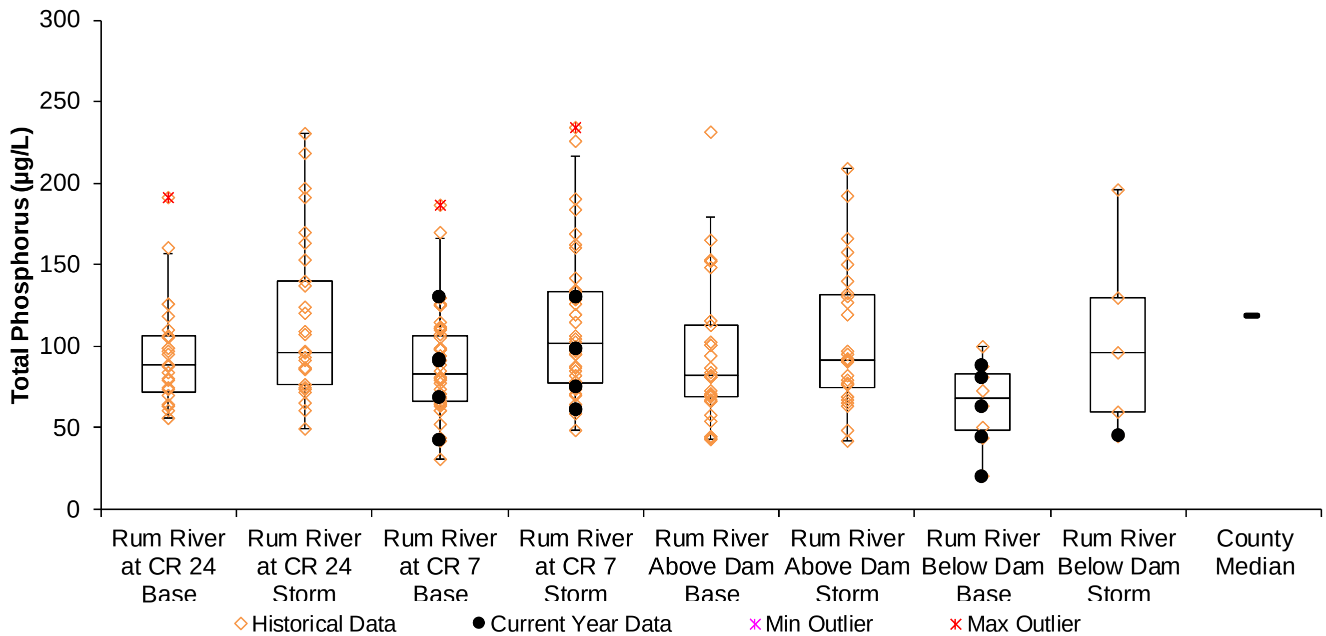
The nutrient phosphorus is one of the most common pollutants in our region, and can be associated with urban runoff, agricultural runoff, wastewater, and many other sources. It causes excessive algal growth and a number of other associated problems for aquatic life and recreation. Phosphorus concentrations in the Rum River are near the state impairment threshold.

In 2019, as in most years prior, total phosphorus averaged near the State water quality standard at 86.6 µg/L at County Road 7. Two of eight samples collected by ACD yielded total phosphorus concentrations over the state standard of 100 µg/L. One exceedance occurred after a storm event and one during baseflow conditions. Interestingly, results from Met Council monitoring below the dam showed lower concentrations at baseflow that any previous monitoring conducted upstream of the dam in the past. From the 6 representative samples used for analysis, total phosphorus averaged just 56.83 µg/L below the dam in 2019. The pool caused by the dam may be causing nutrient laden particles to settle out of the water column as the river slows down and widens upstream of the dam. The dam may be causing water quality improvements in the Rum River due to this settling action that haven't been accounted for in the past. Looking at all data collected at all sites, phosphorus concentrations tend to be higher during storm flows than base flows. Since the Rum River is close to exceeding the phosphorus state standard upstream, efforts should be made to prevent any additional phosphorus loading which may result in the

Rum River being designated as "impaired" for nutrients. Future upgrades to wastewater treatment plants throughout the Rum River watershed may offer phosphorus reductions. At the same time, development should include current stormwater treatment in order to maintain nutrient loading levels and hopefully reduce overall phosphorus levels. Larger reduction strategies will be necessary to offset the increasing loading that will likely occur with increasing development, more frequent and intense precipitation events, upstream ditch cleaning and other factors.

According to the Rum River WRAPS report, preventing additional nutrient loading to the Rum River should be a high priority throughout the watershed. Additionally, current loading sources differ throughout the watershed based on landuse differences. In the lower reaches of the Rum River in Anoka County, stabilization of streambank erosion is identified as the number one strategy for reducing loading in this portion of the watershed. ACD has partnered with Anoka County Parks and the Upper and Lower Rum River WMOs to secure $1.4 Million in grant and matching funds to implement bank stabilization practices along eroding banks in the Rum River over the next three years. These projects will reduce the direct loading of sediment and nutrients to the river from these banks into the future.

Total Phosphorus during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (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 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, such as phosphorus, are attached to particles. Many stormwater treatment practices such as street sweeping, sumps, and stormwater settling ponds, target sediment and these attached pollutants. In 2019, median 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 usually increases during storms, though there is substantial variability (see figure below). There is no clear change in turbidity or suspended solids upstream to downstream at ACD monitoring sites above the Anoka Dam. The average turbidity, in 2019 (all conditions) at County Road 7 was 8.55 NTU. The historical median for Anoka County streams is 11.39 NTU. Turbidity was only elevated on one occasion, after a storm event, where it reached 24.2 NTU. Even though turbidity is no longer used by the state to determine if a stream is impaired, it should continue to be monitored as an indicator of increasing pollutant levels.

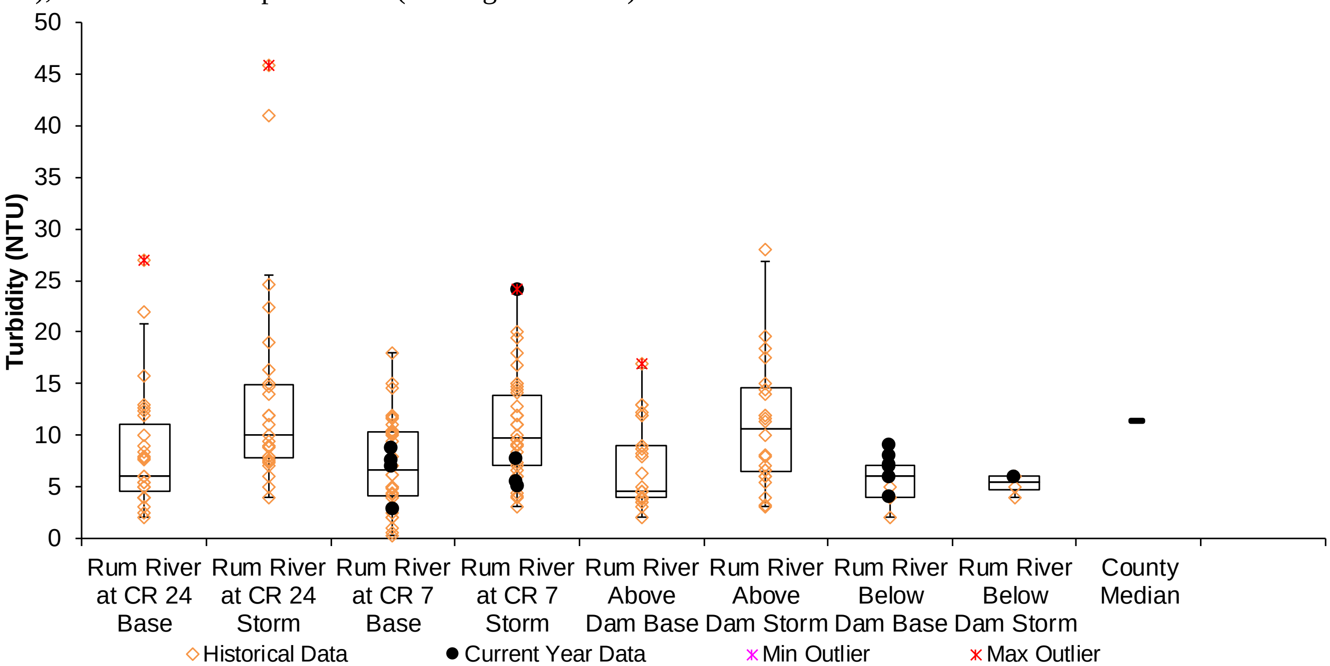
The average TSS concentration (all conditions) in 2019 at County Road 7 was 8.22 mg/L, lower than the Anoka County stream median for TSS of 14.37mg/L. It is also lower than state water quality standard. The state threshold for TSS impairment in the Rum River is 10% of samples April 1-September 30 exceeding 30 mg/L. The highest concentration recorded in 2019 was 10.6 mg/L. ACD has not collected a sample in the Rum River over 30 mg/L TSS since May of 2010.

Like total phosphorus concentrations, samples collected by Met Council below the Anoka Dam had decreased turbidity and TSS. It is likely that the same settling effect that is reducing phosphorus concentrations is also reducing the concentration of suspended particles in the water column. Additionally, like total phosphorus, storm flows increase the concentration of suspended solids within the water column vs. baseflow conditions.

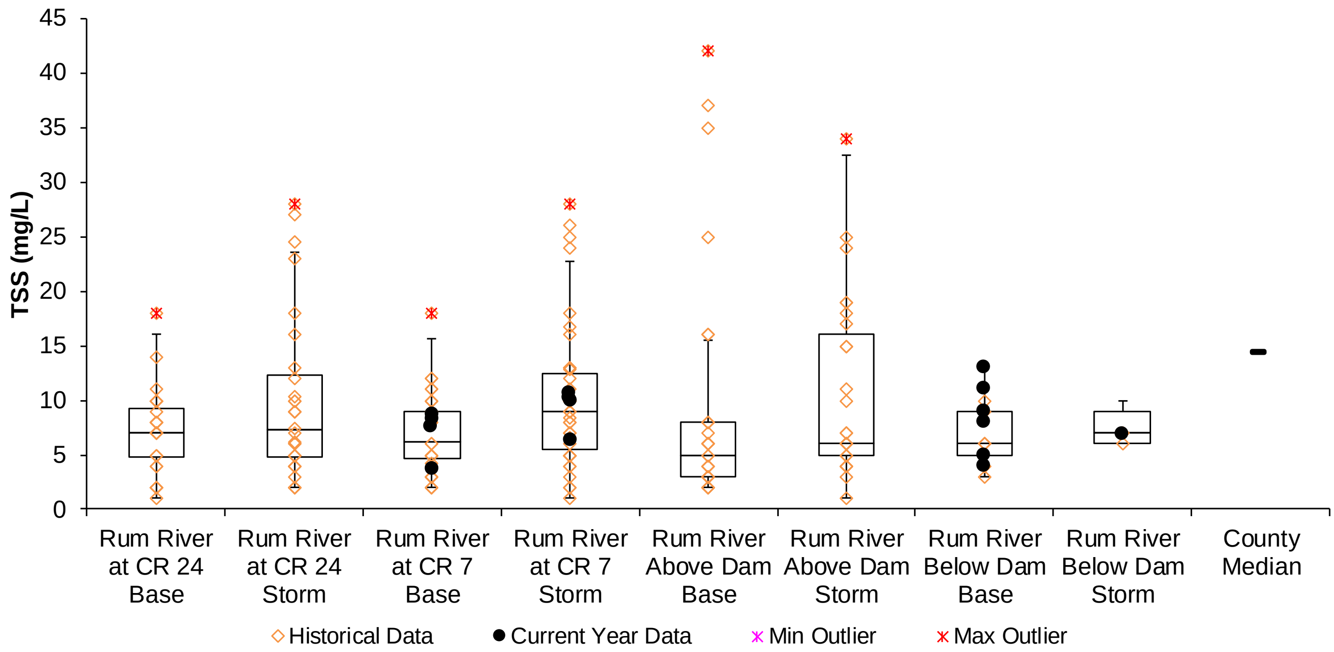
Suspended solids can come from within and outside of the river channel. Sources on land include soil erosion, road sanding, and others. Riverbank erosion and movement of the river bottom also contributes to suspended solids. A moderate amount of this "bed load" is natural and expected.

Though the Rum River remains well under the impairment threshold for TSS, rigorous stormwater treatment should occur as the Rum River watershed continues to develop. Increasing development in the watershed could seriously impact the river, especially given that stormwater carries many pollutants in addition to suspended sediments. There should also be an effort to bring stormwater treatment up-to-date in older developments throughout the watershed.

Turbidity during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2019 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 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



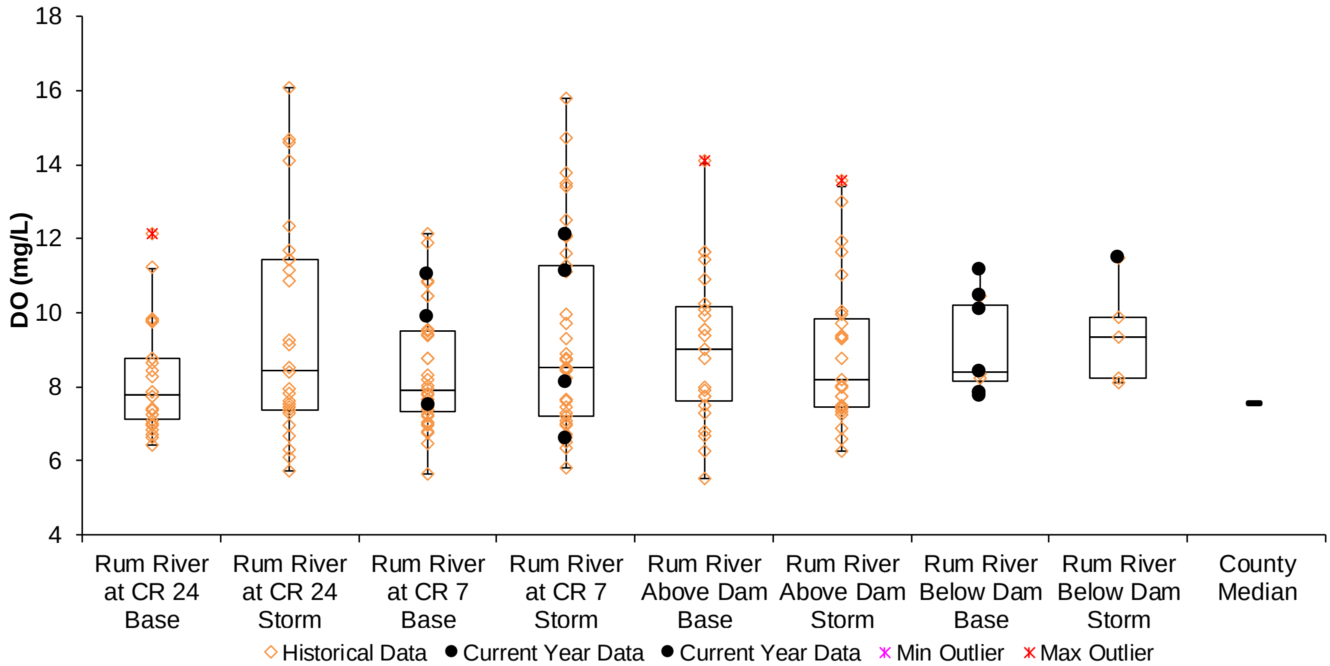
Dissolved Oxygen

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 2019, dissolved oxygen in the Rum River was always above 5 mg/L at all monitoring sites.

The lowest dissolved oxygen observed in the Rum River in 2019 was 6.58 mg/L. Only on five occasions has dissolved oxygen readings been below 6.0 mg/L in the Rum River throughout the monitoring record, with the 3 most recent readings occurring during a single storm in 2011. The low dissolved oxygen result this year was recorded during a storm in July when water temperatures were above 77° F. Warm water holds less oxygen, therefore this low reading is likely a result of low water on a hot day, rather than pollution.

Decreases in dissolved oxygen may result from an increase in the level of nutrients in the stream. Making sure that phosphorus and nitrogen inputs to the stream are maintained or decreased is important for healthy dissolved oxygen levels. The principle sources of these nutrients are fertilizer and wastewater.

Dissolved Oxygen during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

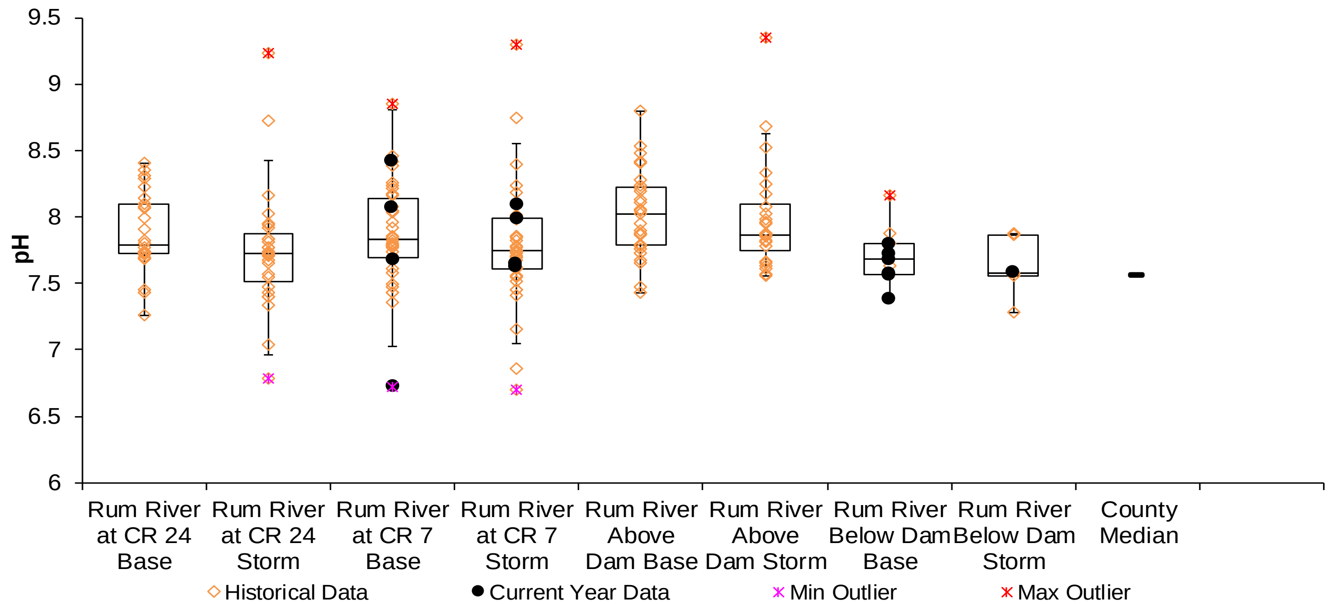


pH

pH refers to the acidity of the water. The state standard is for pH levels 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 and has become more common in recent years (2015, 2017). In these years, exceedances of 8.5 were observed at all sites. 2018-2019 saw a positive change with no sampling events exceeding 8.5.

There are a variety of potential factors leading to temporary spikes in pH in water quality. Although it is a positive development that they did not occur in the past couple years, pH should be continued to be monitored in the Rum River due to the previous spikes.

pH during Baseflow and Storm Conditions. Orange diamonds are historical data from previous years and black circles are 2019 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

In general, water quality in the Rum River is good. However, there is typically a slight increase in specific conductivity moving downstream, phosphorus levels are near State water quality standards, and pH over 8.5 has occurred in recent years, although they did not occur in 2019. Making this a local priority and increasing protection on the river will help avoid much costlier restoration efforts that may be required later on if no action is taken.

In addition to comparing water quality in the Rum River upstream to downstream, water quality should continue to be monitored/compared between Rum River tributaries and the Rum River main stem to help target where pollutant loading is occurring. Based on historical monitoring of direct tributaries in Anoka County, water quality in the Rum River is degraded by most of these smaller systems. Many of the tributaries experience frequent exceedances of State standards, especially for total phosphorus. This is important since the Rum River is already nearing exceedance of the total phosphorus standard.

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 watershed and future developments have the potential to degrade water quality if the river is not included in the local planning process. Specifically, new development should aim to follow more protective stormwater standards, which are designed to maintain, and preferably reduce, phosphorus discharge to the river. Road deicing locally, which has become more sophisticated in recent years, should focus on minimizing salt application while still keeping roads safe.

The Rum River's scenic and natural qualities are also what bring additional developmental pressure to these key protection areas. Local ordinances to preserve scenic nature areas along the Rum River exist but sometimes sufficient enforcement is lacking. Additionally, preservation of riparian parcels with high natural resource quality should be considered with easement or fee title acquisition.

Watershed-wide (Mille Lacs Lake to the Anoka Dam) coordination of Rum River management is increasing. A Watershed Restoration and Protection Strategies (WRAPS) was completed in 2017. It is a scientific study that identifies recommended management strategies. A "One Watershed, One Plan" (1W1P) in 2019-2020 offers multi-county planning. This plan will prioritize and coordinate action. After completion of the 1W1P a new State funding source will become available – Watershed Based Funding – to implement water quality improvement projects. Additionally, ACD has partnered with Anoka County Parks and the Rum River WMOs in Anoka County to secure large sums of grant and match funds to continue stabilizing eroding banks along the river.

Stream Water Quality – Biological Monitoring

Partners: LRRWMO, ACD, Anoka High School

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 health and supplement chemical water quality monitoring 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, this will give a more comprehensive summary of stream conditions. 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

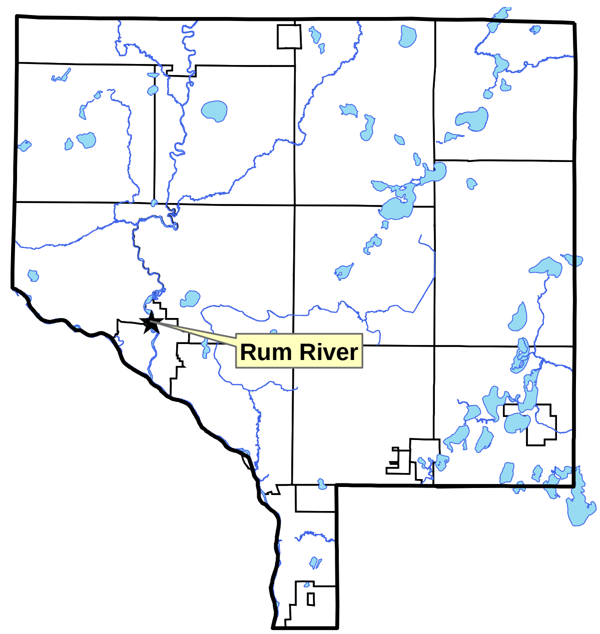
Population Attributes Metrics

% 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 2018

Monitored Since

2001

Student Involvement

Over 100 students in 2019, over 1,300 total since 2001

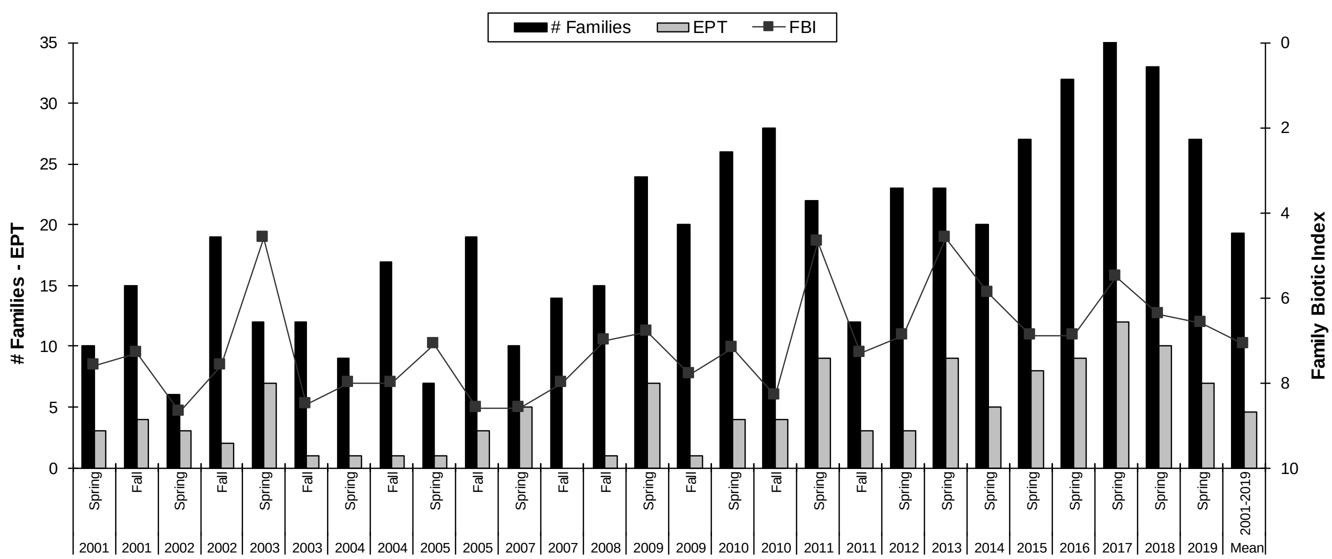
Background

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 2019 with Anoka Conservation District (ACD) oversight. The results for spring 2019 were better than the overall historical average but continue a now two year decline since 2017, which had the best results on record. Students collected 27 different families of invertebrates, a mark only achieved each year since 2015. Seven unique families of the most sensitive taxa (Ephemeroptera, Plecoptera, and Trichoptera; EPT), were collected in 2019. The last three years of monitoring at this site (2016, 2017, and 2018) are the best three years on record, with 2019 and 2015 being slightly lower.

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	2015	2016	2017	2018	2019	Mean
Season	Spring	Spring	Spring	Spring	Spring	2001-2019
FBI	6.90	6.90	5.50	6.40	6.60	7.1
# Families	27	32	41	33	27	19.4
EPT	8	9	12	10	7	4.6
Date	11-May	17-May	15-May	14-May	10-May	
Sampled By	AHS	AHS	AHS	AHS	AHS	
Sampling Method	MH	MH	MH	MH	MH	
Mean # Individuals/Rep.	767	3363	1439	1648	1341	
# Replicates	2	1	2	3	1	
Dominant Family	Siphlonuridae	Siphlonuridae	Pelecypoda	Siphlonuridae	Siphlonuridae	
% Dominant Family	69.3	74.9	26.6	48.1	66.8	
% Ephemeroptera	78.9	78.7	14.9	65.1	74.4	
% Trichoptera	1.4	0	0.1	0.1	0.7	
% Plecoptera	0	0.4	26	1.9	0.8	
% EPT	80.3	79.1	41	67.1	75.9	

Discussion

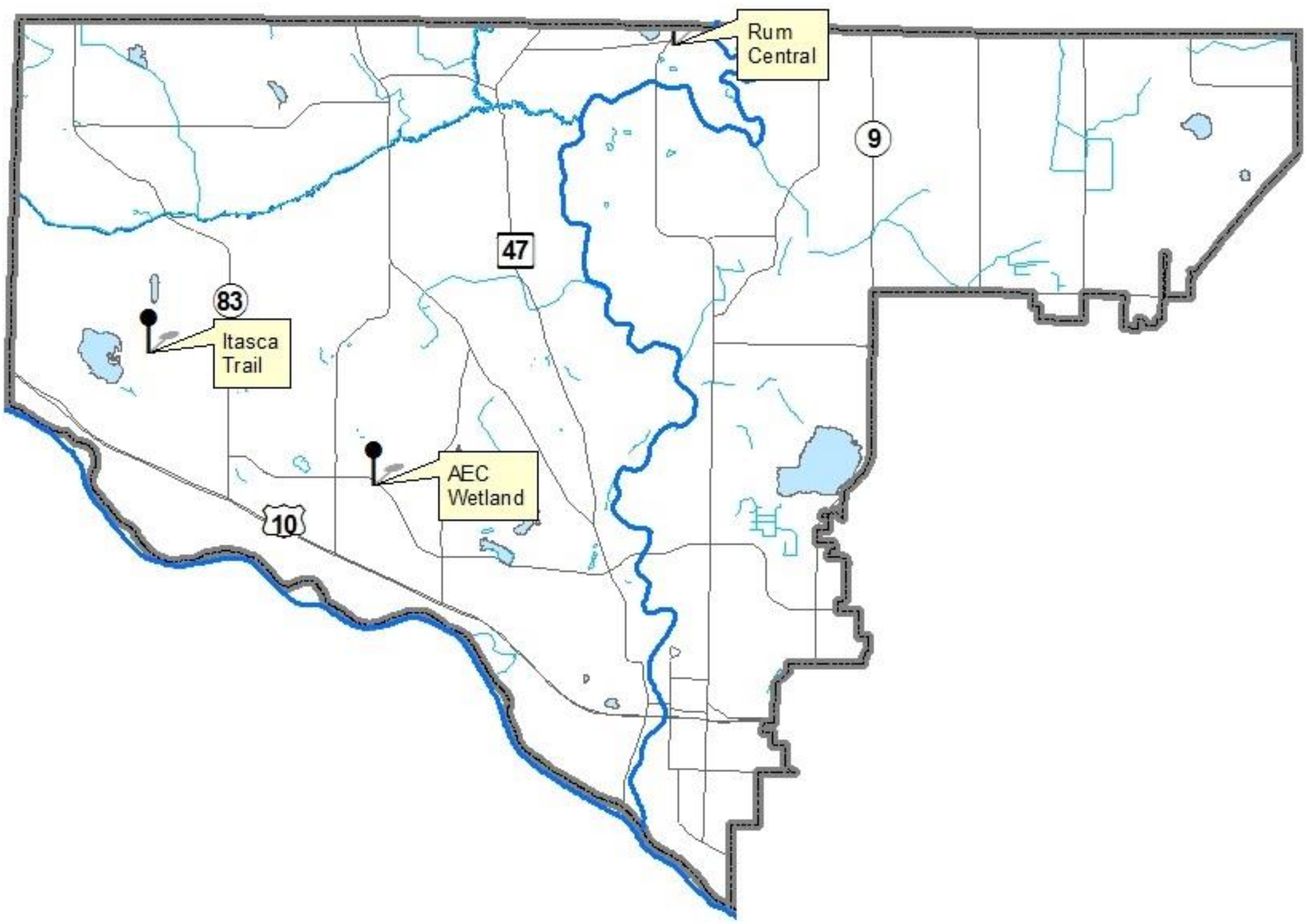
Both chemical and biological monitoring indicate the good quality of this river. Its habitat is ideal for a variety of stream life, and includes a variety of substrates, plenty of woody snags, riffles, and pools. Water chemistry monitoring done at various locations on the Rum River throughout Anoka County 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 monitoring in both the shallow backwater pool and the main channel. 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

Partners:	LRRWMO, ACD
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.

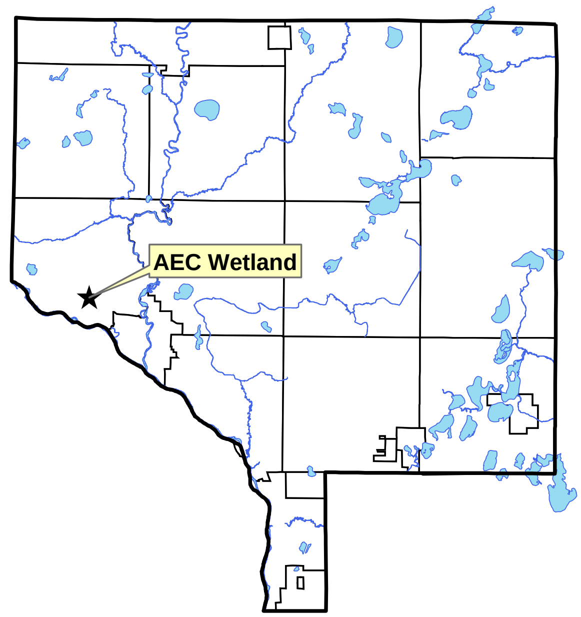
Lower Rum River Watershed Wetland Hydrology Monitoring Sites



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	-

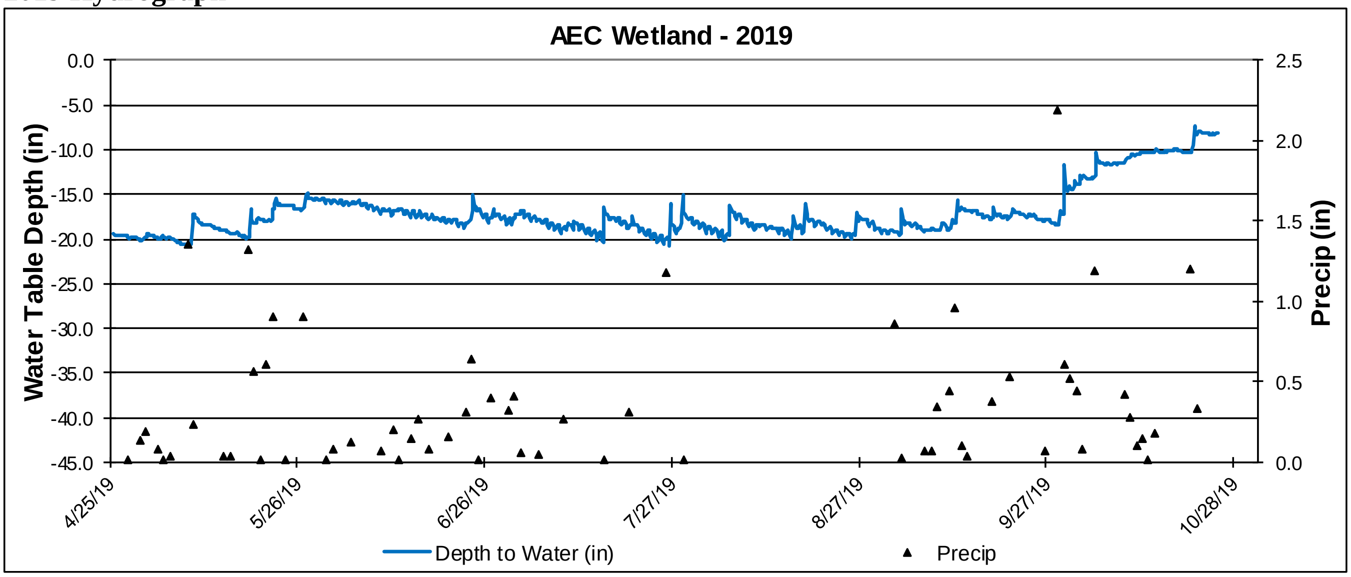
Surrounding Soils: Hubbard coarse sand

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.

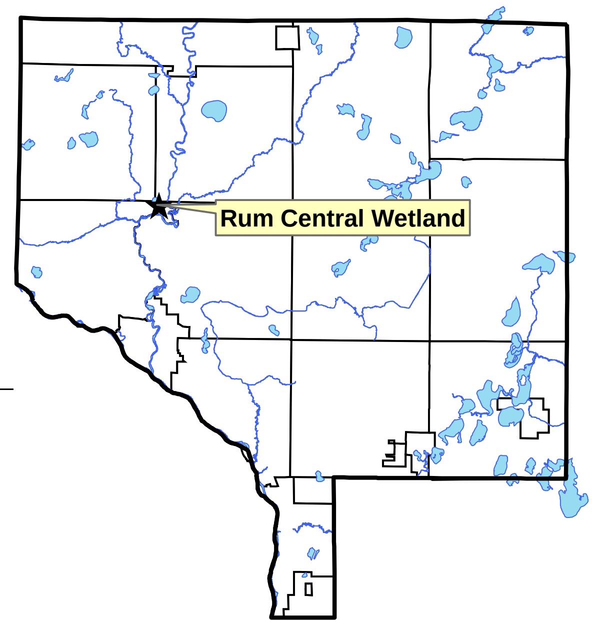
2019 Hydrograph



Wetland Hydrology Monitoring

RUM RIVER CENTRAL REFERENCE WETLAND

Rum River Central Regional Park, Ramsey



Site Information

Monitored Since: 1997

Wetland Type: 6

Wetland Size: ~0.8 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

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

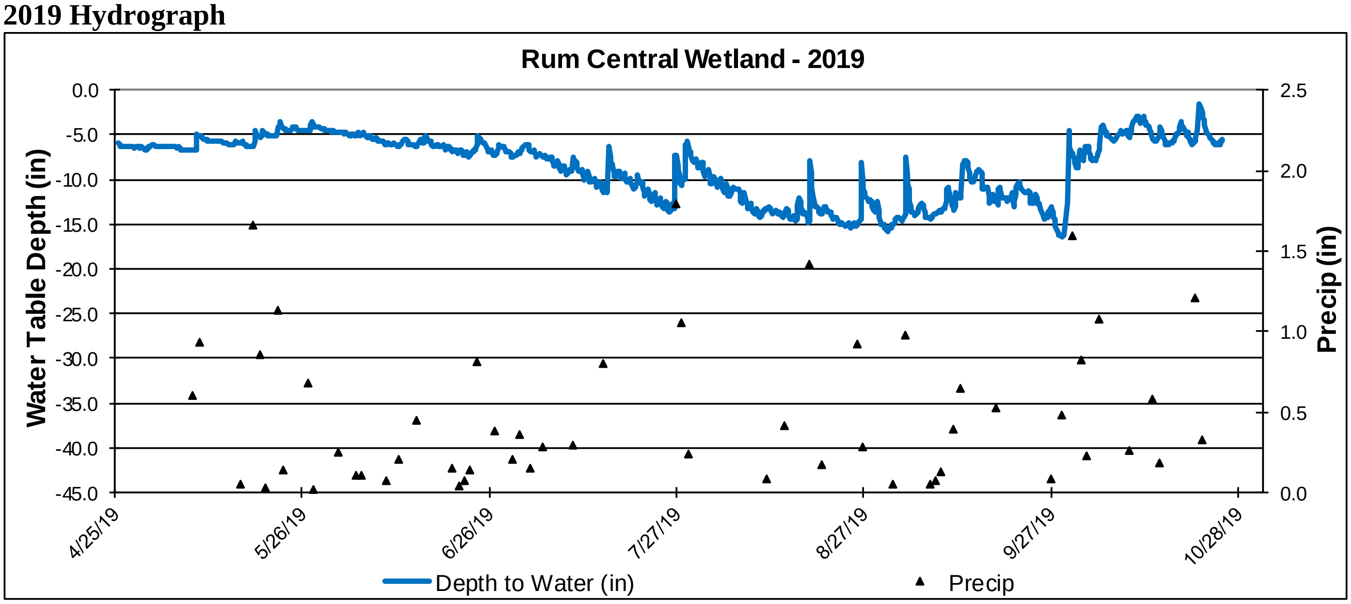
Surrounding Soils: Zimmerman fine sand

Vegetation at Well Location:

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

Other Notes: Well is located at the wetland boundary.

2019 Hydrograph



LAKE ITASCA TRAILS REFERENCE WETLAND

Lake Itasca Trails Park, Ramsey

Site Information

Monitored Since: 2013

Wetland Type: 2/6

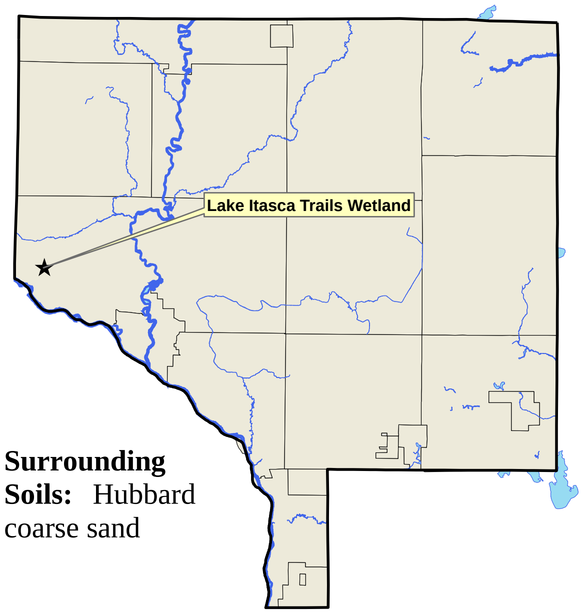
Wetland Size: ~10 acres

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	-



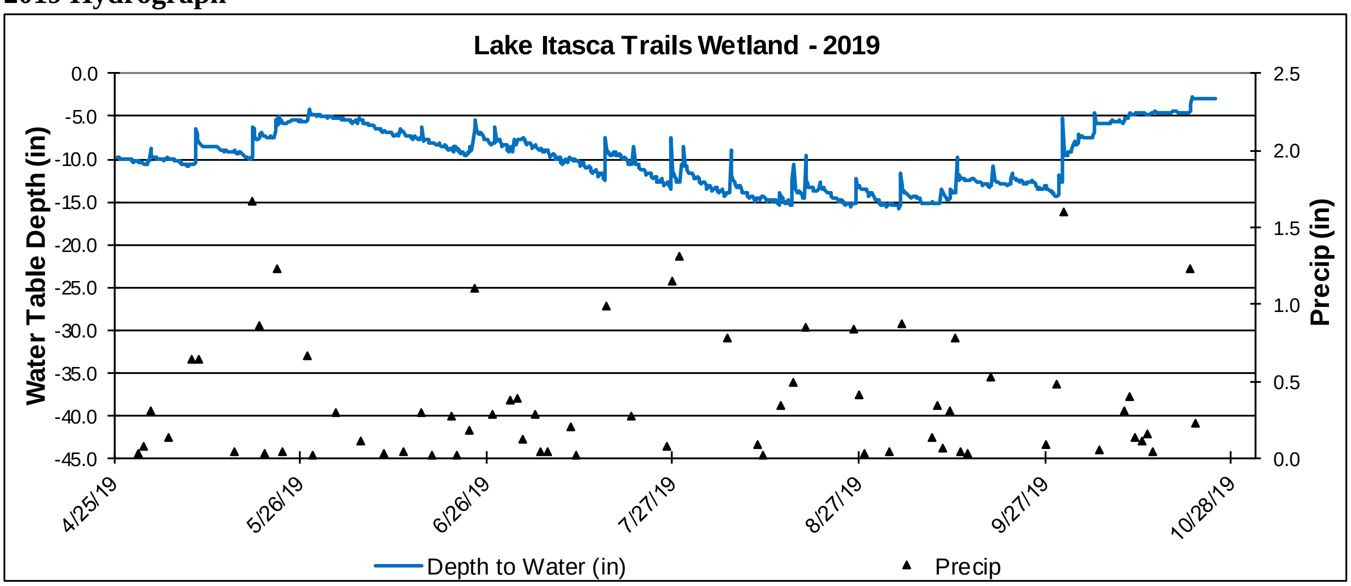
Surrounding Soils: Hubbard coarse sand

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.

2019 Hydrograph



Water Quality Grant Fund

Partners: LRRWMO, ACD

Description: The LRRWMO provides cost share grants 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
2013 LRRWMO Contribution	+	$1,000.00
2013 Expense – Geldacker Mississippi Riverbank	-	$1,000.00
2014 LRRWMO Contribution	+	$2,050.00
2006-14 Expense – Smith Rum Riverbank stabilization	-	$ 2,561.77
2015 LRRWMO Contribution	+	$1,000.00
2016 LRRWMO Contribution	+	$1,000.00
2016 Expense – Brauer Rum Riverbank	-	$1,150.00
2018 LRRWMO Contribution	+	$2,000.00
2014-16 Expense – Anoka rain garden plants	-	$ 916.59
2019 LRRWMO Contribution	+	$2,000.00
Fund Balance		**$5,449.76**

Rum River Bank Stabilizations

Partners: LRRWMO, URRWMO, ACD, MN DNR Conservation Partners Legacy Grant Program, Lessard-Sams Outdoor Heritage Council grant, landowners

Description: 6 riverbank stabilization projects were installed on the Rum River in Anoka and Isanti Counties in 2019. At these sites, cedar tree revetments and willow stakes were used to stabilize eroding banks. The projects were installed with labor from Conservation Corps Minnesota (CCM) work crews. Funding for the 5 revetments installed in Anoka County came from the Conservation Partners Legacy Grant Program from the Outdoor Heritage Fund, a Clean Water Fund CCM crew labor grant, the URRWMO and LRRWMO, and landowner contributions. Funding for 1 additional revetment 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 to reduce sediment loading in the Rum River, as well as to reduce the likelihood of much larger and more expensive corrective projects in the future.

Location: Rum River Central Regional Park, Rum River North County Park, 3 residential properties in Anoka County, and the River Bluff Preserve in Isanti County

Results: Stabilized 650 linear feet of riverbank on the Rum River in Anoka and Isanti Counties.

Rum River Bank Erosion Grants

Partners: ACD, Anoka County Parks, LRRWMO, URRWMO

Description: The Anoka Conservation District (ACD) prepared an inventory of Rum River bank erosion using 360° photos of the riverbanks of the Rum throughout Anoka County. The photos are available through Google Maps using the Street View feature. An inventory report identifying 80 stretches of riverbank with moderate to very severe erosion is available on ACD's website. Estimated project cost and annual sediment load reduction to the river were calculated. ACD used this inventory to apply for grant funding for stabilization projects to correct some of these eroding banks. These applications, and matching money from Anoka County and the Rum River WMOs resulted in $1.4 Million to be used over the next three years for stabilization projects.

Purpose: To identify and prioritize riverbank stabilization sites and be used by ACD and other entities to pursue grant funds to restore or stabilize eroding stretches of Rum Riverbank.

Location: Rum River conveyance throughout Anoka County

Results: Inventory of 80 stretches of moderate to very severe erosion on banks of the Rum River. $1.4 Million has been secured so far in grant and matching funds to implement stabilization projects.

Application illustration for the Lessard-Sams Outdoor Heritage Council to do Rum River stabilization projects utilizing bioengineering approaches. The LSOHC reccomended funding these projects at $952,000 over the next three years, which will be matched with $236,000 in local funds from Anoka County and the Upper and Lower Rum River WMOs.

Anoka Rain Gardens

Partners: City of Anoka, ACD

Description: A street resurfacing project in the 38th Lane neighborhood in the City of Anoka is scheduled for summer of 2020. This neighborhood has two previously installed rain gardens that are performing well, and protecting water quality in the Rum River by treating stormwater that was otherwise piped through the storm sewer system to the river. The City of Anoka hired ACD to design three more rain gardens in this neighborhood that will installed in conjunction with the street resurface project. Collectively, these rain gardens will remove about 80% of the pollutant load from 4.5 acres in this neighborhood. Design work was completed in January of 2020, and installation will happen during the summer of 2020.

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

Location: 38th Lane Neighborhood, Anoka

Results: Three more rain gardens were designed for installation in 2020. Two rain gardens were installed in this same neighborhood in 2017.

Map of installed and planned rain gardens

Newsletter Articles

Partners: LRRWMO, ACD

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 2019, the Anoka Conservation District (ACD) drafted three newsletter infographics and sent them to cities for inclusion in their newsletters. The three brief articles are shown below.

2019 Newsletter Articles

This Storm Drain is Part of Your River

Storm drains lead directly to your lakes, streams, and rivers—not to water treatment facilities! Many drain directly to natural waterways, while others first lead to stormwater ponds where some pollutants, but not all, are captured. **Please keep your storm drains clean** – if you wouldn't dump it in the river, don't dump it in the storm drain.

Lower Rum River Watershed Management Organization
www.LRRWMO.org

A titch less salt, please

Salt is sooo good. Tasty on food. Keeps roads safe. Softens hard water. Yet salt, measured by chlorides, is a growing problem in your local lakes and streams. Water softeners are one place where you can fine tune your salt use to keep area waterbodies healthy and save yourself money.

Softeners use salt when they regenerate, a process that washes accumulated minerals from their ion exchange resin beads. Think of this as a filter that takes out your water's hardness, but needs to be rinsed with saltwater when it gets gunked up. The frequency of regeneration can be based on either water used or time since the last regeneration. In either case, you need to tell the softener what your water's hardness is. If you don't, you may be wasting salt or failing to soften your water sufficiently.

Water hardness tests are readily available. Test kits can be purchased at hardware stores or online. Test strips are free from some companies, like Morton Salt, through their websites. If you are on city water, the city can tell you the hardness. Water softener control panels are generally pretty simple, allowing you to enter your water's hardness.

Salt used by water softeners doesn't disappear. It is discharged to your septic system or to the wastewater treatment plant, but it cannot be removed in those facilities. Salt from your water softener is eventually discharged to the ground or rivers.

The Lower Rum River Watershed Management Organization (LRRWMO) thanks you for helping protect your lakes and streams. The LRRWMO is formed by the cities of Anoka, Andover and Ramsey to manage local water resources. For more information see www.LRRWMO.org.

Your lawn doesn't need more P.

Minnesota law prohibits the use of phosphorus lawn fertilizers in most cases. The reason is simple—there's already adequate phosphorus in your soil. Extra phosphorus will runoff and make lakes and streams green with algae. If your lawn is unhealthy, a lack of phosphorus probably isn't the problem.

Suggestions for a healthy lawn:

- ✓ **Aerate.** This allows water, nutrients, and oxygen to penetrate down to where they're needed.
- ✓ **Mow taller.** In summer 2.5"-3" height promotes deeper root growth and drought resistance.
- ✓ **Water modestly.** 1" per week by rain or irrigation is sufficient. More is wasteful and contributes to nutrient runoff.
- ✓ **Get a soil test.** Find out what fertilizer or lime, if any, you really need. Mail-in tests are available through the University of MN soil testing laboratory for less than $20.
- ✓ **Mulch.** Leaving grass clippings on the lawn provides the equivalent of one fertilizer application per year.
- ✓ **Shop smart.** When purchasing fertilizers look at the three number sequence on the bag. A middle number of "0" indicates that it contains no phosphorus.

Thank you for helping the Lower Rum River Watershed Management Organization (LRRWMO) keep local waterbodies healthy. The LRRWMO is formed by the cities of Anoka, Andover and Ramsey to manage local water resources. For more information see www.LRRWMO.org.

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.

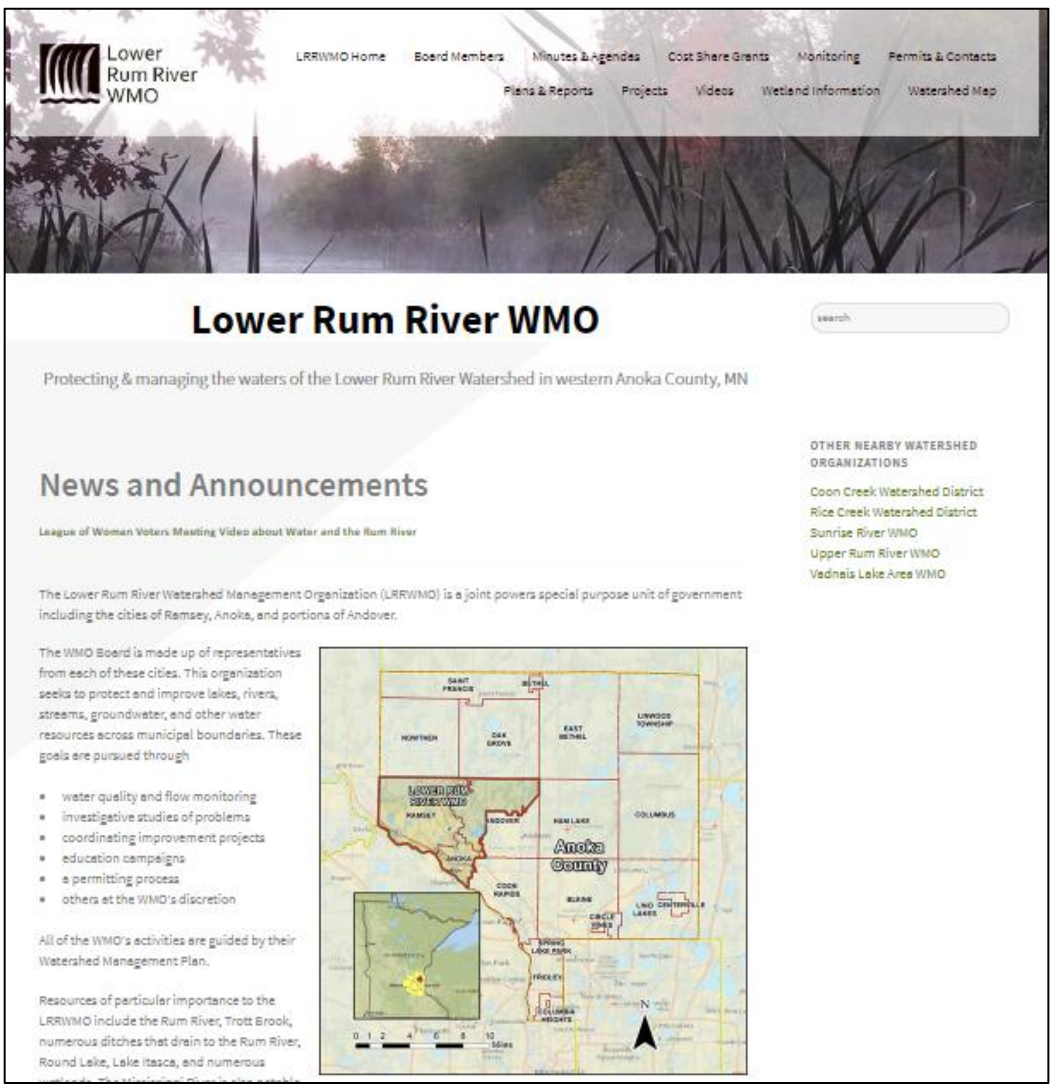
Purpose: To increase awareness of the LRRWMO and its programs. The website also provides tools and information that helps users better understand water resources issues in the area.

Location: LRRWMO.org

Results: In 2019 the LRRWMO's new website, which was launched in 2018, was maintained. The website includes:

- Directory of board members,
- Meeting minutes and agendas,
- Watershed management plan and annual reports,
- Descriptions of work that the organization is directing,
- Highlighted projects,
- Informational videos,
- Maps of the URRWMO.

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.

2019 Financial Table

Lower Rum River Watershed	Volunteer Precip	DNR Groundwater Wells	Wetland Levels	Lake Levels	Lake Water Quality	Stream Water Quality	Biomonitoring	Rum River Small Watersheds Grant	1W1P Rum River Planning	Planning Assistance	Admin/Reporting/Grants	City of Anoka Rain Gardens	Rum River Revetments	Rum River Stabilization - Rum Central Park	LRRWMO Retrofits	Mississippi River Park Stabilization	Website	Education/Newsletter	Outreach Collaborative	Total
Revenues																				
LRRWMO			1950	1240	1825	1975	900				850				417		865	1720		11742
State - Other		138																	12101	12239
DNR OHF													935							935
BWSR Capacity Direct														5588						5588
BWSR Local Water Planning					223															223
Metro ETA & NPEAP														1579	885					2464
Regional/Local									884			9126	8754			2485			764	22012
Anoka Co. General Services		239	79		43			160	4420	204	317	84					727		2075	8348
County Ag Preserves/Projects					367		475						1862	22712						25416
Service Fees							250						1149						66	1464
TOTAL		376	2029	1240	2459	1975	1625	160	5304	204	1167	9210	12699	29879	1302	2485	1592	1720	15006	90431
Expenses-																				
Capital Outlay/Equip		1	2	1	4	1	0		9		0	9	42	4		7	1		15	97
Personnel Salaries/Benefits		347	1739	739	1656	896	1102	146	4899	237	1157	10234	9591	3741	814	2262	1082	1294	9369	51306
Overhead		19	85	40	84	52	68	12	271	12	51	493	404	199	51	95	61	90	529	2613
Employee Training		1	6	3	4	3	4	1	16	2	3	65	32	16	2	5	4	3	37	205
Vehicle/Mileage		5	24	10	24	11	13	1	64	3	18	125	146	47	10	36	14	15	117	682
Rent		17	74	32	87	43	47	7	238	6	51	298	511	151	41	123	50	67	423	2267
Program Participants													699	26144						26843
Program Supplies			126		585	411	80		64			6	566		417		458		1324	4035
TOTAL		390	2056	824	2444	1417	1314	167	5561	259	1279	11229	11991	30303	1334	2528	1669	1468	11813	88048
NET		-14	-27	416	15	558	311	-7	-257	-55	-112	-2020	708	-424	-32	-43	-78	252	3193	2383

Recommendations

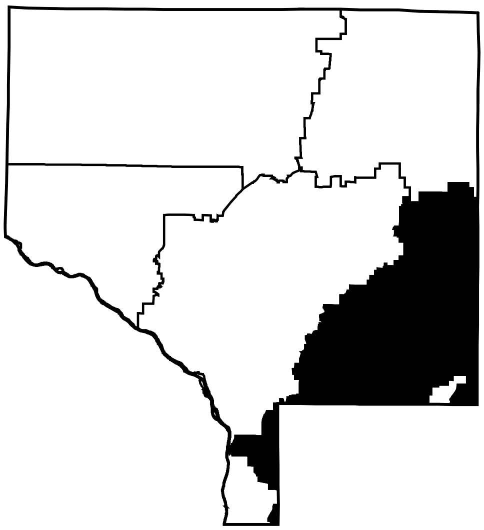
- **Identify and prioritize projects for water quality improvement in the new LRWRMO Watershed Management Plan** being developed in 2020. New non-competitive State Watershed Based Funding may be used for these projects, as well as competitive grants.
- **Continue to install projects identified in the stormwater retrofit 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. Metropolitan Council grant funds were used to construct three projects in 217-2018. Three more projects are being installed by the City of Anoka in 2020. Additional cost-effective projects exist, however landowner willingness and buried utilities are obstacles in many areas.
- **Engage with upstream entities creating a collaborative Rum River One Watershed, One Plan** (1W1P). As the receiving entity at the bottom of the watershed for all water flowing downstream, it is especially important to collaborate on, and prioritize, projects benefitting the river. 1W1P planning continues through 2020.
- **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. The primary project type identified in Anoka County is the stabilization of eroding banks along the Rum River.
- **Maintain or reduce Rum River phosphorus.** Phosphorus levels are close to State water quality standards. It may be appropriate to review development and stormwater discharge ordinances to ensure phosphorus does not increase in coming years.
- **Implement groundwater conservation measures** throughout the watershed and promote them metro-wide. Depletion of shallow groundwater is a concern region-wide.
- **Continue surveillance water monitoring** at a frequency sufficient to detect changes and trends.
- **Continue chloride sampling at all sites on a rotating basis.** Chloride sampling was conducted at County Road 7 in 2018 and 2019. Because this pollutant can have such a profound impact on aquatic life and drinking water, continuing to periodically include it in the monitoring regime is prudent.
- **Continue to support and fund riverbank stabilization projects. $**1.4 Million has been secured by ACD and local matching partners for the next three years, but over 7 miles of eroding bank was identified during our 2018-2019 inventory. Another round of Watershed Based Implementation funding will be coming in 2020. These funds can support additional projects identified in that inventory.

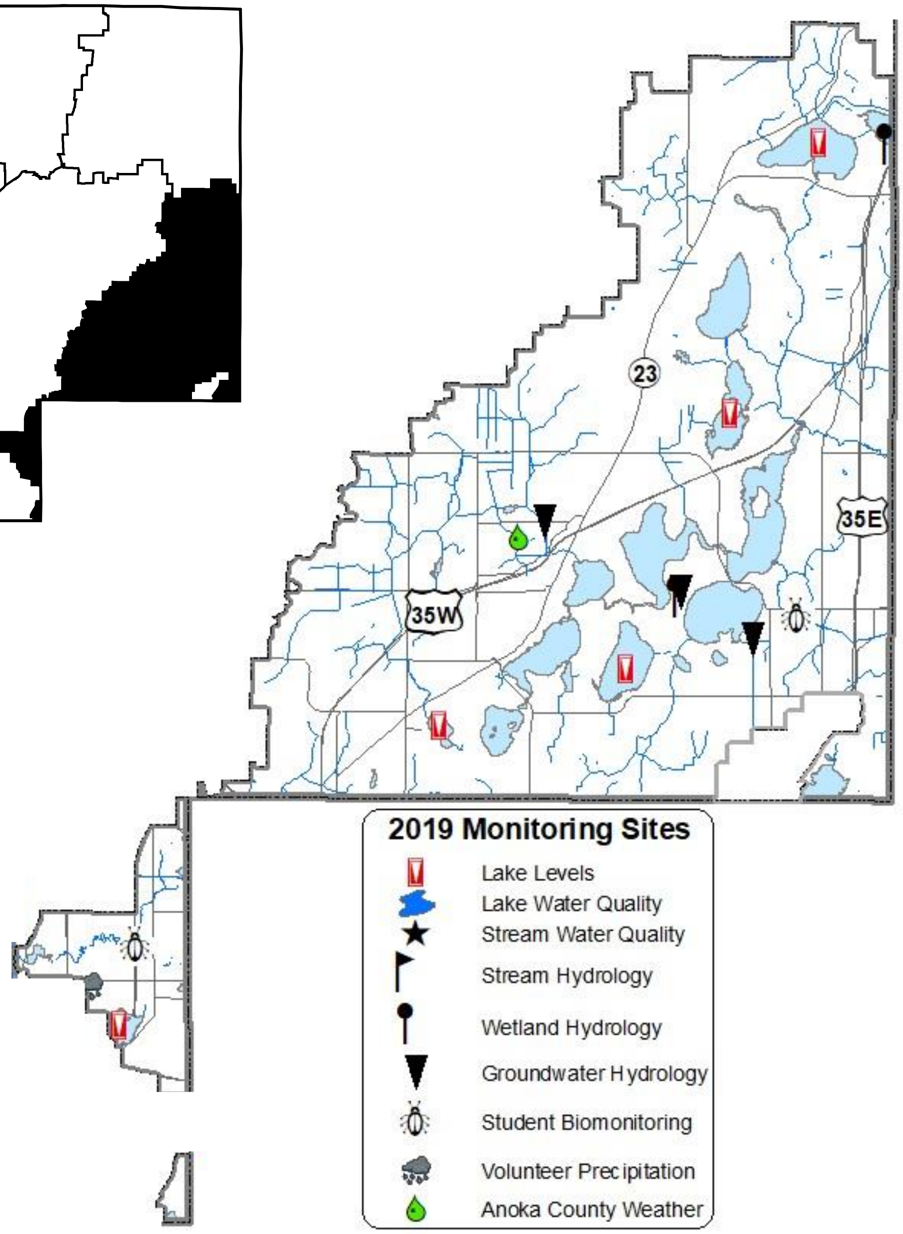
Chapter 5: Rice Creek Watershed

Prepared by the Anoka Conservation District

Chapter 5 - Rice Creek Watershed

Table of Contents





Lake Levels

Partners: RCWD, ACD, volunteers

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).

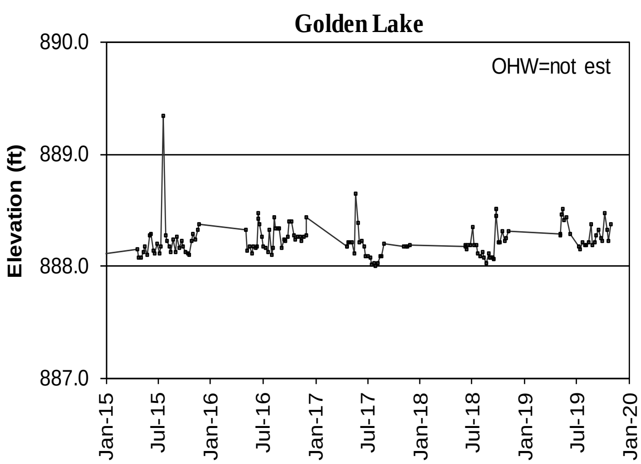
Purpose: To understand lake hydrology, including the impact of climate or other water budget changes. These data are useful for regulatory, building/development, and lake management decisions.

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

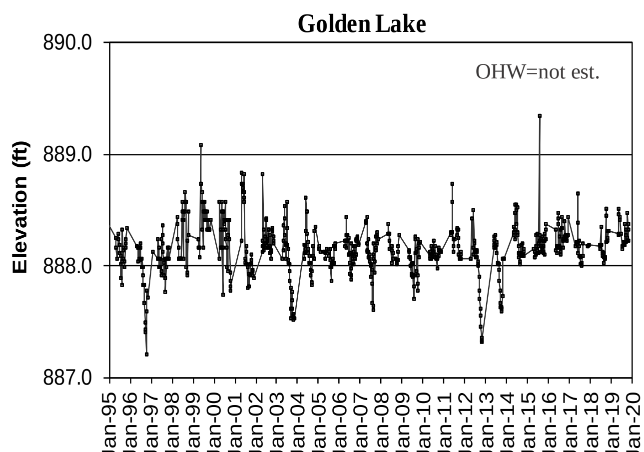
Results: Lake levels were measured by volunteers throughout the 2019 open water season. Lake gauges were installed and surveyed by the Anoka Conservation District and MN DNR. Lakes typically followed the expected pattern of increasing water levels through spring and early summer, followed by a decline through late summer. A large amount of rain through late fall made many lakes rebound to higher than typical levels through late fall into winter. In 2019, lake levels averaged at or slightly above long-term averages. 2019 was the wettest year ever recorded for the state.

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.

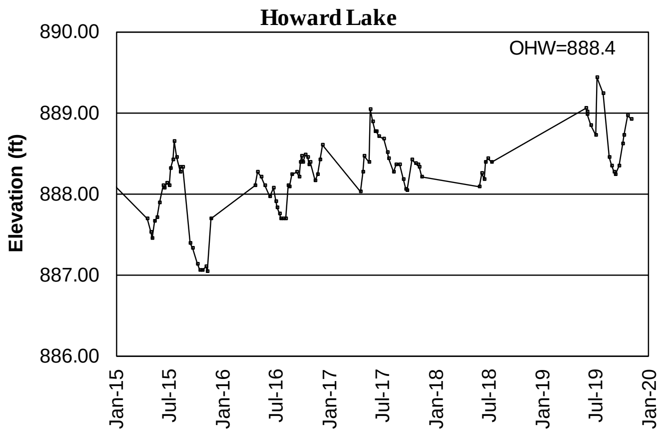
Golden Lake Levels- Last 5 Years



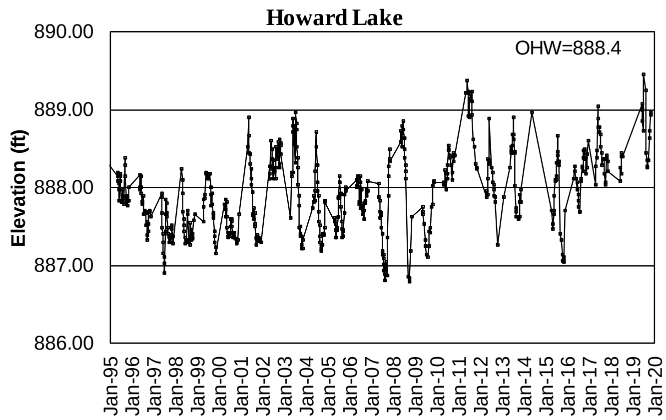
Golden Lake Levels- Last 25 Years



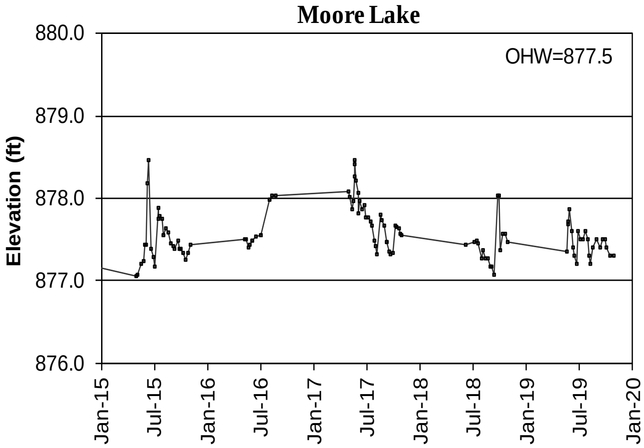
Howard Lake Levels- Last 5 Years



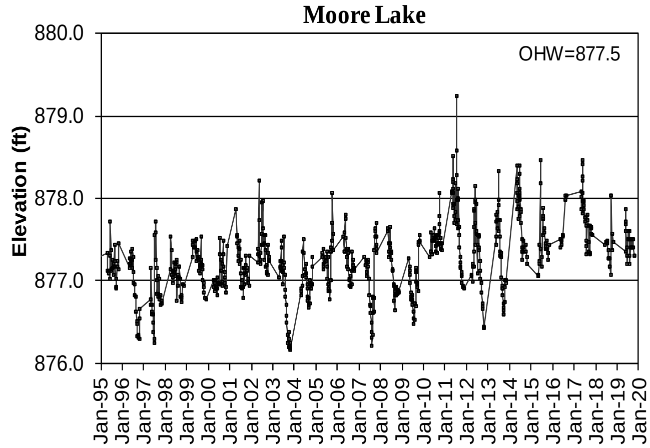
Howard Lake Levels- Last 25 Years



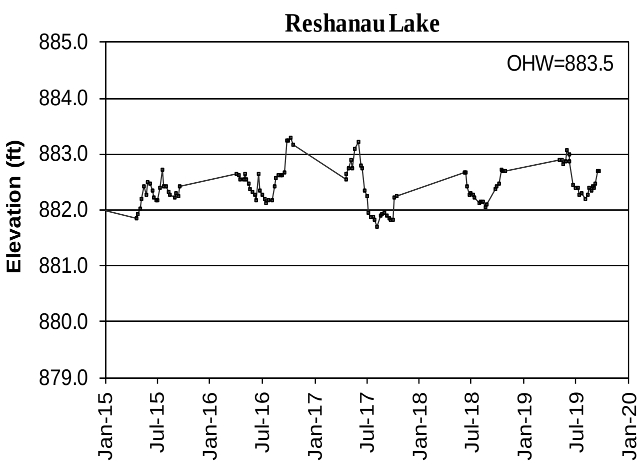
Moore Lake Levels- Last 5 Years



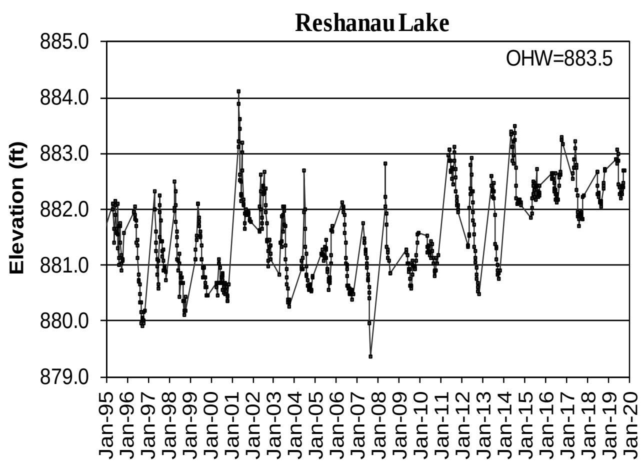
Moore Lake Levels- Last 25 Years



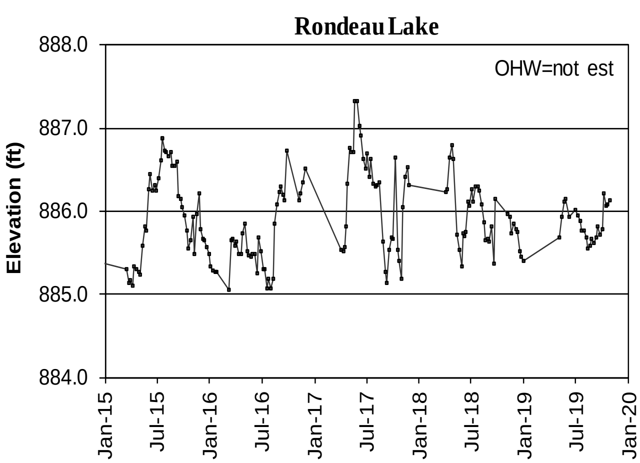
Reshanau Lake Levels- Last 5 Years



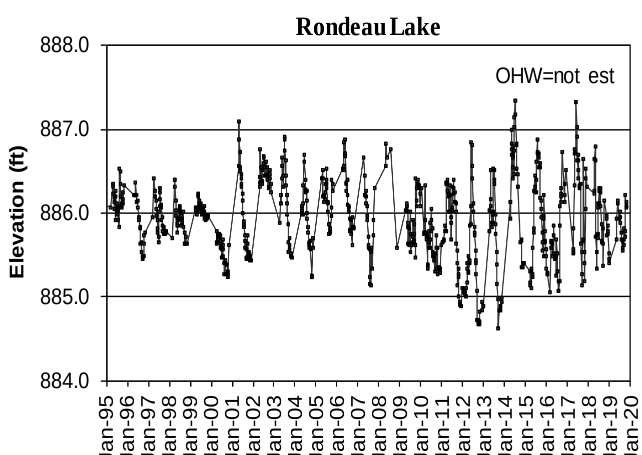
Reshanau Lake Levels- Last 25 Years



Rondeau Lake Levels- Last 5 Years



Rondeau Lake Levels- Last 25 Years



Wetland Hydrology

Partners: RCWD, ACD

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

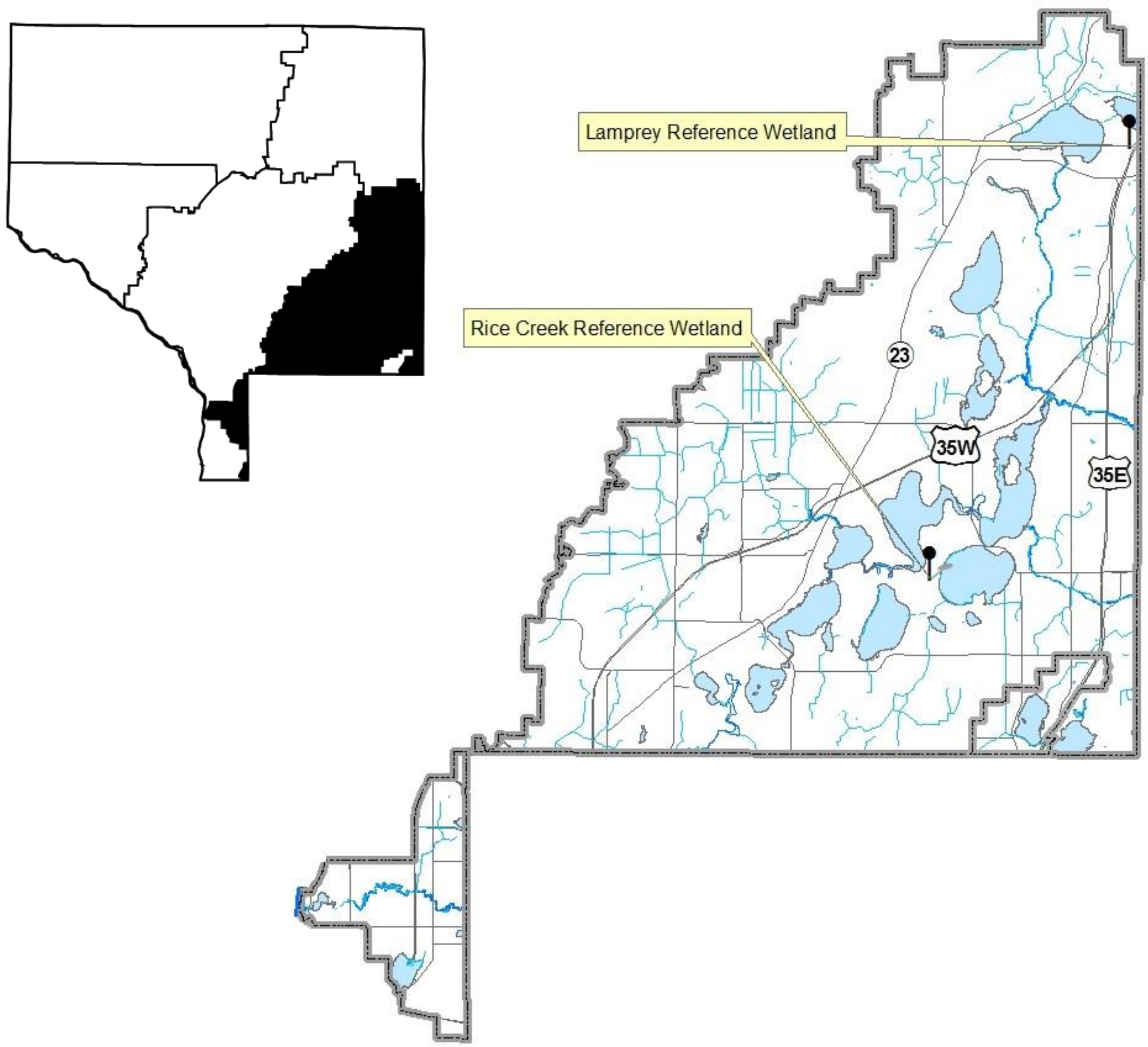
Purpose: To provide an understanding of wetland hydrology, including the impact of climate and land use. These data aid in delineation of nearby wetlands by documenting hydrologic trends including the timing, frequency, and duration of saturation.

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

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

Results: See the following pages.

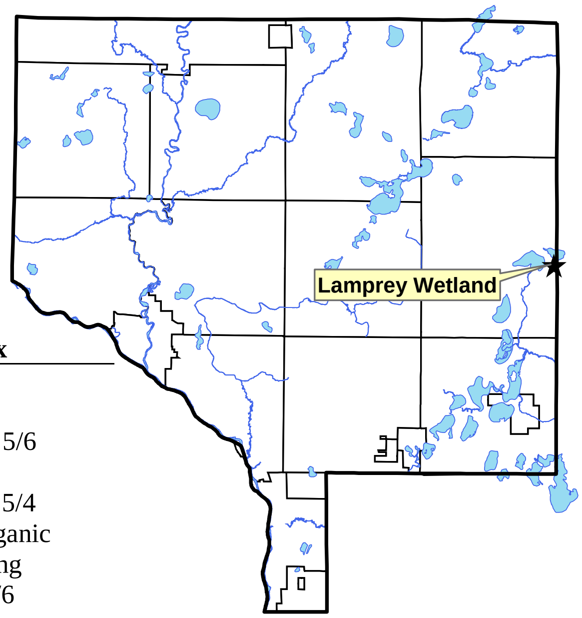
Rice Creek Watershed Wetland Hydrology Monitoring Sites



Wetland Hydrology Monitoring

LAMPREY REFERENCE WETLAND

Lamprey Pass Wildlife Mgmt Area, Columbus



Site Information

Monitored Since: 1999

Wetland Type: 4

Wetland Size: ~0.5 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

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

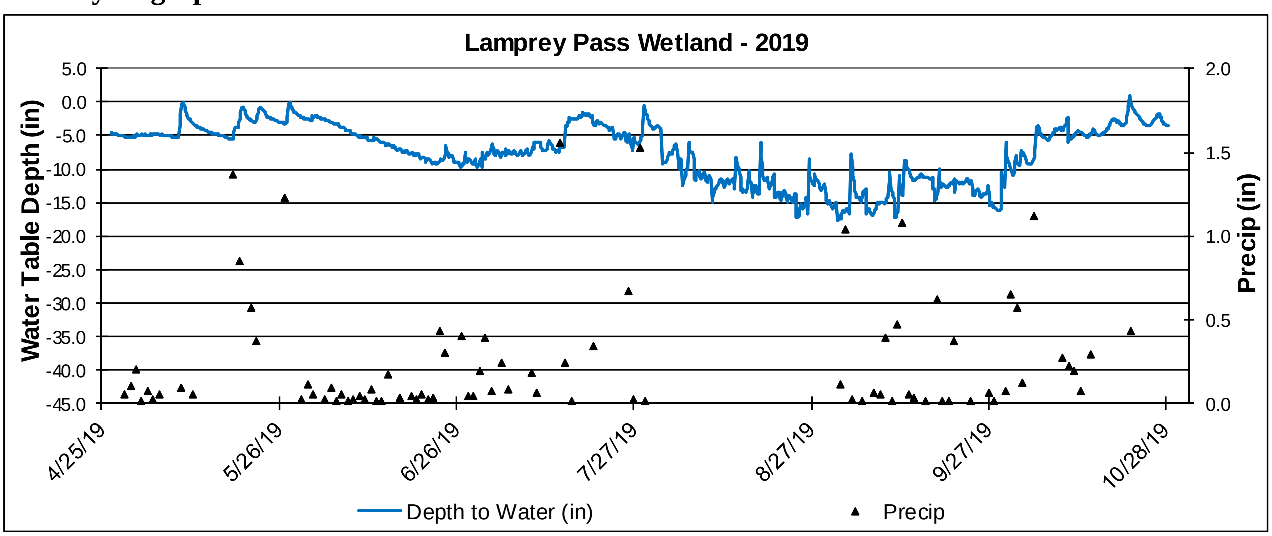
Surrounding Soils: Braham loamy fine sand

Vegetation at Well Location:

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

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

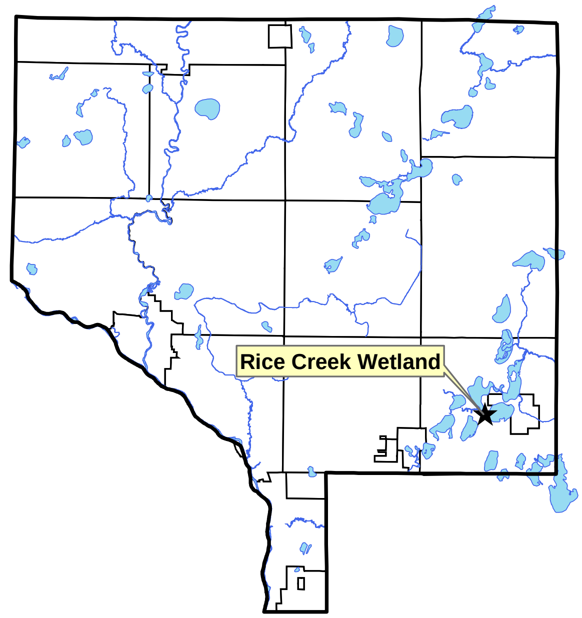
2019 Hydrograph



Wetland Hydrology Monitoring

RICE CREEK REFERENCE WETLAND

Rice Creek Chain of Lakes Regional Park, Lino Lakes



Site Information

Monitored Since: 1996

Wetland Type: 7

Wetland Size: ~0.5 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

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

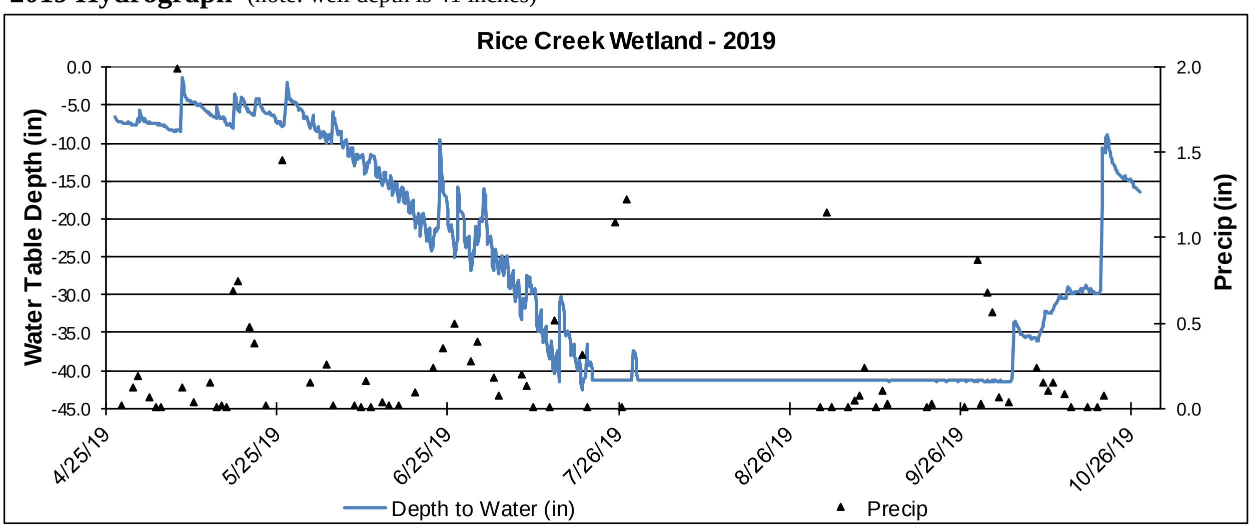
Surrounding Soils: Nessel fine sandy loam and Blomford loamy fine sand

Vegetation at Well Location:

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

Other Notes: This is an intermittent, forested wetland within the regional park between Centerville and George Watch Lakes. It is about 900 feet from George Watch Lake and 800 feet from Centerville Lake. Well is at wetland boundary. During the months August and September the surrounding wetland area was dry.

2019 Hydrograph (note: well depth is 41 inches)



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 collections 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: Clearwater Creek at Centerville City Hall

Rice Creek at Locke Park, upstream of Highway 65

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

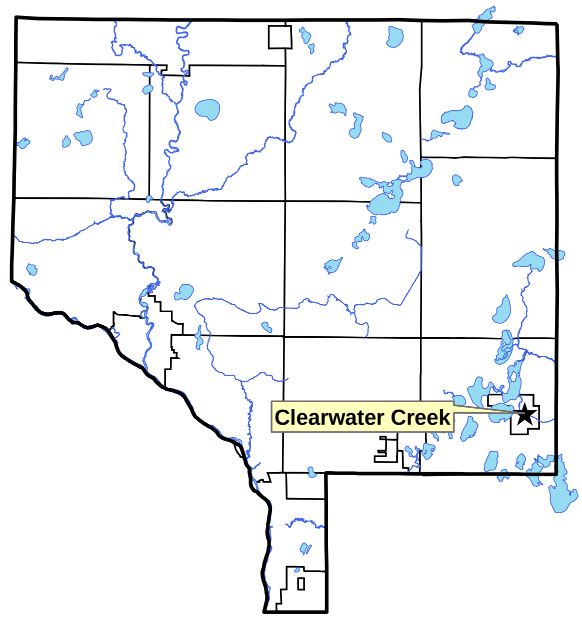
% EPT: This measure compares the number of organisms in the EPT orders (Ephemeroptera - mayflies: Plecoptera - stoneflies: Trichoptera - caddisflies) to the total number of organisms in the sample. A high percent of EPT is good.

% 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).

Biomonitoring

CLEARWATER CREEK

at Centerville City Hall, Centerville



Last Monitored

By FLALC in 2019

Monitored Since

1999

Student Involvement

8 students in 2019, approximately 645 since 1999

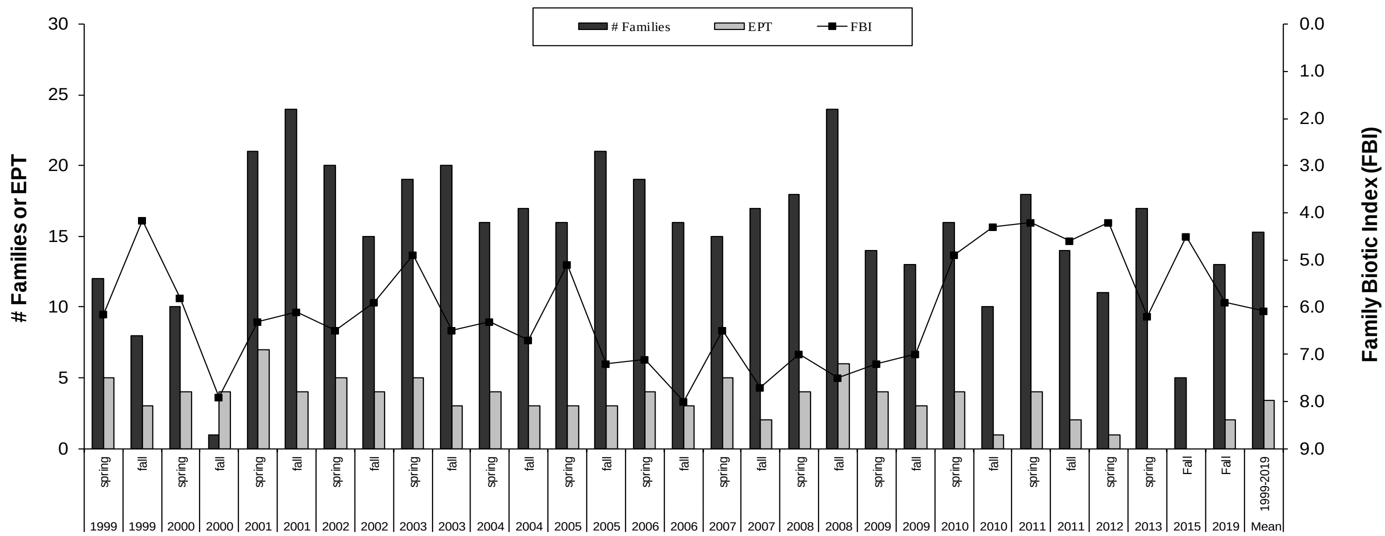
Background

Clearwater Creek originates in Bald Eagle Lake in northwest Ramsey County and flows northwest into Peltier Lake. Land use is an approximately equal mix of residential and agricultural, with some small commercial sites. The land use immediately surrounding the sampling site is entirely residential and developed. The stream banks are steep and eroding in spots. The streambed at the sampling site is gravelly or sandy with larger boulders. The stream is 6-12 inches deep at baseflow and approximately 10-15 feet wide.

Results

Centennial High School classes monitored Clearwater Creek through 2012. In 2013, ACD monitored the creek, and in 2015 and 4-H group monitored it. A Forest Lake Area Learning Center class picked monitoring back up at this site in 2019. Overall, this stream has average or slightly below average conditions based on the invertebrate data. Since 2010, the FBI score has been lower than in most previous years. The lower FBI value suggests an increase in pollution tolerant species. This change may be driven by the dominance of the invertebrate community by Gammaridae and Hyallelidae amphipods since that time, which have moderate tolerance values. The Amphipod families had not been dominant before 2009, and EPT taxa were much more prevalent before that time, averaging about 4 unique EPT families present each year. Since 2010, less than 2 EPT families are present on average, and amphipods have dominated.

Summarized Biomonitoring Results for Clearwater Creek in Centerville



Biomonitoring Data for Clearwater Creek in Centerville

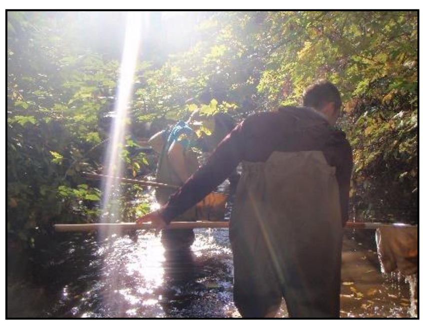
Data presented from the most recent monitored five years. Contact the ACD to request archived data.

Year	**2011**	**2012**	**2013**	**2015**	**2019**	**Mean**
Season	**Fall**	**spring**	**spring**	**Fall**	**Fall**	**1999-2019**
FBI	4.6	4.2	6.2	4.5	5.9	6.1
# Families	14	11	17	5	13	15.3
EPT	2	1	0	0	2	3.4
Date	12-Oct	17-May	28-May	31-Aug	10-Oct	
Sampled By	CHS	CHS	CHS	Anoka 4-H	FLALC	
Sampling Method	MH	MH	MH	MH	MH	
Mean # Individuals/Rep.	146	273	228	152	133	
# Replicates	1	1	1	1	1	
Dominant Family	Gammaridae	Gammaridae	Hyalellidae	Gammaridae	Hyalellidae	
% Dominant Family	80.1	87.9	34.2	65.7	36.1	
% Ephemeroptera	0.7	2.2	0.0	0.0	1.5	
% Trichoptera	0.7	0.0	0.0	0.0	26.3	
% Plecoptera	0.0	0.0	0.0	0.0	0.0	

Discussion

This creek's biological community is probably limited by a combination of habitat, hydrology, and water chemistry factors. This creek has been highly modified and primarily a straightened ditch throughout much of its flow path. Clearwater Creek is listed as impaired for dissolved oxygen as well as both fish and invertebrate biota. It's likely that Bald Eagle Lake, which is impaired for nutrients and serves as the Creek's headwaters, is contributing to the low oxygen concentrations. However it is worth noting that Bald Eagle Lake had an alum treatment in 2014 and 2016 to reduce phosphorus levels, which may reduce oxygen demand in Clearwater Creek.

Centennial High School students at Clearwater Creek



Biomonitoring

RICE CREEK

at Hwy 65, Rice Creek West Regional Trail Corridor, Fridley

Last Monitored

By Totino Grace High School in fall 2019

Monitored Since

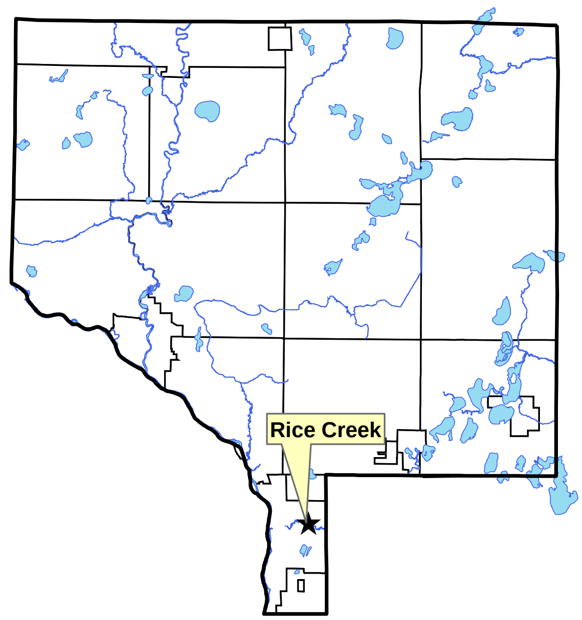
1999

Student Involvement

40 students in 2019, approximately 1,300 since 2001

Background

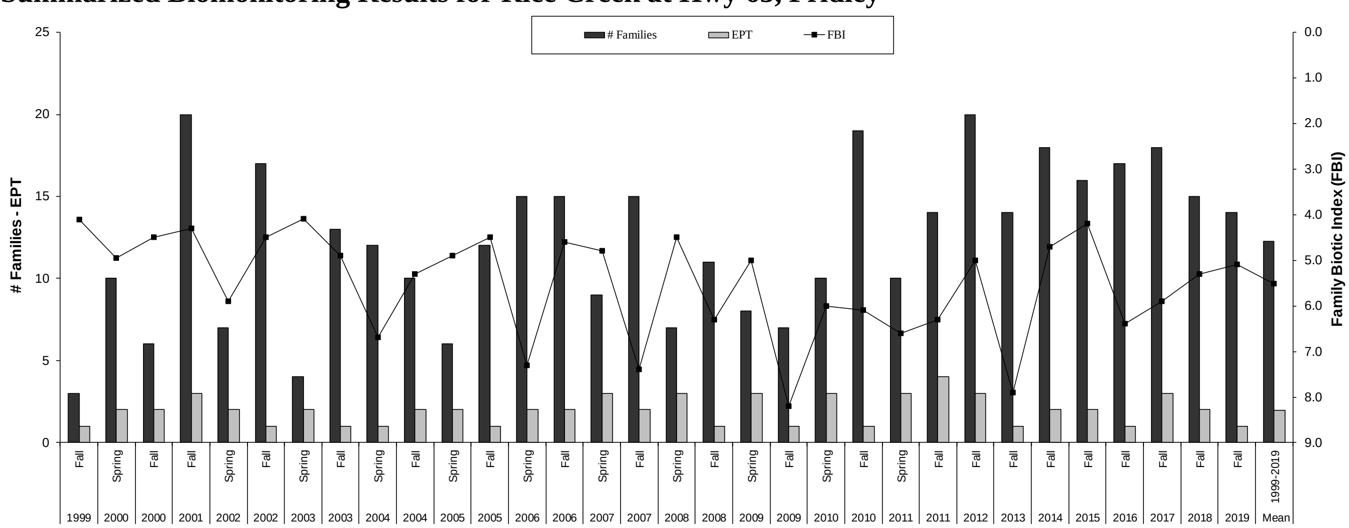
Rice Creek originates from Howard Lake in east-central Anoka County and flows south and west through the Rice Creek Chain of Lakes and eventually to the Mississippi River. Sampling is conducted in the Rice Creek West Regional Trail Corridor, which encompasses a large portion of the stream's riparian zone in Fridley. This site is forested. Outside of this forested buffer, the watershed is 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 2019, 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 five of the past six years in a generalist family of the Trichopera order, Hydropshychidae. The number of EPT families present has been below the county average in all years. EPT are generally pollution-sensitive, but the caddisfly family Hydropsychidae, is an exception to that rule. It thrives in relatively poor environmental conditions. Hydropsychidae was the only EPT taxa collected in 2019.

Summarized Biomonitoring Results for Rice Creek at Hwy 65, Fridley



Biomonitoring Data for Rice Creek at Highway 65

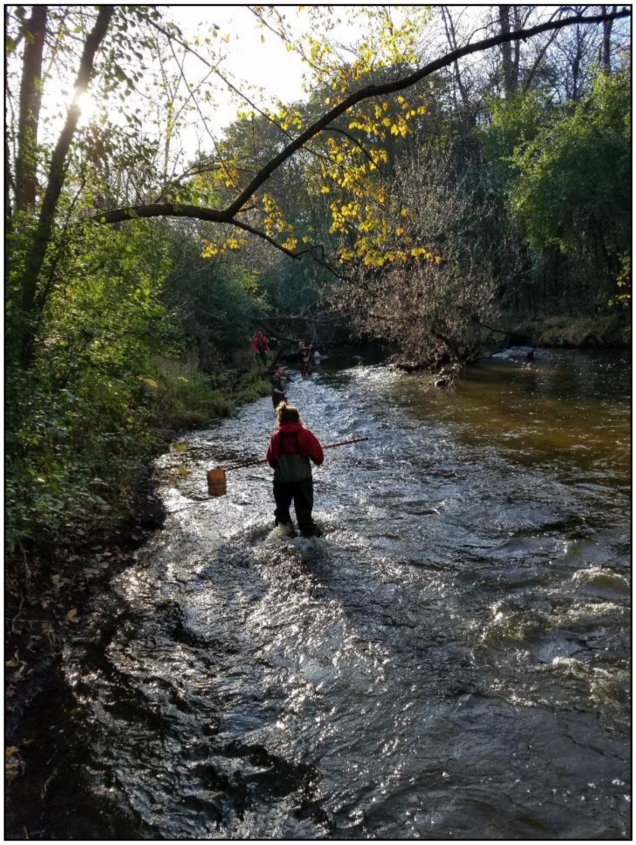
Data presented from the most recent monitored five years. Contact the ACD to request archived data.

Year	2015	2016	2017	2018	2019	Mean
Season	Fall	Fall	Fall	Fall	Fall	1999-2019
FBI	4.2	6.4	5.9	5.3	5.1	5.5
# Families	16	17	18	15	14	12.3
EPT	2	1	3	2	1	2.0
Date	13-Oct-15	18-Oct-16	17-Oct-17	15-Oct-18	15-Oct-19	
Sampled By	TGHS	TGHS	TGHS	TGHS	TGHS	
Sampling Method	MH	MH	MH	MH	MH	
# Individuals	730	272	545	509	322	
# Replicates	1	1	1	1	1	
Dominant Family	Hydropsychidae	Hydropsychidae	Simuliidae	Hydropsychidae	Hydropsychidae	
% Dominant Family	92.6	41.5	65.2	24.6	48.4	
% Ephemeroptera	0.4	0	2	14.5	0	
% Trichoptera	92.6	41.5	12.3	24.6	48.4	
% Plecoptera	0.0	0	0	0	0	
% EPT	93.0	41.5	14.3	39.1	48.4	

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. This portion of Rice Creek is impaired for both fish and invertebrate biota.

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 selection assistance, construction oversight, long-term project monitoring, and other services as needed.

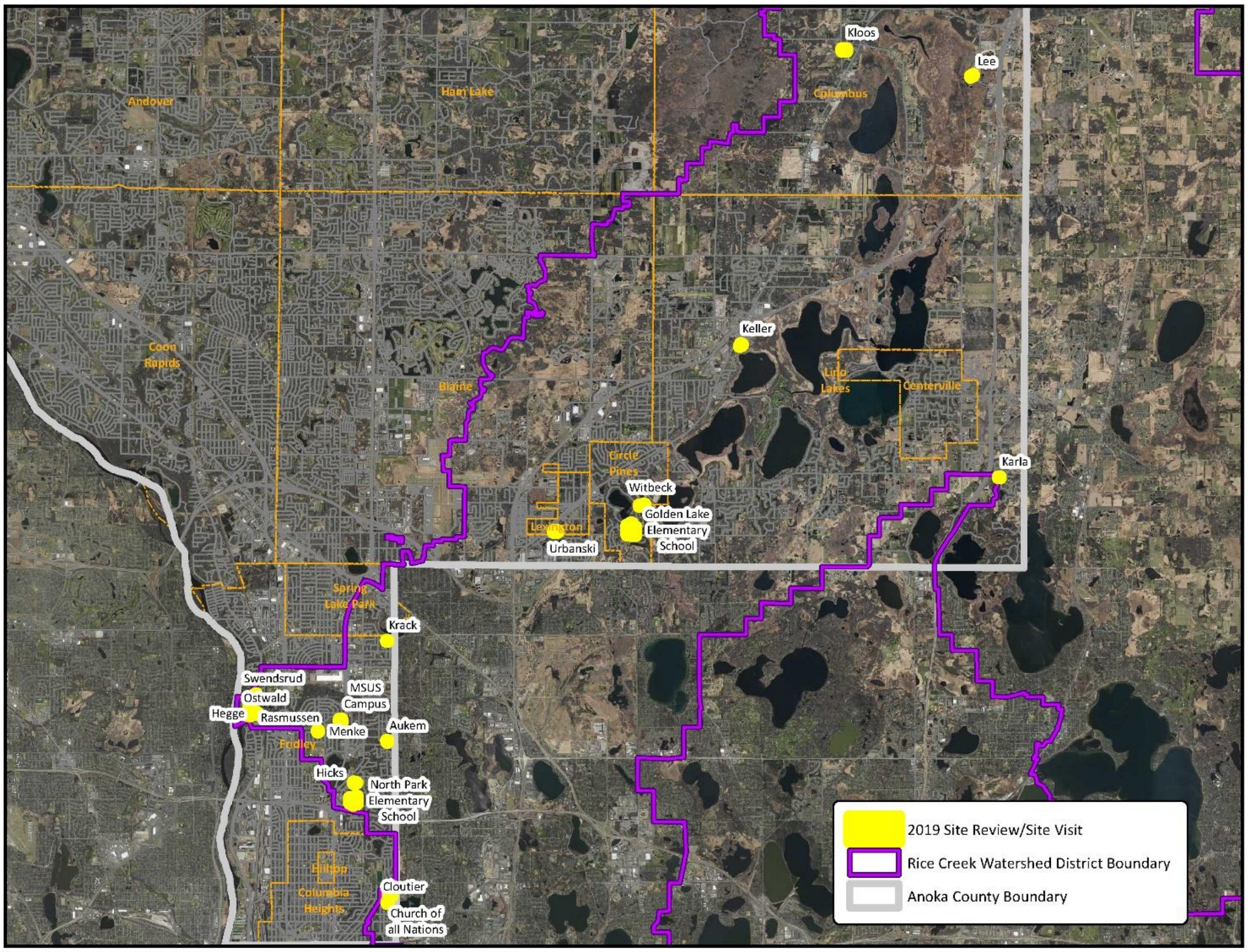
Purpose: To assist property owners within the Rice Creek watershed with the design and installation of water quality improvement BMPs.

Results: Below is a summary of technical assistance provided in 2019.

2019 Summary

Formal property reviews/site visits were conducted at 19 sites throughout the Rice Creek watershed in Anoka County (see overview map below for specific locations). Project types included nine rain gardens, two infiltration basins at schools, three lakeshore stabilizations, one streambank stabilization, and three backyard drainage or habitat projects.

Sites within the Rice Creek watershed at which ACD provided technical assistance in 2019.



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.

2019 Rice Creek Watershed Financial Summary

Rice Creek Watershed	Volunteer Precip	DNR Groundwater Wells	Wetland Levels	Lake Levels	Biomonitoring	Landowner Tech Asst. - RCWD	Blaine SNA Restoration	Golden Lake Pump Assisted IESF	Outreach Collaborative	Total
Revenues										
RCWD			1300	1500	1800	7386				11986
State - Other		344						72821	13007	86172
DNR OHF							4037			4037
Metro ETA & NPEAP								6992		6992
Regional/Local								58619	821	59440
Anoka Co. General Services	143	597	53						2230	3023
County Ag Preserves/Projects					950			4662		5612
Service Fees					500				71	571
TOTAL	143	941	1353	1500	3250	7386	4037	143093	16129	177832
Expenses-										
Capital Outlay/Equip	0	2	1	1	0	12	1	7	16	41
Personnel Salaries/Benefits	136	868	1159	1231	2205	7022	2302	17154	10070	42147
Overhead	8	47	56	67	135	358	113	843	568	2195
Employee Training	1	3	4	5	8	26	15	111	39	211
Vehicle/Mileage	2	11	16	16	26	95	27	205	125	524
Rent	6	44	50	53	94	318	62	470	455	1552
Program Participants								119911		119911
Program Supplies	3		84		160		2006	7993	1423	11669
TOTAL	155	976	1371	1374	2628	7831	4526	146693	12697	178250
NET	-12	-35	-18	126	622	-445	-489	-3600	3432	-419

Recommendations

- **Continue to install cost effective projects** identified in previously completed Subwatershed Retrofit Analyses. Projects identified in these studies would be ideal candidates for targeted outreach about available cost share funds. In many cases, projects are already sited, and the water quality benefits of potential projects have already been modelled.

- **Continue the biomonitoring program** with area schools at Rice Creek and Clearwater Creek. This program provides dual benefits in contributing to a long-term bio-indicator dataset as well as educating local youth on their natural resources. Clearwater Creek was monitored again in 2019 in lieu of the hard to access Hardwood Creek. Clearwater Creek provides a much easier sampling location for the classes

- **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 invertebrate data for Anoka County RCWD streams continues to indicate a depleted invertebrate community.

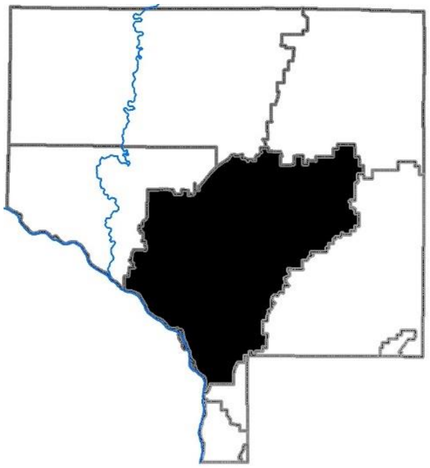
- **Continue efforts to reduce road salt use.** Chlorides are pervasive throughout shallow aquifers and the streams that feed them. Conductivity readings are increasing throughout the County, and it is likely that stream chloride concentrations are following suit.

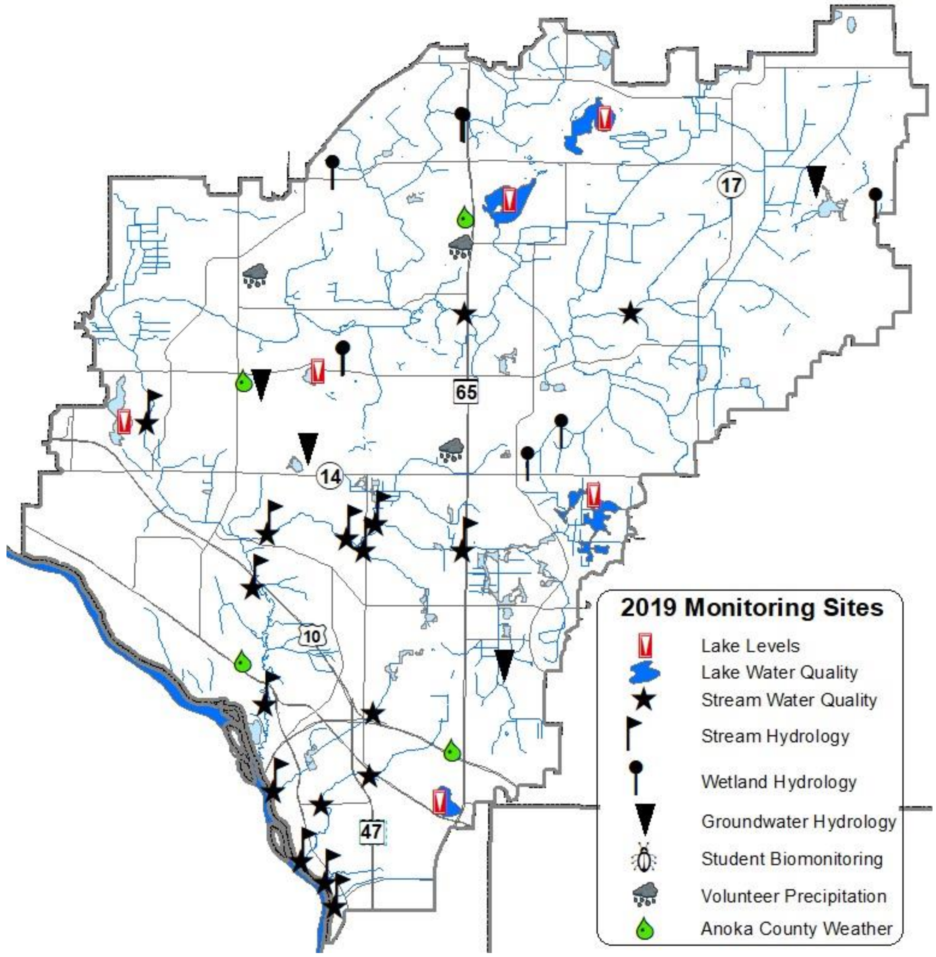
Chapter 6: Coon Creek Watershed

Prepared by the Anoka Conservation District

oon Creek Watershed

Table of Contents





17
65
14
10
47
2019 Monitoring Sites
Lake Levels
Lake Water Quality
Stream Water Quality
Stream Hydrology
Wetland Hydrology
Groundwater Hydrology
Student Biomonitoring
Volunteer Precipitation
Anoka County Weather

SUMMARY OF FINDINGS

Description:

This is a brief summary of new findings and notable results from 2019. Detailed analyses for all individual sites can be found below in the appropriate section of the work results.

Precipitation:

- No tipping bucket data was collected in 2019. Volunteer data and online resources showed a record breaking precipitation year resulting the wettest year on record for Minnesota.

Lake Levels:

- Overall, lakes had increasing water levels in spring and early summer that declined into mid-summer. 2019 was the wettest year on record for Minnesota, so high lake levels were observed throughout the year at most lakes. Lake levels remained high through the end of the year with most lakes freezing near or above their OHW at the end of 2019.

Lake Water Quality:

- Ham Lake's water quality was slightly above-average , receiving an overall B letter grade. Total phosphorus and chlorophyll-a concentrations were both similar to previous years, while Secchi transparency showed a slight increase.
- Ham Lake temperature and dissolved oxygen profiles were recorded in 2019. The profiles show stratification during the summer months (mid-May to mid-September) with mixing and re-stratification by the end of September.
- Sunrise Lake was monitored for the second year. Overall water quality declined from 2018 to a C grade. Typical water quality conditions for Sunrise Lake are still unknown.
- Lake Netta continues to have good water quality.
- Laddie Lake received a B letter grade, which would likely be higher if Secchi transparency could be included in analysis.

Lake AIS Surveys

- Hybridized milfoil, curly-leaf pondweed and Chinese mystery snails were again observed in Ham Lake. All AIS in the lake were at similar densities to 2018.
- Two new AIS were discovered in Laddie Lake with the finding of both the Chinese and banded mystery snails.
- No new AIS were discovered in Lake Netta.
- Curly-leaf pondweed was again found in Sunrise Lake.

Stream Hydrology:

- Rating Curves were developed for two monitoring sites in the Sand Creek system (Ditch 60 at Happy Acres Park and Sand Creek at Morningside). Attempts to develop a third rating curve at Ditch 39 did not result in a usable curve due the monitoring site being located in a floodplain area with damming issues.
- Stream stages were above average in 2019 with many streams not reaching true baseflow throughout the season between continual rain events.

Stream Water Quality:

- In general, elevated phosphorus concentrations, especially during storms, are an issue throughout the watershed and Anoka County as a whole.
- Many smaller tributary streams have very high baseflow specific conductance.
- High *E. coli* levels persist throughout the watershed.

RECOMMENDATIONS

- **Shorten the stage reading interval for smaller, flashier creeks** in the lower portions of the watershed with new equipment now being used that can better handle the volume of readings. A 15-minute interval should be used at all creek sites apart from the main channels of Sand Creek and Coon Creek.

- **Update dated stream rating curves.** Changes in stream morphology necessitate periodic updates by manually measuring flow and stage under a variety of water levels, especially in sandy systems. For the past couple of years, and continuing into 2020 we have been developing new rating curves at streams and tributary ditches where none exist. It is important to also keep existing curves updated, especially ones that were developed 10 years ago.

- **Continue implementing water quality monitoring at new sites,** or sites not monitored for a number of years, where upstream to downstream analysis indicates an influx of pollutants. In 2020 a new water quality monitoring site will be developed at Woodcrest Creek and Ditch 20 upstream of where each enters Coon Creek. This will help to further the investigation into the water quality decline of Coon Creek as it flows through the upper portion of its watershed.

- **Continue monitoring chlorides regularly.** Samples collected in 2019 offered a valuable update to results collected from 2007-2012. Sand Creek at Xeon in particular had higher storm event chloride concentrations than ever before measured at this site. Streams in developed watersheds are at especially high risk of elevated and increasing chloride concentrations.

- **Investigate phosphorus loading to Springbrook Creek**. During baseflow, total phosphorus concentrations decrease moving downstream in Springbrook Creek. During storms however, concentrations at the downstream site, 79th Way, increase greatly and often exceed state standards. Investigation into potential loading of TP from the Nature Center wetland complex may help guide future work in this system.

- **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.

LAKE LEVELS

Description: Weekly water level monitoring in lakes. The past five years are shown 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:

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

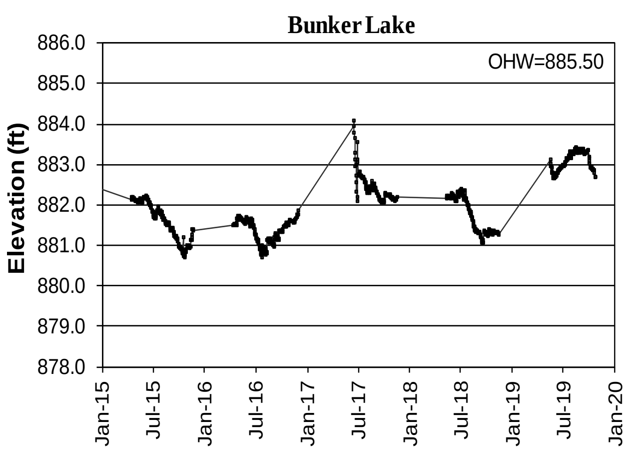
Results: In 2019, lake levels were measured by volunteers 39 times at Ham Lake, 27 times at Lake Netta, 31 times at Crooked Lake, 40 times at Laddie Lake and 18 times at Sunrise Lake. Water levels at Bunker Lake were monitored May through November using an electronic gauge, which reported the daily average of six readings each day.

Overall, lakes had increasing water levels in spring and early summer that declined into mid-summer. 2019 was the wettest year on record for Minnesota, so generally high lake levels were observed throughout the year at most lakes compared to their historical records. Lake levels remained high through the end of the year with most lakes freezing near or above their OHW level at the end of 2019.

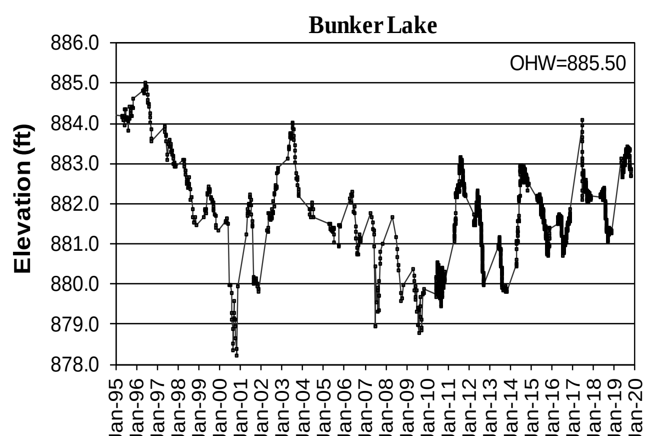
Ordinary High Water Level (OHW), the elevation below which a DNR permit is needed to perform work, is listed for each lake on the corresponding graphs below.

Coon Creek Watershed 2019 Lake Level Monitoring Sites

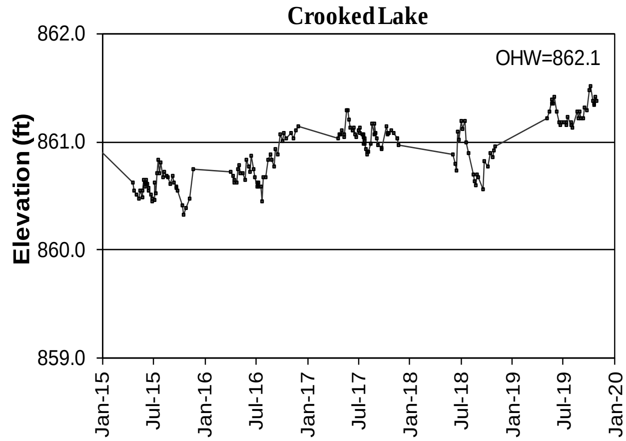
Bunker Lake Levels – last 5 years



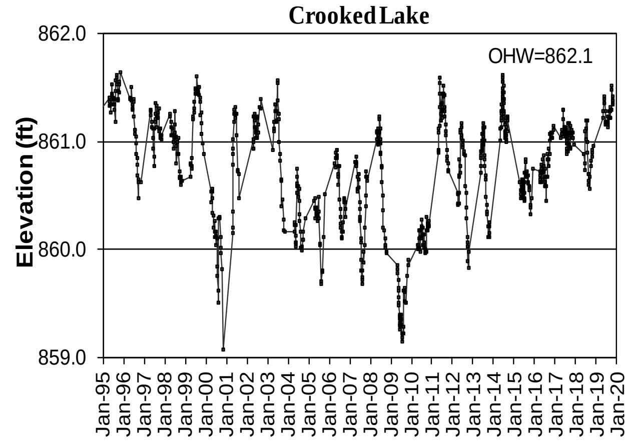
Bunker Lake Levels- last 25 years



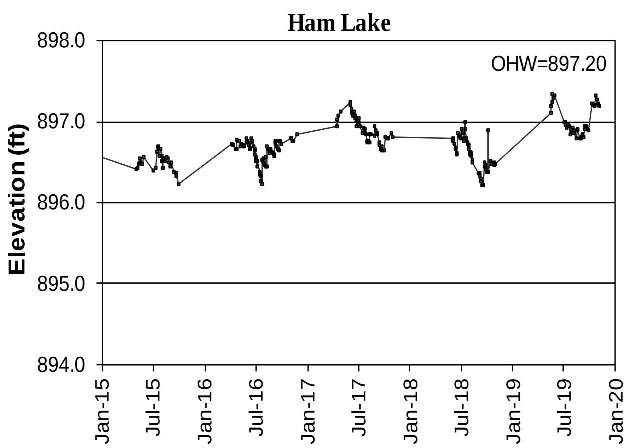
Crooked Lake Levels- last 5 years



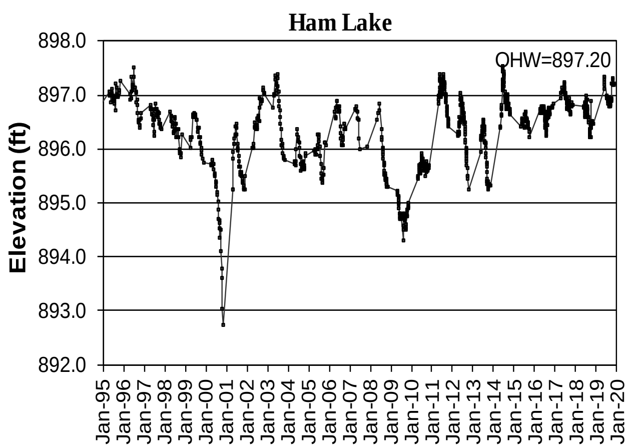
Crooked Lake Levels- last 25 years



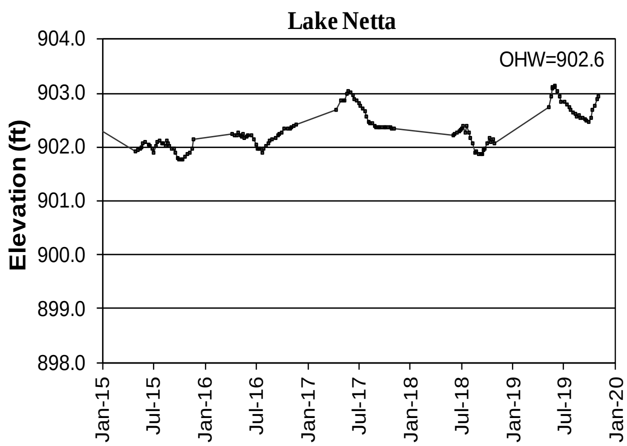
Ham Lake Levels- last 5 years



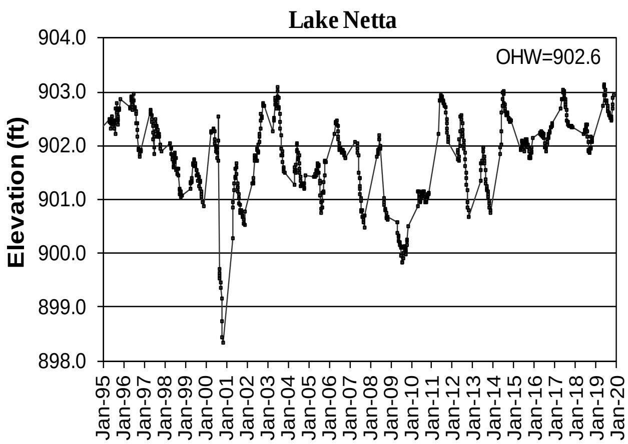
Ham Lake- Last 25 years



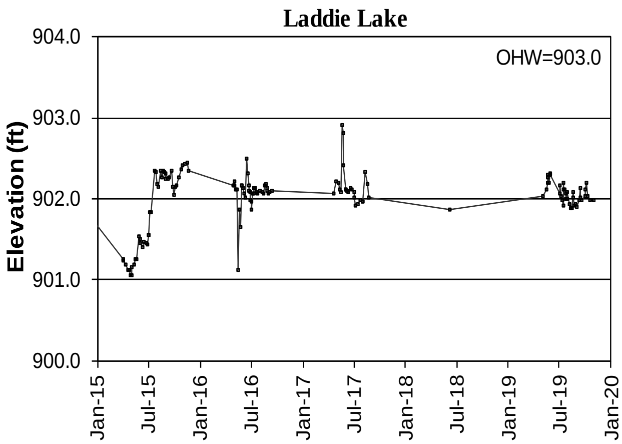
Lake Netta Levels- last 5 years



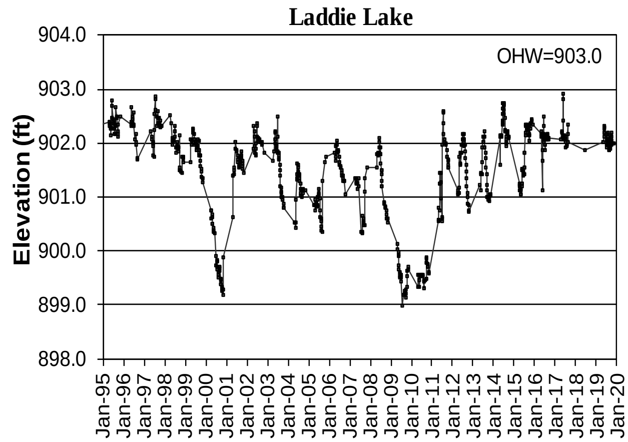
Lake Netta Levels- last 25 years



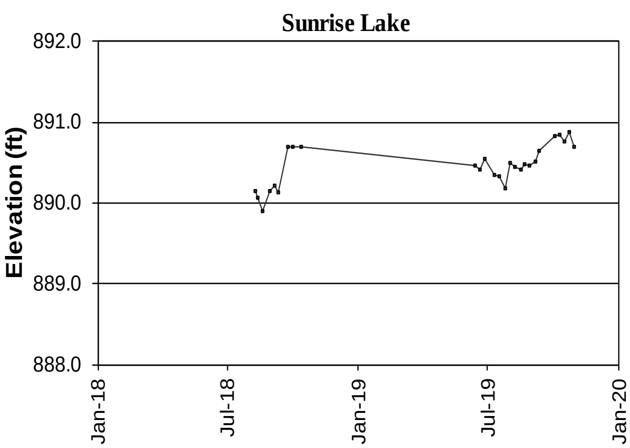
Laddie Lake Levels- last 5 years



Laddie Lake Levels- last 25 years



Sunrise Lake Levels- 2018-2019



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

Lake	Year	Average	Min	Max
Bunker	2015	881.61	880.72	882.23
	2016	881.37	880.70	881.88
	2017	882.42	882.05	884.07
	2018	881.07	881.73	882.40
	2019	883.09	882.67	883.43
Crooked	2015	860.58	860.33	860.83
	2016	860.77	860.45	861.09
	2017	861.06	860.89	861.29
	2018	860.87	860.56	861.20
	2019	861.28	861.14	861.52
Ham	2015	896.49	896.23	896.69
	2016	896.64	896.24	896.84
	2017	896.91	896.65	897.24
	2018	896.60	896.21	896.99
	2019	897.02	896.80	897.34

Lake	Year	Average	Min	Max
Netta	2015	901.97	901.76	902.14
	2016	902.16	901.89	902.35
	2017	902.62	902.34	903.04
	2018	902.13	901.86	902.40
	2019	902.93	902.47	903.13
Laddie	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
	2019	902.05	901.88	902.32
Sunrise	2018	890.30	889.90	890.69
	2019	890.54	890.18	890.87

LAKE WATER QUALITY

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

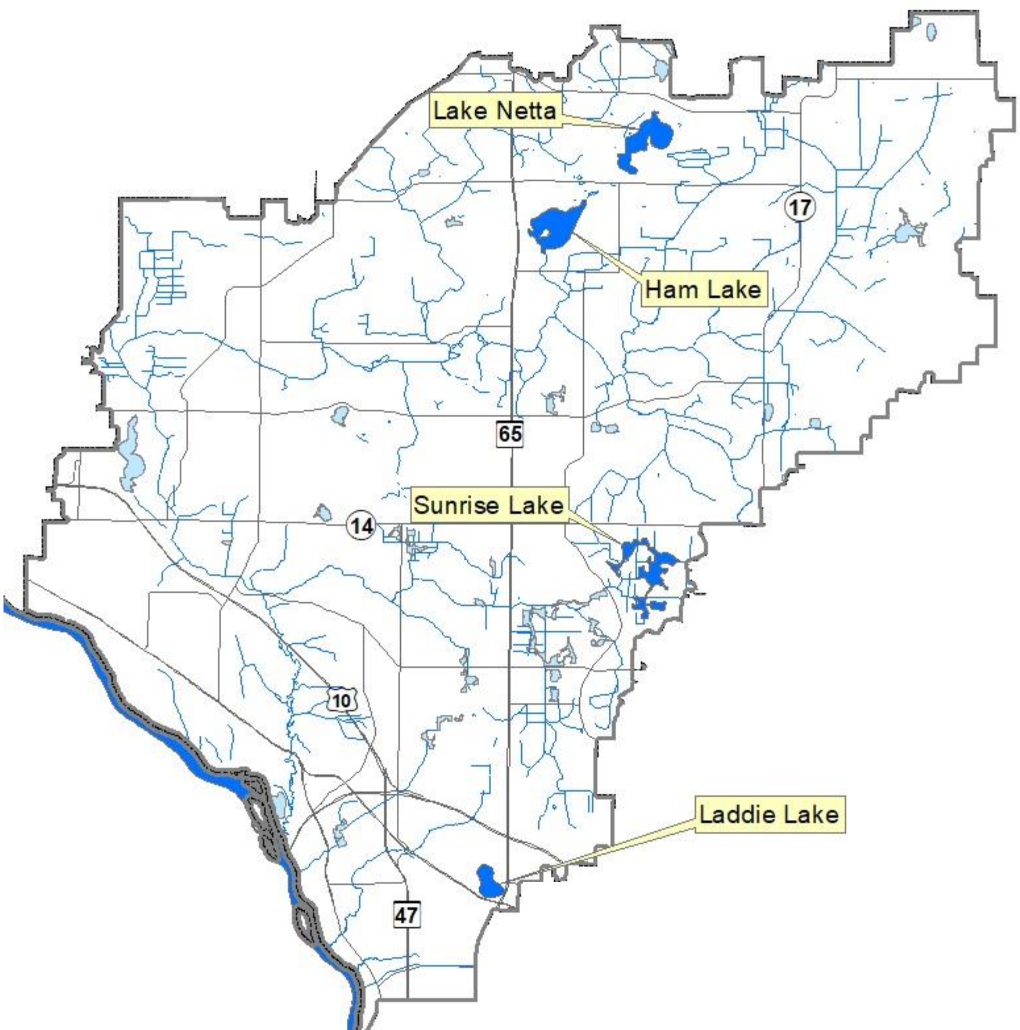
Purpose: To detect water quality trends and diagnose the cause of changes.

Locations:

Site	City
Ham Lake	Ham Lake
Lake Netta	Ham Lake
Sunrise Lake	Blaine
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 2019 Lake Water Quality Monitoring Sites



Ham Lake

City of Ham Lake, Lake ID # 02-0053

Background

Ham Lake has a surface area of 193 acres with a maximum depth of 22 feet (6.7 m). Public access to the lake is located in Ham Lake City Park which boarders the south side of the lake. The public access includes a well-maintained boat landing with a dock and a fishing pier. The lake is used extensively by recreational boaters and anglers. Ham Lake has an active aeration system that is run throughout the winter to help prevent winter fish kills. The lake is surrounded by single-family homes of moderate density. There is also a privately-owned campground and vacant/forested land bordering the lake. The watershed for Ham Lake is a mixture of residential, commercial and vacant land.

2019 Results

In 2019 Ham Lake's water quality was slightly above average for this region of the state (NCHF Ecoregion), receiving a B letter grade for the third monitoring year in a row (2016, 2017, 2019). In 2000-2001 Ham Lake received C letter grades. Since then, the lake has fluctuated between A and B grades. Total phosphorus (TP) and Chlorophyll-a were both observed at typical levels compared to other monitoring years with TP averaging 25.3 µg/L and Cl-a averaging 7.6 µg/L. Secchi transparency increased from 2017 with an average depth of 8.2 feet. Throughout the sampling year, Cl-a and TP increased through early September, and Secchi transparency decreased. This is a common trend as algal activity increases as the water warms and daily sunlight hours increase. Ham Lake temperature and dissolved oxygen profiles were also recorded in 2019. These measurements were made at the deepest point on the lake at 1 foot intervals. The profiles show stratification during the summer months (mid-May to early-September) with mixing occurring between September 4 and September 24. The highest TP and Cl-a concentrations were measure on September 4 when the lake was nearly mixed. By September 24, the lake had mixed, reestablished a thermocline, and TP and Cl-a concentrations had receded.

Trend Analysis

Twenty 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 2019). Lake water quality has fluctuated from "A" to "B" throughout most monitoring years, 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 transparency across all years of existing data using a one-way ANOVA. Including all years, a significant trend of improving (decreasing) 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 with a p value currently approaching the significance threshold.

Discussion

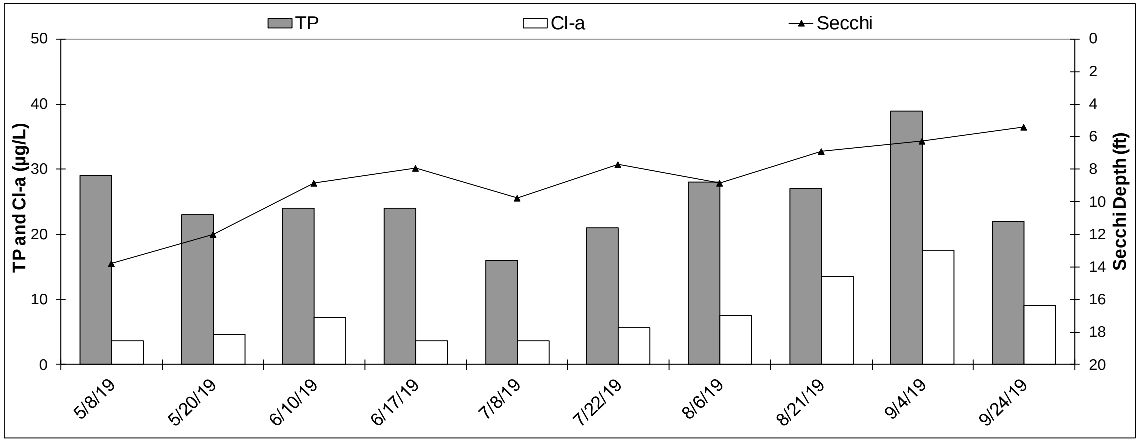
Water quality in Ham Lake remains good for a metro-area lake. Current threats to lake water quality include increasing shoreline development activities, aging and/or deteriorating septic systems, aggressive aquatic plant removal by lakeshore homeowners, invasive curly leaf pondweed, and the presence of hybrid water milfoil (HWM). A sample of milfoil was collected in a 2018 survey and sent into a lab for identification and was determined to be a hybridized milfoil. An AIS early detection survey conducted in 2019 by ACD, showed curly-leaf pondweed and HWM throughout the littoral zone of the lake. The lake association began chemically treating Ham Lake in 2014 and continues annually as needed. A cursory look at graphed water quality results since 2014 shows higher concentrations of TP and Cl-a, as well as lower average Secchi clarity in recent years. The timing of these observations may coincidentally be related to the AIS chemical treatments, with weather and other factors likely playing a role. Continued monitoring of the lake should track water quality trends and examine how they may be influenced by annual herbicide treatments.

A 2018-2022 comprehensive lake management plan was recently completed for Ham Lake. This management plan focuses on AIS inventory, AIS treatment and prevention, promoting lake-friendly shoreline practices, and increased enforcement of septic system regulations. Implementation of the comprehensive lake management plan should help keep water quality trends from declining in the future.

Ham Lake

City of Ham Lake, Lake ID # 02-0053

2019 Daily Results



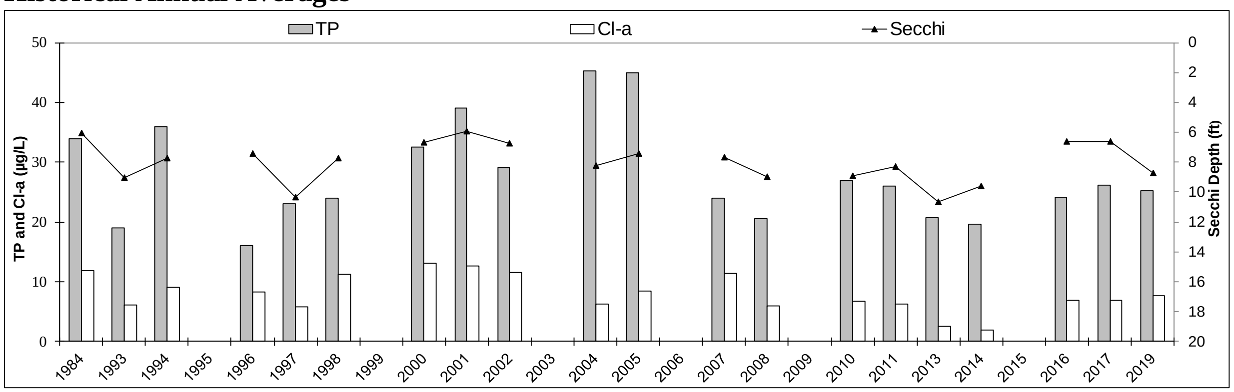
2019 Median Results

pH		8.1
Specific Conductivity	mS/cm	0.36
Turbidity	NTU	2.55
D.O.	mg/l	10.12
D.O.	%	116.6
Temp.	°F	72.44
Salinity	%	0.18
Cl-a	µg/L	6.4
T.P.	µg/l	24.0
Secchi	ft	8.38

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**
2019	B	A	B	**B**
State standards	40 µg/L	14 µg/L	>4.6 ft	

Historical Annual Averages

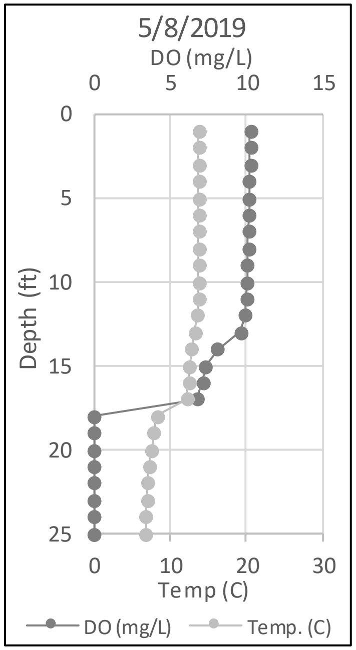


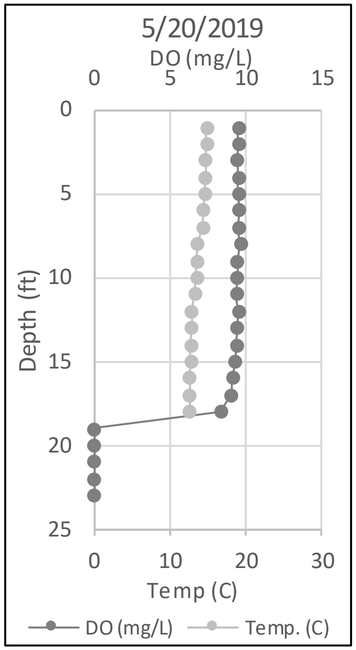
Ham Lake
2019 Water Quality Data

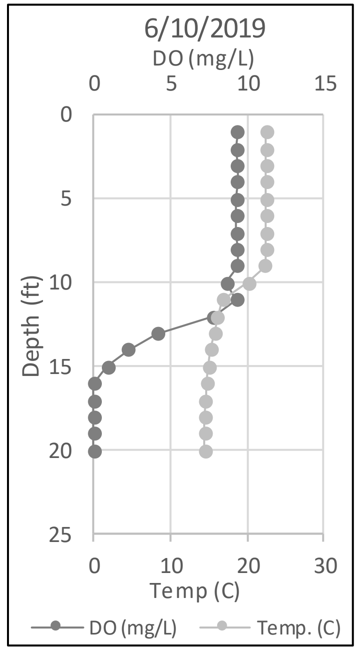
	Units	R.L.*	5/8/2019	5/20/2019	6/10/2019	6/17/2019	7/8/2019	7/22/2019	8/6/2019	8/21/2019	9/4/2019	9/24/2019			
		Time:	9:30	17:00	12:30	15:45	14:50	15:30	14:35	15:15	14:45	15:50			
			Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.02	8.38	8.35	8.31	5.37	7.94	8.19	7.96	7.93	8.17	7.86	5.37	8.38
Specific Conductivity	mS/cm	0.01	0.366	0.383	0.394	0.345	0.355	0.381	0.381	0.346	0.352	0.316	0.362	0.316	0.394
Turbidity	NTU	1	N/A	0.00	1.60	3.30	0.00	1.80	0.00	4.00	3.30	6.50	2	0	7
D.O.	mg/l	0.01	11.60	9.60	9.05	9.25	12.24	9.87	11.35	10.36	10.58	9.16	10.31	9.05	12.24
D.O.	%	1	111.7	97.4	108.0	109.5	154.6	124.1	145.2	124.6	121.5	107.7	120.4	97.4	154.6
Temp.	°C	0.1	13.69	14.61	22.47	22.46	26.89	26.15	27.09	24.64	21.04	21.37	22.0	13.7	27.1
Temp.	°F	0.1	56.6	58.3	72.4	72.4	80.4	79.1	80.8	76.4	69.9	70.5	71.7	56.6	80.8
Salinity	%	0.01	0.18	0.18	0.19	0.17	0.17	0.18	0.19	0.17	0.17	0.15	0.18	0.15	0.19
Cl-a	µg/L	1	3.70	4.70	7.20	3.60	3.70	5.60	7.50	13.50	17.60	9.10	7.6	3.6	17.6
T.P.	mg/l	0.005	0.029	0.023	0.024	0.024	0.016	0.021	0.028	0.027	0.039	0.022	0.025	0.016	0.039
T.P.	µg/l	5	29.0	23.0	24.0	24.0	16.0	21.0	28.0	27.0	39.0	22.0	25.3	16.0	39.0
Secchi	ft		13.8	12.0	8.8	7.9	9.8	7.7	8.8	6.9	6.3	5.4	8.7	5.4	13.8
Secchi	m		4.2	3.7	2.7	2.4	3.0	2.3	2.7	2.1	1.9	1.6	2.7	1.6	4.2
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

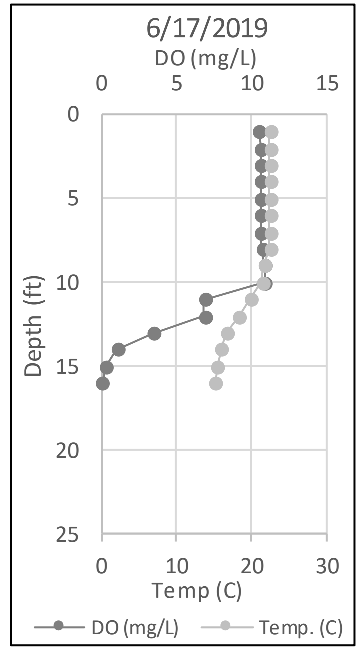
*reporting limit

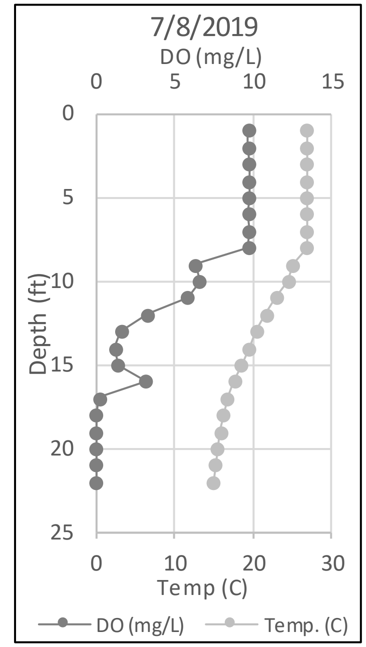
Ham Lake Profiles

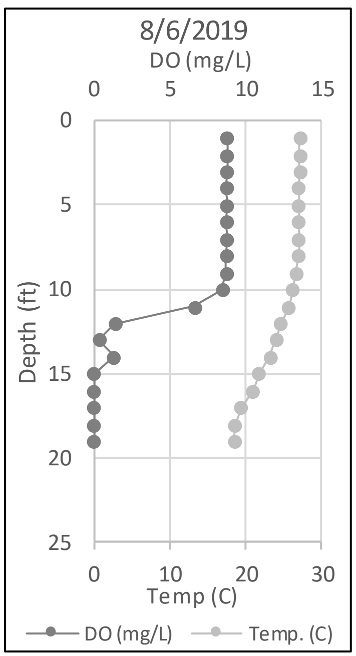


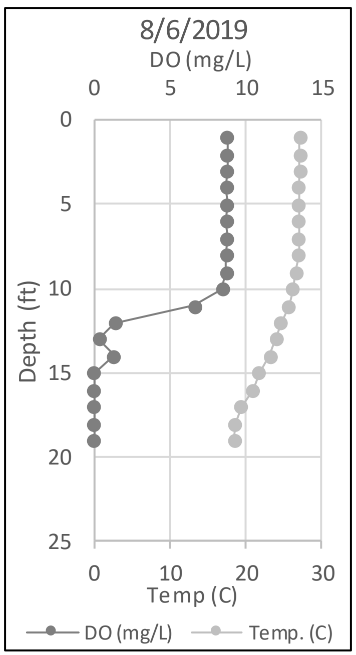


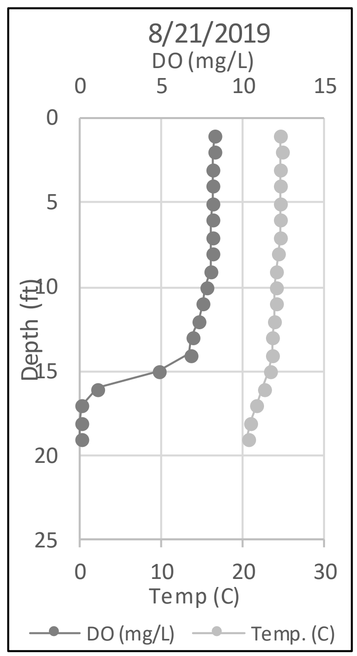


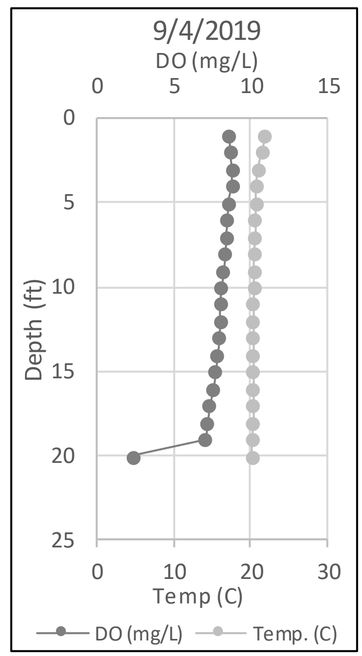


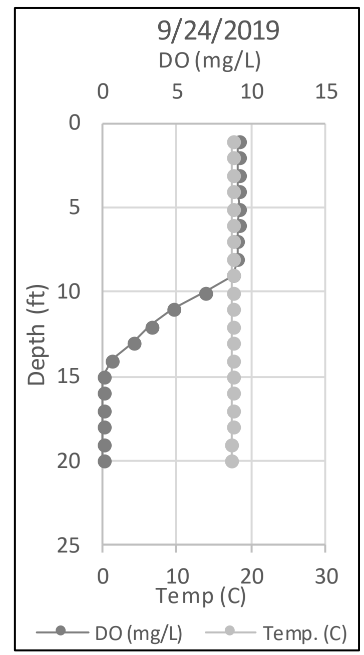












Lake Netta

City of Ham Lake, Lake ID # 02-0052

Background

Lake Netta is located in central Anoka County, northeast of Ham Lake. It has a surface area of 168 acres and a maximum depth of 19 ft. (5.8 m). There is a small public canoe access on the west side of the lake located in Gladys Jones Park. The lake is rarely used for recreation due to difficult accessibility. The lakeshore is partially developed, with houses along the east and southeast portions of the lake. The small watershed is a mixture of residential, commercial, and vacant land. Though the direct sources of pollutant loading into the lake are currently limited, as development within the watershed continues it will be important to track potential impacts of that development on water quality.

2019 Results

In 2019, Lake Netta once again had above-average water quality for this region of the state (NCHF Ecoregion), achieving an overall A letter grade. Lake Netta has received an A letter grade for the fifth consecutive monitoring year (since 2013). This high mark was driven by low concentrations of total phosphorus and chlorophyll-*a* as well as high Secchi transparency. The 2019 average total phosphorus concentration (22 µg/L) was only slightly higher than the lowest average on record which occurred in 2015 (17 µg/L). Chlorophyll-a concentrations have been low in Lake Netta since 1999, and in 2019 the chlorophyll-a averaged 3.5 µg/L. Secchi transparency averaged 8.3 ft. in 2019. Other water quality parameters were similar to previous years indicating the stability of the clear water and healthy submerged vegetation community in this system.

An aquatic invasive species survey was conducted in 2019 throughout the littoral zone and high priority areas of Lake Netta. No new AIS were observed in 2019, and Lake Netta continues to host a diverse and healthy native plant community. This community is likely a large contributor to the lake's great water quality acting as a large sink for nutrients in the lake.

Trend Analysis

Sixteen years of water quality data have been collected by the Anoka Conservation District (1997-1999, 2001, 2003-2004, 2006-2007, 2009-2010, 2012-2013 and 2015-2016, 2018-2019), along with Secchi transparency measurements taken by citizens for five additional years. A statistically significant improvement in water quality has taken place (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,12} = 4.75$, $p = 0.03$). The main driver of this significant trend seems to be declining Chlorophyll-a levels. For each parameter individually, a one-way ANOVA for annual averages was run. Chlorophyll- a concentrations showed a statistically significant downward trend ($F_{1,15} = 5.86$, $p = 0.01$). Total phosphorus concentrations seem to be declining and are close to showing a statistical downward trend ($F_{1,15} = 5.86$, $p = 0.08$). Secchi transparency has no significant trend ($F_{1,15} = 2.72$, $p = 0.34$).

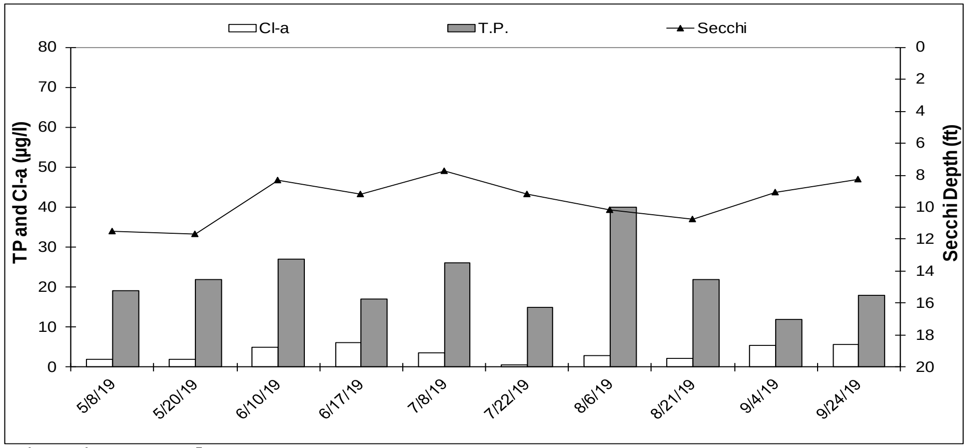
Discussion

Good water quality in Lake Netta has been observed since 1997, the year ACD began regularly monitoring water quality. The lake receives only a small amount of direct runoff from its small watershed. The majority of biotic production in the lake is through a robust submerged macrophyte (large plant) community instead of algae. This plant community is essential to the lake's healthy water quality because the vegetation helps sequester nutrients from the water column, making them unavailable to algae. Current vegetation on the lake bottom also minimizes sediment disturbance by wind or boats and provide refuges for zooplankton, particularly daphnia, which also actively consume algae. Protecting the healthy in-lake vegetation should be a focus in order to maintain the lake's good water quality. Good shoreline stewardship, including maintaining vegetated buffers near the water's edge, by property owners should also be a focused effort of management.

LAKE NETTA

City of Ham Lake, Lake ID # 02-0052

2019 Results



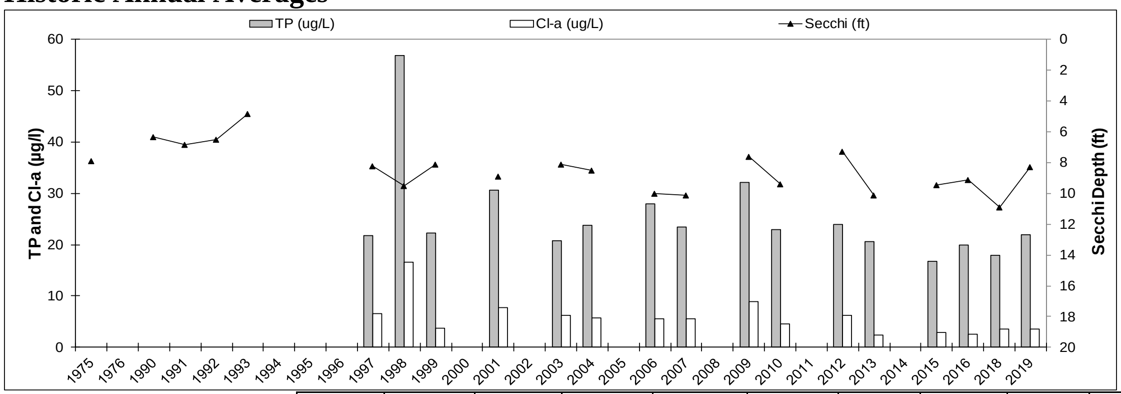
2019 Median Values

pH		7.43
Specific Conductivity	mS/cm	0.238
Turbidity	NTU	0.50
D.O.	mg/l	7.62
D.O.	%	90.20
Temp.	°F	75.2
Salinity	%	0.1
Cl-a	µg/L	2.8
T.P.	µg/l	18.0
Secchi	ft	11.2

Historical Report Card

Year	TP (µg/L)	Cl-a (µg/L)	Secchi (m)	Overall
1975			B	
1990			C	
1991			C	
1992			C	
1993			C	
1997	A	A	B	**B**
1998	C	B	B	**B**
1999	A	A	B	**A**
2001	B	A	B	**B**
2003	A	A	B	**A**
2004	B+	A	B	**A**
2006	B	A	B+	**B+**
2007	B	A	A	**B+**
2009	C	A	B	**B**
2010	A-	A	B+	**A-**
2012	B+	A	B	**B+**
2013	A	A	A	**A**
2015	A	A	B	**A**
2016	A	A	B	**A**
2018	A	A	A	**A**
2019	A	A	A	**A**
State Standards	40 ug/L	14 ug/L	>4.6 ft	

Historic Annual Averages



2019 Water Quality Data

	Units	R.L.*	5/8/2019	5/20/2019	6/10/2019	6/17/2019	7/8/2019	7/22/2019	8/6/2019	8/21/2019	9/4/2019	9/24/2019	Average	Min	Max
Time:			10:30	18:00	13:40	16:45	16:00	16:20	15:30	16:15	15:15	16:50			
pH		0.1	8.10	8.20	8.24	7.98	7.73	7.66	7.85	7.62	7.64	7.90	7.89	7.62	8.24
Specific Conductivity	mS/cm	0.01	0.225	0.233	0.248	0.275	0.239	0.250	0.250	0.233	0.225	0.204	0.238	0.204	0.275
Turbidity	FNRU	1	N/A	0.0	1.1	1.7	0.7	1.2	0.0	1.1	0.5	1.6	1	0	2
D.O.	mg/l	0.01	10.00	8.59	9.01	8.35	11.10	8.53	9.34	8.41	9.10	10.36	9.28	8.35	11.10
D.O.	%	1	97.9	87.3	109.2	99.5	145.0	109.6	111.4	102.3	103.2	123.9	109	87	145
Temp.	°C	0.1	14.41	14.92	23.22	22.36	27.07	26.50	26.48	24.57	20.83	20.99	22.1	14.4	27.1
Temp.	°F	0.1	57.9	58.9	73.8	72.2	80.7	79.7	79.7	76.2	69.5	69.8	71.8	57.9	80.7
Salinity	%	0.01	0.11	0.11	0.12	0.11	0.12	0.12	0.12	0.11	0.11	0.10	0.11	0.10	0.12
Cl-a	ug/L	1	1.90	1.90	4.90	6.20	3.60	0.64	2.90	2.20	5.40	5.70	3.53	0.64	6.20
T.P.	mg/l	0.005	0.019	0.022	0.027	0.017	0.026	0.015	0.040	0.022	0.012	0.018	0.022	0.012	0.040
T.P.	ug/l	5	19	22	27	17	26	15	40	22	12	18	22	12	40
Secchi	ft	0.1	11.50	11.66	8.33	9.16	7.75	9.16	10.2	10.8	9.1	8.3	9.6	7.8	11.7
Secchi	m	0.1	3.5	3.6	2.5	2.8	2.4	2.8	3.1	3.3	2.8	2.5	2.9	2.4	3.6
Physical			1	1	1	1	1	2	1	1	1	1	1.1	1.0	2.0
Recreational			2	2	2	2	2	2	2	2	2	2	2.0	2.0	2.0

Sunrise Lake

City of Blaine, Lake ID # 00-147

Background

Sunrise Lake is a 160 acre constructed lake that was dug in 2004-2005 as part of The Lakes of Radisson development in the City of Blaine. The lake is made up of a series of basins surrounded by high density housing developments. The basins are irregularly shaped with many peninsulas to maximize lakefront property potential. Sunrise Lake is a private lake with access available only to residents. On the north side of the lake's largest bay there is a public park with a beach operated by the City of Blaine. A community boat launch exists on the northwest side of the lake's second largest basin. Only electric motors are allowed on Sunrise Lake. The majority of the lakeshore has some degree of native plantings which serve as healthy lakeshore buffers.

The lake serves as a point of confluence for many individual laterals of County Ditch 41, which eventually becomes Sand Creek. Monitoring occurred at the deepest point in the second largest bay across from the community public access. This site was selected because it is one of the deepest points (16-17 feet) in all of the basins, and it is downstream of the largest bay where the public beach is located.

2019 Results

In 2019, Sunrise Lake received an overall C letter grade based on the grading scale for natural lakes in this ecoregion (NCHF). This was a decline from a B- grade received in 2018, when the lake was first monitored. Total phosphorus (TP) averaged 39.0 µg/L in 2019 and Secchi transparency averaged 4.8 ft. Results for both of these parameters were better than State standards. Chlorophyll-a (Cl-a) had higher concentrations, averaging 20.98 µg/L and in excess of the State standard of 14 µg/L. Because Sunrise Lake is not a natural public waterbody these State standards are only guidelines. There is not yet enough monitoring data to perform trend analysis or make assumptions of normal conditions for this lake.

ACD performed AIS surveys in 2018 and 2019 throughout Sunrise Lake. The invasive plant curly-leaf pondweed was present throughout most littoral areas during early summer surveys. The most abundant plant noted during the late summer assessment was the native plant spiny naiad (*Najas marina*). Spiny naiad is native to this region of Minnesota, and was observed growing densely in 2018 and 2019 throughout many areas of the bays. Sunrise Lake contains a unique aquatic micro-culture considering the unnatural basin was dug just over a decade ago and offers limited access for recreation. It is possible that spiny naiad was able to flourish, due to the lack of other plants that normally outcompete this native plant in natural lakes. Sunrise Lake is home to a few other native macrophyte species but is likely very vulnerable to future infestation of additional invasive species because of its unnatural origin and the dominance of its macrophyte community by one species. A stand of invasive *Phragmites australis* was spotted near the Lakes Parkway Bridge and the invasive species purple loosestrife was overserved on 4 occasions along the shoreline. The invasive phragmites was chemically treated in fall of 2019 and continued control efforts are planned as part of the ongoing Anoka County phragmites control pilot project.

Trend Analysis

This was the second year of water quality data collection at Sunrise Lake so trend analysis is not possible.

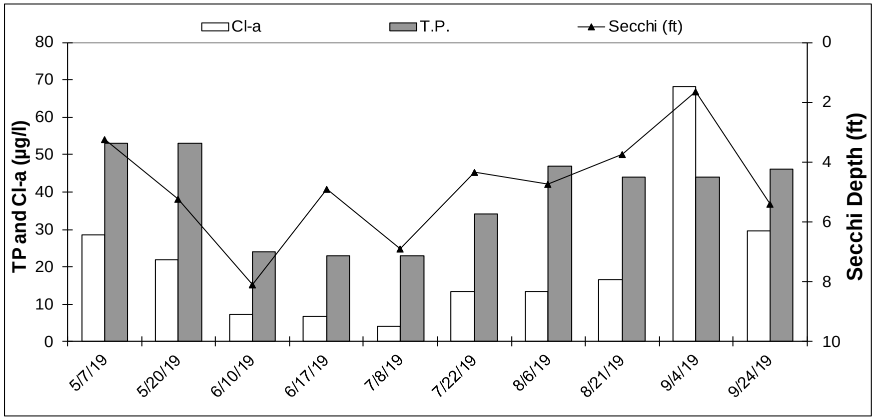
Discussion

Sunrise Lake has relatively good water quality considering the high level of development on its immediate shoreline and beyond. To maintain or improve water quality in this basin, it is important to keep current shoreline buffers, minimize the effects of erosion on public and private beaches, and treat stormwater before it flows into the lake. Curly-leaf pondweed has been dense in some areas of Sunrise Lake, including in 2018, a year that populations were greatly suppressed in other lakes due to late ice out. It is possible that this invasive plant will be a recreation, and potentially a water quality issue in the near future. Any control efforts should be carefully planned to limit potential adverse impacts on the native plant community and on nutrient cycling.

Sunrise Lake

City of Blaine, Lake ID # 00-147

2019 Results



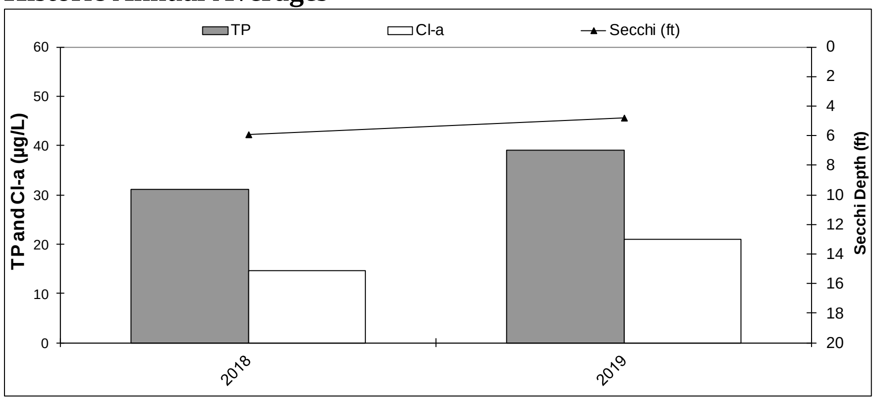
2019 Median Values

pH		7.98
Specific Conductivity	mS/cm	0.992
Turbidity	NTU	2.90
D.O.	mg/l	9.00
D.O.	%	112.34
Temp.	°F	75.5
Salinity	%	0.5
Cl-a	µg/L	13.8
T.P.	µg/l	28.0
Secchi	ft	5.7

Historic Report Card

Year	TP	Cl-a	Secchi	Overall
2018	B	B	C	**B-**
2019	C	C	C	**C**
State Standard	40 ug/L	14 ug/L	>4.6 ft	

Historic Annual Averages



2019 Water Quality Data

	Units	R.L.*	5/7/2019	5/20/2019	6/10/2019	6/17/2019	7/8/2019	7/22/2019	8/6/2019	8/21/2019	9/4/2019	9/24/2019	Average	Min	Max
Time			14:45	4:15	11:30	15:00	13:45	14:50	13:45	14:40	13:30	15:00			
pH		0.1	8.60	8.29	8.30	8.35	8.30	7.99	8.14	7.91	7.90	8.17	8.20	7.90	8.60
Specific Conductivity	mS/cm	0.01	1.020	0.383	1.102	1.002	1.043	1.085	1.066	0.953	0.933	0.316	0.890	0.316	1.102
Turbidity	FNRU	1	N/A	0.000	1.800	5.700	0.600	6.9	3.0	6.7	8.8	3.8	4	0	9
D.O.	mg/L	0.01	16.27	10.88	9.40	9.72	12.44	12.48	13.16	10.35	13.12	11.92	11.97	9.40	16.27
D.O.	%	1	163.500	108.300	110.900	117.100	163.700	159.1	157	126	149	135	139	108	164
Temp.	°C	0.1	14.6	14.7	22.17	22.6	26.99	26.2	27.3	24.8	21.2	21.4	22.2	14.6	27.3
Temp.	°F	0.1	58.2	58.4	71.9	72.7	80.6	79.2	81.2	76.7	70.2	70.5	72.0	58.2	81.2
Salinity	%	0.01	0.50	0.53	0.54	0.49	0.51	0.54	0.53	0.47	0.46	0.42	0.50	0.42	0.54
Cl-a	µg/L	1	28.60	22.00	7.20	6.70	4.20	13.40	13.40	16.70	68.10	29.50	20.98	4.20	68.10
T.P.	mg/L	0.005	0.053	0.053	0.024	0.023	0.023	0.034	0.047	0.044	0.044	0.046	0.039	0.023	0.053
T.P.	µg/L	5	53	53	24	23	23	34	47	44	44	46	39	23	53
Secchi (ft)	ft	0.1	3.25	5.25	8.08	4.91	6.91	4.33	4.8	3.8	1.7	5.4	4.8	1.7	8.1
Secchi	m	0.1	1.0	1.6	2.5	1.5	2.1	1.3	1.4	1.1	0.5	1.6	1.5	0.5	2.5
Physical			3.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.4	2.0	3.0
Recreational			3.0	3.0	1.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.3	1.0	3.0

*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, and is split between the cities of Blaine and 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. The park provides no easy access to the water's edge, 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 difficult accessibility. It does, however, attract a large amount of waterfowl throughout the year. The west side of the lake is bordered by single-family homes, the south and east by four-lane highways and commercial businesses, and the north bordered by the city park.

2019 Results

Laddie Lake has a lengthy monitoring history dating back to 1980 albeit with some large gaps between monitoring years. Recently, the lake has been monitored in 2016, 2017 and 2019. In 2019, water quality was above average for this region, receiving an overall B letter grade. It is likely that the annual overall grade would be better if Secchi transparency readings were able to be properly conducted on the lake. Secchi transparency exceeds the lake's depth on each occasion monitored. Dense vegetation blanketing the bottom of the lake also hinders accurate Secchi transparency readings. The water does appear to be very clear, and its true clarity would likely positively factor into its overall letter grade. Total phosphorus (TP) averaged 23 µg/L, which was a decrease from 2017 and more similar to the 2016 average. Chlorophyll-a (Cl-a) averaged 4.74 µg/L. Both were well below their respective state standards. The highest concentrations of TP and Cl-a were collected in early August of 2019.

The lake is slightly eutrophic, but much of the plant growth is macrophytic (large plants), not algae. Robust populations of native plants are healthy in a shallow lake such as this one and help keep the water clear. Macrophytes grow to or near to the surface on 95% of the lake from June through September. The dominant native macrophyte is *Potamogeton robbinsii* (Robin's or Fern-leaf Pondweed). Unfortunately, during the 2019 AIS early detection surveys, invasive Chinese Mystery Snails and Banded Mystery Snails were discovered and were prevalent throughout the lake. Chinese Mystery Snails have been present in Ham Lake for a number of years, but were newly discovered in Laddie Lake in 2019. It in unknown if mystery snails were newly introduced to the lake in 2019 or just documented for the first time.

Trend Analysis

Seventeen years of water quality data have been collected by the Metropolitan Council and the Anoka Conservation District. This lake was first monitored in 1980, followed by a 13-year hiatus from monitoring. From 1993 to 2005 monitoring occurred on a more regular schedule, with a sparse record thereafter until 2016. Results from 1980 were excluded from analysis because they are singular outliers in the dataset. To analyze trends since 1993, a repeated measures MANOVA with response variables Total Phosphorus (TP) and Chlorophyll-a (Cl-a) was used. Secchi transparency was also excluded because the shallow depth of the lake does not allow for a true representation of actual water clarity by Secchi. A statistically significant water quality trend was not detected ($F_{1,14}=0.029$, $p=0.86$). We also examined variables TP and Cl-a individually, again excluding results from 1980, using a one-way ANOVA. Both parameters showed no significant trend and a nearly flat best fit line.

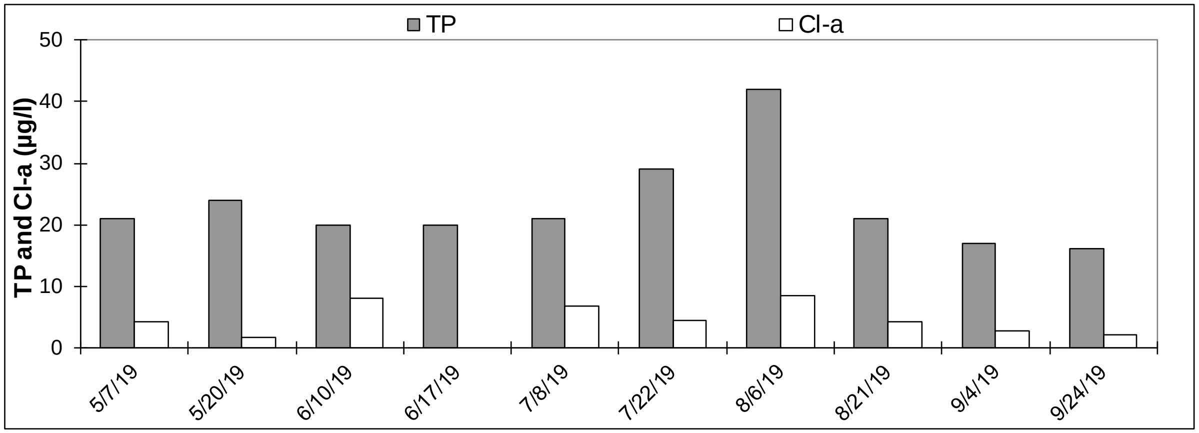
Discussion

Shallow lakes such as Laddie tend to stabilize into one of two alternative states; clear and macrophyte dominated like Laddie, or cloudy and algae dominated like Typo Lake in northern Anoka County. Laddie is doing quite well for a shallow lake in an urbanized setting. However, if phosphorus loads from stormwater inputs increase, or additional AIS are introduced to the lake, the system could be overwhelmed and pushed into the alternative stable state. Once shallow lakes like Laddie become cloudy and algal driven with a mass die off of native macrophytes, it is a very tough management prospect to return it to a healthier state. The lake should be watched closely for any water quality deterioration, particularly a trend of increasing TP concentrations, or the introduction of invasive vegetation or carp.

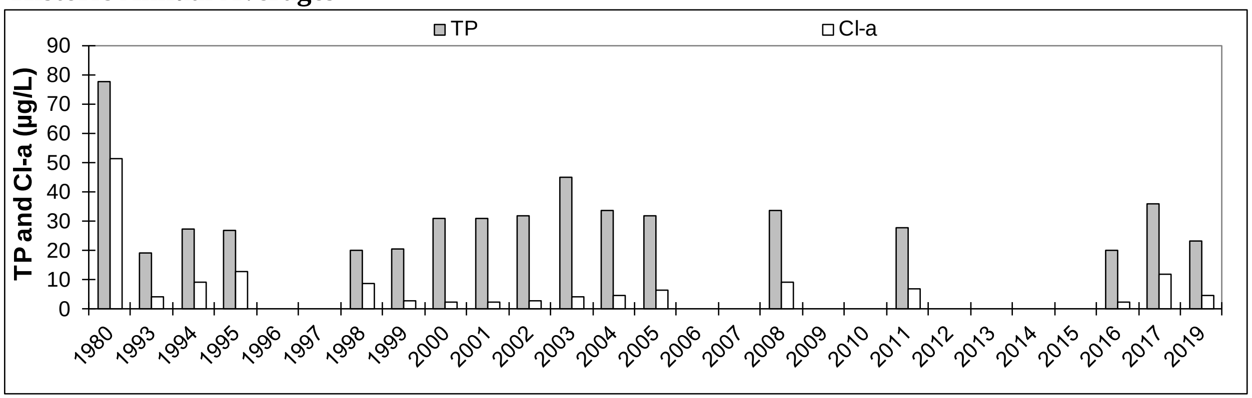
Laddie Lake

City of Coon Rapids, Lake ID # 00-451

2019 Results



Historic Annual Averages



2019 Median Results

pH		9.31
Specific Conductivity	mS/cm	0.922
Turbidity	NTU	2.05
D.O.	mg/l	12.37
D.O.	%	148.6
Temp.	°F	72.96
Salinity	%	0.45
Cl-a	µg/L	4.2
T.P.	µg/l	21.0

Historical Report Card

Year	TP	Cl-a	Overall
1980	D	D	**D**
1993	A	A	**A**
1994	B	A	**B**
1995	B	B	**B**
1998	B	A	**B**
1999	B	A	**B**
2000	B	A	**B**
2001	B	A	**B**
2002	B	A	**B**
2003	C	A	**B**
2004	C	A	**B**
2005	B	A	**B**
2008	C	A	**B**
2011	B	A	**B**
2016	A	A	**A**
2017	C	B	**B**
2019	B	B	**B**
State standards	60 µg/L	20 µg/L	

2019 Water Quality Data		Date:	5/7/2019	5/20/2019	6/10/2019	6/17/2019	7/8/2019	7/22/2019	8/6/2019	8/21/2019	9/4/2019	9/24/2019			
		Time:	2:15	15:45	10:50	14:30	13:05	14:00	13:05	13:40	13:00	14:15			
	Units	R.L.*	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Average	Min	Max
pH			9.57	8.95	9.97	9.93	9.85	9.04	9.47	9.15	8.83	8.84	9.36	8.83	9.97
Specific Conductivit	mS/cm		0.931	0.929	0.922	0.845	0.937	0.915	0.944	0.865	0.890	0.774	0.895	0.774	0.944
Turbidity	FNRU		N/A	0	9.4	4.4	2.1	4.1	0	2	0.5	2.8	3	0	9
D.O.	mg/L		15.02	10.69	8.44	9.65	14.68	12.59	12.72	14.68	11.84	12.15	12.25	9.65	15.02
D.O.	%		158.6	109.0	97.2	117.0	181.4	160.0	172.0	178.7	138.2	138.6	145.1	97.2	181.4
Temp.	°C		16.60	15.05	21.67	23.32	27.87	26.04	28.58	25.30	22.19	21.86	22.85	15.05	28.58
Temp.	°F	0.1	61.9	59.1	71.0	74.0	82.2	78.9	83.4	77.5	71.9	71.3	73	59	83
Salinity	%	0.01	0.45	0.45	0.46	0.41	0.46	0.46	0.49	0.42	0.44	0.38	0.44	0.38	0.49
Cl-a	ug/L	0.5	4.20	1.70	8.10	<1	6.80	4.50	8.50	4.10	2.70	2.1000	4.74	1.7	8.5
T.P.	mg/L	0.010	0.021	0.024	0.020	0.020	0.021	0.029	0.042	0.021	0.017	0.016	0.023	0.016	0.042
T.P.	ug/L	10	21	24	20	20	21	29	42	21	17	16	23.100	16	42
Physical			1.00	1.00	2.00	2.00	3.00	2.00	3.00	2.00	2.00	2.00	2.0	1.0	3.0
Recreational			3.00	3.00	4.00	4.00	4.00	3.00	4.00	3.00	3.00	3.00	3.4	3.0	4.0

*reporting limit

STREAM WATER QUALITY AND HYDROLOGY MONITORING

Description: Water chemistry grab sampling, continuous stage, and storm event water quality monitoring

Purpose: To detect water quality trends and changes, collect continuous stage data over time, and inform pollutant loading and flood modeling.

Locations: Throughout the watershed

Methods: See Below

Water Chemistry Grab Sampling

Grab samples are collected during both storm and baseflow conditions throughout the open water season and sent to a certified laboratory for analysis. Parameters analyzed by the lab include total phosphorus, total suspended solids, *E.coli* bacteria, and periodically, chlorides. Eight samples are collected at each site; four during baseflow conditions and four following storm events. Storms are 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-producing events.

Physical and chemical water parameters are also measured with portable meters during each grab sample occasion. Parameters measured with portable meters include pH, specific conductance, turbidity, temperature, salinity, and dissolved oxygen. Transparency tube water clarity readings are also collected at each visit, as is water level (stage) using a staff gauge surveyed to mean sea level elevation.

This report includes data from all years and all sites for each subwatershed to provide a broad view of a stream's water quality under a variety of conditions. Water quality assessments are based on upstream-to-downstream comparisons, a comparison of baseflow conditions and post-storm conditions, and an overall assessment compared to other Anoka County streams and state water quality standards. Mean and median results for each parameter at the furthest downstream site are tabulated for comparison to state standards. All results are graphed in box and whisker style plots.

Continuous Stage

Continuous stage data is recorded using water level logging equipment deployed in the stream for the duration of the open water season. These readings are converted to elevation using readings collected from the surveyed staff gauge also installed at each location. Stage readings are collected at regular intervals ranging from 15 minutes to 2 hours, depending on the flashiness of the particular site.

Storm Event Water Quality

Each year, certain sites are selected for more intensive monitoring over the course of storm events. A water quality sonde is deployed in the stream shortly before a storm is forecasted and left in the stream until after the storm has ceased and the site has returned to baseflow condition. Parameters collected during storm event sampling include pH, salinity, specific conductance, temperature, dissolved oxygen, and turbidity. Sondes are left in place for a period of two days to two weeks. This data provides a picture of the change in water quality over the duration of various sized storms, rather than a single snapshot of water quality at the time of grab sample collection. In some instances, water level was already high before the storm and remains high after the storm. This was especially the case in 2019, the wettest year on record in Minnesota.

Precipitation

Precipitation data is provided alongside water quality results. Precipitation totals were collected by volunteers who recorded daily rain gauge data or from eleven Anoka County EMS Weather Stations. The closest reliable precipitation record for each site was used.

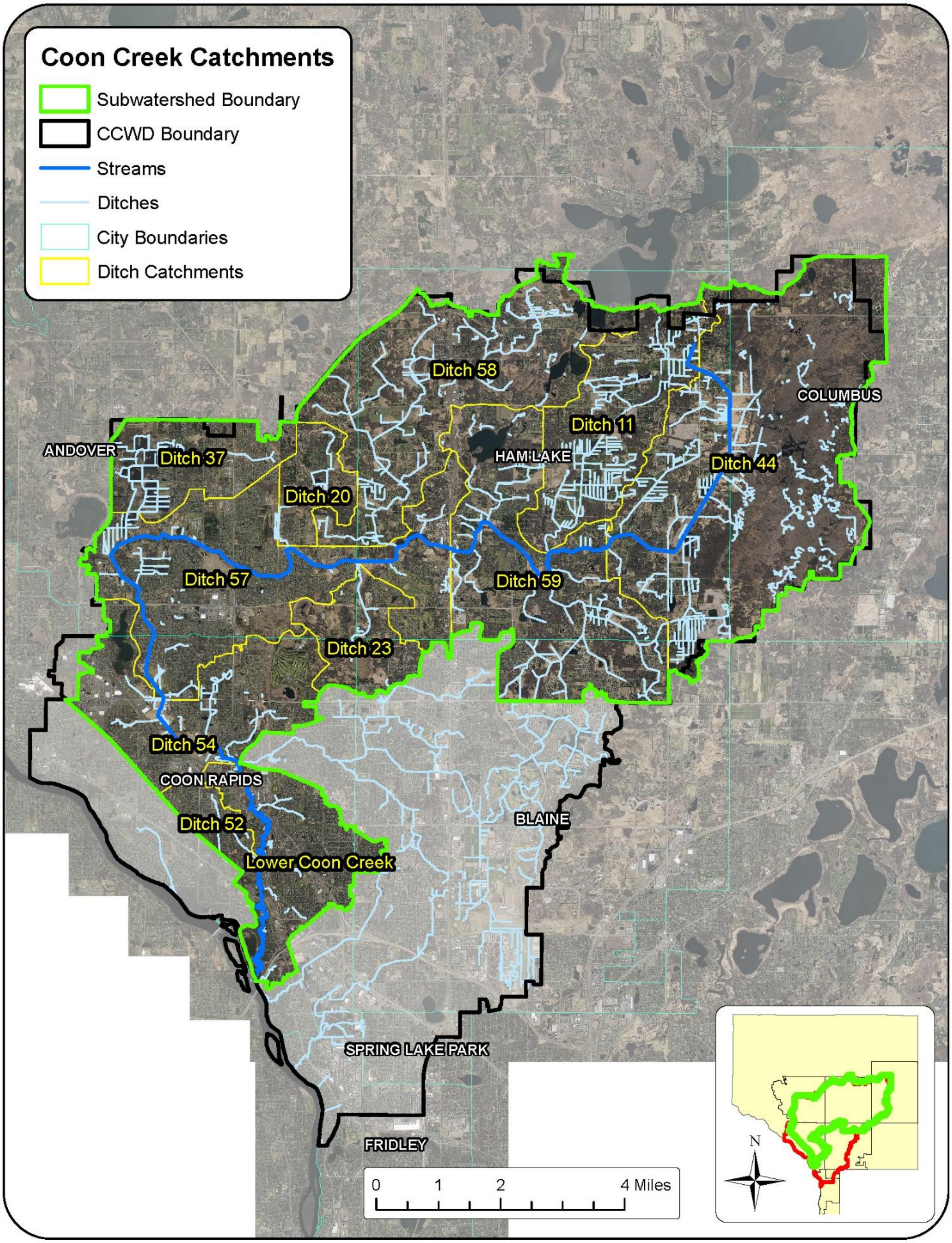
Water Quality Monitoring – Coon Creek Main Stem and Tributary Ditches

Coon Creek Main Stem and Tributary Ditches Monitoring Sites		
Site Name/ SiteID	**Years Monitored**	**2019 Data Collected**
Coon Cr at Lexington Blvd S007-539	2013-2016	
Ditch 11 at 149st Ave (tributary) S007-541	2013-2017	
Coon Cr at Naples St S007-057	2012-2019	Water Chemistry Grab Samples
Coon Cr at Hwy 65 S005-259	2018-2019	Water Chemistry Grab Samples
Ditch 58 at Andover Blvd (tributary) S005-830	2013-2018	Water Chemistry Grab Samples
Coon Cr at Shadowbrook Townhomes S004-620	2007-2016	
Coon Cr at Prairie Rd. S007-540	2013, 2017, 2018	
Coon Cr at 131st Ave S005-257	2010-2019	Water Chemistry Grab Samples, Continuous Stage
Coon Cr at Lions Park (Hanson Blvd) S004-171	2007-2017	
Coon Creek at 111th S007-559	2018-2019	Water Chemistry Grab Samples, Continuous Stage, Storm Event Water Quality
Ditch 52 at Robinson (tributary) S015-117	2018	
Coon Cr at Vale St S003-993	2005-2019	Water Chemistry Grab Samples, Continuous Stage, Storm Event Water Quality

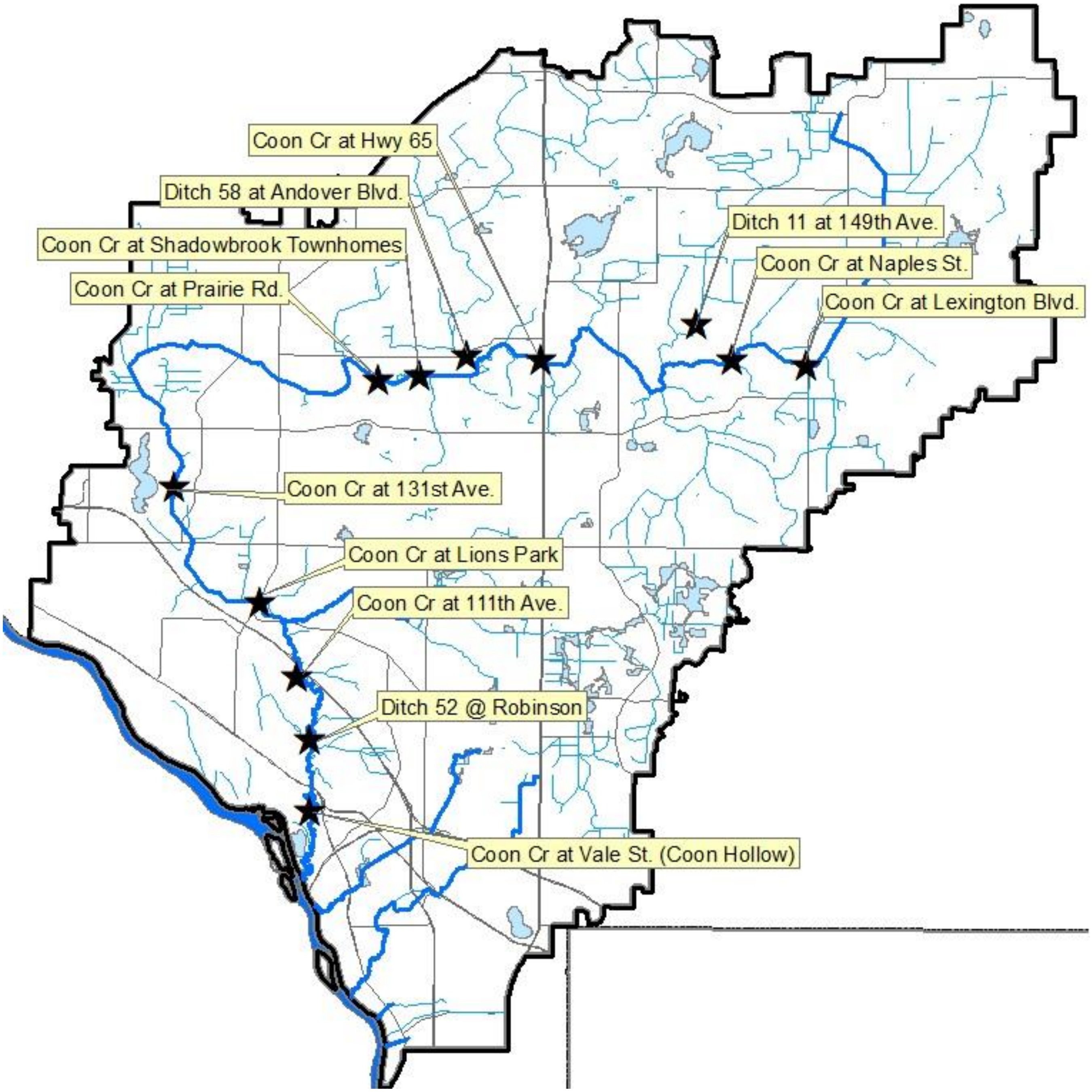
Background

Coon Creek and its tributaries (excluding the Sand Creek subwatershed) drain approximately 49,000 acres through central Anoka County. The main stem of Coon Creek starts as a ditched channel (Ditch 44) near the intersection of Crosstown Blvd. and Lexington Ave. in northeastern Ham Lake. The channel continues south and east approximately 27 miles, draining Ham Lake, southern Andover, western Blaine, and much of Coon Rapids, before emptying into the Mississippi River between the Coon Rapids Dam and Highway 610. Many tributary ditch systems join with Coon Creek throughout the system. These ditch systems, and Coon Creek itself, drain a mixture of rural agriculture and residential, suburban residential, and commercial land usage. Land usage shifts from primarily rural agriculture and residential in the northern portions of Ham Lake, which primarily drain through open channel ditch systems, to more dense suburban residential and commercial usage through Andover and Coon Rapids which primarily drains through subsurface stormwater infrastructure before outletting to the Creek itself.

The rural ditch systems that drain agricultural and residential lands to Coon Creek, primarily in the northern portions of the watershed include the Ditch 44, 11, 59, 58, 20, 23 and 37 systems. The ditch systems draining primarily suburban residential and commercial lands in the lower reaches of the watershed include the Ditch 52 and Ditch 41 (Sand Creek) systems. The central portions of the main channel of Coon Creek make up the Ditch 57 drainage area, and the lower portions of the main channel make up the Ditch 54 drainage area. Coon Creek is listed as an impaired water for aquatic life and aquatic recreation due to elevated levels of *E. coli* bacteria and poor invertebrate communities. New standards for aquatic life (Tiered Aquatic Life Use Standards) may take into consideration the fact that the creek is part of a public ditch system and, therefore, may lower aquatic life expectations and affect the impairment standards for this waterbody.


Coon Creek Catchments
Subwatershed Boundary
CCWD Boundary
Streams
Ditches
City Boundaries
Ditch Catchments
Ditch 58
COLUMBUS
Ditch 11
ANDOVER
Ditch 37
HAM LAKE
Ditch 44
Ditch 20
Ditch 57
Ditch 59
Ditch 23
Ditch 54
COON RAPIDS
Ditch 52
BLAINE
Lower Coon Creek
SPRING LAKE PARK
FRIDLEY
0 1 2 4 Miles
N

Coon Creek Main Stem and Tributary Ditch Monitoring Sites



Results and Discussion

Coon Creek is listed as impaired for aquatic recreation (*E. coli*) and invertebrate biota, with total phosphorus and TSS identified as the primary stressors along with poor habitat and altered hydrology. Total phosphorus levels throughout the watershed often exceed state water quality standards, as do TSS levels during storms. Coon Creek water quality declines in a statistically significant fashion moving upstream to downstream, though primarily in the upper portions of the watershed. Water quality in Coon Creek is compromised by a number of factors, but it appears that efforts by the CCWD within the watershed to improve stormwater treatment are making a difference in areas where this work is occurring, primarily in the developed areas in the downstream portions of the watershed. Modern stormwater treatment in newer developed areas paired with investments from the CCWD towards improving the stormwater treatment in underserved areas and maintaining the channel appear to be holding the line and preventing further decline of water quality. There is no significant change in total phosphorus or TSS concentrations from the monitoring site at 131st Ave. to Vale St. Additionally, there is no significant change at Vale St. over time since 2005 for these parameters.

Unfortunately, the ditch systems in the upper portions of the watershed appear to be degrading Coon Creek water quality, based on concentrations, to levels that will prevent it from ever having good water quality downstream if new management measures aren't implemented in these areas. A significant decline in water quality is documented through the main channel in the upper reaches, namely from Naples St. to 131st Ave. Many ditch systems that drain rural and agricultural areas join Coon Creek throughout this portion of the watershed. These ditch systems are not all monitored, but the ditches that are monitored appear to have poor water quality. Additionally, the primary source of *E. coli* bacteria in Coon Creek as identified by the TMDL, is livestock (cattle and horses). These are far more prevalent in the upper reaches of the watershed, and sometimes immediately adjacent to the creek itself. Domestic pets are listed as the next largest source after livestock. Another likely source of *E. coli* throughout the watershed is waterfowl, which congregate throughout much of the drainage area and in the creek itself. A shift in focus and resources to the upstream reaches of the Coon Creek watershed may be the most beneficial next step to improving water quality through the entirety of the system. A more in-depth analysis of individual parameters can be found below.

Specific conductance and Chlorides

Dissolved pollutant concentrations are higher in downstream reaches of Coon Creek, where there is more impervious area with more dense development (see figures below). Median specific conductance increases gradually from upstream (0.437 mS/cm) to downstream (0.774 mS/cm) during baseflow conditions. Median specific conductance (all years) following storm events shows a smaller difference between upstream and downstream, ranging from 0.411 to 0.519 mS/cm. The median specific conductance concentration in Coon Creek at Vale St. is higher during both baseflow conditions and post storm event than the composite countywide median for Anoka County streams of 0.420 mS/cm

This lends some insight into the pollutant sources. If dissolved pollutants were only elevated after storms, stormwater runoff would be suspected as the primary driver. Because dissolved pollutants are highest during baseflow conditions, pollution of the shallow groundwater which feeds the stream during baseflow is suspected to be a primary contributor. In Coon Creek, especially further downstream, specific conductance is higher during baseflow conditions, meaning the local groundwater feeding the stream at baseflow is likely a significant source of dissolved pollutants.

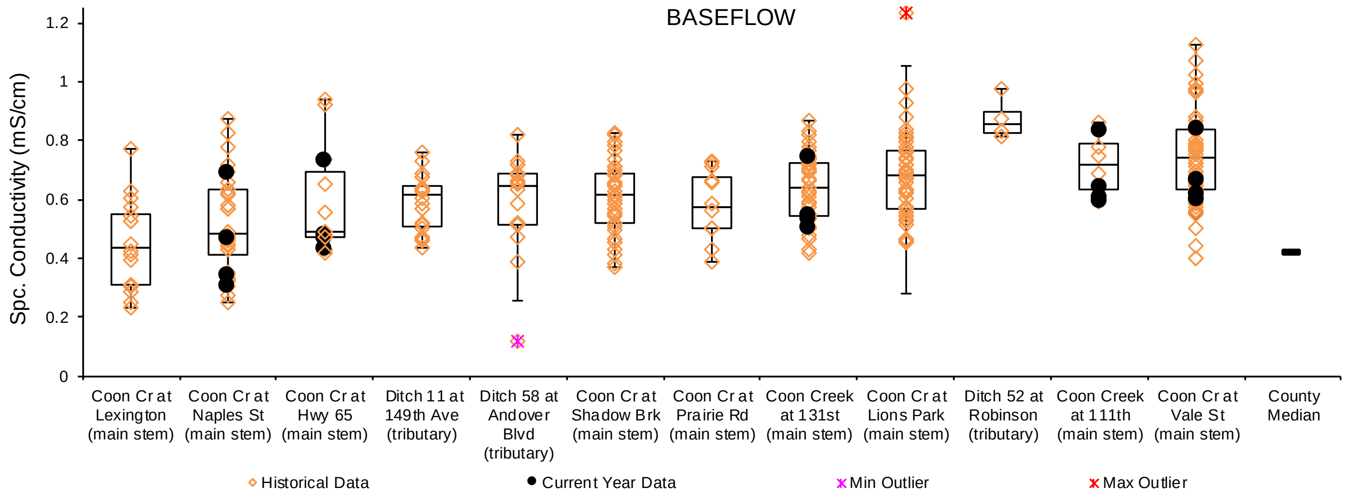
Storms help dilute some of the pollutant load, making the increase from upstream to downstream smaller. However, upstream median values during all conditions are still above average in Coon Creek compared to other Anoka County streams. Prevention measures to reduce specific conductance (such as reduced road salting) should be a focus of management.

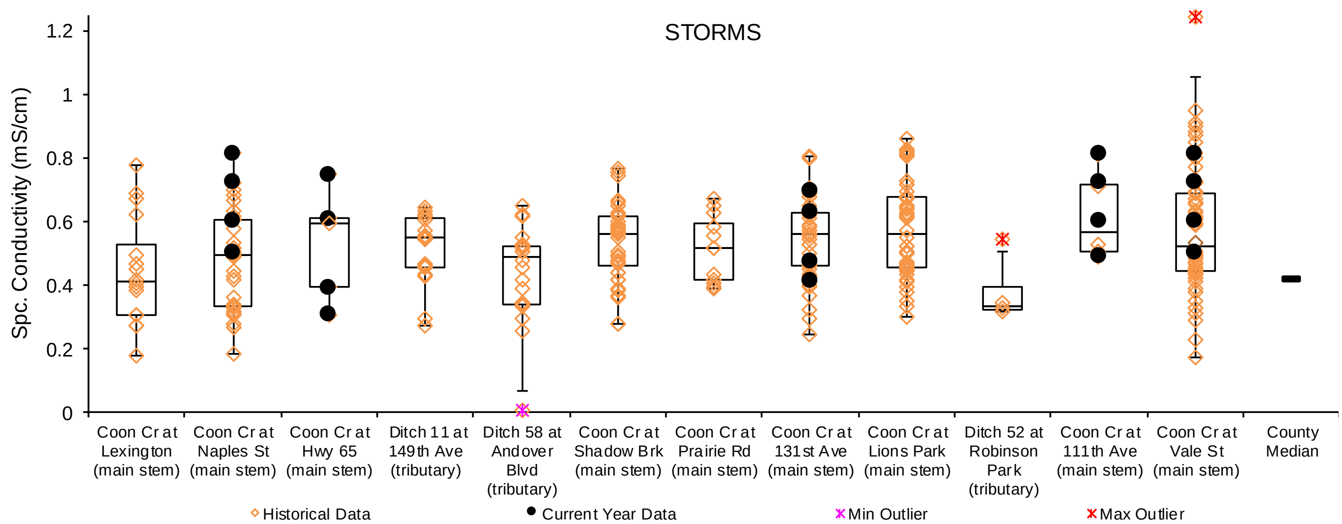
Chloride sampling has not occurred enough in Coon Creek for statistical analysis, but a cursory look at the box plots of chloride concentrations below shows an increase in chloride moving downstream through Coon Creek for samples collected in 2019 and prior years. As the creek progresses through its watershed, road and housing densities increase dramatically. This is likely causing additional loading of chlorides in these reaches through road salting, water softeners, and potential industrial inputs. Although the concentrations of chlorides increase dramatically moving downstream, the concentrations in grab samples have not approached state standard concentrations (230 mg/L chronic and 860 mg/L acute).

Median specific conductance in Coon Creek Data is from Vale St for specific conductance and chlorides all years through 2019.

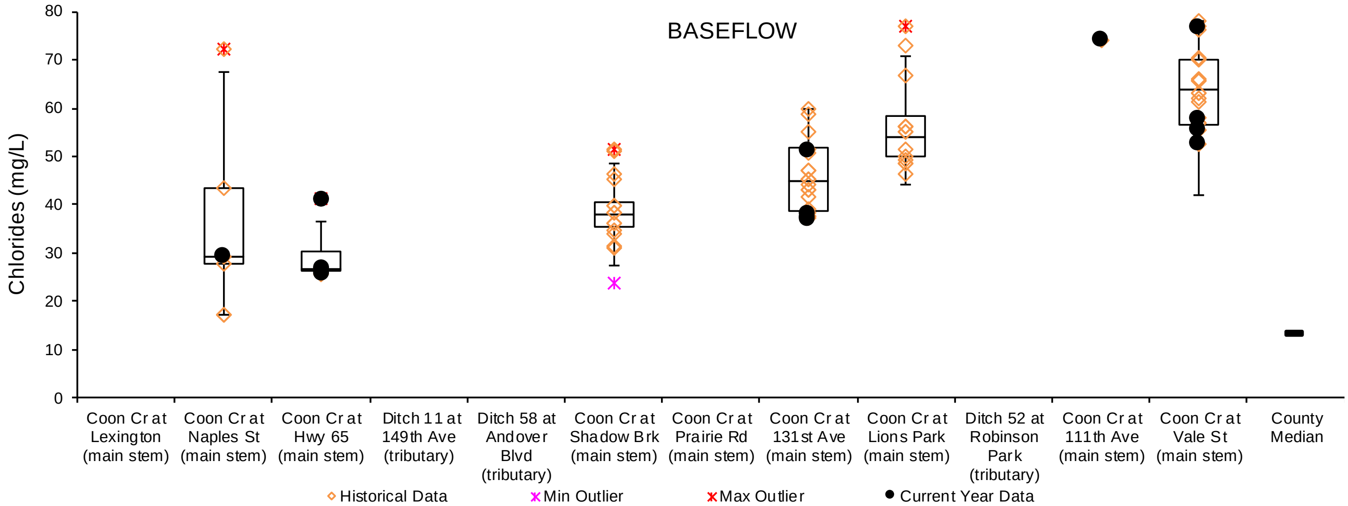
	Specific conductance (mS/cm)	**Chlorides (mg/L)**	**State Standard**	**N**
Baseflow	0.744	63.85	Specific conductance – none Chlorides 860 mg/L acute, 230 mg/L chronic	55
Storms	0.519	53.30		56
All	0.655	59.3		111
Occasions > state standard				0

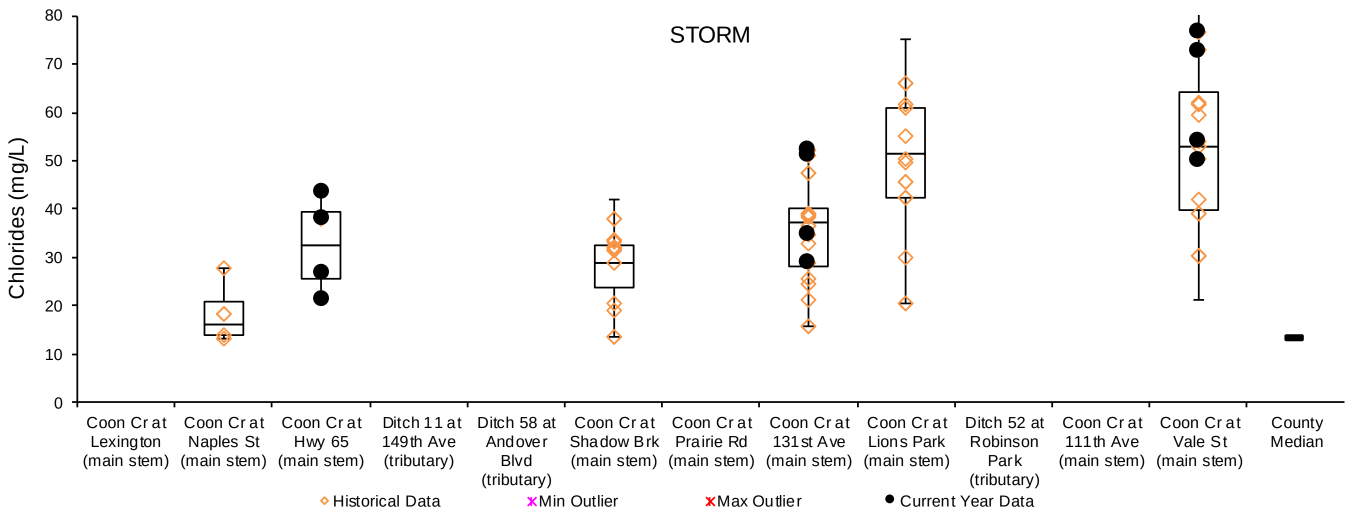
Specific conductance at Coon Creek Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Chlorides at Coon Creek Orange diamonds are historical data from previous years and black circles are 2019 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 state water quality standard for Total Phosphorus (TP) for streams in this region is 100 µg/L, and Coon Creek eventually may be designated as impaired as it often exceeds the standard, especially during storms. Coon Creek does have a TMDL in place for TP even without the impaired designation for this pollutant because it is identified as a stressor for aquatic macroinvertebrates, which the creek is impaired for. Best management practices to address stormwater phosphorus loading would be beneficial along the entire stream length, but especially in the upper ditched portions of the watershed. ANOVA analyses at three sites moving upstream to downstream (Coon Creek at Naples St, 131st Ave, and Vale St.) show a significant increase in TP concentrations from the upstream portions of the watershed to the approximate mid-point of the watershed (Naples St. to 131st Ave.) during both baseflow and stormflow conditions. In both scenarios, no additional significant increase is present from 131st Ave. to the downstream monitoring site at Vale St.

Focusing on the upper portions of the watershed, the monitoring sites at Lexington Ave. and Naples St. both generally have baseflow concentrations below the state standard, and often are below that standard during post-storm sampling as well. However, the two monitored ditch systems that join with Coon Creek downstream of these sites (Ditch 11 and Ditch 58) generally have higher phosphorus concentrations than the creek itself. Ditch 11, where phosphorus concentrations are generally high in all conditions, appears to be contributing to the downstream degradation of Coon Creek water quality. The average concentration of TP samples collected in Ditch 11 at 149th Avenue from 2013-2017 was 140 µg/L for baseflow events and 281 µg/L for storm events, both higher than the state standard at 100 µg/L. Other ditch systems with similar land use that join with Coon Creek in these upper reaches are also likely contributing to the increases in phosphorus concentration moving downstream through the watershed.

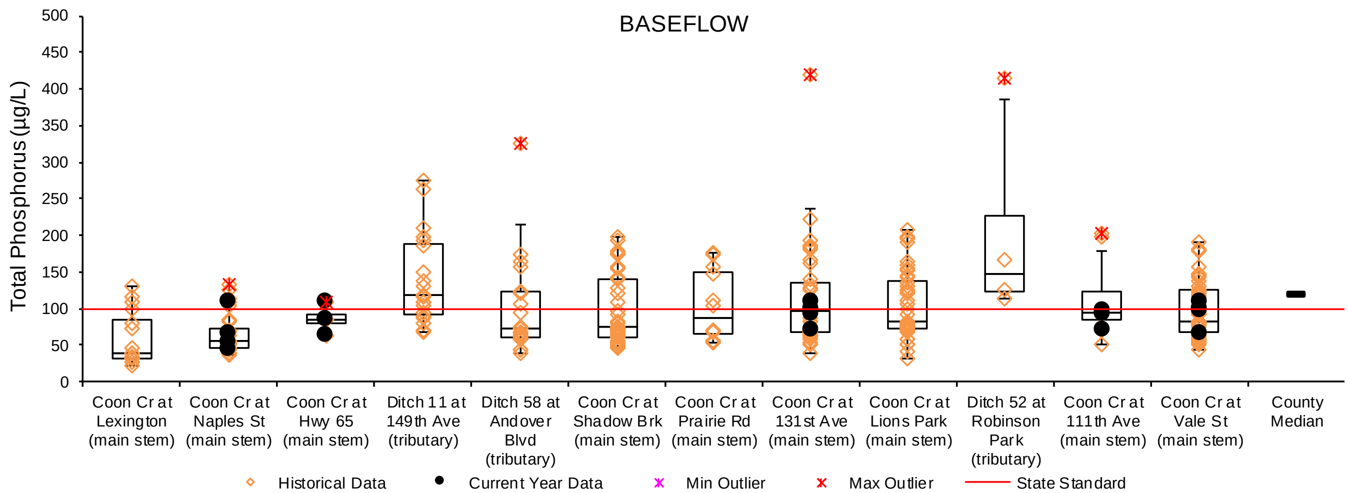
Of particular note, in the lower reaches of the watershed, the change in stormflow TP concentrations between 131st Ave. and Vale St. is close to being statistically significant ($p=0.08$) in a downward (improving) direction. For all samples collected at these sites during storm flows, TP concentrations at 131st Ave. average 210.88 µg/L, while concentrations at Vale St. average 161.78 µg/L. When analyzing change over time at Vale St., no significant change is found for either baseflow or storm event total phosphorus from 2005-2019. The Coon Creek Watershed District has invested a lot of money and effort into stormwater treatment practices and stream improvement projects in this portion of the watershed. Stormwater management in this portion of the watershed appears to have quantifiable impacts towards improving phosphorus concentrations in the creek during storm events. However, the concentrations in these lower watershed reaches often still exceed state standards.

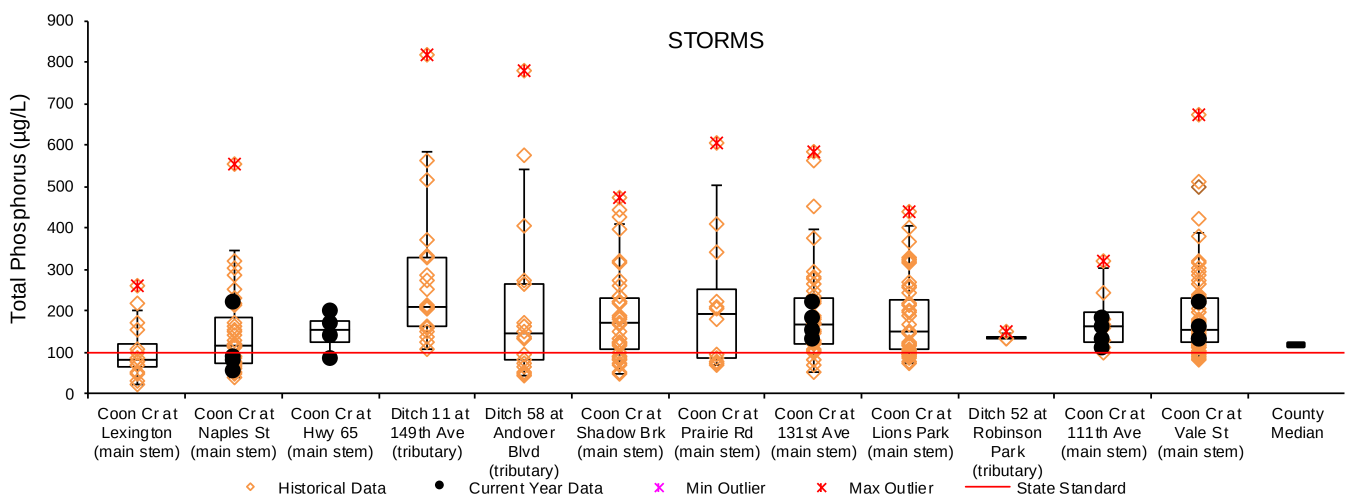
The Coon Creek TMDL, approved in 2016, delegates acceptable loads of pollutants in Coon Creek on a load duration curve (LDC) instead of a fixed daily or annual load in pounds. The LDC for Coon Creek is graphed on a plot with flow-weighted daily loads for phosphorus samples collected at Vale Street from 2005-2014 (Page 47, Figure 16). This plot shows that the creek exceeds its LDC for TP during high and very high flows almost 100% of the time, while often maintaining acceptable loads during low and very low flows. Pairing the results shown on this curve with our grab sample concentration analysis indicates that additional treatment of stormwater in the upper reaches of the watershed should be a high priority for management in Coon Creek. It is likely that the ditch systems joining Coon Creek in its upper reaches are flushing large loads of phosphorus into the creek during storm events that cannot be diluted or settle out attached to particles before travelling through the entire system.

Average and median total phosphorus in Coon Creek Data is from Vale St for all years through 2019.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	97.47	83.00	100 µg/L	59
Storms	195.93	152.5		60
All	147.1	127.0		119
Occasions > state standard				76 (64%) (55 storms, 21 baseflow)

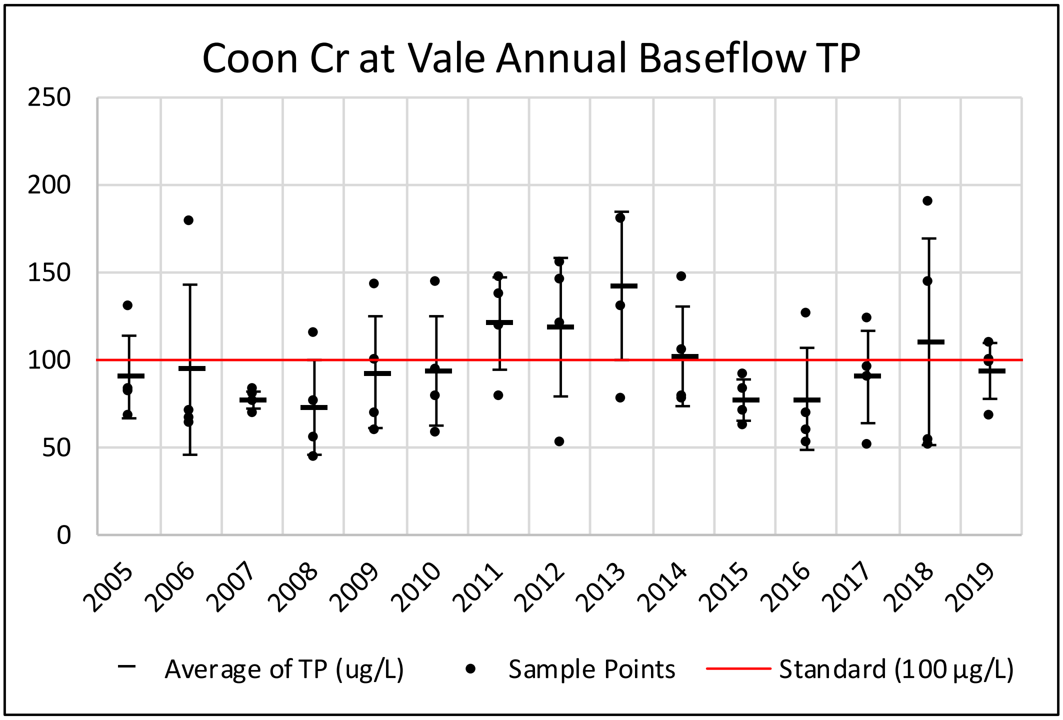
Total Phosphorus at Coon Creek Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

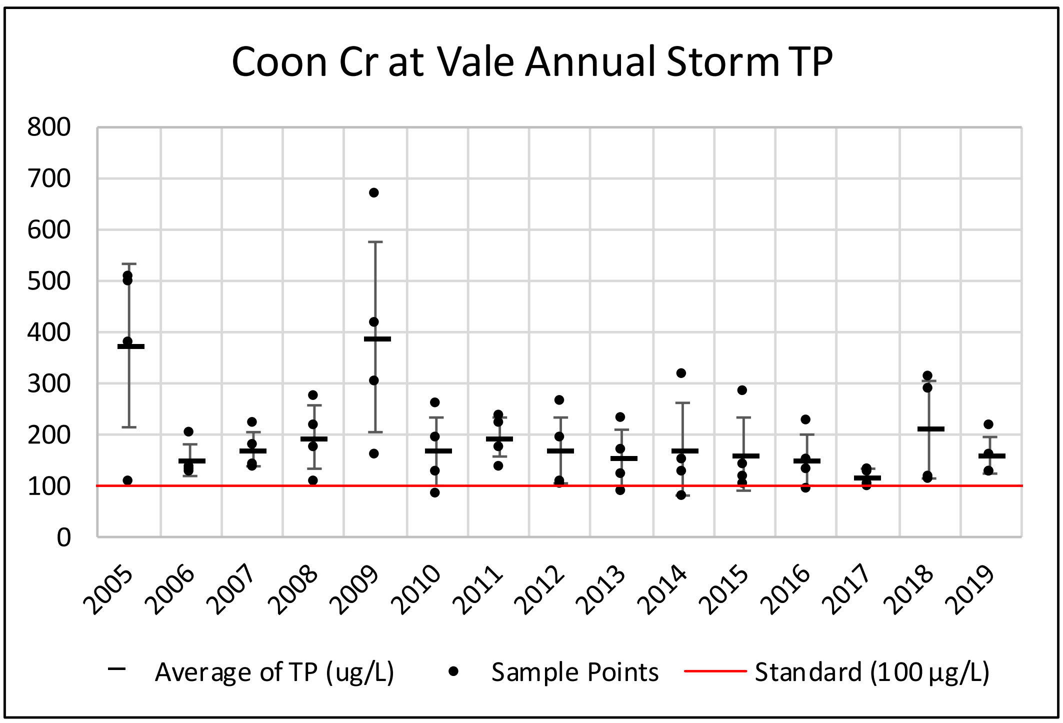




Parameter	Significant Change in Annual $\bar{X}$ (2005-2019)	p=	Standard Error of Means
Total Phosphorus - Baseflow	None	0.58	19.75
Total Phosphorus - Storm	None	0.08	72.32

Coon Creek at Vale St. - Annual average TP Concentration - ANOVA regression 2005-2019


Coon Cr at Vale Annual Baseflow TP
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Average of TP (ug/L)
Sample Points
Standard (100 µg/L)


Coon Cr at Vale Annual Storm TP
800
700
600
500
400
300
200
100
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Average of TP (ug/L)
Sample Points
Standard (100 µg/L)

ANOVA Matrix for Baseflow Total Phosphorus	Coon Creek at Naples St.	Coon Creek at 131st Ave.	Coon Creek at Vale St.
Coon Creek at Naples St.		Significant Increase Naples $\bar{X}$= 66.31µg/L 131st $\bar{X}$= 111.88 µg/L p= < 0.01	Significant Increase Naples $\bar{X}$= 66.31µg/L Vale $\bar{X}$= 101.63 µg/L p= < 0.01
Coon Creek at 131st Ave.			No Sig. Change 131st $\bar{X}$= 111.88 µg/L Vale $\bar{X}$= 101.63 µg/L p= 0.50
Coon Creek at Vale St.			

ANOVA Matrix for Storm Total Phosphorus	Coon Creek at Naples St.	Coon Creek at 131st Ave.	Coon Creek at Vale St.
Coon Creek at Naples St.		Significant Increase Naples $\bar{X}$=146.84µg/L 131st $\bar{X}$= 210.88 µg/L p= < 0.05	No Sig. Change Naples $\bar{X}$=146.84µg/L Vale $\bar{X}$= 161.78 µg/L p= 0.51
Coon Creek at 131st Ave.			No Sig. Change 131st $\bar{X}$= 210.88 µg/L Vale $\bar{X}$= 161.78 µg/L p= 0.08
Coon Creek at Vale St.			

Total Suspended Solids and Turbidity

Similar to TP, Coon Creek has a TMDL for TSS because it is identified as a stressor for aquatic macroinvertebrates in the creek, not because the creek is impaired for TSS. TSS concentrations in Coon Creek follow a very similar pattern to TP concentrations, but are generally at levels below the state standards and below the LDC for TSS in the Coon Creek TMDL. The state water quality standard for TSS in the Central River Nutrient Region is 30 mg/L. The stream occasionally exceeds the state standard concentration during storm events in its middle and lower reaches.

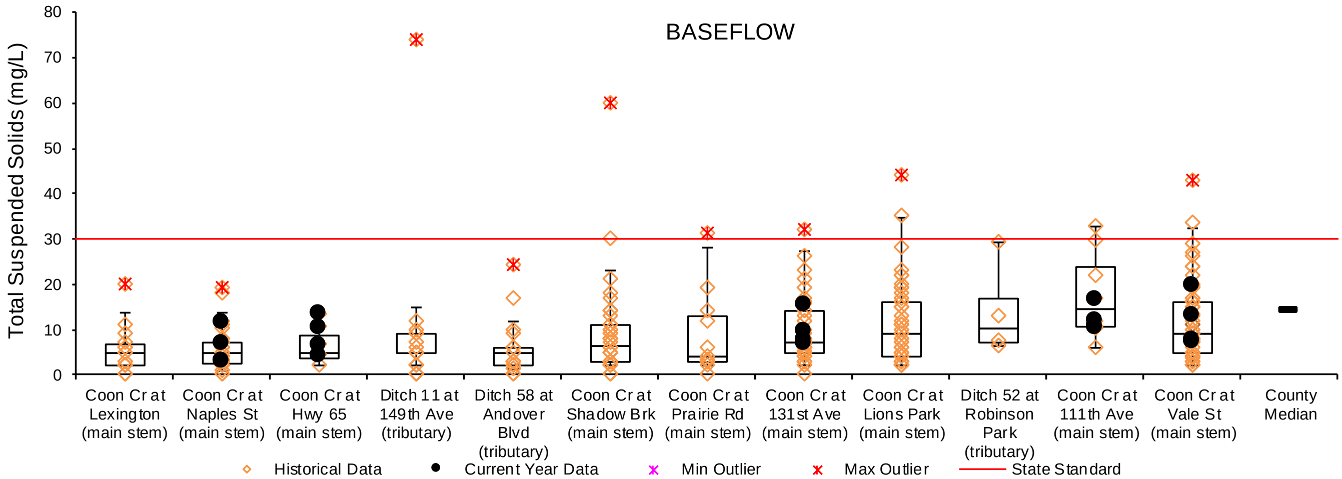
ANOVA analyses at three sites moving upstream to downstream (Coon Creek at Naples St, 131st Ave, and Vale St.) show a significant increase in TSS concentrations from the upstream portions of the watershed to the approximate mid-point of the watershed (Naples St. to 131st Ave.) during both baseflow and stormflow conditions. In both scenarios, no additional significant increase is present from 131st Ave. to the downstream monitoring site at Vale St. There is also no significant change in TSS over time at Vale St. from 2005 through 2019. The LDC plot for TSS in Coon Creek from the TMDL (Page 42, Figure 13) shows that TSS loads are generally only exceeded during high and very high flows at Vale Street. Concentrations during grab samples also indicate that concentrations remain below state standards most of the time, and only exceed that standard occasionally following storm events.

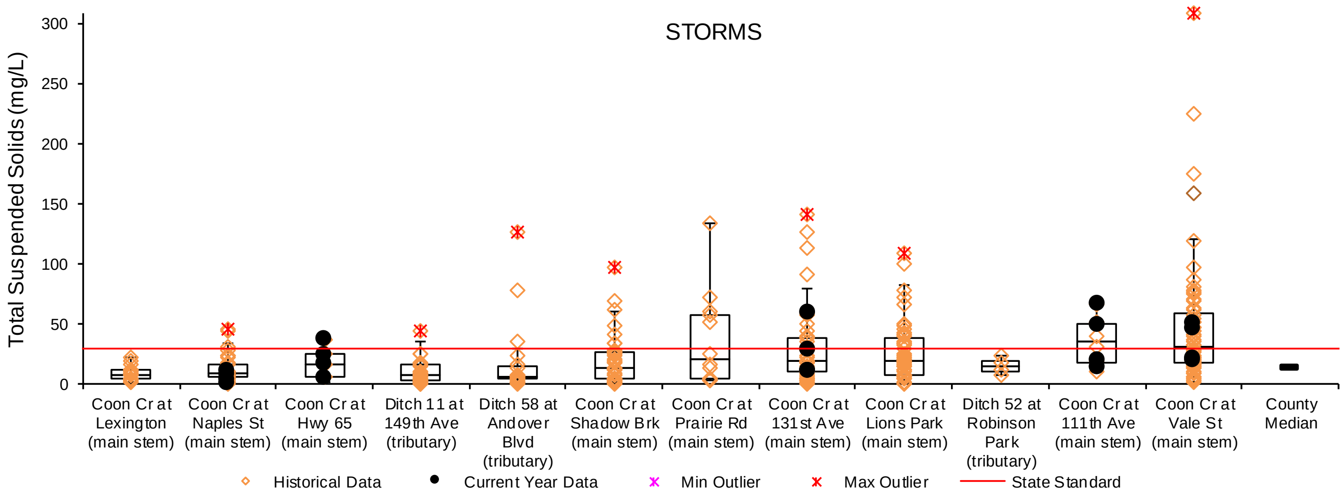
While TSS concentrations and daily flow-weighted loads generally conform to state standards and the LDC respectively in Coon Creek at Vale Street, it should be noted that significant increases in concentrations moving from the upstream reaches to more central monitoring sites mirror the trends observed for TP and should be a high priority for management of Coon Creek's water quality. In the TMDL, it is estimated that 63% of all TSS loading to Coon Creek is due to streambank erosion. If this is the case, that erosion may be more severe in upper reaches of the watershed where TSS concentrations are increasing. These unstable banks may offer a good starting point for the reduction of both TP and TSS in Coon Creek through stabilization efforts, or efforts to reduce the rapid increase in flow and erosive energy from water rushing through the ditch systems during storm events. Any efforts to reduce TSS loading to Coon Creek in these upper reaches will also reduce phosphorus loading to the creek as well as improve the water quality of the entire creek downstream of the implemented projects. Additionally, as the northern portion of the subwatershed develops, it is important to continue enforcing stringent stormwater regulations and compliance with construction site best practices.

Average and median total suspended solids in Coon Creek Data is from Vale St for all years through 2019.

	Average TSS (mg/L)	Median TSS (mg/L)	State Standard	N
Baseflow	11.70	9.0	30 mg/L	60
Storms	48.79	31.0		60
All	30.25	17.0		120
Occasions > state TSS standard				32 (27%) (30 during storm flows)

Total Suspended Solids at Coon Creek Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

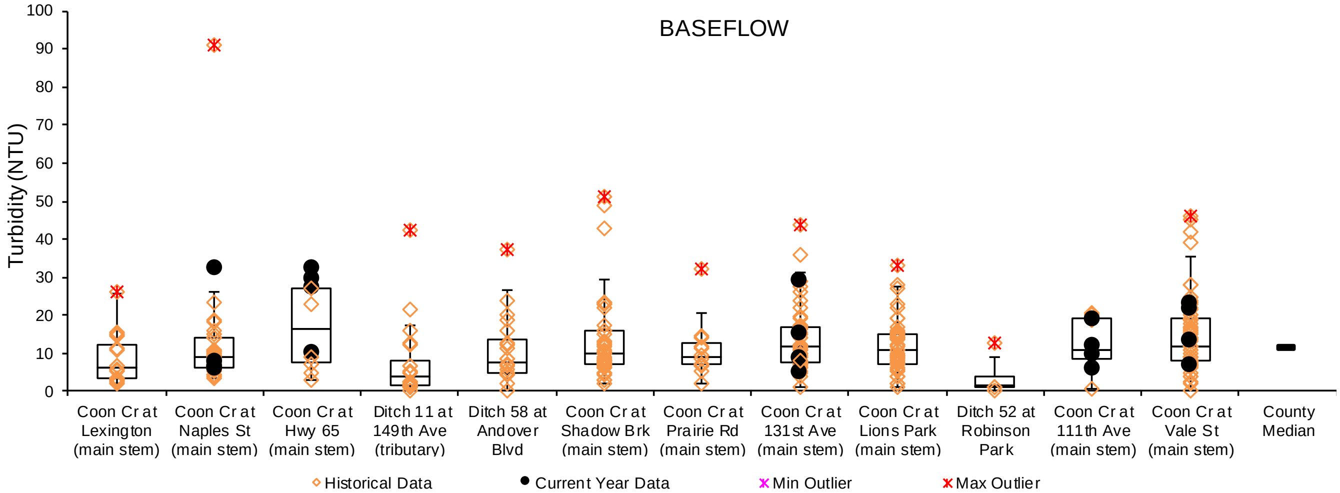


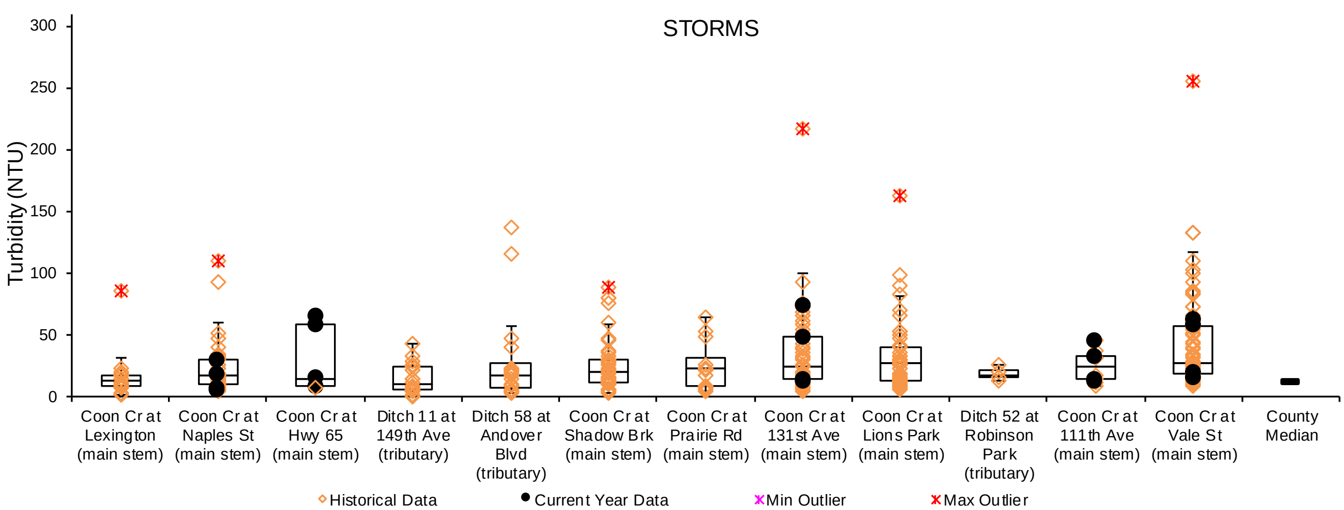


Average and median turbidity in Coon Creek Data is from Vale St for all years through 2019

	Average Turbidity (NTU)	Median Turbidity (NTU)	State Standard	N
Baseflow	14.88	12.0	N/A	59
Storms	44.5	26.3		60
All	29.81	18.7		119

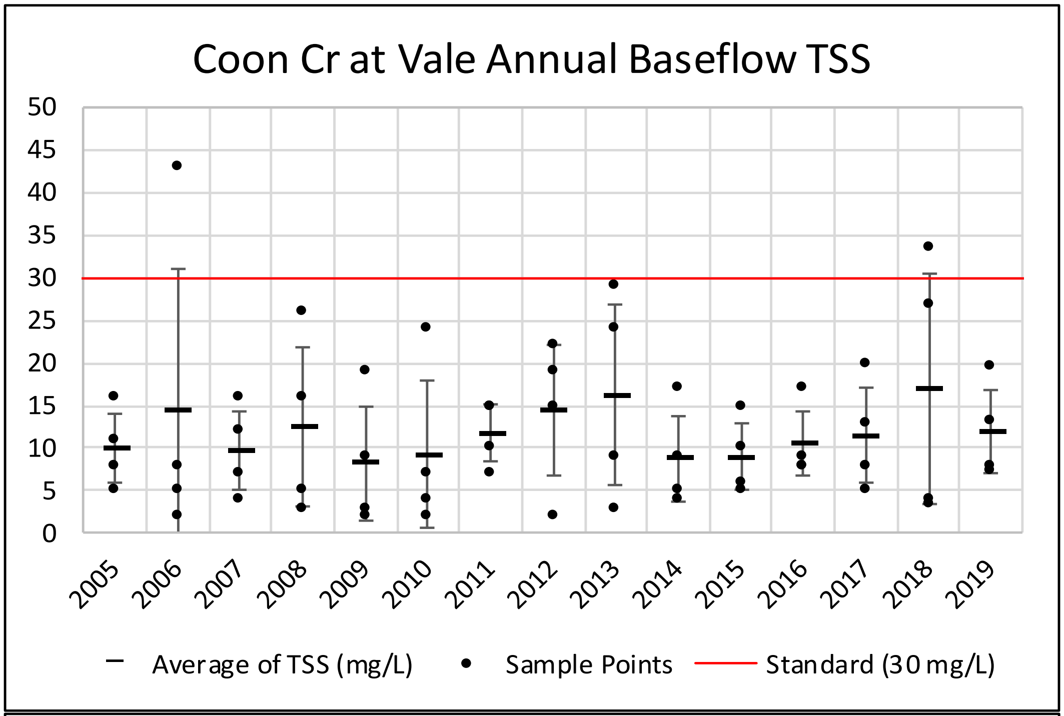
Turbidity at Coon Creek Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

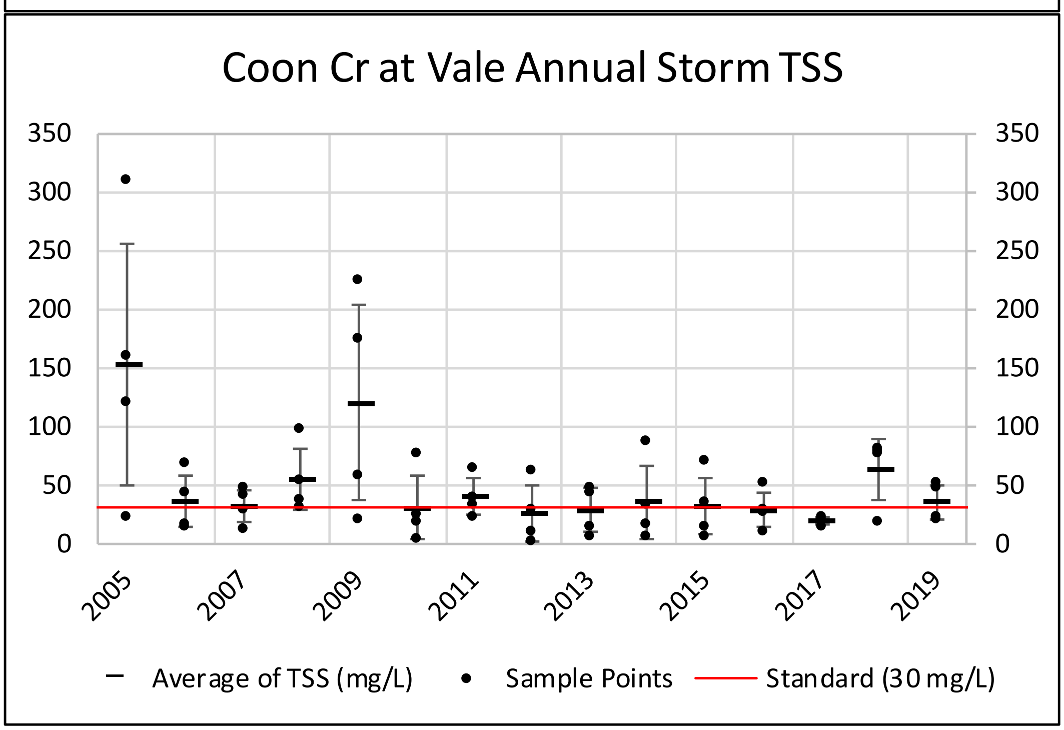




Coon Creek at Vale St. - Annual average ANOVA regression TSS 2005-2019

Parameter	Significant Change in Annual $\bar{X}$ (2005-2019)	p=	Standard Error of Means
Total Suspended Solids - Baseflow	None	0.46	2.81
Total Suspended Solids - Storm	None	0.08	34.67





ANOVA Matrix for Baseflow Total Suspended Solids	Coon Creek at Naples St.	Coon Creek at 131st Ave.	Coon Creek at Vale St.
Coon Creek at Naples St.		Significant Increase Naples $\bar{X}$= 5.58 mg/L 131st $\bar{X}$= 9.77 mg/L $p = < 0.01$	Significant Increase Naples $\bar{X}$= 5.58 mg/L Vale $\bar{X}$= 12.13 mg/L $p = < 0.01$
Coon Creek at 131st Ave.			No Sig. Change 131st $\bar{X}$= 9.77 mg/L Vale $\bar{X}$= 12.13 mg/L $p = 0.23$
Coon Creek at Vale St.			

ANOVA Matrix for Storm Total Suspended Solids	Coon Creek at Naples St.	Coon Creek at 131st Ave.	Coon Creek at Vale St.
Coon Creek at Naples St.		Significant Increase Naples $\bar{X}$= 12.55mg/L 131st $\bar{X}$= 33.78 mg/L $p = < 0.01$	Significant Increase Naples $\bar{X}$= 12.55mg/L Vale $\bar{X}$= 33.28 mg/L $p = <0.01$
Coon Creek at 131st Ave.			No Sig. Change 131st $\bar{X}$= 33.78 mg/L Vale $\bar{X}$= 33.28 mg/L $p = 0.95$
Coon Creek at Vale St.			

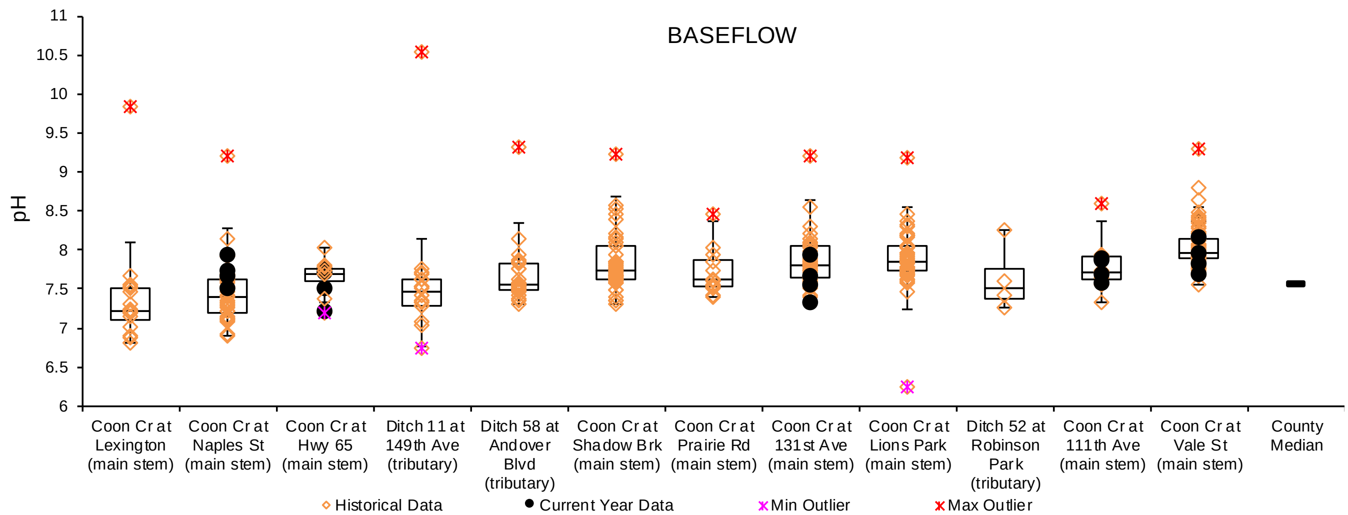
pH

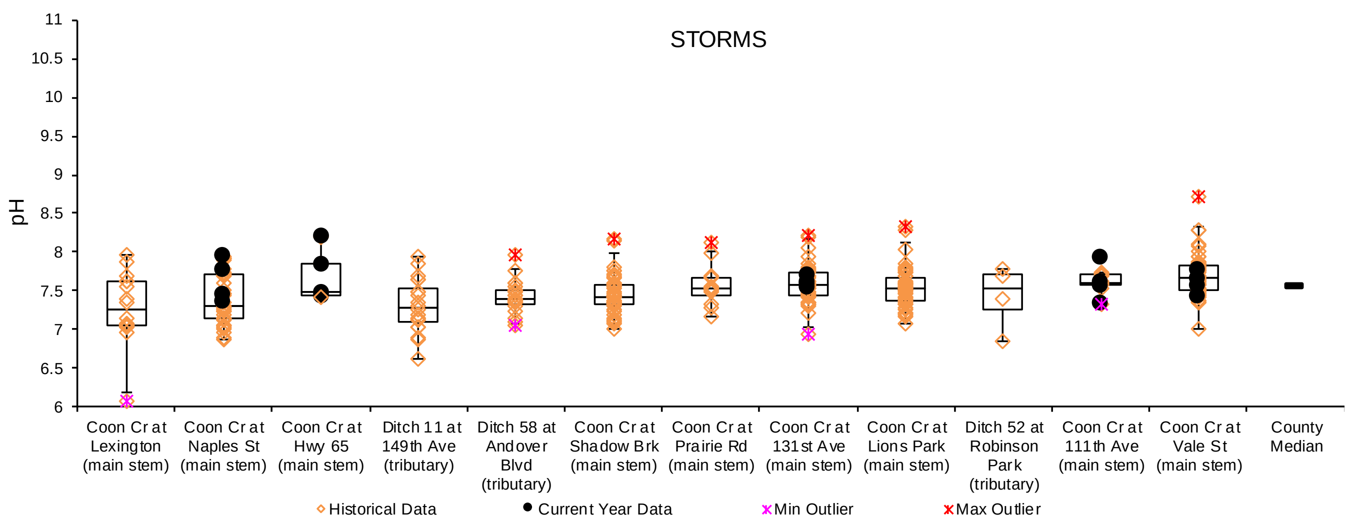
pH levels in Coon Creek are normally within the state standard range of 6.5-8.5. Typically, pH is lower during storm events because rainfall is more acidic. Exceedances of state standards have occurred, but they are rare and are not currently a concern within the creek.

Average and median pH in Coon Creek Data is from Vale St for all years through 2019.

	Average pH	Median pH	State Standard	N
Baseflow	8.04	7.97	6.5-8.5	59
Storms	7.69	7.66		56
All	7.87	7.85		115
Occasions outside state standard				4 (3 during baseflow)

pH at Coon Creek Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





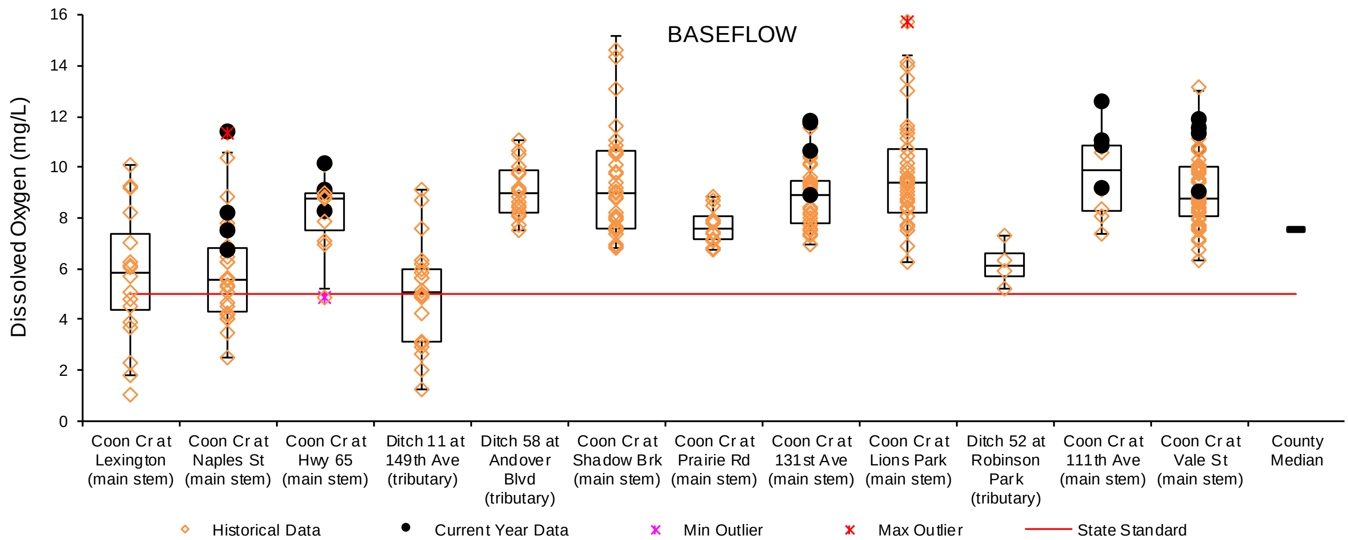
Dissolved Oxygen

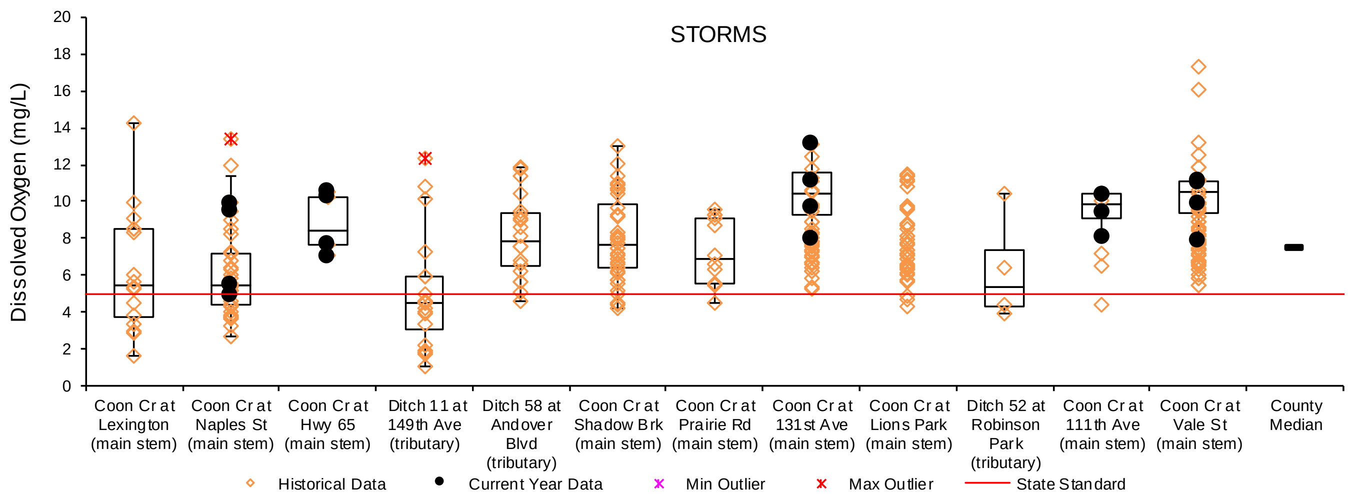
Low dissolved oxygen (DO) levels are generally not an issue in Coon Creek, especially in the downstream reaches of the creek. In past years, low DO readings all occurred in the upstream reaches of the main stem and in Ditch 11. There is an apparent increase in DO levels between these upstream sites and the site located near the Shadowbrook housing development. Higher DO levels are present in the larger and more natural channel found further downstream than the levels observed in the small ditched channels upstream.

Average and median dissolved oxygen in Coon Creek Data is from Vale St for all years through 2019.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	9.29	8.80	5 mg/L daily minimum	56
Storms	8.65	8.00		58
All	8.95	8.65		114
Occasions <5 mg/L				0

Dissolved oxygen at Coon Creek Orange diamonds are historical data from previous years and black circles are 2019 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

The chronic state water quality standard for *E. coli* in streams is based on a calculated geometric mean of not less than five samples in any given calendar month. This mean should not exceed 126 MPN. An additional standard of not more than 10% of all samples in a given month should not exceed 1260 MPN is also listed. Because we monitor streams throughout the year, only collecting eight samples total, we do not have sufficient numbers of samples for any given calendar month to calculate geometric means or percentage-based exceedances comparable to these standards.

During baseflow conditions, *E. coli* concentrations are generally lower in the upper reaches of the Coon Creek system and higher downstream. Median *E. coli* for all years at sites moving upstream to downstream ranges from 71.0 MPN at Naples St. to 138.5 MPN at Vale St during baseflow conditions. Though the sampling frequency requirements were not met for comparison to state standards, bacteria levels during baseflow generally are below the 126 MPN chronic state water quality standard benchmark in the upper watershed.

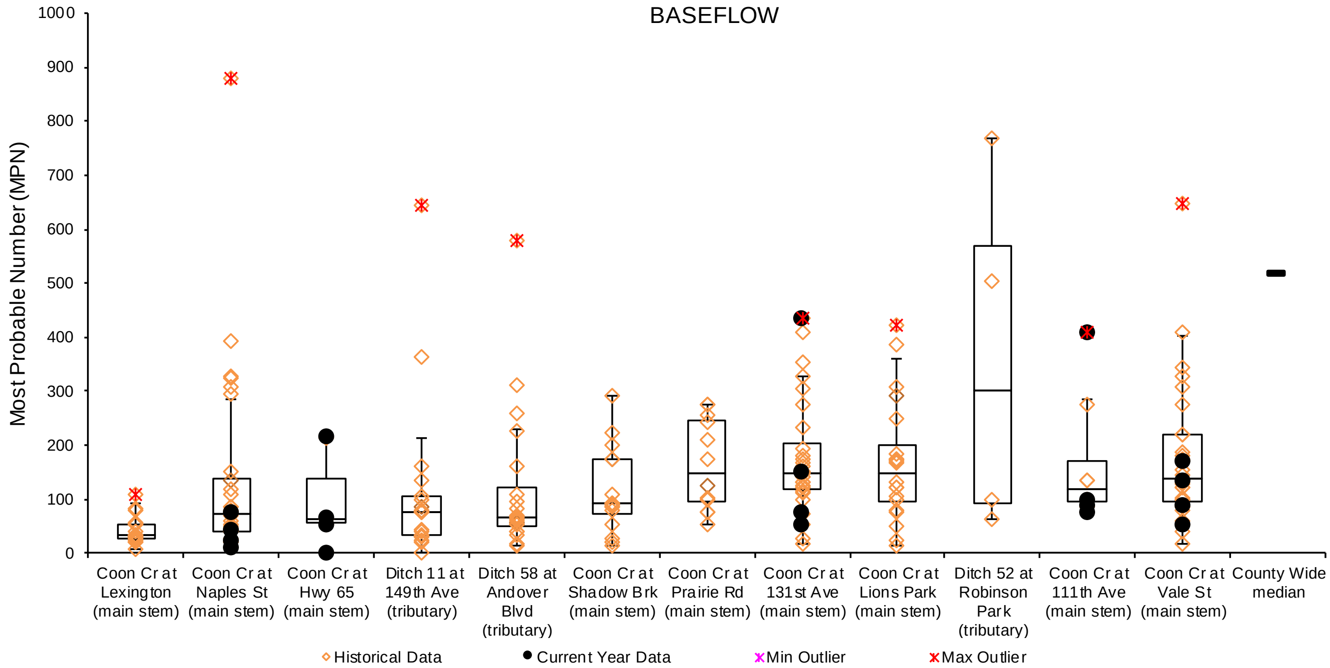
During baseflow conditions, all sites downstream of Naples St. exceeded 126 MPN on at least one occasion in 2019. Although *E. coli* concentrations were lower than previous years at monitored sites in 2019, median *E. coli* for all years suggest that *E. coli* concentrations are likely close to exceeding the state standard most of the time in the lower reaches of the watershed. During storms, *E. coli* concentrations were significantly higher and more variable (note the order of magnitude difference in Y-axis scales in the graphs below). Median *E. coli* during storms from upstream to downstream ranges from 433.5 MPN at Naples St to 945.5 MPN at Vale St. In 2019, all but three samples collected at all sites post-storm exceeded 126 MPN. Although the sampling frequency requirements are again not met, *E. coli* levels in all Coon Creek grab samples during storms in 2019 only exceeded 1,260 MPN on one occasion (13% of samples), and that was at 131st Ave.

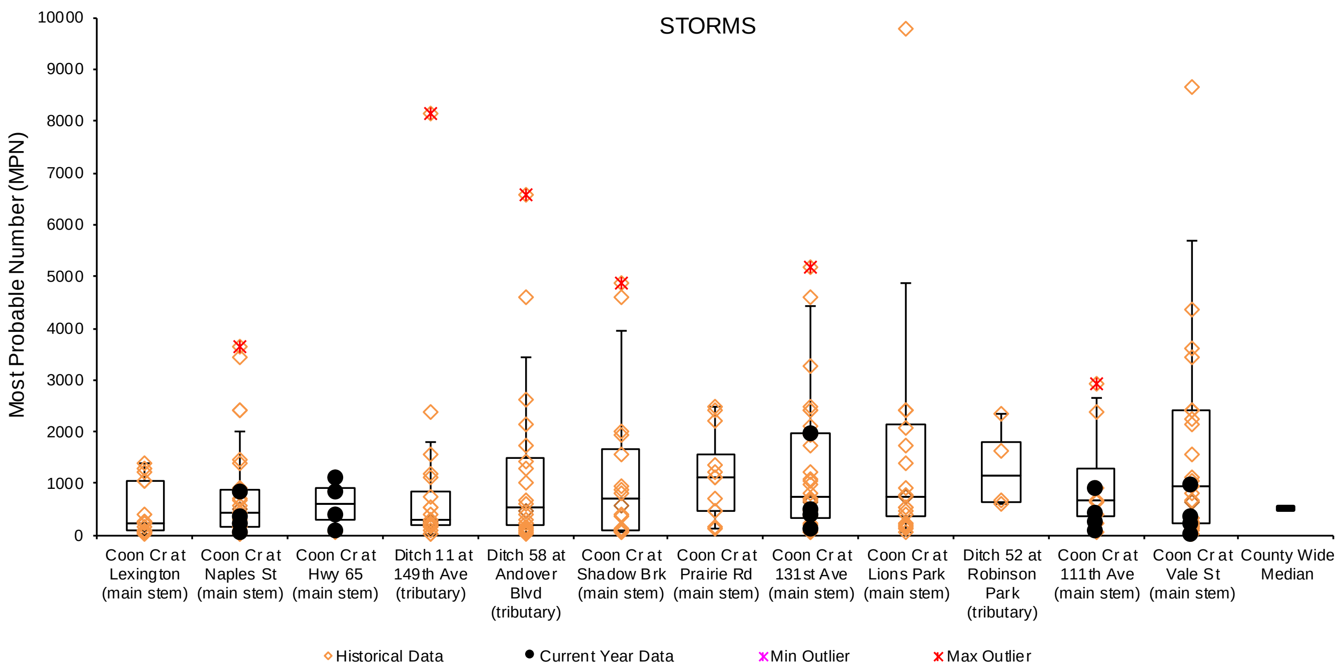
Coon Creek is listed as impaired for aquatic recreation due to *E. coli* and the *E. coli* LDC in the Coon Creek TMDL (Page 51, Figure 20) shows that the creek often exceeds acceptable loads during all flow levels, low to very high. *E. coli* sources can be harder to pinpoint than sources of other pollutant loading because concentrations fluctuate wildly up or down without additional input due to this particular pollutant being a living organism. The TMDL estimates that livestock (51%) and domestic dogs (37%) contribute most of the *E. coli* load to Coon Creek. Most of the livestock, which are primarily identified as horses, occur in the upstream portions of the watershed. Domestic dogs likely exist throughout the watershed. Horses as point sources near the creek should be easy to identify in the upper portions of the watershed. An education campaign, and potentially some monetary incentives, could help address these sources. It’s also possible that waterfowl have a larger *E. coli* footprint in Coon Creek than road surveys conducted for the TMDL may suggest. Additionally, implementation strategies to address TSS and TP loading by reducing soil erosion and organic debris will also reduce particle-bound sources of *E. coli*.

Average, Geomean and median *E. coli* in Coon Creek Data is from Vale St. 2013-2019.

	Average *E. coli* (MPN)	**Geomean *E. coli* (MPN)**	**Median *E. coli* (MPN)**	**State Standard**	**N**
Baseflow	177.92	136.77	138.50	Monthly Geometric Mean >126	28
Storms	1,939.77	789.57	945.5		28
All	1,058.85	329.03	218.5	Monthly 10% average >1260	48
Occasions >126 MPN					16 baseflow (57%), 25 storm (89%)
Occasions >1260 MPN					0 baseflow, 11 storm (39%)

***E. coli* at Coon Creek** Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





YSI Continuous Stream Water Quality Monitoring – Coon Creek Main Stem

COON CREEK

at 111th Avenue & Vale Street, Coon Rapids

Background

On the following pages, results from each storm monitored in 2019 are shown. This includes four storm events at both Coon Creek at 111th and Coon Creek at Vale Street, the two furthest downstream monitoring sites. The graphs show daily precipitation totals as well as the stream hydrograph for the duration of the storm. Separate graphs show each water quality parameter graphed with water elevation. The text below summarizes findings for both monitoring sites across all storms for each parameter.

Results and Discussion

Turbidity

- Turbidity data provided by continuous monitoring can be erratic as suspended debris often gets trapped in the sensor guard and affects measurements on deployments. This can cause very irregular readings that rapidly jump up and down, or stay very high once the stream returns back to baseflow.
- In general, turbidity rises rapidly at the beginning of storms, along with stage at both sites. Maximum turbidity readings for individual storms at both sites typically reached levels between 50 and 250 NTU.
- In some cases, stage and turbidity were each slow to return to normal baseflow levels ,likely due to continued precipitation and the above average saturation of the watershed and water levels in general throughout 2019.
- At baseflow, Coon Creek runs quite clear with typical turbidity readings between 0 and 10 NTU.

Specific Conductance

- Specific conductance decreases during storm events in Coon Creek at both monitoring sites. When creek stage rises due to storm runoff, conductance drops. During brief, intense rainfall stream conductance drops sharply. This relationship indicates that the shallow groundwater that feeds the stream during baseflow conditions has higher specific conductance than stormwater runoff.
- Infiltration of road deicing salts is a likely source of dissolved pollutants in streams at baseflow year round due to contamination of the surficial groundwater that feeds the streams.
- At baseflow, Coon Creek specific conductance generally remains between 700 and 1,100 µS/cm.

Dissolved Oxygen

- The recorded dissolved oxygen concentrations in Coon Creek were within the healthy range, >5mg/L. The lowest reading recorded was at Vale St. in late-July when dissolved oxygen levels dropped to 5.5 mg/L. On this occasion, water temperatures were greater than 71° F as warmer water holds less dissolved oxygen.
- Diel fluctuations in dissolved oxygen concentrations in Coon Creek are also typically less than 2 mg/L. The state standard for maximum diel oxygen flux in this region is 3.5 mg/L.

Temperature

- Water temperature is generally not considered a concern in Coon Creek because there are no trout or other temperature sensitive organisms.

pH

- When water levels rise due to storm runoff, Coon Creek pH declines. Rainwater is more acidic than the local shallow groundwater feeding the creek.
- pH stayed within the desired range of 6.5 to 8.5 that is specified in state water quality standards.

Precipitation

- Monitored storm totals for Coon Creek at 111th ranged from 0.69 inch to 3.29 inches, and all but one storm event were spread out over several days.
- Monitored storm totals for Coon Creek at Vale St. ranged from 0.32 inch to 3.51 inches. All storms cause a rapid rise in stage, typically between six inches and two feet.

Site Comparison

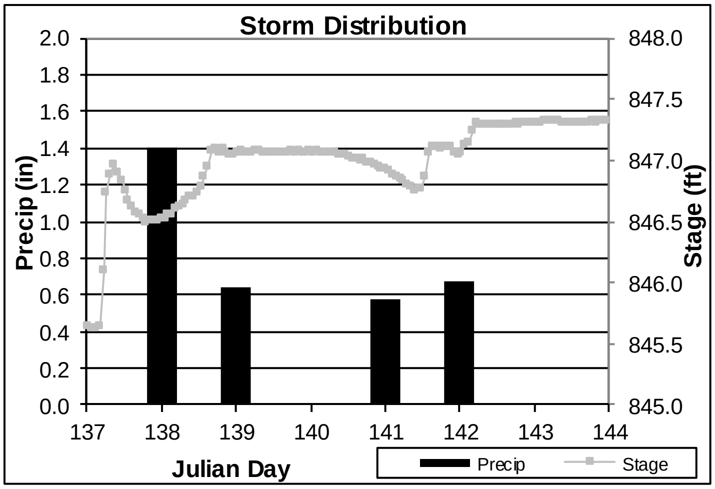
- Parameter and stage reacted similar at both Coon Creek sites when compared side-by side during storm events.

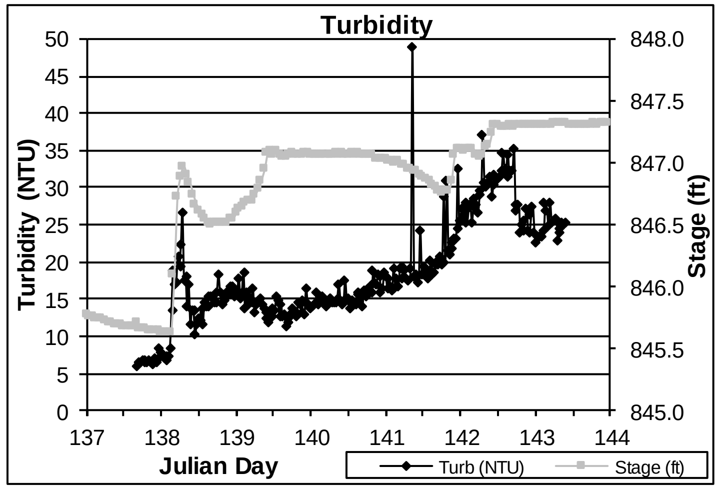
YSI Continuous Monitoring – Coon Creek at 111th Ave
Storm 1 – May 17th to May 23rd

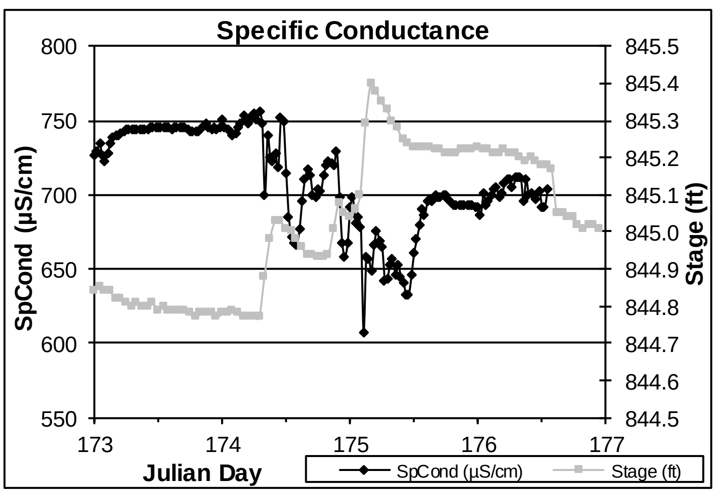
Storm Summary:

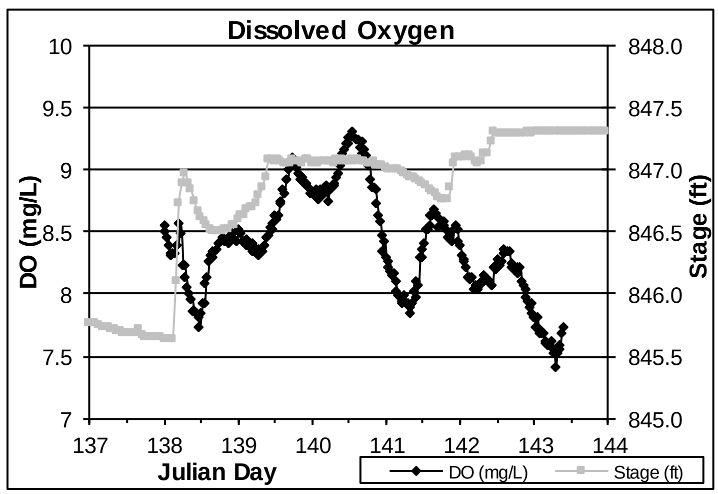
Dates: 17 May 2019 (Day 137) to 23 May 2019 (Day 143)

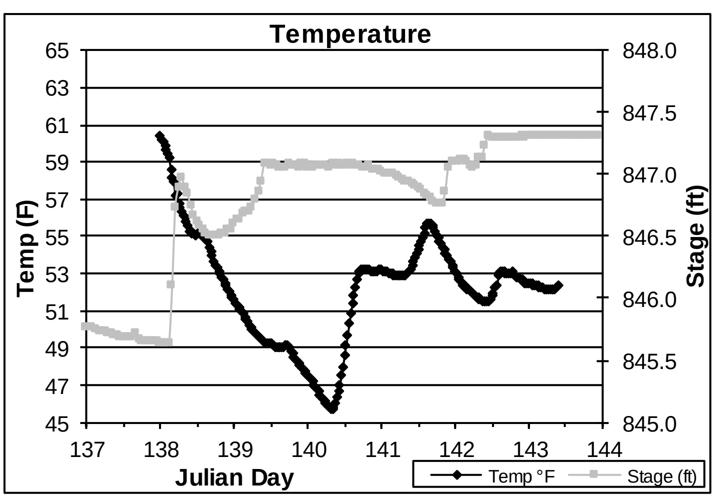
Precipitation: 3.29 in.

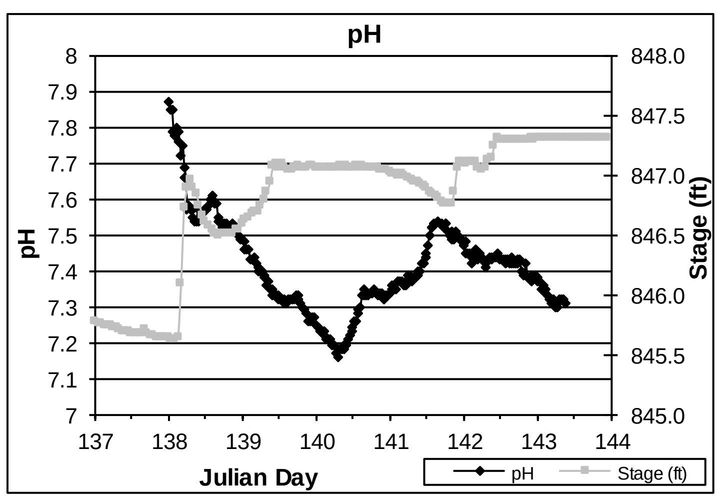










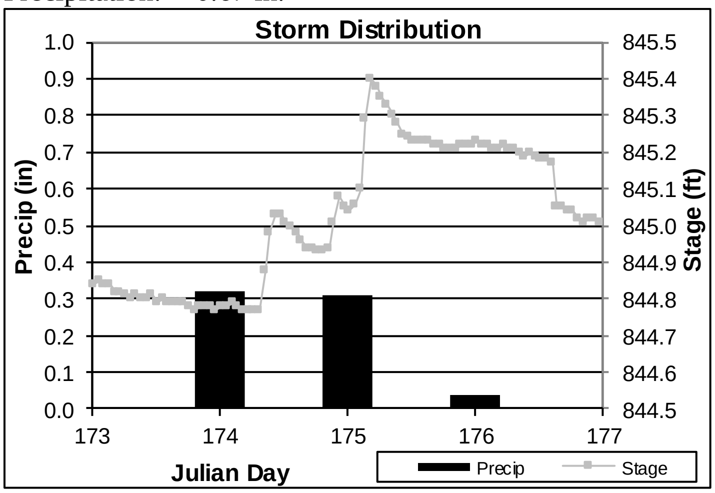


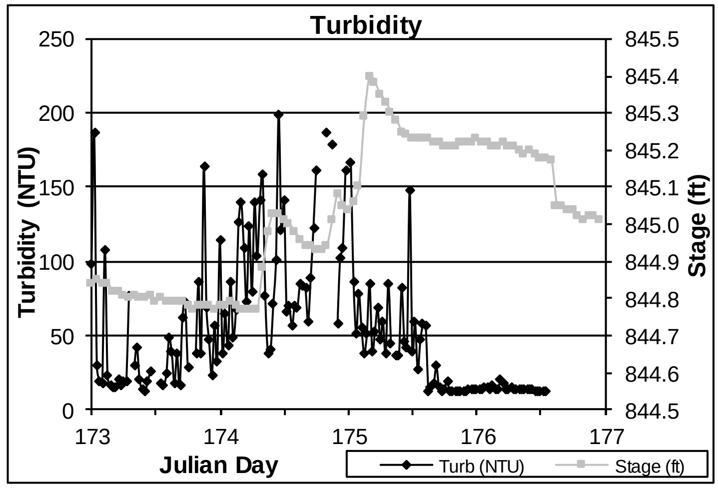
YSI Continuous Monitoring – <u>Coon Creek at 111th Ave</u>
Storm 2 – June 22nd to June 25th

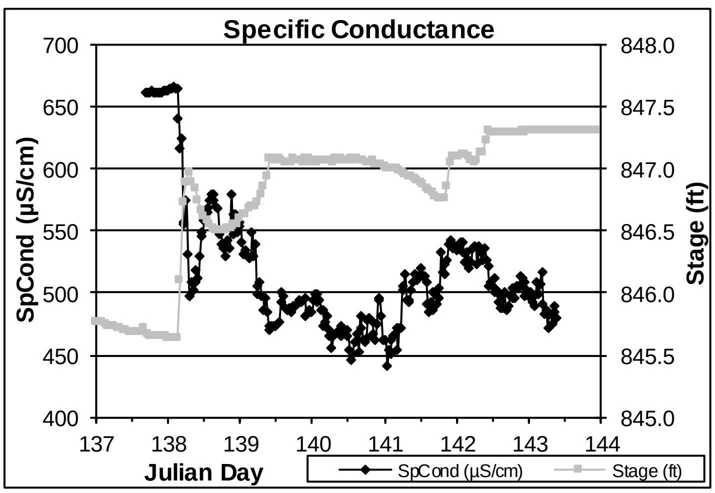
<u>Storm Summary:</u>

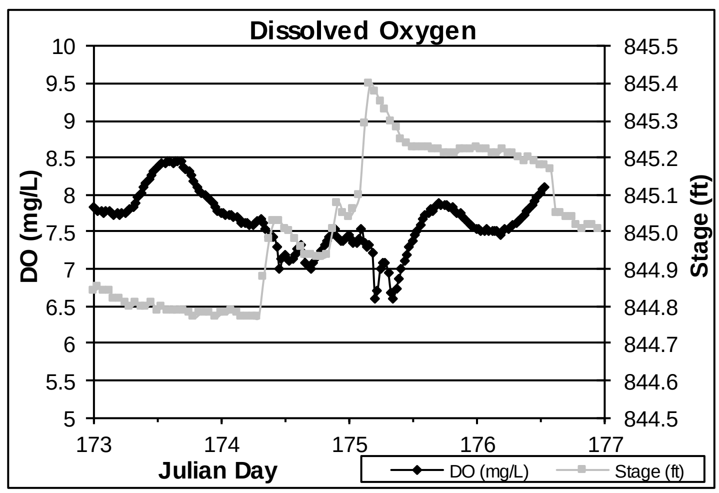
Dates: 22 June 2019 (Day 173) to 25 June 2019 (Day 176)

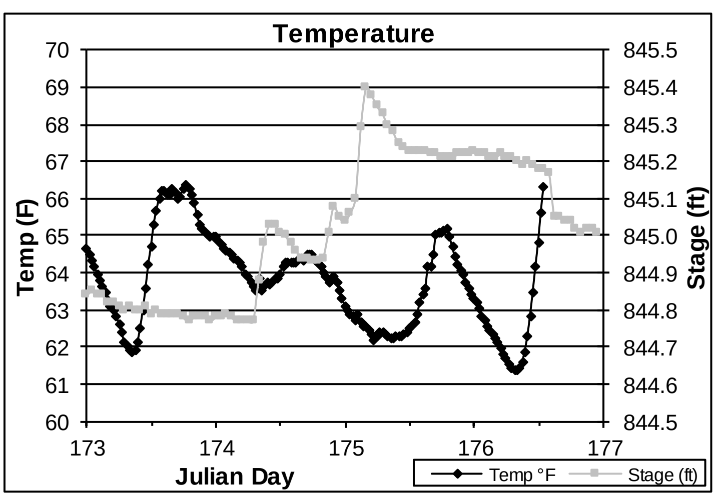
Precipitation: 0.67 in.

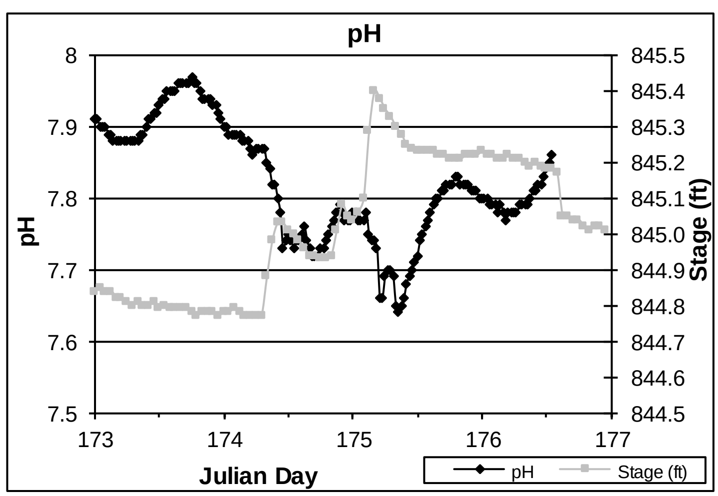










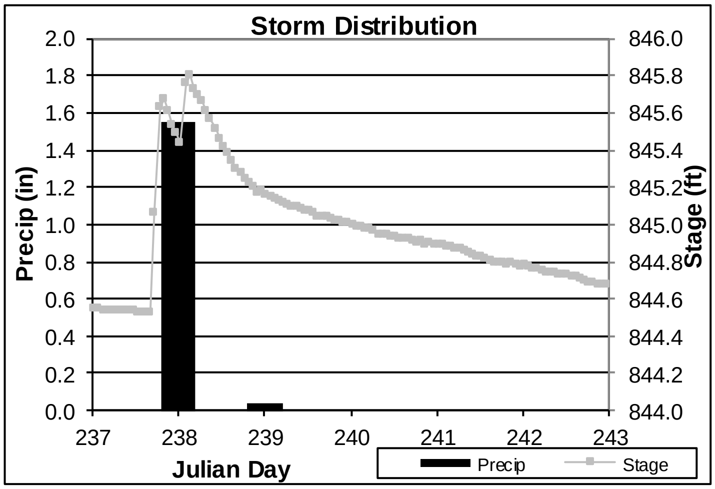


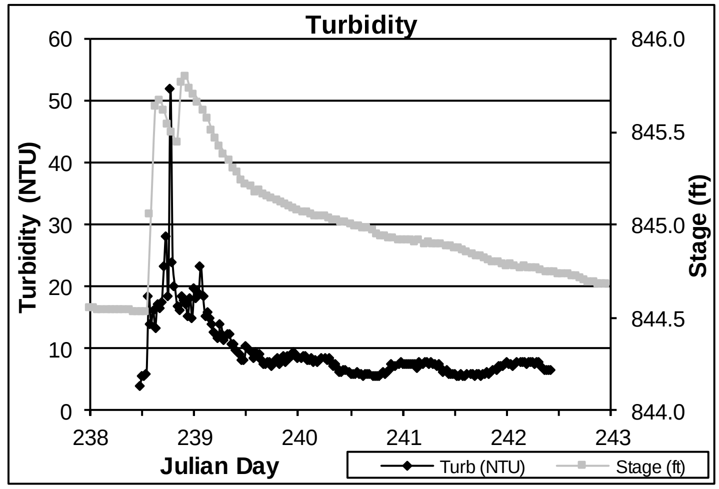
Note: Turbidity readings may have been affected by debris in the sensor guard.

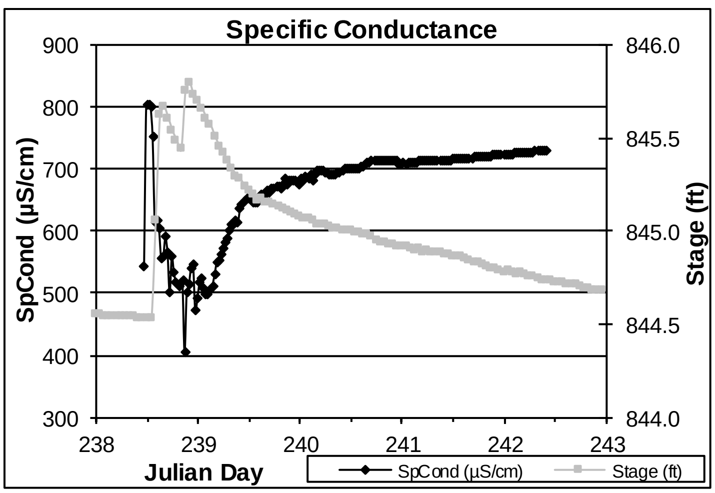
YSI Continuous Monitoring – Coon Creek at 111th Ave
Storm 3 – August 26th to August 30th

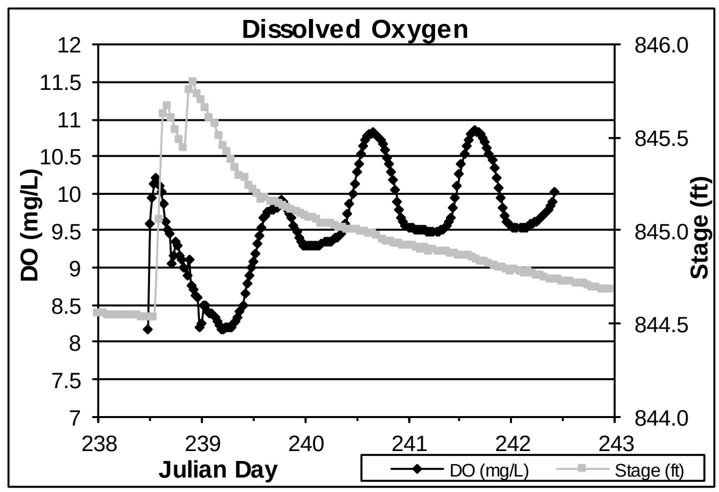
Storm Summary:

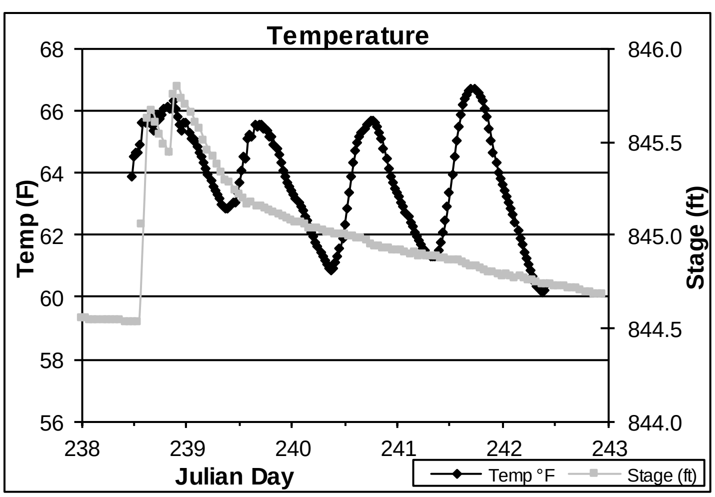
Dates: 26 August 2019 (Day 238) to 30 August 2019 (Day 242)
Precipitation: 1.59 in.

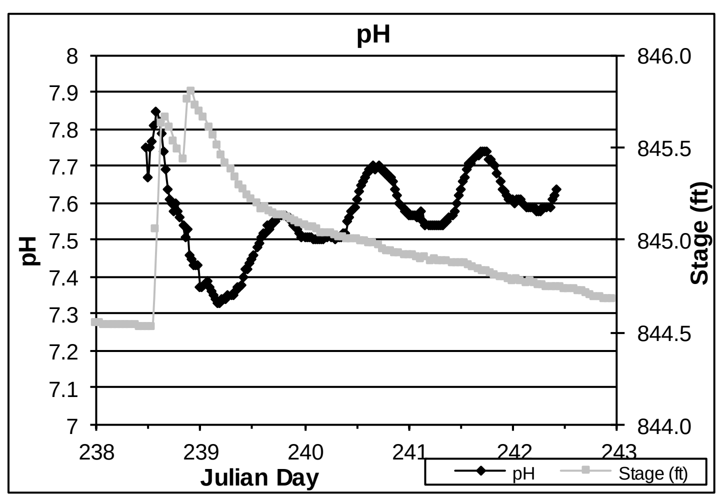










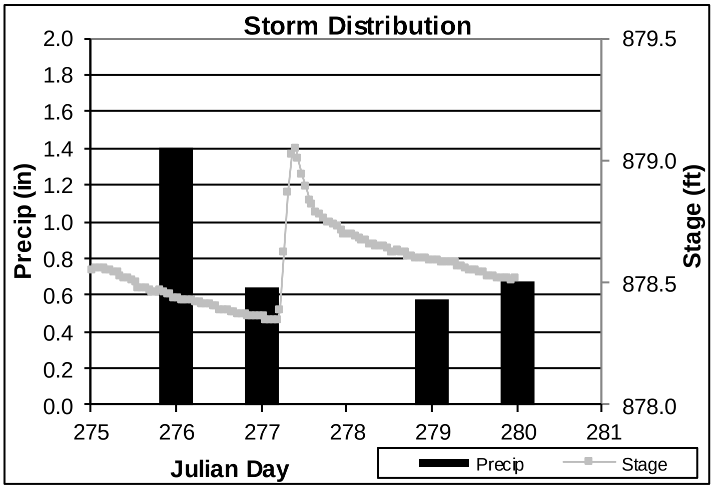


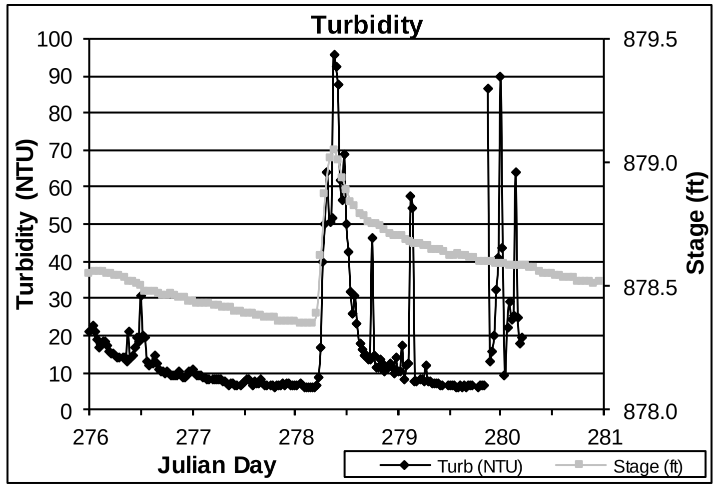
YSI Continuous Monitoring – <u>Coon Creek at 111th Ave</u>
Storm 4 – October 3rd to 7th

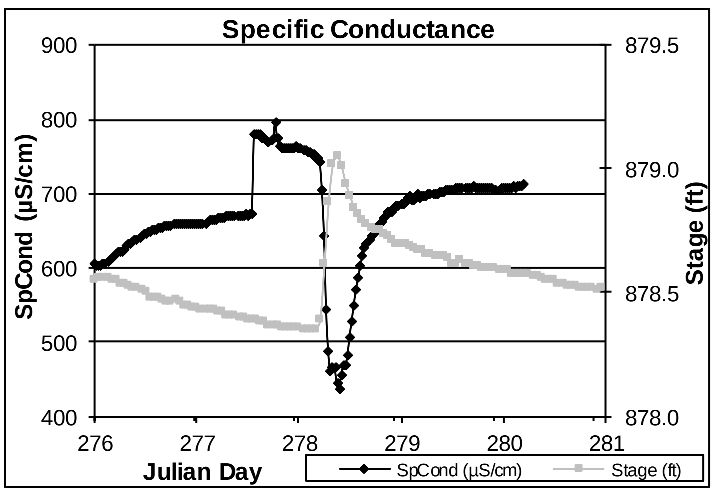
<u>Storm Summary:</u>

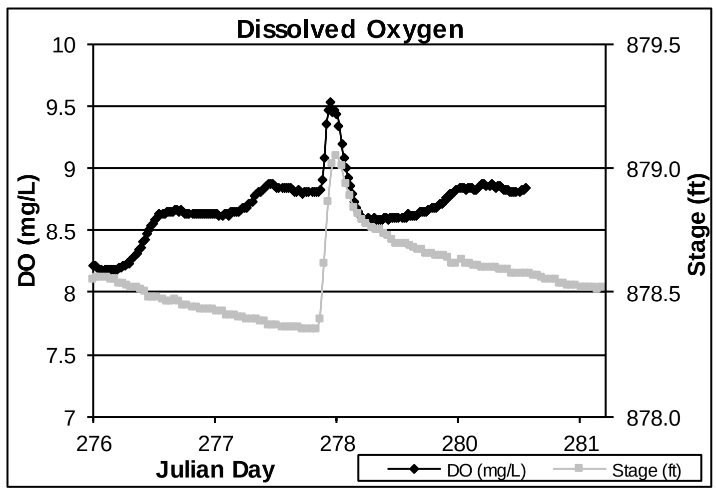
Dates: 3 October 2019 (Day 276) to 7 October August 2019 (Day 280)

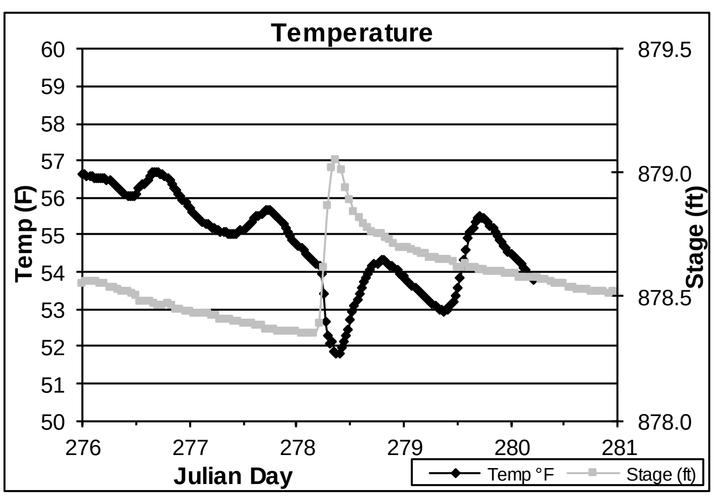
Precipitation: 3.29 in.

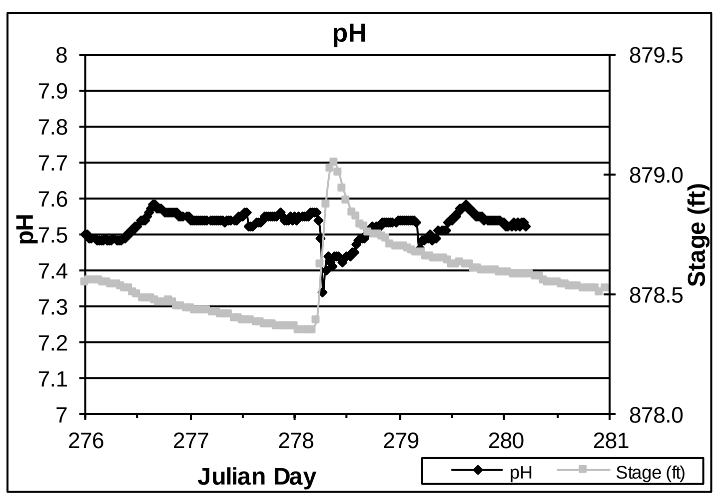












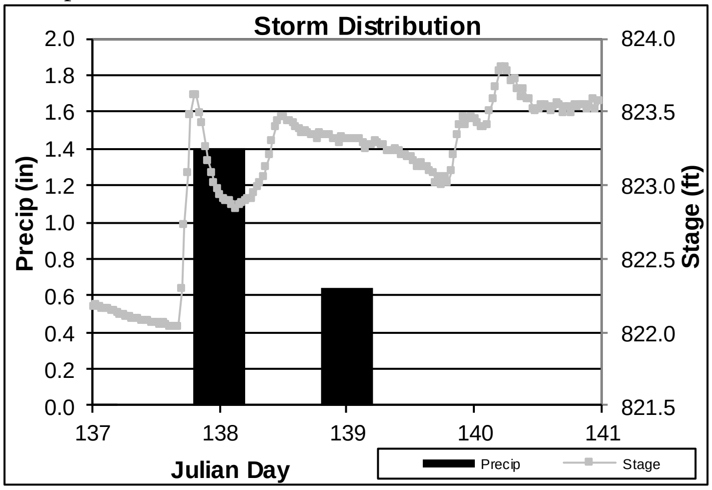
YSI Continuous Monitoring – Coon Creek at Vale St.
Storm 1 – May 17th to 23rd

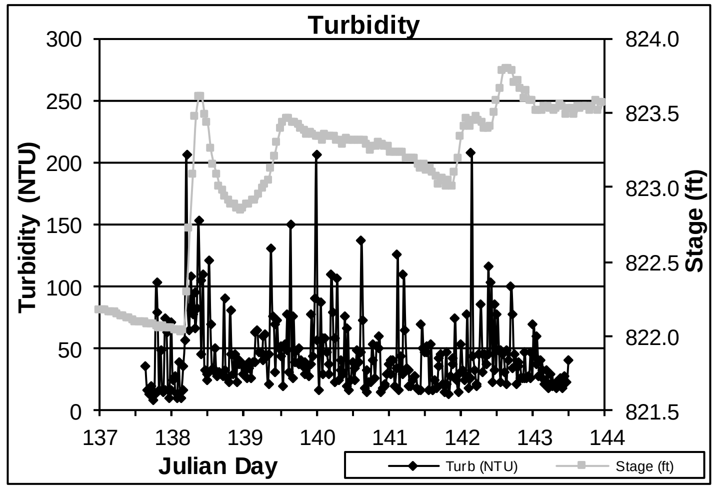
Coon Creek at Vale St.

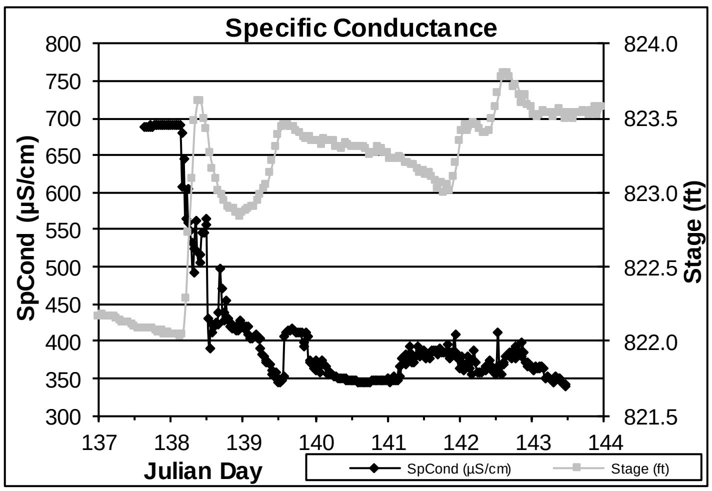
Storm Summary:

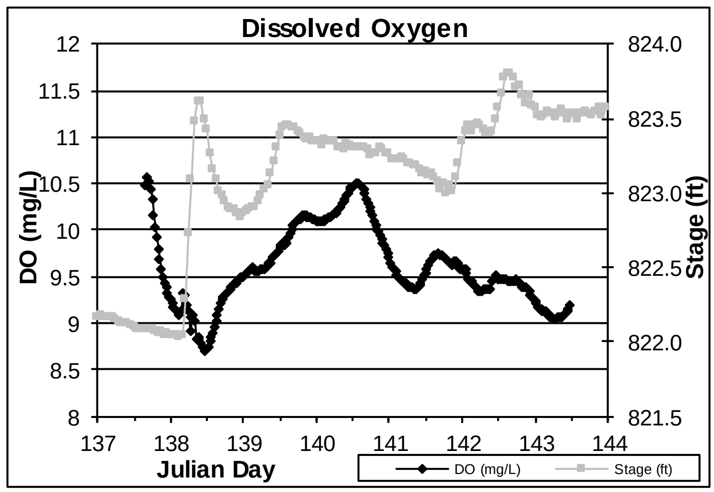
Dates: 17 May 2019 (Day 137) to 23 May 2019 (Day 143)

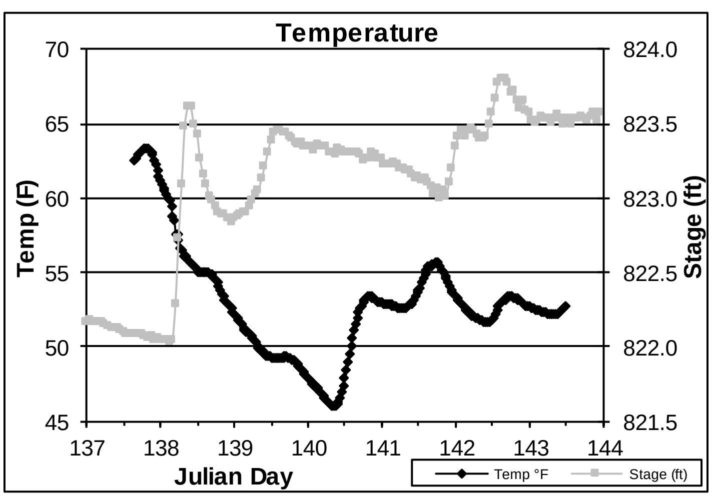
Precipitation: 2.05 in.

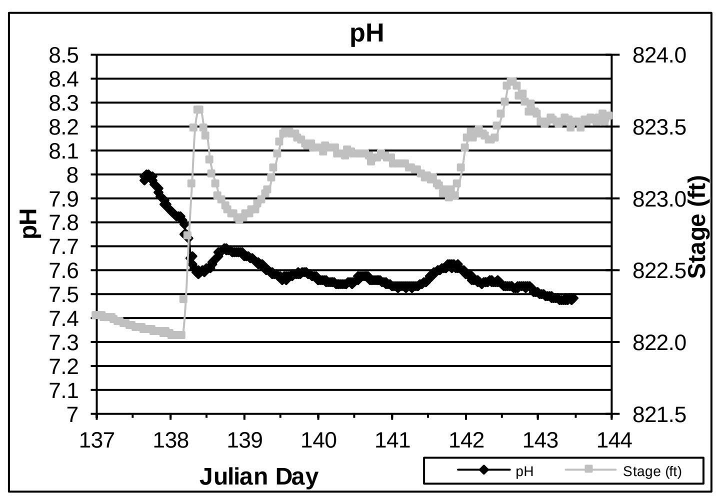












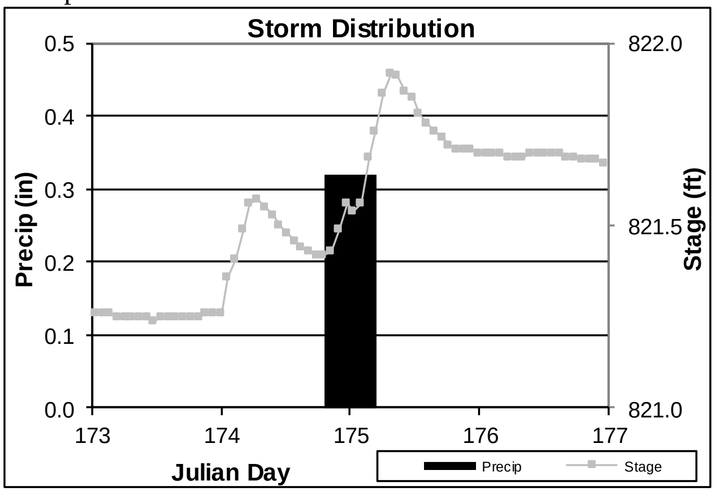
Note: Turbidity readings may have been affected by debris in the sensor guard.

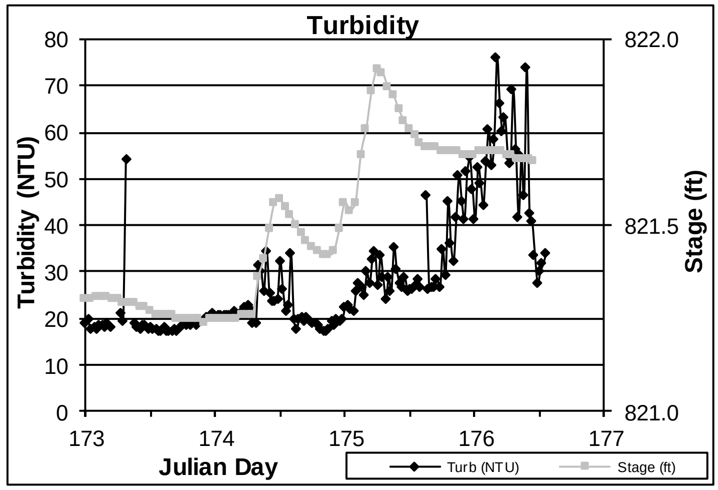
YSI Continuous Monitoring – <u>Coon Creek at Vale St.</u>
Storm 2 – June 22nd to 25th

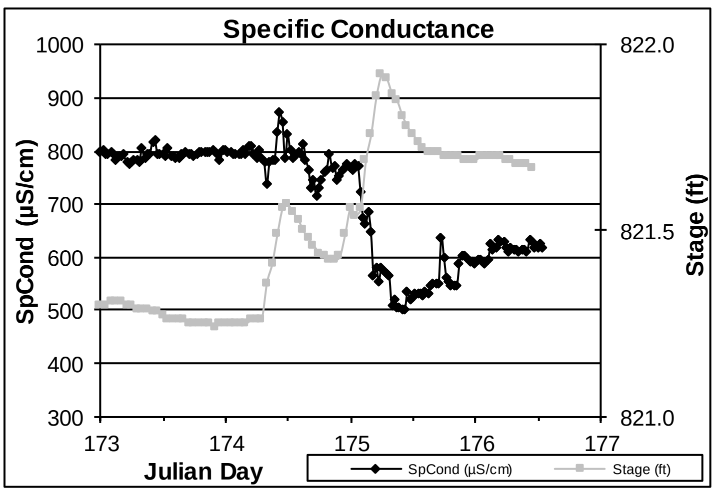
<u>Storm Summary:</u>

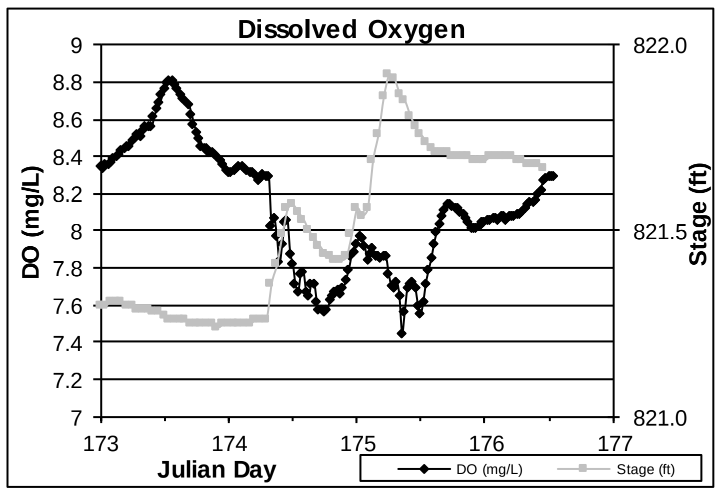
Dates: 22 June 2019 (Day 176) to 25 June 2019 (Day 173)

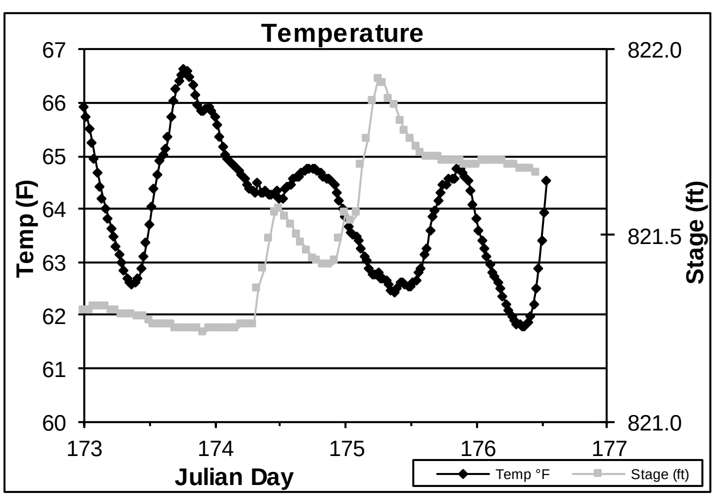
Precipitation: 0.32 in.

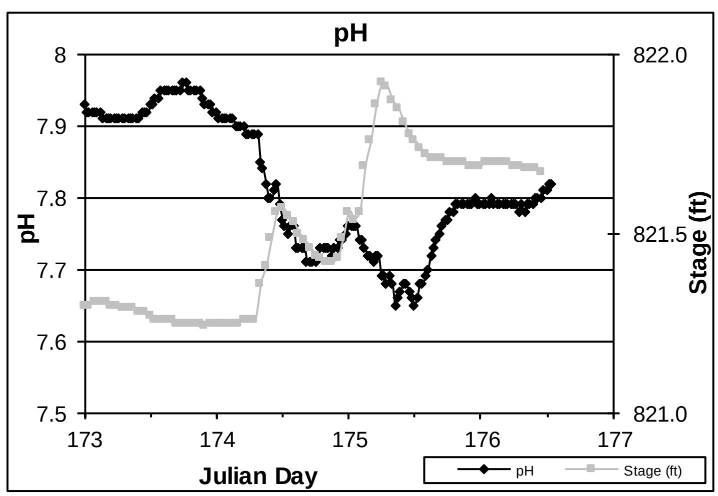










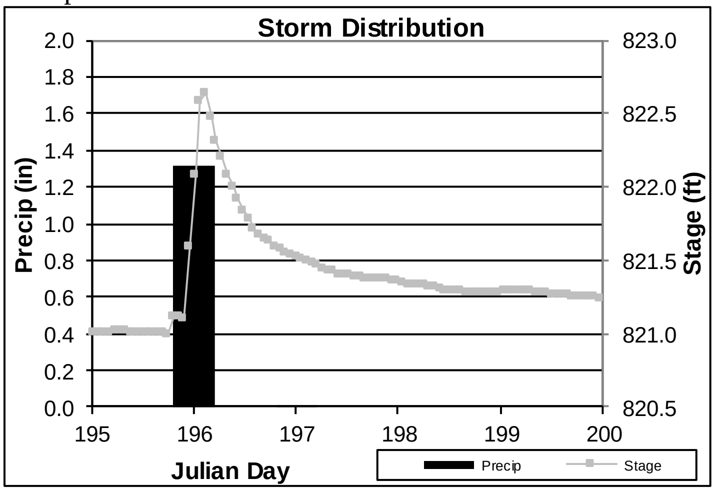


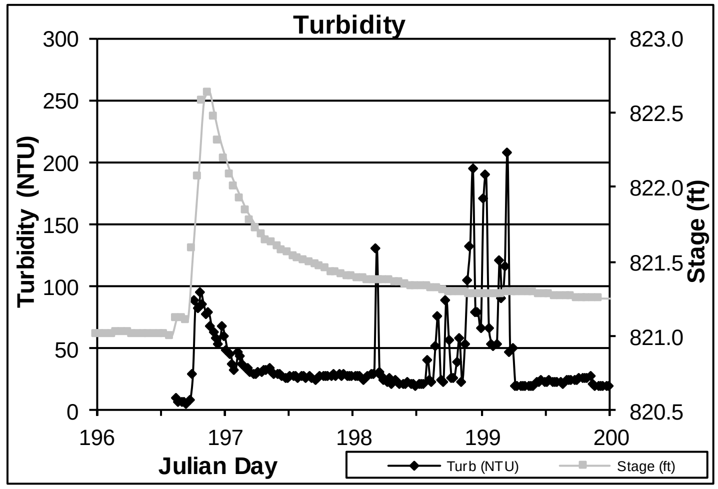
YSI Continuous Monitoring – <u>Coon Creek at Vale St.</u>
Storm 3 – July 15th to 18th

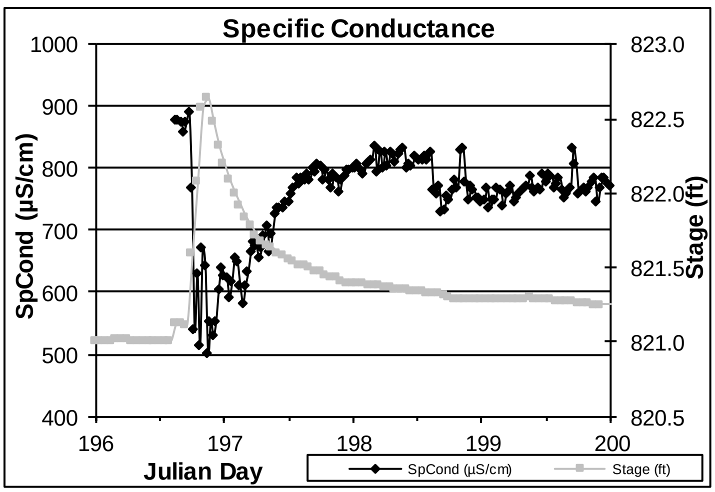
<u>Storm Summary:</u>

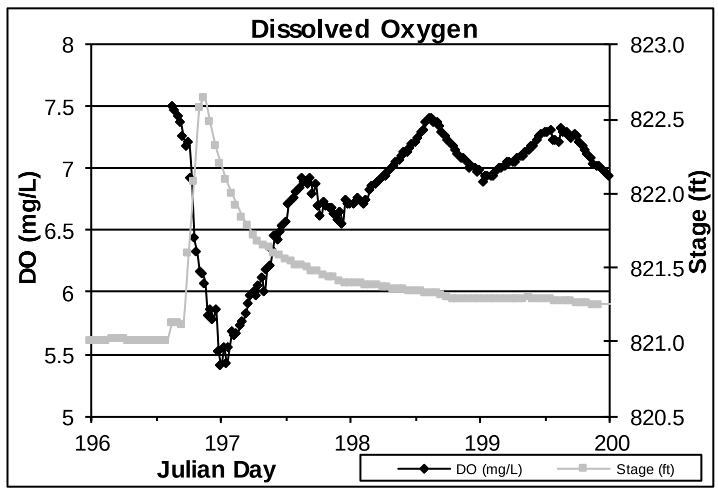
Dates: 15 July 2019 (Day 176) to 18 July 2019 (Day 200)

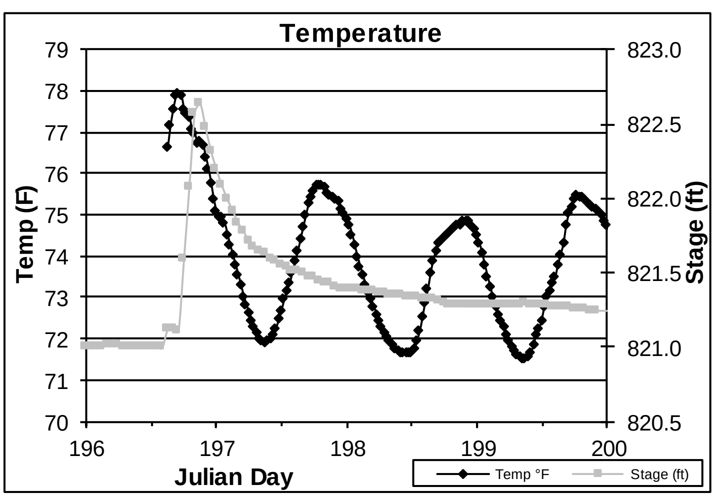
Precipitation: 1.33 in.

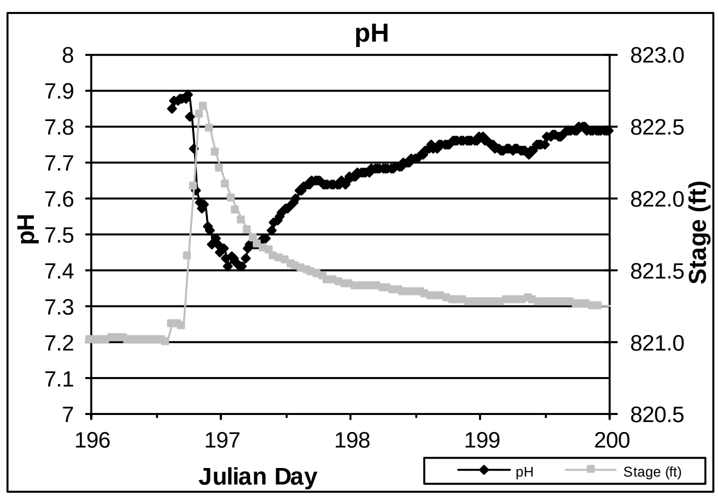










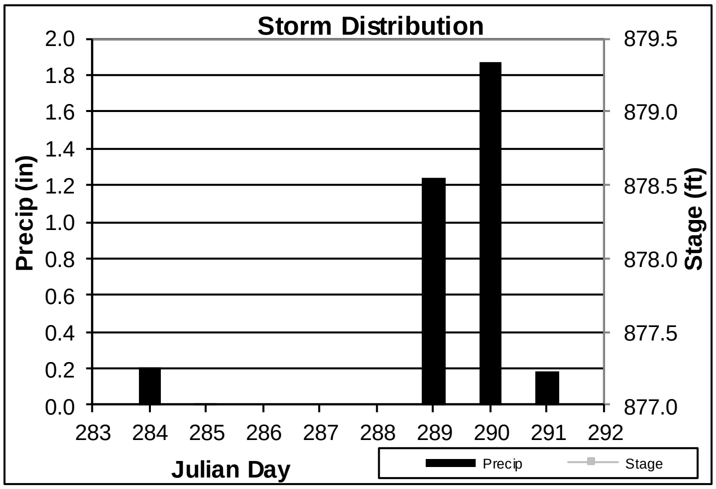


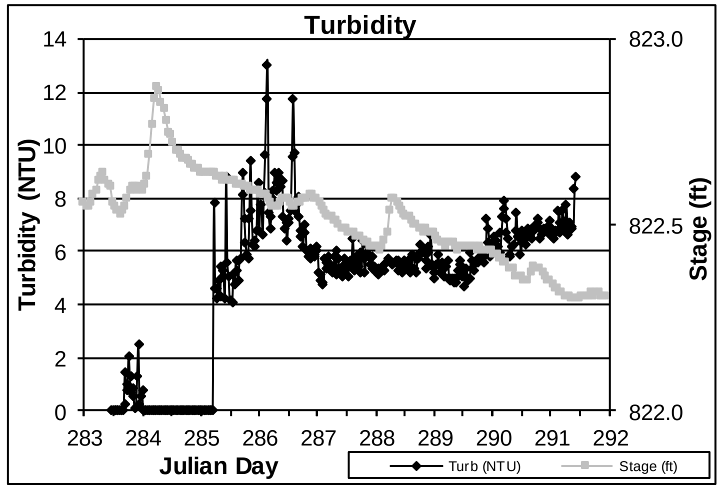
YSI Continuous Monitoring – Coon Creek at Vale St.
Storm 4 – October 10th to 18th

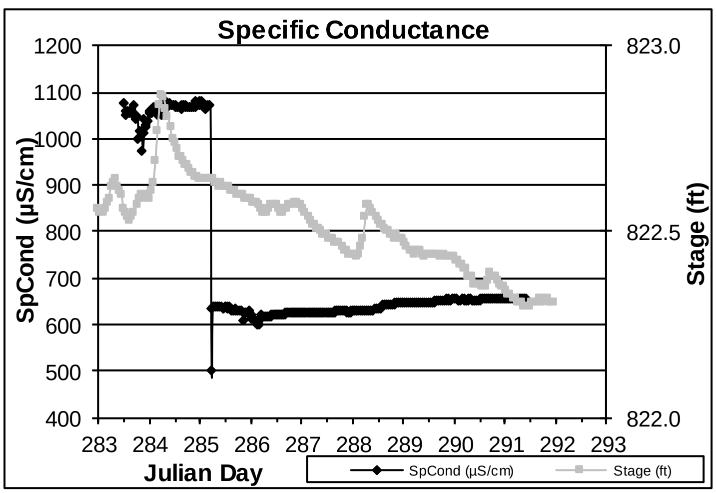
Storm Summary:

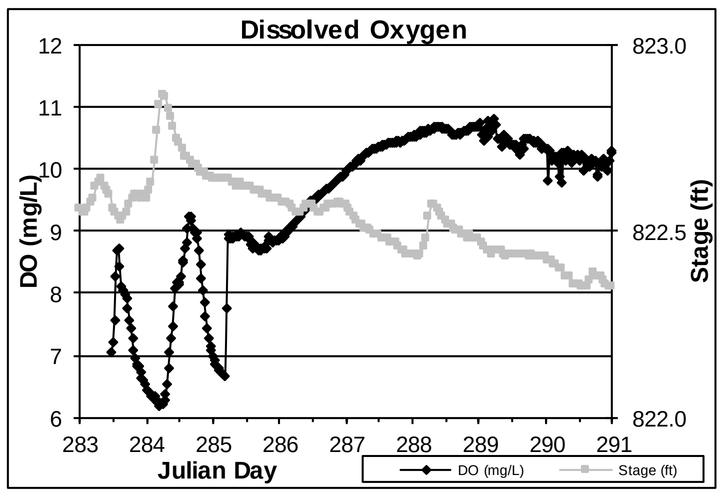
Dates: 10 October 2019 (Day 283) to 18 October 2019 (Day 291)

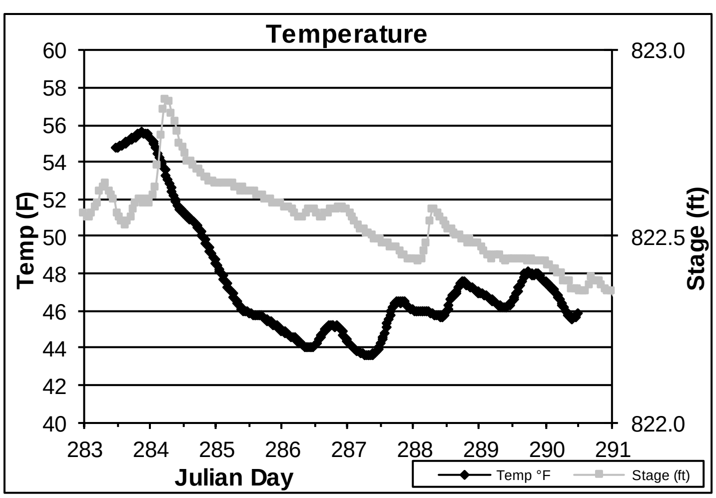
Precipitation: 3.51 in.

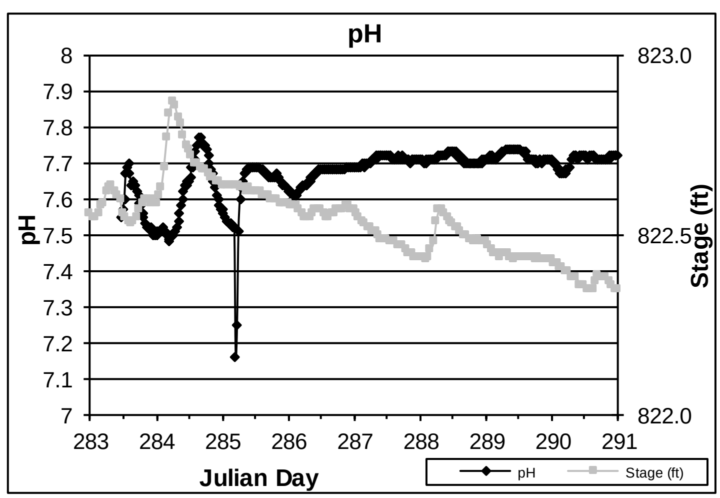












Stream Hydrology Monitoring – Coon Creek Main Stem

COON CREEK

at 131st Ave. NW, Coon Rapids

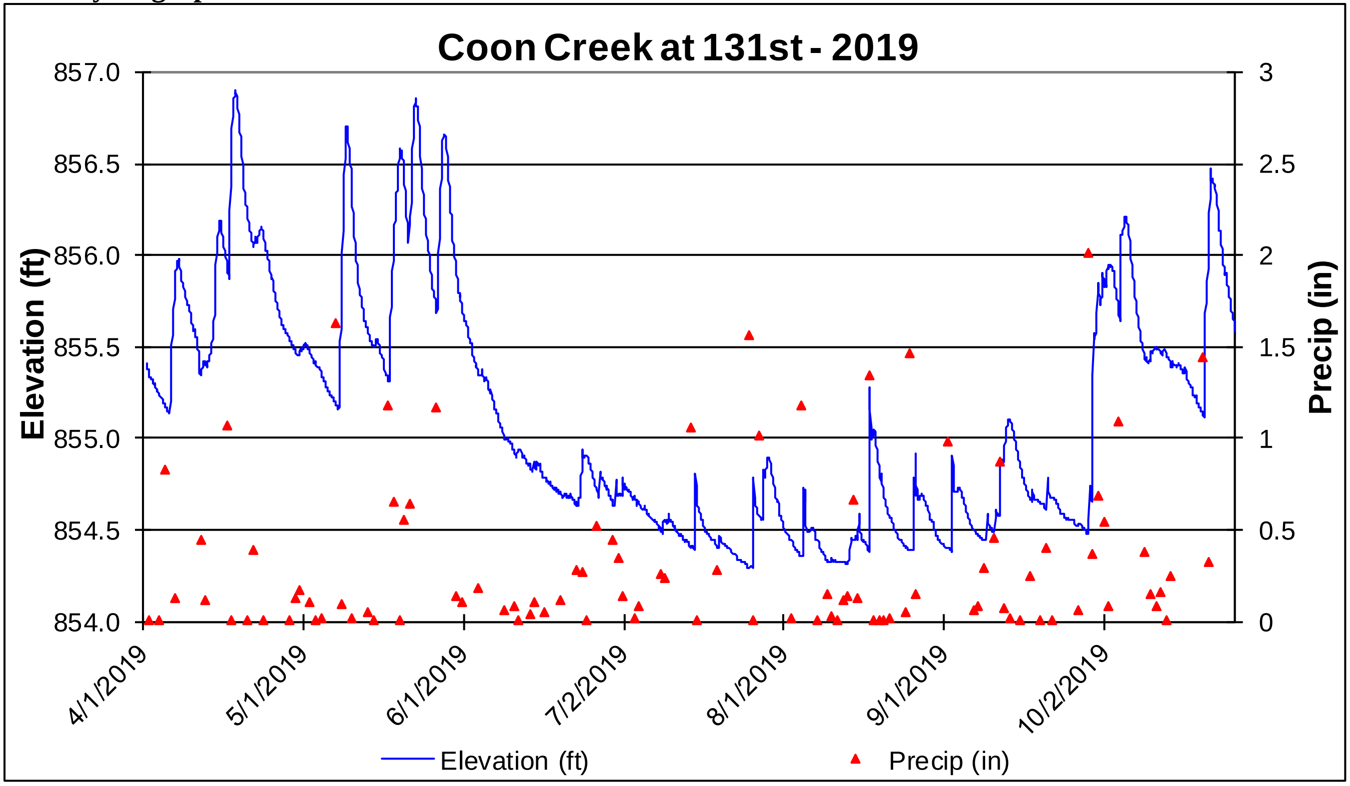
Notes

This site normally has a seasonal range of variation in stage between 1.5 and 3.0 ft. Throughout the season in 2019, water levels fluctuated 2.61 ft. at this site. The creek had its highest water level in the spring, most likely the result of snow melt and frequent rain events.

The site is not as flashy as other monitored sites downstream. It usually reacts slowly and at a lesser magnitude in total stage flux to rain events. During a May 8th rain event of 1.63 inches, the creek rose 1.53 ft. over the course of 36 hours at this site. In contrast, the same storm event caused the stage at Vale St. to rise 1.67 ft. in just 11 hours. At 111th Ave. this storm caused the stage to rise 1.51 ft. in 11 hours. There were several other occasions throughout the 2019 season where the creek responded in a similar fashion. This is the furthest upstream site that was monitored for continuous stage. It seems that as the drainage size of Coon Creek increases, along with piped stormwater input in developed areas, the creek responds more intensely to rain events.

A rating curve has not been developed for this site.

2019 Hydrograph

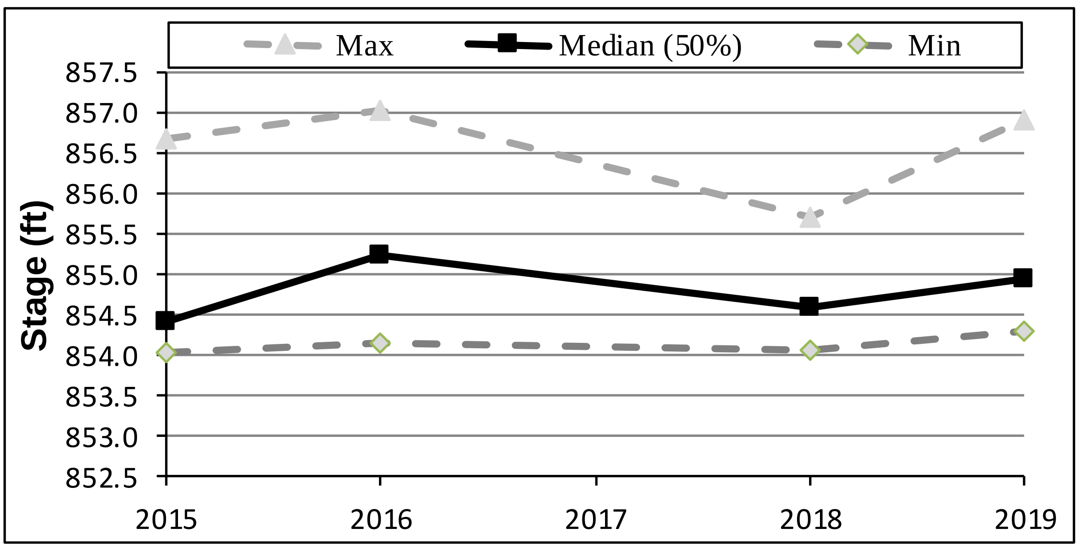


COON CREEK

at 131st Ave. NW, Coon Rapids

Summary of All Monitored Years

Percentiles	2015	2016	2018	2019
Min	854.03	854.14	854.04	854.29
2.5%	854.09	854.32	854.08	854.33
10.0%	854.16	854.45	854.13	854.43
25.0%	854.27	854.71	854.32	854.57
Median (50%)	854.41	855.23	854.58	854.94
75.0%	854.68	855.65	854.76	855.58
90.0%	855.03	855.88	855.02	856.09
97.5%	855.79	856.19	855.40	856.57
Max	856.66	857.04	855.71	856.90



Coon Creek

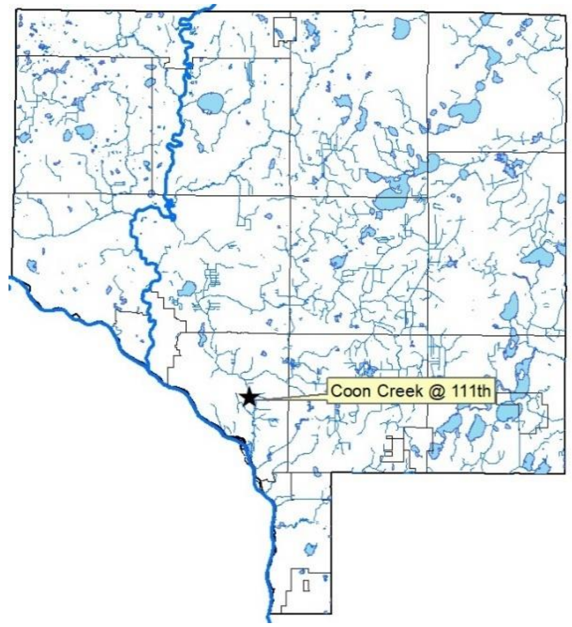
at 111th Ave. NW, Erlandson Park, Coon Rapids

Notes

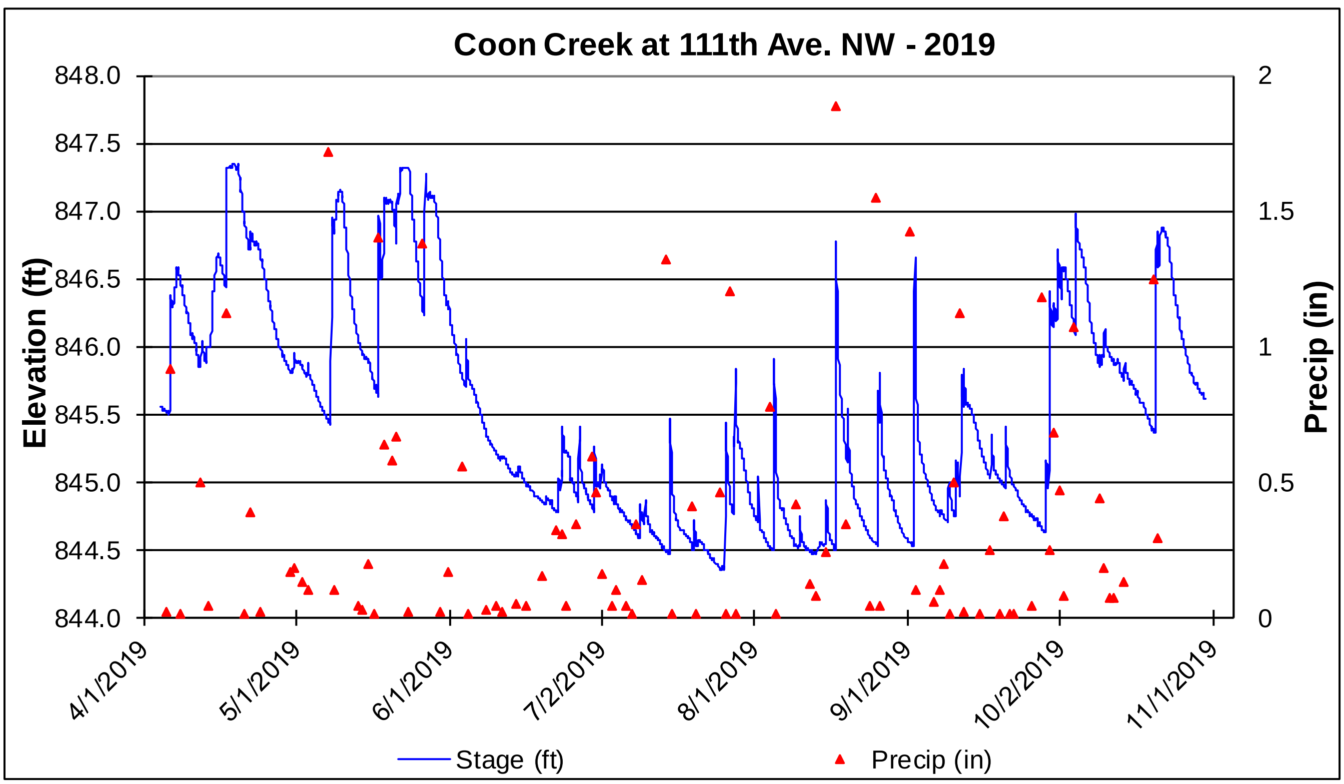
Stage at this site is flashy in response to storms, with similar fluctuations in stage occurring in less than half the time of fluctuations at 131st Ave. upstream.

During the 2019 season the creek at the 111th Ave site fluctuated 3.6 ft. between its minimum and maximum recorded stage. This was the largest range of stage fluctuation recorded at the three Coon Creek sites. During a 1.89 inch storm on August 18th, stage rose 1.77 ft. between two consecutive hourly readings.

A rating curve was established for this site in 2018 and is displayed below.



2019 Hydrograph

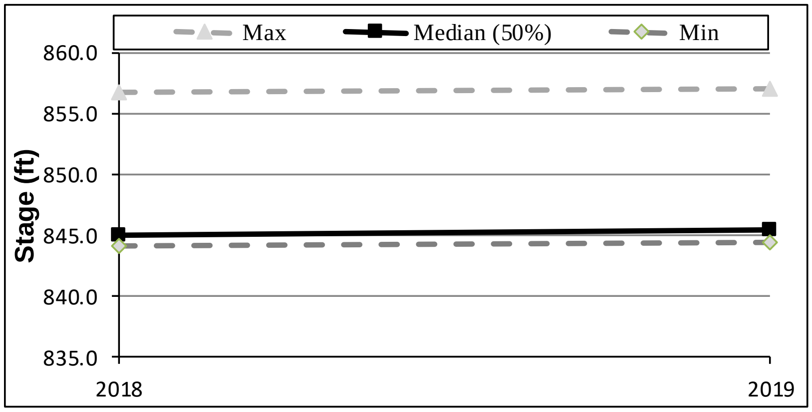


COON CREEK

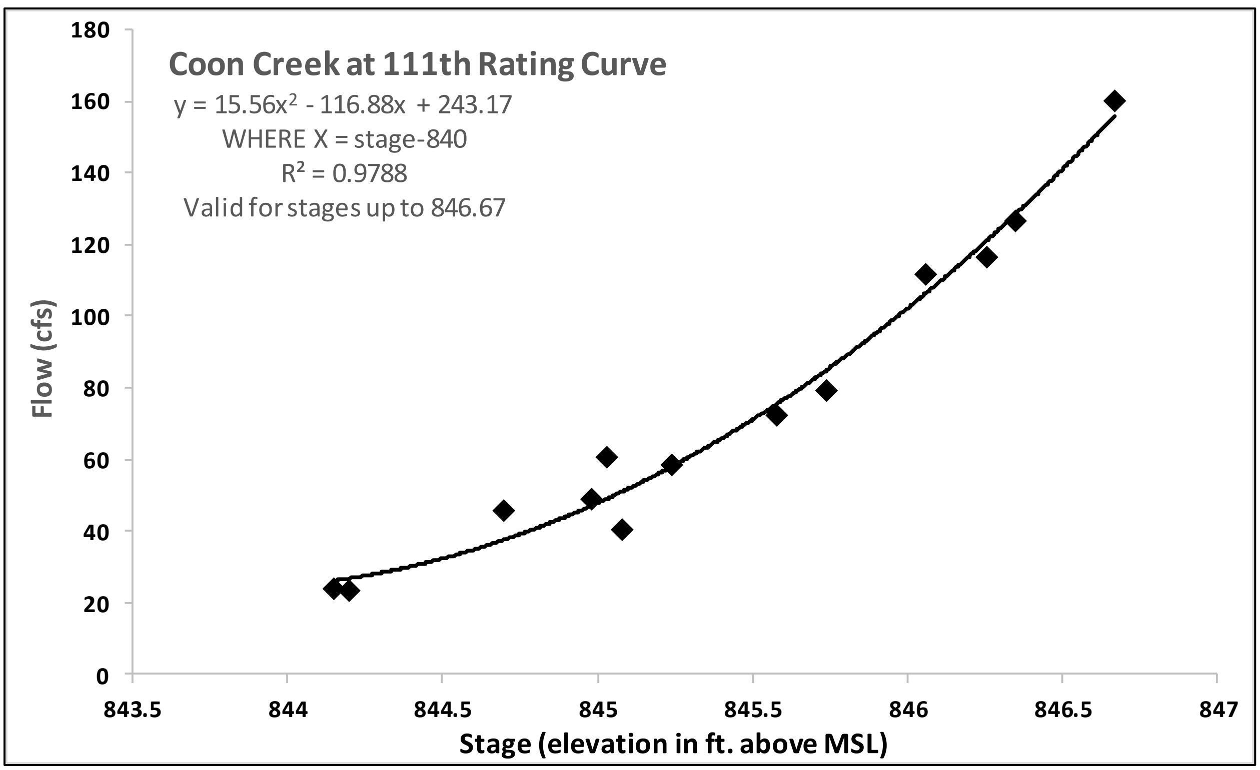
at 111th Ave. NW, Erlandson Park, Coon Rapids

Summary of All Monitoring Years

Percentiles	2018	2019
Min	844.02	844.35
2.5%	844.08	844.48
10.0%	844.24	844.58
25.0%	844.50	844.81
Median (50%)	844.94	845.35
75.0%	845.51	846.09
90.0%	845.88	846.75
97.5%	846.45	847.20
Max	847.46	847.35

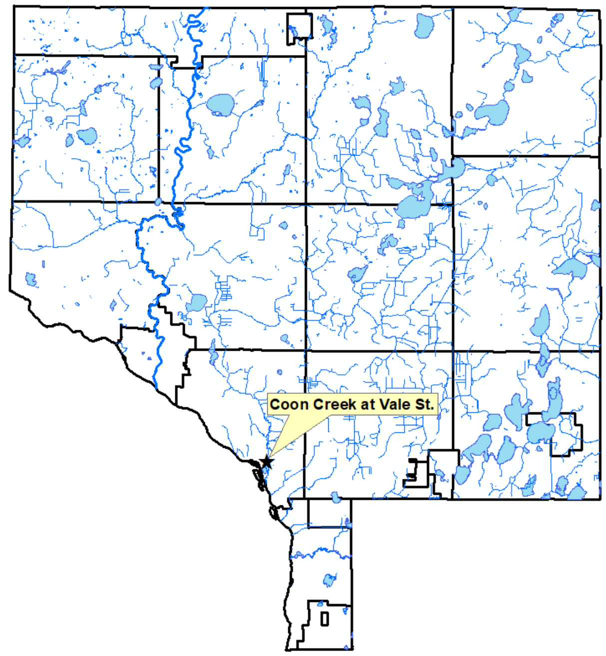


Rating Curve - 2018



COON CREEK

at Coon Creek Hollow, Vale Street, Coon Rapids



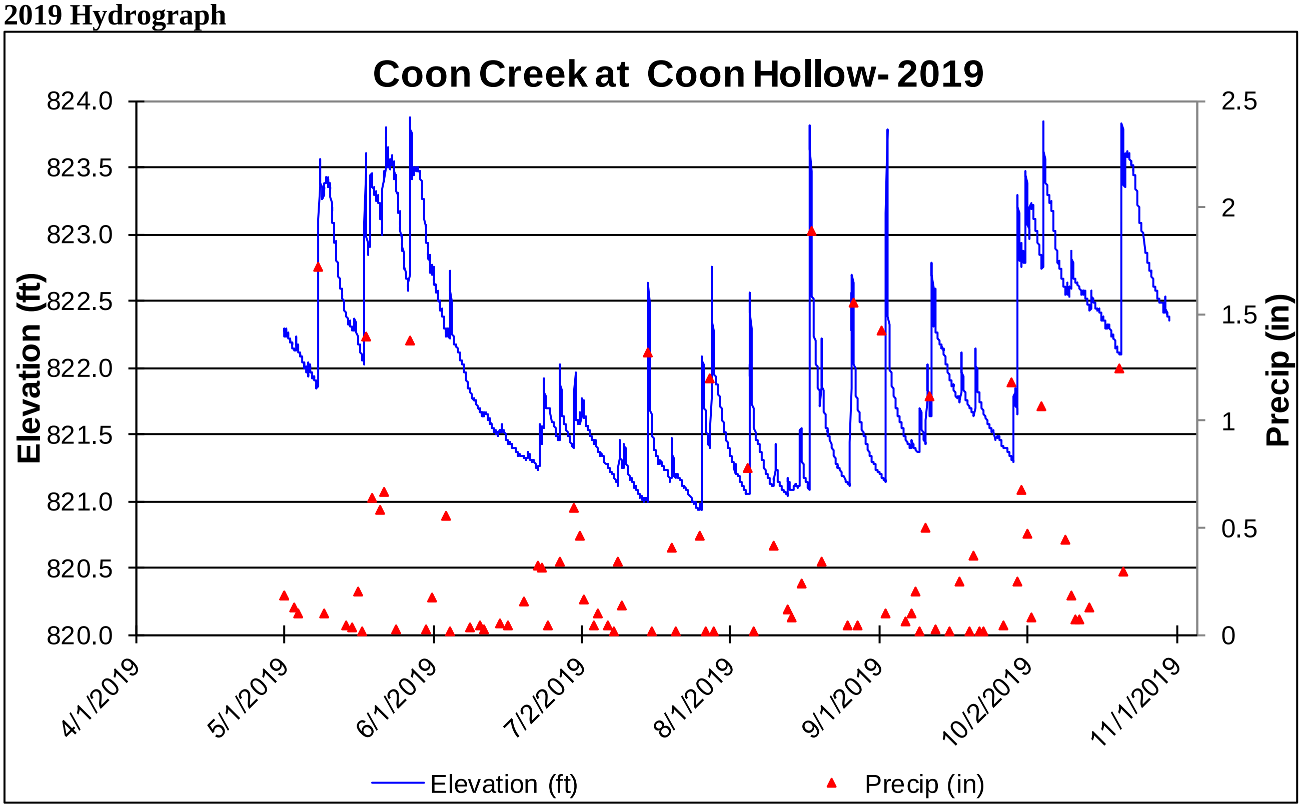
Notes

In 2019, water levels at Vale St. fluctuated 2.95 ft. This was the smallest range recorded at this site since stage monitoring began back in 2005. Stage remained higher than average throughout the year in 2019, with no sustained period at baseflow. The hydrograph shows declining stage readings leading up to each subsequent storm event.

Coon Creek has flashy responses to rain events, 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 a large amount of stormwater infrastructure input from the urbanized portions of the lower watershed. Opportunities for storage of stormwater on the landscape are likely limited, but should be explored.

During a 1.89 inch rain event on August 18th the creek rose 1.77 ft. in two hours. A storm of 1.42 inches on September 2nd caused stage in the creek to rise 2.02 ft. in two hours. A rating curve was established for this site in 2005 and was updated in 2010. It is displayed below.

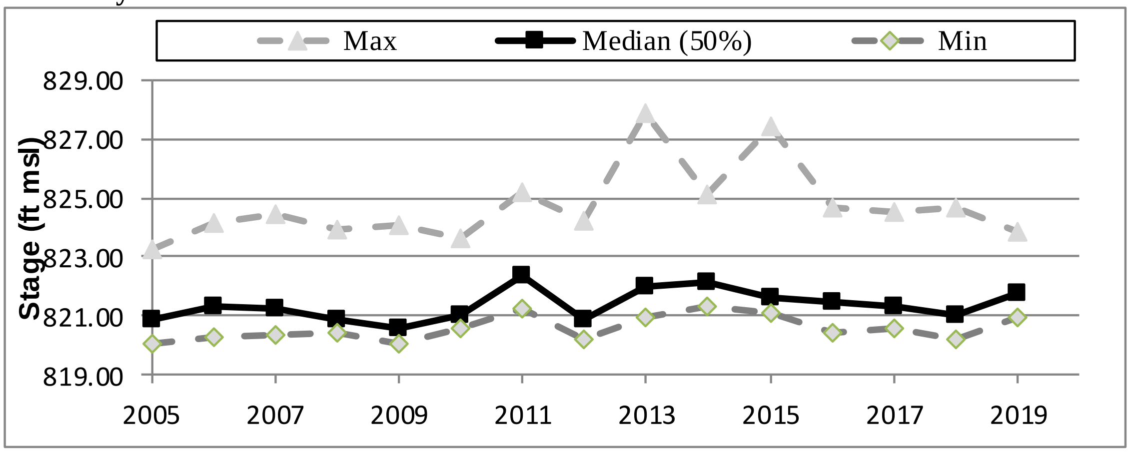
2019 Hydrograph



COON CREEK

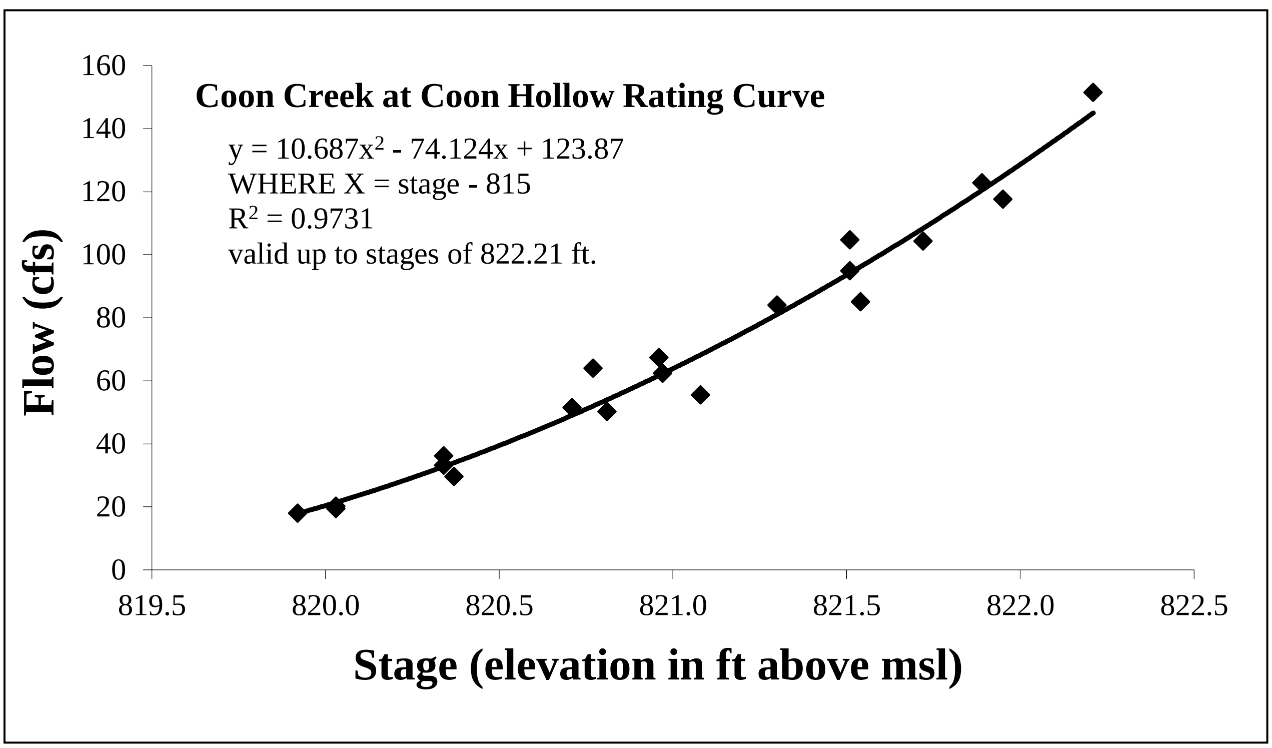
at Coon Creek Hollow, Vale Street, Coon Rapids

Summary of All Monitored Years



Percentiles	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
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	820.22	820.93
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	820.28	821.05
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	820.40	821.16
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	820.60	821.37
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	821.03	821.75
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	822.21	822.49
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	822.56	823.19
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	823.33	823.52
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	824.69	823.88

Rating Curve (2010 - updated)



Water Quality Monitoring – Sand Creek System

Sand Creek System Monitoring Sites		
Site Name/ SiteID	**Years Monitored**	**2019 Data Collected**
Ditch 41 at Radisson Rd, Blaine S006-421	2010-2017	
Ditch 41 at Highway 65, Blaine S005-639	2009-2019	Water Chemistry Grab Samples, Continuous Stage,
Ditch 41 at Happy Acres Park, Blaine S005-641	2009	
Ditch 60 at Happy Acres Park, Blaine S005-642	2009, 2019	Water Chemistry Grab Samples, Continuous Stage
Ditch 41 at University Avenue, Coon Rapids S005-264	2008	
Ditch 39 at University Avenue, Coon Rapids S005-638	2009. 2019	Water Chemistry Grab Samples, Continuous Stage
Sand Cr at Morningside Mem. Gardens, Coon Rapids S006-420	2010-2019	Water Chemistry Grab Samples, Continuous Stage, Storm Event Water Quality
Sand Cr at Xeon Street, Coon Rapids S004-619	2007-2019	Water Chemistry Grab Samples, Continuous Stage, Storm Event Water Quality

Background

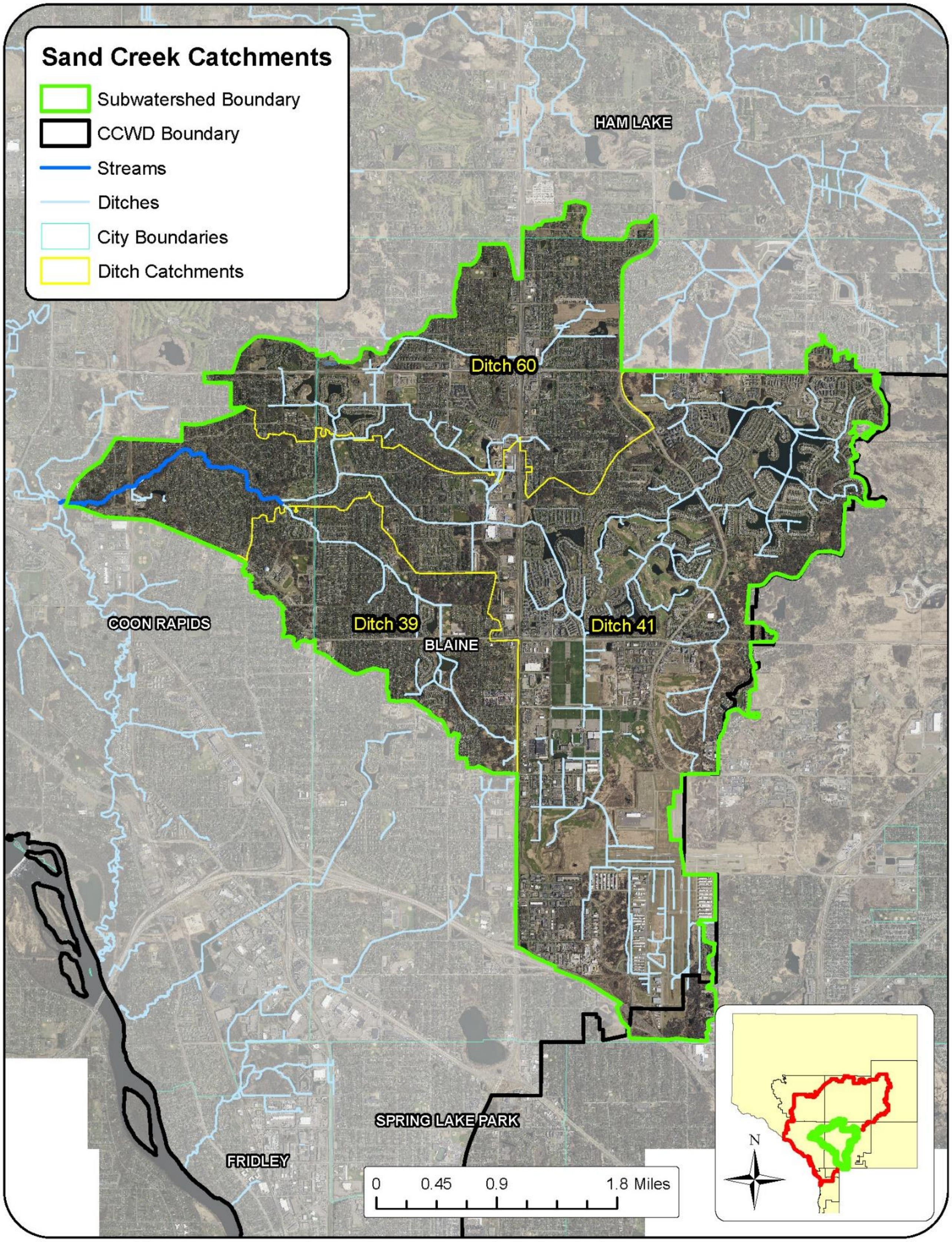
Sand Creek is the largest tributary to Coon Creek. It is comprised of three major ditch systems that join near University Avenue in Blaine and Coon Rapids. The primary ditch system comprising the Sand Creek subwatershed is Ditch 41. Ditch 41 drains 6,658 acres of suburban residential, commercial, and retail areas throughout western Blaine. In the upstream portions of this system (upstream of Highway 65), the system comprises of a complex network of ditch tributaries and man-made ponds and lakes which serve as stormwater treatment practices and as aesthetic landscape features.

The northern portion of this network comprises primarily of the Lakes of Radisson Development, which includes dense single family "lakeshore" homes built around five man-made basins. After flowing through these lakes, the ditch system continues through a series of ponds through the golf course ponds of the TPC Twin Cities golf course, and finally through another network of ponds in the Club West Development.

The southern portion of the Ditch 41 system upstream of Highway 65 drains primarily commercial areas of the western Highway 65 corridor, including large shopping centers, athletic complexes, schools, and small businesses. It also drains a significant portion of the Anoka County Airport in Blaine. These drainage ways combine and join with the rest of the Ditch 41 system at the Club West ponds before crossing under Highway 65.

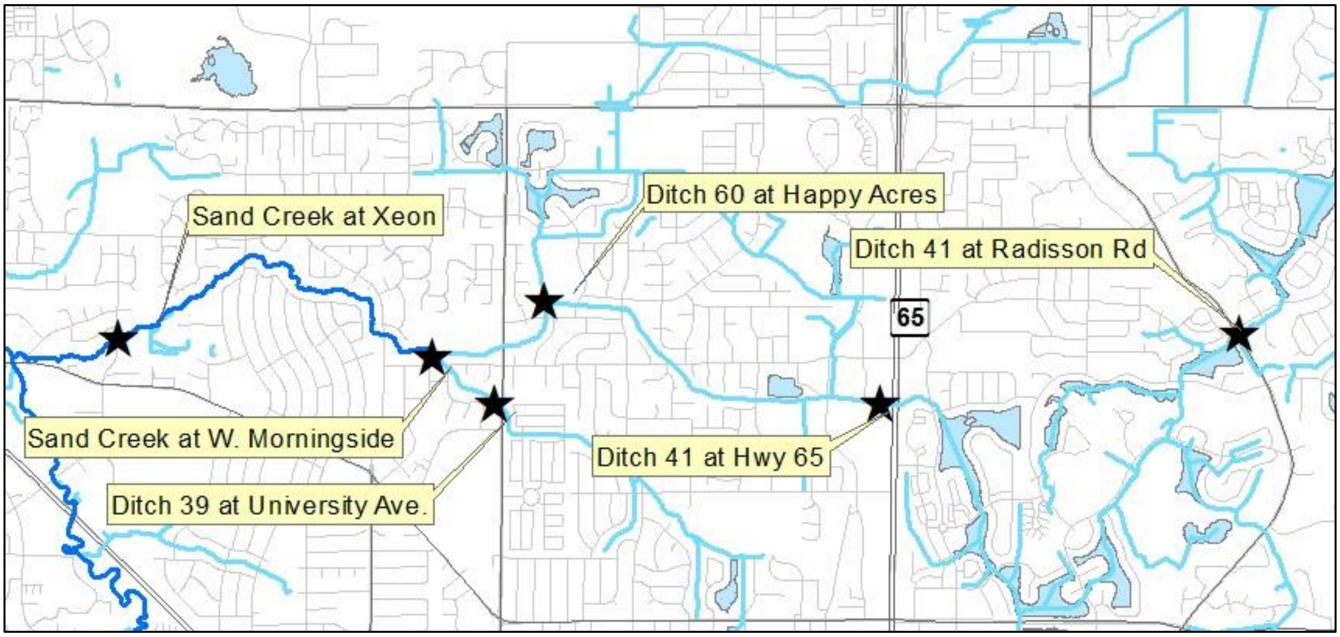
A couple of small tributaries join with Ditch 41 shortly after crossing Highway 65 before it reaches Happy Acres Park about a quarter-mile east of University Avenue and joins with Ditch 60 from the north. The tributaries of Ditch 60 drains 2,279 acres of primarily residential housing in northwestern Blaine before consolidating into a large stormwater pond in the Crescent Ponds development. This pond then outlets via a short ditch channel that joins with Ditch 41 at Happy Acres Park before continuing under University Avenue. Ditch 39 joins with Ditch 41 from the south about a quarter-mile east of University Avenue. Ditch 39 drains 1,395 acres of primarily residential usage before crossing University Ave. and emptying into a stormwater pond in the 116th Ave. Loop. This stormwater pond outlets via a culvert that connects with Ditch 41 in the southwest corner of the West Morningside Memorial Gardens property.

In this report, the resulting stream from the consolidation of these three ditch systems will be called Sand Creek from the point of this confluence to its outfall at Lions Coon Creek Park in central Coon Rapids where it joins with Coon Creek. From West Morningside Memorial Gardens, Sand Creek flows west approximately two miles through residential neighborhoods. Much of these two miles includes a narrow wooded parkland paralleling the creek. At its confluence with Coon Creek, Sand Creek is about 15 ft. wide and 2.5-3 ft. deep during baseflow conditions. Sand Creek is impaired for *E. coli* and invertebrate biota downstream of West Morningside Memorial Gardens. New standards for aquatic life (Tiered Aquatic Life Use Standards) currently under development may take into consideration the fact that the creek is part of a public ditch system and, therefore, may lower aquatic life expectations and affect the impairment standard for this waterbody.



Sand Creek Catchments
Subwatershed Boundary
CCWD Boundary
Streams
Ditches
City Boundaries
Ditch Catchments
HAM LAKE
Ditch 60
COON RAPIDS
Ditch 39
BLAINE
Ditch 41
SPRING LAKE PARK
FRIDLEY
0 0.45 0.9 1.8 Miles
N

Sand Creek Monitoring Sites



Results and Discussion

Sand Creek water quality generally meets state standards for most parameters, other than *E. coli*. Sand Creek is listed as impaired for aquatic recreation due to *E. coli* and for invertebrate biota. It has load duration curves for total phosphorus and TSS in the Coon Creek TMDL due to these parameters being listed as stressors to aquatic life. Loading of these different pollutants into the Sand Creek system seems to be happening in different areas of the watershed for each.

Based on pollutant concentrations, Ditch 60 and Ditch 39 are degrading Sand Creek water quality for phosphorus, with higher concentrations measured in each during both baseflow and storm conditions than in Ditch 41 at Hwy 65, or at Morningside Memorial Gardens after all three ditches join. Total phosphorus concentrations have not increased in the main channel of Sand Creek over time at Xeon St. nor do they increase moving upstream to downstream from Morningside Memorial Gardens to Xeon St. in all three individual ditches, but increases moving downstream in the main channel of Sand Creek from Morningside Memorial Gardens to Xeon St. The TMDL attributes only 13% of TSS loading in Sand Creek to bank erosion, but that factor may be underestimated in the lower portion of the Creek between Morningside and Xeon St. A 2018-19 stream restoration project along Sand Creek near Xeon St. should help stabilize banks in these lower reaches, as well as help dissipate erosive energy during high flow events, which is when the creek exceeds its TSS LDC.

E. coli loading happens throughout the watershed, with dogs identified in the TMDL as the primary source of the bacteria. The TMDL may be underestimated the effect that waterfowl are having on *E. coli* in this stream due to the transient nature of waterfowl through migration and daily feeding routines. ACD staff have witnessed waterfowl by the hundreds in many areas of Sand Creek periodically during sampling.

Management strategies for each of these pollutants may be harder to consolidate into projects that will improve all of these pollutant types. Targeting phosphorus loading from stormwater should occur in the upper portions of the tributary ditch subwatersheds, namely Ditch 60 and Ditch 39. Targeting TSS loading should occur in the lower reaches of the stream channel, potentially through the further stabilization of eroding banks and additional remeandering projects. One large remeander project occurred in 2019-20 near Olive St. Targeting of *E coli* bacteria cannot likely be accomplished in any single location, but may be best done through educational resources and offering dog waste disposal resources to users of the Sand Creek Trail park system.

Specific conductance and Chlorides

Sand Creek's dissolved pollutant levels as measured by specific conductivity are higher than levels found in Coon Creek, which Sand Creek drains into. The long-term median under all conditions for specific conductance in Sand Creek at Xeon St. is 0.794 mS/cm compared to the median for all Coon Creek monitoring sites upstream of this confluence at Lions Coon Creek Park and at 131st Ave, each of which has a longer term median near 0.520 mS/cm.

Sand Creek's watershed is primarily suburban residential with the unique characteristic of many man-made and densely developed basins at the headwaters of one of the three main contributing ditches. The watershed 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. Other streams in the Sand Creek watershed in similar land use settings have comparable dissolved pollutant levels.

From upstream to downstream in Sand Creek there is little change in concentrations of dissolved pollutants (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 slightly higher concentrations.

Dissolved pollutants can easily infiltrate into shallow groundwater that feeds streams during baseflow conditions. This causes continuous high levels of specific conductance that actually decline during storm events when dilution occurs. If stormwater runoff was the primary source of dissolved pollutants in the creek, one indicator would be higher conductivity during storm events. When chlorides were monitored at Xeon Street during baseflow conditions, median levels were 10%-15% higher than during storms. This is not to say that storm runoff is free of dissolved pollutants; rather the concentration is lower than what is found in shallow groundwater feeding Sand Creek. From a management standpoint, it is important to remember that the sources of dissolved pollutants generated from both stormwater and baseflow are generally the same, and preventing the pollutants' initial release into the environment should be a high priority.

High concentrations of dissolved pollutants in Sand Creek are contributing to the degradation of Coon Creek. Both creeks were monitored at sites just before they join (Coon Cr at Lions Park and Sand Cr at Xeon). Across all years monitored, Sand Creek's median specific conductance is approximately 20% higher than Coon Creek (0.840 vs 0.682 mS/cm) before this junction.

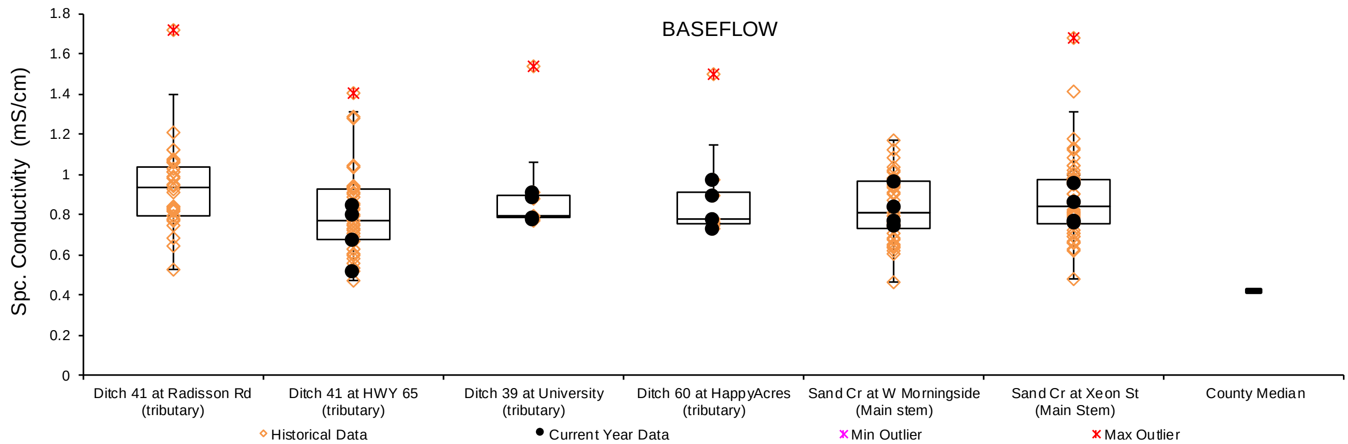
Median chloride concentrations are also higher in Sand Creek than in Coon Creek (76 vs 54 mg/L). Chloride samples were collected in 2019 in each of Sand Creek's individual contributing ditch systems as well as the Creek itself. Concentrations were very similar during both baseflow conditions and following storm events, with storm events causing slightly increased concentrations. Of the contributing ditch systems, Ditch 60 consistently had the highest concentration of chlorides. In such a densely developed watershed, de-icing salts used for roadways, parking lots, and private driveways are a likely contributor of much of the chlorides entering the creek system.

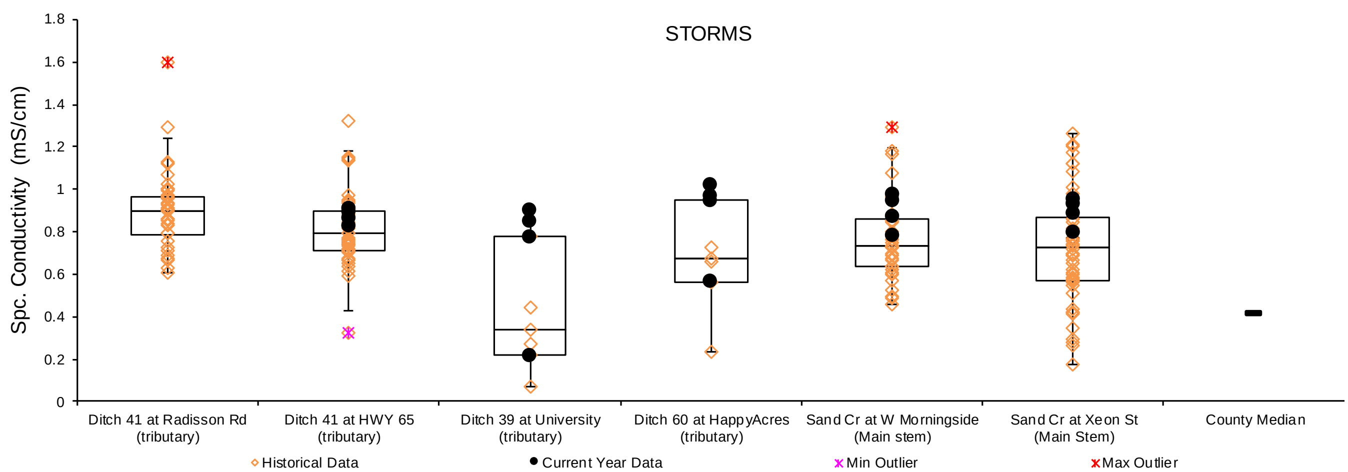
Seven years of chloride sample collection has now occurred at the downstream site at Xeon St, 2007-2012 and 2019. While this is not a large enough record to assess trends over time, looking at annual averages for these samples offers insight into any potential changes in the system. Baseflow annual average concentrations range from a low of 66.8 mg/L in 2012 to a high of 95.6 mg/L in 2009. The 2019 average was right in between at 83.2 mg/L. During storm flows, from 2007-2012, annual average concentrations ranged from 47.6 mg/L in 2010 to 68.25 mg/L in 2008. These averages are generally lower than the baseflow averages for the same year. Storm samples in 2019, however, exceeded all of these annual averages with an average of 102.3 mg/L. This was the first year that the average storm flow concentration exceeded the baseflow concentration during the same monitoring year, and is the highest average on record for either condition over any monitored year.These elevated storm event chloride concentrations are worth tracking in future monitoring years. No individual samples on record have approached the 230 mg/L chronic state standard for chlorides.

Average and median specific conductance and median chlorides in Sand Creek Data is from Xeon St for specific conductance and chlorides all years through 2019.

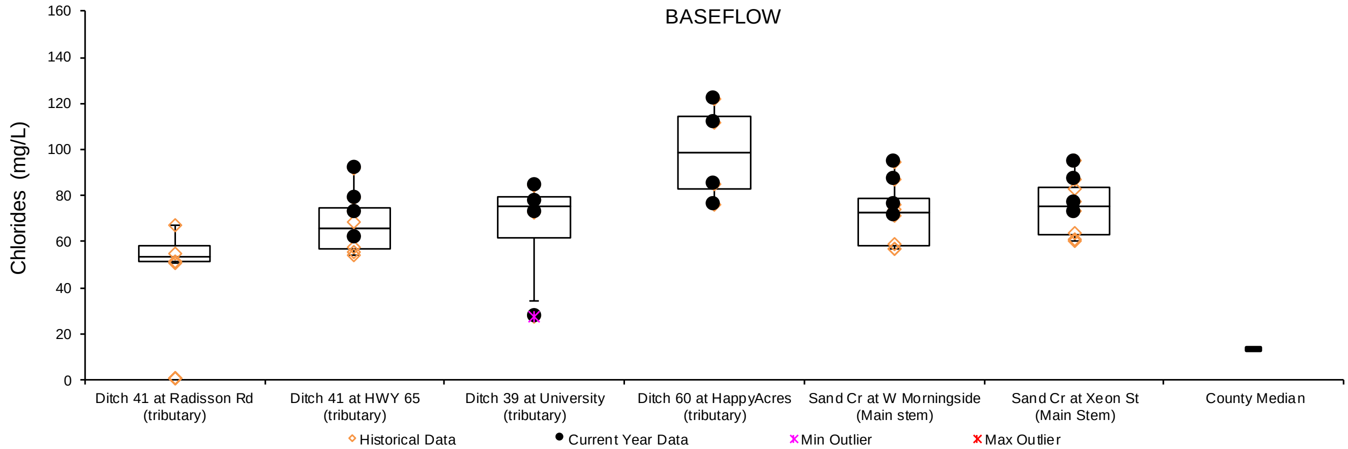
	Average Specific conductance (mS/cm)	Median Specific conductance (mS/cm)	Median Chlorides (mg/L)	State Standard	N (Sp Cond.)
Baseflow	0.878	0.840	75.75	Specific conductance – none Chlorides 860 mg/L acute, 230 mg/L chronic	52
Storms	0.719	0.723	71.75		52
All	0.798	0.769	71.70		104
Occasions > state standard					0

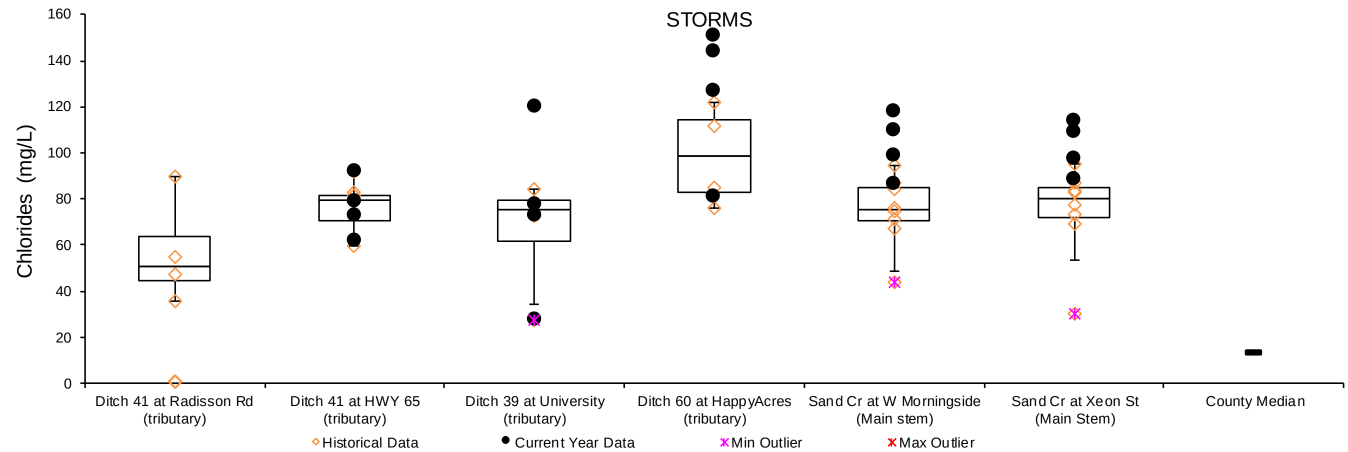
Specific conductance at Sand Creek Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Chlorides at Sand Creek Orange diamonds are historical data from previous years and black circles are 2019 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

Similar to Coon Creek, Sand Creek is not listed as impaired for total phosphorus, but it does have an approved TMDL for the nutrient as a result of the aquatic life impairment. Our grab sample monitoring shows TP concentrations generally remain below the state standard of 100 µg/L in Sand Creek (see table and figures below). The long-term median for TP in Sand Creek at Xeon St. (all years) is 61 µg/L during baseflow and 89 µg/L during storm events. However, Sand Creek at Xeon St. samples during storm events average 107 µg/L (mean), slightly higher than the state standard. Since 2007, post-storm samples collected at Xeon St. have exceeded the state standard 36% of the time.

Phosphorus loading occurs throughout the Sand Creek watershed, but the Ditch 39 and Ditch 60 systems seem to degrade Sand Creek water quality more than Ditch 41 does. At the Ditch 41 monitoring site at Highway 65, upstream of both lateral ditch confluences, total phosphorus levels are generally low during both baseflow and storm events. Prior to 2019, Ditch 39 and Ditch 60 were only monitored in 2009, so very limited information was available to assess their impact on the Sand Creek system as a whole. After again monitoring these ditches, it appears that both have relatively poor water quality compared to Ditch 41 and contribute to the degradation of Sand Creek downstream. Both of these ditches exceeded 100 µg/L during baseflow and storm sampling events in both 2009 and 2019.

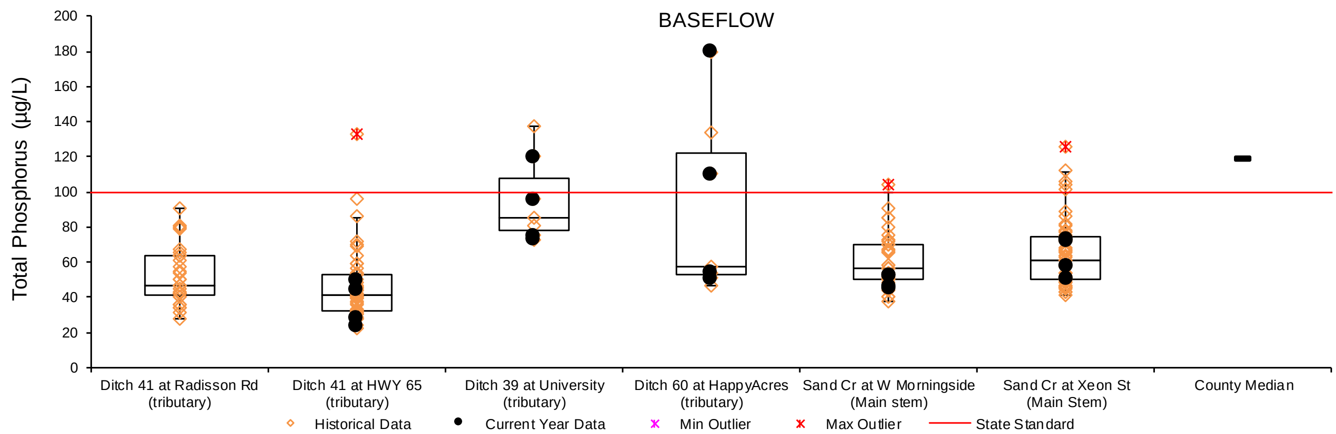
After the confluence of all three ditch systems, TP concentrations at the Morningside Memorial Gardens site still generally falls below the state standard 100 µg/L, though exceedances during storm events are common. Continuing to move downstream to Xeon Street, Sand Creek flows as a more natural meandering channel with a protective park system adjacent to it. Total phosphorus concentrations do not increase in a statistically significant way through this stretch during either baseflow or storm conditions. Recent work in this portion of the subwatershed includes construction of a new stormwater pond, many rain garden installations that treat stormwater runoff from residential neighborhoods draining to Sand Creek, as well as large channel restoration and remeander projects near Xeon St. in 2018-20 that stabilized eroding banks and will provide additional habitat for aquatic biota.

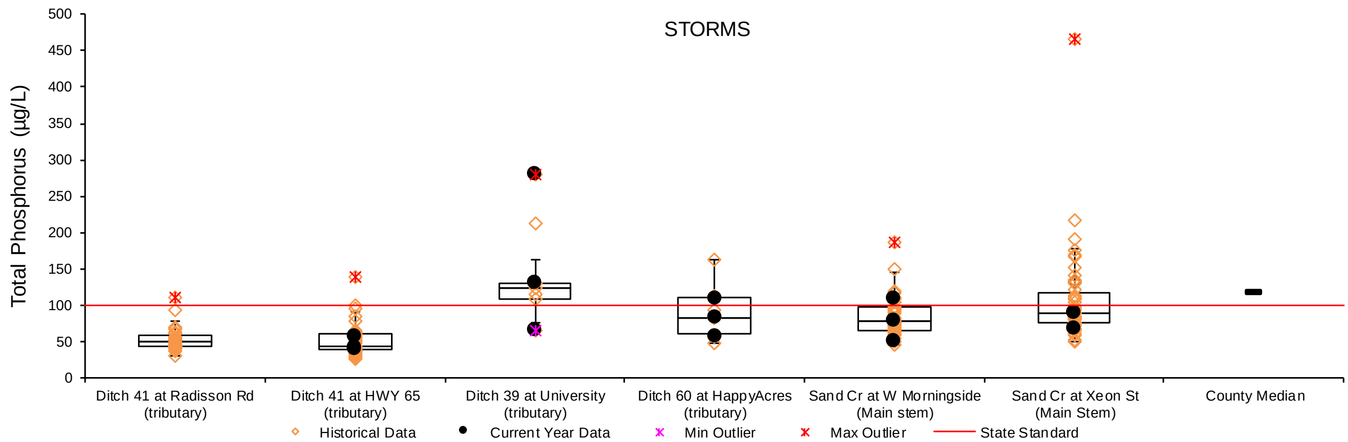
The Coon Creek TMDL, approved in 2016, also delegates acceptable levels of pollutants in Sand Creek on a load duration curve (LDC). The LDC for Sand Creek is graphed on a plot with flow-weighted daily loads for phosphorus samples collected at Xeon Street (Page 48, Figure 17). This plot shows that Sand Creek exceeds its LDC for TP occasionally, and at all flow levels from low to very high. Average TP concentrations only exceed the LDC during very high flows. Pairing the results shown on this curve with our grab sample concentration analysis indicates that additional treatment of stormwater, especially in the individual catchments of Ditch 39 and Ditch 60, should be a high priority for management in Sand Creek.

Average and median total phosphorus in Sand Creek Data is from Xeon St for all years through 2019.

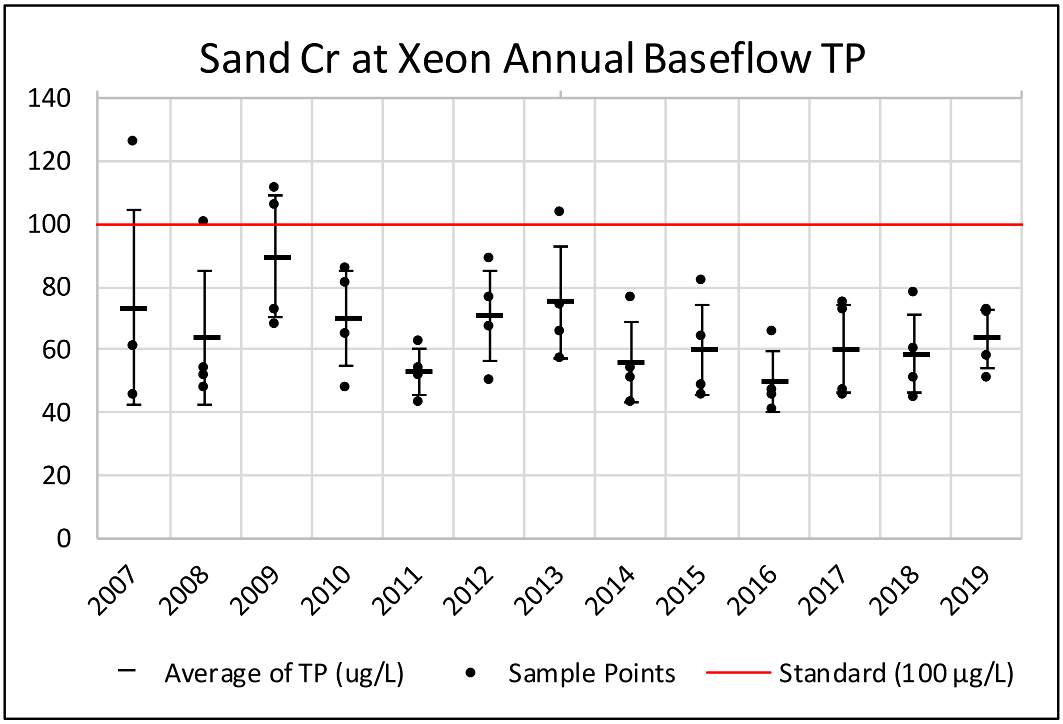
	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	64.98	61.0	100	52
Storms	106.92	89		51
All	85.74	75.0		95
Occasions > state standard				18 (36%) storm 5 (10%) baseflow

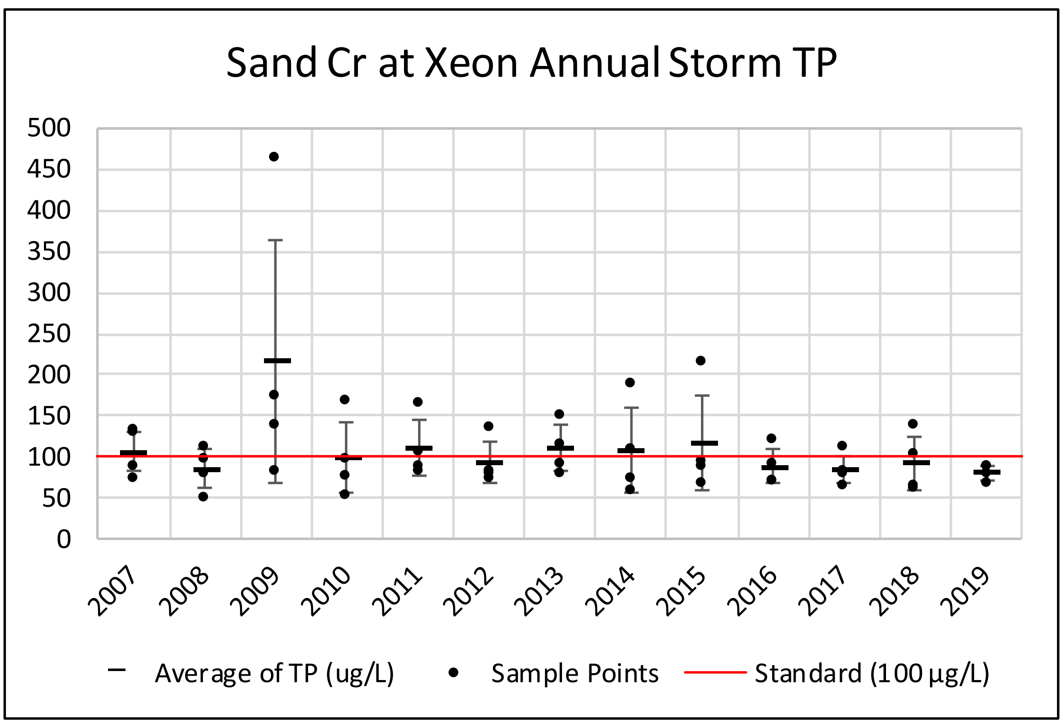
Total phosphorus at Sand Creek Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Sand Creek at Xeon St. - Annual average ANOVA regression TP 2007-2019





ANOVA Matrix for Baseflow Total Phosphorus	Sand Cr at West Morningside Memorial Gardens (WMMG)	Sand Cr at Xeon St.
Sand Cr at Morningside Memorial Gardens		No Sig. Change WMMG $\bar{X}$= 58.25 µg/L Xeon $\bar{X}$= 60.28 µg/L p= 0.54
Sand Cr at Xeon St.		

ANOVA Matrix for Storm Total Phosphorus	Sand Cr at West Morningside Memorial Gardens (WMMG)	Sand Cr at Xeon St.
Sand Cr at Morningside Memorial Gardens		No Sig. Change WMMG $\bar{X}$= 84.0 µg/L Xeon $\bar{X}$= 97.17 µg/L p= 0.10
Sand Cr at Xeon St.		

Total Suspended Solids and Turbidity

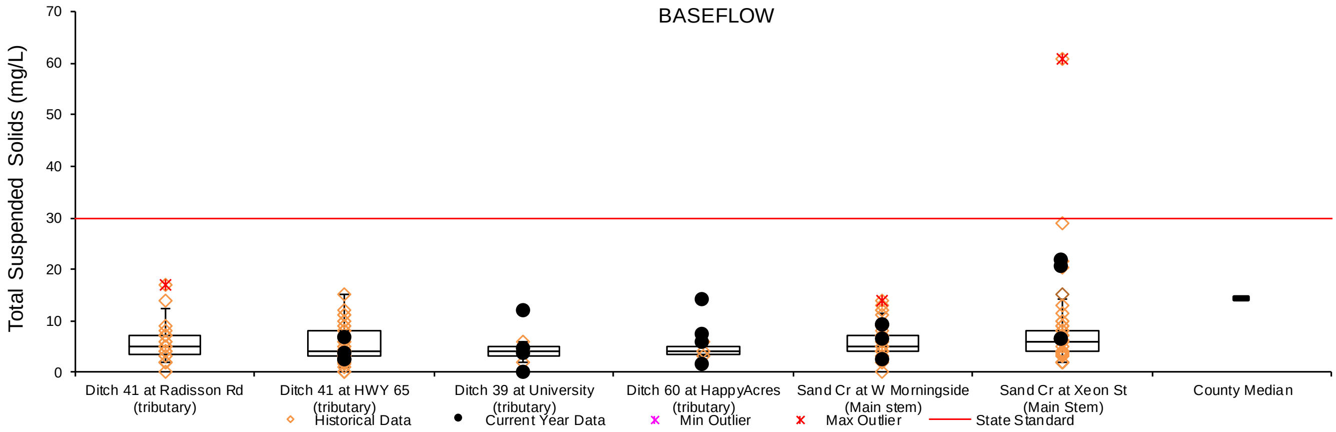
TSS concentrations are generally low in Sand Creek, although storm flow concentrations are elevated in the downstream portions of the Creek and appear to not follow the same loading pattern as TP does through the system. Unlike TP, TSS concentrations are generally low during all conditions in each of the three individually monitored ditch tributaries before their confluences. At baseflow, TSS concentrations remain low through the remainder of the Sand Creek channel, averaging just 7.88 mg/L for all baseflow samples at Xeon St. The state standard concentration for TSS for streams in this region is 30 mg/L, a mark only exceeded once at Xeon St. during baseflow conditions. During storms, however, TSS concentrations are elevated starting at West Morningside Memorial Gardens and continuing to Xeon St. downstream, where the state standard has been exceeded in 10% of storm samples. Additionally, storm flow TSS concentrations increase in a statistically significant way between Morningside and Xeon St. though no increase is present at Xeon St. over time. Interestingly, storm flow TSS concentrations remain low in all three of the individual ditches upstream of their confluences, likely the result of large stormwater basins that allow for particle settling.

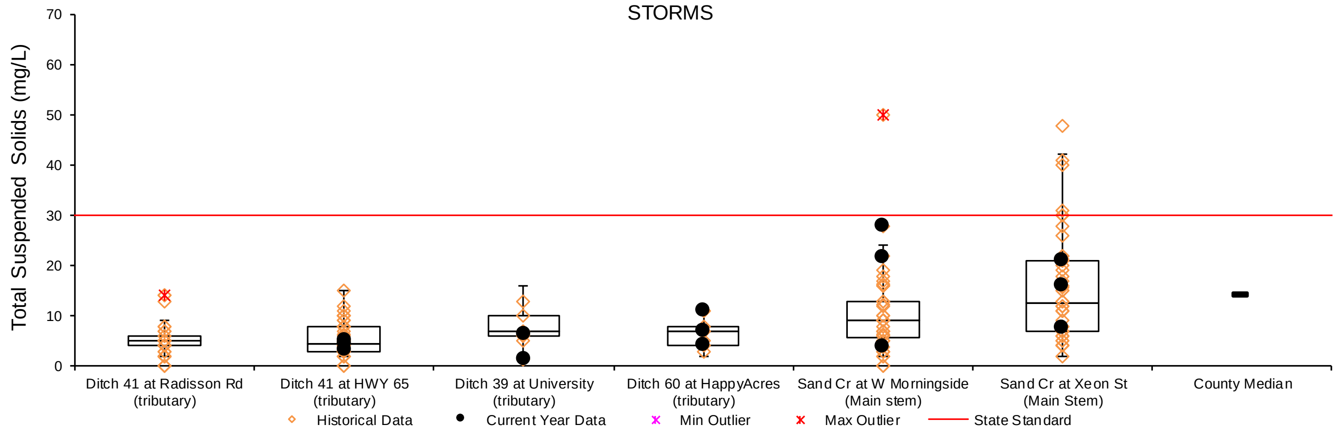
The approved Coon Creek TMDL contains a Load Duration Curve for TSS in Sand Creek at the Xeon St. monitoring station (Page 43, Figure 14). The results graphed on this curve show only a couple of exceedances of for TSS, and only at high to very high flows. In contrast to total phosphorus loading, which appears to be highest from the Ditch 39 and Ditch 60 tributaries, TSS loading in Sand Creek appears to be occurring in the main channel after the confluence of the three ditches, and primarily during larger storm events that cause high flows. This may suggest that high flows are causing excessive erosion of unstable banks in the lower Sand Creek channel, increasing the TSS load through this portion of the system. The recent stabilization and remeander projects near Xeon and Olive Streets should help stabilize this portion of the Creek. Additionally of note, while the Coon Creek TMDL identifies bank erosion as a major contributor of TSS to Coon Creek (63%), it is considered only a minor factor in Sand Creek accounting for just 13% of the total TSS load. If this is the case, there may be some large source(s) of TSS washing into the Creek in the lower portion of the watershed during storm events that is not contributing additional phosphorus in an equivalent manner. Any sources contributing these large loads of particulates into the Creek may be identifiable by large swaths of deposited material near storm drain inlets or other direct drainage sources of stormwater to the Creek. If no large sources of sediment can be identified on the landscape, the TMDL may be vastly underestimating bank erosion in Sand Creek. In many streams, management of TP and TSS sources on the landscape is best accomplished through stormwater practices that will capture and treat both before they enter the stream system. In the Sand Creek system, it appears that the sources of loading for these pollutants may be different, and management of each may be best accomplished with separate strategies.

Average and median total suspended solids in Sand Creek Data is from Xeon St for all years through 2019.

	Average Total Suspended Solids (mg/L)	Median Total Suspended Solids (mg/L)	State Standard	N
Baseflow	7.88	6.0	30 mg/L TSS	52
Storms	17.19	12.50		52
All	12.53	8.0		96
Occasions > state TSS standard				5 (10%) storm 1 (2%) baseflow

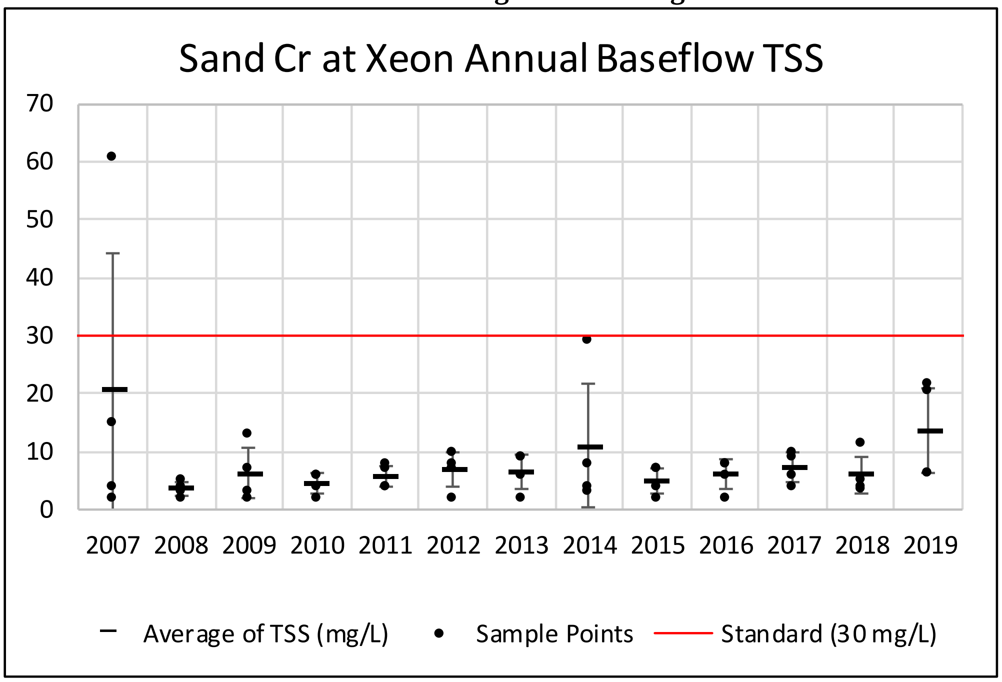
Total suspended solids at Sand Creek Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

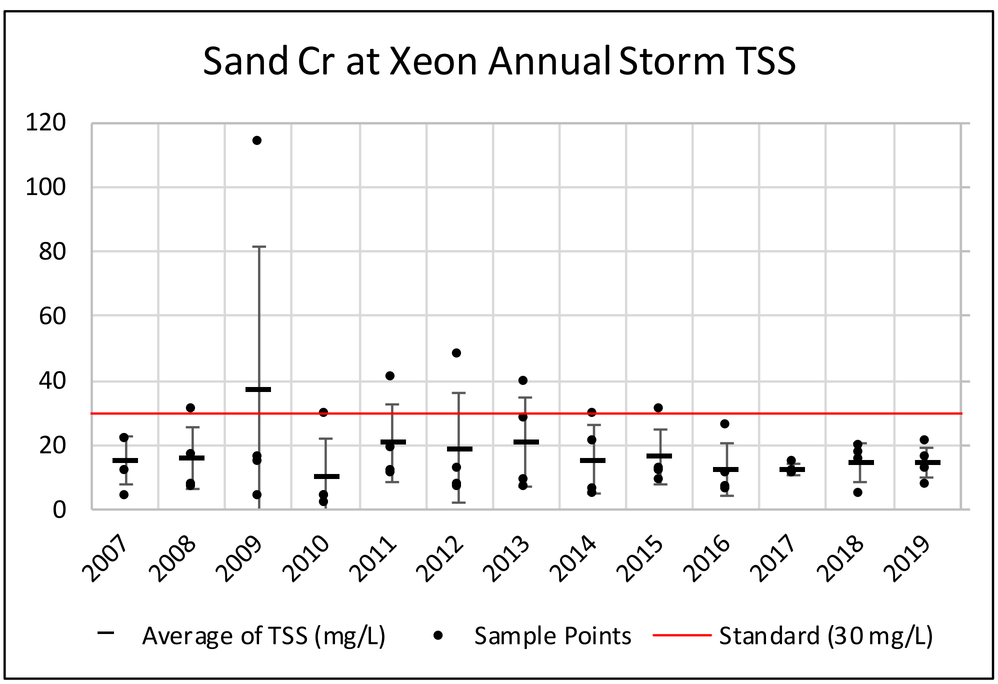




Parameter	Significant Change in Annual $\bar{X}$ (2005-2019)	p=	Standard Error of Means
Total Suspended Solids - Baseflow	None	0.79	4.05
Total Suspended Solids - Storm	None	0.23	3.80

Sand Creek at Xeon St. - Annual average ANOVA regression TSS 2007-2019





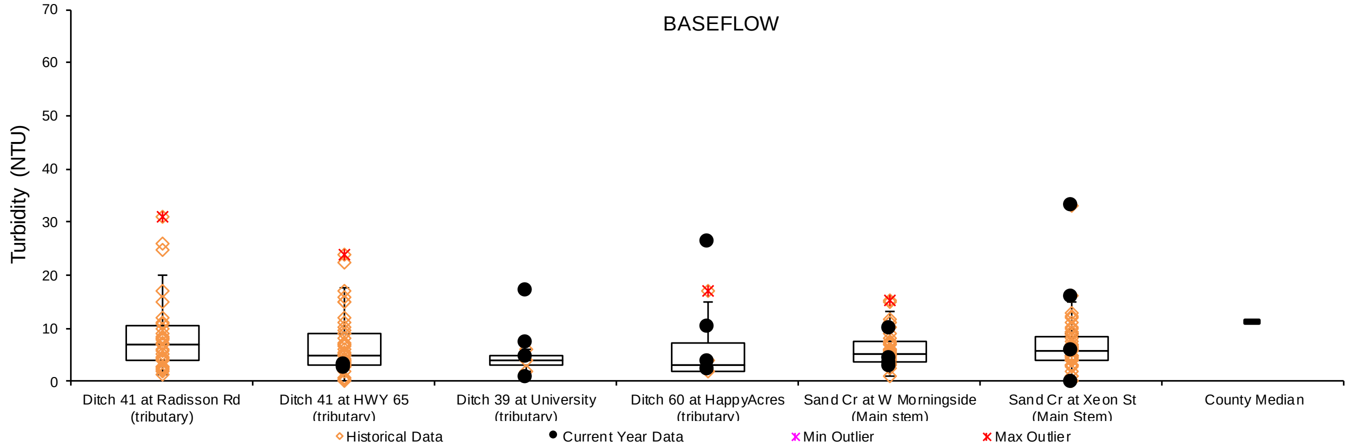
ANOVA Matrix for Baseflow Total Suspended Solids	Sand Cr at West Morningside Memorial Gardens (WMMG)	Sand Cr at Xeon St.
Sand Cr at Morningside Memorial Gardens		No Sig. Change WMMG $\bar{X}$= 5.70 mg/L Xeon $\bar{X}$= 7.31 mg/L p= 0.13
Sand Cr at Xeon St.		

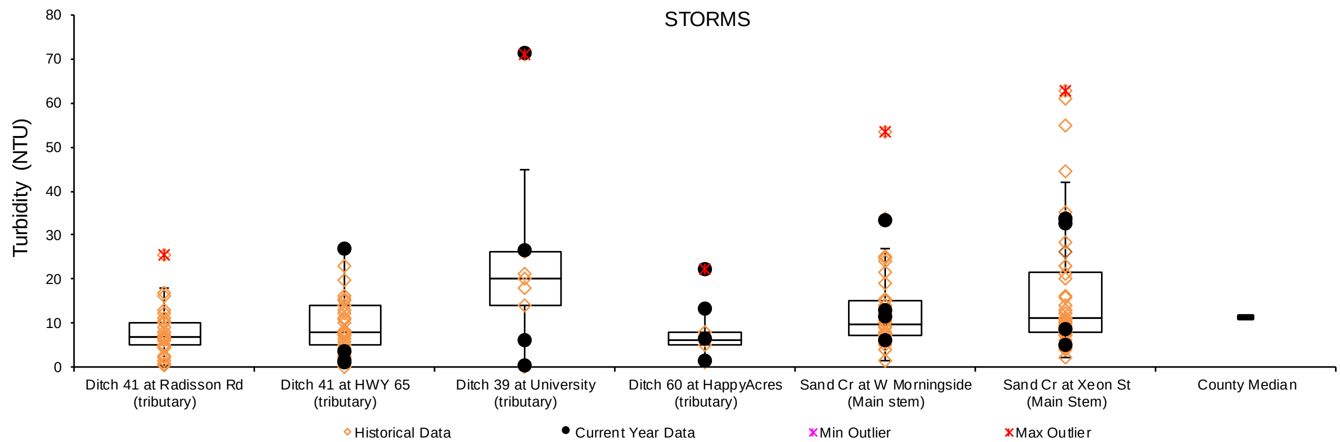
ANOVA Matrix for Storm Total Suspended Solids	Sand Cr at West Morningside Memorial Gardens (WMMG)	Sand Cr at Xeon St.
Sand Cr at Morningside Memorial Gardens		Significant Increase WMMG $\bar{X}$= 10.28 mg/L Xeon $\bar{X}$= 15.03 mg/L p= < 0.05
Sand Cr at Xeon St.		

Average and median turbidity in Sand Creek Data is from Xeon St for all years through 2019.

	Average Turbidity (NTU)	Median Turbidity (NTU)	State Standard	N
Baseflow	9.60	5.8	n/a	51
Storms	16.80	11.0		52
All	13.23	8.0		103

Turbidity at Sand Creek Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





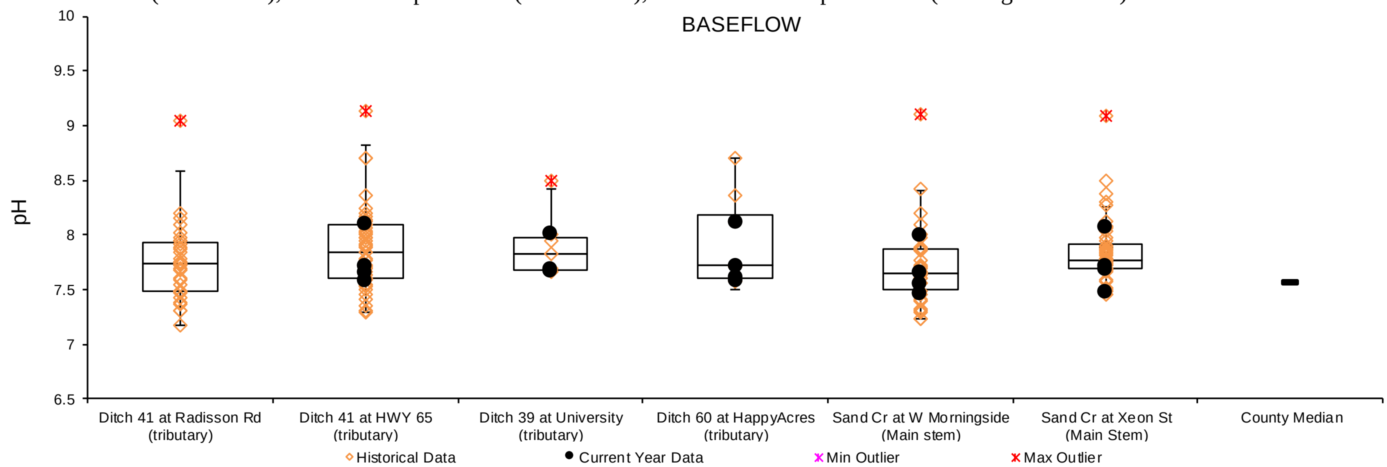
pH

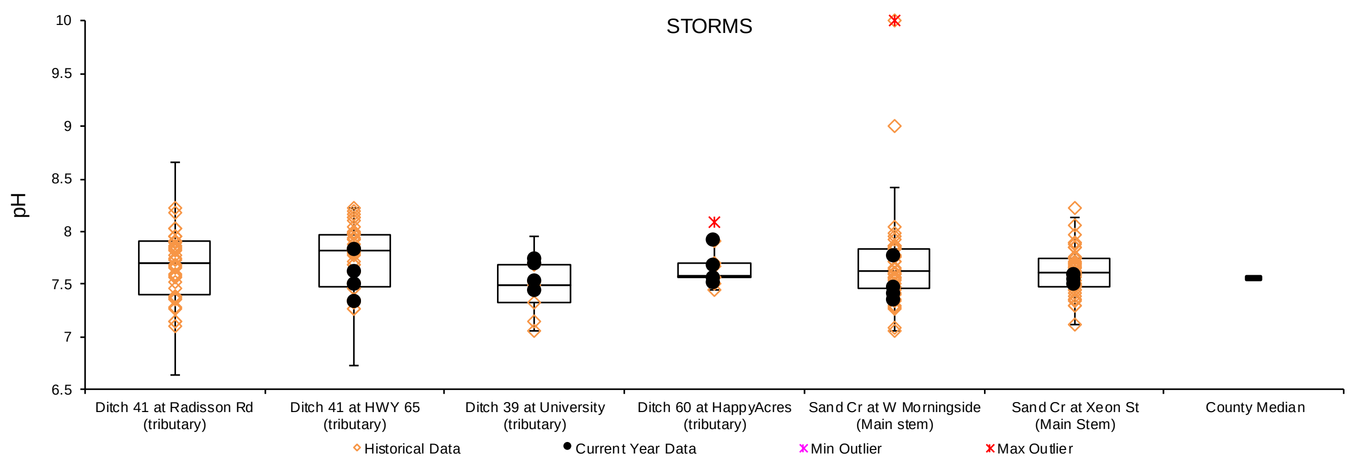
Sand Creek pH remained within the acceptable range in 2019. Individual outliers have caused a couple high readings in excess of 9.0 in the monitoring history. These may be due to a poor calibration of the sampling equipment. The median for all conditions at Xeon is 7.77. The Minnesota Pollution Control Agency water quality standard is the pH range of 6.5 and 8.5. In general, pH is lower during storms because rainwater is more acidic.

Average and median pH in Sand Creek Data is from Xeon St for all years through 2019.

	Average pH	Median pH	State Standard	N
Baseflow	7.84	7.77	6.5-8.5	51
Storms	7.81	7.60		52
All	7.82	7.77		103
Occasions outside state standard				1 baseflow (2%) 2 storm (4%)

pH at Sand Creek Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





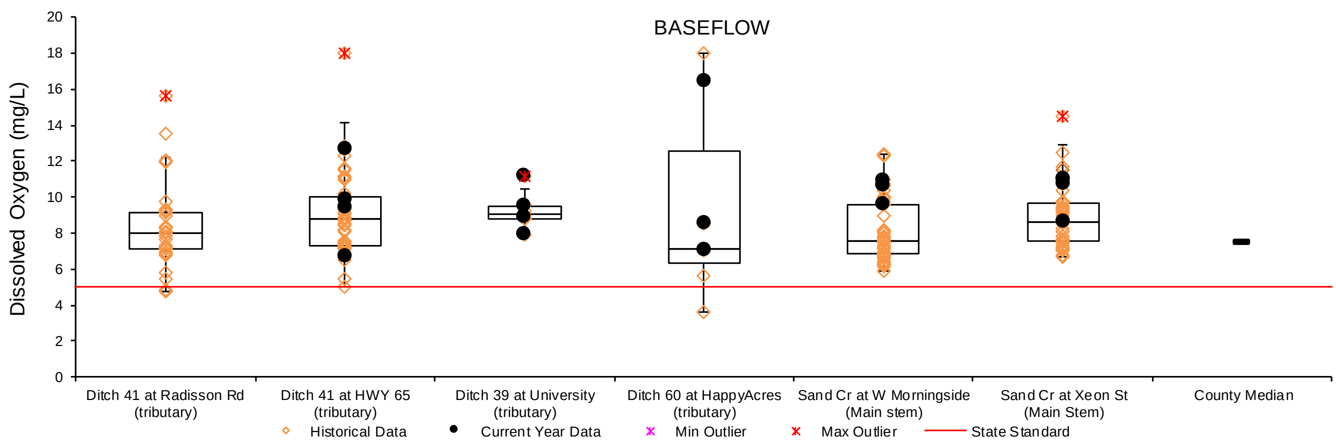
Dissolved Oxygen

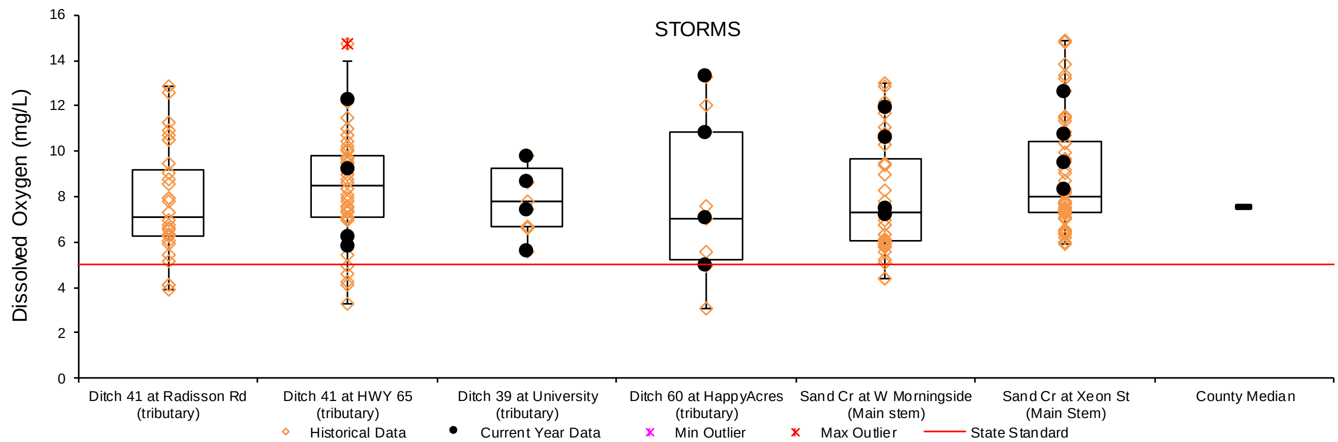
Dissolved oxygen is healthy in lower reaches of Sand Creek, and has never been recorded below 5 mg/L at Xeon St. However, on 13 of 208 (6%) sampling occasions across all monitored years at other upstream sites, DO dropped below 5 mg/L. Overall, there are no significant management concerns about dissolved oxygen levels in Sand Creek, but it should continue to be monitored with an invertebrate biota impairment in place. It is also possible that low oxygen levels in the headwater systems could be contributing to phosphorus loading if select ponds are not functioning as designed and are instead leaching phosphorus under some conditions.

Average and median dissolved oxygen in Sand Creek. Data is from Xeon St for all years through 2019.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.85	8.57	5 mg/L daily minimum	48
Storms	8.95	7.96		52
All	8.90	8.22		100
Occasions <5 mg/L				0 at Xeon St., 13 at other sites

Dissolved Oxygen at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating lines).





E. coli

The chronic state water quality standard for *E. coli* in streams is based on a calculated geometric mean of not less than five samples in any given calendar month. This mean should not exceed 126 MPN. An additional standard of not more than 10% of all samples in a given month should not exceed 1260 MPN is also listed. Because we monitor streams throughout the year, only collecting eight samples total, we do not have sufficient numbers of samples for any given calendar month to calculate geometric means or percentage-based exceedances comparable to these standards. It has been determined, however, that *E. coli* levels in Sand Creek are high enough to warrant an impairment listing for the bacteria, and subsequently, a TMDL load duration curve exists for *E. coli* in Sand Creek. We will examine the *E coli* levels observed in our grab samples, the LDC for *E. coli* in Sand Creek, as well as source analysis from the Coon Creek TMDL.

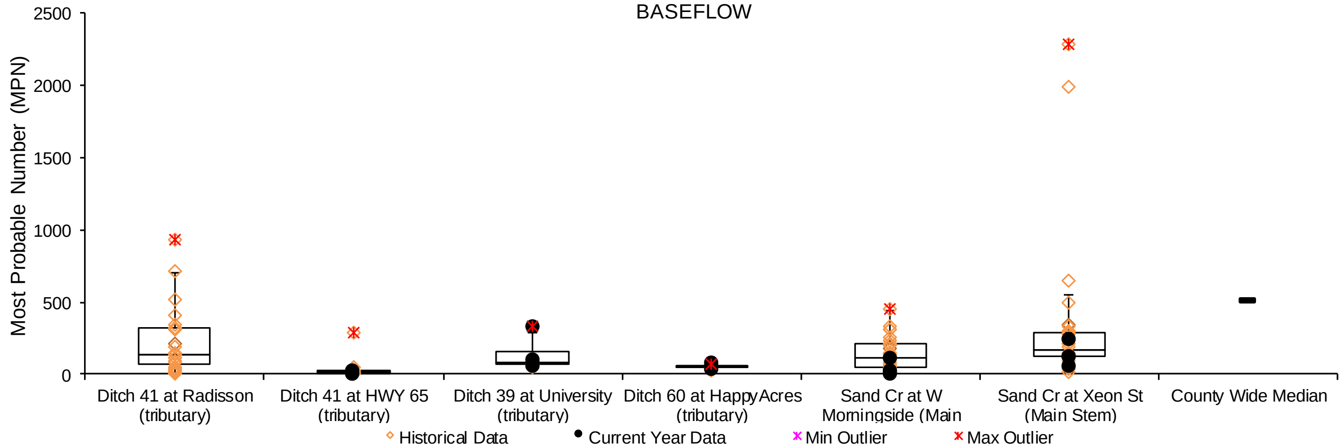
Looking to each of the contributing ditches as potential sources of *E. coli* in Sand Creek, it appears that Ditch 60 is contributing very little with consistently low results during baseflow and only slightly elevated results during storms in 2019 compared to the other ditches. Three out of four storm samples did however exceed 126 MPN. Ditch 39 is contributing higher amounts of *E. coli,* especially during storms with an average of 1204 MPN following storms, and one baseflow sample exceeding 126 MPN in 2019. Ditch 41 has been more perplexing with high levels of *E. coli* during both baseflow and storms at the furthest upstream monitoring site at Radisson Road during past monitoring years (this site was not monitored in 2019), and a consistently sharp decline at the monitoring site at Highway 65. Again in 2019, Ditch 41 at Highway 65 had very low levels of *E. coli*. This may be due to chemical treatment in the TPC and/or Club West ponds just upstream of Highway 65.

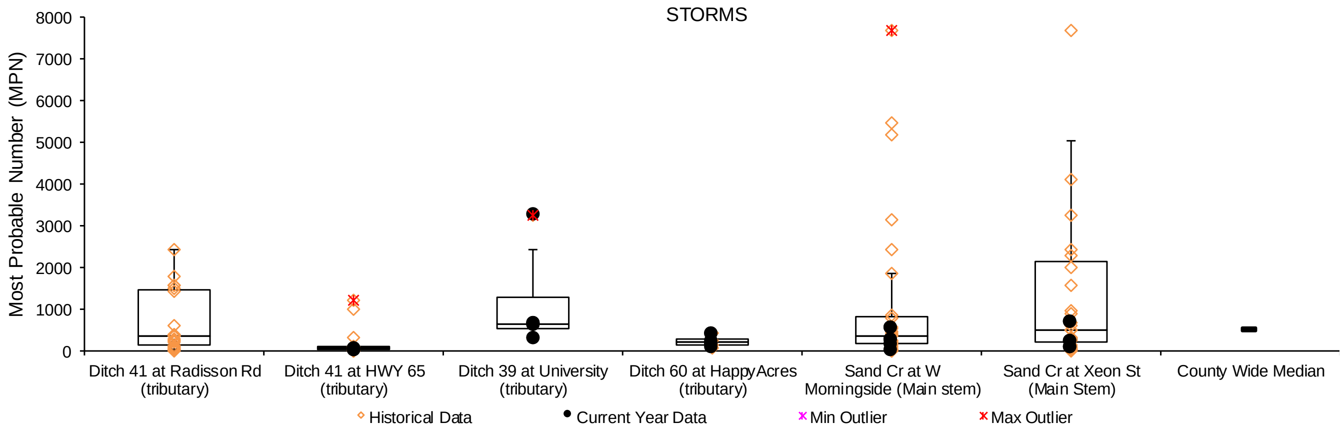
The Coon Creek TMDL offers more insight into *E. coli* loading into Sand Creek. The Load Duration Curve plot (Page 51, Figure 21) shows exceedances of acceptable flow-weighted loads of *E. coli* in most samples and across all flow ranges at Xeon St. The TMDL lists pet dogs as primary source of *E. coli* to Sand Creek accounting for 89% of all input. Considering the entire Sand Creek system drains primarily suburban residential neighborhoods, identifying hot zones and target areas for addressing *E. coli* could be a challenge. Perhaps a more widespread outreach and education effort, paired with resources such as dog waste bag stations and trash receptacles along the popular trail system would be good starting points.

Average, Geomean and median *E. coli* in Sand Creek. Data is from Xeon St. for all years through 2019.

	Average *E. coli* (MPN)	**Geomean *E. coli* (MPN)**	**Median *E. coli* (MPN)**	**State Standard**	**N**
Baseflow	334.18	172.88	168.50	Monthly Geometric Mean >126	28
Storms	2,046.68	567.53	487.0		27
All	1,174.86	309.45	243.0		55
Occasions >126 MPN				Monthly 10% average >1260	15 (60%) baseflow, 18 (75%) storm
Occasions >1260 MPN					2 (7%) baseflow, 9 (33%) storm

***E. coli* at Sand Creek.** Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the me dian (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating lines).





YSI Continuous Stream Water Quality Monitoring – Sand Creek System

SAND CREEK

at Morningside Memorial Gardens & Xeon Street, Coon Rapids

Background

On the following pages, results from each storm monitored in 2019 are shown. This includes 4 storm events at both Sand Creek at Memorial Gardens and Sand Creek at Xeon Street, the two furthest downstream monitoring sites. The graphs show daily precipitation totals as well as the stream hydrograph for the duration of the storm. Separate graphs show each water quality parameter graphed with water elevation. The text below summarizes findings for both monitoring sites across all storms for each parameter.

Results and Discussion

Turbidity

- Turbidity data provided by continuous monitoring can be erratic as suspended debris often gets trapped in the sensor guard and affects measurements on deployments. This can cause very irregular readings that rapidly jump up and down, or stay very high once the streams returns back to baseflow.
- In general, turbidity rises rapidly at the beginning of storms, along with stage at both sites. Maximum turbidity readings for individual storms at each site is generally low, less than 50 NTU, although some storm events elevate turbidity more.
- In some cases, stage and turbidity were each slow to return to normal baseflow levels, likely due to continued precipitation and the above average saturation of the watershed and water levels in general throughout 2019.
- At baseflow, Sand Creek runs quite clear with typical turbidity readings between 0 and 10 NTU.

Specific Conductance

- Specific conductance decreases during storm events in Sand Creek at both monitoring sites. When creek stage rises due to storm runoff, conductance drops. During brief, intense rainfall stream conductance drops sharply. This relationship indicates that the shallow groundwater that feeds the stream during baseflow conditions has higher specific conductance than stormwater runoff.
- Infiltration of road deicing salts is a likely source of dissolved pollutants in streams at baseflow year round due to contamination of the surficial groundwater that feeds the streams.
- At baseflow, Sand Creek specific conductance generally remains between 700 and 1,100 µS/cm. This is a similar range at baseflow to Coon Creek specific conductance, but Sand Creek usually has higher specific conductance than Coon Creek when measured on the same day.

Dissolved Oxygen

- Dissolved oxygen levels in Sand Creek were within the healthy range, >5mg/L. The lowest DO observed was at Xeon St. where DO levels still remained above 6 mg/L in late-June – early-July. During both occasions, water temperatures were greater than 70° F. Warmer water has a lower capacity for dissolved oxygen.
- Dissolved oxygen is generally higher in Sand Creek than in Coon Creek, and diel flux is smaller.

Temperature

- Water temperature is generally not considered a concern in Sand Creek because there are no trout or other

pH

- pH typically declines during storm events in Sand Creek. When water levels rise, pH declines because rainwater is more acidic and has a lower pH than that of local shallow groundwater.
- pH stayed within the desired range of 6.5 to 8.5 that is specified in state water quality standards.

Precipitation

- Storm totals for Sand Creek at Xeon ranged from 0.43 to 1.82 inches. The majority of precipitation during each storm event occurred within a single 24 hour window.
- Storm totals for Sand Creek at Morningside ranged from 1.80 inch – 1.82 inch events. The duration of two storm events were within 24 hours and the other two storms precipitation fell over stretched over several days.

Site Comparison

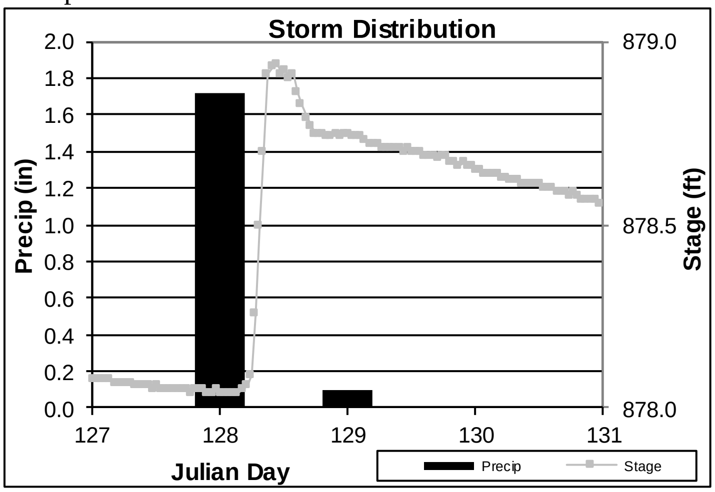
- Parameter and stage reacted similar at both Sand Creek sites when compared side-by side during storm events.

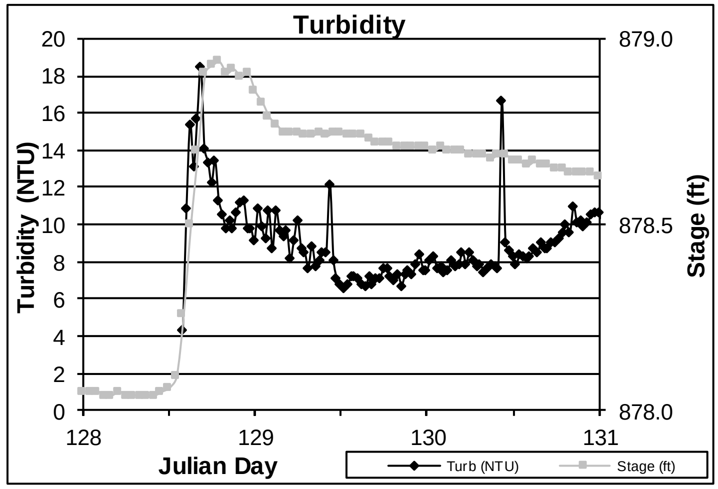
YSI Continuous Monitoring – <u>Sand Creek at Morningside Memorial Gardens</u>
Storm 1 – May 7th to May 11th

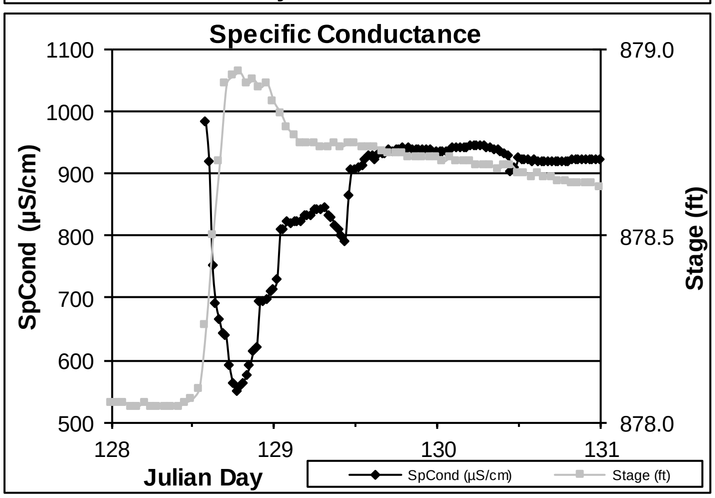
<u>Storm Summary:</u>

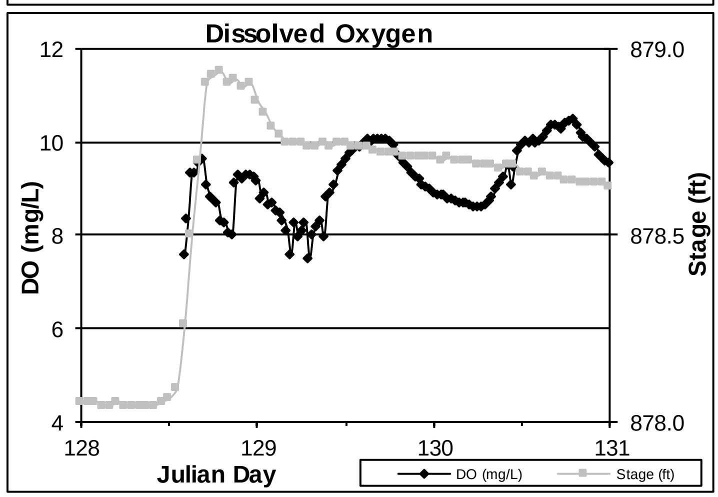
Dates: May 7 2019 (Day 127) to May 11 2019 (Day 131)

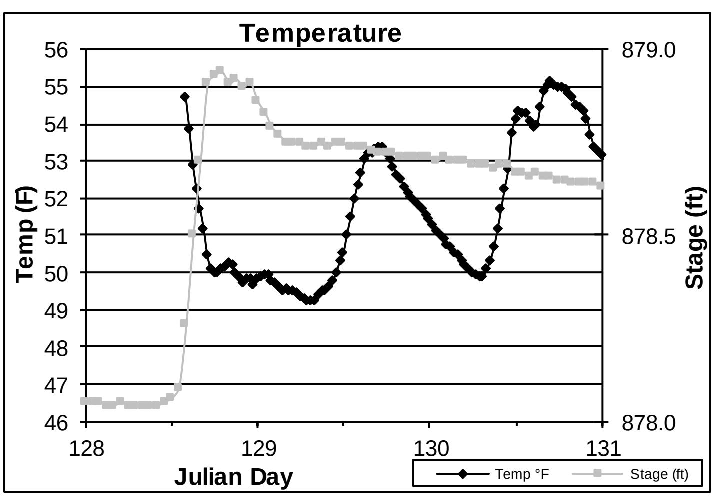
Precipitation: 1.82 in.

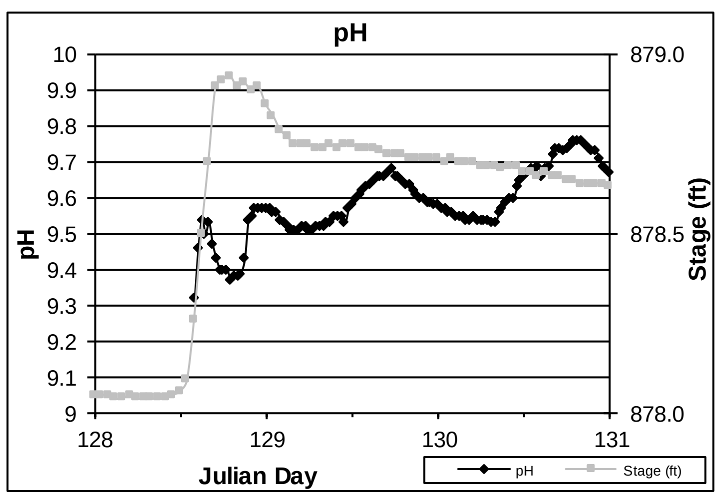










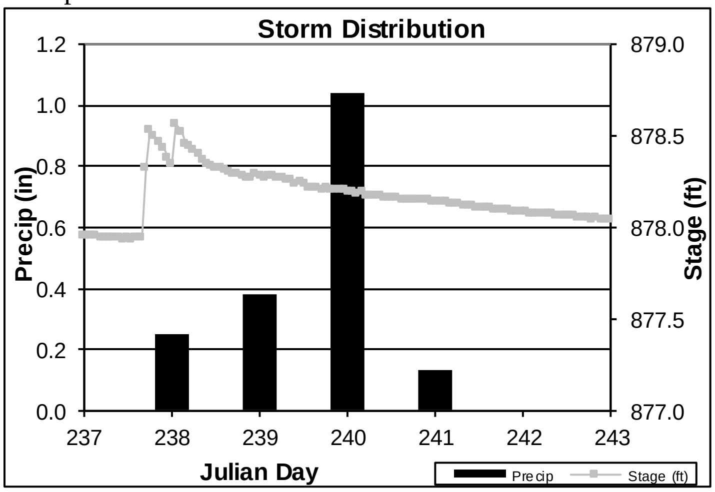


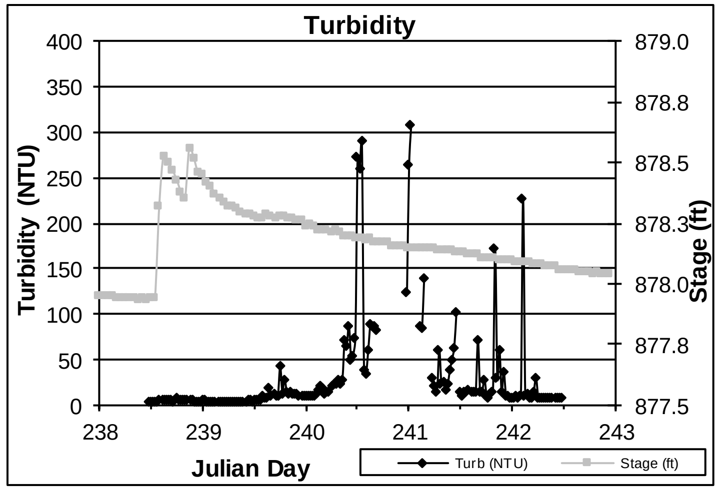
YSI Continuous Monitoring – <u>Sand Creek at Morningside Memorial Gardens</u>
Storm 2 – August 26th to 30th

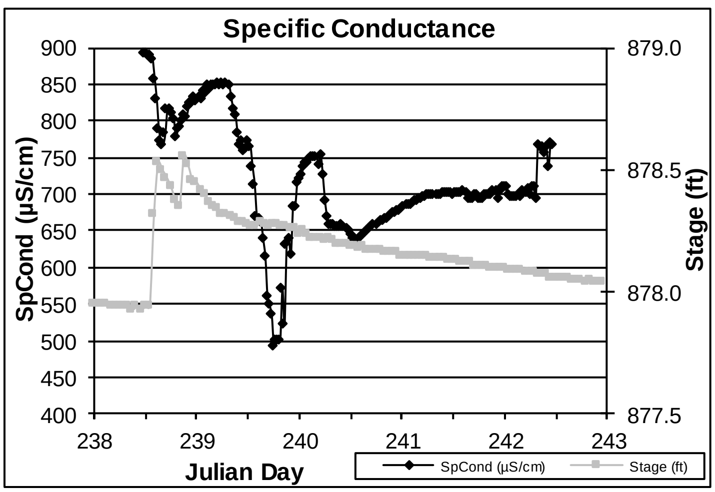
<u>Storm Summary:</u>

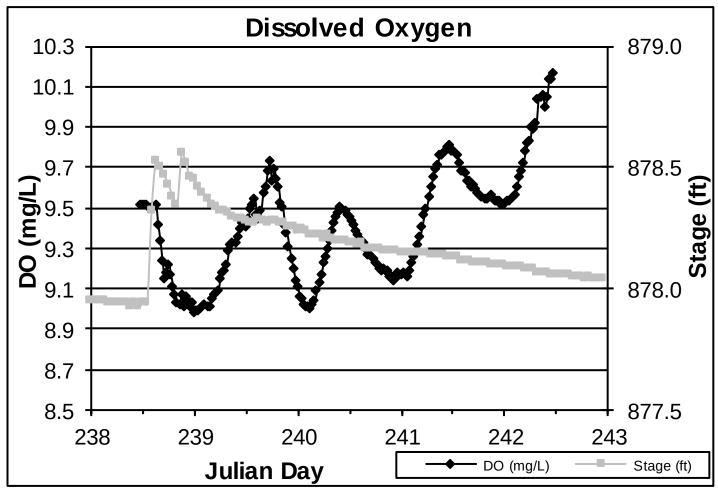
Dates: 26 August 2019 (day 238) to 30 August 2019 (day 242)

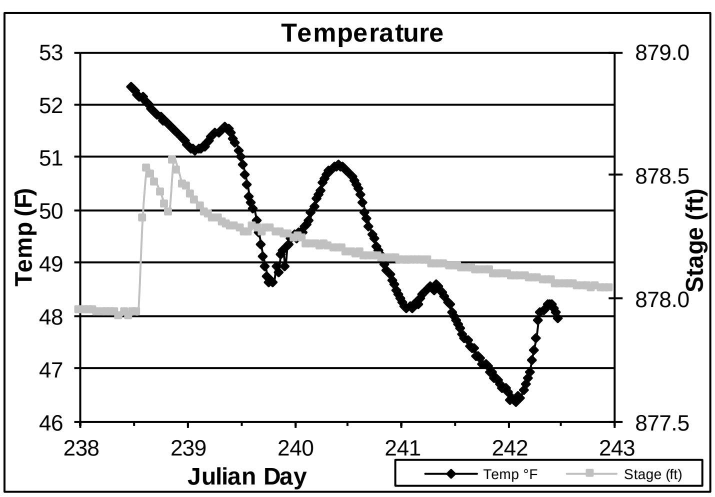
Precipitation: 1.80 in.

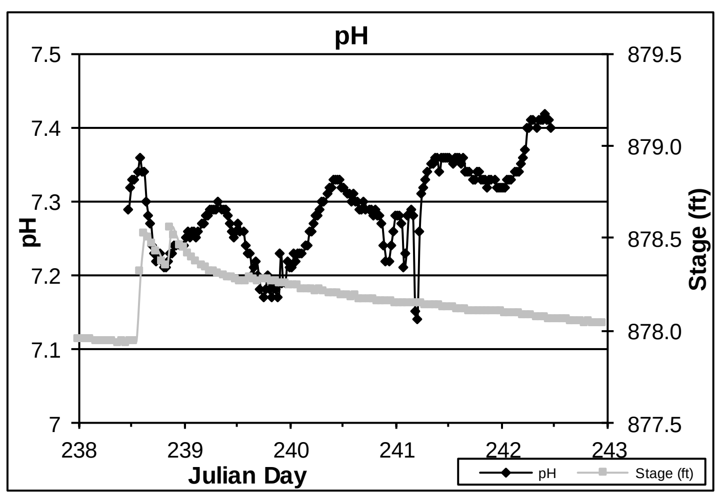












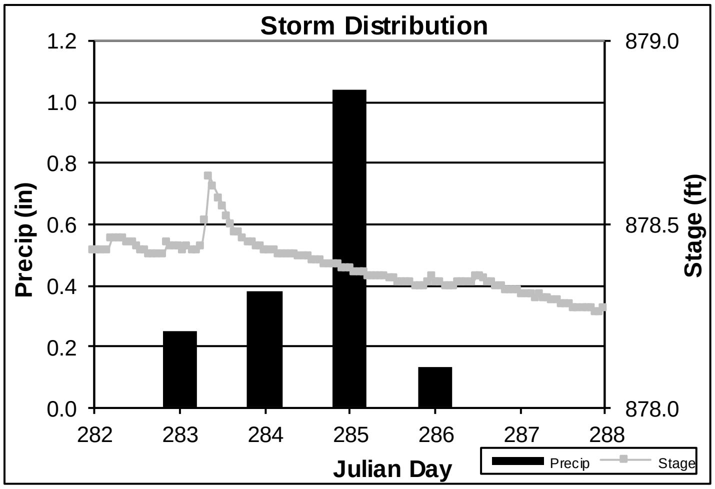
Note: High turbidity spikes may be due to debris on the turbidity sensor.

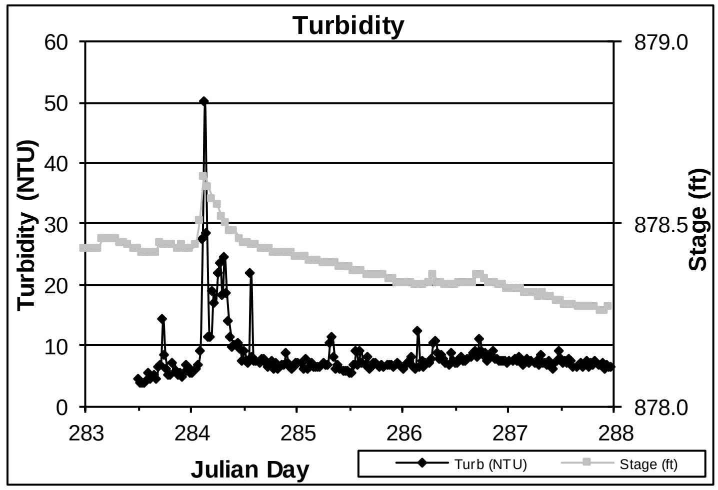
YSI Continuous Monitoring – <u>Sand Creek at Morningside Memorial Gardens</u>
Storm 3 – October 10th to 14th

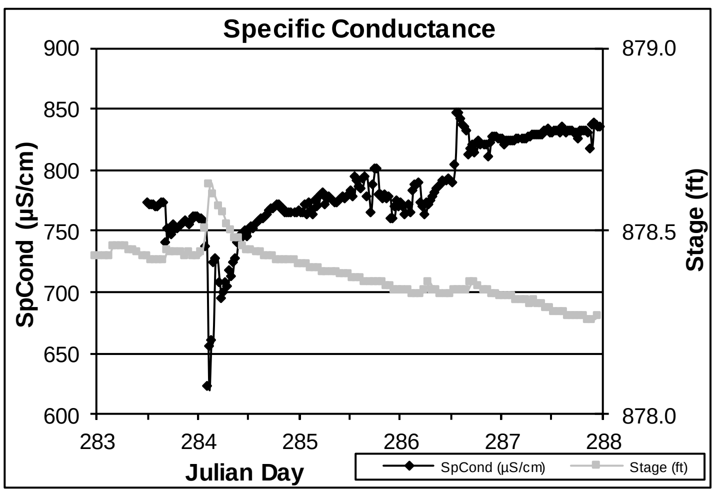
<u>Storm Summary:</u>

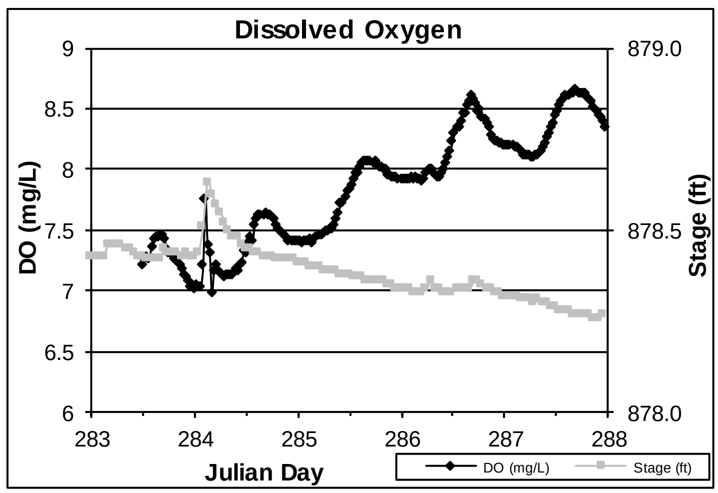
Dates: 10 October 2019 (day 283) to 14 October 2019 (day 287)

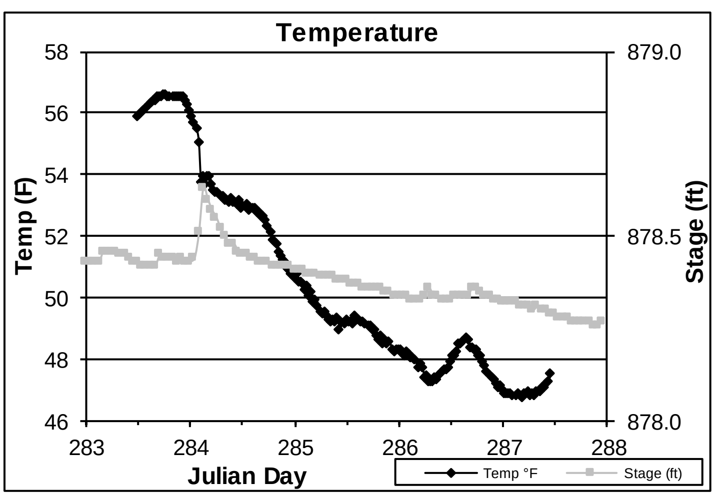
Precipitation: 1.80 in.

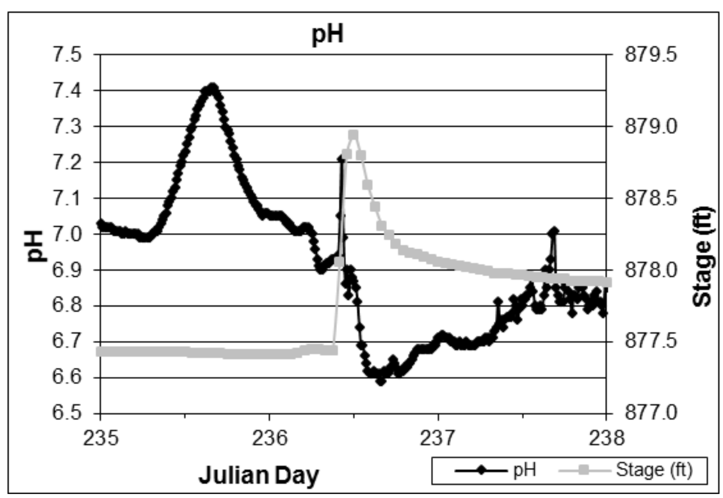






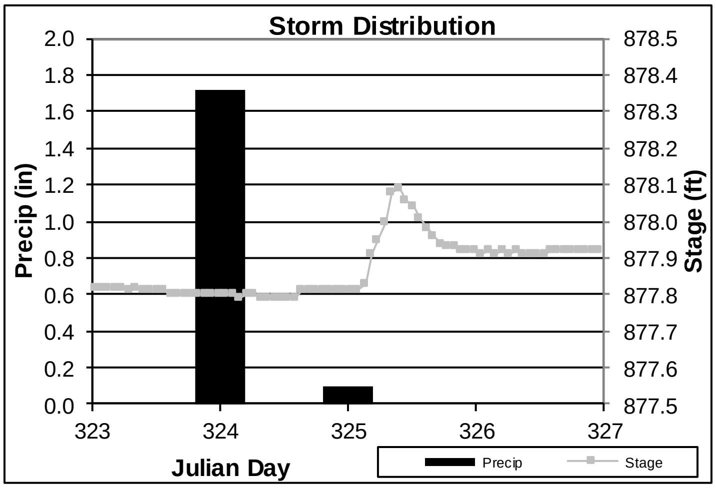


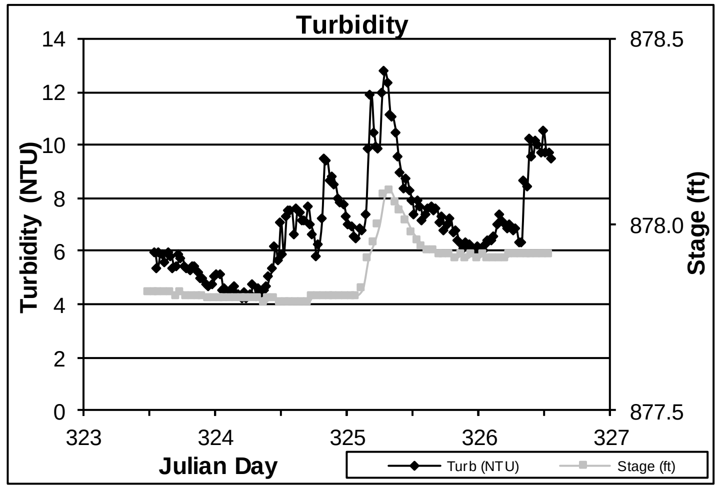


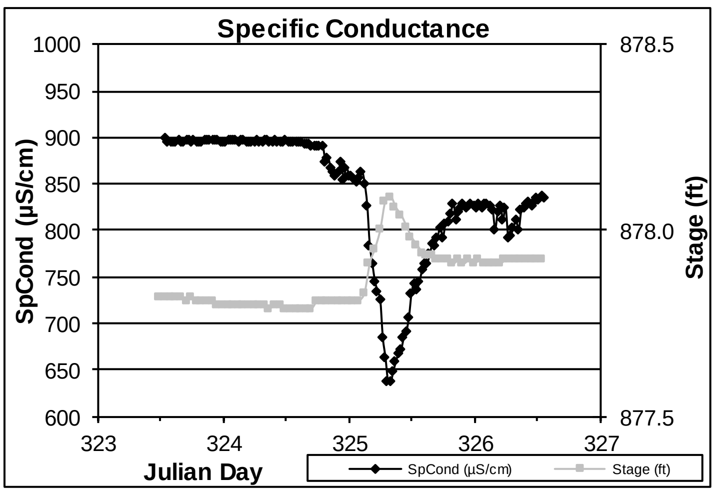


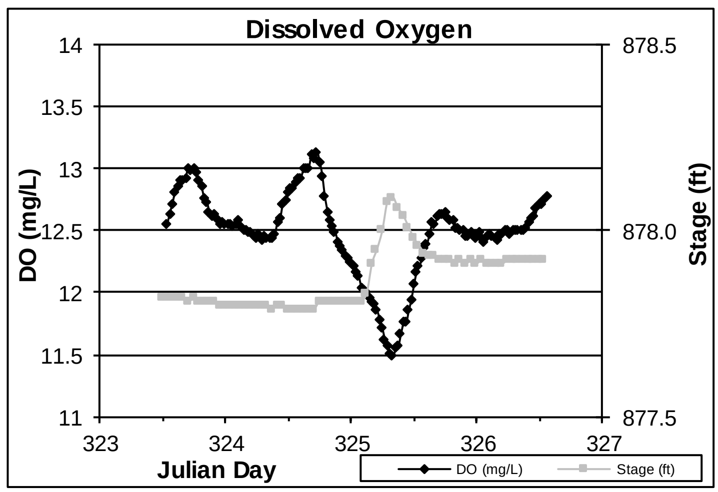
YSI Continuous Monitoring – Sand Creek at Morningside Memorial Gardens
Storm 4 – November 19th to 22rd

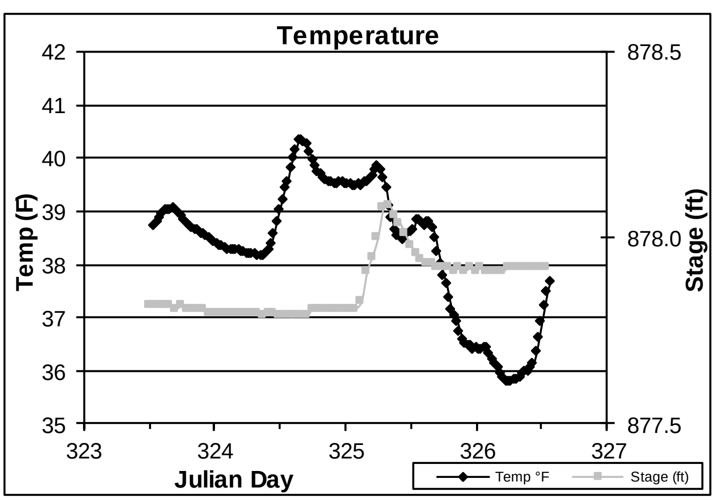
Sand Creek at Morningside Cemetery
Storm Summary:
Dates: 19 November 2019 (day 323) to 22 November 2019 (day 326)
Precipitation: 1.82

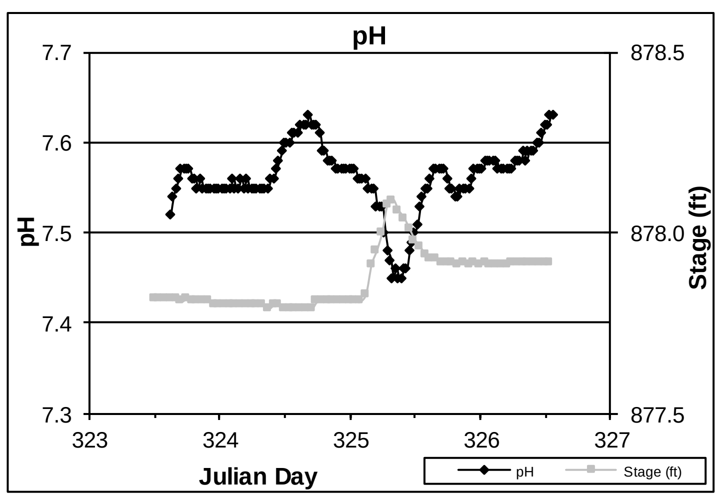






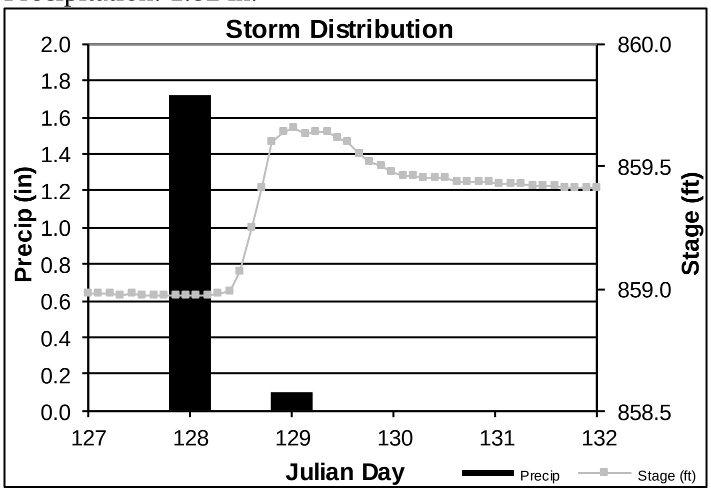


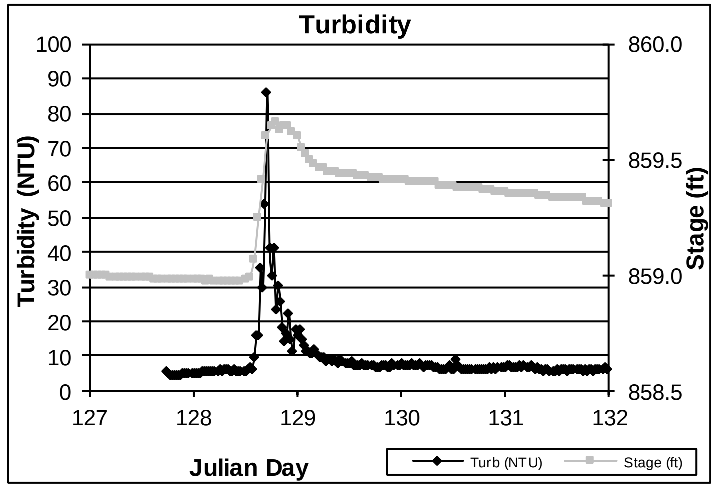


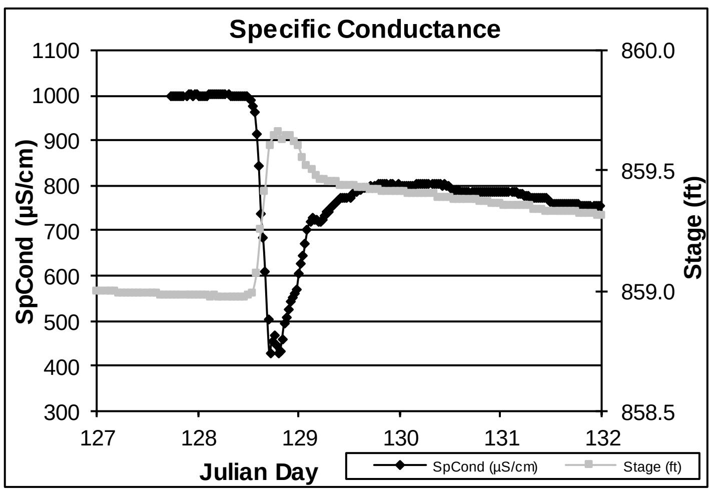


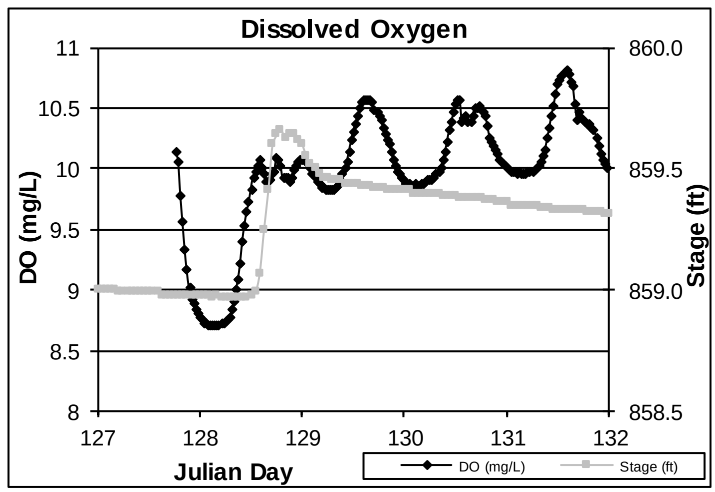
YSI Continuous Monitoring – <u>Sand Creek at Xeon St.</u>
Storm 1 – May 7th to 11th

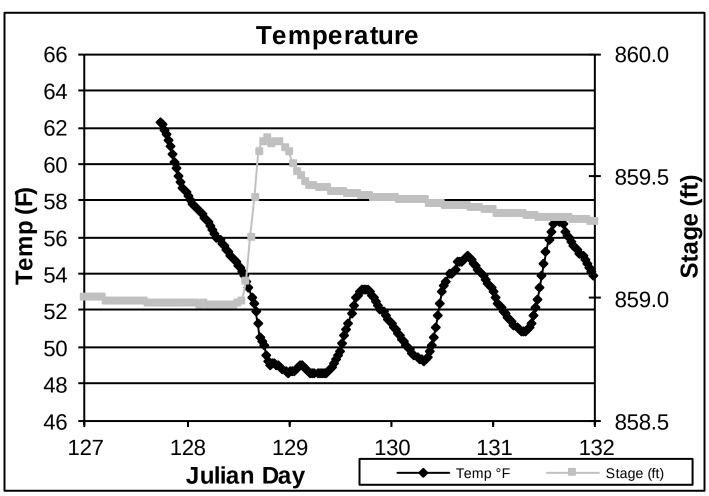
<u>Storm Summary:</u>
Dates: 7 May 2019 (day 181) to 11 May 2019 (day 185)
Precipitation: 1.82 in.

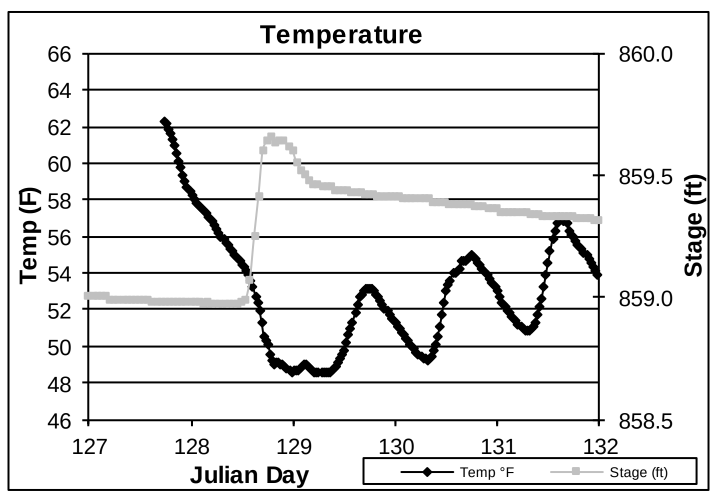






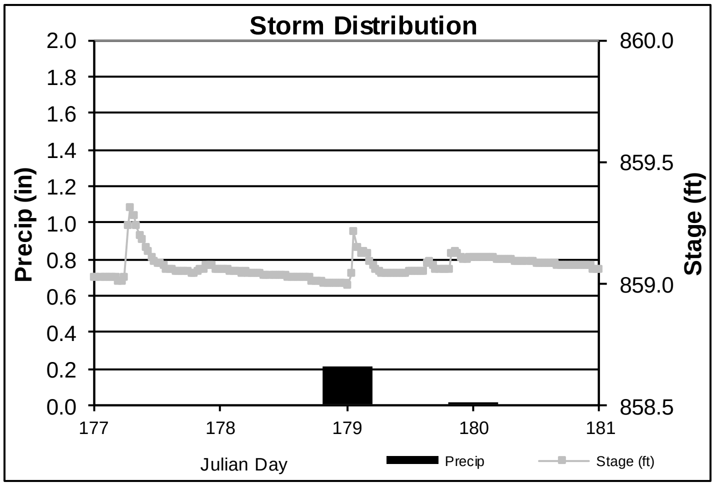


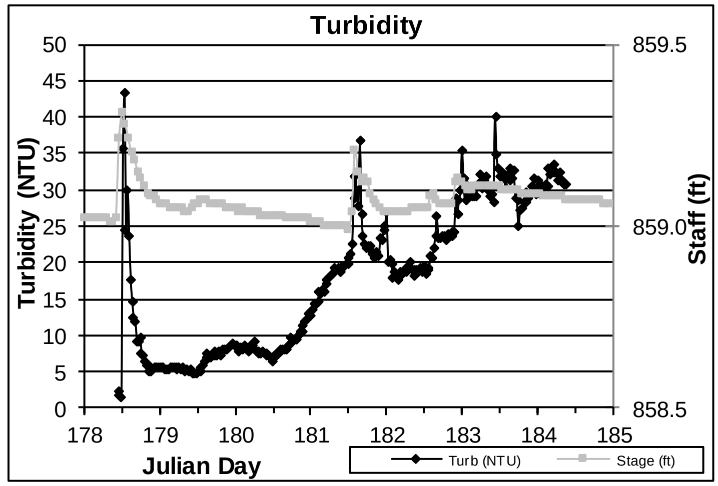


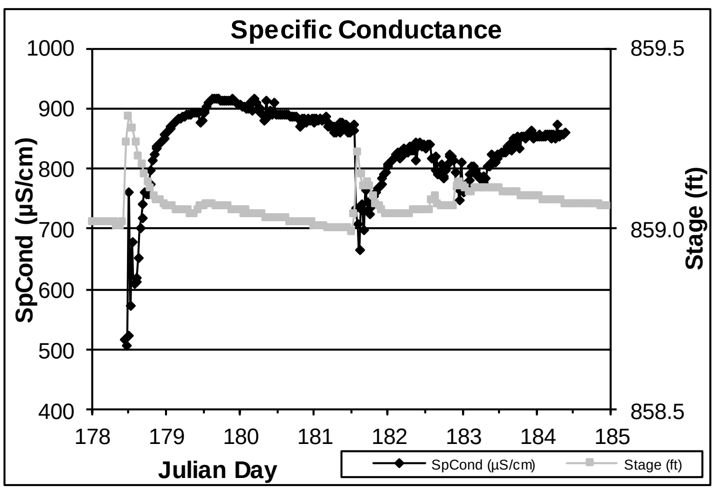


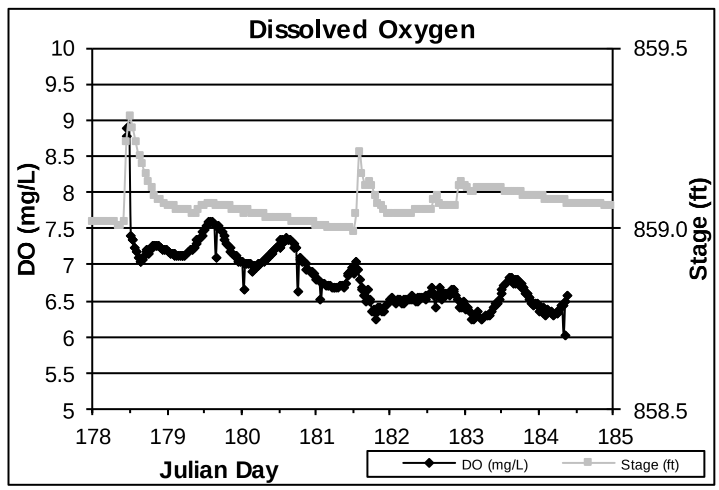
YSI Continuous Monitoring – <u>Sand Creek at Xeon St.</u>
Storm 2 – June 27st to July 3rd

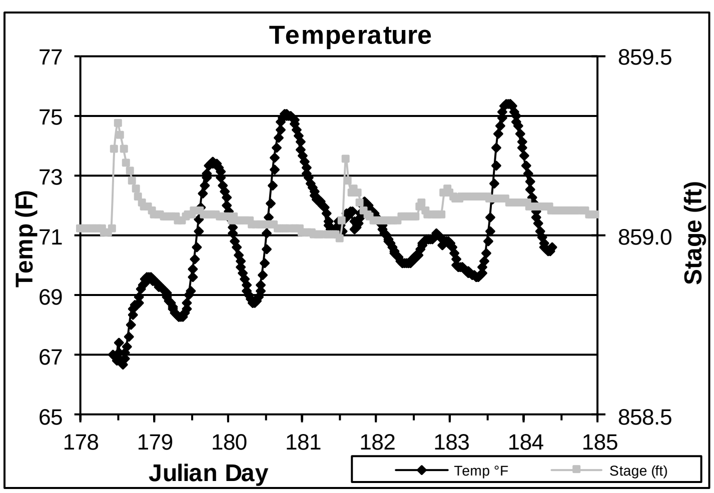
<u>Storm Summary:</u>
Dates: 27 June 2019 (day 178) to 3 July 2019 (day 184)
Precipitation: 1.46 in.

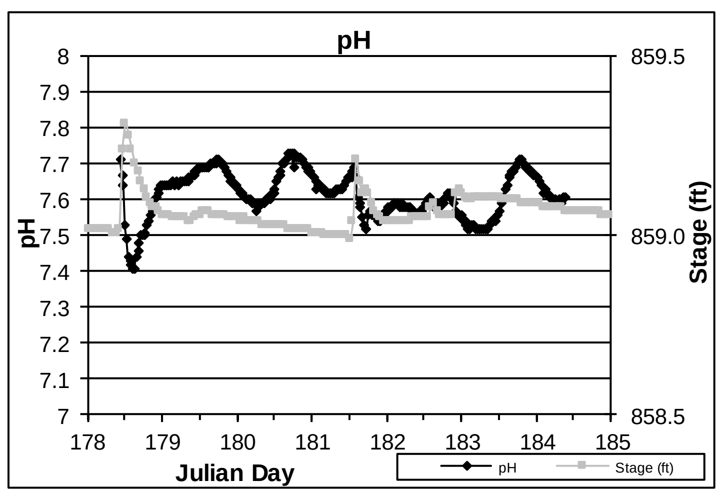










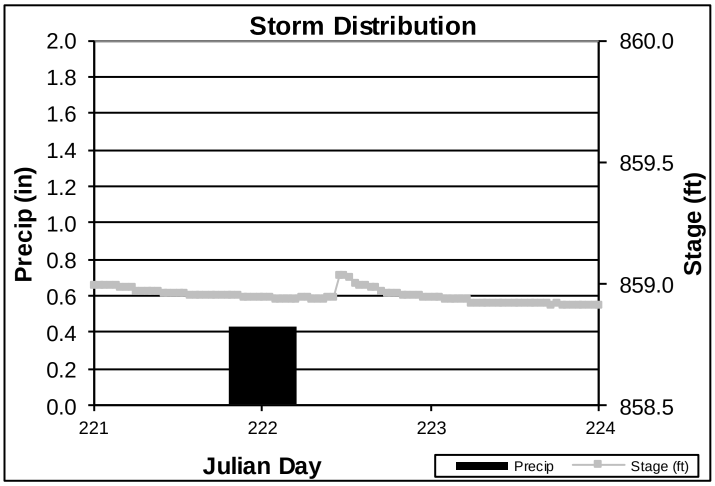


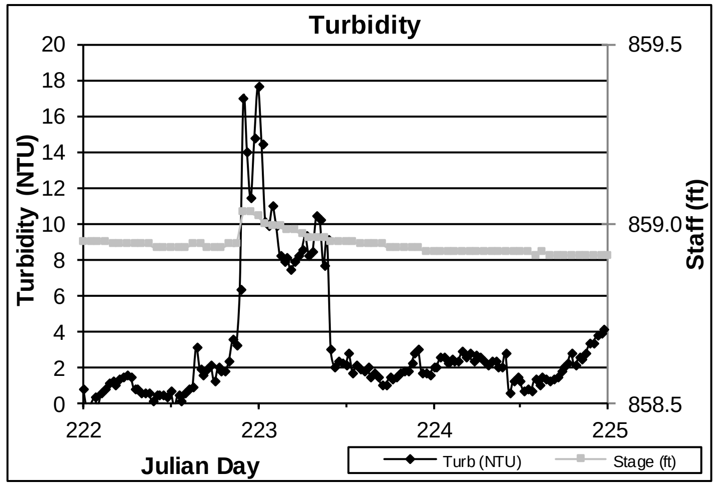
YSI Continuous Monitoring – <u>Sand Creek at Xeon St.</u>
Storm 3 – August 10th to 12th

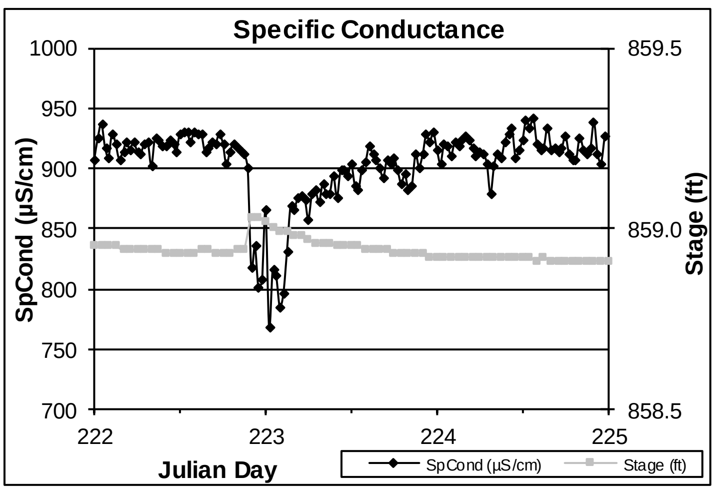
<u>Storm Summary:</u>

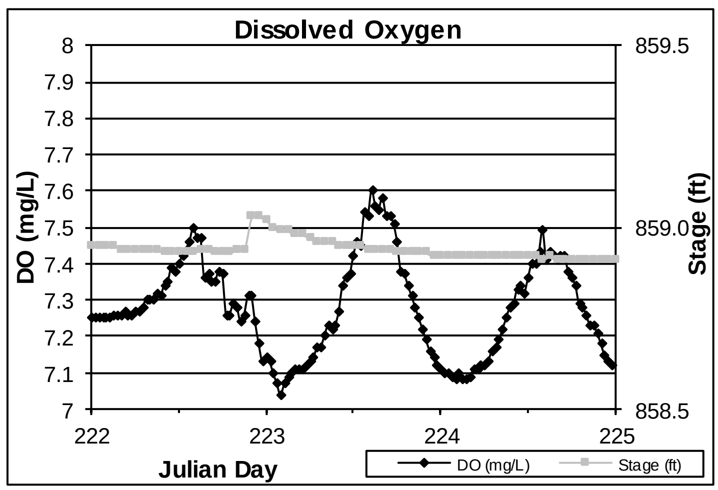
Dates: 10 August 2019 (day 222) to 12 August 2019 (day 224)

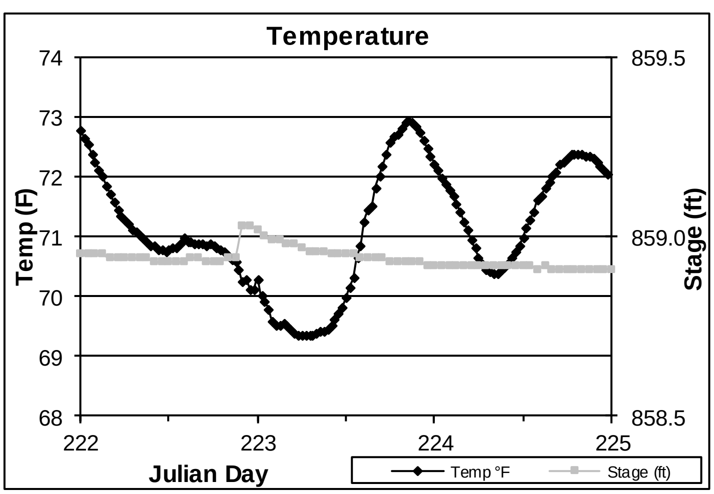
Precipitation: 0.43 in.

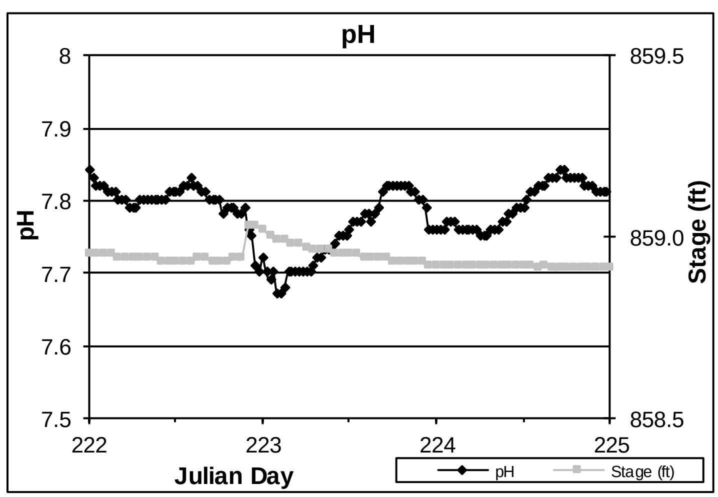










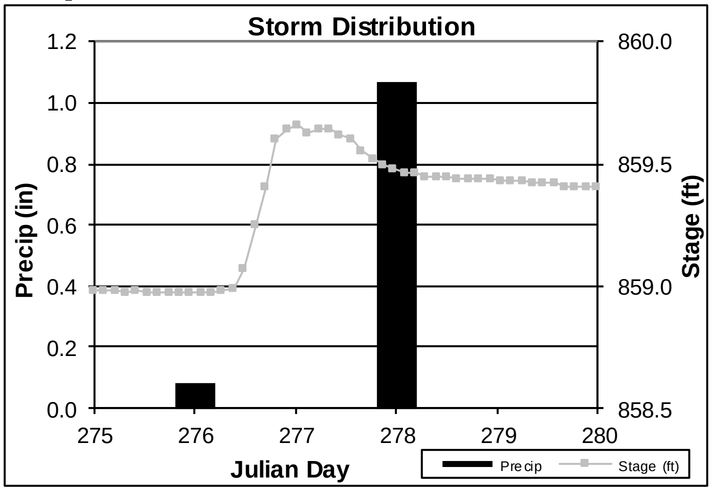


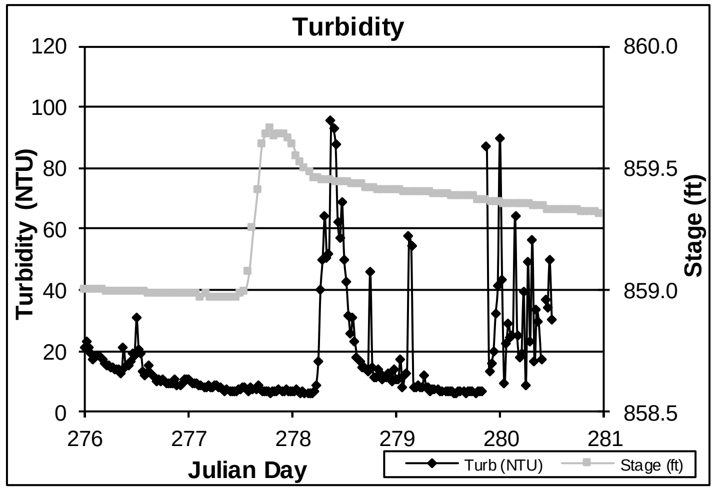
YSI Continuous Monitoring – Sand Creek at Xeon St.
Storm 4 – Oct. 3rd to 7th

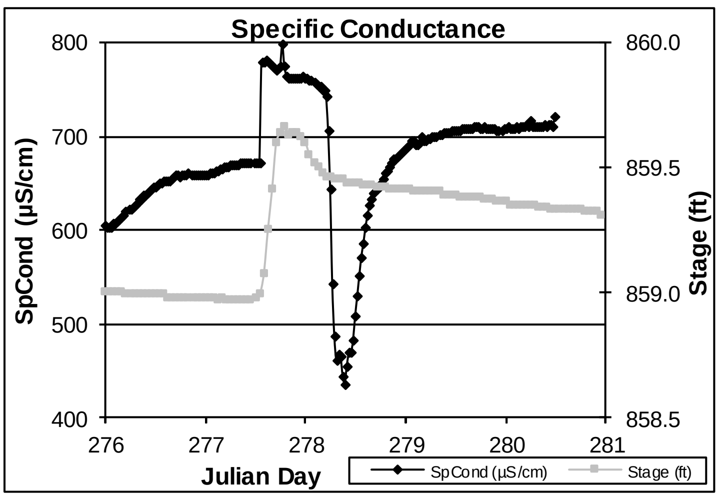
Storm Summary:

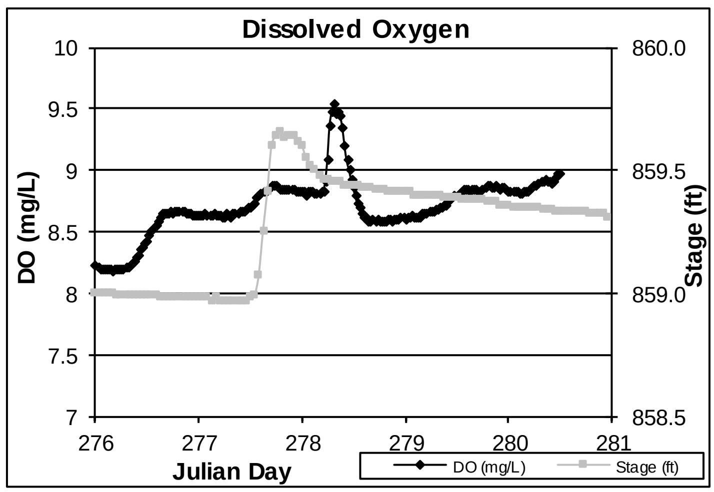
Dates: 3 October 2019 (day 276) to 7 October 2019 (day 280)

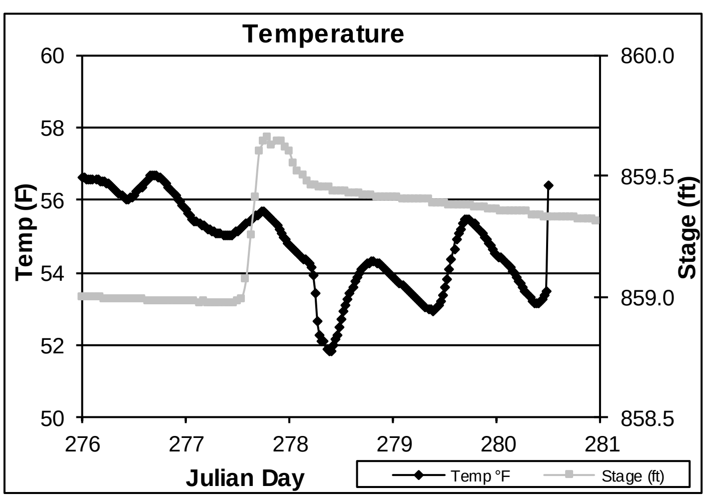
Precipitation: 1.15 in.

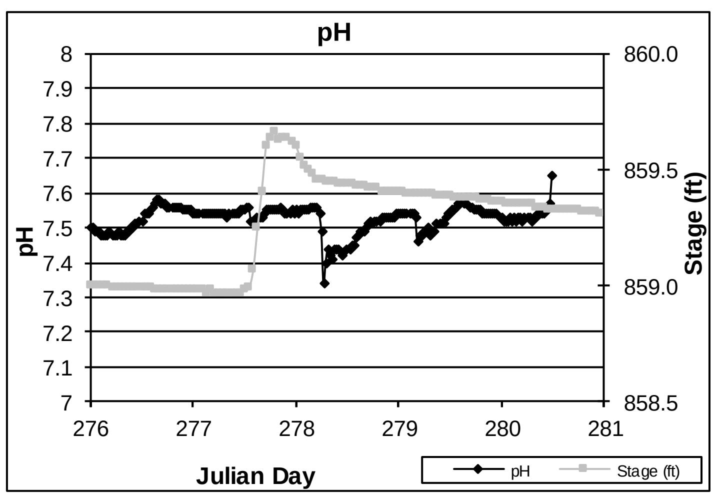












DITCH 60

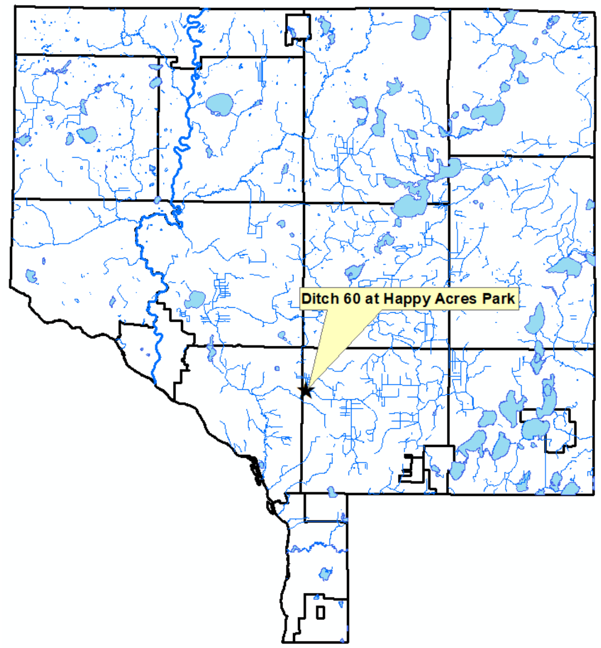
at Happy Acres Park, Blaine

Notes

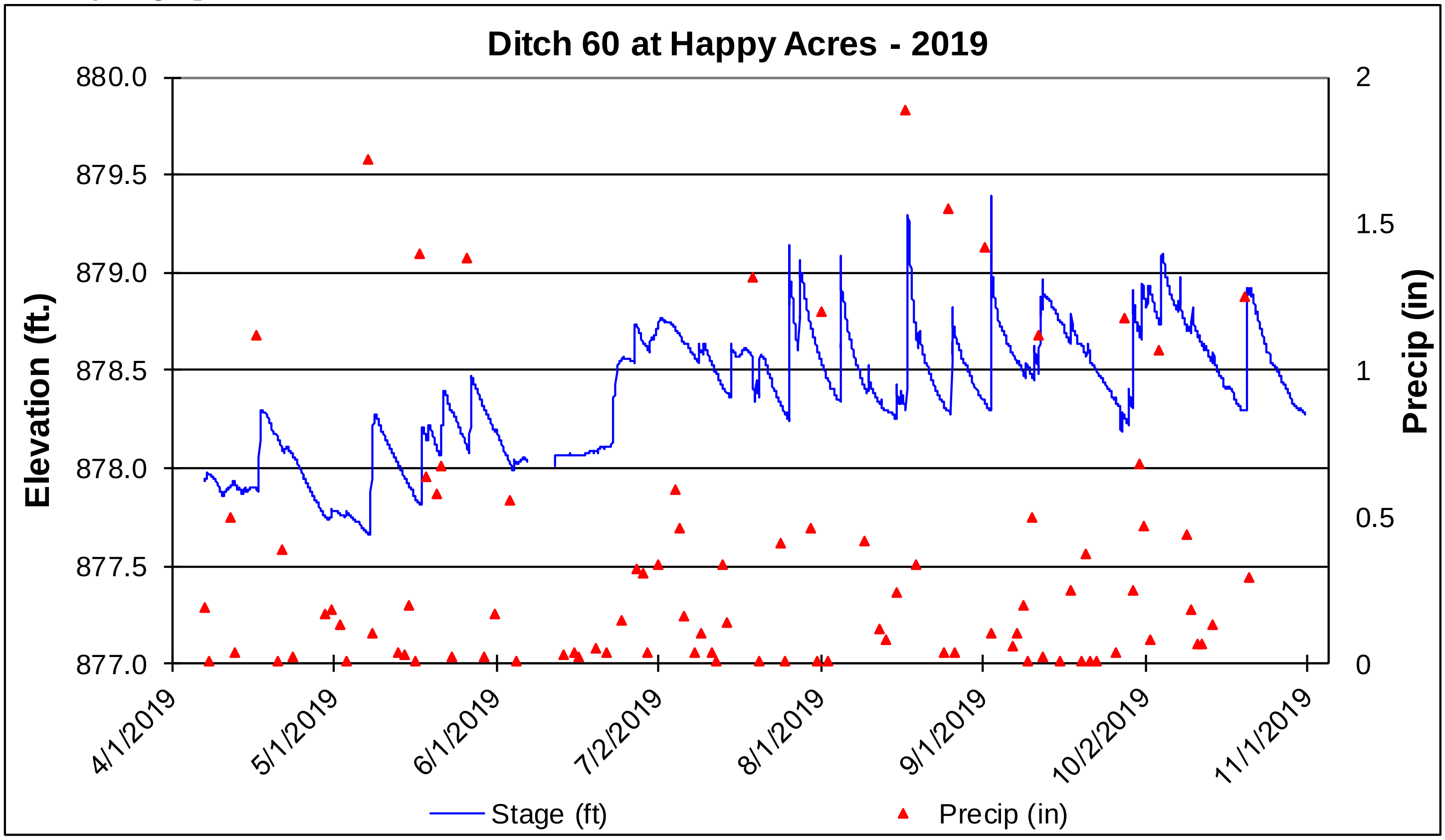
2019 was the first year of stage monitoring at this site. Ditch 60 at Happy Acres flucuated 1.73 ft. throughout the season. Monitoring indicated a potential issue of backing up or damming of the drainage through June and early July. Walking inspections were conducted upstream and downstream from the Ditch 60 monitoring site, and no clear blockages were identified. Because of the record rainfall through 2019 the entire watershed may have just been backed up with high water levels that took time to recede.

The site was flashy in response to rain events with numerous instances of water levels increasing nearly a foot in a single hour. Water levels in this ditch may have been suspended above baseflow levels through the entire 2019 season. In early May, a low stage of 877.66 feet was recorded. After this there was a backwater effect in the system into July, and stage never receded below 878.19 feet thereafter.

A rating curve was established for this site in 2019 and is displayed below.



2019 Hydrograph



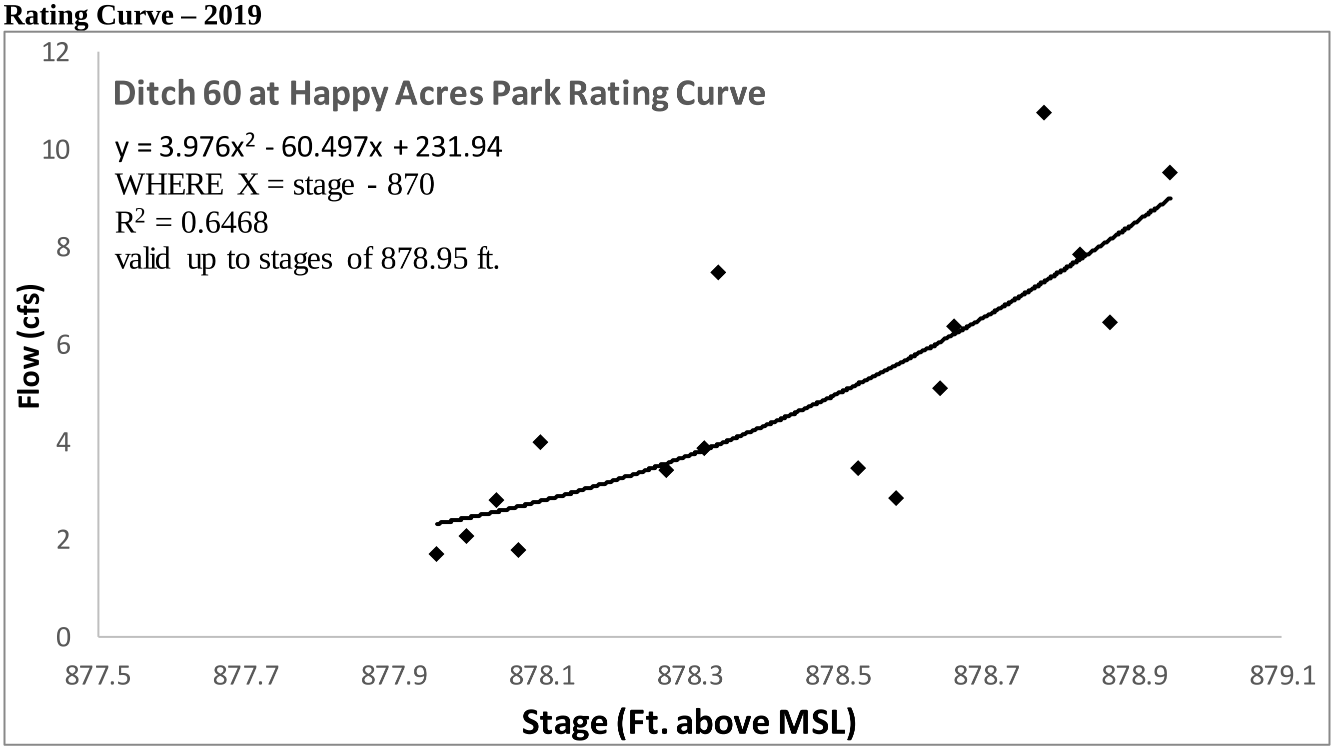
DITCH 60

at Happy Acres Park, Blaine

Summary of All Monitored Years

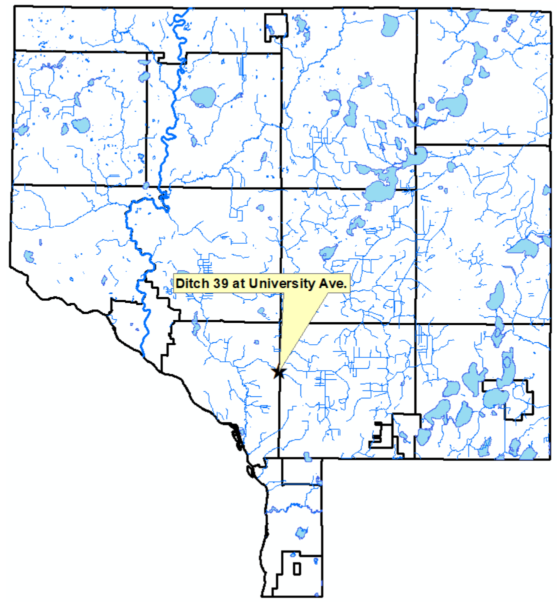
Percentiles	2019
Min	877.66
2.5%	877.75
10.0%	877.90
25.0%	878.11
Median (50%)	878.40
75.0%	878.61
90.0%	878.77
97.5%	878.91
Max	879.39

Rating Curve – 2019



DITCH 39

at University Ave., Coon Rapids



Notes:

This was the first year of stage monitoring at this site. In 2019, Ditch 39 at University Ave. flucuated 1.83 ft. throughout the season. The site is flashy with very rapid spikes and recessions of stage in response to storms. During a 1.42 inch rain event in early-September, stage rose 1.74 ft. in only an hour.

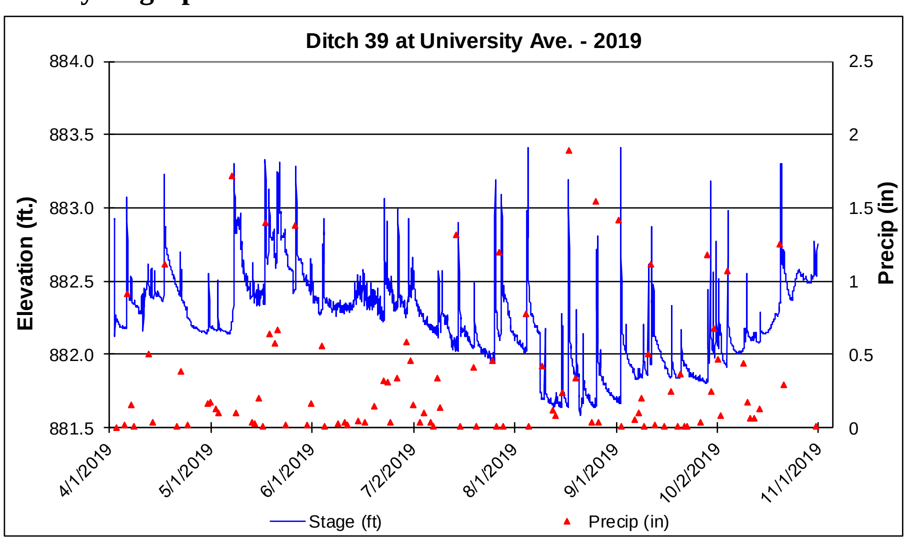
Development of a rating curve was attempted for this site in 2019, but no usable curve was produced. The ditch at this site is located in a wider flood plain wetland with no definable banks above flood stages. Access to this creek upstream is difficult, but would provide a better monitoring site in a more defined channel.

Discharge readings collected over 15 sampling efforts ranged from 0.481 cfs to 4.75 cfs, with an overall average of 1.90 cfs. In contrast, Ditch 60 at Happy Acres Park ranged from 1.67 cfs to 10.76 cfs over 16 readings with an average of 4.96 cfs during the same time period. Sand Creek at Morningside averaged 27.86 cfs over 12 readings.

Summary of All Monitored Years

Percentiles	2019
Min	881.58
2.5%	881.67
10.0%	881.83
25.0%	882.03
Median (50%)	882.22
75.0%	882.41
90.0%	882.58
97.5%	882.89
Max	883.41

2019 Hydrograph



SAND CREEK

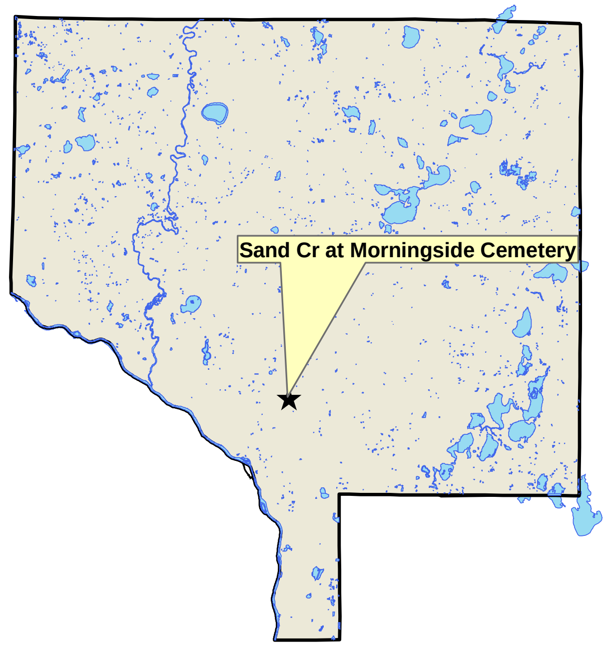
at Morningside Memorial Gardens, Coon Rapids

Notes:

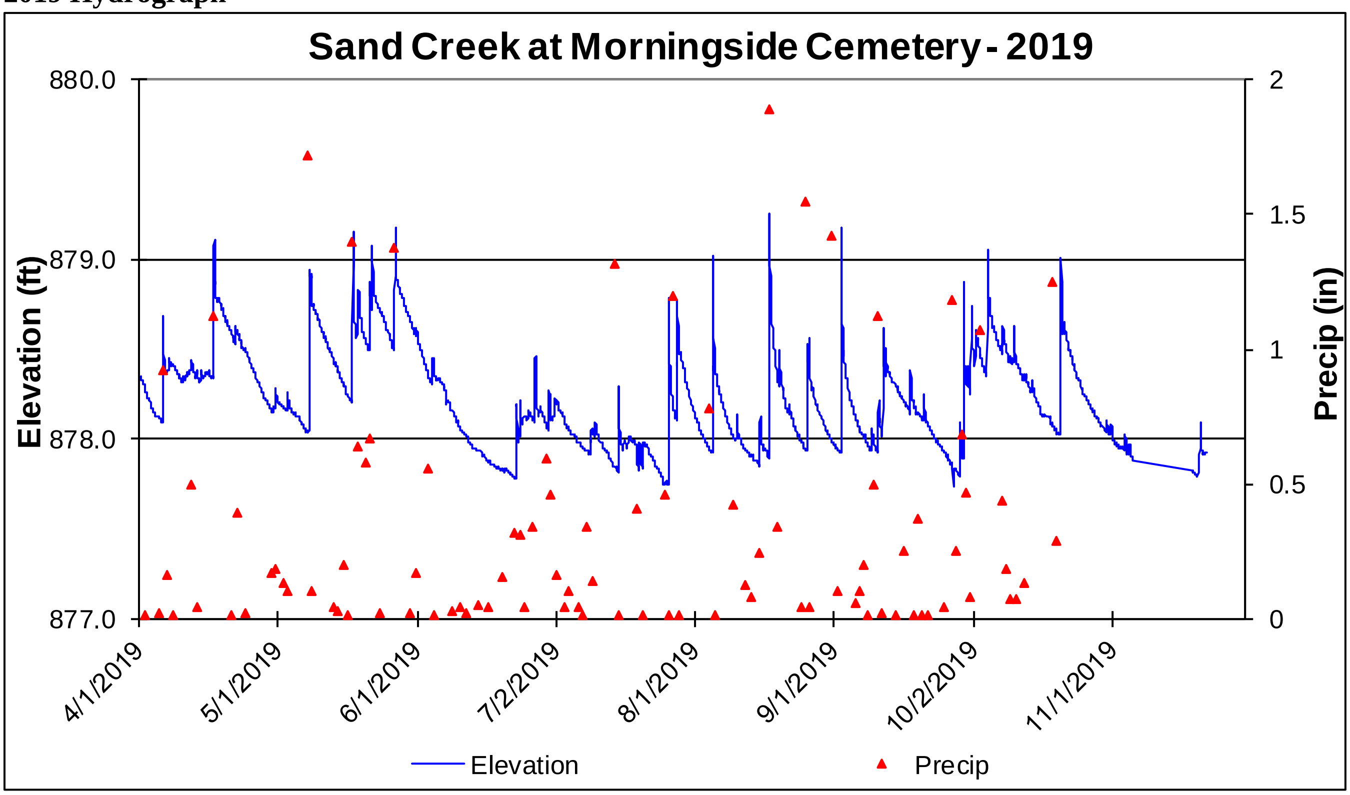
Water levels at the Sand Creek at Morningside site fluctuated 1.52 ft. throughout the 2019 season, the smallest range since the site began being monitored back in 2010. The highest average water level was also recorded, likely due to 2019 being the wettest year on record for the state.

The creek is very narrow as it flows through this site causing water levels to be very flashy in response to rain events. During a 1.89 inch rain event in late-August the creek rose one foot in 2 hours. Water levels were slower to recede compared to previous years which is most likely due to the higher frequency and intensity of rain events causing sustained high water levels regionally. Based on minimum stage readings from all prior years monitored, this site may never have reached true baseflow stages throughout 2019.

A rating curve was established for this site in 2019 and is displayed below.



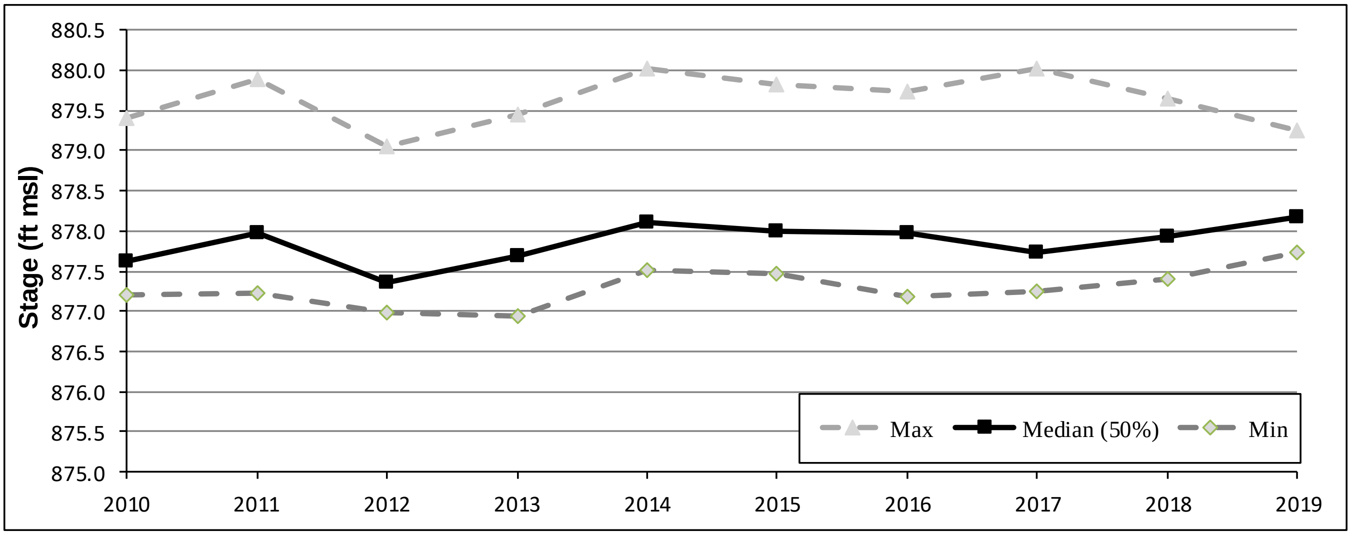
2019 Hydrograph



SAND CREEK

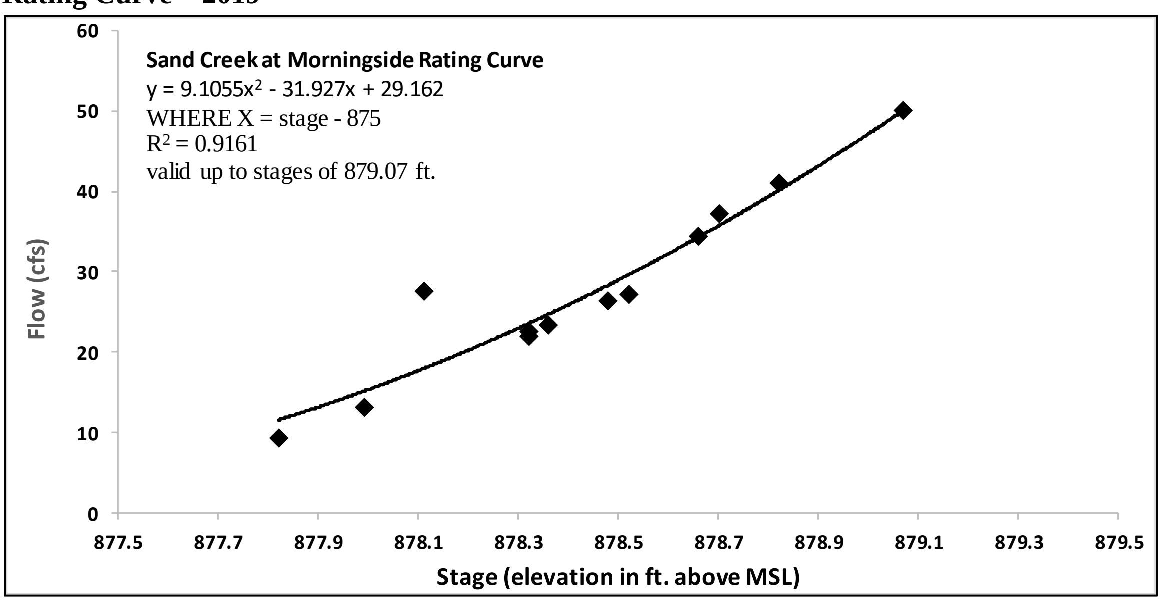
at Morningside Cemetery, Coon Rapids

Summary of All Monitored Years



Percentiles	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Min	877.19	877.22	876.98	876.95	877.51	877.46	877.18	877.25	877.41	877.73
2.5%	877.27	877.28	877.00	877.18	877.56	877.52	877.49	877.34	877.49	877.81
10.0%	877.36	877.36	877.03	877.28	877.62	877.66	877.58	877.41	877.68	877.91
25.0%	877.45	877.72	877.15	877.38	877.81	877.80	877.70	877.53	877.80	878.00
Median (50%	877.62	877.98	877.35	877.69	878.10	877.99	877.98	877.73	877.92	878.17
75.0%	877.79	878.22	877.65	877.93	878.43	878.19	878.26	877.96	878.10	878.38
90.0%	877.95	878.55	877.94	878.42	878.72	878.39	878.54	878.27	878.34	878.60
97.5%	878.26	878.86	878.38	878.75	879.16	878.70	878.93	878.80	878.60	878.79
Max	879.41	879.89	879.06	879.46	880.02	879.82	879.73	880.02	879.65	879.25

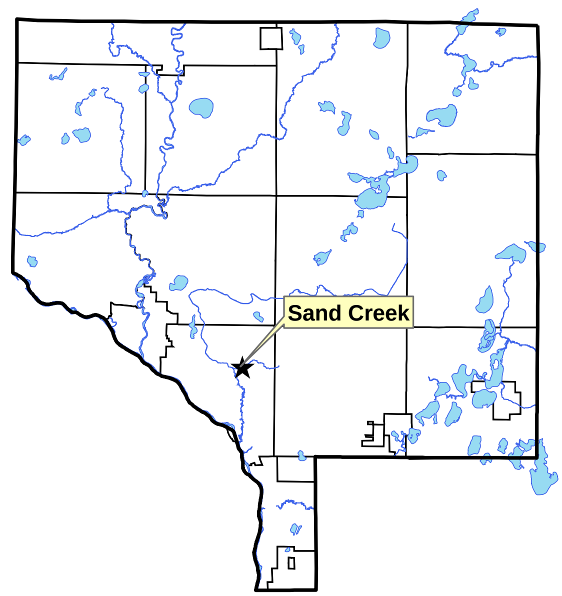
Rating Curve – 2019



SAND CREEK

at Xeon Street, Coon Rapids

Notes

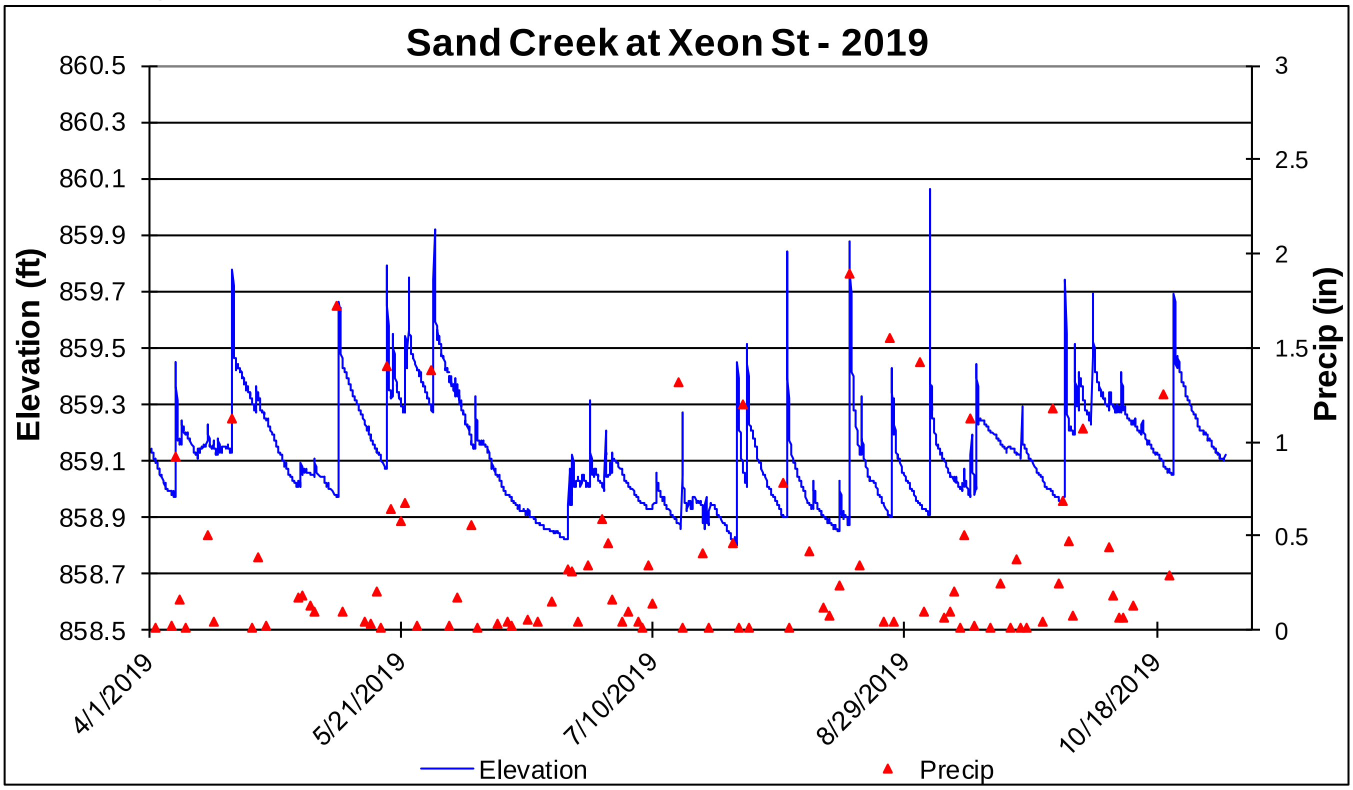


Stage at Sand Creek at Xeon St. fluctuates less than stage at Morningside Memorial Gardens upstream. Occasionally, large storms will cause water levels to rise up a foot or more in a matter of hours, but these types of storm events are not common. Stage at this site fluctuates less to similar storms than the Morningside site located a little further upstream. This is likely because the channel of Sand Creek widens considerably between the monitoring sites, allowing the additional influx of water to spread out more. This mitigates bounce in stage even though the contributing drainage area to this point of the creek is larger.

In 2019 water levels at this site fluctuated 1.26 feet throughout the season ,the smallest range since 2002. Continuous rain throughout 2019 prevented the Creek from ever receding to true baseflow stages, keeping the stages high throughout the year and limiting to total range of fluctuation.

A rating curve was established for this site in 2013 and is displayed below.

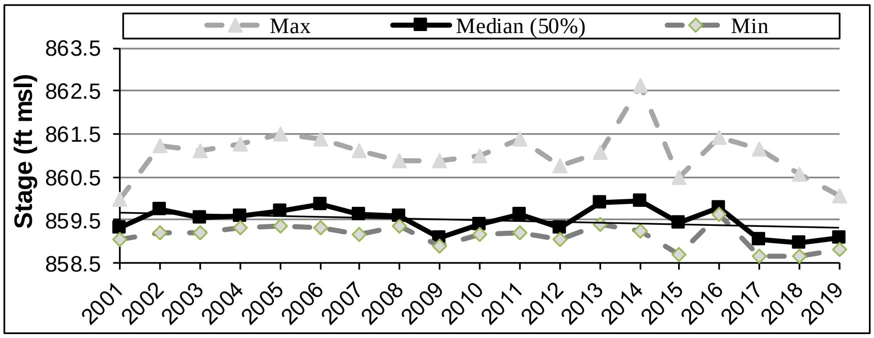
2019 Hydrograph



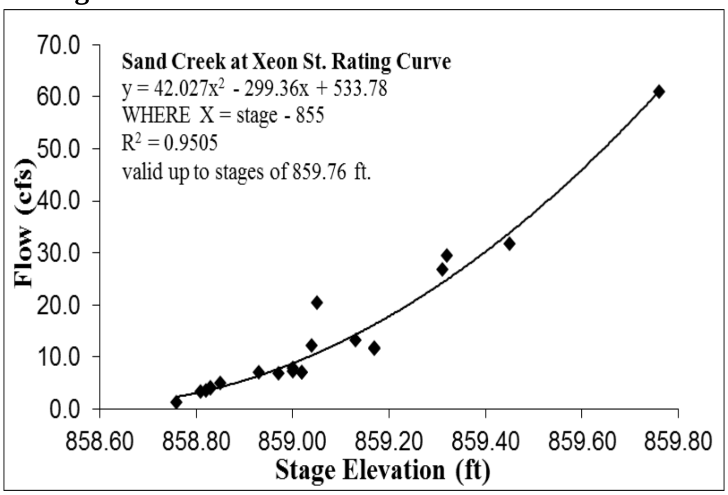
SAND CREEK

at Xeon Street, Coon Rapids

Summary of All Monitored Years



Rating Curve – 2013



Summary of All Monitored Years

Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Min	859.06	859.22	859.21	859.31	859.35	859.32	859.17	859.35	858.91	859.15
2.5%	859.09	859.44	859.26	859.33	859.41	859.43	859.30	859.44	858.99	859.24
10.0%	859.15	859.48	859.32	859.40	859.45	859.54	859.41	859.48	859.03	859.28
25.0%	859.23	859.61	859.41	859.46	859.55	859.70	859.47	859.53	859.05	859.33
Median (50%)	859.33	859.75	859.55	859.60	859.72	859.86	859.64	859.58	859.10	859.40
75.0%	859.49	859.93	859.75	859.80	859.97	860.01	859.81	859.78	859.29	859.52
90.0%	859.54	860.09	860.00	860.03	860.21	860.12	859.98	859.94	859.38	859.60
97.5%	859.65	860.32	860.28	860.32	860.51	860.27	860.11	860.13	859.54	859.75
Max	860.00	861.22	861.13	861.27	861.50	861.38	861.10	860.88	860.87	861.01

Percentiles	2011	2012	2013	2014	2015	2016	2017	2018	2019
Min	859.19	859.06	859.40	859.23	858.69	859.64	858.66	858.65	858.80
2.5%	859.22	859.07	859.53	859.42	858.96	859.67	858.69	858.69	858.85
10.0%	859.28	859.11	859.60	859.61	859.03	859.70	858.84	858.80	858.91
25.0%	859.47	859.18	859.70	859.79	859.16	859.73	858.94	858.85	858.98
Median (50%)	859.65	859.33	859.90	859.96	859.44	859.78	859.04	858.97	859.10
75.0%	859.89	859.53	860.04	860.28	859.66	859.84	859.36	859.11	859.23
90.0%	860.08	859.76	860.18	861.08	859.82	860.00	859.57	859.26	859.36
97.5%	860.33	860.11	860.37	861.93	860.04	860.38	859.96	859.47	859.50
Max	861.40	860.78	861.06	862.65	860.48	861.43	861.15	860.56	860.06

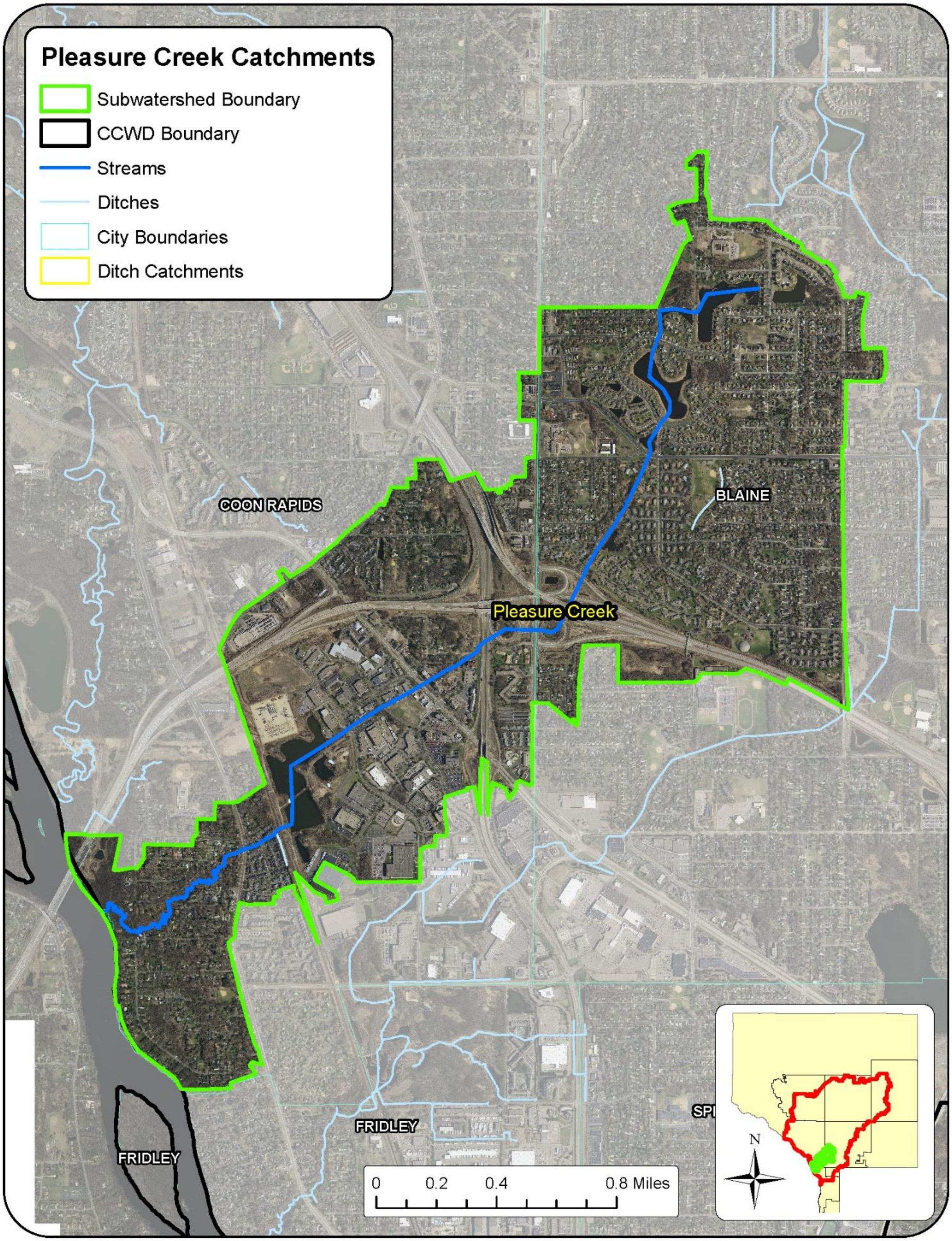
Water Quality Monitoring – Pleasure Creek

Springbrook Creek (Ditch 17) Monitoring Sites		
Site Name/ SiteID	**Years Monitored**	**2019 Data Collected**
Pleasure Cr at Pleasure Cr Parkway S005-636	2009	
Pleasure Cr at 99th Ave S005-637	2009	
Pleasure Cr at 96th Lane S005-263	2008, 2018, 2019	Water Chemistry Grab Samples
Pleasure Creek at 86th Avenue S003-995	2006-2019	Water Chemistry Grab Samples, Continuous Stage

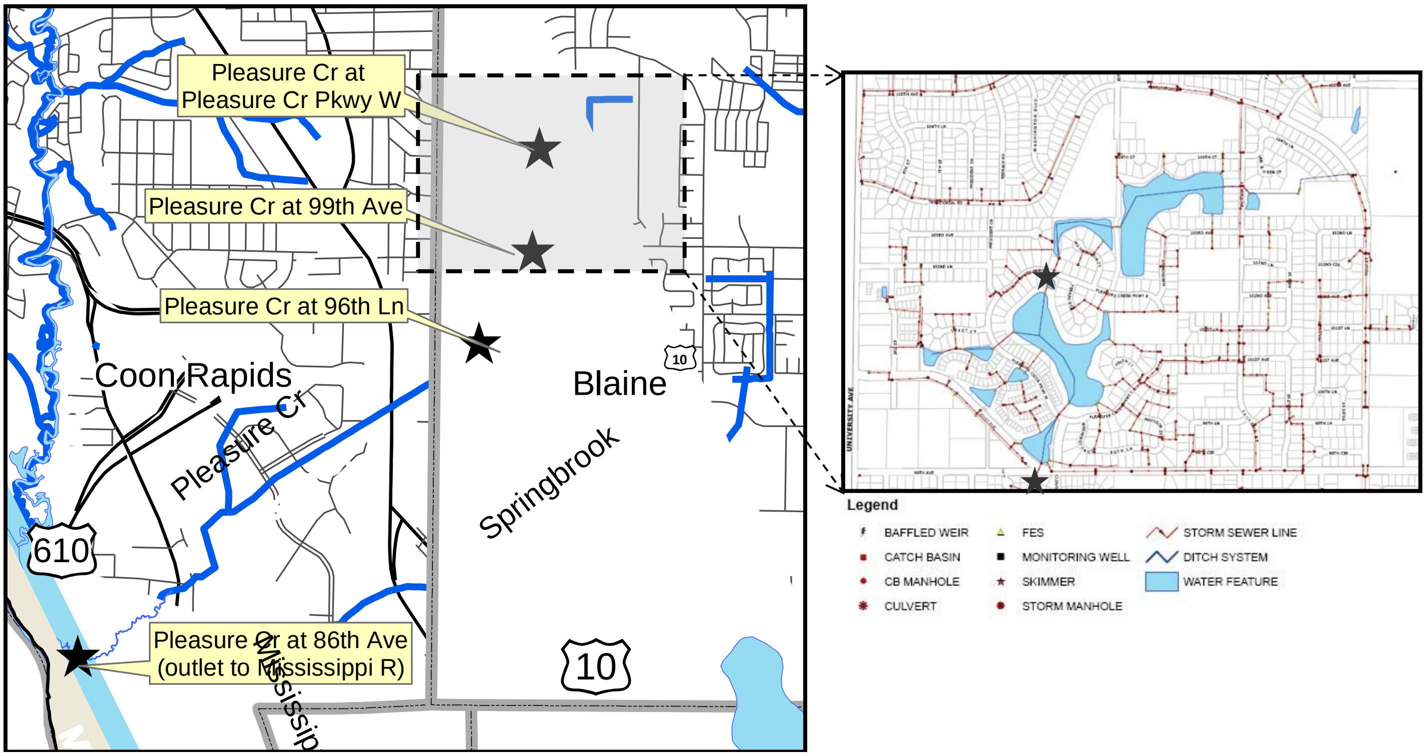
Background

Pleasure Creek drains 1,880 acres through southwestern Blaine and southern Coon Rapids. The watershed consists primarily of suburban residential and commercial land use. Pleasure Creek begins as the outlet channel for a series of stormwater ponds in the Blaine Haven development. The creek flows as a straightened ditch channel for about 1.5 miles before emptying into a large stormwater pond in the commercial area between East River Road and Coon Rapids Boulevard in southern Coon Rapids. This pond outlets through about a quarter-mile of culvert under railroad tracks and East River Road before Pleasure Creek continues as a meandering channel for its final 1.5 miles to its confluence with the Mississippi River. The creek is about 8-10 ft. wide and 0.5 to 1 foot deep near its outlet at baseflow.

Pleasure Creek is listed as an impaired water by the MN Pollution Control Agency for invertebrate biota and *E. coli* bacteria. New standards for aquatic life (Tiered Aquatic Life Use Standards) currently under development may take into consideration the fact that the creek is part of a public ditch system and, therefore, may lower aquatic life expectations and affect the impairment standard for this waterbody.


Pleasure Creek Catchments
Subwatershed Boundary
CCWD Boundary
Streams
Ditches
City Boundaries
Ditch Catchments
COON RAPIDS
BLAINE
Pleasure Creek
FRIDLEY
FRIDLEY
0 0.2 0.4 0.8 Miles
N

Pleasure Creek Monitoring Sites



Results and Discussion

Pleasure Creek is currently listed as impaired for poor invertebrate biota and high *E. coli*. The Coon Creek TMDL also contains load duration curves (LDC) for TSS and total phosphorus in Pleasure Creek because these pollutants are identified as stressors for aquatic life in this stream.

Neither total phosphorus nor TSS are especially problematic in Pleasure Creek, only exceeding state standard concentrations occasionally, and primarily during storm events. Exceedances of the LDC for each of these parameters in Pleasure Creek are also rare and typically only occur at very high flows.

E. coli levels are very high in Pleasure Creek. The chronic standard concentration of 126 MPN is exceeded 68% of the time at baseflow and 82% of the time during storms at 86th Ave. Additionally, the Pleasure Creek LDC for *E. coli* in the Coon Creek TMDL is exceeded in the majority of sample events plotted at all flow levels. Similar to Sand Creek, the TMDL attributes over 90% of *E. coli* loading in Pleasure Creek to domestic dogs, but this assumption may be underrepresenting the contribution of waterfowl into this creek.

Chlorides were sampled in CCWD streams in 2019, with Pleasure Creek having higher concentrations than other streams in the watershed. The chronic state standard for chlorides is 230 mg/L. Pleasure Creek near its outlet at 86th Ave. exceeded that concentration two of the four storm samples in 2019, and averaged 185.5 mg/L over all eight samples collected in 2019. Pleasure Creek has not exceeded the acute standard of 860 mg/L in any sample. While these concentrations do comply with state standards, they are higher than other streams monitored in the county and in the watershed. Chlorides are a particularly problematic pollutant to aquatic life and in drinking water. Pleasure Creek flows into the Mississippi River and its water quality has implications for both.

Specific conductance and Chlorides

Specific conductance and chlorides in Pleasure Creek are high. The long-term median for specific conductance during baseflow conditions at the 86th Ave. site is 1.096 mS/cm. By comparison, the median for all Anoka County streams is 0.420 mS/cm. The long-term median for specific conductance post-storms in Pleasure Creek is even higher at 1.170 mS/cm at 86th Ave. There is a notable increase in specific conductance from 96th lane to 86th Ave. 96th lane also has a much more consistent and smaller range of concentrations than does 86th Ave., which fluctuates to a far greater degree.

Chlorides are a common dissolved pollutant, most often associated with road deicing salts. Like specific conductance, chlorides increase from upstream to downstream quite dramatically, with concentrations at 86th Ave often doubling concentrations at 96th lane on the same day. Median chloride concentrations at the three Pleasure Creek monitoring sites upstream of 86th Ave. during all conditions are 69.5, 71, and 88.2 mg/L (upstream to downstream). At 86th Ave, the median chloride concentration is 164.5 mg/L, approximately double the median concentration at 96th Lane. By contrast, the median for all streams monitored in Anoka County is 13.29 mg/L. The state water quality standards for chlorides are 230 mg/L (chronic) and 860 mg/L (acute). While Pleasure Creek only exceeded the chronic standard (262 mg/L) in one grab sample in 2019, no monitoring occurred during snowmelt when chloride concentrations are potentially the highest.

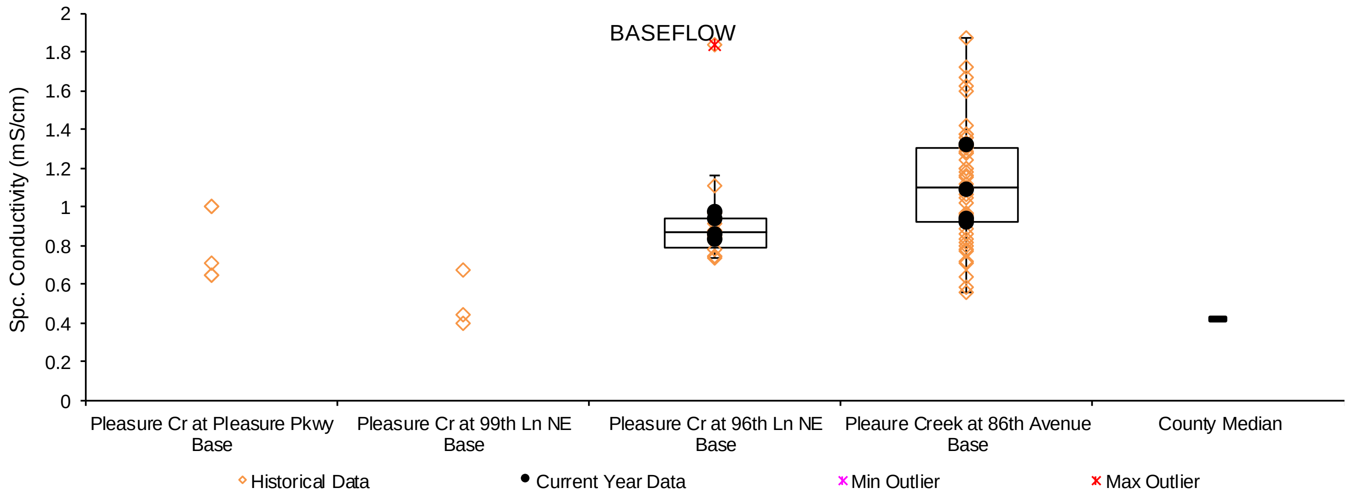
Both specific conductance and chlorides are slightly higher during storms than baseflow conditions. This is the opposite of most other area streams. At those other streams road deicing salt infiltration to the shallow water table that feeds stream base flows is an often-suspected source of pollutants. This is still probably occurring at Pleasure Creek, based on high baseflow specific conductance. However, higher specific conductance observed post-storms indicate that stormwater runoff directly to Pleasure Creek also has very high levels of dissolved pollutants. In this situation there is likely a large amount of dissolved pollutants on the landscape contributing to high specific conductance during storms as well as high levels during baseflow conditions due to contaminated shallow ground water.

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.

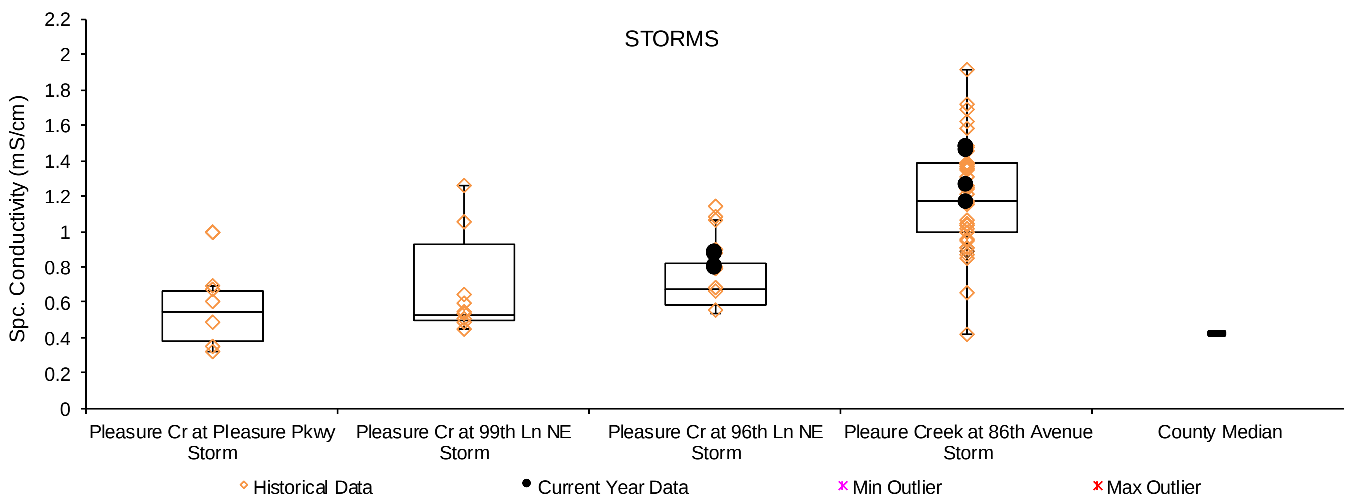
Average and median specific conductance and chlorides in Pleasure Creek at 86th Ave. for specific conductance and chlorides all years through 2019.

	Average specific conductance (mS/cm)	Median specific conductance (mS/cm)	Median Chlorides (mg/L)	State Standard	N
Baseflow	1.113	1.096	147.5	Specific conductance – none Chlorides 860 mg/L acute, 230 mg/L chronic	49
Storms	1.200	1.170	184.5		43
All	1.149	1.147	151.0		92
Occasion > state standard					0 baseflow 4 storm (11%)

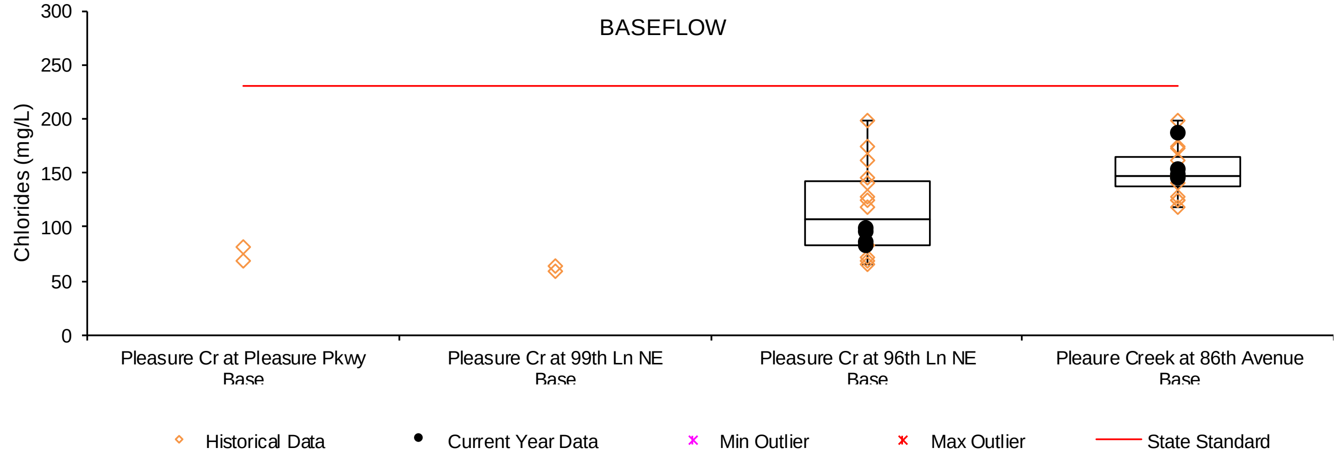
Specific conductance at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2019

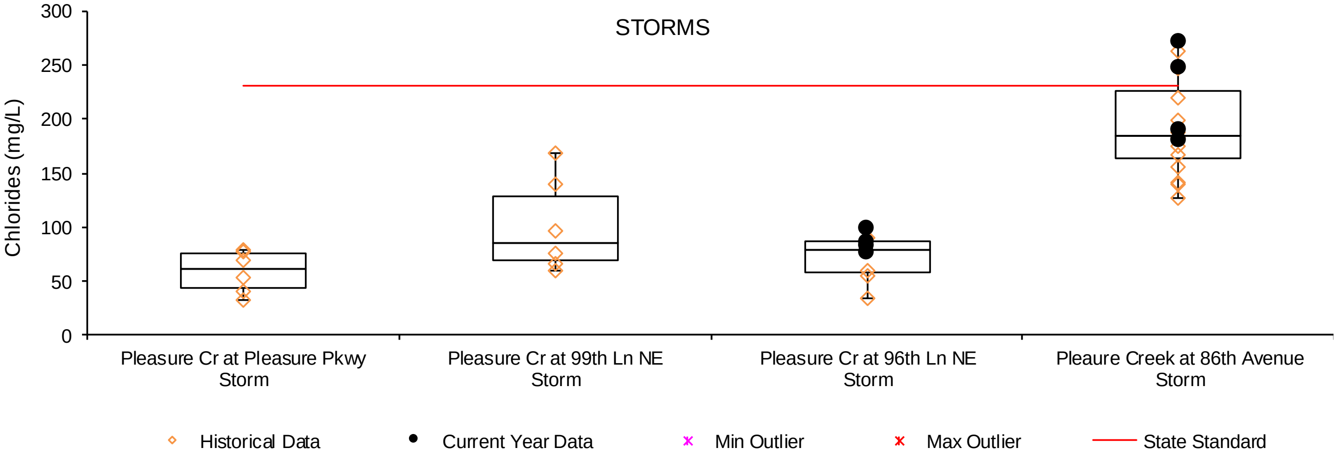


readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Chlorides at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2019 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

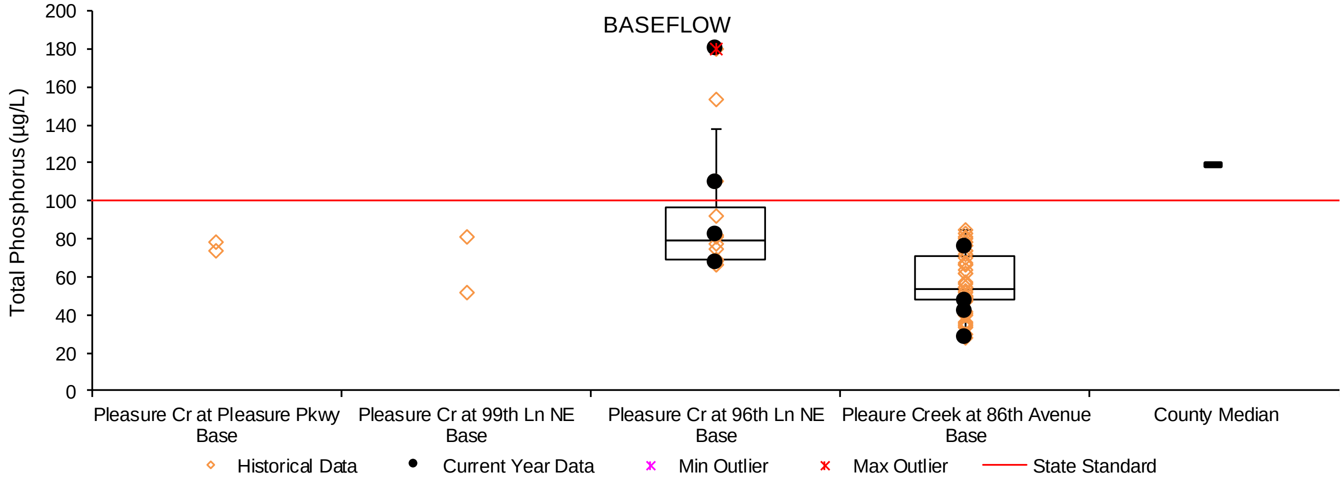
Total phosphorus (TP) is generally low in Pleasure Creek during baseflow conditions and slightly higher during storms. In all conditions, TP concentrations in Pleasure Creek are lower than other streams in Anoka County with a composite median of 68.0 µg/L compared to the overall countywide median of 118.8 µg/L. Pleasure Creek has exceeded the State standard of 100 µg/L during 29% of storm samples including once in 2019 at 96th Lane. The TP concentration at 96th lane also exceeded 100 µg/L on three occasions, twice during baseflow, once in July and once in October. Turbidity was also elevated during these two samples with algae and leaves noted by monitoring staff. Phosphorus loading into this system seems to be occurring primarily in the upstream portions of the drainage area, unlike chlorides and dissolved pollutants. It is possible that one or more ponds in the headwaters are exporting phosphorus under some conditions.

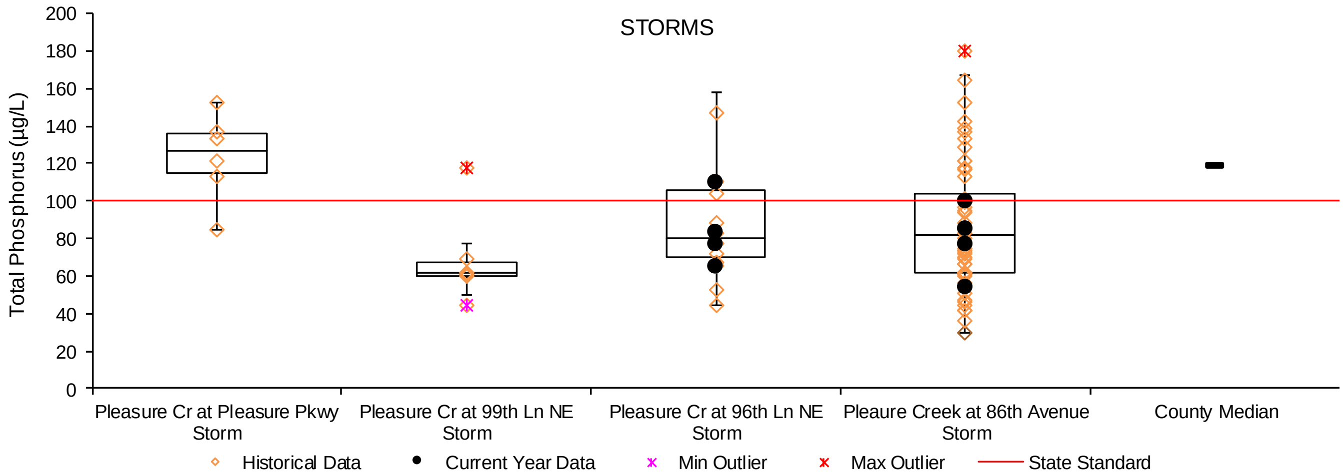
The Pleasure Creek LDC for TP in the Coon Creek TMDL (Page 48, Figure 18) shows that Pleasure Creek does not often exceed acceptable TP loads, and generally only does so at very high flow. This indicates that stormwater infrastructure in this creek's watershed is doing a good job of treating stormwater for TP during all but the largest storm events.

Median TP in Pleasure Creek. Data is from the 86th Avenue site and all years through 2019.

	Average Total Phosphorus (µg/L)	**Median Total Phosphorus (µg/L)**	**State Standard**	**N**
Baseflow	56.7	53.5	100	44
Storms	87.2	81.5		52
All	74.8	68.0		96
Occasions > state standard				0 baseflow 15 (29%) storms

Total phosphorus at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2019 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

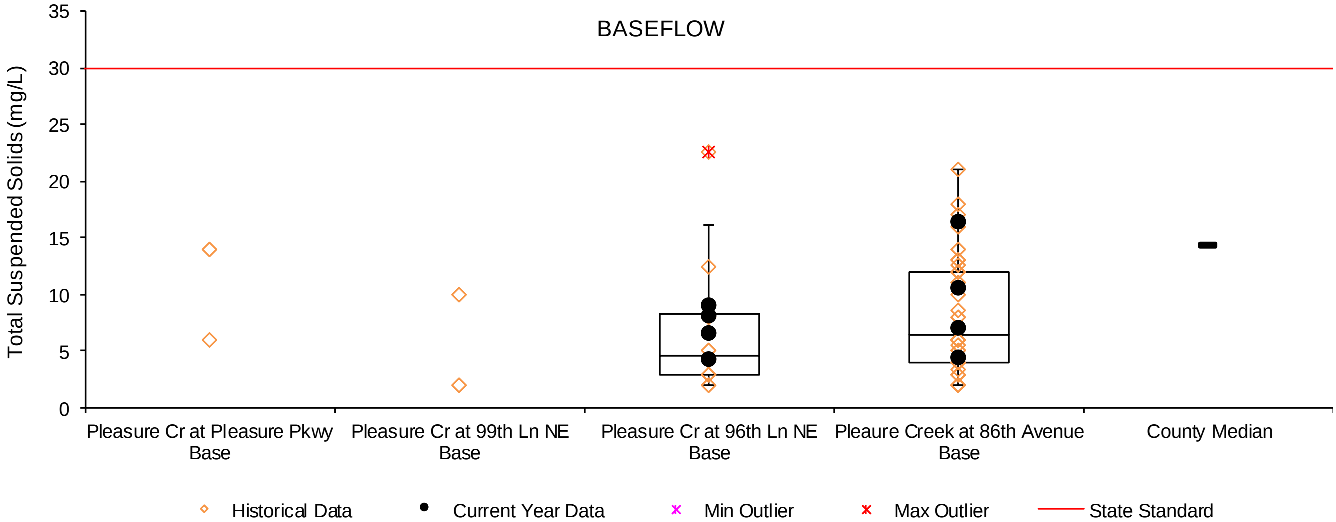
TSS and turbidity are both generally low during baseflow conditions but during storm events TSS (all years) has exceeded the state standard of 30mg/L, 37% of the time. No sample in 2019 exceeded the state standard concentration. The LDC for TSS in Pleasure Creek in the Coon Creek TMDL (Page 43, Figure 15) shows that Pleasure Creek does exceed acceptable TSS loads periodically, but again, usually during very high flow.

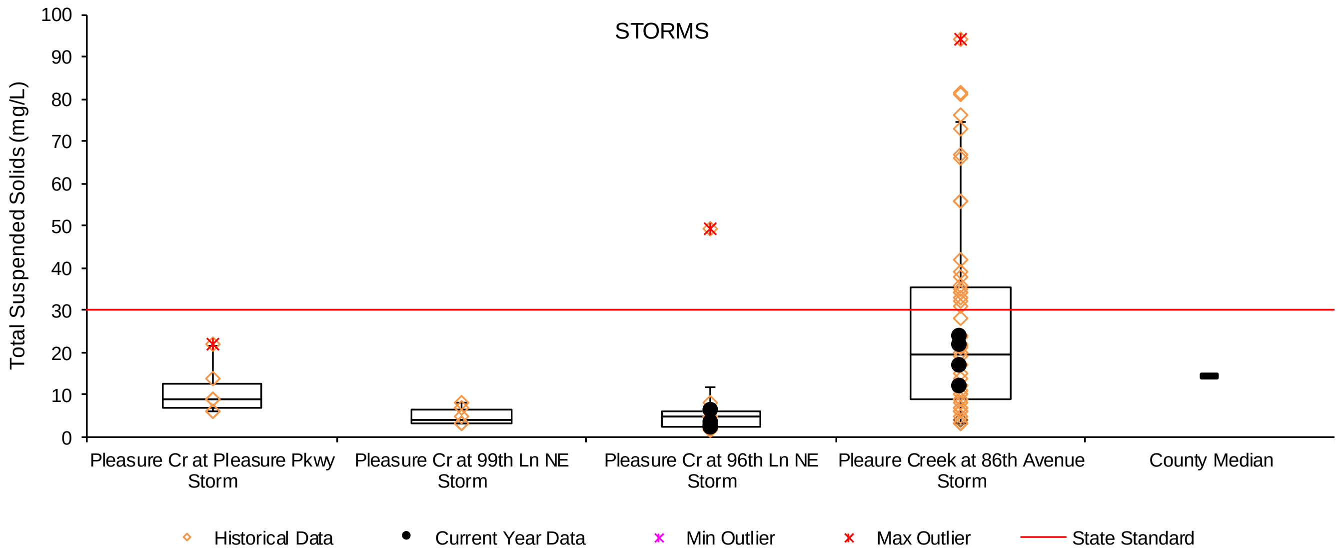
The generally low turbidity and TSS, as well as TP, likely reflect the effectiveness of a system of stormwater ponds located just upstream of East River Road. Increases in both parameters during some storms, particularly larger storms, is not unexpected for any stream. Additional stormwater treatment near, and downstream of, East River Road would likely be the most effective with improving water quality in Pleasure Creek because treatment upstream is already fairly robust.

Average and median total suspended solids in Pleasure Creek. Data is from the 86th Avenue site and all years through 2019.

	Average Total Suspended Solids (mg/L)	**Median Total Suspended Solids (mg/L)**	**State Standard**	**N**
Baseflow	8.1	6.5	30 mg/L TSS	44
Storms	26.9	19.5		52
All	18.6	10.0		96
Occasions > state TSS standard				0 baseflow 19 (37%) storm

Total suspended solids at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

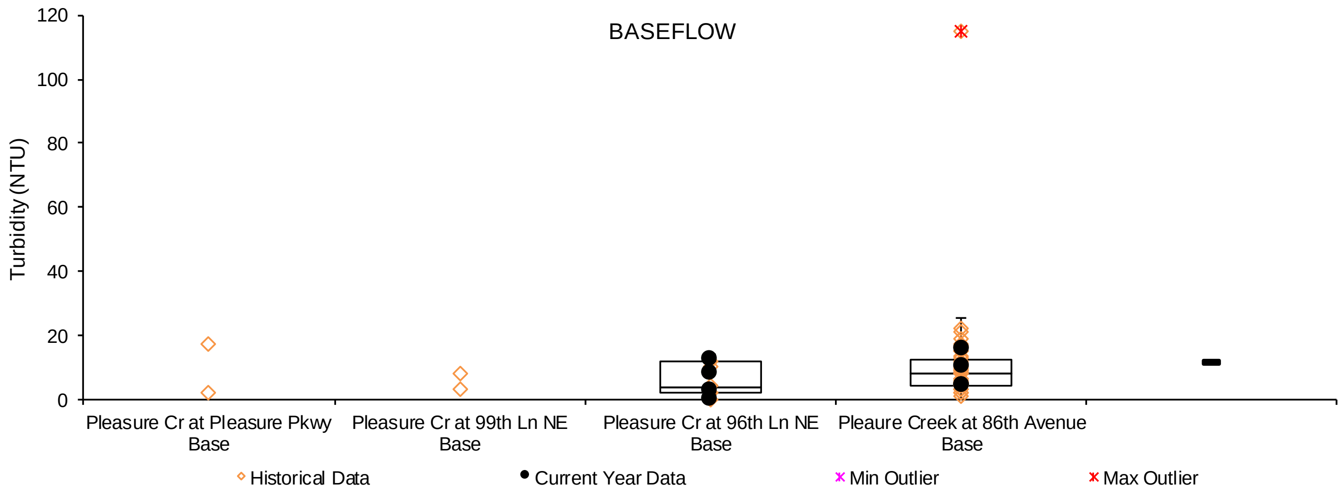


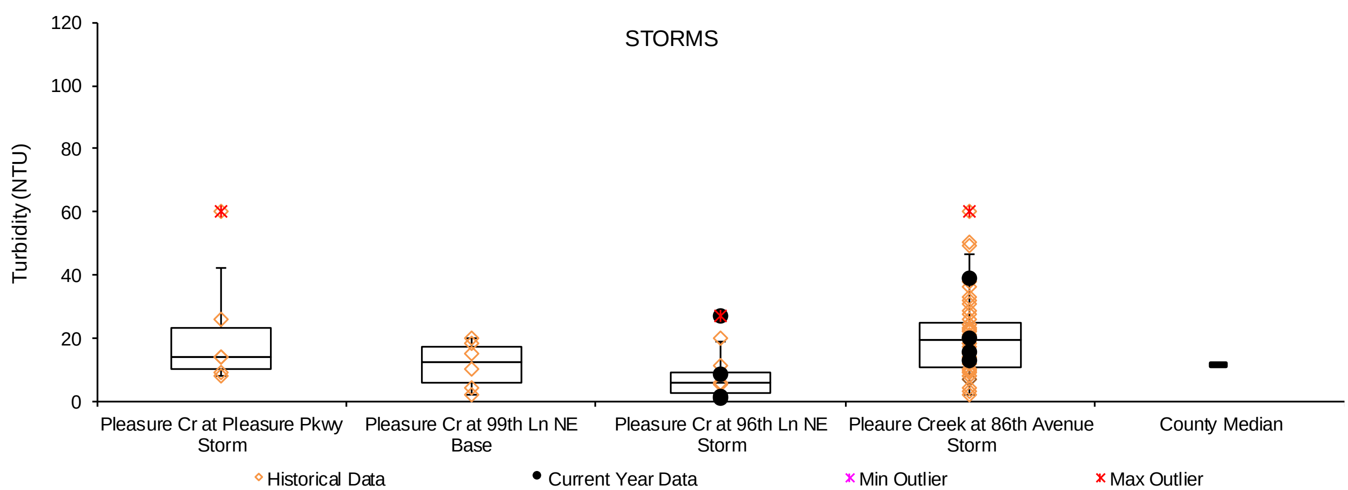


Average and median turbidity in Pleasure Creek. Data is from the 86th Avenue site and all years through 2019.

	Average Turbidity (NTU)	Median Turbidity (NTU)	State Standard	N
Baseflow	10.3	7.7	n/a	55
Storms	20.4	19.2		55
All	16.3	13.8		110
Occasions > state TSS standard				

Turbidity at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





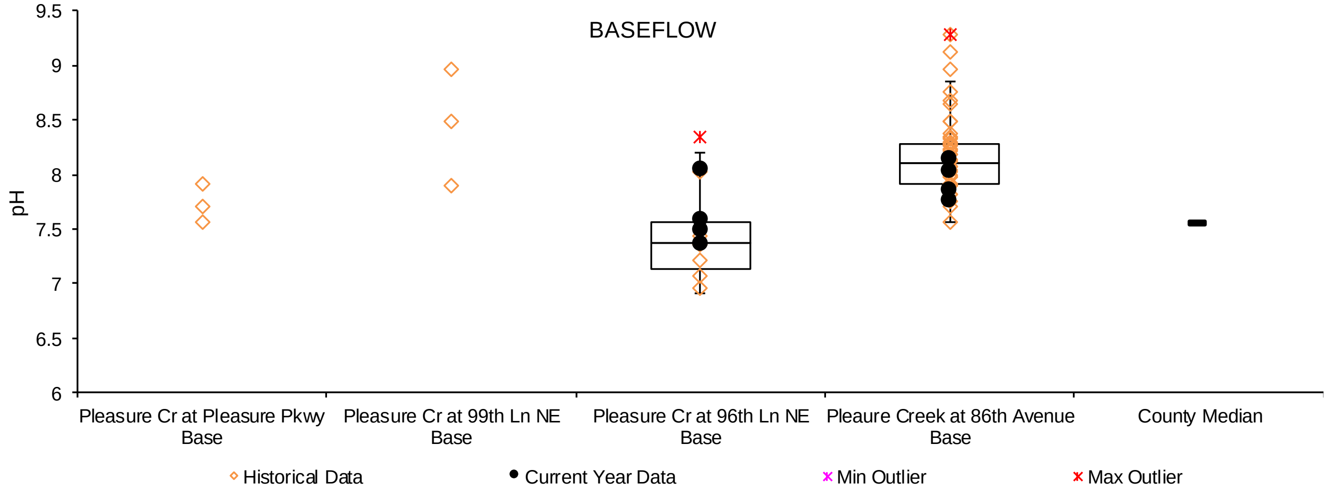
pH

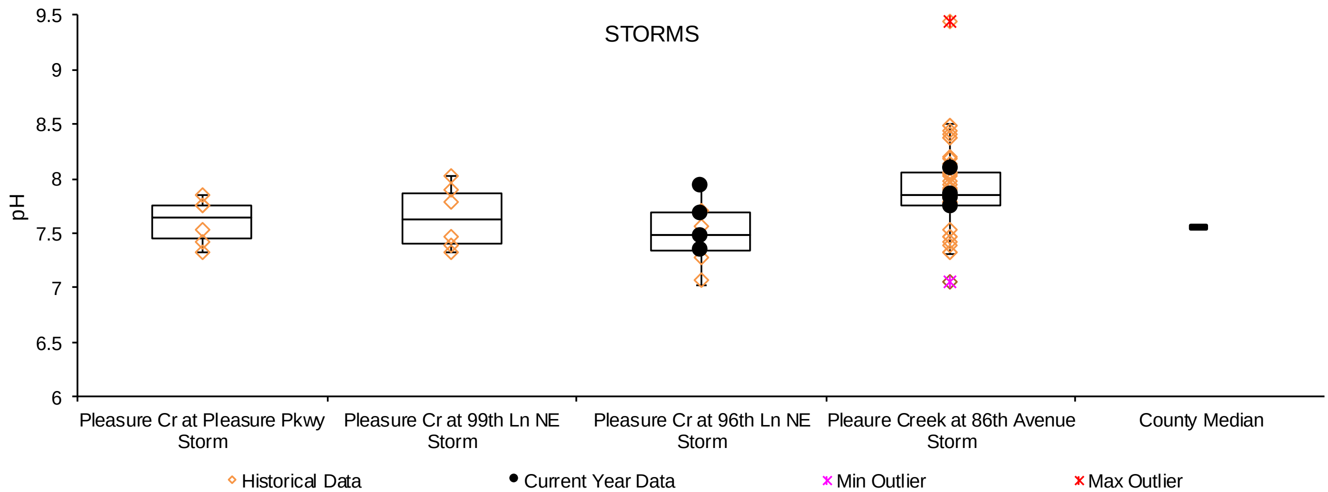
Pleasure Creek pH has generally remained within the state water quality standard range of 6.5-8.5, but median and average values are at the higher end of that range and higher than the long-term median for all Anoka County streams (7.56). Eight exceedances of 8.5 have occurred in 109 samples collected since 2002. Seven of these eight exceedances occurred during baseflow conditions. This is not surprising given that rain is typically more acidic that water on the landscape and often reduces pH during storms.

Average and Median pH in Pleasure Creek. Data is from the 86th Avenue site and all years through 2019.

	Average pH	Median pH	State Standard	N
Baseflow	8.15	8.10	6.5-8.5	56
Storms	7.91	7.85		53
All	8.08	8.05		109
Occasions outside state standard				7 (13%) baseflow 1 (2%) storm

pH at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





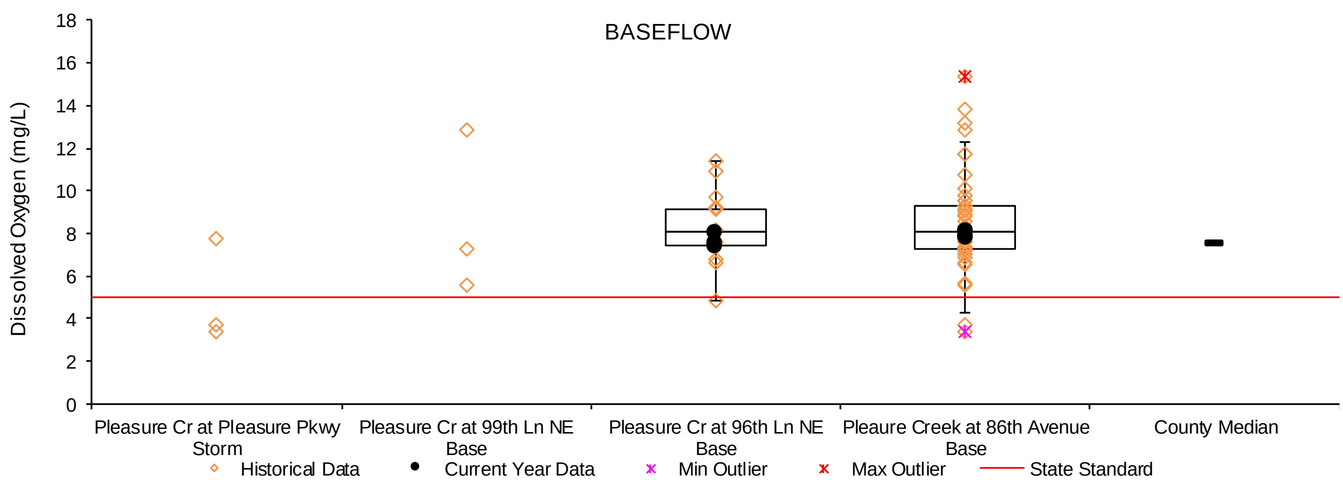
Dissolved Oxygen

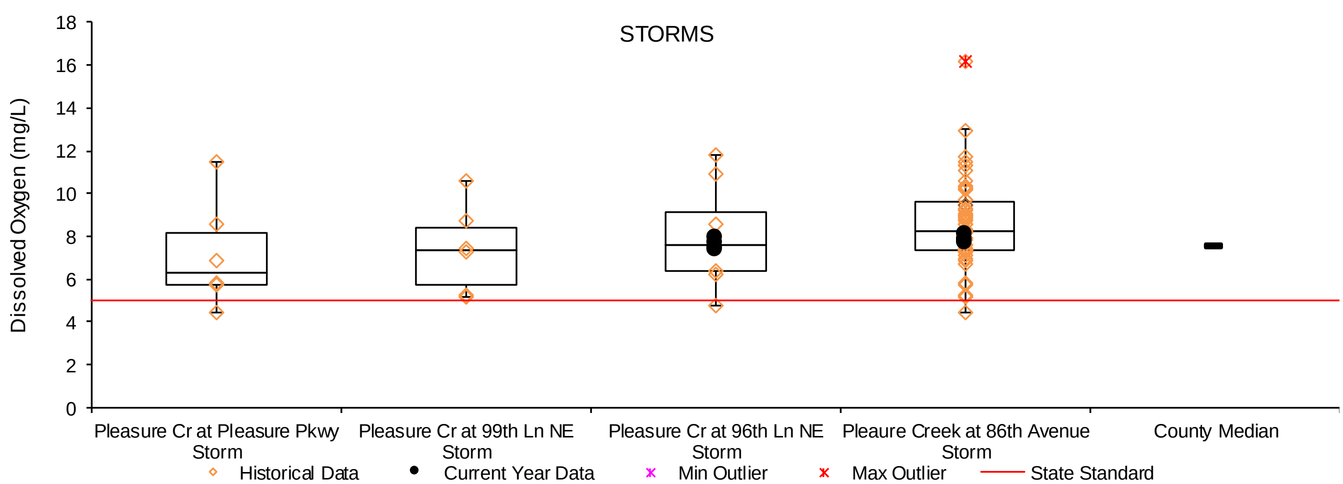
Dissolved oxygen (DO) levels in Pleasure Creek are generally within the acceptable range, only falling below that concentration in three of 105 samples collected since 2001 at 86th Ave. Overall, there does not appear to be an issue with this parameter in Pleasure Creek.

Average and Median dissolved oxygen in Pleasure Creek. Data is from the 86th Avenue site and all years through 2019.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.49	8.08	5 mg/L daily minimum	51
Storms	8.60	8.22		54
All	8.62	8.31		105
Occasions <5 mg/L				3

Dissolved Oxygen at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2019 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

The chronic state water quality standard for *E. coli* in streams is based on a calculated geometric mean of not less than five samples in any given calendar month. This mean should not exceed 126 MPN. An additional standard of not more than 10% of all samples in a given month should not exceed 1260 MPN is also listed. Because we monitor streams throughout the year, only collecting eight samples total, we do not have sufficient numbers of samples for any given calendar month to calculate geometric means or percentage-based exceedances comparable to these standards

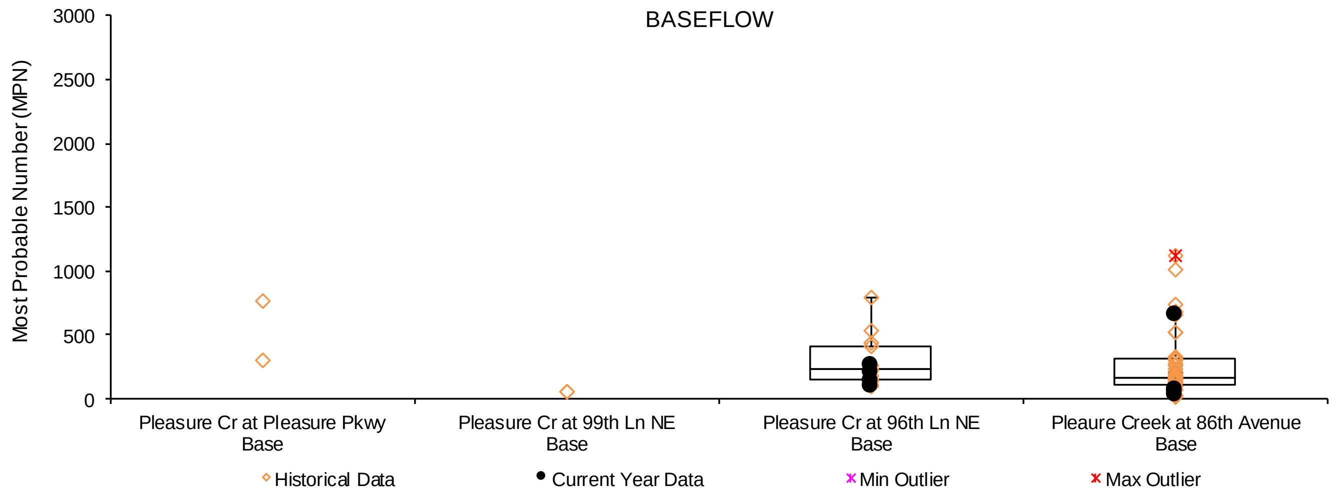
Pleasure Creek is listed as impaired for aquatic recreation due to excessive *E. coli*, and the Coon Creek TMDL contains a Load Duration Curve for this parameter (Page 52, Figure 22). Samples collected until 2014 are plotted on this chart and show exceedances of acceptable levels compared to the LDC for the majority of samples collected. High *E. coli* still persists today, so people should be wary about contact and inadvertent consumption of Pleasure Creek water. The TMDL attributes 92% of Pleasure Creek *E. coli* input to domestic dogs. Similar to the other streams in the Coon Creek TMDL, it is possible that waterfowl are underrepresented.

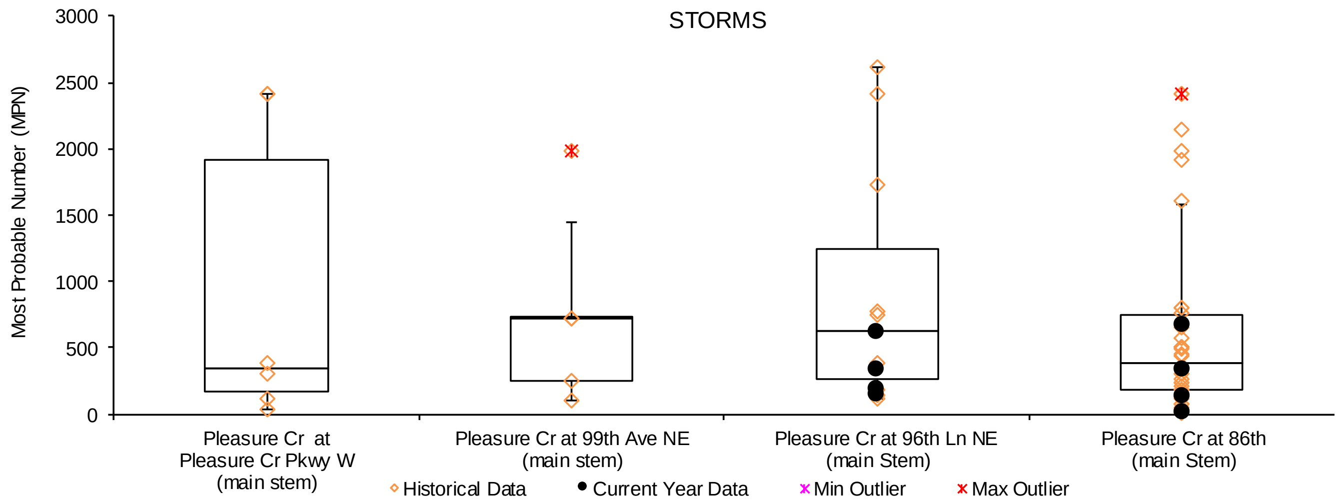
While current sampling frequency does not allow calculations based on state standards, *E. coli* measurements collected in 2019 are still informative. Four of eight samples collected during baseflow and seven of eight samples post-storm event, exceeded the chronic standard of 126 MPN. Post-storm and baseflow concentrations were similar for both monitored sites in 2019.

Average and median *E. coli* in Pleasure Creek. Data is from the 86th Avenue site only, all data through 2019.

	Average *E. coli* (MPN)	**Median *E. coli* (MPN)**	**State Standard**	**N**
Baseflow	289.20	166.50	Monthly Geometric Mean >126 Monthly 10% average >1260	34
Storms	649.72	391.0		34
All	469.46	251.0		68
Occasions >126 MPN **Occasions >1260 MPN**				23 (68%) baseflow, 28 (82%) storm 0 baseflow, 6 (18%) storm

***E. coli* at Pleasure Creek.** Orange diamonds are historical data from previous years and black circles are 2019 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

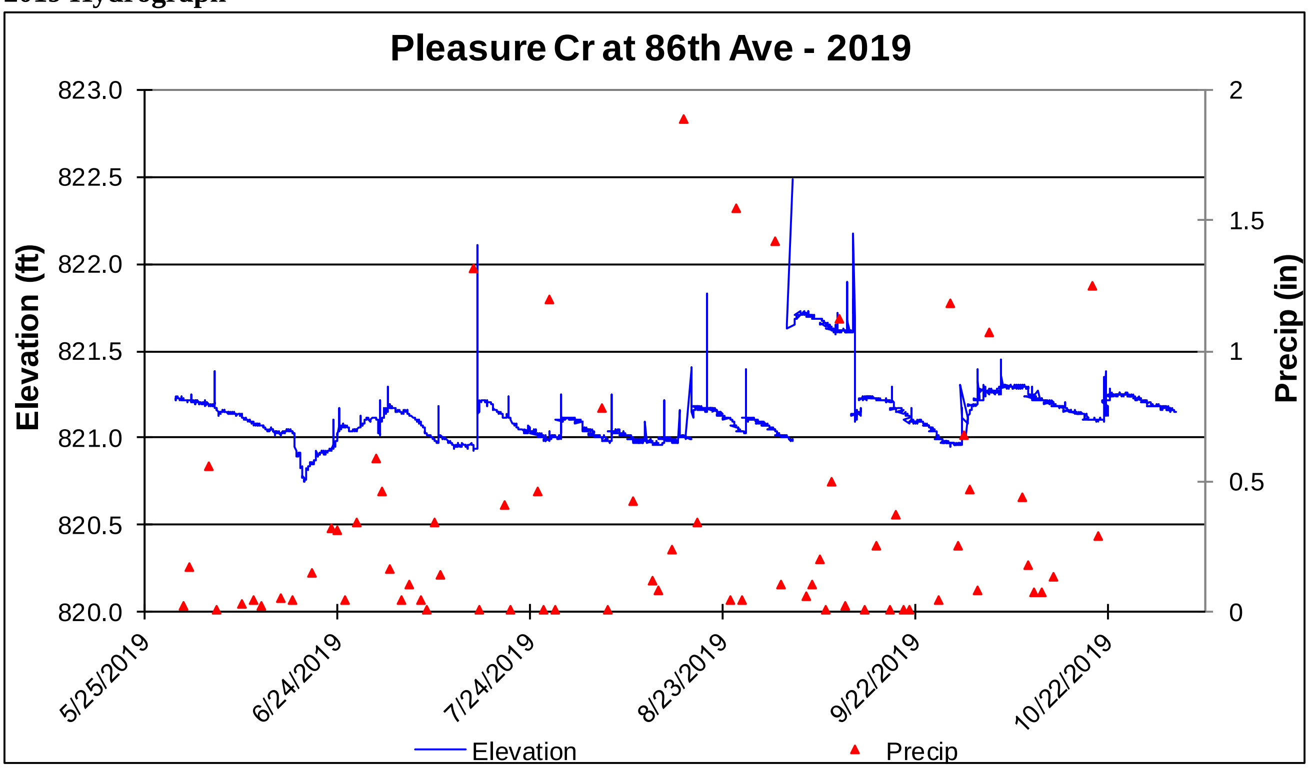
at 86th Ave, Coon Rapids

Notes:

Pleasure Creek at 86th fluctuated 1.74 feet throughout 2019. Stage reading frequency was shortened to one hour instead of two for 2019, but based on the hydrograph, it looks like the reading interval of one hour was still too long to catch most of the storm surges. The site is very flashy, with a 1.32 inch storm on July 15 causing an increase of 1.17 feet between consecutive hourly readings. Unfortunately, we don't know if there was a higher point during that storm surge between these hourly readings, or to what extent other storms caused the stage to rise to between readings.

There was a streambank stabilization project installed at the monitoring site in 2019 and monitoring equipment had to be reinstalled once the project was complete. The banks and creek bed were both regraded during the project, changing the characteristics of the channel. Through that project the banks were lined with rock and the channel is now mostly walled in. The rating curve, which was developed for this site in 2013, will likely have to be reestablished. The collection interval for stage data should also be decreased in subsequent monitoring years.

2019 Hydrograph

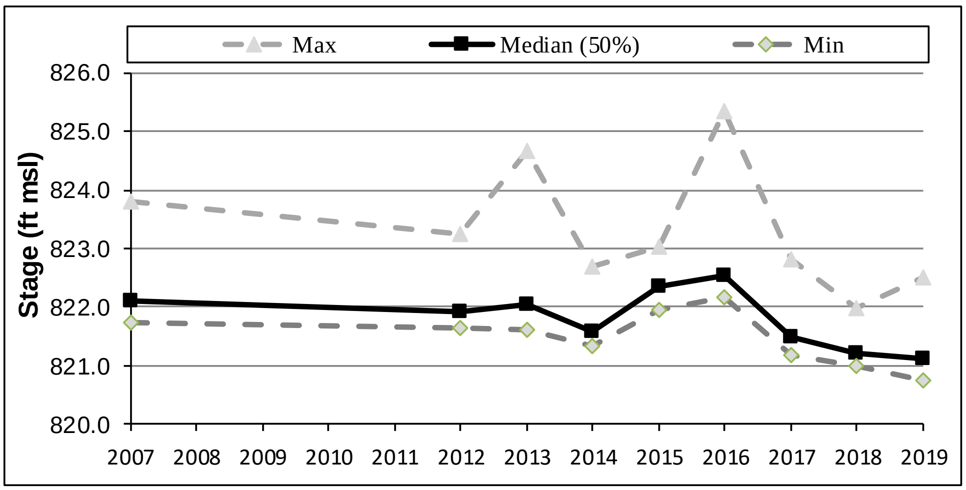


PLEASURE CREEK

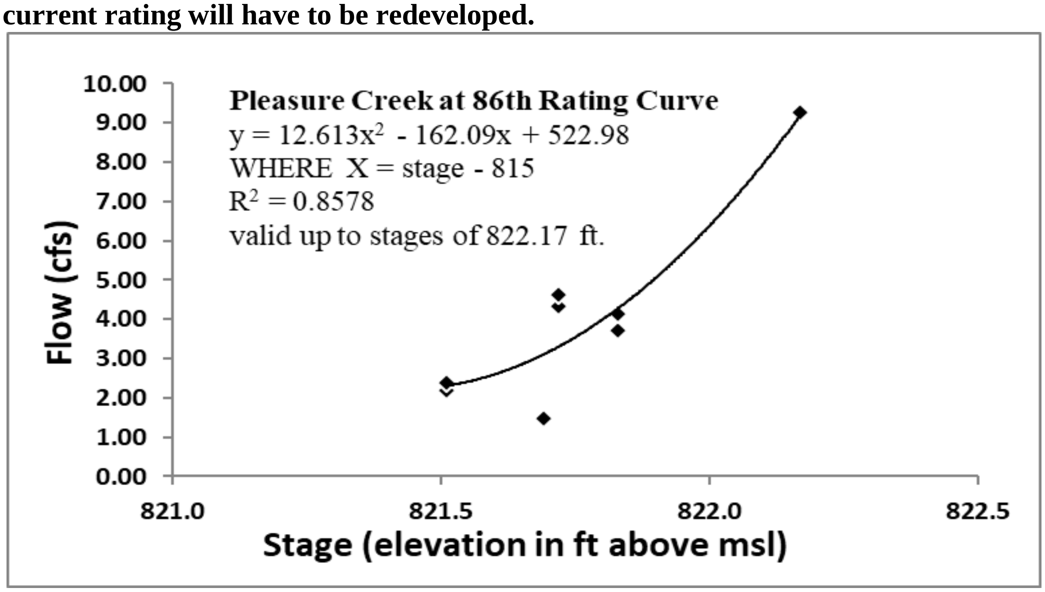
at 86th Ave, Coon Rapids

Summary of All Monitored Years

Percentiles	2007	2012	2013	2014	2015	2016	2017	2018	2019
Min	821.73	821.63	821.60	821.34	821.95	822.17	821.18	820.99	820.75
2.5%	821.77	821.69	821.63	821.38	821.98	822.20	821.26	821.01	820.91
10.0%	821.84	821.77	821.73	821.42	822.02	822.27	821.31	821.06	820.97
25.0%	821.95	821.80	821.78	821.45	822.26	822.46	821.40	821.13	821.03
Median (50%)	822.10	821.93	822.04	821.57	822.34	822.54	821.48	821.21	821.11
75.0%	822.32	822.04	824.67	821.82	822.46	822.61	821.59	821.29	821.20
90.0%	822.49	822.19	824.67	821.98	822.56	822.70	821.69	821.43	821.27
97.5%	822.63	822.33	824.67	822.19	822.61	822.81	821.82	821.52	821.69
Max	823.79	823.25	824.67	822.70	823.04	825.33	822.81	821.99	822.49



Rating Curve (2013) – A streambank stabilization project was completed at this site in 2019 and the current rating will have to be redeveloped.



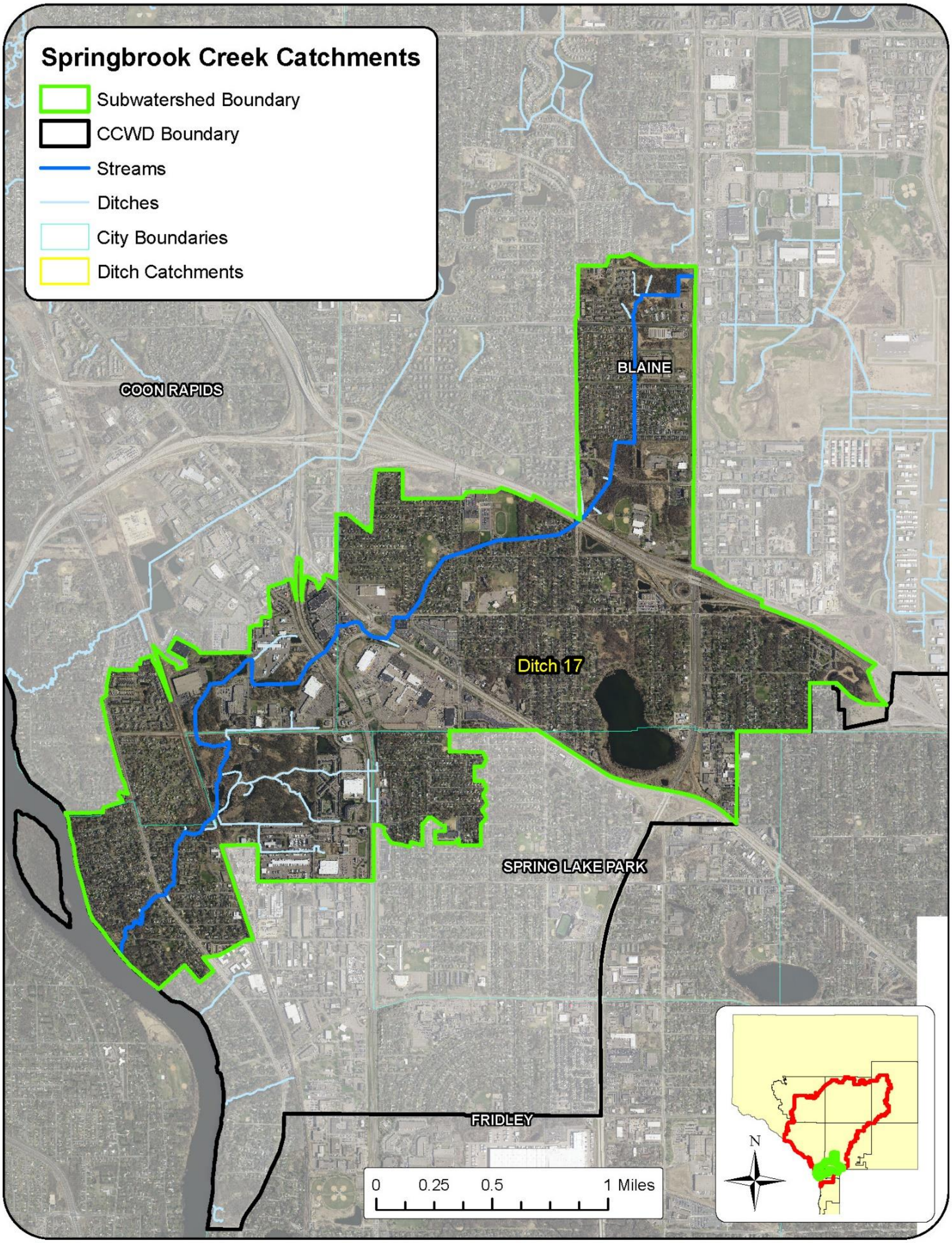
Water Quality Monitoring – Springbrook Creek

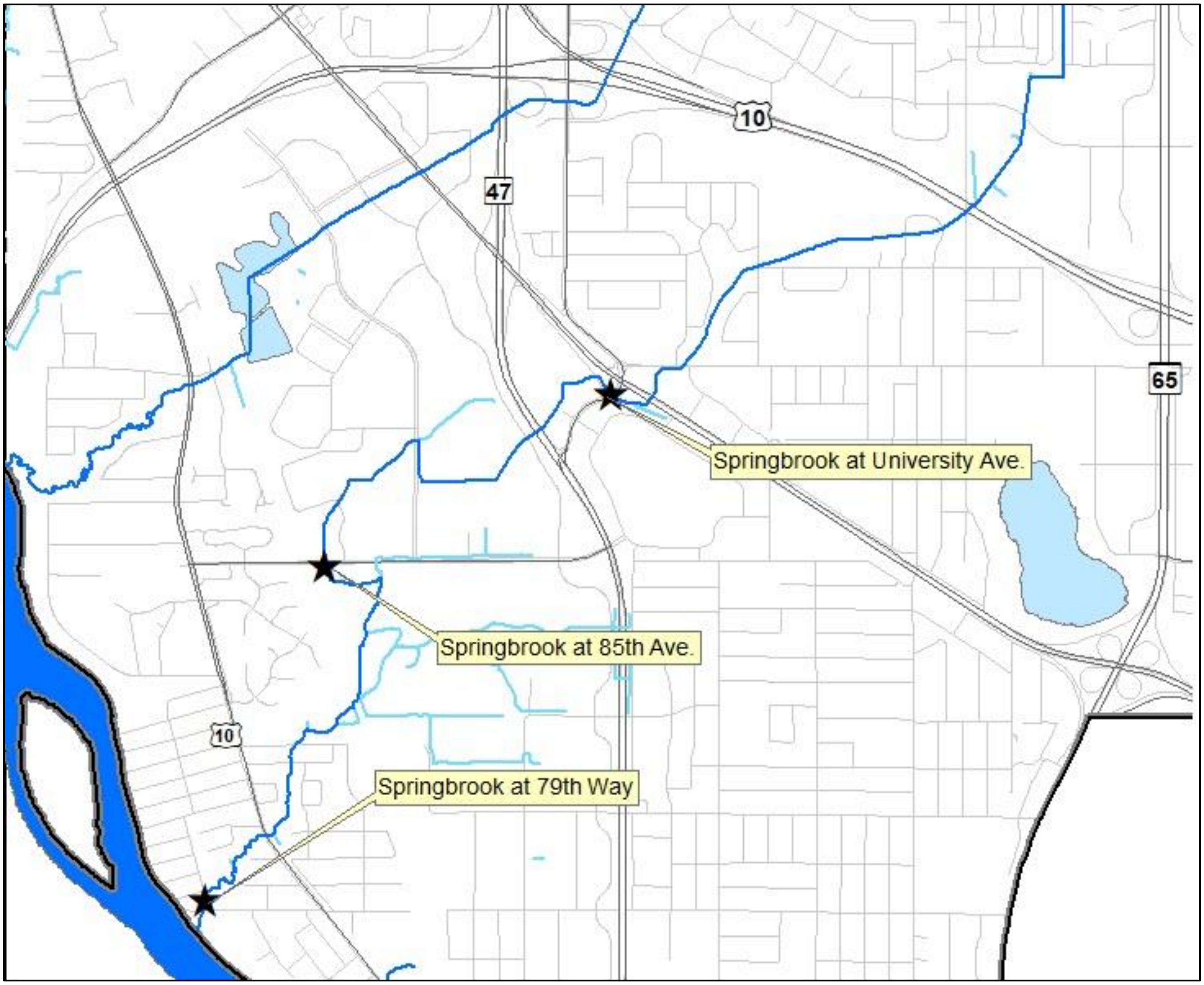
Springbrook Creek (Ditch 17) Monitoring Sites		
Site Name/ SiteID	**Years Monitored**	**2019 Data Collected**
Springbrook at University, Blaine S007-542	2013-2019	Water Chemistry Grab Samples
Springbrook at 85th Avenue, Fridley S007-543	2013-2019	Water Chemistry Grab Samples
Springbrook at 79th Way, Fridley S006-140	2012-2019	Water Chemistry Grab Samples, Continuous Stage

Background

Springbrook Creek (Ditch 17) is a small waterway draining an urbanized and highly modified watershed. This watershed does not drain to Coon Creek, but is included in the Coon Creek Watershed District jurisdictional boundary as well as the Coon Creek TMDL. The watershed includes portions of the Cities of Blaine, Coon Rapids, Spring Lake Park and Fridley. The primary channel flows approximately 5 miles from a small ditched wetland north of 99th Ave. in Blaine, through the southeastern corner of Coon Rapids, through the wetland impoundment in Springbrook Nature Center in northern Fridley, and finally to the Mississippi River. Several small ditch tributaries and numerous subsurface stormwater conveyance systems contribute to the creek, with many branches joining at the Springbrook Nature Center impoundment. From the outlet of the nature center, the creek flows approximately one mile to its confluence with the Mississippi River in a single, meandering channel. At its outlet, Springbrook Creek is about 10 ft. wide and 1 foot deep at baseflow. The stream is flashy, with water levels that increase dramatically following rainfall and quickly recede thereafter.

In the early 2000s Springbrook Creek was the subject of a multi-partner project focused on monitoring and improving water quality through the implementation of capital improvement projects. Funding support for the project came from a MN Pollution Control Agency grant and from the City of Fridley. During that effort, several projects to improve stormwater treatment and also rehabilitate the nature center impoundment were implemented. Water quality monitoring during this time produced only a small amount of usable data, but enough was collected to indicate water quality and hydrology problems in the system. More regular monitoring of this creek has taken place since 2012 at the three monitoring sites mapped below.


Springbrook Creek Catchments
Subwatershed Boundary
CCWD Boundary
Streams
Ditches
City Boundaries
Ditch Catchments
BLAINE
COON RAPIDS
Ditch 17
SPRING LAKE PARK
FRIDLEY
0
0.25
0.5
1 Miles
N



Results and Discussion

Springbrook Creek, like other creeks in the watershed, is impaired for aquatic recreation due to elevated *E. coli* concentrations and invertebrate biota with TP identified as a main stressor. Unlike the other streams in the Coon Creek TMDL, Springbrook Creek does not have TSS identified as a stressor to stream biota and so does not have a load duration curve (LDC) for that parameter.

Total Phosphorus concentrations are high in Springbrook Creek, especially during storms. The average concentration of all TP samples collected at 79th way exceeds the state standard of 100 µg/L at 102 µg/L. The average concentration for storm samples collected at this site is 132 µg/L. The LDC plot for TP in Springbrook Creek in the Coon Creek TMDL (Page 49, Figure 19) shows that acceptable TP loads are exceeded in each grab sample collected during all but the lowest flow conditions. Springbrook Creek has an LDC for TP because the parameter is identified as a stressor for aquatic macroinvertebrates, but it is not beyond reason that the creek could also carry a TP impairment of its own under MN's river eutrophication standards.

E. coli levels are high in Springbrook Creek. The chronic standard concentration of 126 MPN is exceeded over 50% of the time at baseflow and 90% of the time during storms at 79th Way. Additionally, the Springbrook Creek LDC for *E. coli* in the Coon Creek TMDL is exceeded in the majority of sample events plotted at all flow levels.

Similar to Sand Creek, the TMDL attributes 89% of *E. coli* loading in Pleasure Creek to domestic dogs, but this assumption may be underrepresenting the contribution of waterfowl into this creek.

Chlorides were sampled in CCWD streams in 2019, with Springbrook Creek having higher concentrations than other streams in the watershed. The chronic state standard for chlorides is 230 mg/L. While Springbrook Creek near its outlet at 79th Way has not exceeded that concentration in any grab samples, it averaged 156 mg/L in eight grab samples collected in 2019. Springbrook Creek has not exceeded the acute standard of 860 mg/L in any sample. While these concentrations do comply with state standards, they only represent growing-season conditions and they are much higher than other streams monitored in the county and higher than Coon Creek and Sand Creek in the watershed. Chlorides are a particularly problematic pollutant to aquatic life and in drinking water. Springbrook Creek flows into the Mississippi River and its water quality has implications for both.

Specific conductance and Chlorides

Springbrook dissolved pollutant levels as measured by specific conductance are higher than other streams in the watershed. The long-term median for specific conductance in Springbrook at 79th Way during all conditions is 0.913 mS/cm. By contrast, the median for Coon Creek at Vale St. is 0.655 mS/cm. Median specific conductance at 79th Way (all years) is lower during storm events (0.863 mS/cm) compared to baseflow conditions (1.013 mS/cm).

Chloride sampling was conducted in Springbrook Creek in 2019 for the first time since 2012. The median chloride concentration at 79th Way was 156 mg/L, which matches composite median with 2012 data included. In 2019, concentrations during baseflow vs post storm events were similar at 79th Way, but the relationship moving upstream to downstream was not. At baseflow, chloride concentrations upstream were higher, and declined moving downstream. During post storm sampling, the opposite was true. The same relationship is true in the specific conductance data. One post storm sample at 85th Ave. resulted in a chloride concentration of 254 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 tend to be the highest. No sample approached the acute state standard of 860 mg/L

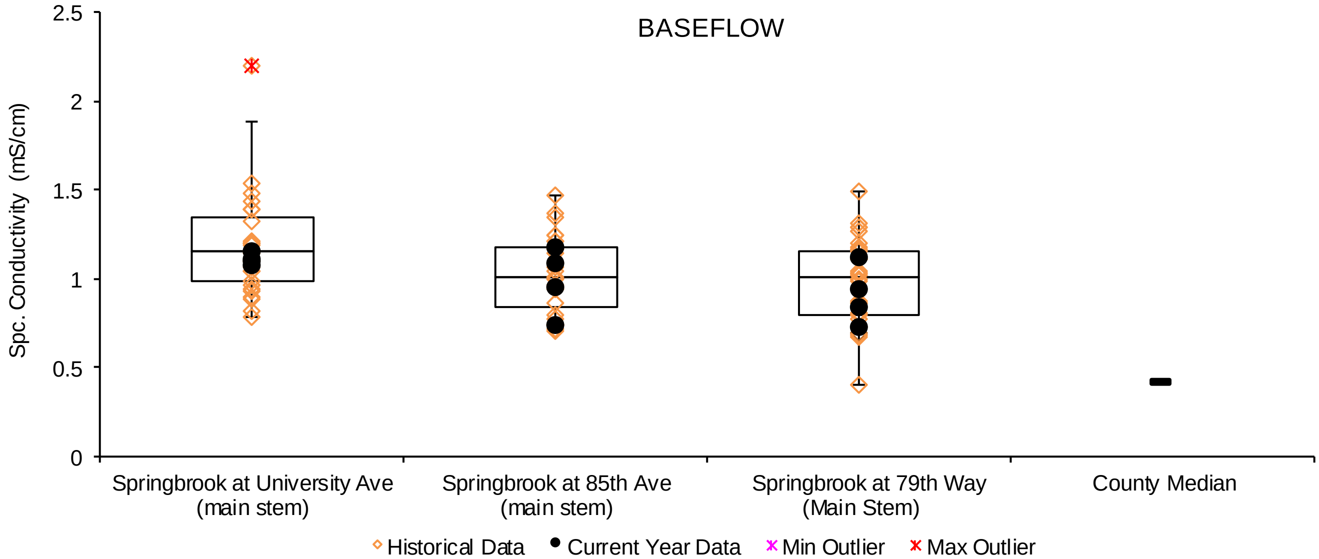
Springbrook's high dissolved pollutants are lower during storm flows, suggesting that the local shallow groundwater is a pollutant source during baseflow conditions. Road deicing salts are often a contributor when similar conditions are found elsewhere in the region, but interestingly actual chloride concentrations did not show the same decline during storms that overall specific conductance did. Regardless, chlorides in the shallow groundwater that feeds baseflow in Springbrook Creek appear to be a problem, causing higher concentrations in this creek than others in the watershed. 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, suggested that runoff from impervious surfaces directly to the stream is also problematic.

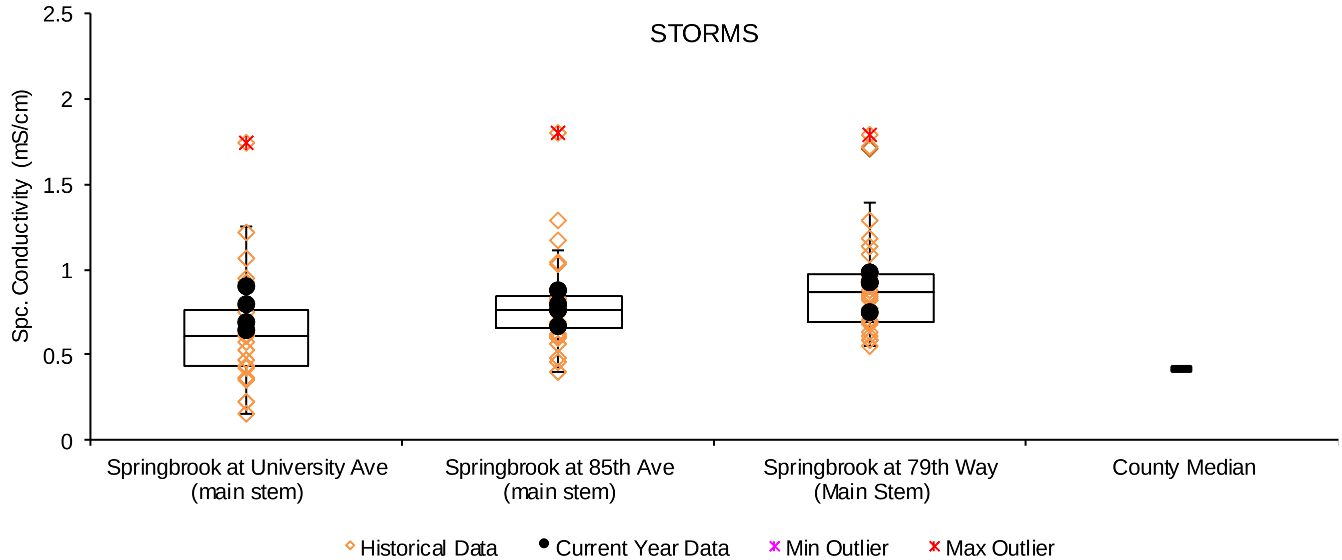
Dissolved pollutants are especially difficult to manage once in the environment. They are not removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also risk contaminating groundwater. The first approach to dissolved pollutant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

Average and median specific conductance and chlorides in Springbrook Creek. Data is from 79th Way for specific conductance and chlorides all years through 2019.

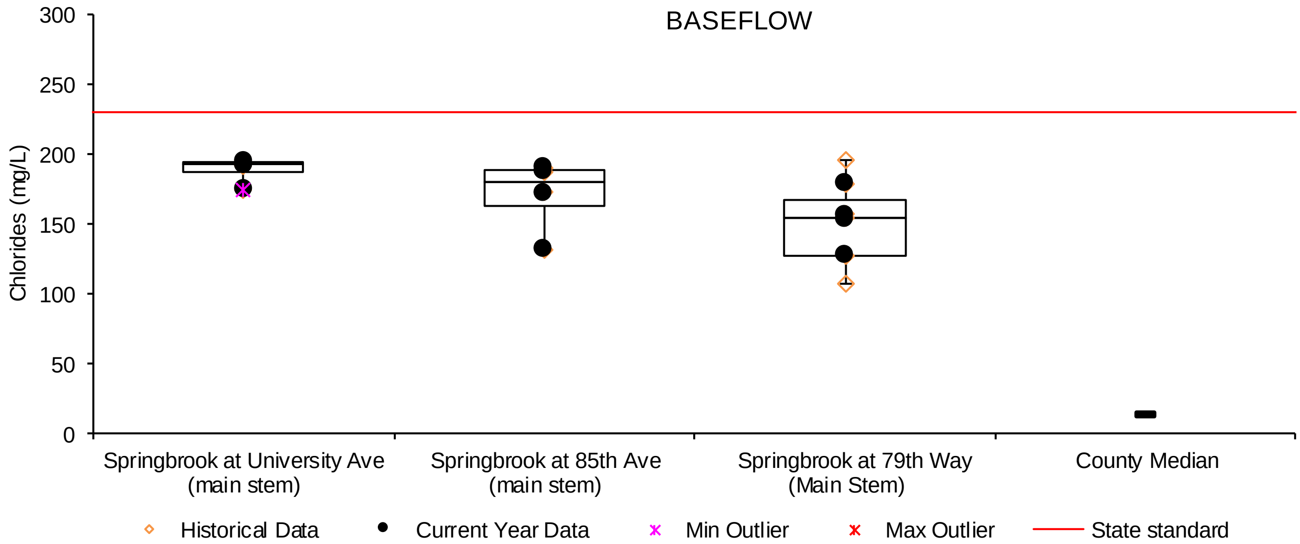
	Average Specific Conductance (mS/cm)	**Median Specific Conductance (mS/cm)**	**Median Chlorides (mg/L)**	**State Standard**	**N (Spc. Cond)**
Baseflow	0.982	1.013	154	Specific conductance – none Chlorides 860 mg/L acute, 230 mg/L chronic	32
Storms	0.923	0.863	173		32
All	0.952	0.913	157		64
Occasions > State Standard					0 baseflow 2 storm (19%)

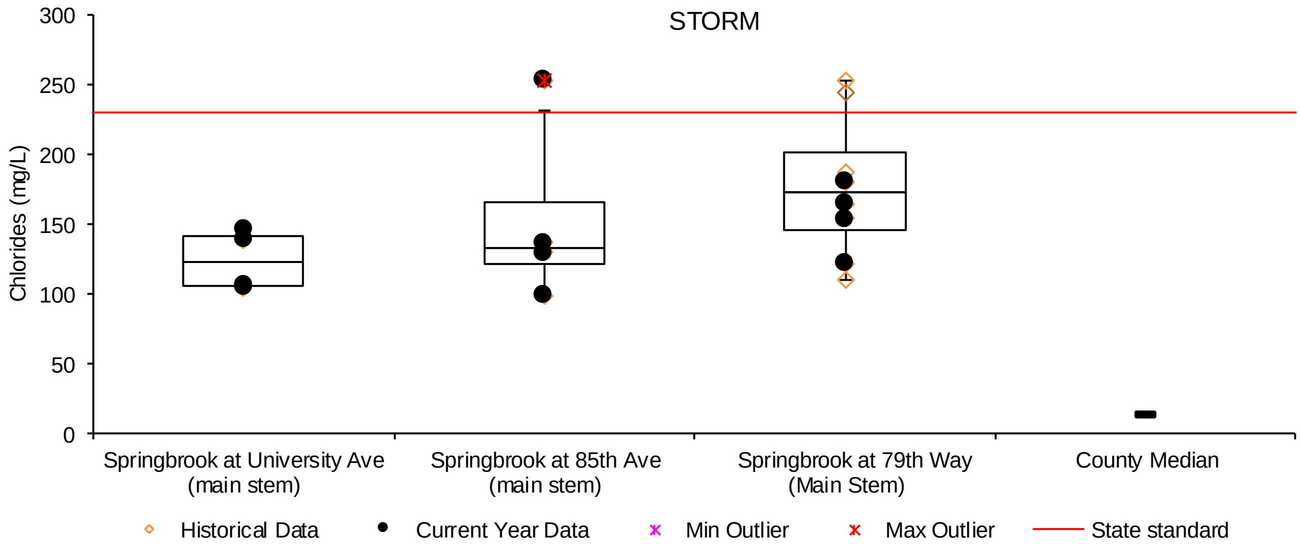
Specific conductance at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





Chlorides at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2019 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

Springbrook Creek often exceeds the state water quality standard of 100 µg/L during storm events. During baseflow conditions TP levels only exceeded the standard on one occasion in 2019 at the furthest upstream site (University Ave.). Post-storm TP concentrations are much higher in Springbrook Creek, and exceed 100 µg/L most of the time. The average of all post-storm TP samples collected at this site is 132 µg/L.

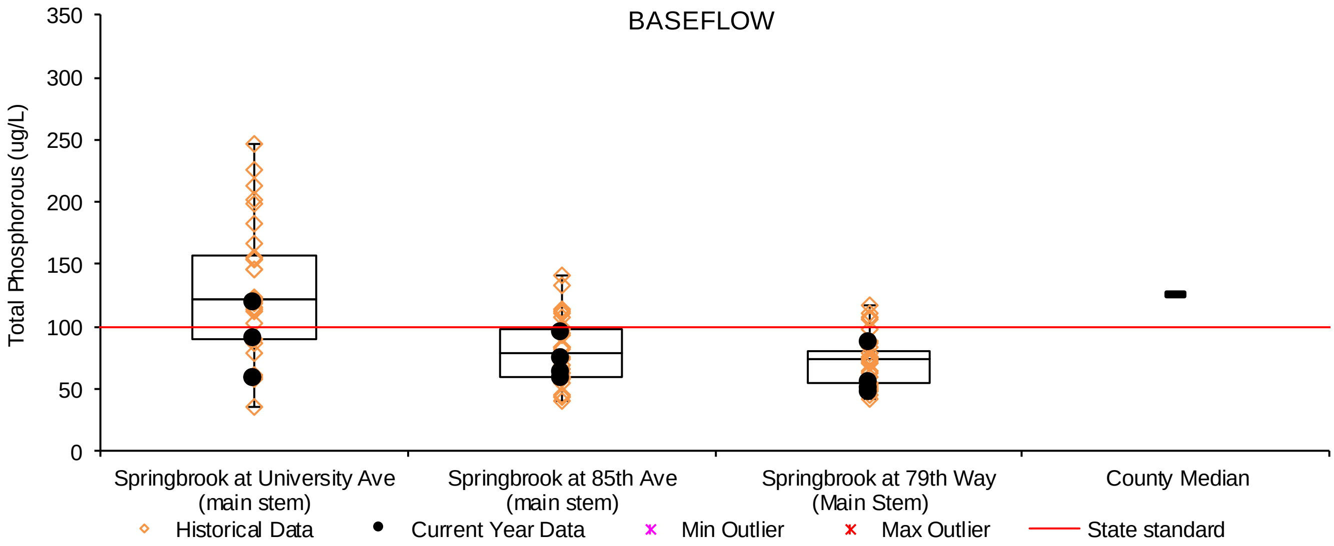
It is interesting to note that there is an apparent decrease in TP levels moving from upstream to downstream during baseflow conditions. Long-term median concentrations at the three sites are 121, 78.5, and 74.5 µg/L respectively. This suggests that active water quality projects and best management practices are effectively removing phosphorus from the Springbrook system throughout the watershed. One likely source of treatment is the large wetland complex located in the Springbrook Nature Center, although a decrease also occurs between the two previous upstream sites. Overall, the system is doing a decent job of maintaining total phosphorus concentrations and helping keep TP levels below the State standard during baseflow.

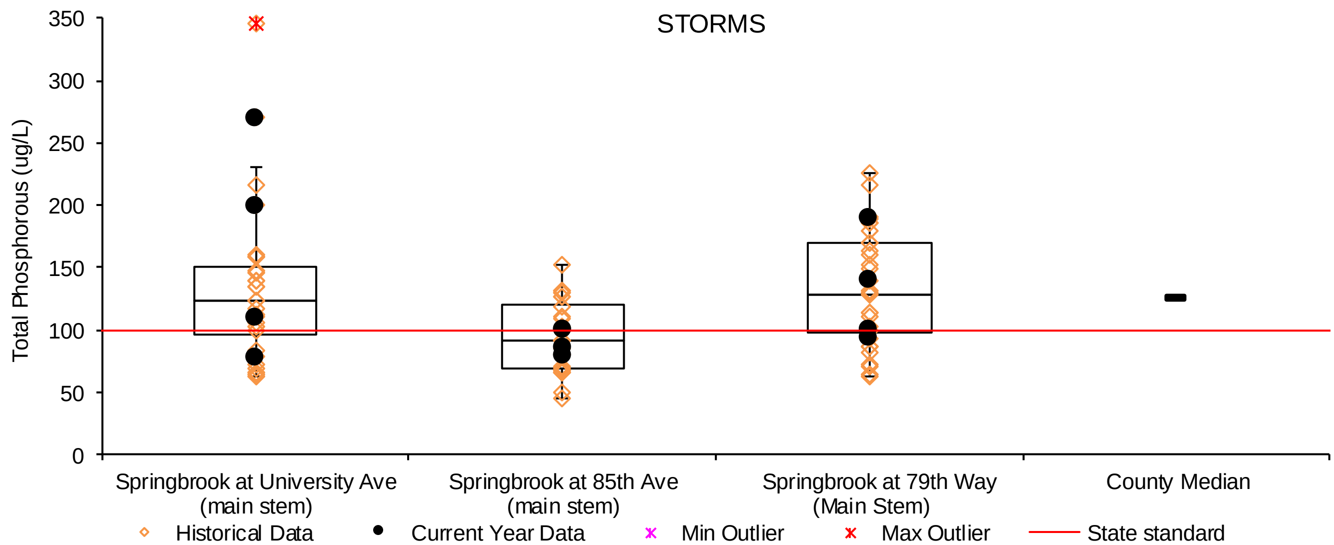
Following storm events there was a slight decrease in TP moving upstream to downstream, but concentrations at 79th Way are much higher than at baseflow. It appears that the Springbrook Nature Center wetland complex and other stormwater treatment practices in the area are undersized or overwhelmed by the volume of water and pollutants from the watershed during storm events. Adding additional capacity for treatment is advised, but the limited available space in this urban setting presents a challenge. Gaining a better understanding of whether the increase in total phosphorus being flushed through this complex during storms is predominantly dissolved or particulate phosphorus would better inform any water management decisions including the planning of any additional retrofits to the system. Following storm events, phosphorus concentrations at the 79th Way site exceed State standards 65% of the time.

Average and median total phosphorus in Springbrook Creek. Data is from 79th Way for all years through 2019.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	72.34	74.50	100	32
Storms	131.78	128.5		32
All	102.06	87.0		64
Occasions > state standard				4 (12%) Baseflow 21 (65%) storm

Total phosphorus at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2019 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

TSS and turbidity in Springbrook Creek are generally low during baseflow conditions and elevated following storms, especially at 79th Way. During baseflow conditions TSS concentrations are low at all sites and remain low following storm events at the two upstream sites. Interestingly, there is a large increase in post-storm TSS concentrations between 85th Ave. and 79th Way. The area between the two sites contains a large wetland complex located at the Springbrook Nature Center. These wetlands are potentially getting filled in with sediment that is re-suspended and flushed through during storm events. After storms, TSS concentrations at 79th way exceed the 30 mg/L state standard 28% of the time.

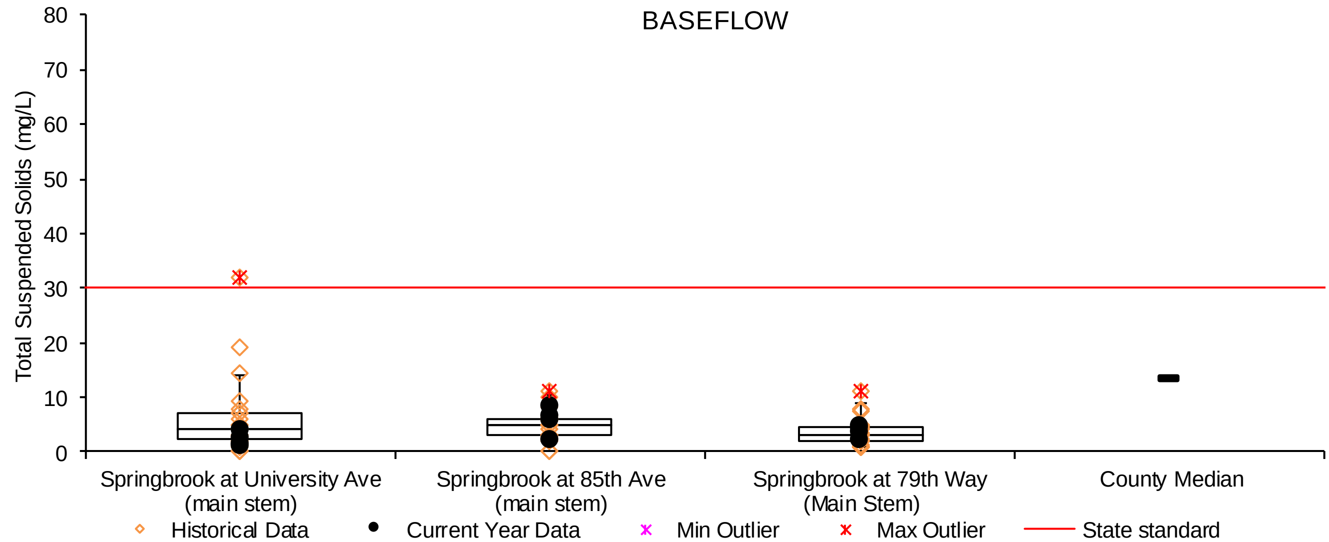
Based on long-term average concentrations, TSS does not increase moving upstream to downstream during baseflow but does during storm flow. The long-term (all years) median for TSS concentrations during storms are 3.0, 8.0, and 19.5 mg/L, moving upstream to downstream. The largest likely contributor of TSS to Springbrook Creek is solids transported by stormwater conveyances from impervious surfaces.

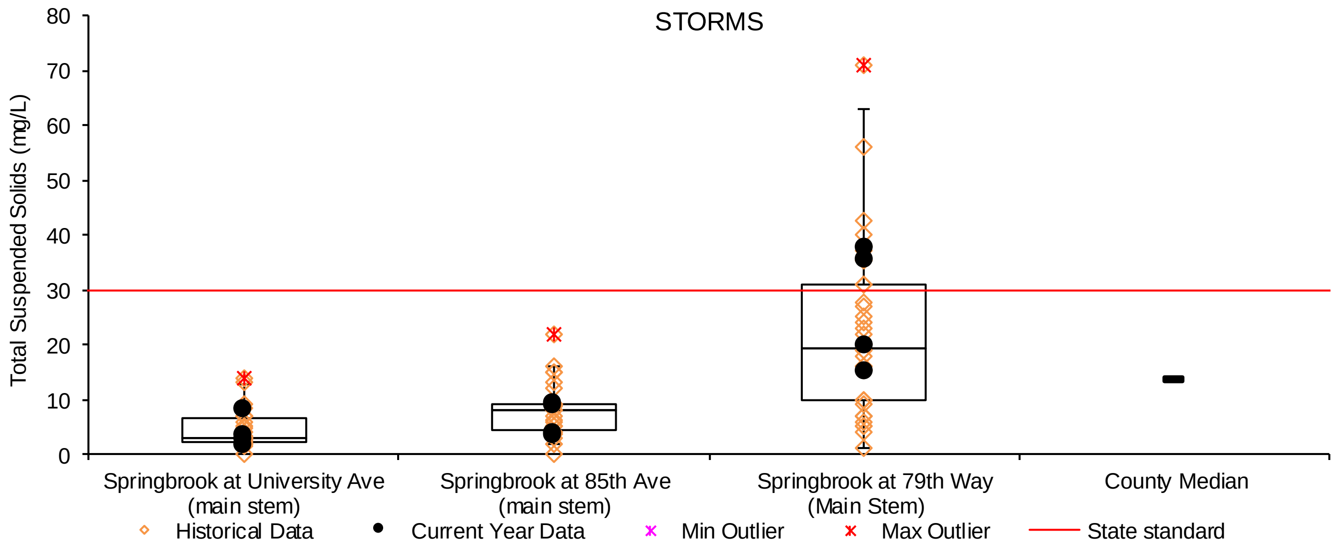
During baseflow conditions, turbidity is similarly low, only exceeding 5 NTU on three occasions at 79th Way since 2012. Turbidity does increase during storm flows and follows the same trend of increasing downstream. The long-term median turbidity (all years) post-storm at each site is 5.5, 9.8, and 15.3 NTU respectively from upstream to downstream. This indicates the same source of pollutant loading from downstream stormwater as TSS.

Average and median total suspended solids in Springbrook Creek. Data is from 79th Way for all years through 2019.

	Average Total Suspended Solids (mg/L)	Median Total Suspended Solids (mg/L)	State Standard	N
Baseflow	3.53	3	30 mg/L TSS	32
Storms	21.63	19.00		31
All	12.84	5.0		63
Occasions > state TSS standard				0 baseflow 8 (26%) storm

Total suspended solids at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

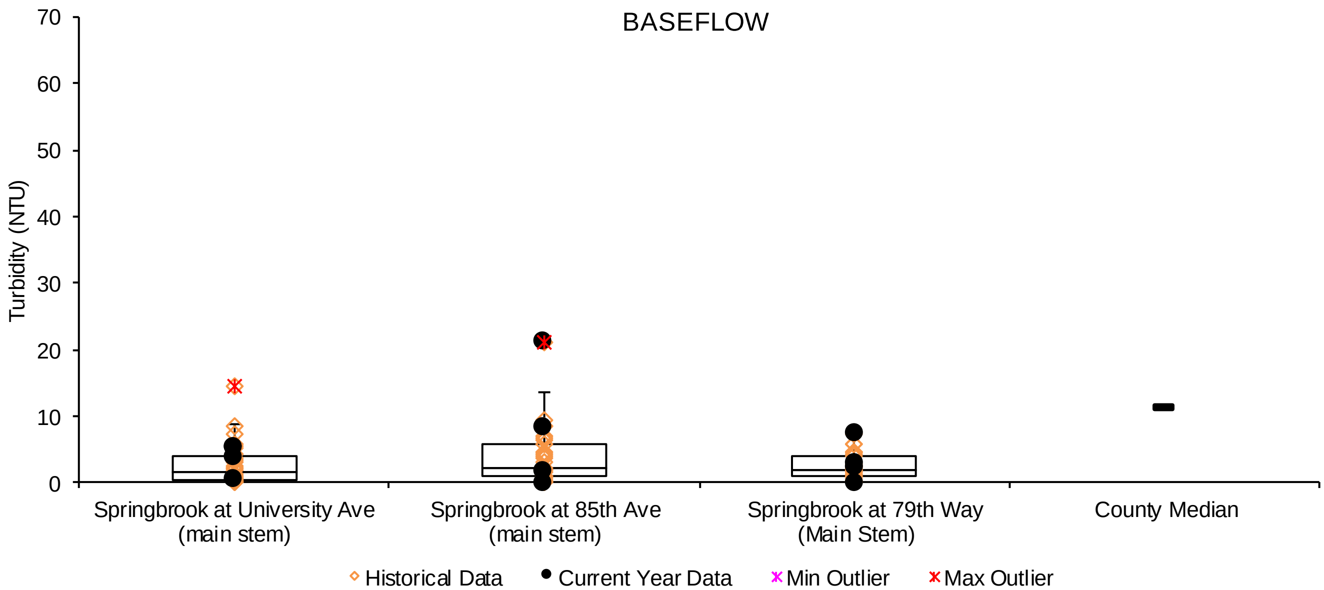


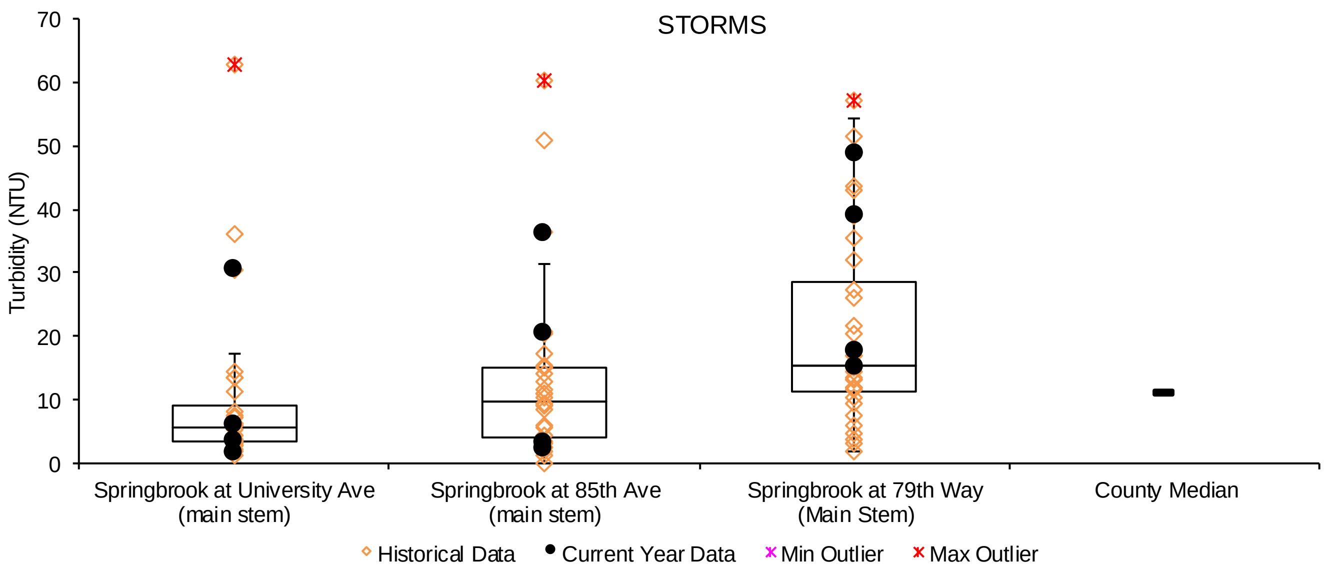


Average and median turbidity in Springbrook Creek. Data is from 79th Way for all years through 2019.

	Average Turbidity (NTU)	Median Turbidity (NTU)	State Standard	N
Baseflow	2.29	1.9	n/a	32
Storms	20.75	15.30		32
All	11.52	4.75		64

Turbidity at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





pH

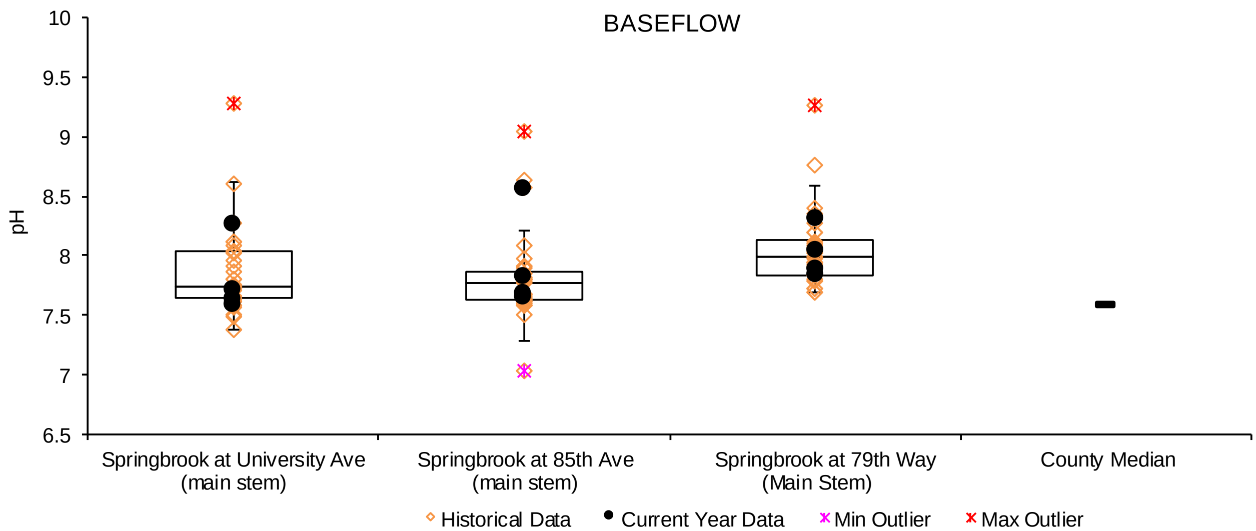
Springbrook Creek generally maintains healthy pH levels within the State water quality standard range of 6.5-8.5. Only a couple of rare outlier readings exceeding 8.5 have occurred.

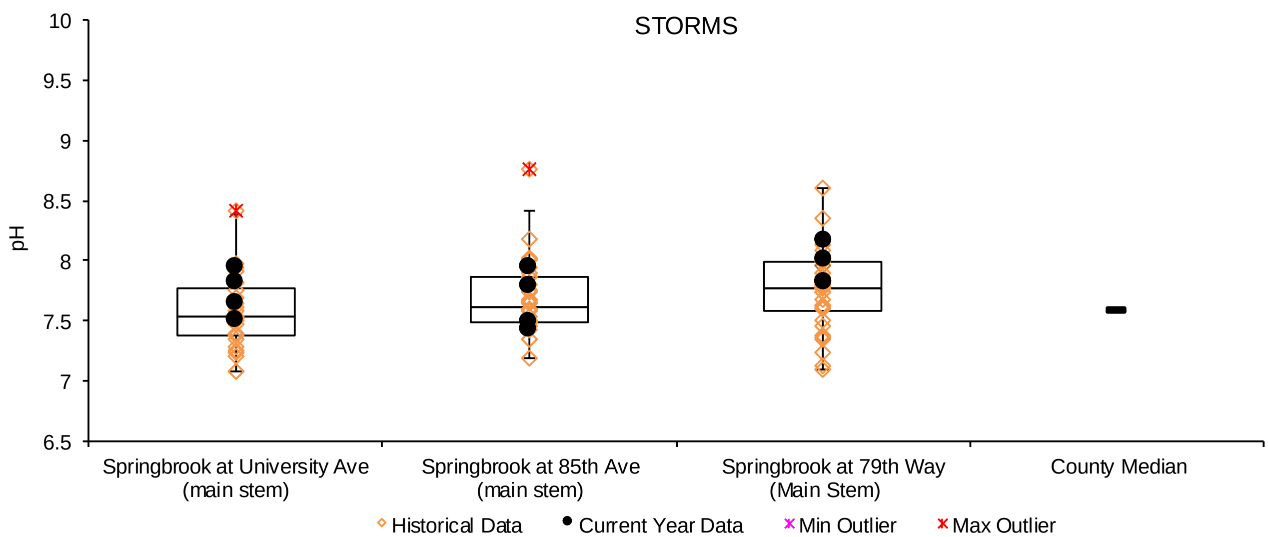
Average and median pH in Springbrook Creek. Data is from 79th Way for all years through 2019.

	Average pH	Median pH	State Standard	N
Baseflow	8.05	7.98	6.5-8.5	32
Storms	7.78	7.77		32
All	7.90	7.89		56
Occasions outside state standard				3*

one result questionable

pH at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).





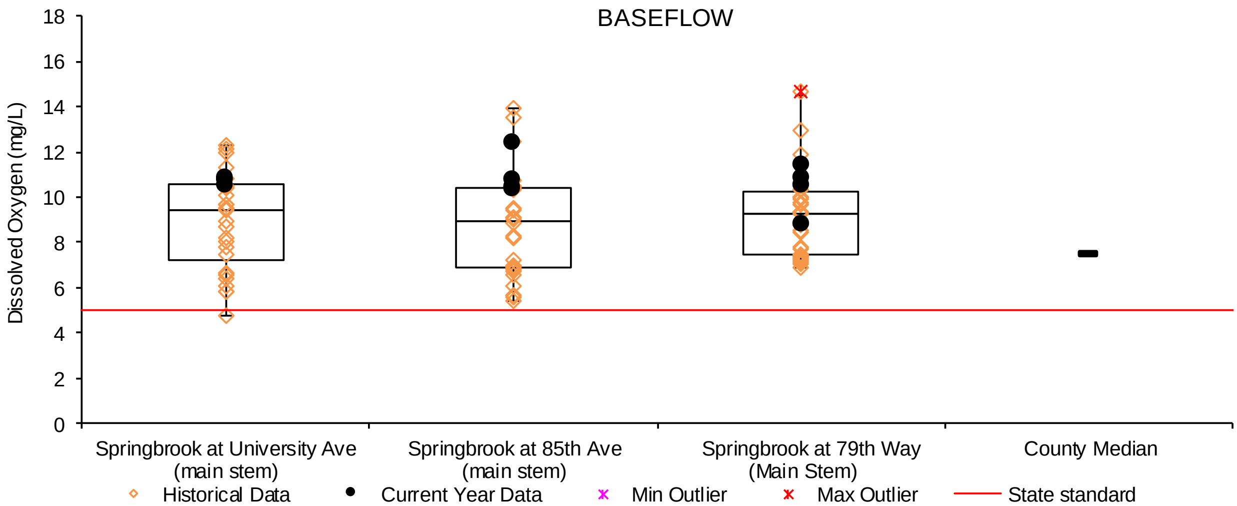
Dissolved Oxygen

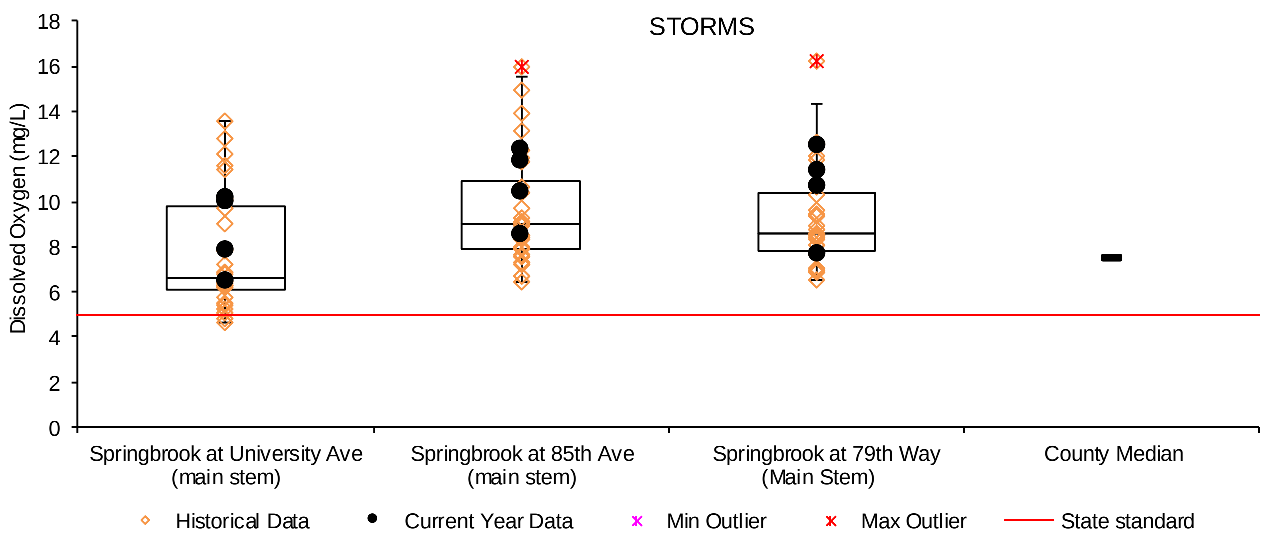
Dissolved Oxygen levels in Springbrook Creek are generally high and in a healthy range. There have been a few instances at the furthest upstream site (University Ave.) that have been below or near the standard, but in general low DO levels are not a concern in the Springbrook Creek system.

Median dissolved oxygen in Springbrook Creek. Data is from 79th Way for all years through 2019.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	9.22	9.28	5 mg/L daily minimum	30
Storms	9.23	8.55		32
All	9.28	8.77		62
Occasions <5 mg/L				0

Dissolved Oxygen at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2019 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

The chronic state water quality standard for *E. coli* in streams is based on a calculated geometric mean of not less than five samples in any given calendar month. This mean should not exceed 126 MPN. An additional standard of not more than 10% of all samples in a given month should not exceed 1260 MPN is also listed. Because we monitor streams throughout the year, only collecting eight samples total, we do not have sufficient numbers of samples for any given calendar month to calculate geometric means or percentage-based exceedances comparable to these standards

E. coli levels during baseflow conditions are usually near the chronic standard of 126 MPN at all of the Springbrook sites. Out of the 84 baseflow samples collected since 2013, *E. coli* has only once exceeded the acute standard of 1260 MPN (Springbrook at University Ave.). Interestingly, during baseflow conditions, median *E. coli* concentrations since 2013 decrease between University Ave. (157.5 MPN) and 85th Ave. (63.0). It seems that the ponds and wetlands located between the University Ave and 85th Ave sites are providing some level of treatment during baseflow conditions. However, *E. coli* concentrations tend to rebound again between the 85th Ave and 79th Way sites.

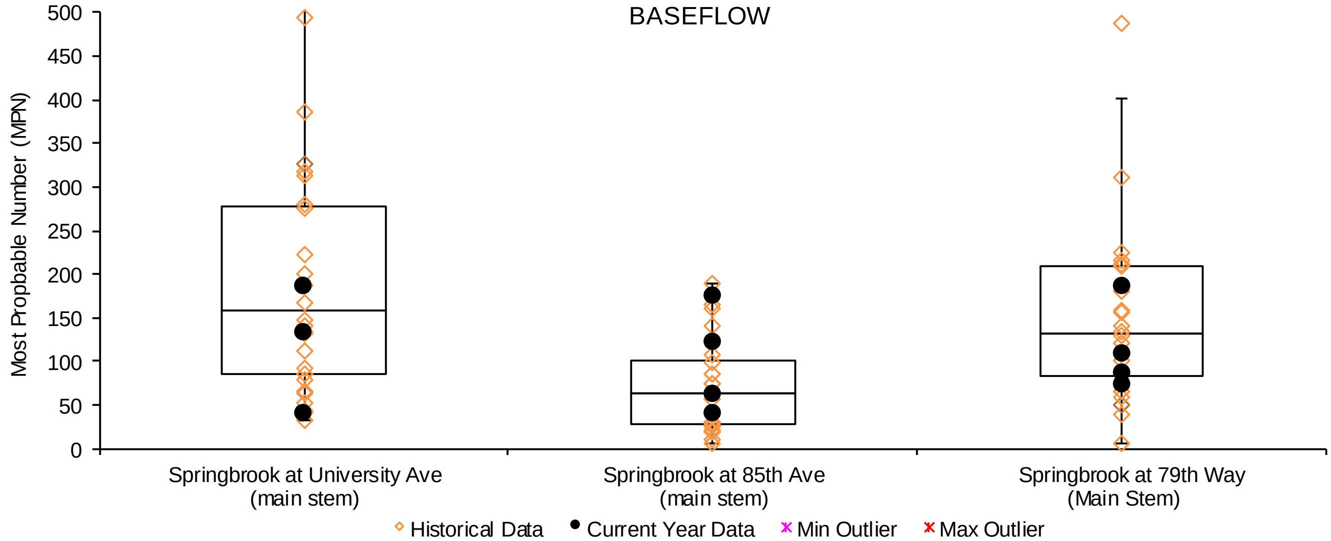
During storm events *E. coli* tends to be significantly higher (note the difference in scale on the charts below), but the same pattern remains between the sites with the middle site (85th Ave.) having lower levels than the upstream site (University Ave.). Median *E. coli* concentrations following storms for all years from upstream to downstream are 1,553, 648.8, and 1,046 MPN, respectively. These levels are all quite high, and 90% of post-storm samples collected at 79th Way have exceeded 126 MPN and nearly half of the samples collected at 79th way during following storms have exceeded the acute standard of 1260 MPN.

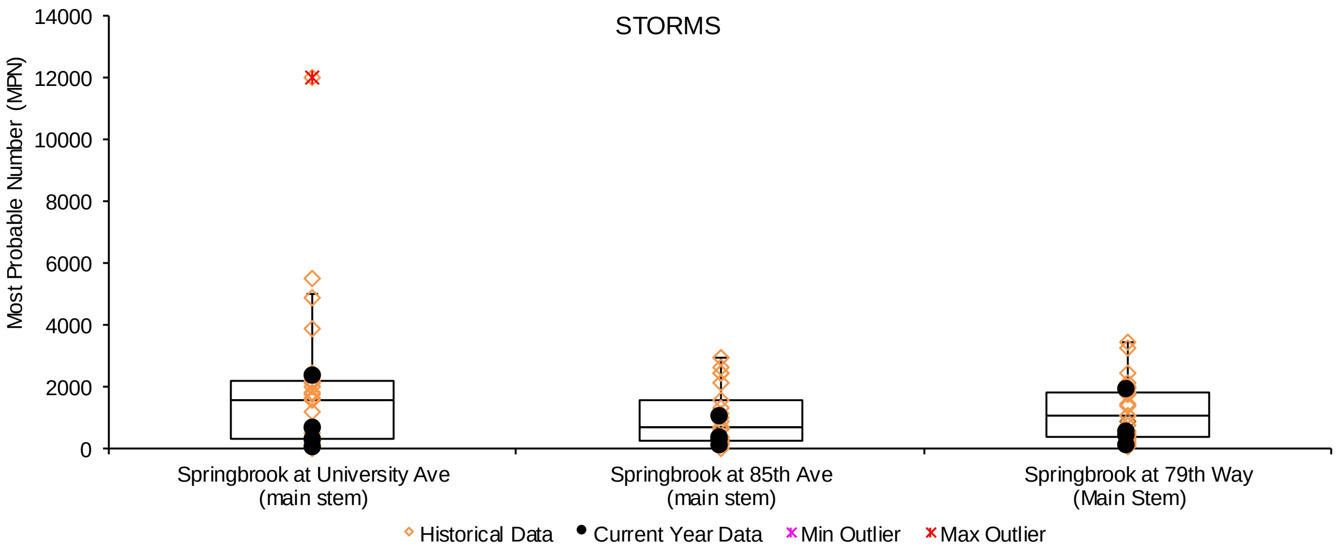
The *E. coli* LDC from the Coon Creek TMDL shows that *E. coli* exceeds acceptable levels often and at all flows.

Average and median *E. coli* in Springbrook Creek. Data is from 79th Way for all years through 2019

	Average *E. coli* (MPN)	Median *E. coli* (MPN)	State Standard	N
Baseflow	176.88	132.5	Monthly Geometric Mean >126 Monthly 10% average >1260	28
Storms	1,150.46	1,046.0		29
All	672.21	225.0		57
Occasions >126 MPN **Occasions >1260 MPN**				15 (54%) baseflow, 26 (90%) storm 0 baseflow, 12 (41%) storm

***E. coli* at Springbrook.** Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

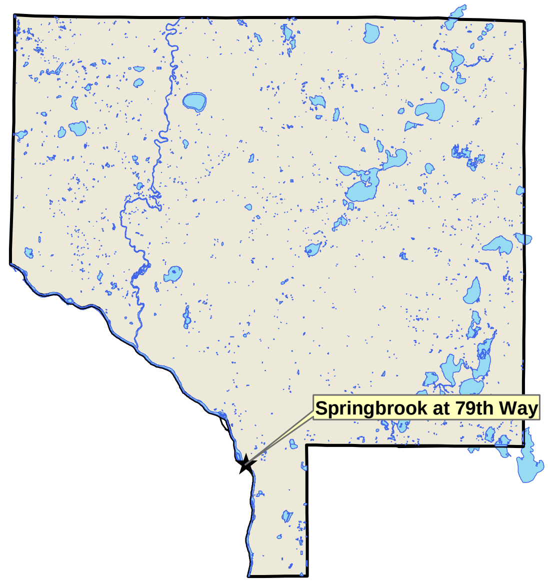




Stream Hydrology Monitoring – Springbrook Creek

SPRINGBROOK

at 79th Way, Fridley



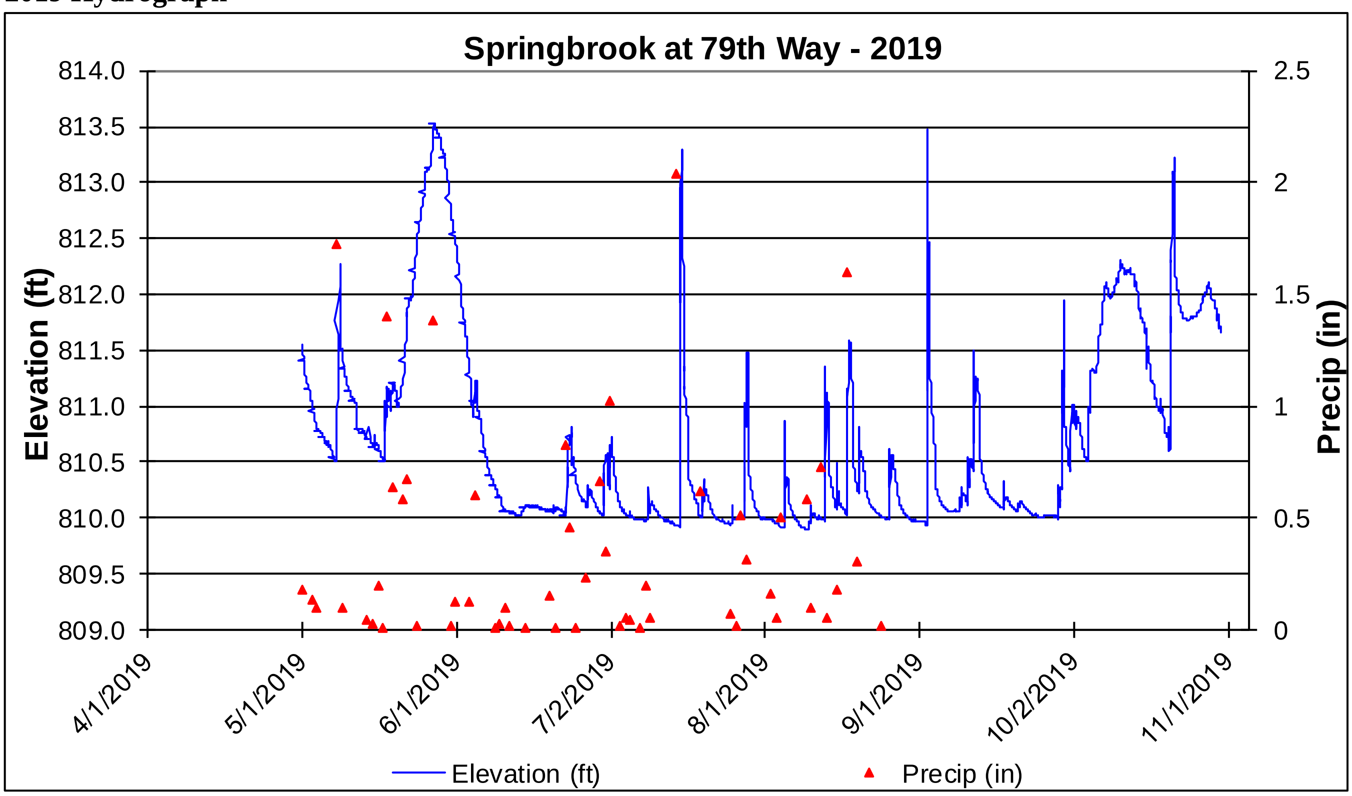
Notes:

The creek is flashy at this site, with water levels rising quickly during rainfall and receding quickly thereafter, despite a likely dampening effect of the Springbrook Nature Center wetland complex just upstream.

Throughout the 2019 season the creek stage fluctuated 3.64 ft. between its highest and lowest measured levels. One 2019 storm that occurred in early September caused stage to rise by 3.53 ft. between consecutive hourly readings. Stage then receded 2.35 ft. within the next hour. As was the case at Pleasure Creek, stage reading frequency was shortened to one hour instead of two for 2019, but based on the hydrograph, it looks like the reading interval of one hour was still too long to catch most of the storm surges. The reading interval should be shortened further in future monitoring seasons.

A rating curve was developed for this site in 2018, but frequent flooding at this site from debris and potential Mississippi backwater during very high stages decreases the usability of the rating curve at this site.

2019 Hydrograph



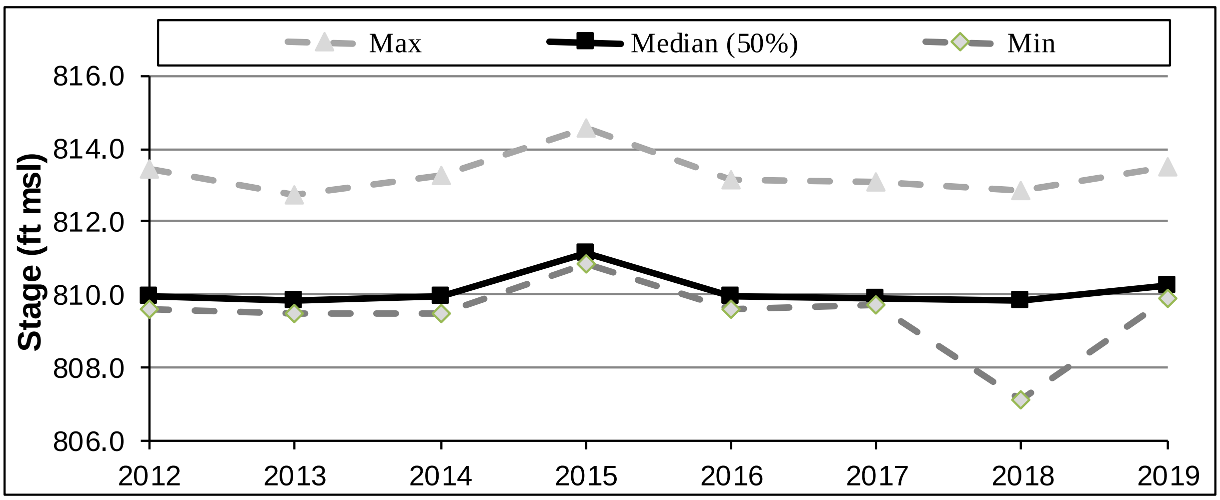
Stream Hydrology Monitoring

SPRINGBROOK

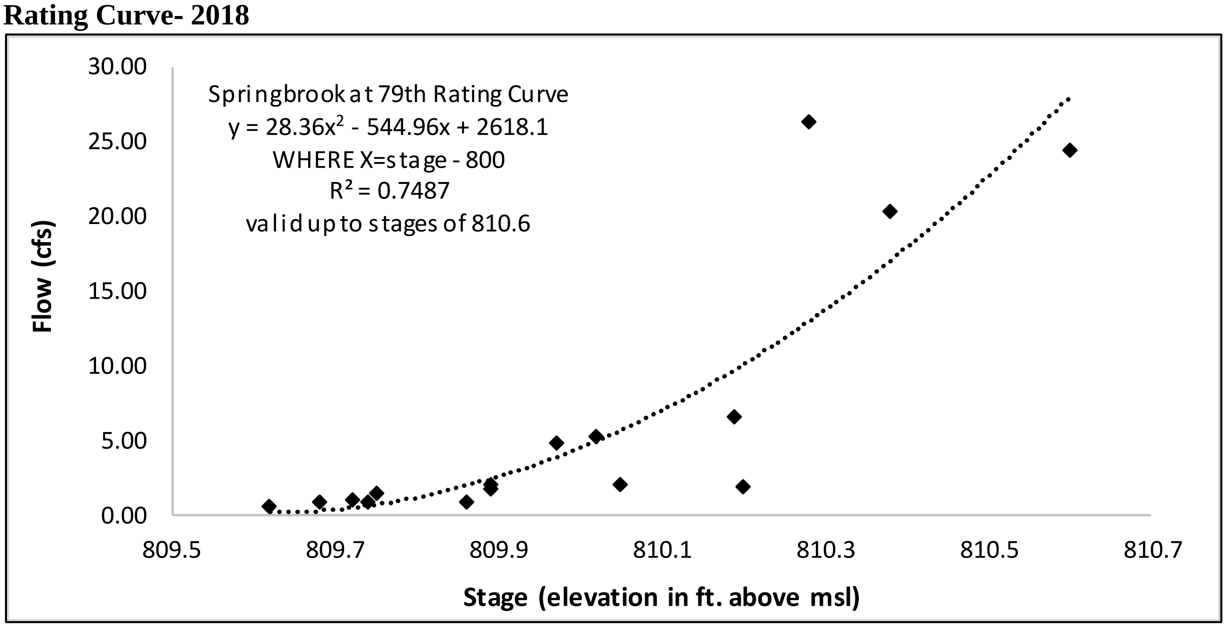
at 79th Way, Fridley

Summary of All Monitored Years

Percentiles	2012	2013	2014	2015	2016	2017	2018	2019
Min	809.62	809.47	809.46	810.85	809.59	809.6883	807.10	809.89
2.5%	809.65	809.54	809.63	810.91	809.67	809.7217	809.56	809.94
10.0%	809.69	809.60	809.66	810.96	809.74	809.78	809.59	809.99
25.0%	809.76	809.67	809.72	811.04	809.79	809.83	809.71	810.05
Median (50%)	809.97	809.84	809.93	811.13	809.93	809.9133	809.85	810.26
75.0%	810.29	810.08	811.62	811.30	810.13	810.0967	810.01	811.14
90.0%	811.24	810.71	812.99	811.73	810.50	810.41	810.27	812.04
97.5%	812.87	812.17	813.18	812.63	811.28	811.5063	810.65	813.10
Max	813.43	812.76	813.25	814.57	813.16	813.0717	812.85	813.53



Rating Curve- 2018



Water Quality Monitoring – Oak Glen Creek and Stonybrook Creek

Springbrook Creek (Ditch 17) Monitoring Sites		
Site Name/ SiteID	**Years Monitored**	**2019 Data Collected**
Oak Glen Creek at Logan Parkway S014-975	2017-2019	Water Chemistry Grab Samples, Continuous Stage
Stonybrook at Alden Way S014-964	2017-2019	Water Chemistry Grab Samples, Continuous Stage

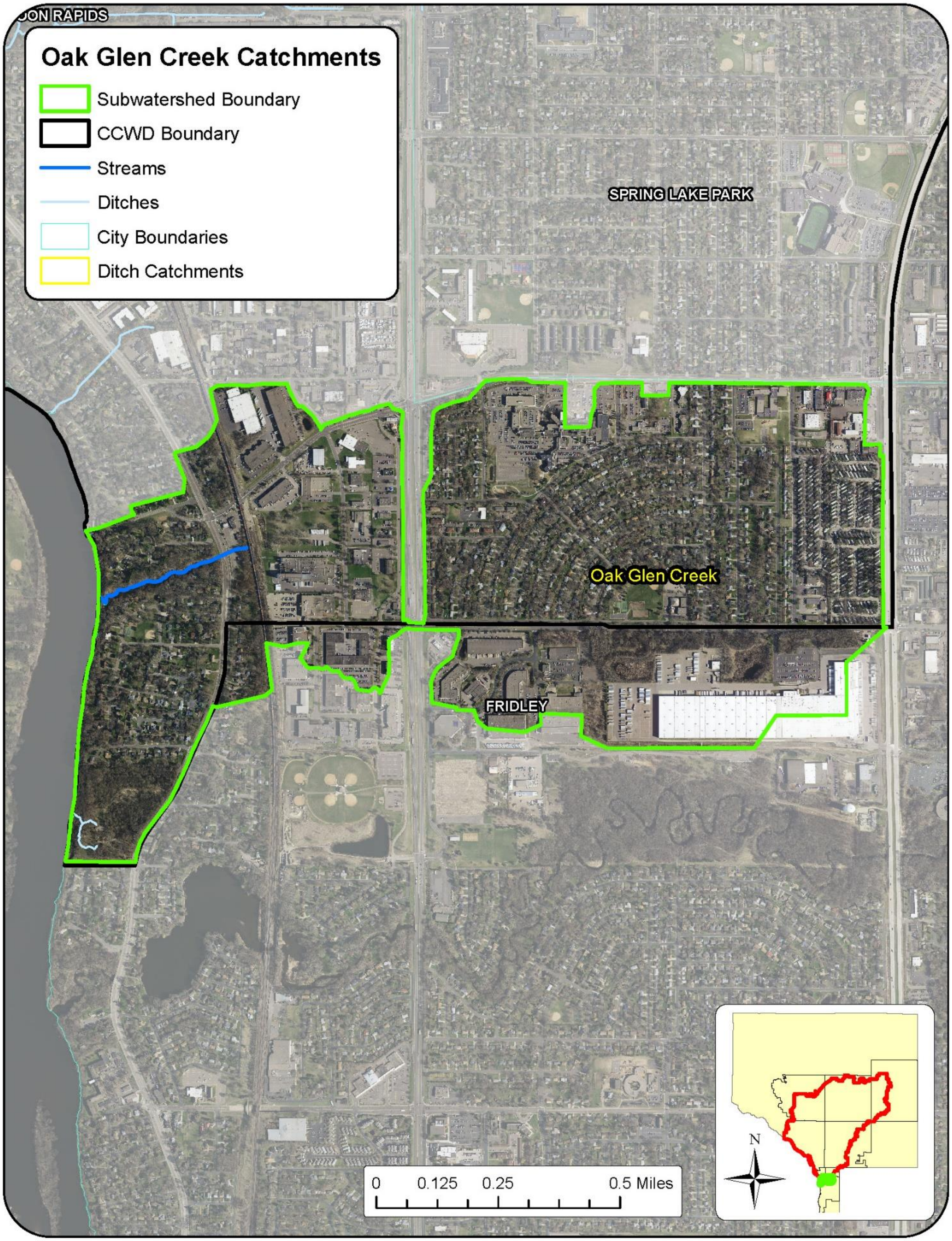
Background

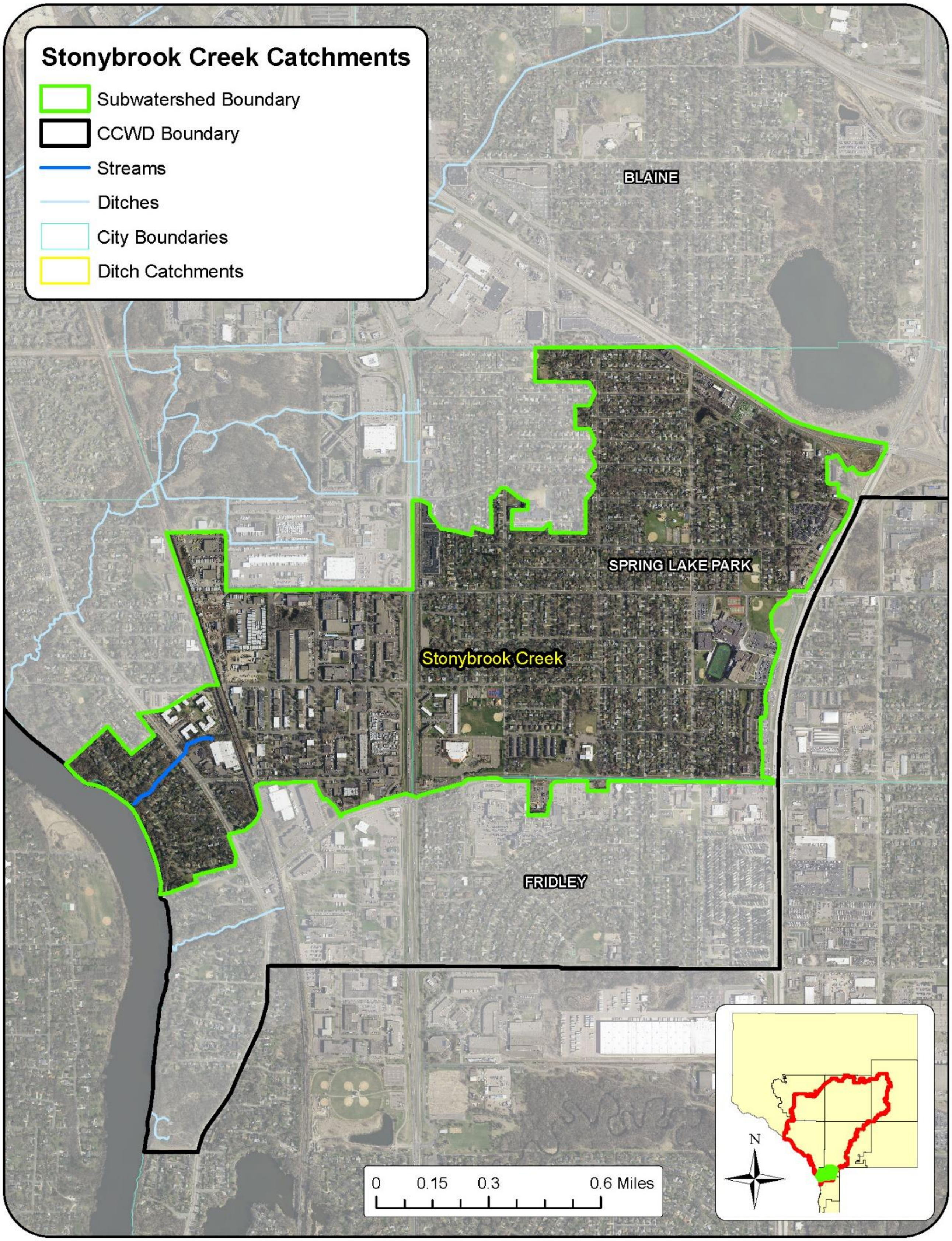
Oak Glen Creek and Stonybrook Creek are small waterways that drain their respective subwatersheds directly to the Mississippi River in Fridley. These creeks have very similar watershed and channel characteristics and are very close to each other geographically. They also have been monitored in tandem since 2017. Because of these factors the two creeks are presented together in this report, though they flow entirely independently of each other, and do not join at any point.

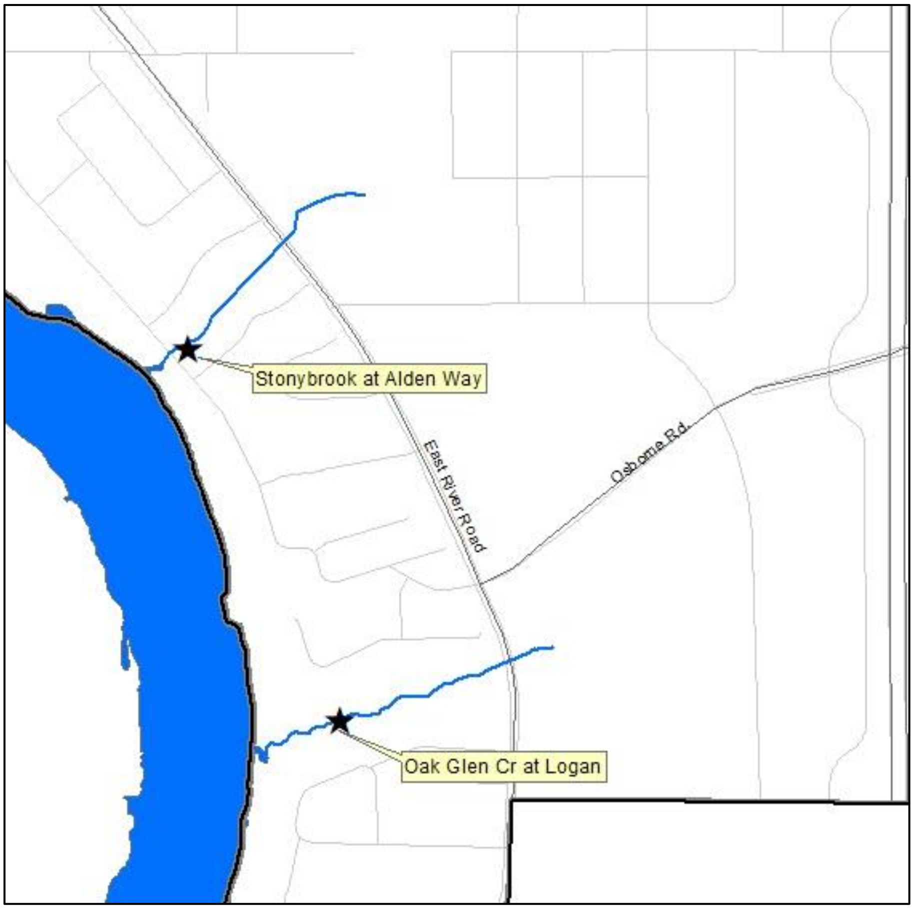
Oak Glen Creek is a small waterway that drains directly to the Mississippi River. The Oak Glen watershed is approximately 660 acres of mostly commercial development and dense residential land use in Fridley. The watershed boundaries are Highway 65 to the east, Osborne Road to the north, and 71st Avenue to the south. The majority of this subwatershed comprises of a network of storm sewer inlets and conveyances to the west of East River Road. This network daylights into a stormwater pond adjacent to the railroad tracks along the west side of East River Road. In 2017, this stormwater pond was expanded and had an iron enhanced sand filter added for additional water quality benefit.

The creek exists as an open channel for its final approximately 1,400 ft. between East River Road and the Mississippi River. The channel is deeply cut and narrow, descending about 40 ft. to the River. Due to the steep grade change and volume of stormwater received, this creek channel eroded a 40 foot deep gully adjacent to the 21 homes along this short stretch of creek, and deposited a large delta of sediment into the Mississippi River. In 2013 and 2014, the bottom of the V-shaped gully was widened and stabilized with riprap and rock check dams to prevent further down cutting and bank failure.

Stonybrook Creek is a small waterway that drains about 900 acres of mostly urbanized and industrial watershed in northern Fridley and western Spring Lake Park. The stream's contributing area starts about one mile east of the Mississippi River as a collection of storm sewer inlets and conveyances. The last 1/3 of the one-mile watershed is an open, deeply cut channel that descends 40 ft. to the Mississippi River. The sampling site is located about 250 ft. upstream of the confluence, just east of Alden Way in Fridley. The creek is only about 10 ft. wide and 6 in. deep during baseflow conditions at the sampling site. Due to the entire 900 acre watershed being rapidly piped to the small channel, rain events frequently cause the stage to rise over 3 feet in a matter of minutes in the lower creek channel. Write something about new stormwater bypass that went online in 2019 (or 2018?) diverting all the stormflow around our monitoring site by pipe beneath adjacent street..


Oak Glen Creek Catchments
Subwatershed Boundary
CCWD Boundary
Streams
Ditches
City Boundaries
Ditch Catchments
OON RAPIDS
SPRING LAKE PARK
Oak Glen Creek
FRIDLEY
N
0
0.125
0.25
0.5 Miles


Stonybrook Creek Catchments
Subwatershed Boundary
CCWD Boundary
Streams
Ditches
City Boundaries
Ditch Catchments
BLAINE
SPRING LAKE PARK
Stonybrook Creek
FRIDLEY
N
0
0.15
0.3
0.6 Miles



Results and Discussion

2019 was the third consecutive year these streams were monitored, and some major water quality concerns are evident. Dissolved pollutants as measured by specific conductance do not have a state water quality standard, but both of these streams are higher than any other stream ever monitored in Anoka County.

Chlorides were sampled in CCWD streams in 2019, with Oak Glen and Stonybrook Creek having higher concentrations than most streams in the watershed. The chronic state standard for chlorides is 230 mg/L which both sites exceeded throughout the year especially in Oak Glen Creek with the average concentration being 240.0 mg/L in 2019. Chlorides are a particularly problematic pollutant to aquatic life and in drinking water. Both Oak Glen Creek and Stonybrook flow into the Mississippi River and its water quality has implications for both.

For other parameters, these streams both have generally good water quality and low flow during baseflow conditions. However stage, total phosphorus, TSS, *E. coli,* and turbidity spike in very short order, and to occasionally very high levels, during even small storm events. The elevation of these creeks jumps two to three feet within minutes of rain events beginning, and water quality deteriorates immediately as well. ACD staff have noted Stonybrook running black in color while out sampling after storm events. Because of their flashiness, these creeks can be very difficult to monitor for true storm flows as well because they recede back to baseflow conditions so quickly after the rain stops falling.

Because the contributing drainage areas to these creeks is so small, and the systems are so flashy, the water quality in the channels is going to immediately reflect the water quality of the stormwater entering the storm drains upstream. Both creeks have had large channel stabilization projects completed in recent years to prevent bluff erosion of the deep cut channel banks. Additionally, the stormwater pond and IESF project installed in 2017 should start improving stormwater quality in Oak Glen Creek by providing storage and treatment of stormwater prior to it entering the final channel to the Mississippi River. Additional opportunities to intercept, store, and treat stormwater from the Stonybrook catchment before it dumps into its final channel should be explored to provide some treatment of the water flushing through this system as well.

Specific conductance and Chlorides

Specific conductance in Oak Glen Creek and Stonybrook Creek is higher than in any of the Anoka County streams monitored by ACD. Oak Glen Creek had slightly higher readings on average than Stonybrook but the median level for each creek well exceeds 1.0 mS/cm. While these median values are exceptionally high compared to other streams, some individual readings have been far greater than the medians. Though storms generally cause the specific conductance in these creeks to drop, the highest reading recorded in 2019 at Oak Glen Creek (3.05 mS/cm) and Stonybrook Creek (2.54 mS/cm) each occured during a storm event on April 17th. This may be evidence of short-term flushes of very high pollutant loads causing large spikes in specific conductance to these creeks during storms. These types of flushes may warrant further investigation.

Despite the very high readings during one particular storm, these creeks generally have lower specific conductance during storms than during baseflow conditions. This indicates that large quantities of dissolved pollutants are entering these streams through the surficial shallow groundwater that feeds baseflow. Storm events then dilute the creek lowering the conductance for a short period of time. There is not currently a state standard for specific conductance in streams, but these values are indicative of high levels of dissolved pollutants entering these creeks.

Chloride concentrations are high in these creeks as well. In Oak Glen Creek, concentrations from six of 12 samples in 2019 exceeded the chronic state standard of 230 mg/L, resulting in an average and median concentration exceeding that value as well. Stonybrook only exceeded this concentration on one sampling occasion, but on that occasion the concentration of chlorides was 622 mg/L, this reading was recorded during one of the first intense storm events of the year when the highest chloride levels would be seen due to road de-icing over the winter.

Both of these streams' watersheds are small and highly 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 baseflow in local streams. These types of pollutants are difficult to remove once they enter the environment and they do not break down over time.

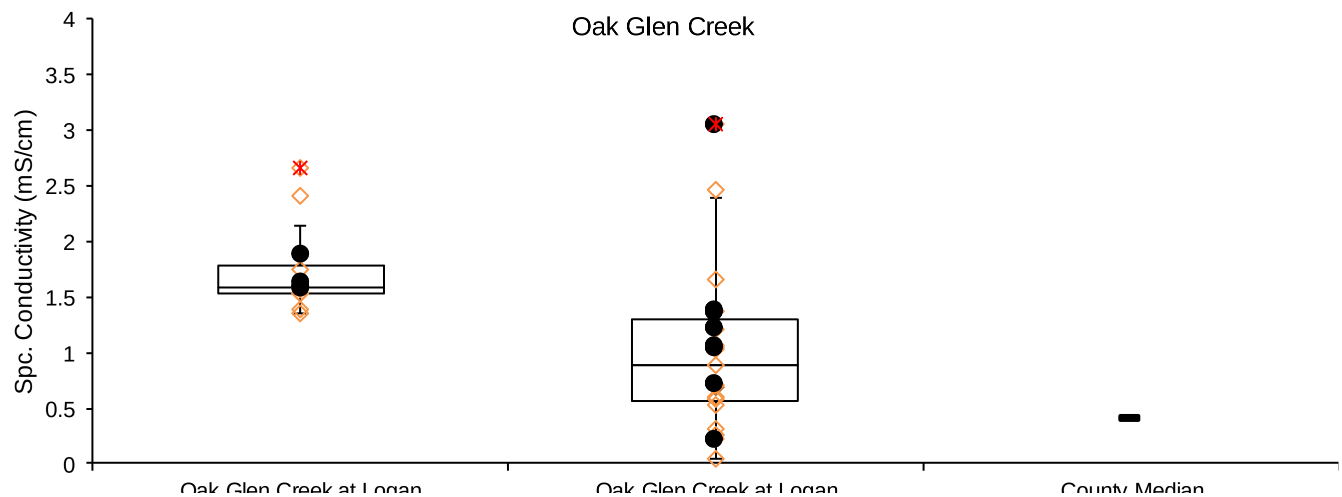
Dissolved pollutants are especially difficult to manage as they are not removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also then runs the risk of contaminating groundwater. The first approach to dissolved pollutant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

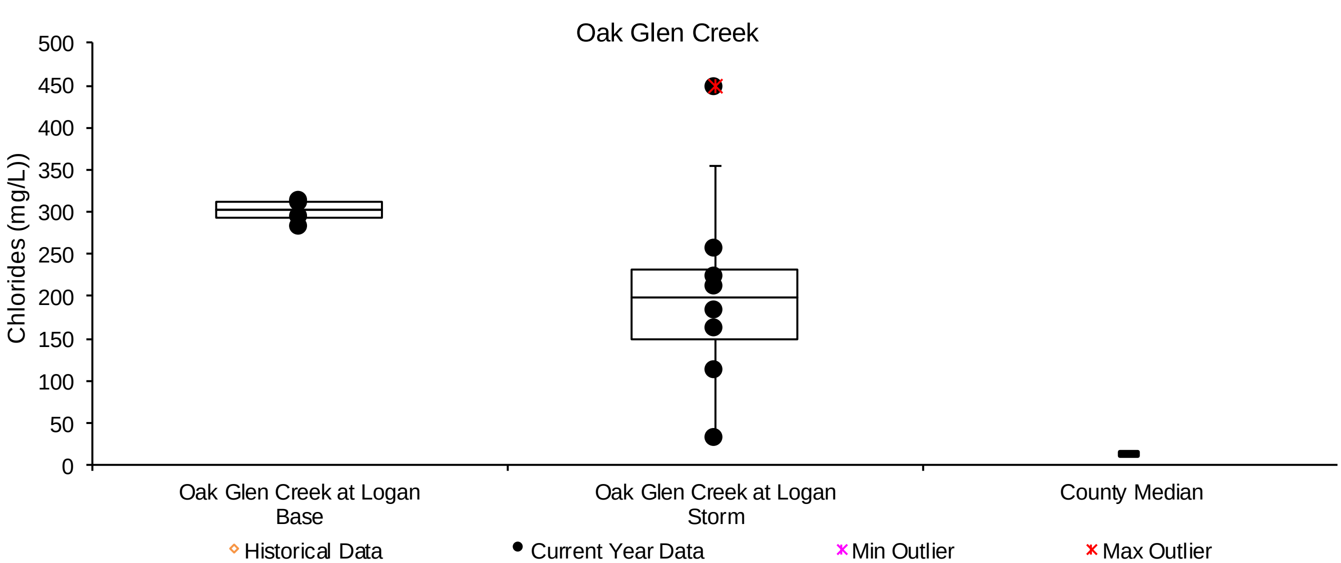
Average and median specific conductance and Chlorides in Oak Glen Creek. All data collected 2017-2019.

	Average specific conductance (mS/cm)	Median specific conductance (mS/cm)	Median Chlorides (mg/L)	State Standard	N
Baseflow	1.744	1.595	302.50	Specific conductance – none Chlorides 860 mg/L acute, 230 mg/L chronic	13
Storms	1.004	0.884	197.50		19
All	1.290	1.371	240.00		32
Occasions > state standard					4 (100%) baseflow 2 (25%) storm

***** outlier sample of 16.2 mS/cm in August, 2018 not included in analysis

Specific conductance/Chlorides at Oak Glen Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).

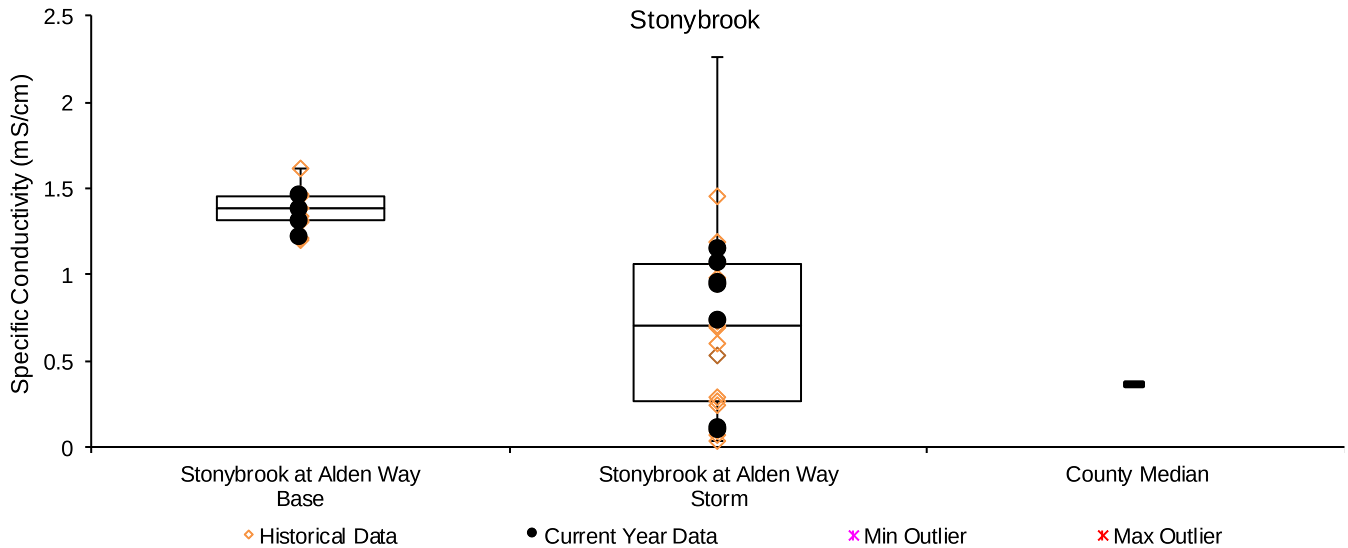


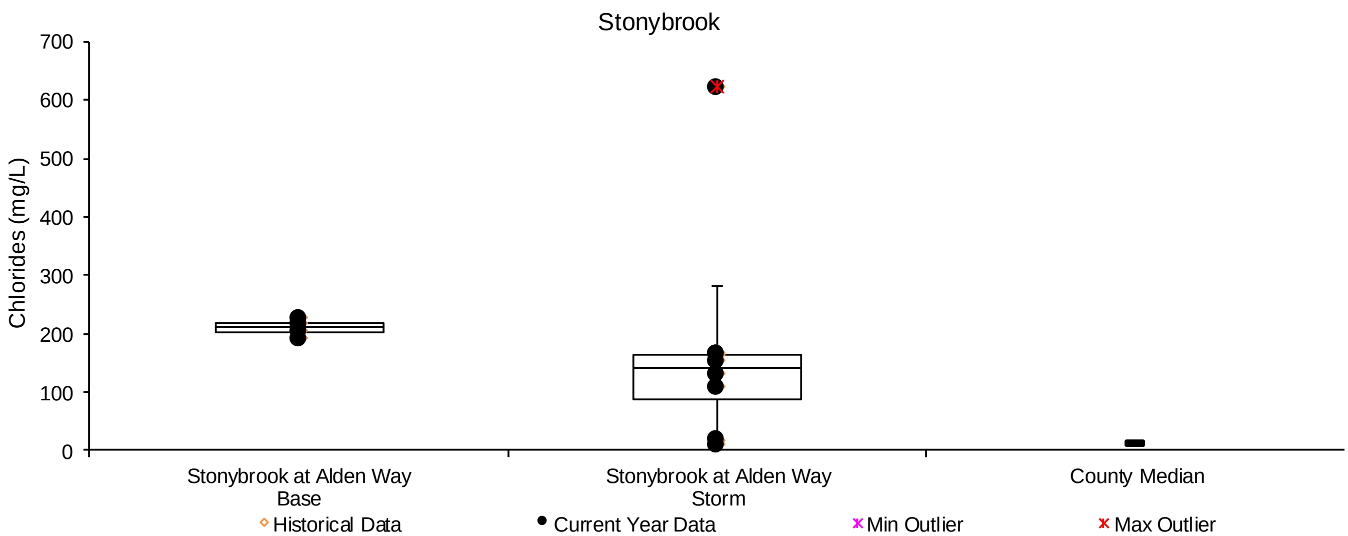


Average and median specific conductance in Stonybrook. All data collected 2017-2019.

	Average specific conductance (mS/cm)	Median specific conductance (mS/cm)	Median Chlorides (mg/L)	State Standard	N
Baseflow	1.375	1.385	210.50	Specific conductance – none	13
Storms	0.753	0.705	142.50		21
All	0.990	1.168	165.00	Chlorides 860 mg/L acute, 230 mg/L chronic	34
Occasions > state standard					0 baseflow 1 (12%) storm

Specific conductance/Chlorides at Stonybrook. Orange diamonds are historical data from previous years and black circles are 2019 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

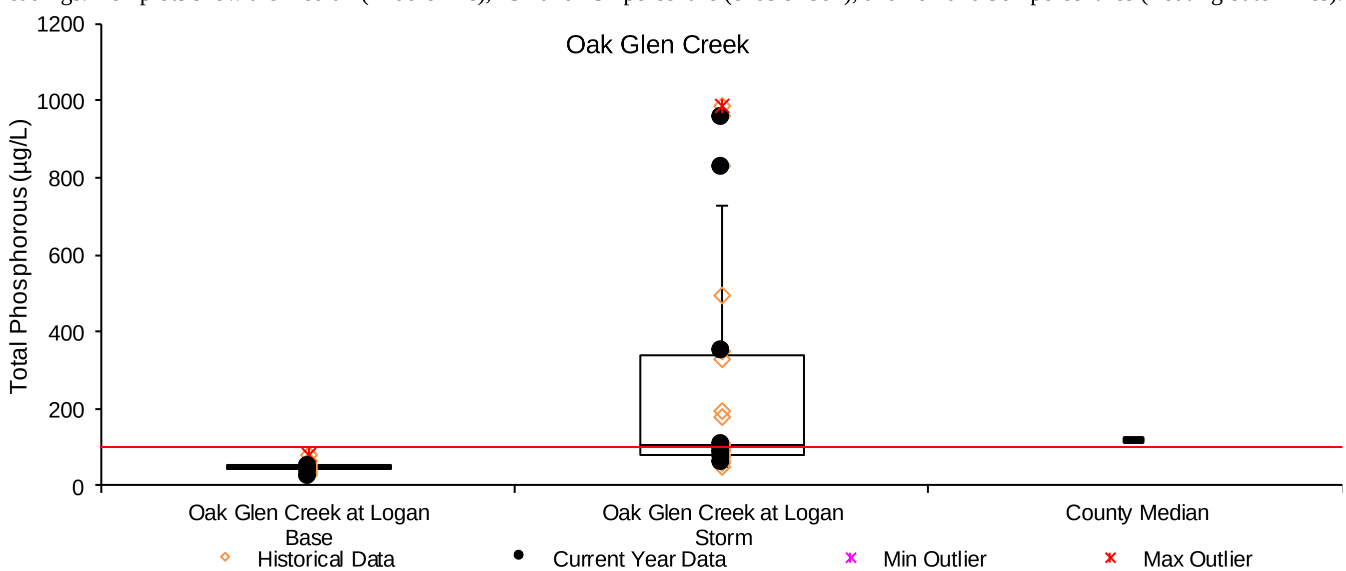
While median values for phosphorus in Oak Glen Creek are relatively low compared to the state standard, post-storm samples exceeded 100 µg/L in four out of eight samples collected in 2019. This stream was subject to special timed storm sampling with the goal of capturing the true flush of the system. It is clear that large amounts of phosphorus are quickly flushed through this system during storm events, though the median TP concentration for post-storm sampling was 104 µg/L, just slightly above the state standard.

Stonybrook also has high phosphorus concentrations during storm events. Similar to Oak Glen Creek, specially timed storm sample trips to capture the initial storm pulse found total phosphorus in exceedance of the state standard in six of eight samples taken in 2019. Phosphorus concentrations during baseflow conditions were low, with median and average values well below the standard. This stream is also very flashy, and storm events result and intense spikes to the stage, volume, and pollutant concentration. In both of these streams, capturing the sediment and nutrients on the landscape before they enter the system and into the Mississippi during storm flows should be a focus of management.

Average and median total phosphorus in Oak Glen Creek. All data collected 2017-2019.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	47.07	43.0	100 Phosphorus (µg/L)	13
Storms	274.21	108.0		19
All	181.93	75.00		32
Occasions > state standard				0 baseflow 10 (53%) storms

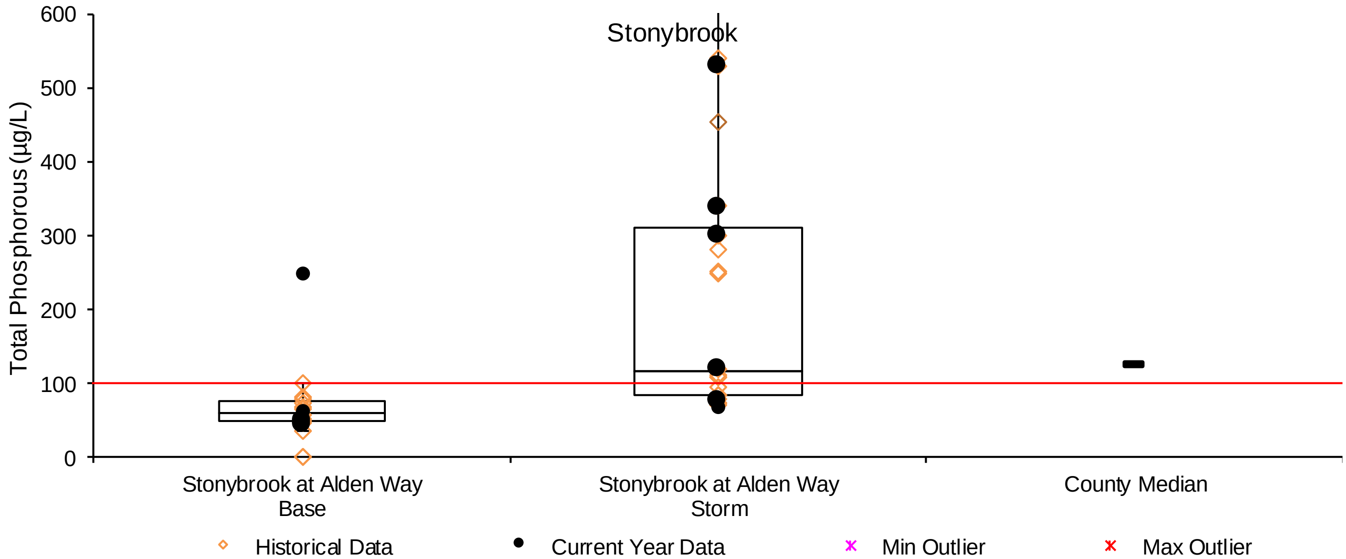
Total phosphorus at Oak Glen Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median total phosphorus in Stonybrook. All data collected 2017-2019.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	62.75	60.0	100	12
Storms	230.15	115.0		20
All	167.37	83.5		32
Occasions > state standard				0 baseflow 13 (65%) storms

Total phosphorus at Stonybrook. Orange diamonds are historical data from previous years and black circles are 2019 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

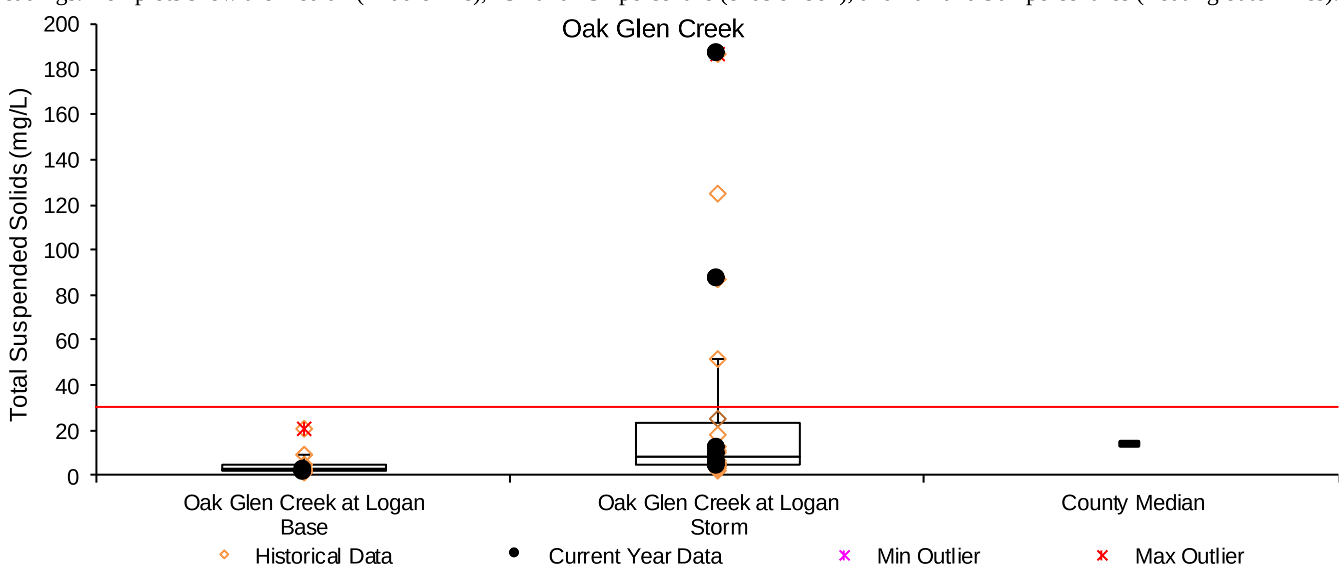
Oak Glen Creek has relatively low TSS and turbidity levels during baseflow conditions, never exceeding the TSS state standard of 30 mg/L. However during two storm events in 2019, Oak Glen Creek had concentrations exceeding 30 mg/L, with one event in May having more than six times that concentration at 187.0 mg/L. Turbidity levels are elevated in storm samples as well. During special storm sampling, one turbidity reading of 173.0 NTU was recorded. Storm surges flush through these systems at such a fast rate that it is difficult to collect samples at the perfect moment even when standing in the creek during the storm.

Similarly, Stonybrook has low TSS and turbidity levels during baseflow conditions, both of which sharply increase during storms. Stonybrook exceeded the 30 mg/L state standard for TSS in three of the eight storm samples collected in 2019. Three turbidity readings exceeded 100 NTU during 2019 storms, but YSI continuous data from past years indicates that turbidity gets much higher at this site. Similar to Oak Glen Creek, it is difficult to time sampling to effectively capture the flush through the system. ACD staff have witnessed Stonybrook water appearing as an opaque black color after even small rain events.

Average and median total suspended solids in Oak Glen Creek. All data collected 2017-2019.

	Average Total Suspended Solids (mg/L)	Median Total Suspended Solids (mg/L)	State Standard	N
Baseflow	4.86	2.2	30 mg/L	13
Storms	31.52	8.2		18
All	20.34	4.9		31
Occasions > state TSS standard				0 baseflow 4 (22%) storms

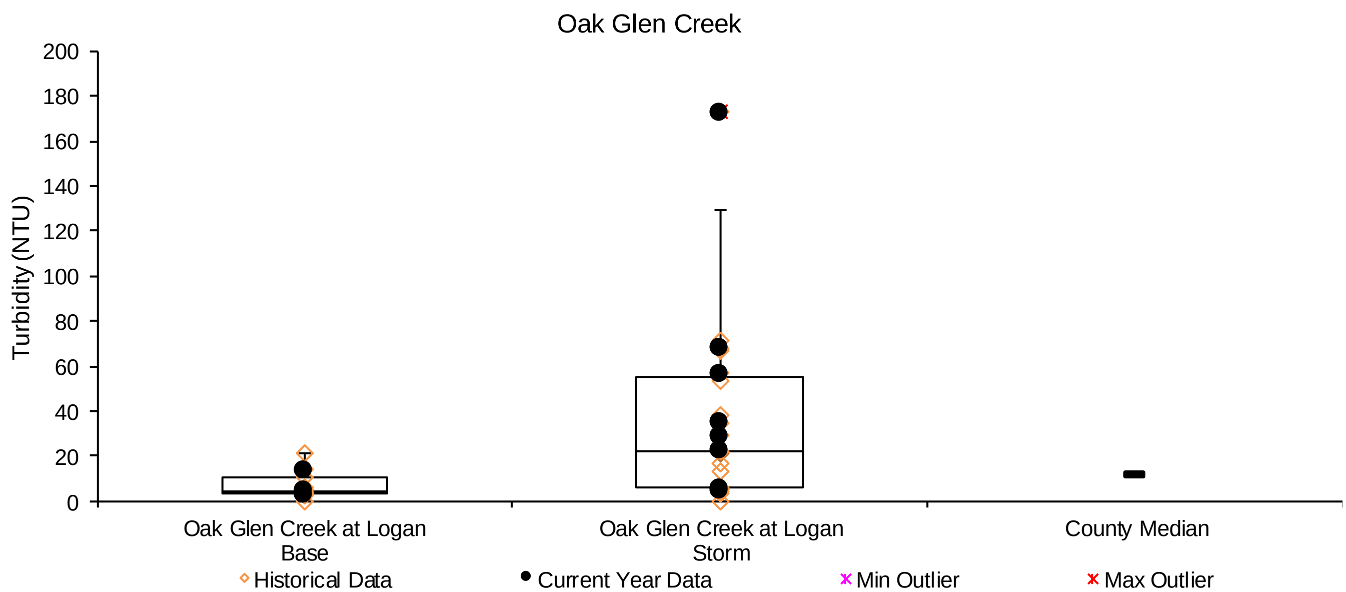
Total suspended solids at Oak Glen Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median turbidity in Oak Glen Creek. All data collected 2017-2019.

	Average Turbidity (NTU)	Median Turbidity (NTU)	State Standard	N
Baseflow	6.94	4.3	n/a	13
Storms	36.16	22.10		19
All	24.29	12.05		32

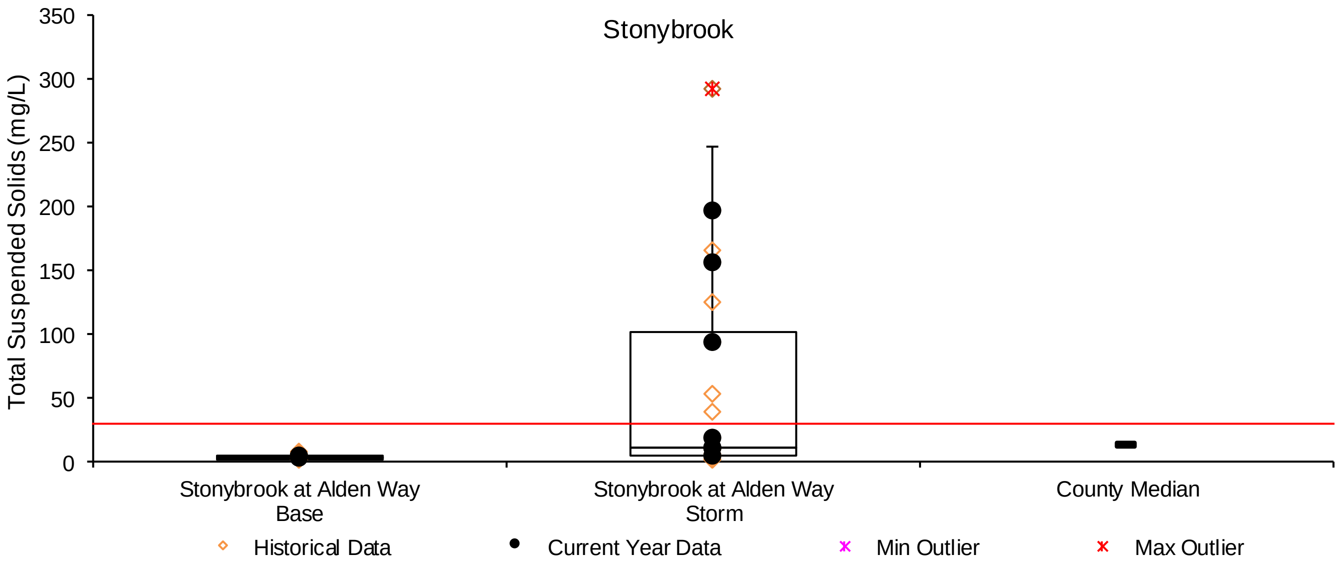
Turbidity at Oak Glen Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median total suspended solids in Stonybrook. All data collected 2017-2019.

	Average Total Suspended Solids (mg/L)	Median Total Suspended Solids (mg/L)	State Standard	N
Baseflow	3.85	3.2	30 mg/L TSS	12
Storms	60.27	11.0		20
All	39.11	6.15		32
Occasions > state TSS standard				0 baseflow 8 (40%) storms

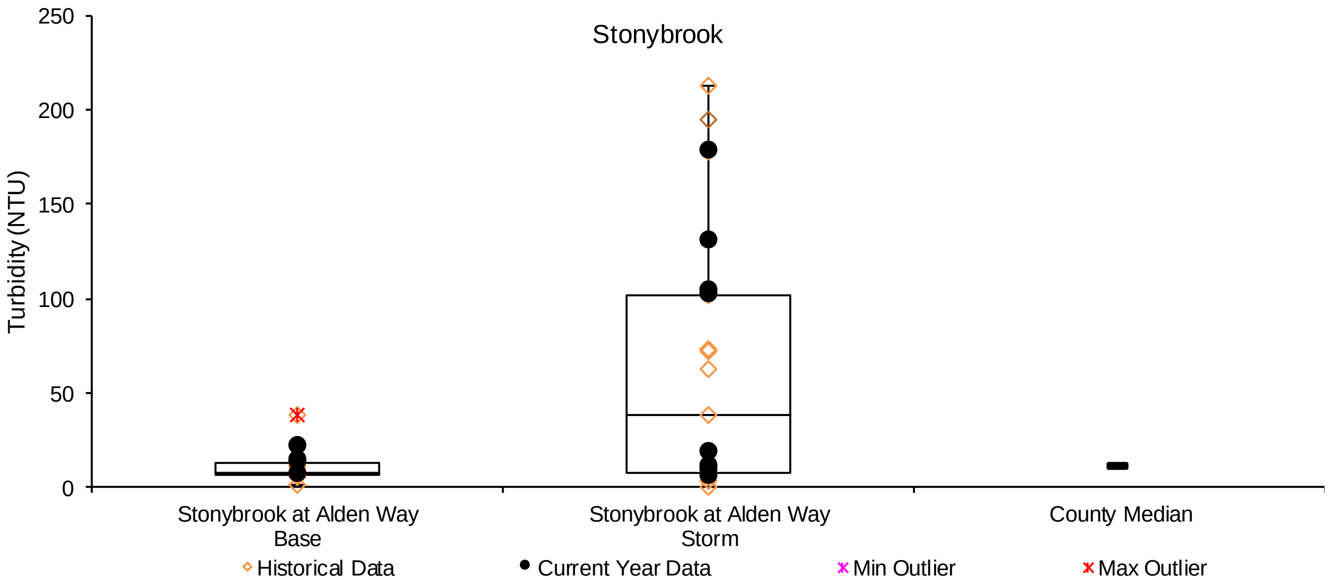
Total suspended solids at Stonybrook. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median turbidity in Stonybrook. All data collected 2017-2019.

	Average Turbidity (NTU)	Median Turbidity (NTU)	State Standard	N
Baseflow	11.42	7.1	n/a	13
Storms	63.13	38.00		21
All	43.36	12.45		34

Turbidity at Stonybrook. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



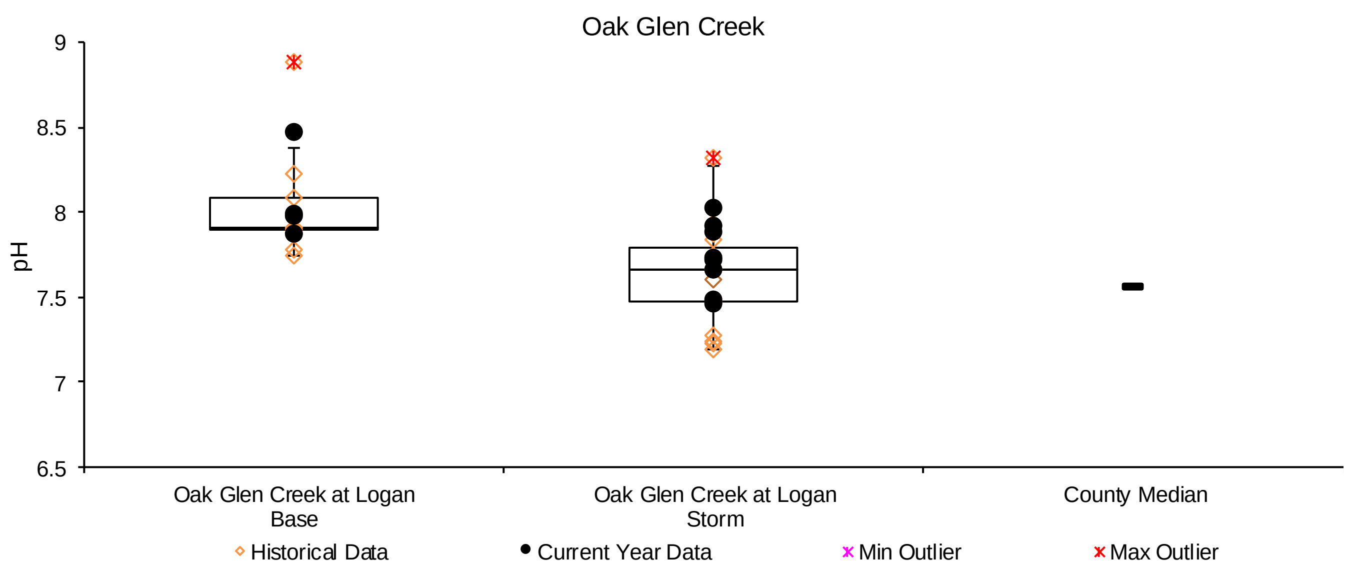
pH

pH is generally stable and within the healthy range for both Oak Glen Creek and Stonybrook. These sites both showed a similar decline in pH during storm flows due to the slight acidity of rainfall compared to ambient water. Both streams stayed within the range of 6.5 and 8.5.

Average and median pH in Oak Glen Creek. All data collected 2017-2019.

	Average pH	Median pH	State Standard	N (each site)
Baseflow	8.04	7.91	6.5-8.5	13
Storms	7.64	7.66		19
All	7.80	7.81		32
Occasions outside state standard				1 (8%) baseflow 0 storms

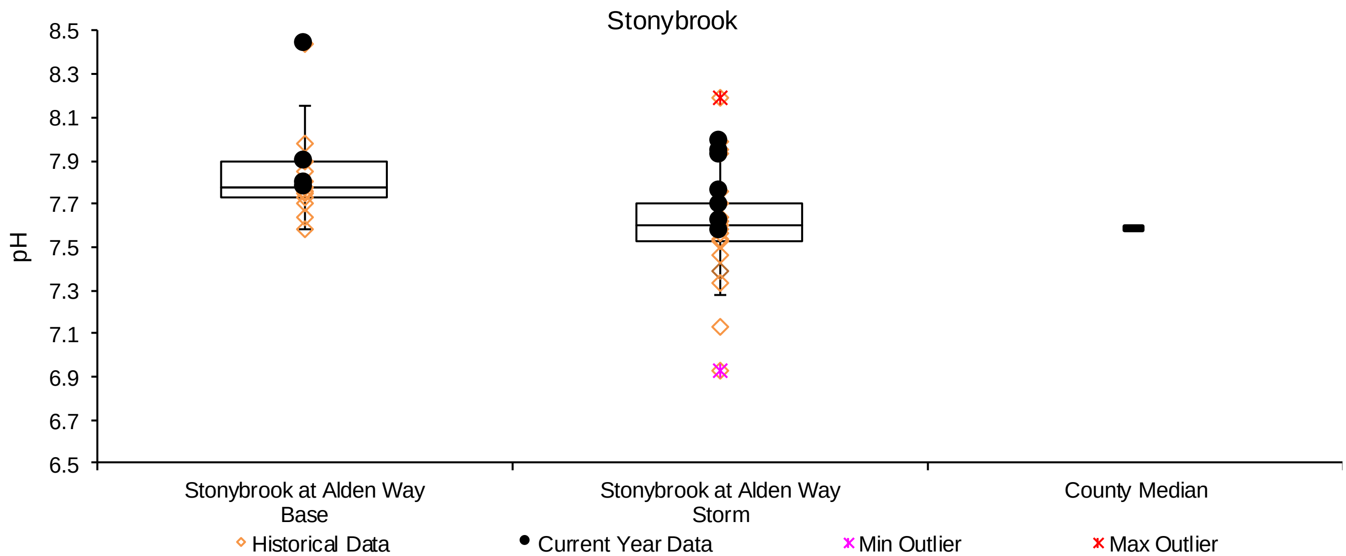
pH at Oak Glen Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median pH in Stonybrook. All data collected 2017-2019.

	Average pH	Median pH	State Standard	N (each site)
Baseflow	7.89	7.78	6.5-8.5	13
Storms	7.60	7.60		21
All	7.17	7.67		34
Occasions outside state standard				0

pH at Stonybrook. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



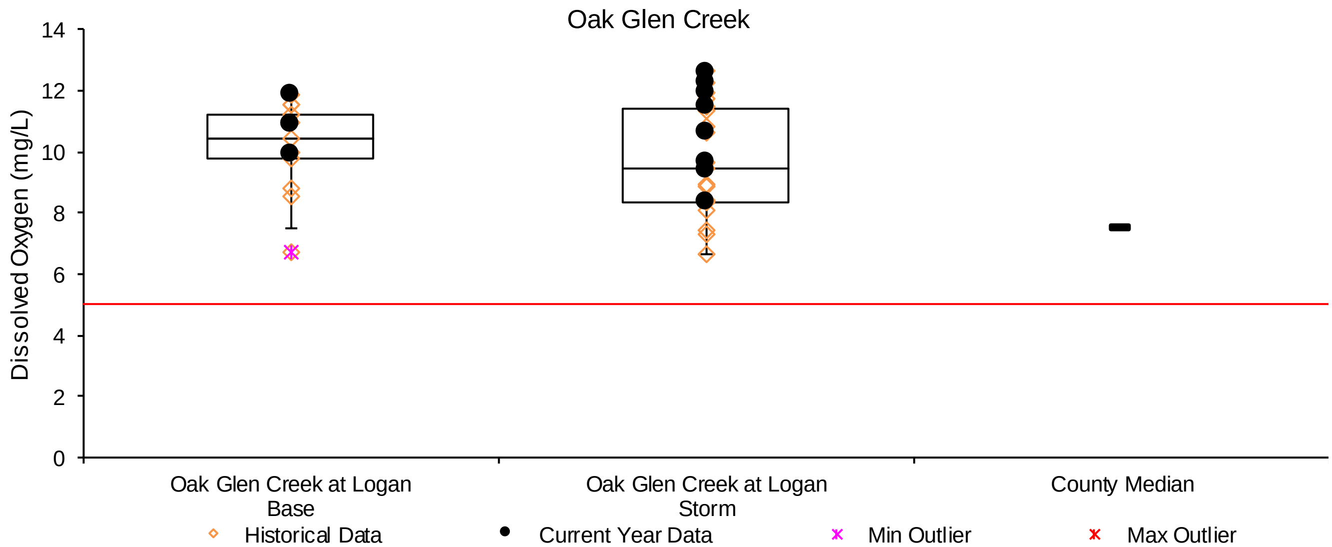
Dissolved Oxygen

Sampling in 2019 showed dissolved oxygen (DO) levels to be healthy and stable in both Oak Glen and Stonybrook. During sample collection, neither Oak Glen nor Stonybrook approached the state standard of a <5 mg/L daily minimum, and both had median values approximately double that level. These streams have quite turbulent flow as they traverse down steep gullies past the monitoring sites and remain well aerated.

Average and median dissolved oxygen in Oak Glen Creek. All data collected 2017-2019.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N (each site)
Baseflow	10.18	10.42	5 mg/L daily minimum	13
Storms	9.71	9.44		19
All	9.90	9.96		32
Occasions <5 mg/L				0

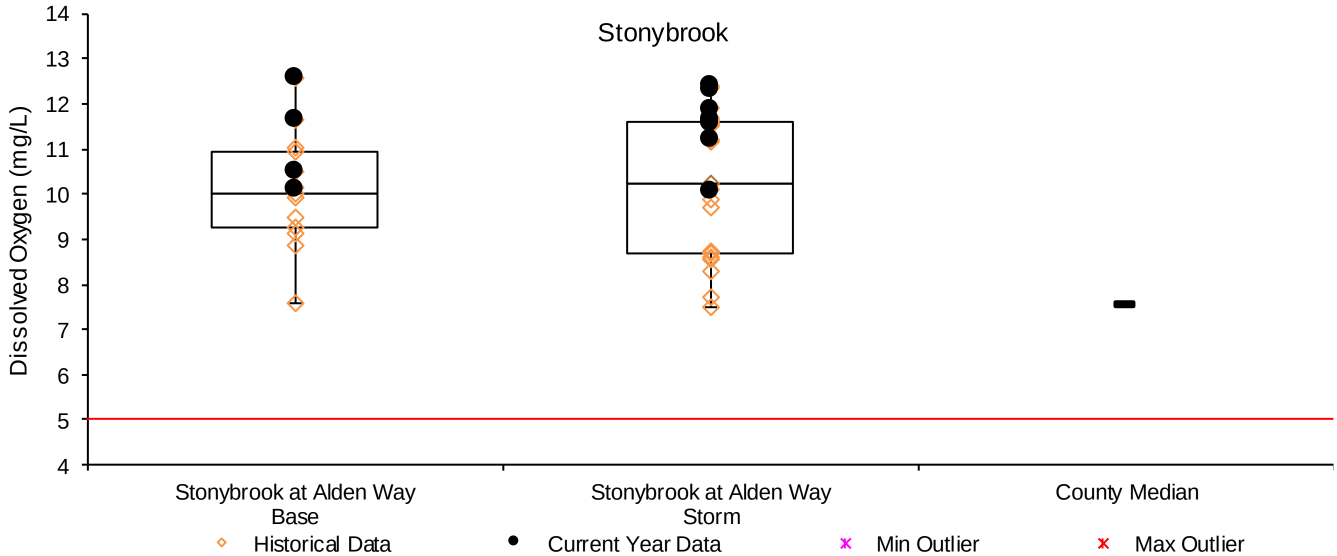
Dissolved Oxygen at Oak Glen Creek. Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median dissolved oxygen in Stonybrook. All data collected 2017-2019.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N (each site)
Baseflow	10.08	10	5 mg/L daily minimum	13
Storms	10.24	10.24		21
All	10.18	10.11		34
Occasions <5 mg/L				0

Dissolved Oxygen at Stonybrook. Orange diamonds are historical data from previous years and black circles are 2019 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

The chronic state water quality standard for *E. coli* in streams is based on a calculated geometric mean of not less than five samples in any given calendar month. This mean should not exceed 126 MPN. An additional standard of not more than 10% of all samples in a given month should not exceed 1260 MPN is also listed. Because we monitor streams throughout the year, only collecting eight samples total, we do not have sufficient numbers of samples for any given calendar month to calculate geometric means or percentage-based exceedances comparable to these standards.

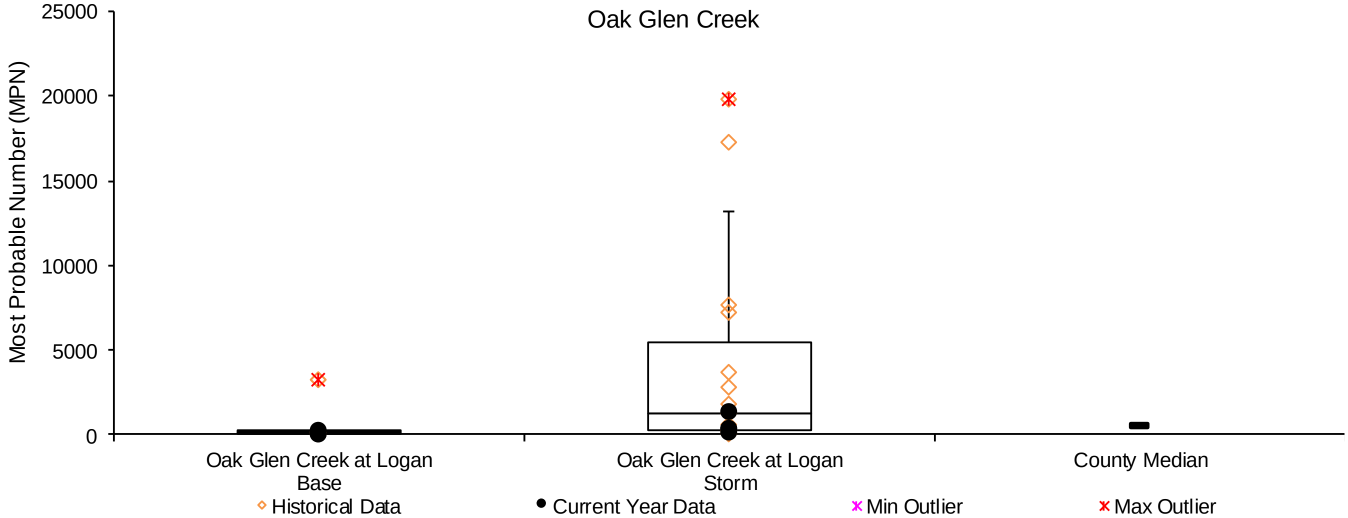
Three years of sampling of these streams (2017-2019) indicates that *E. coli* may be an issue in Oak Glen Creek. Oak Glen Creek exceeded the chronic standard of 126 MPN in six of eight samples collected in 2019. Additionally, eight of fifteen post-storm samples taken since 2017, exceeded 1,260 MPN, the acute standard. Based on these results, it is very likely that Oak Glen Creek could be impaired for *E. coli* if sampled frequently enough to compare to water quality state standards.

Stonybrook Creek *E. coli* levels are equally concerning. Three out of the four baseflow samples, and all four post-storm samples taken in 2019, exceeded the chronic 126 MPN standard, and all but one post-storm sample exceeded 1,260 MPN. One storm sample taken in late July exceeded 10,000 MPN. Median and average *E. coli* concentrations during both baseflow and storm conditions exceed the chronic and acute state standards. It is likely that Stonybrook Creek would also be impaired for *E. coli* if sampled frequently enough for evaluation against state standards.

Average and median *E. coli* in Oak Glen Creek. All data collected 2017-2019.

	Average *E. coli* (MPN)	**Median *E. coli* (MPN)**	**State Standard (MPN)**	**N**
Baseflow	633.41	143.0	Monthly Geometric Mean >126	12
Storms	4,253.26	1,314		15
All	2,644.44	279		27
Occasions >126 MPN			Monthly 10% average >1260	7 (58%) baseflow 13 (87%) storms
Occasions >1260 MPN				2 (17%) baseflow 8 (53%) storms

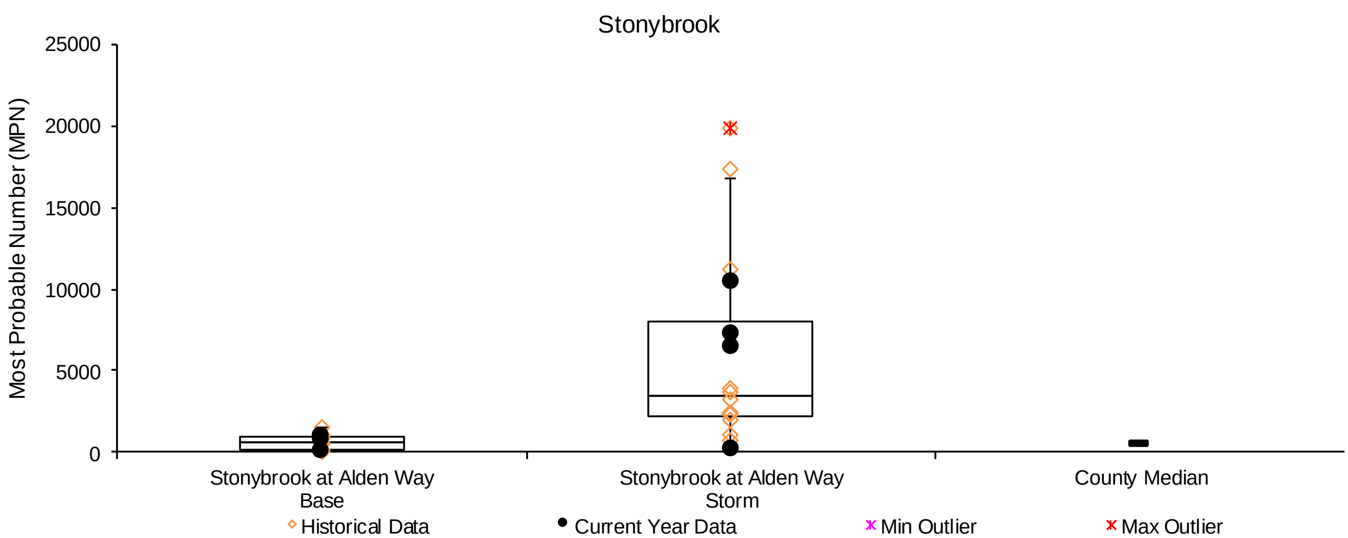
***E. coli* at Oak Glen Creek.** Orange diamonds are historical data from previous years and black circles are 2019 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Average and median *E. coli* in Stonybrook. All data collected 2017-2019.

	Average *E. coli* (MPN)	Median *E. coli* (MPN)	State Standard (MPN)	N
Baseflow	593.83	568.50	Monthly Geometric Mean >126	12
Storms	5,905	3,454.5		16
All	3,629.78	1,310	Monthly 10% average >1260	28
Occasions >126 MPN				9 (75%) baseflow 16 (100%) storms
Occasions >1260 MPN				1 (8%) baseflow 13 (81%) storms

***E. coli* at Stonybrook.** Orange diamonds are historical data from previous years and black circles are 2018 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).



Stream Hydrology Monitoring – Stonybrook Creek

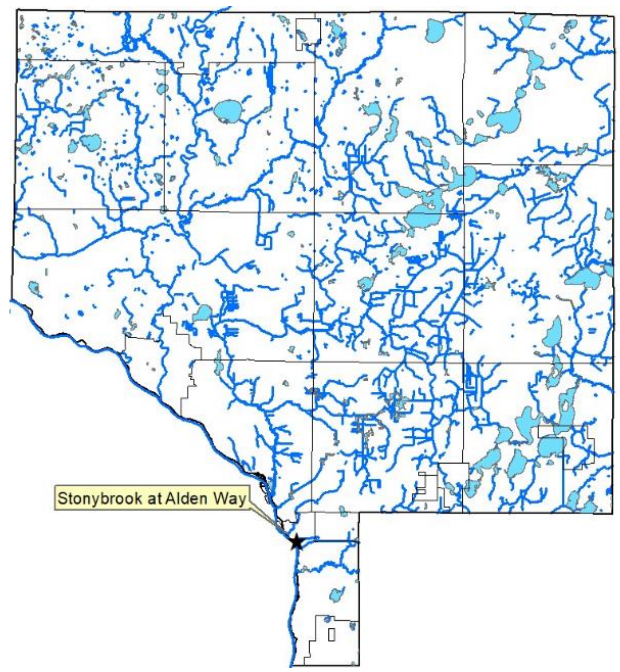
STONYBROOK CREEK

at Alden Way, Fridley

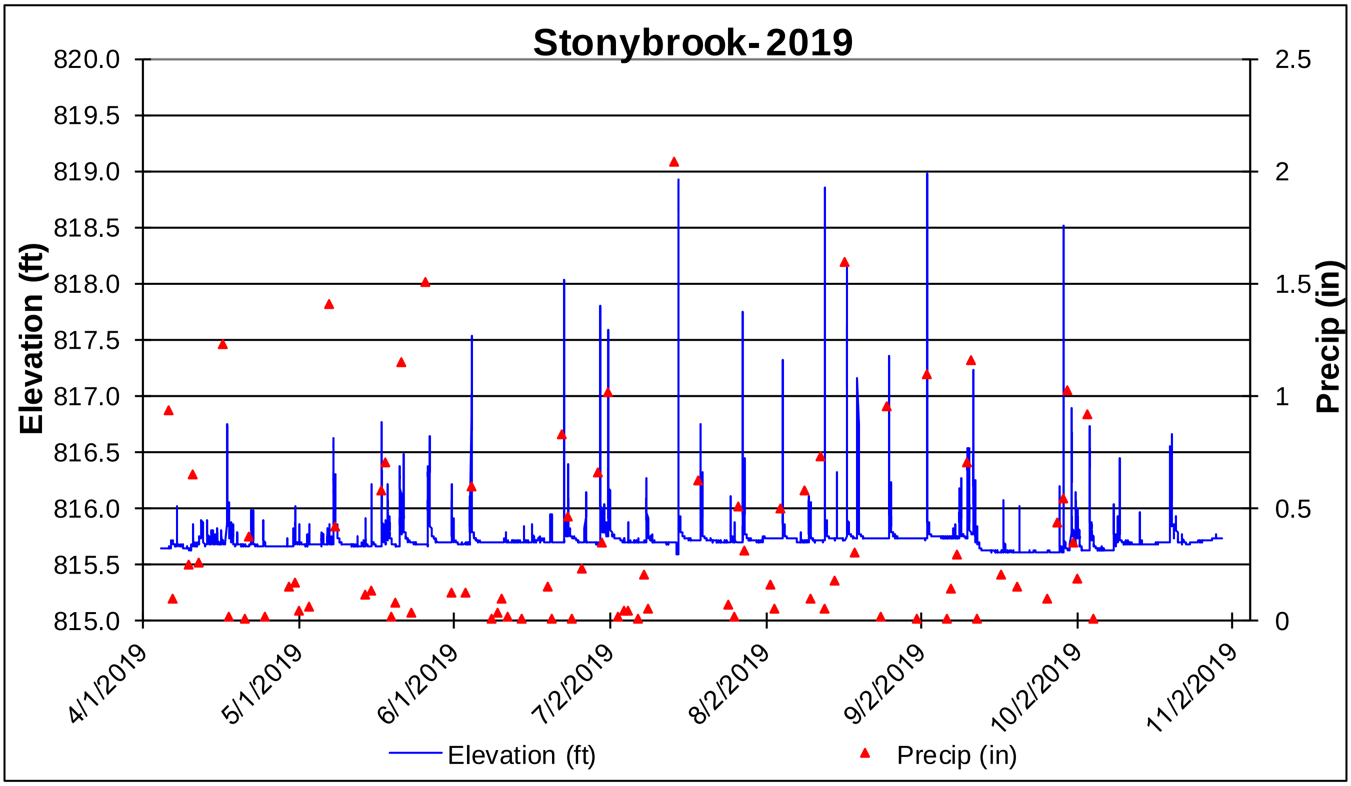
Notes

Given its size and channelized characteristics, Stonybrook has extremely flashy reactions to rain events, with virtually instantaneous spikes and plummets in water level. 2017 was the first year in which stage was recorded for Stonybrook. New monitoring equipment was installed at this site and set to 15 minute recording intervals for 2019 in order to properly capture these fast fluctuations. This year stage at Stonybrook varied 3.39 ft. On one occasion in July, water levels in the creek rose 3.34 ft. within just 2 hours and then fell 2.14 ft. over the following hour. This was in response to a 2.04 inch rain event.

No rating curve has been established for this site.



2019 Hydrograph

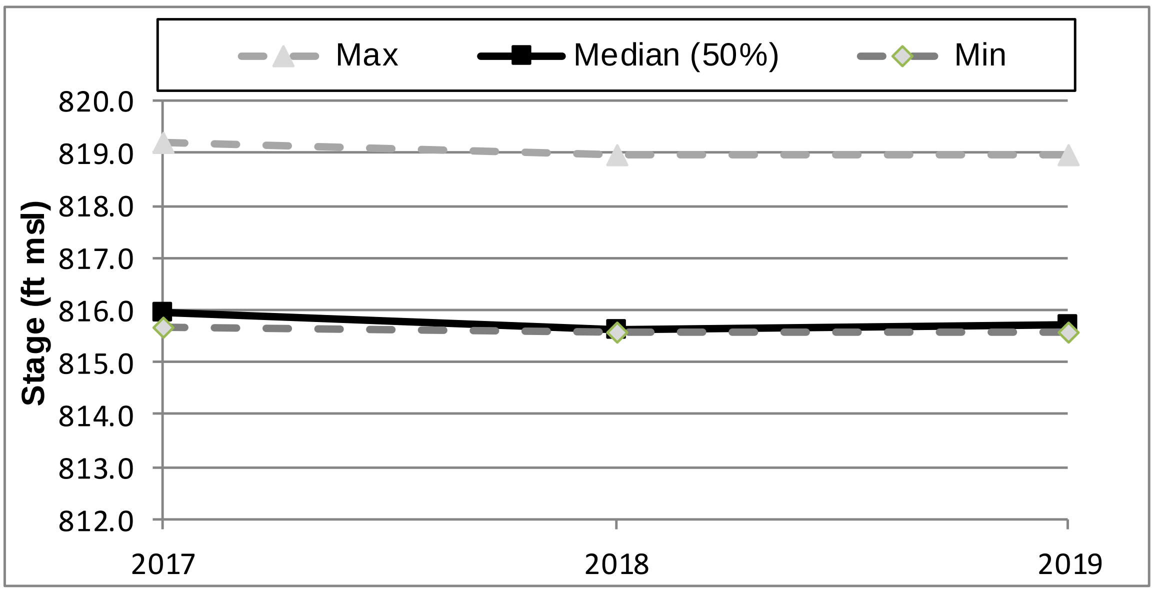


STONYBROOK

at Alden Way, Fridley

Summary of All Monitored Years

Percentiles	2017	2018	2019
Min	815.65	815.56	815.59
2.5%	815.80	815.57	815.61
10.0%	815.91	815.58	815.64
25.0%	815.93	815.59	815.67
Median (50%)	815.96	815.61	815.70
75.0%	816.00	815.64	815.72
90.0%	816.07	815.69	815.78
97.5%	816.30	815.92	816.04
Max	819.20	818.98	818.98



Stream Hydrology Monitoring – Oak Glen Creek

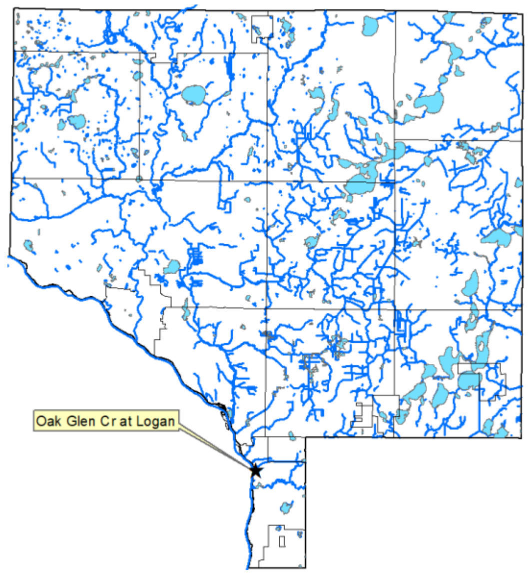
OAK GLEN CREEK

at Logan Parkway, Fridley

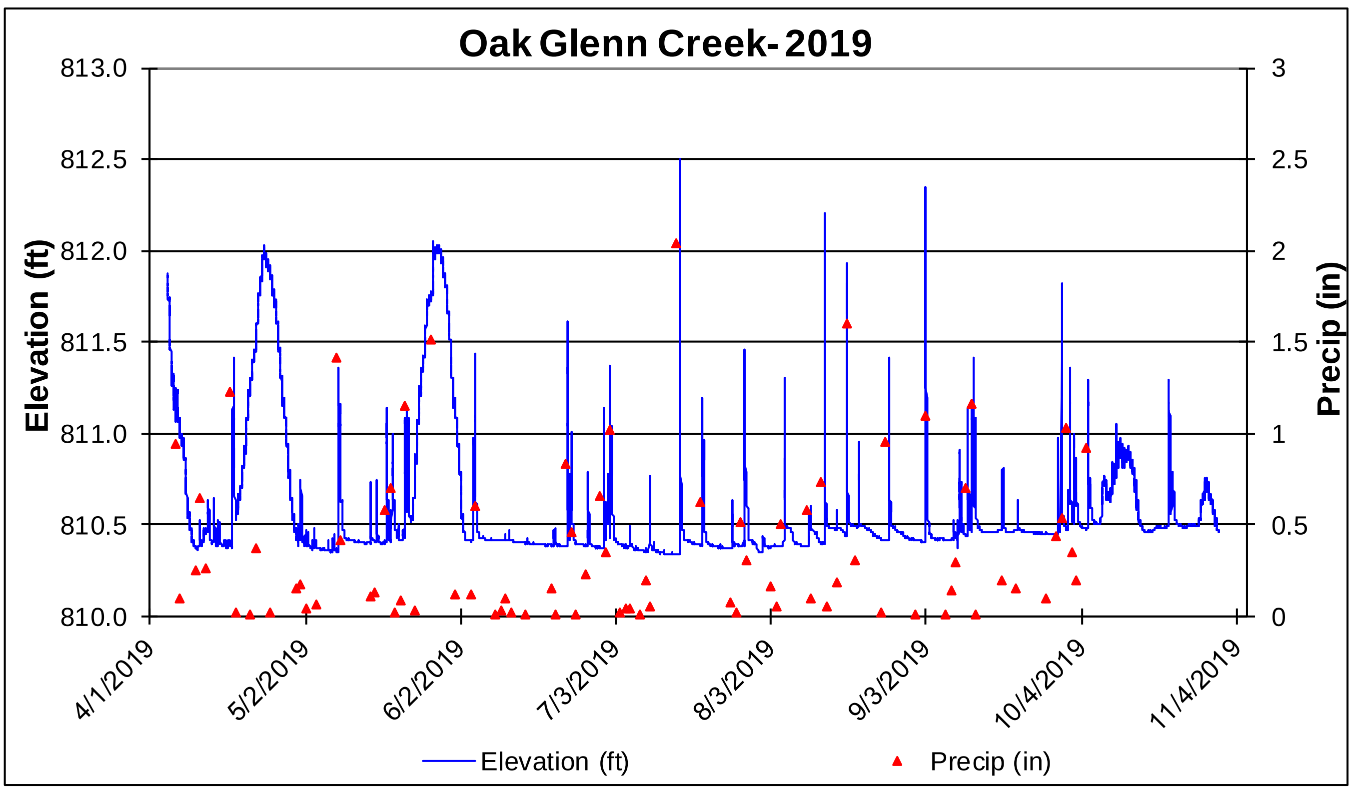
Notes:

Similar to Stonybrook Creek, Oak Glen Creek stage responds incredibly quickly to rainfall. Rain events, even rather small ones frequently cause the stage to rise by more than two feet within an hour. Recession of these levels is almost as instantaneous once the rain stops. New monitoring equipment was also installed at this site and set to 15 minute recording intervals for 2019 in order to properly capture these fast fluctuations

No rating curve has been established for this site.



2019 Hydrograph

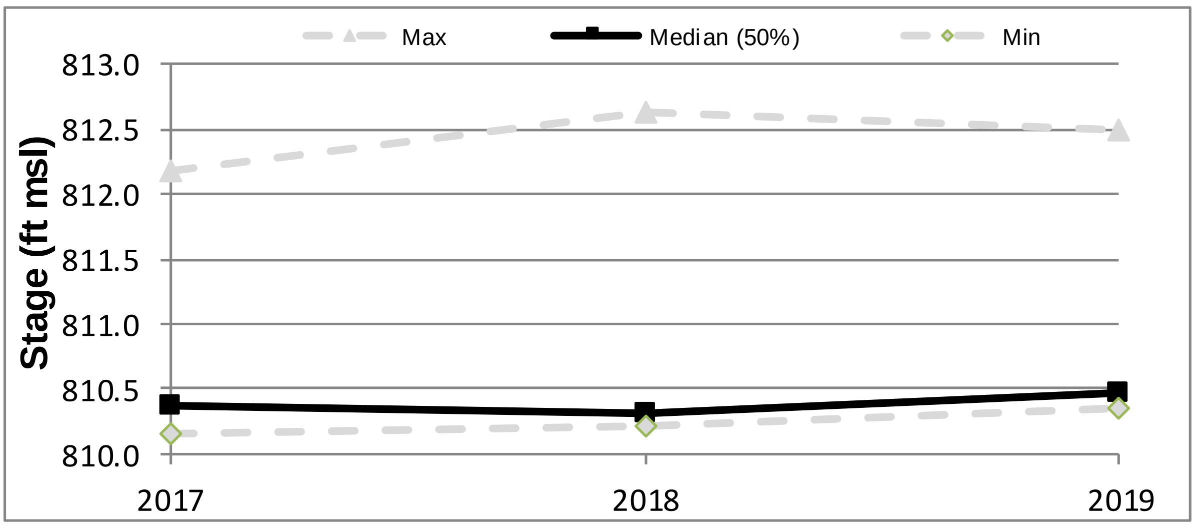


OAK GLEN CREEK

at Logan Parkway, Fridley

Summary of All Monitoring Year

Percentiles	2017	2018	2019
Min	810.15	810.22	810.34
2.5%	810.23	810.27	810.35
10.0%	810.28	810.28	810.38
25.0%	810.31	810.29	810.40
Median (50%)	810.37	810.32	810.46
75.0%	810.42	810.39	810.56
90.0%	810.49	810.43	811.06
97.5%	810.74	810.72	811.81
Max	812.17	812.64	812.50



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)

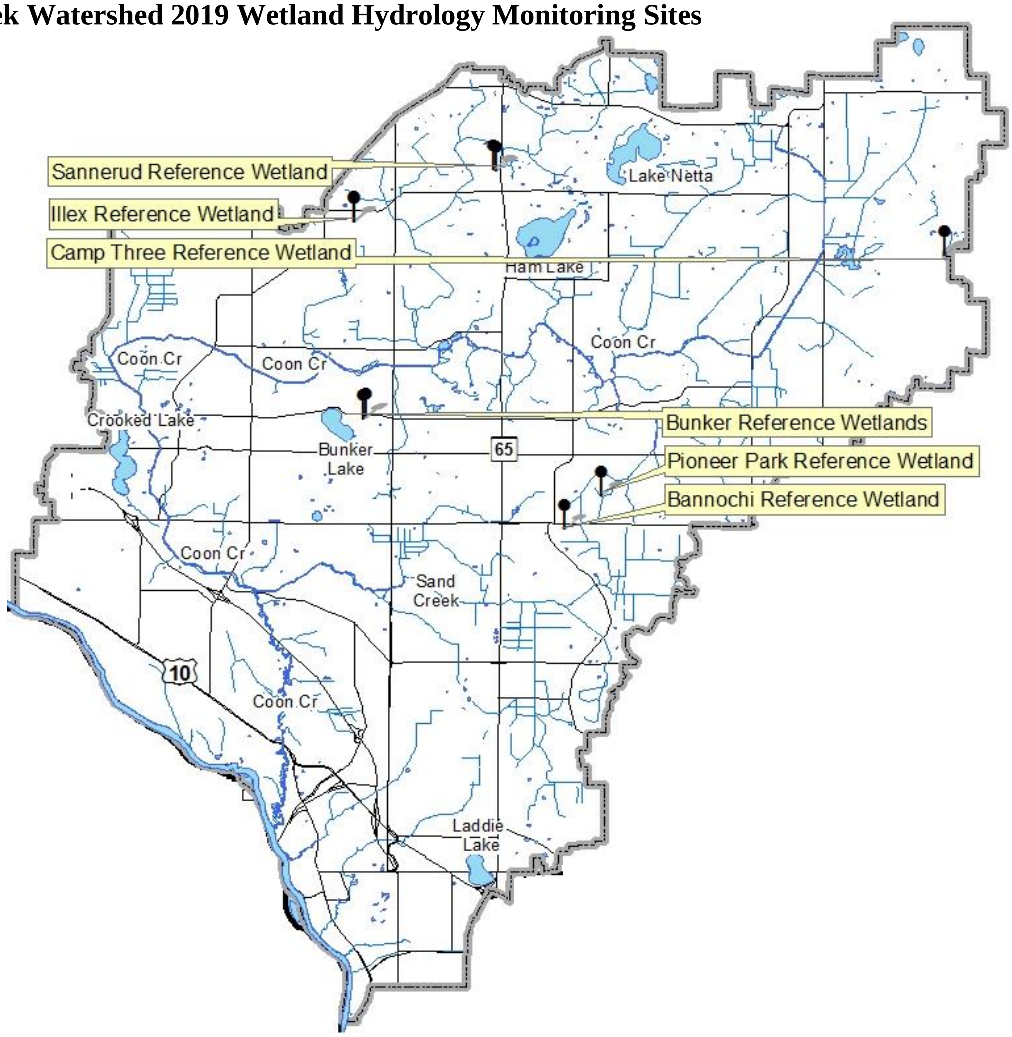
Pioneer Park Wetland, Pioneer Park off Main St., Blaine

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.

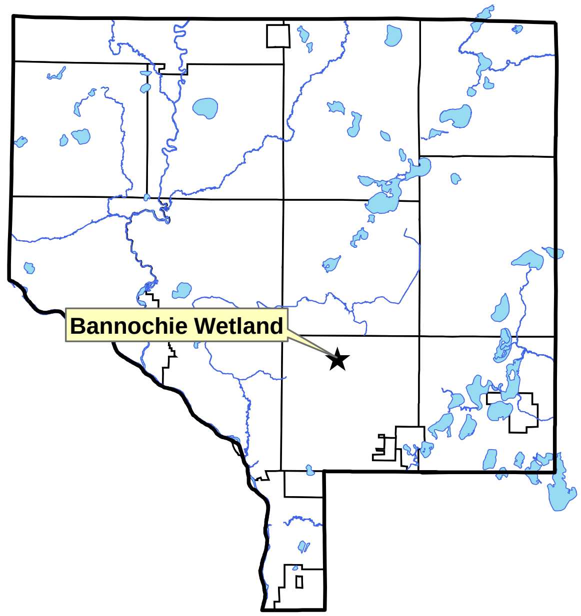
Coon Creek Watershed 2019 Wetland Hydrology Monitoring Sites



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	-

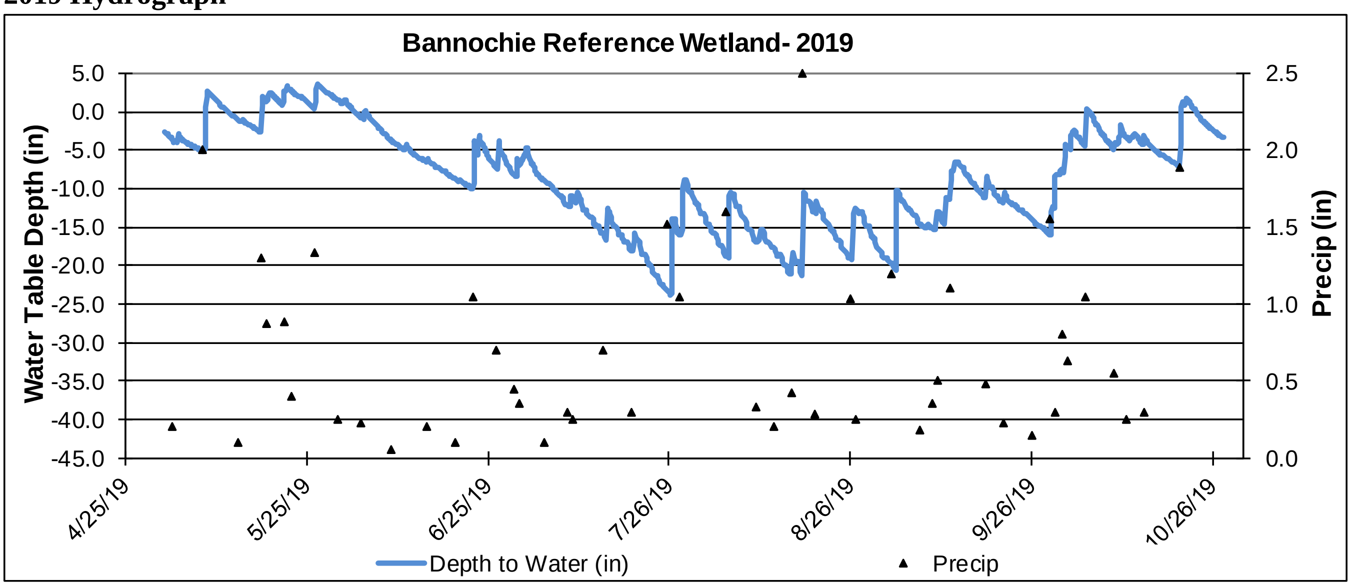
Surrounding Soils: Rifle and some Zimmerman fine sand

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.

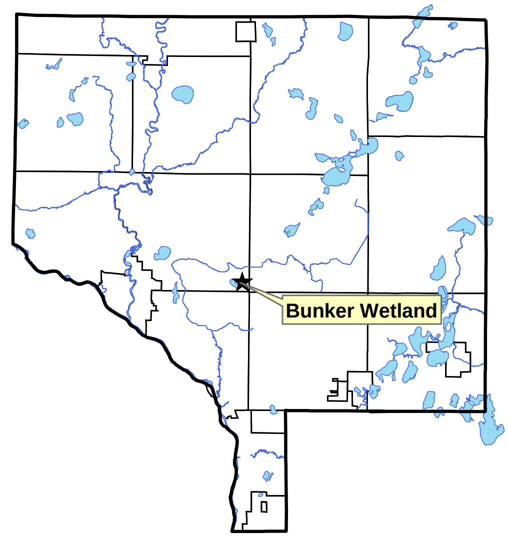
2019 Hydrograph



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	-

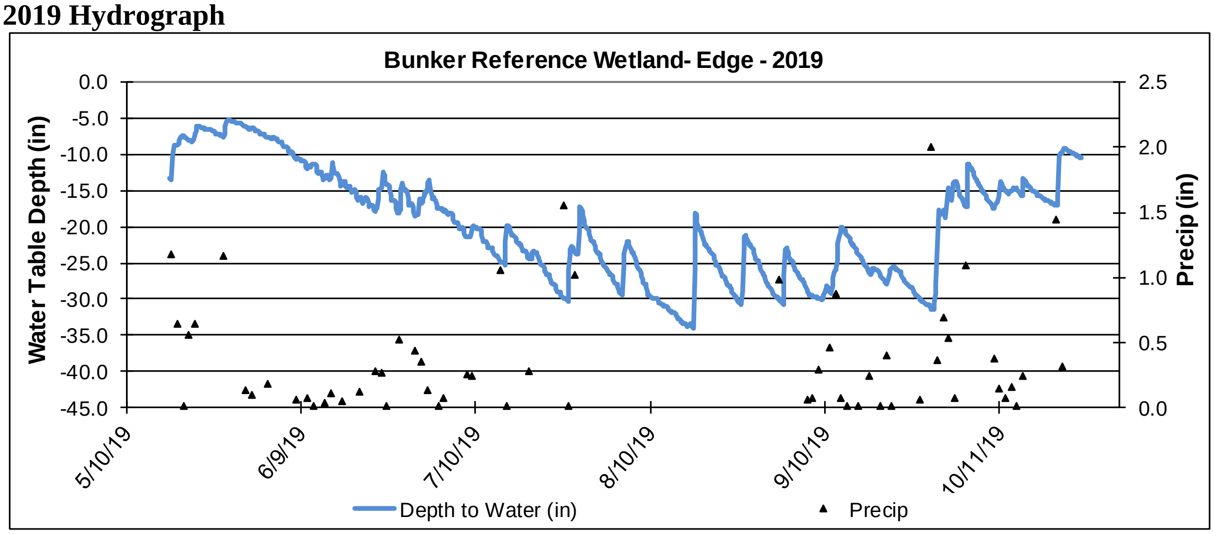
Surrounding Soils: Zimmerman fine sand

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 in. 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.

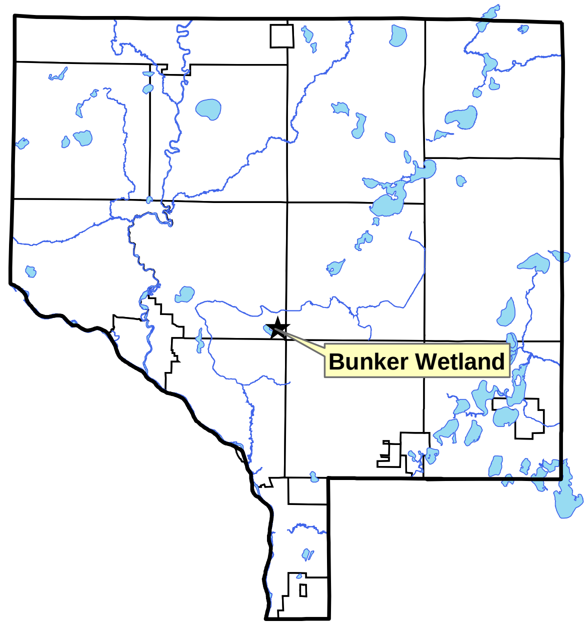
2019 Hydrograph



Wetland Hydrology Monitoring

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	-

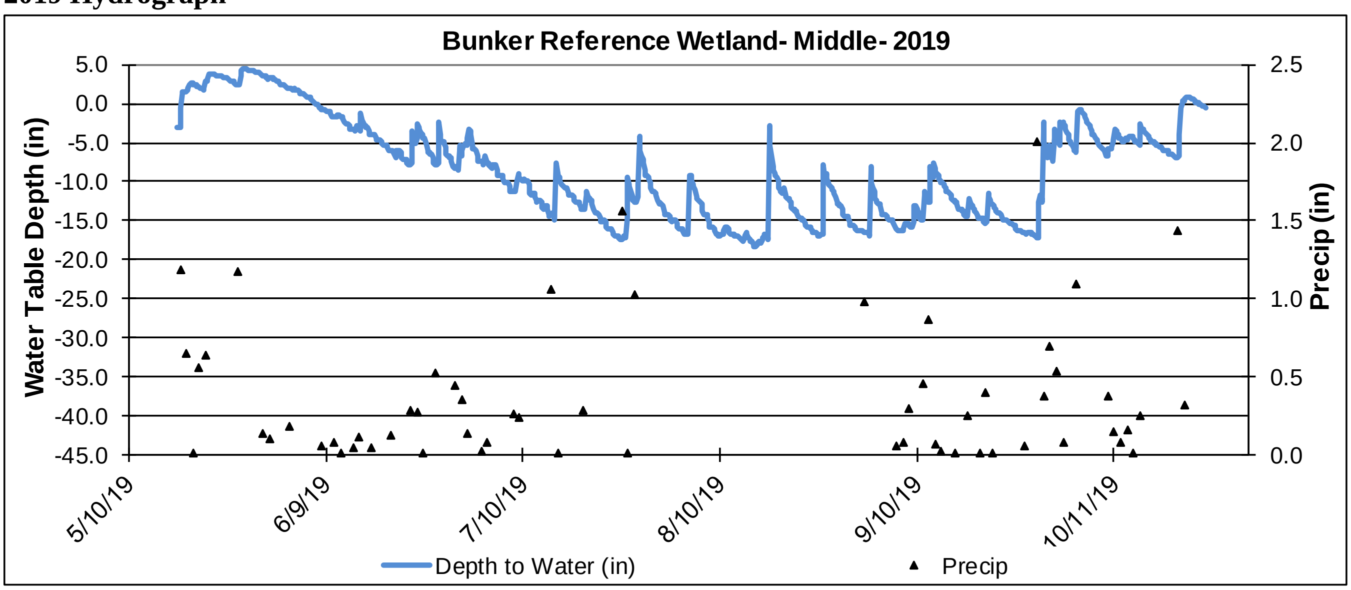
Surrounding Soils: Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Poa palustris	Fowl Bluegrass	90
Polygonum sagitatum	Arrow-leaf Tearthumb	20
Aster spp.	Aster undiff.	10

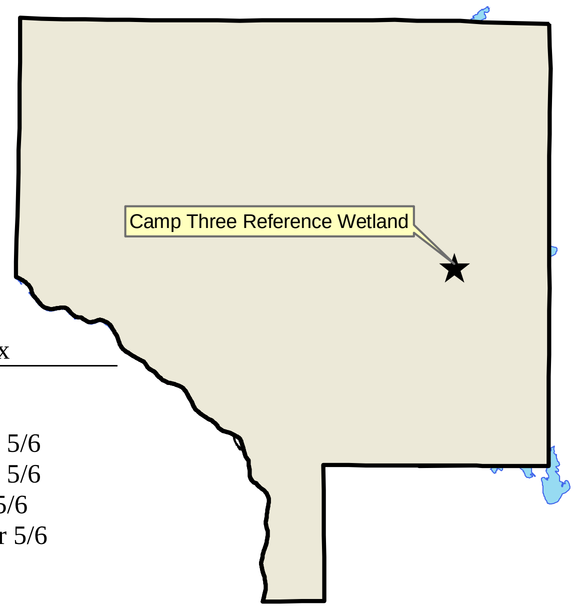
Other Notes: This well at the middle of the wetland and was installed at the end of 2005 and first monitored in 2006.

2019 Hydrograph



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

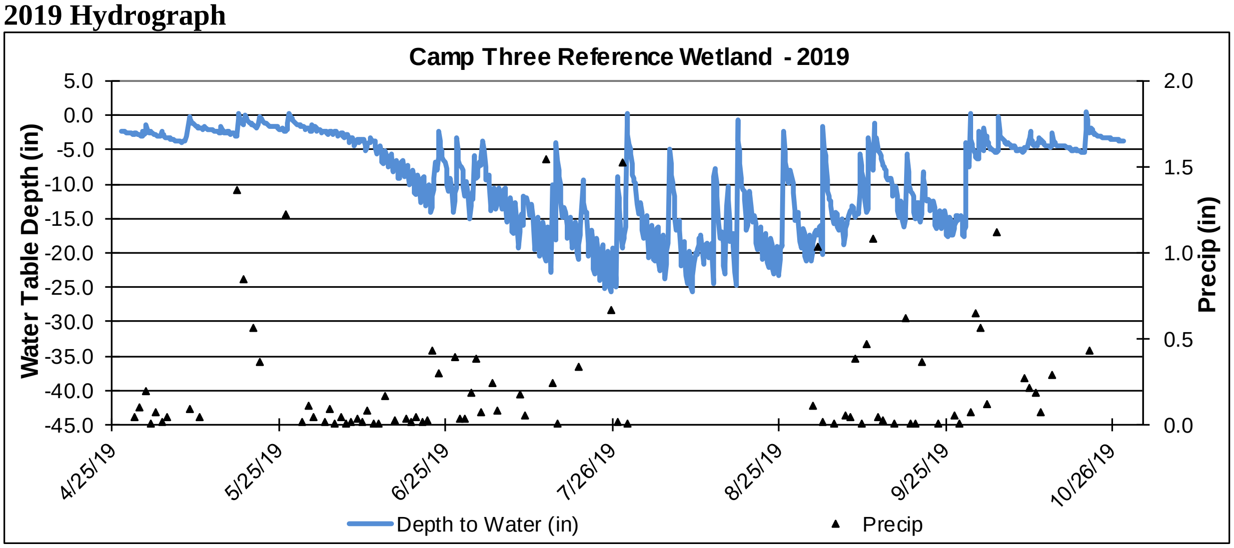
Surrounding Soils: Zimmerman Fine Sand

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 in. throughout summer 2008. This may have been due to water control structures elsewhere in the Carlos Avery Wildlife Management Area.

2019 Hydrograph

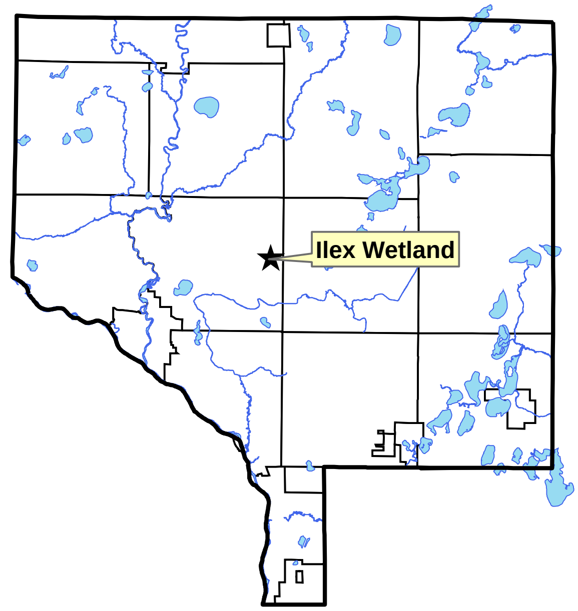


Wetland Hydrology Monitoring

ILEX REFERENCE WETLAND - EDGE

City Park at Ilex St and 159th Ave, Andover

Site Information



Monitored Since: 1996

Wetland Type: 2

Wetland Size: ~9.6 acres

Isolated Basin? Yes

Connected to a Ditch? No

Soils at Well Location:

Horizon	Depth	Color	Texture	Redox
A	0-10	10yr2/1	Fine Sandy Loam	-
Bg	10-14	10yr4/2	Fine Sandy Loam	-
2Ab	14-21	N2/0	Sandy Loam	-
2Bg1	21-30	10yr4/2	Fine Sandy Loam	-
2Bg2	30-45	10yr5/2	Fine Sand	-

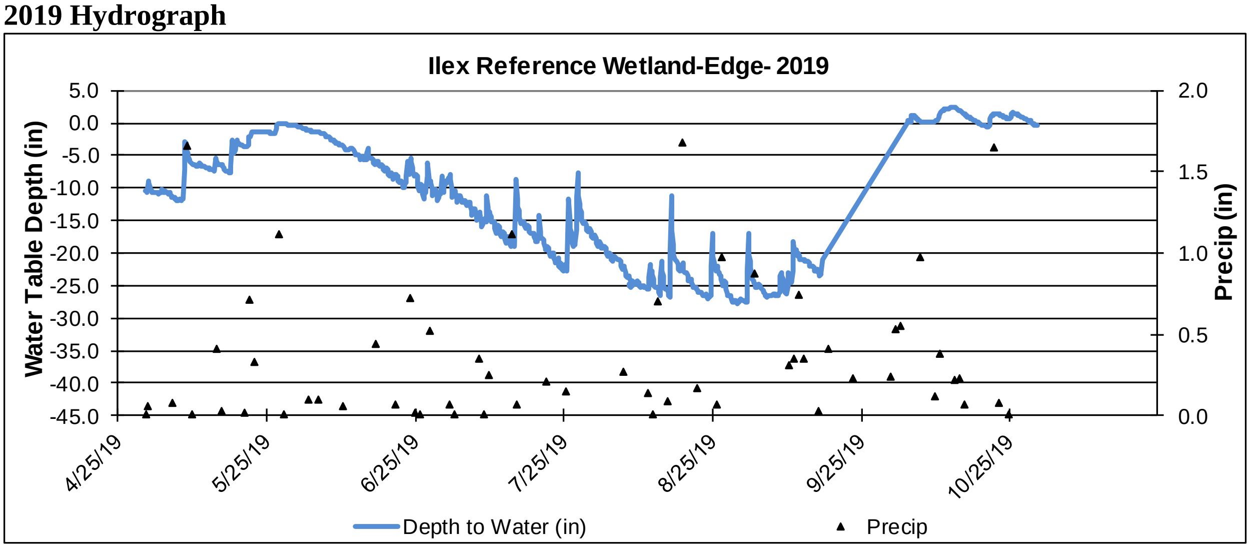
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Solidago gigantia	Giant Goldenrod	20
Populus tremuloides (T)	Quaking Aspen	20
Rubus strigosus	Raspberry	10

Other Notes: This well is located at the wetland boundary. In 2000-2005 the water table was only once within 15 in.es of the surface and seldom within 40 in.es. 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.

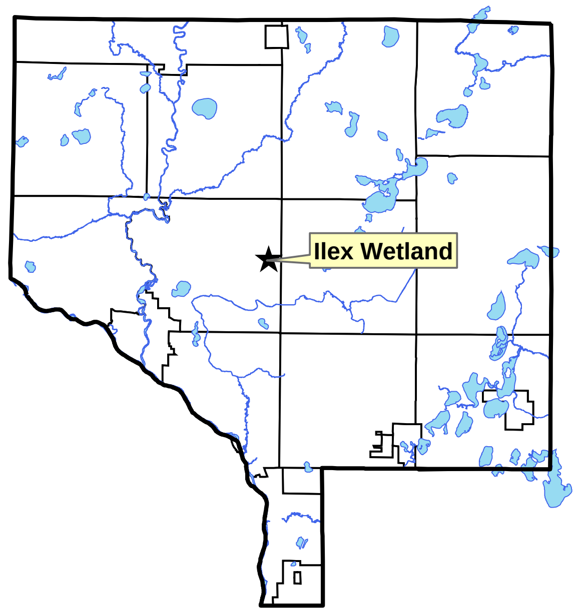
2019 Hydrograph



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	-

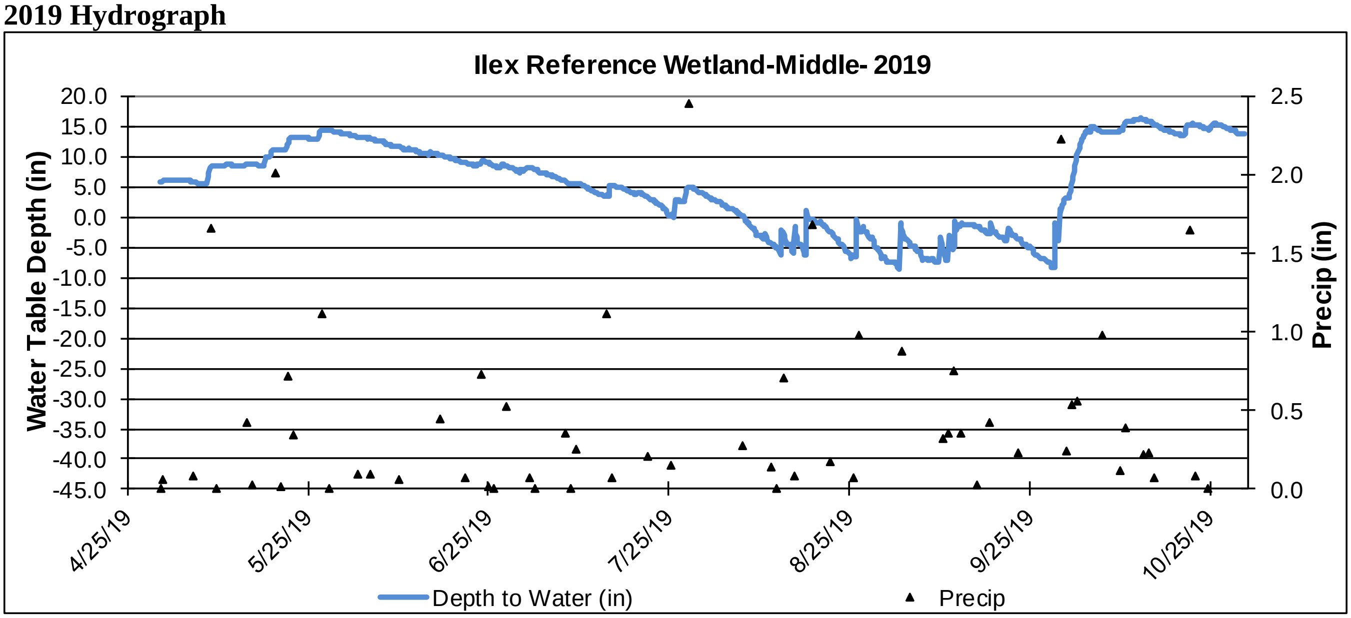
Surrounding Soils: Loamy wet sand and Zimmerman fine sand

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	80
Typha angustifolia	Narrow-leaf Cattail	40

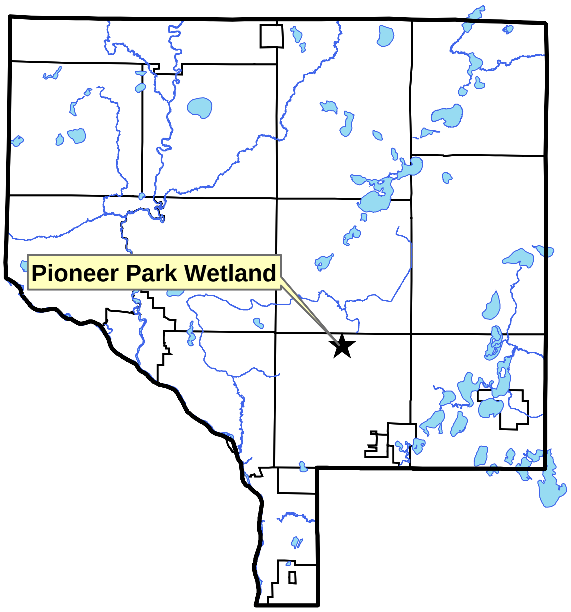
Other Notes: This well is located near the middle of the wetland basin.

2019 Hydrograph



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	-

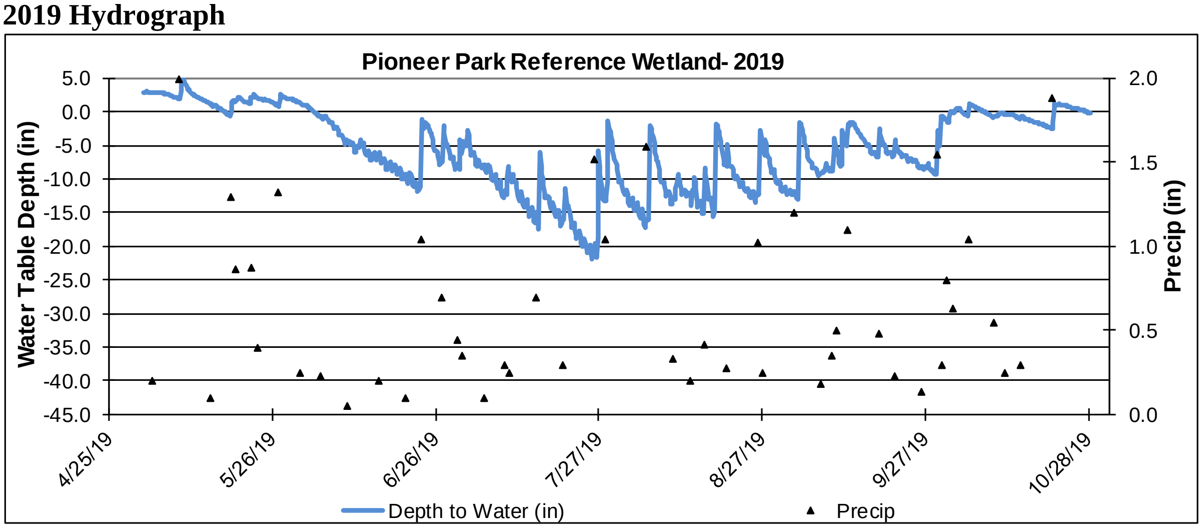
Surrounding Soils: Rifle and loamy wet sand.

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)

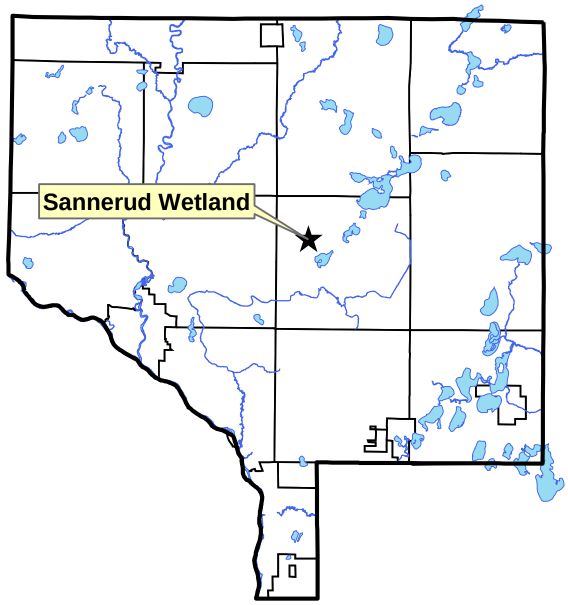
2019 Hydrograph



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	-

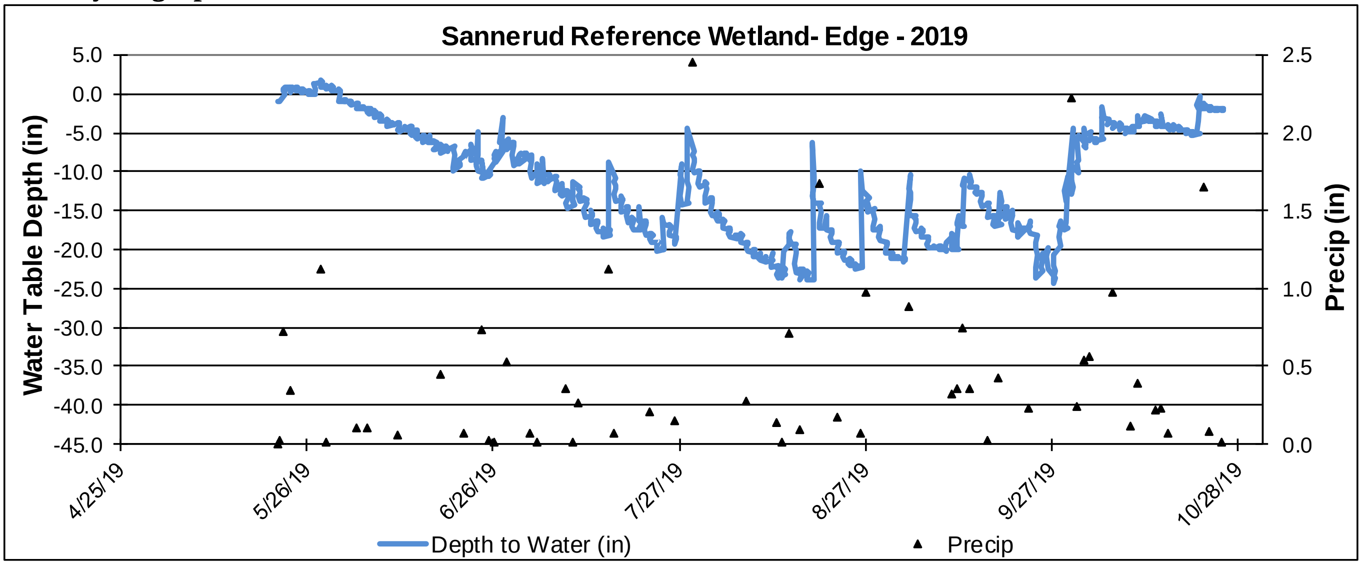
Surrounding Soils: Zimmerman and Lino.

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 in.es deep.

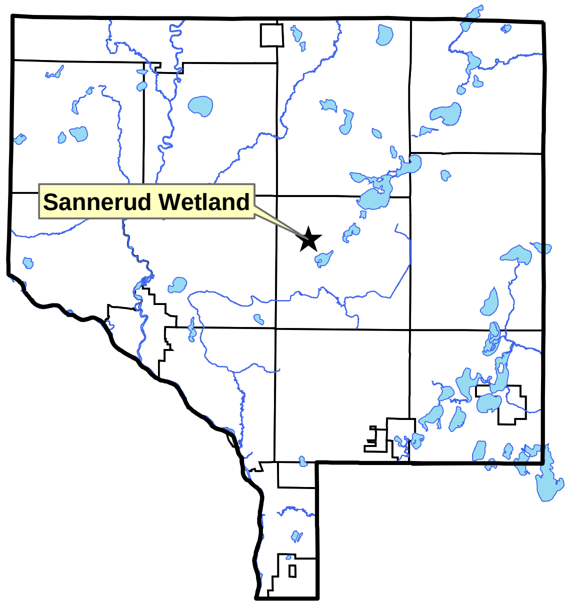
2019 Hydrograph



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	-

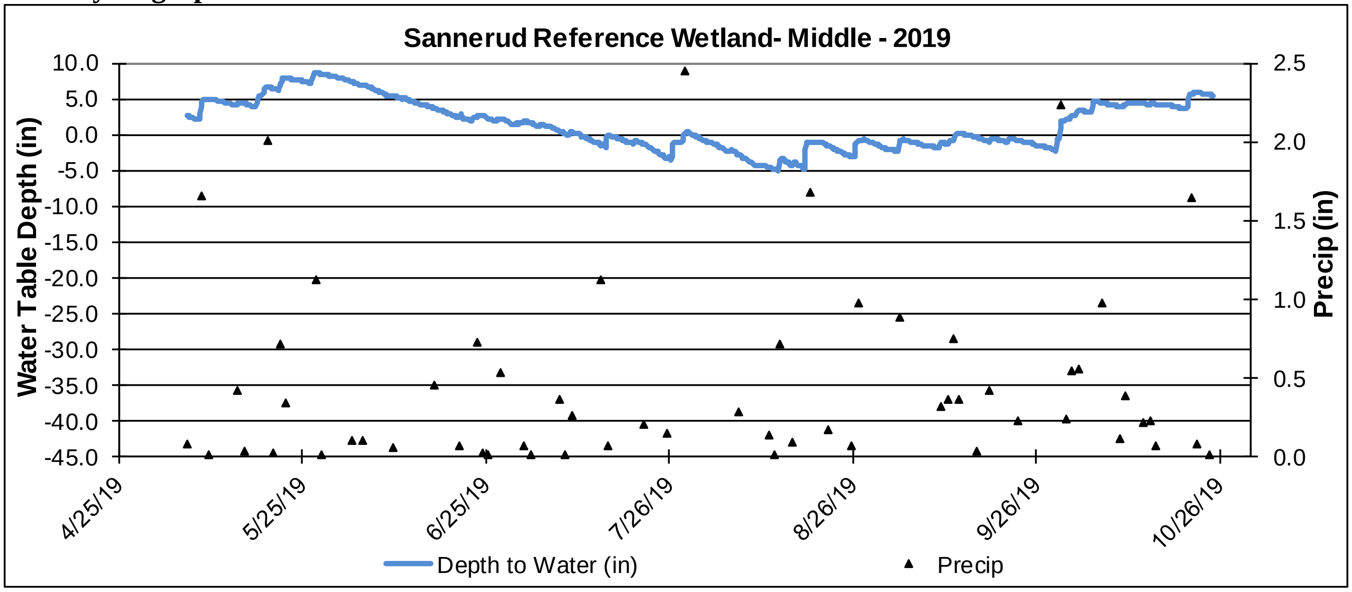
Surrounding Soils: Zimmerman and Lino.

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.

2019 Hydrograph



Reference Wetland Analyses

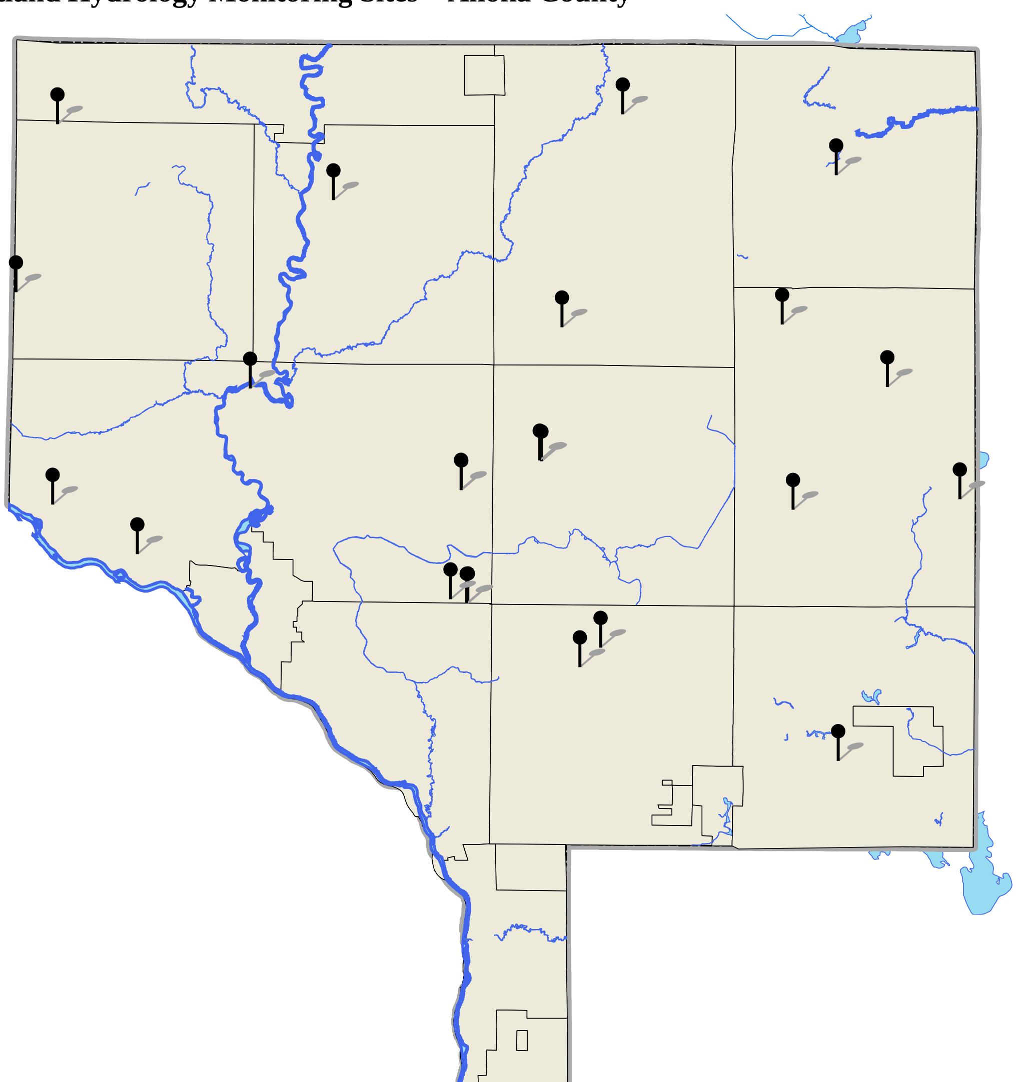
Description: This section includes analyses of wetland hydrology data of 23 reference wetland sites collected at 19 locations. Shallow groundwater levels at the edge of these wetlands are recorded every four hours. Many have been monitored since 1996. These analyses summarize this enormous multi-year, multi-wetland dataset. In the process of doing this analysis, a database summarizing all of the data was created. This database will allow many other, more specific, analyses to be done to answer questions as they arise, particularly through the wetland regulatory process.

Purpose: To provide a summary of the known hydrological conditions in wetlands across Anoka County that can be used to assist with wetland regulatory decisions. In particular, these data assist with deciding if an area is or is not a wetland by comparing the hydrology of an area in question to known wetlands in the area. The database created to produce the summaries below can be used to answer other, more specific, questions as they arise.

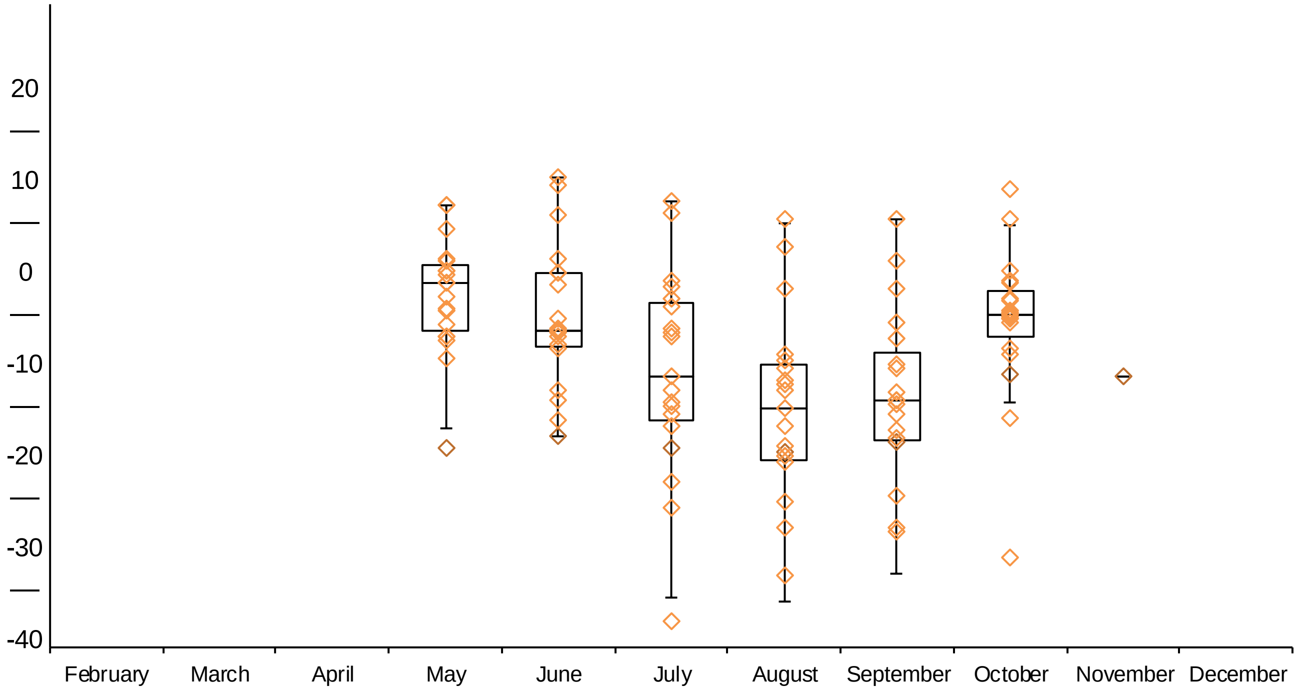
Locations: All 23 reference wetland hydrology monitoring sites in Anoka County.

Results: On the following pages. Data has been summarized for the most recent year alone, as well as across all years with available data.

Reference Wetland Hydrology Monitoring Sites – Anoka County



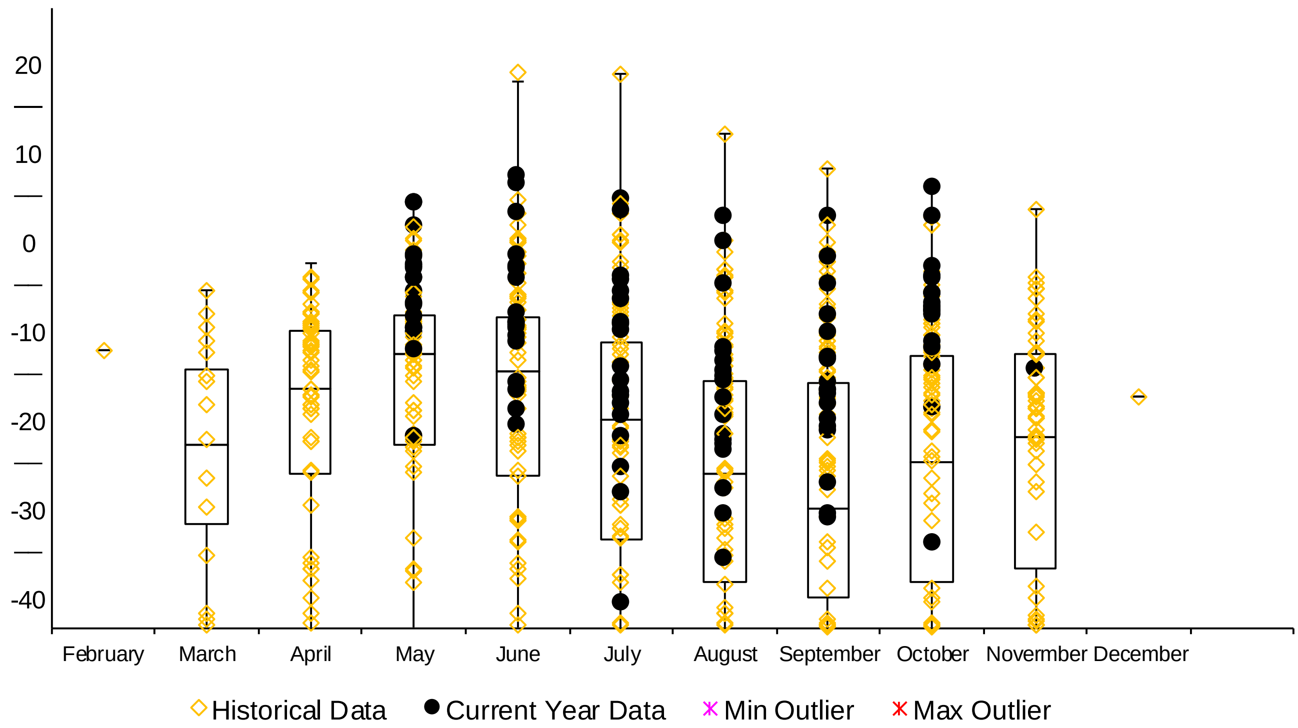
2019 Reference Wetland Water Levels Summary: Each marker represents the median depth to the water table at the edge of one reference wetland for a given month in 2018. The quantile boxes show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (floating horizontal lines). Maximum well depths were 40 to 45 in, so a reading < -40 in. likely indicates water was below the well at an unknown depth.



Quantiles

Month	Min	10%	25%	Median	75%	90%	Max
5	-18.4	-7.0	-5.6	-0.5	1.5	6.0	8.2
6	-17.2	-13.6	-7.3	-5.5	0.7	7.7	11.2
7	-37.1	-22.5	-15.3	-10.6	-2.5	1.3	8.5
8	-41.3	-28.1	-19.6	-14.1	-9.3	-0.2	6.6
9	-41.3	-27.1	-17.5	-13.2	-7.9	-0.4	6.5
10	-30.3	-11.3	-6.1	-3.8	-1.3	2.0	9.8
11	-10.6	-10.6	-10.6	-10.6	-10.6	-10.6	-10.6

1996-2019 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 2018. 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 in., so a reading < -40 in. likely indicates water was below the well at an unknown depth.



Quantiles

Month	Min	10%	25%	Median	75%	90%	Max
2	-8.6	-8.6	-8.6	-8.6	-8.6	-8.6	-8.6
3	-41.6	-39.1	-28.3	-19.3	-10.8	-6.4	-1.9
4	-41.6	-33.5	-22.7	-13.0	-6.5	-2.7	1.2
5	-41.6	-31.1	-19.4	-9.0	-4.8	-1.3	8.2
6	-50.5	-34.9	-22.8	-11.0	-5.0	0.3	22.9
7	-67.9	-39.3	-30.0	-16.6	-7.8	-2.5	22.6
8	-50.3	-39.9	-34.9	-22.6	-12.1	-5.2	15.9
9	-48.8	-40.4	-36.5	-26.5	-12.3	-5.7	11.8
10	-45.0	-40.0	-34.9	-21.3	-9.2	-4.1	9.8
11	-46.9	-39.7	-33.3	-18.4	-9.2	-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 is 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 is a quantitative, non-subjective tool.

The simplest use of the reference wetland data in a regulatory setting is to compare water levels in the reference wetlands to water levels in a disputed area. The graphics and tables above are based upon percentiles of the water levels experienced at known wetland boundaries. The quantile boxes in the figures delineate the 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentiles. Water table depths outside of the box have a low likelihood of occurring, or may only occur under extreme circumstances such as extreme climate conditions or in the presence of anthropogenic hydrologic alterations. If sub-surface water levels in a disputed area are similar to those in reference wetlands, there is a high likelihood that the disputed area is a wetland.

This approach can be refined by examining data from only the year of interest and only certain wetland types. This removes much of the variation that is due to climatic variation among years and due to wetland type. Substantial variation in water levels will no doubt remain among wetlands even after these factors are accounted for, but this exercise should provide a reasonable framework for understanding what hydrologic conditions were present in known wetlands during a given time period.

Water table levels are recorded every 4 hours at all 23 reference wetlands (except during winter), and the raw water level data are available through the Anoka Conservation District.

Aquatic Invasive Species Early Detection Surveys

Description: AIS early detection surveys are conducted twice annually on up to five lakes in partnership with the Coon Creek Watershed District (CCWD). ACD conducts a meandering boat survey on each lake in early and late summer. During the surveys, ACD staff meander between the shoreline and maximum rooting depth around the lake. In lakes shallow enough for plants to root throughout, meanders are made from shoreline to shoreline. Invasive aquatic vegetation is searched by tossing a weed rake from the boat. At least 20 rake tosses are performed on each lake throughout each of the surveys. Any new infestations to each lake are noted and CCWD and MN DNR staff are notified.

Starting in 2018, CCWD lakes were surveyed as Tier 1 or Tier 2 lakes. Tier 1 lakes surveyed included a 30 minute visual search at the public access and 10 minute visual searches at each of three separate target sites in addition to the meandering boat search and weed rake tosses. Tier 2 lakes included a 10 minute visual search at each public access in addition to the meandering boat search and weed rake tosses. Visual searches were performed by wading and slowly paddling the boat to not cloud up the water.

Purpose: To detect new invasive aquatic species in CCWD lakes

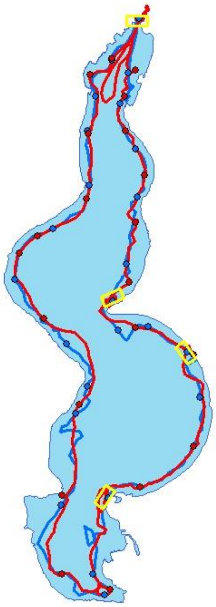
Locations:

Site	City	Dates Surveyed
Crooked Lake	Andover/Coon Rapids	6/25/2019 & 8/22/2019
Ham Lake	Ham Lake	6/18/2019 & 8/22/2019
Lake Netta	Ham Lake	6/19/2019 & 8/29/2019
Sunrise Lake	Blaine	6/19/2019 & 8/23/2019
Laddie Lake	Blaine/Spring Lake Park	6/19/2019 & 8/29/2019

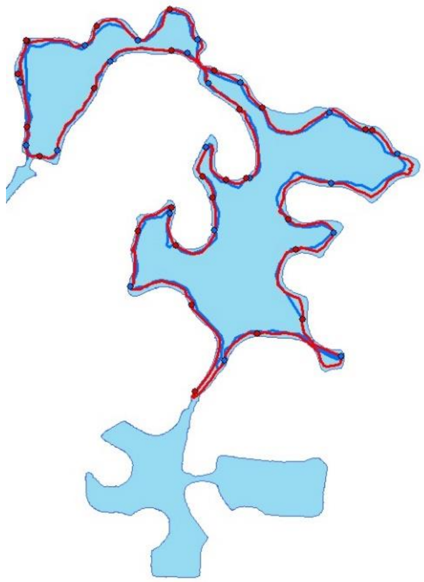
Results: Surveys were conducted in June and August of 2019. The Banded Mystery Snail and the Chinese Mystery Snail species were discovered in Laddie Lake, both are invasive to Minnesota. Curly-Leaf Pondweed was once again observed in Sunrise Lake at nuisance levels. In Ham Lake Eurasian Water Milfoil was discovered to be a type of hybrid-milfoil after a sample was collected in 2018 and sent to a lab for identification. The hybrid-milfoil seemed to recede compared to 2018 levels. Chinese Mystery Snail (invasive) remained prevalent in Ham Lake in 2019. Lake Netta continued to host a diverse and healthy native plant community with no submerged invasive species discovered.

Meandering boat tracks and weed rake toss locations are shown in the maps below.

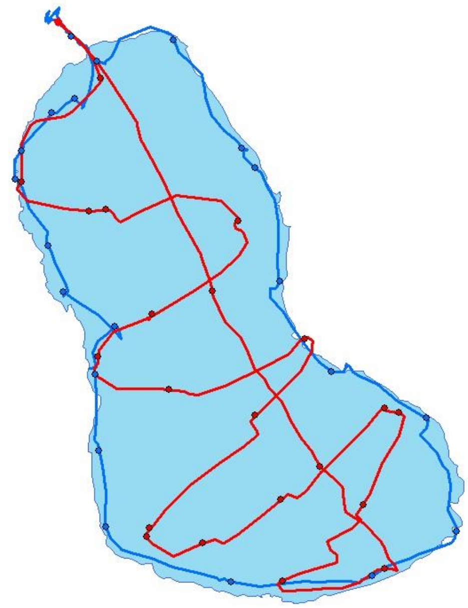
Crooked Lake

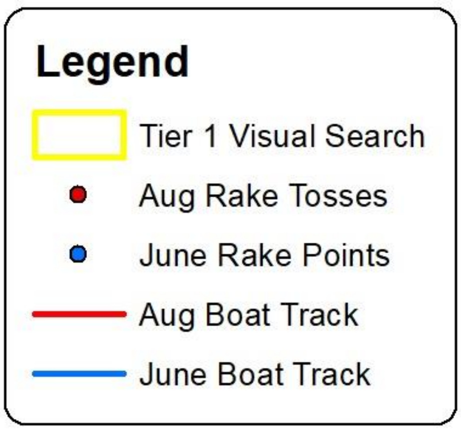


Sunrise Lake



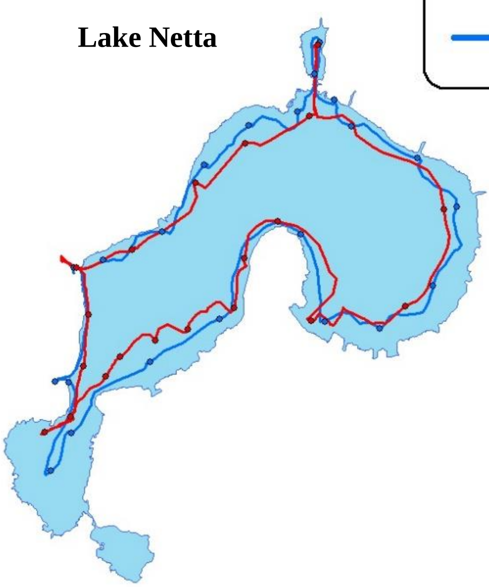
Laddie Lake



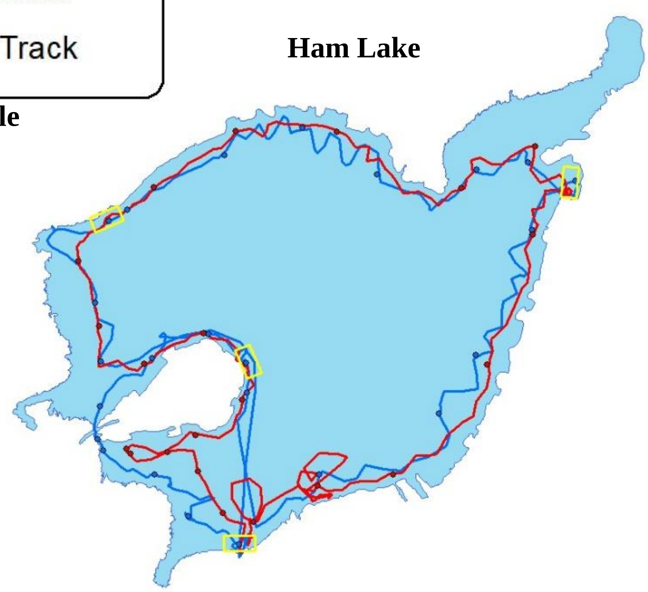


Maps not to scale

Lake Netta



Ham Lake



FINANCIAL SUMMARY

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

Coon Creek Watershed District 2019 Financial Summary

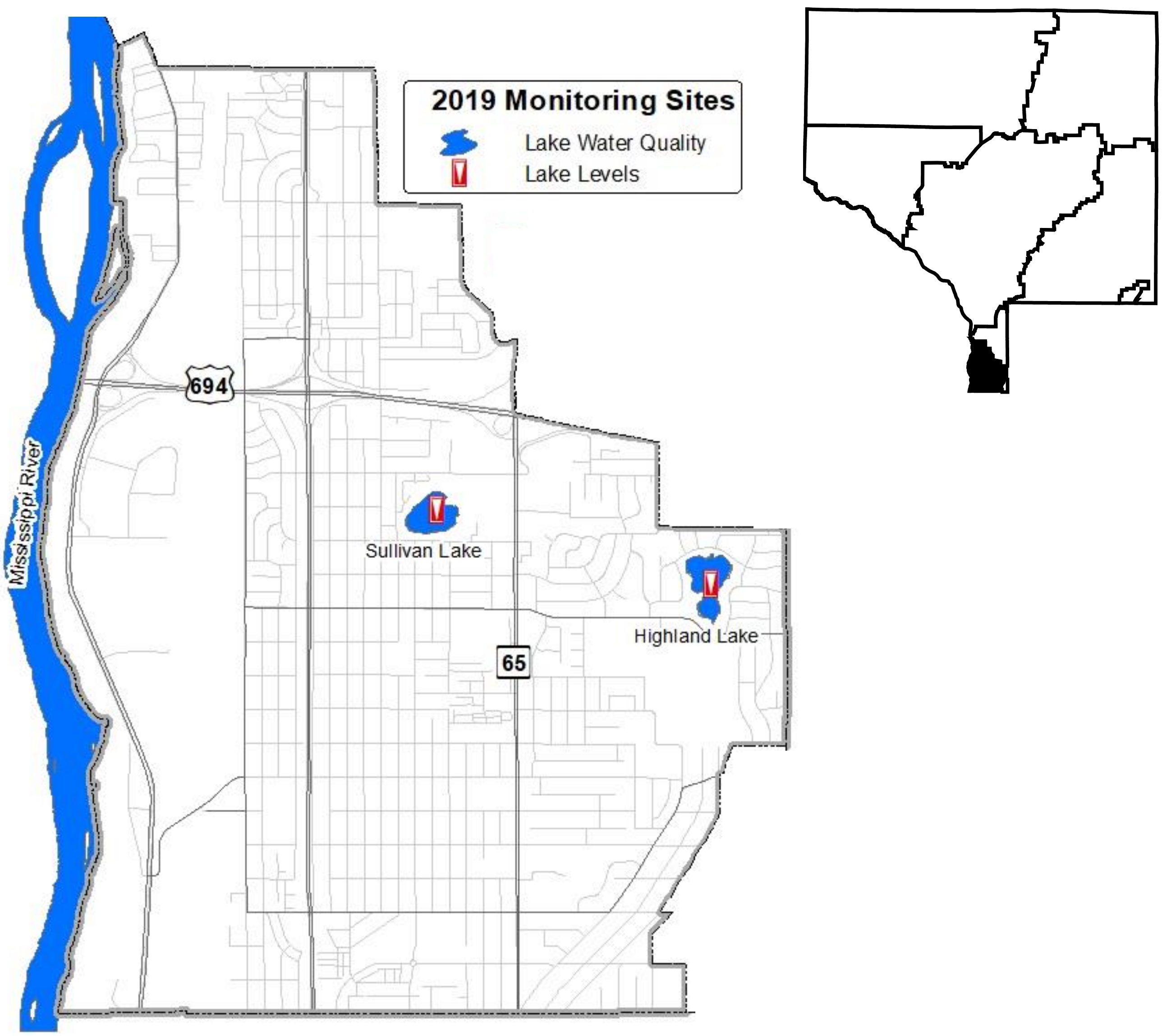
Coon Creek Watershed	Volunteer Precip	DNR Groundwater Wells	Wetland Levels	Lake Levels	Stream Levels	Rating Curves	Lake Water Quality	Stream Water Quality	Stream Water Quality (storm event)	Rain Garden Efficacy	Rain Garden Efficacy	AIS Early Detection	Mississippi Riverbank Stabilization	Outreach Collaborative	Total
Revenues															
CCWD			4872	1550	8400	7500	7900	38775	2800		3400	2500			77697
State - Other		481											215868	22459	238808
BWSR Capacity Direct													5269		5269
BWSR Local Water Planning					5643		891								6534
Metro ETA & NPEAP													12790		12790
Regional/Local														1417	1417
Anoka Co. General Services	286	836	184				174		5828	1050	4253	1559	2199	3851	20220
County Ag Preserves/Projects							1469						14271		15740
Service Fees													69009	122	69131
TOTAL	286	1318	5056	1550	14043	7500	10434	38775	8628	1050	7653	4059	319405	27849	447606
Expenses-															
Capital Outlay/Equip	0	3	5	1	23	10	17	20	11	2	11	12	52	27	196
Personnel Salaries/Benefits	272	1216	4057	1478	12682	5558	6623	15230	8087	962	8330	3674	24136	17388	109693
Overhead	16	66	198	81	640	248	335	889	445	41	394	155	1303	982	5791
Employee Training	1	4	15	5	40	19	18	49	27	3	51	8	91	68	398
Vehicle/Mileage	3	16	56	19	177	82	94	191	106	15	104	59	312	216	1451
Rent	12	61	174	64	606	250	348	734	379	44	263	203	1138	785	5062
Program Participants													243424		243424
Program Supplies	6		293		660		2341	6981	99	58			50464	2458	63359
TOTAL	311	1366	4797	1648	14828	6167	9776	24095	9154	1125	9153	4110	320920	21924	429374
NET	-25	-48	259	-98	-785	1333	658	14680	-525	-75	-1500	-52	-1515	5925	18232

Chapter 7: Mississippi Watershed

Prepared by the Anoka Conservation District

Mississippi Watershed Management Organization

Table of Contents



Lake Levels

Partners: MWMO, ACD, MN DNR, volunteers

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.

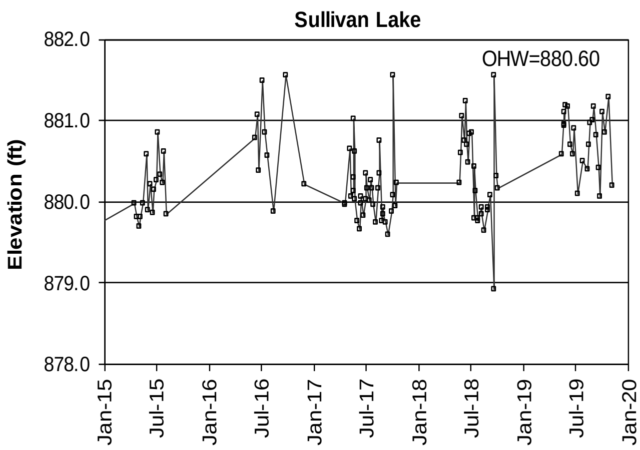
Locations: Sullivan/Sandy Lake
Highland Lake

Results: Lake levels were measured 23 times at each lake, May through October of 2019. Sullivan Lake water levels typically fluctuate rapidly, routinely bouncing by half a foot in response to single rainfall events due to the volume of stormwater directed to the lake compared to its small basin size. In 2019, Sullivan levels fluctuated less than the last couple of years, just 1.24 feet total, due mostly to sustained high levels throughout the year.

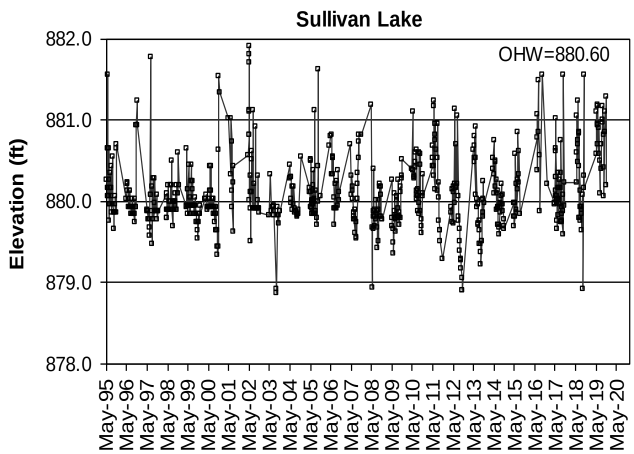
Highland Lake water levels fluctuated even less only ranging 0.32 feet throughout the season. Although 2019 was the wettest year on record Highland lake levels stayed consistent with recent averages. Both of these lakes have controlled outlet structures which help to cap the lakes' highest levels and prevent flooding.

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



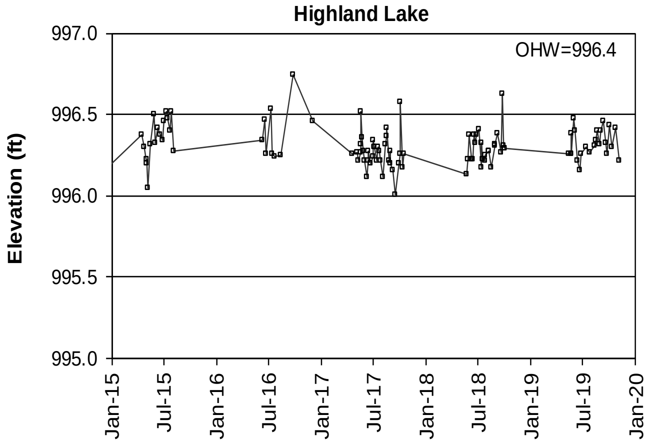
Sullivan/Sandy Lake Levels last 25 years



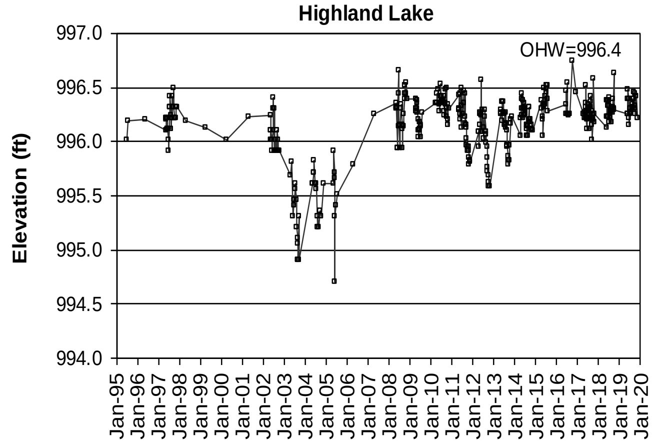
Sullivan/Sandy Lake level 5 year summary

Year	Average	Min	Max
2015	880.14	879.69	880.85
2016	880.76	879.88	881.56
2017	880.13	879.6	881.56
2018	880.29	878.93	881.57
2019	880.77	880.06	881.3
5-year	880.36	878.93	881.57

Highland Lake Levels last 5 years



Highland Lake Levels 1995-2018



Highland Lake level 5-year summary

Year	Average	Min	Max
2015	996.36	996.05	996.52
2016	996.40	996.24	996.75
2017	996.27	996.01	996.58
2018	996.30	996.13	996.63
2019	996.32	996.16	996.48
5-year	996.31	996.01	996.75

Lake Water Quality

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

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

Locations: Sullivan/Sandy Lake
Highland Lake

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

Sullivan/Sandy Lake

City of Columbia Heights, Lake ID # 02-0080

Background

Sullivan Lake, also known as Sandy Lake, is located in south central Anoka County. It has a surface area of 16.8 acres and a maximum depth of 9 feet (2.7 m). A walking trail system/park circumscribes the lake. Adjacent to the trail is a mix of residential and commercial uses. The walking trail around the lake is used extensively, but the lake itself is used very little for recreation, and there is no easy access to the water. The lake's watershed is highly urbanized, and the lake essentially serves as a flow-through stormwater pond. The stormwater conveyance system draining 433 acres of primarily residential and commercial areas of Columbia Heights and Fridley discharges directly into Sullivan Lake. The lake is listed as impaired by the MPCA for both nutrients and aquatic recreation, likely related to the volume of stormwater piped to this small lake. Water exiting this lake is discharged to the Mississippi River via additional subsurface conveyances.

Results 2019

Sullivan/Sandy Lake maintains a track record of very poor water quality. Overall water quality for all monitored years received a D letter grade or worse. The lake is highly eutrophic, and phosphorus levels are routinely two to three times the threshold for an impaired designation by the MPCA. The lake is unsuitable for swimming during the entire growing season. Both total phosphorus and chlorophyll-a levels were lower in 2019 than they were in 2016 when the lake was last sampled, but both still showed high concentrations. Total phosphorus exceeded the shallow lake water quality standard (60 µg/L) in all five sampling events in 2019. Chlorophyll-a also more than doubled the state standard (20 µg/L) in four out of five samples collected. Past depth profiles indicate that dissolved oxygen is too low for most fish (<4 mg/L) below four feet, and is too low for most aquatic life (<1 mg/L) near the bottom. This is likely due to oxygen consumption by decomposition of expired algae.

Trend Analysis

Fifteen years of water quality data have been collected by the Metropolitan Council (1993-2003) and the Anoka Conservation District (2004, 2005, 2013, 2016, and 2019). There is no significant trend in overall water quality when accounting for phosphorus, chlorophyll-a, and Secchi transparency (repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, $F_{2,12}=1.92$, $p=0.2$). We examined each of the response variables separately using a one-way ANOVA to gain insight into how individual parameters are trending over time. Total phosphorus for the total monitoring record through 2016 showed a significant increase in annual average concentrations ($F_{1,12}=1.92$, $p=0.015$), however the average concentration for 2019 was low enough to reduce the trend to non-significance ($F_{1,12}=1.92$, $p=0.076$). There is no significant trend over time for either Secchi transparency or chlorophyll-a.

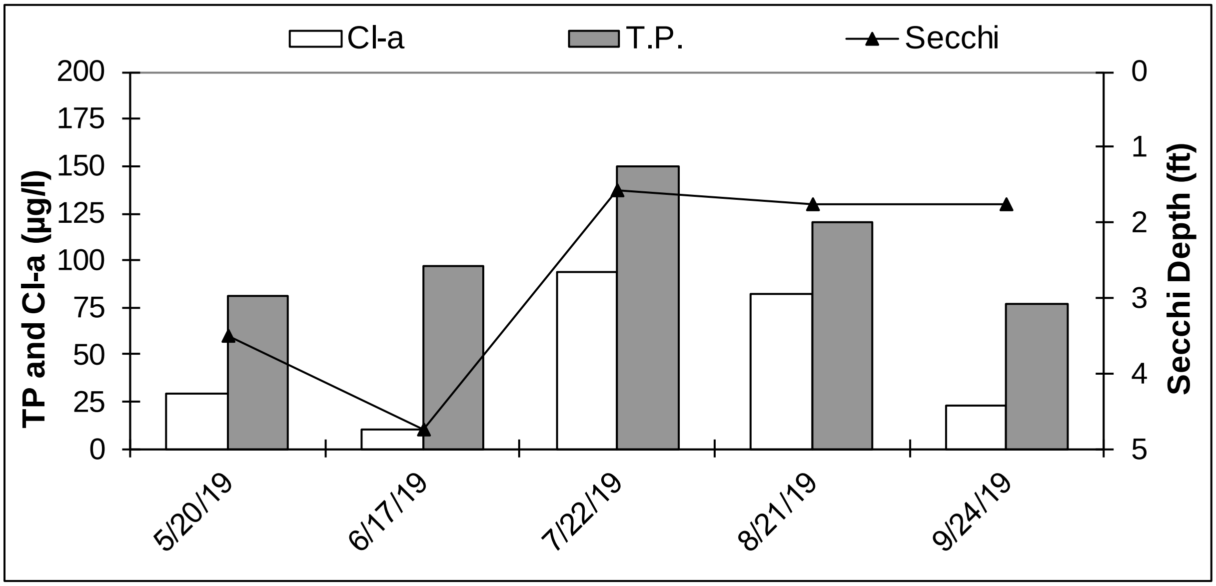
Discussion

Sullivan Lake likely has poor water quality because of both the quality and quantity of stormwater that it receives. Stormwater from urbanized areas commonly has high concentrations of sediment, nutrients and other pollutants. When a small lake receives the majority of its water volume from highly polluted stormwater sources, it can't offer the dilution factor that most lakes can. Improvements to the stormwater system that could benefit Sullivan Lake, especially projects ranked high in the 2019 Subwatershed Assessment Analysis, should be explored.

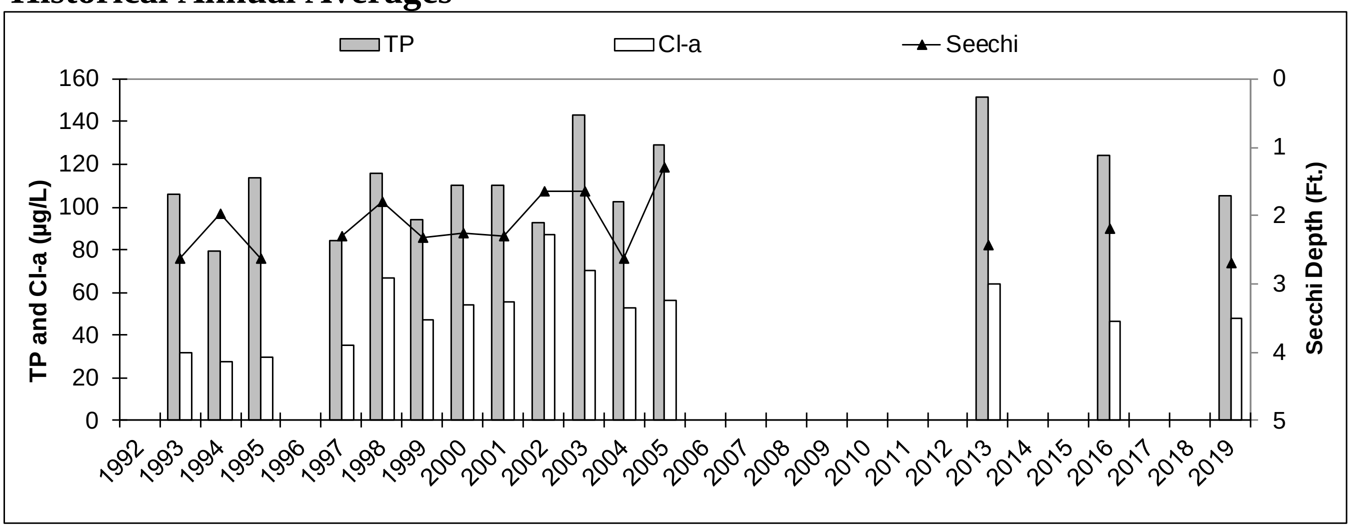
Sullivan Lake		Date	5/20/2019	6/17/2019	7/22/2019	8/21/2019	9/24/2019			
2019 Water Quality Data		Time	14:30	13:20	13:00	12:40	13:15			
	Units	R.L.*	Results	Results	Results	Results	Results	Average	Min	Max
pH			8.18	7.75	8.48	7.81	8.64	8.17	7.75	8.64
Specific Conductivity	mS/cm		0.826	0.483	0.326	0.199	0.150	0.397	0.150	0.826
Turbidity	FNRU		6.5	6.6	30.2	30.3	30.2	21	7	30
D.O.	mg/l		10.18	7.88	15.17	10.26	11.97	11.09	7.88	15.17
D.O.	%		98.8	90.1	188.7	115.7	132.9	125.2	90.1	188.7
Temp.	°C		12.84	22.37	24.32	22.75	20.50	20.56	12.84	24.32
Temp.	°F	0.1	55.1	72.3	75.8	73.0	68.9	69.0	55.1	75.8
Salinity	%	0.01	0.39	0.24	0.16	0.09	0.07	0.2	0.1	0.4
Chloride	mg/l	0.1	196.0	101.0	54.5	34.3	24.0	82.0	24.0	196.0
Cl-a	ug/l	0.5	29.6	10.7	93.4	81.7	23.5	47.8	10.7	93.4
T.P.	mg/l	0.010	0.081	0.097	0.150	0.120	0.077	0.105	0.077	0.150
T.P.	ug/l	10	81	97	150	120	77	105	77	150
Secchi	ft	0.1	3.5	4.8	1.58	1.8	1.8	2.7	1.6	4.8
Secchi	m	0.1	1.1	1.4	0.5	0.5	0.5	0.8	0.5	1.4
Physical			3.0	3.0	3.0	3.0	3.00	3.0	3.0	3.0
Recreational			4.0	4.0	4.0	3.0	3.00	3.6	3.0	4.0

*reporting limit

2019 Results



Historical Annual Averages



2019 Medians

pH		8.18
Specific Conductivity	mS/cm	0.326
Turbidity	NTU	30.2
D.O.	mg/l	10.26
D.O.	%	115.7
Temp.	°F	77.26
Salinity	%	0.16
Chlorides	mg/L	54.5
Cl-a	µg/L	29.6
T.P.	µg/l	97
Secchi	ft	1.75

Historical Report Card

Year	TP	Cl-a	Secchi	Overall
1993	D		D	**D**
1994	D	C	F	**D**
1995	D	C	D	**D**
1997	D	C	D	**D**
1998	D	D	F	**D**
1999	D	C	D	**D**
2000	D	D	D	**D**
2001	D	D	D	**D**
2002	D	F	F	**F**
2003	D	D	F	**D**
2004	D	D	D	**D**
2005	D	D	F	**D**
2013	D	D	D	**D**
2016	D	C	D	**D**
2019	D	C	C	D
State Standards	60 ug/L	20 ug/L	>3.3 ft	

Highland Lake

City of Columbia Heights, Lake ID # 02-0079

Background

Highland Lake is a shallow lake with approximately 14 acres of surface area in south central Anoka County. It is surrounded by the mostly wooded Kordiak park, which features a popular paved trail that circumnavigates Highland Lake   The contributing watershed to Highland lake is 140 acres of primarily residential land cover that drains to Highland Lake via direct storm sewer discharge. Like Sullivan Lake, Highland Lake is listed as impaired by the MPCA for both nutrients and aquatic recreation, likely related to the volume of stormwater piped to this small lake.

Results 2019

The Anoka Conservation District (ACD) monitored Highland Lake for the first time in 2016. Prior to 2016, the lake had been monitored through the MPCA citizen volunteer program annually from years 2000-2007. Throughout its recorded history, Highland Lake has had extremely high levels of nutrients and chlorophyll-a, which are likely contributing to poor water clarity.. In 2019, Highland Lake had poor water quality compared to other lakes in the region (NCHF Ecoregion), receiving an overall F grade. Highland Lake has consistently scored an F letter grade since 2002. Total phosphorus levels in the lake were two to four times the state standard (60 µg/L) for shallow lakes in the NCHF Ecoregion on every sampling event and the seasonal average more than tripled the state standard (190.2 µg/L). In 2019, Chlorophyll-a exceeded the state standard (20 µg/L) on all five sampling events with a maximum concentration of 308.0 µg/L and a seasonal average of 139.8 µg/L. This was a large increase from the 2018 Cl-a average of 49.6 µg/L.

Trend Analysis

Ten years of water quality data have been collected by the MPCA (2000-2007) and the Anoka Conservation District (2016 and 2019). While this is a pretty small dataset to perform any meaningful statistical analysis on, we did perform a repeated measures MANOVA with response variables TP, Cl-a, and Secchi depth, ($F_{2,6}=0.48, p=0.67$) *and each of the response variables separately, using a one-way ANOVA.* None of these analyses produced a trend of statistical significance. *A surficial look at the data graphed (below) appears to show that water quality steadily deteriorated through the early 2000s, with almost year on year increases in average phosphorus, and decreases in Secchi transparency from 2000-2007. Recent results from 2016 and 2019 appear to have broken that trend. While we don't have a long enough monitoring record to show any statistical trends in water quality for Highland Lake, its water quality remains very poor and should be a high priority for manangment efforts.* Improvements to the stormwater system that could benefit Highland Lake, especially projects ranked high in the 2019 Subwatershed Assessment Analysis, should be explored.

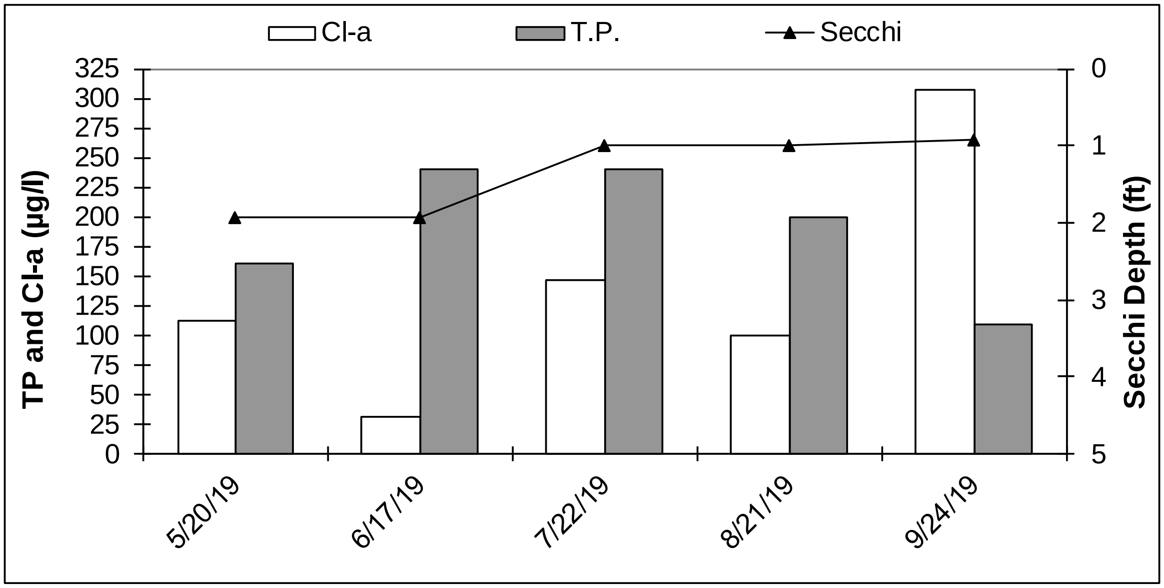
Discussion

Highland Lake, similar to Sullivan Lake, likely has poor water quality because of both the quality and quantity of stormwater that it receives. Stormwater from urbanized areas can be high in sediment, nutrients and other pollutants. Improvements to the storm water system that could benefit Highland Lake should be explored.

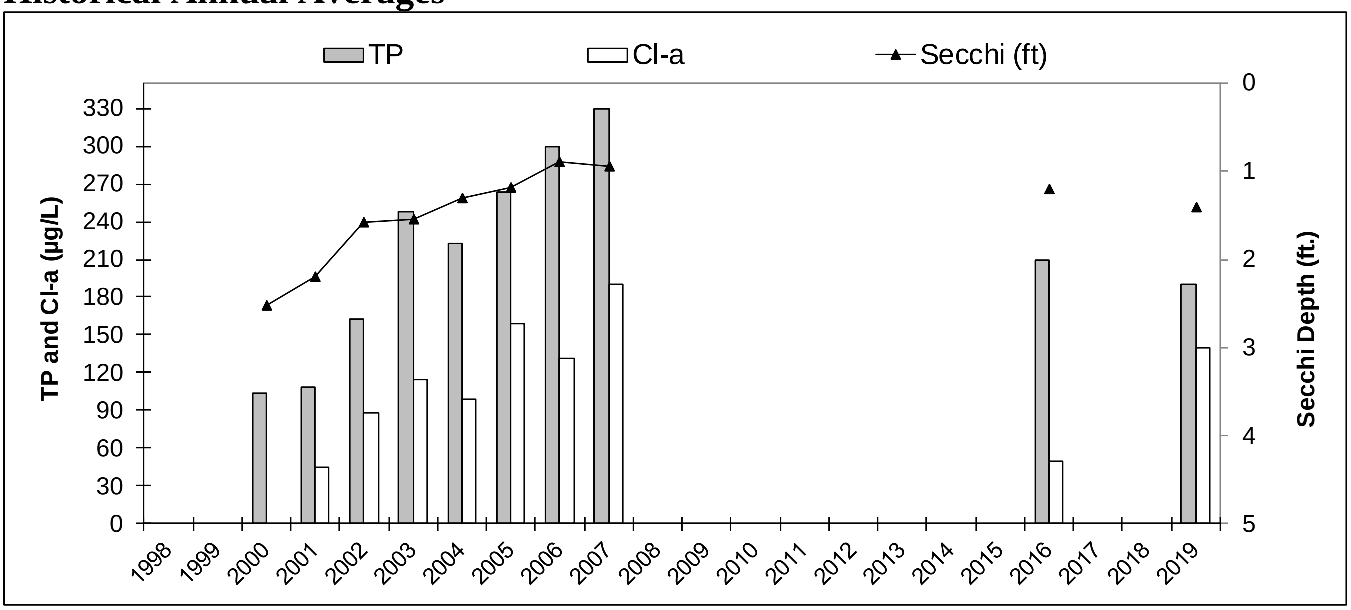
Highland Lake										
2019 Water Quality Data		Date:	5/20/2019	6/17/2019	7/22/2019	8/21/2019	9/24/2019			
		Time:	14:30	13:45	13:20	13:10	13:40			
	Units	R.L.*	Results	Results	Results	Results	Results	Average	Min	Max
pH		0.1	8.60	7.90	7.79	7.64	8.08	8.00	7.64	8.60
Specific Conductivity	mS/cm	0.01	0.281	0.258	0.233	0.174	0.148	0.219	0.148	0.281
Turbidity	FNRU	1	55.00	58.90	49.40	49.90	60.20	55	49	60
D.O.	mg/l	0.01	14.38	12.45	11.49	15.55	13.08	13.39	11.49	15.55
D.O.	%	1	138.0	147.6	129.9	157.8	142.8	143.2	129.9	157.8
Temp.	°C	0.1	12.95	21.64	23.06	22.70	19.60	20.0	13.0	23.1
Temp.	°F	0.1	55.3	71.0	73.5	72.9	67.3	68.0	55.3	73.5
Salinity	%	0.01	0.13	0.12	0.11	0.08	0.07	0.10	0.07	0.13
Cl-a	ug/L	0.5	113.0	32.0	146.0	100.0	308.0	139.8	32.0	308.0
T.P.	mg/l	0.010	0.160	0.241	0.240	0.200	0.110	0.190	0.110	0.241
T.P.	ug/l	10	160	241	240	200	110	190.200	110	241
Chloride	mg/L		40.8	35.3	26.5	21.7	16.6	28.2	17	41
Secchi	ft	0.1	1.9	1.9	1.0	1.0	0.9	1.4	0.9	1.9
Secchi	m	0.1	0.6	0.6	0.3	0.3	0.3	0.4	0.3	0.6
Physical			4	3.0	3.0	3.0	3.0	3.2	3.0	4.0
Recreational			4	4.0	3.0	3.0	3.0	3.4	3.0	4.0

*reporting limit

2019 Results



Historical Annual Averages



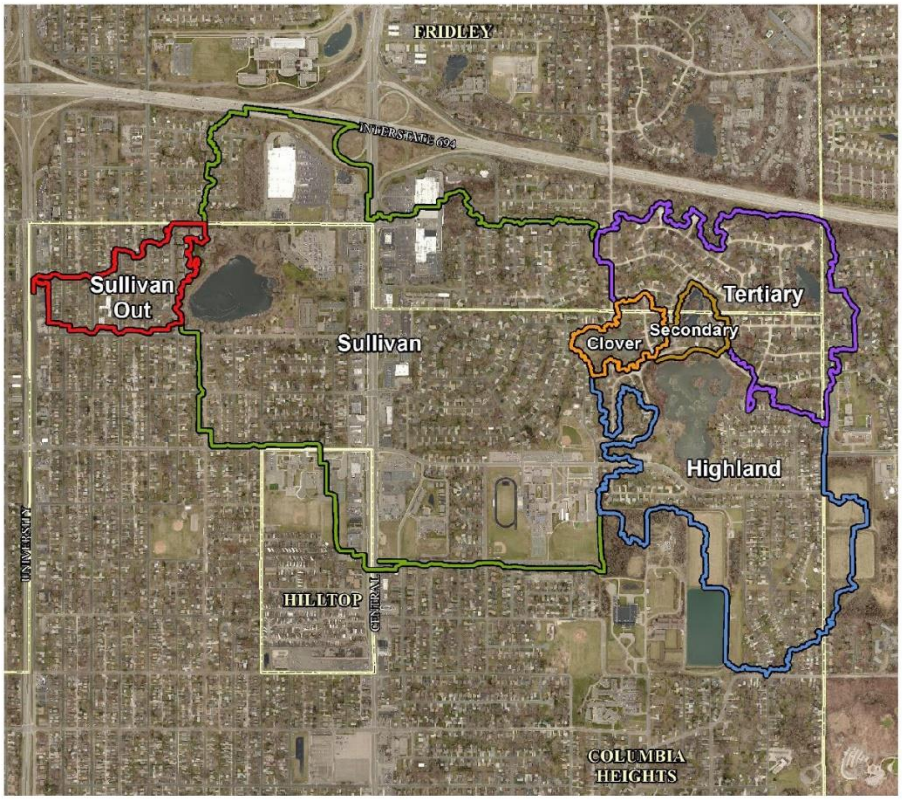
2019 Medians

pH		7.9
Specific Conductivity	mS/cm	0.233
Turbidity	NTU	55
D.O.	mg/l	13.08
D.O.	%	142.8
Temp.	°F	70.952
Salinity	%	0.11
Chlorides	mg/L	113
Cl-a	µg/L	26.5
T.P.	µg/l	200
Secchi	ft	1

Historical Report Card

Year	TP	Cl-a	Secchi	Overall
2000	D		D	**D**
2001	D	C	F	**D**
2002	F	F	F	**F**
2003	F	F	F	**F**
2004	F	F	F	**F**
2005	F	F	F	**F**
2006	F	F	F	**F**
2007	F	F	F	**F**
2016	F	D	F	**F**
2019	F	F	F	**F**
State Standards	60 ug/L	20 ug/L	>3.3 ft	

Highland and Sullivan Lakes SRA



Highland and Sullivan Lakes Stormwater Retrofit Analysis

Prepared by:

ANOKA CONSERVATION DISTRICT

for the

MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

Description: The Mississippi WMO contracted the Anoka Conservation District to perform a Stormwater Retrofit Analysis (SRA) for the subwatershed areas draining to Highland and Sullivan Lakes, as well as three nearby stormwater ponds, Clover, Secondary, and Tertiary Ponds. This process was aimed at identifying and prioritizing potential best management practices for stormwater treatment that could be retrofit into the already developed landscape to benefit the lakes and ponds.

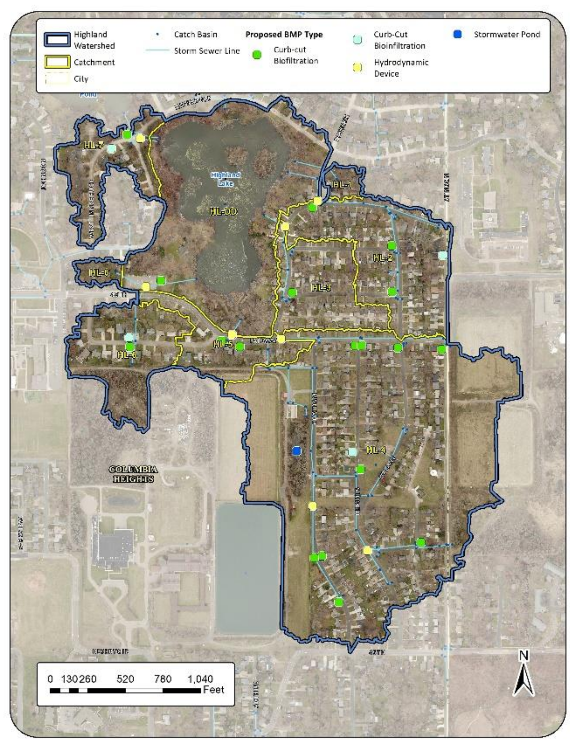
Purpose: Generate a list of potential stormwater retrofit projects in a priority drainage area ranked by cost effectiveness for pollutant removal.

Location: Contributing drainage areas to Highland and Sullivan Lakes, as well as Clover, Secondary, and Tertiary Ponds.

Results: ACD developed models of the drainage areas down to the scale of individual micro catchments draining to each stormwater catch basin using the Source Loading and Management Model for Windows (WinSLAMM). Using these models, we assessed the base conditions of the subcatchments draining to each water resource, as well as the existing conditions factoring in all existing stormwater treatment. This process gave us a relative estimates of pollutant delivery from the subcatchments to the lakes and ponds.

The next step in the analysis involved ACD siting individual stormwater practices that could be retrofit into the existing landscape. To do this, we paired an intensive GIS analysis of the individual catchments, and drove or walked each catchment to the extent practicable. We then modeled each identified potential project and assessed the relative pollutant removal to the receiving water bodies, as well as provided a cost estimate for the installation of each project. Using the modeled pollutant treatment potential, and expected cost of installation for each potential project, we ranked all 123 potential retrofit projects for cost effectiveness of pollutant removal.

The full report, including the ranked project list, is available from the Anoka Conservation District or the Mississippi WMO. It can be found on the ACD website at: https://www.anokaswcd.org/images/AnokaSWCD/Reports/Highland_and_Sullivan_Lakes_SRA.pdf



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.

Mississippi Watershed Management Organization 2019 Financial Summary

Mississippi WMO	Volunteer Precip	Lake Levels	Lake Water Quality	Highland Sullivan SRA	Outreach Collaborative	Total
Revenues						
MWMO		600	2400	7600		10600
State - Other					2742	2742
BWSR Local Water Planning			446			446
Metro ETA & NPEAP				17383		17383
Regional/Local					173	173
Anoka Co. General Services	143		87	1840	470	2540
County Ag Preserves/Projects			735			735
Service Fees					15	15
TOTAL	143	600	3667	26823	3400	34633
Expenses-						
Capital Outlay/Equip	0	0	8	11	3	24
Personnel Salaries/Benefits	136	493	3312	24926	2123	30989
Overhead	8	27	167	1387	120	1709
Employee Training	1	2	9	50	8	70
Vehicle/Mileage	2	6	47	344	26	425
Rent	6	21	174	1242	96	1539
Program Supplies	3		1171		300	1474
TOTAL	155	549	4888	27961	2677	36230

Recommendations

- Continue to monitor water quality and water levels on Highland and Sullivan Lakes.
- Implement practices identified in the Highland and Sullivan SRA report to benefit the water quality of these two lakes. Both lakes have very poor water quality, are impaired for nutrients and recreation, and both have popular parks adjacent to them that many visitors and occupants of the area frequent. Many people would enjoy and appreciate improved water quality in these lakes.