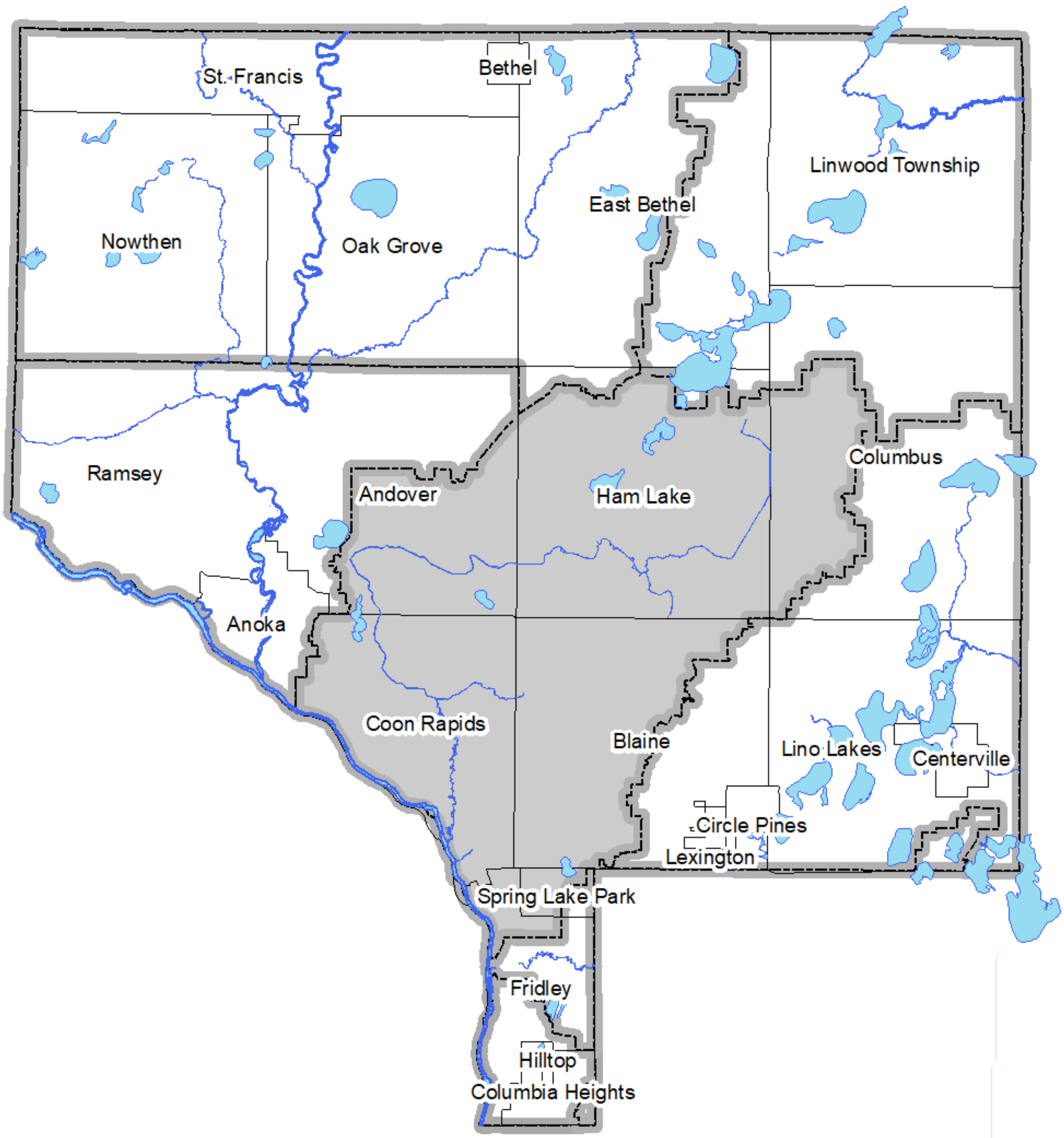
Excerpt from the 2022 Water Almanac

Chapter 6: Coon Creek Watershed



Prepared by the Anoka Conservation District

Table of Contents

Summary of Findings

Description: This is a brief summary of new findings and notable results from 2022. Detailed analyses for all individual sites can be found within this report.

Precipitation:

- Overall, 2022 was drier but precipitation throughout the state varied. In Anoka County, a few heavy rainfalls in spring gave way to abnormally dry or drought conditions throughout the growing season and fall.

Lake Levels:

- Water levels on all lakes declined throughout the open water season due to drought conditions, with some lakes at the second or third lowest levels seen in the last 25 years. Bunker Lake had no standing water by late-summer.

Stream Hydrology:

- Ditches and streams saw less fluctuation in stage than previous years and many of the stream sites recorded the lowest water elevations on record.
- Flow rates were minimal throughout the season and some sites periodically had no flow.

Wetland Hydrology:

- In 2022, reference wetland sites experienced low water levels, resulting in water levels dropping below the measurable depth of equipment at some sites.

Stream Water Quality:

- Elevated total phosphorus (TP) concentrations, especially during storms, are an issue throughout the Coon Creek watershed. Along the main stem of Coon Creek, TP increases the most in the upper portions of the watershed. TP declines or holds steady in the lower portions of the watershed. In the Sand Creek subwatershed, phosphorus is highest in the Ditch 39 and 60 tributaries and less so in Ditch 41. Pleasure Creek phosphorus is moderate except during some storms. Springbrook Creek phosphorus is routinely high, especially during storms.
- TP concentrations at the Sand Creek outlet are improving in a statistically significant fashion over time during baseflow conditions.
- High *E. coli* levels persist throughout the watershed, and are highest in Pleasure Creek and Springbrook Creek. In Coon Creek, *E. coli* is lowest in the upper watershed and moderate in the lower watershed. In Sand, Pleasure and Springbrook Creeks, *E. coli* sources appear to be throughout the watershed.
- Dissolved pollutants are a concern watershed-wide. There is some evidence that levels are increasing over time. Springbrook and Pleasure Creeks have by far the highest dissolved pollutants; chloride is likely a significant contributor.

Recommendations

- **Continue to update older stream rating curves.** Changes in stream morphology necessitate periodic updates by manually measuring flow and stage under a variety of water levels. Discrete flow measurements collected during water quality sampling have been used for this purpose and used to develop rating curves at new monitoring sites.

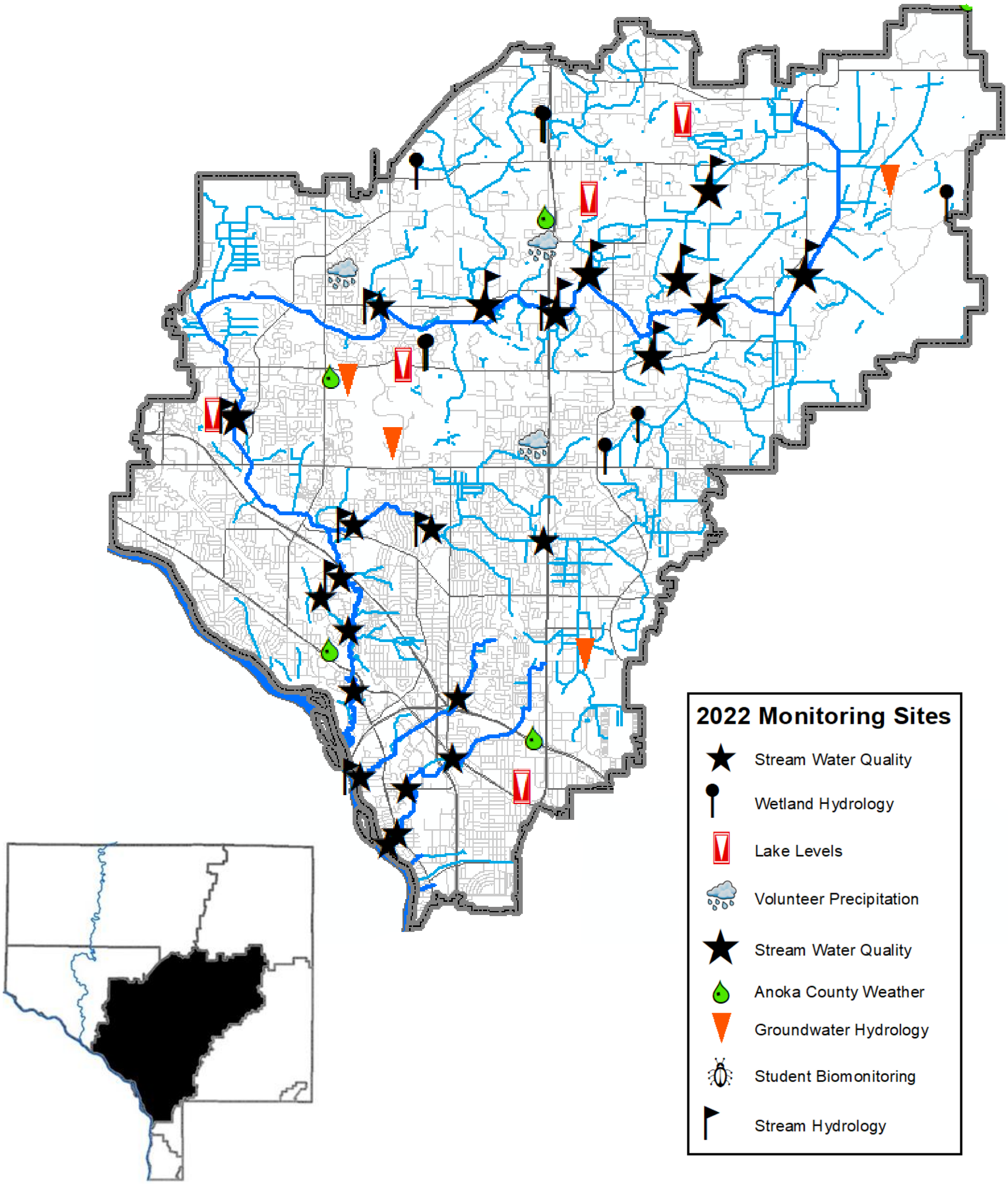
- **Continue implementing water quality monitoring at new sites,** and continue prioritizing sites where upstream to downstream analysis indicates an influx of pollutants. Over the past few years several new water quality sites were established in the upper portions of the watershed which will aid in understanding pollutant loading throughout the watershed.
  - Ditch 11, 37, 58, and Ditch 59 tributaries to Coon Creek should be priority monitoring locations to evaluate phosphorus loading in the Coon Creek System.
  - Ditch 60 and Ditch 39 tributaries to Sand Creek should be priority monitoring locations to evaluate phosphorus loading in the Sand Creek System.
  - Investigation into potential TP loading from the Springbrook Nature Center wetland complex or surrounding neighborhoods to examine phosphorus loading in the Springbrook system, especially during larger storms.

- **Continue monitoring chlorides regularly and consider collecting winter and spring samples.** Overall chlorides seem to be trending higher at many of the monitoring sites. Streams in developed watersheds are at especially high risk of elevated and increasing chloride concentrations.

- **Continue implementing stormwater treatment practices.** Total phosphorus and *E. coli* are priority pollutants because they are either high or identified as an aquatic life stressor throughout the watershed. Because of the difficulty of addressing *E. coli*, it may be practical to focus on TP with secondary benefits of *E. coli* reductions. This is particularly the case where practices such biochar that can reduce both are feasible. In the upper portions of the watershed where lands are less developed and more rural., recent monitoring on tributary ditches reveal high sources of pollutant loading in the main stem of Coon Creek. Implementing stormwater treatment in these areas should be a priority and a holistic management approach is likely required including agricultural best management practices.

- **Continue implementing stormwater treatment practices in targeted locations.** While practices in many locations are justified, some locations to target include:
  - Coon Creek upstream of 131st Avenue for phosphorus.
  - Coon Creek downstream of 131st Avenue for *E. coli*.
  - Sand Creek tributaries of Ditch 39 and Ditch 60 for phosphorus.
  - Pleasure Creek and Springbrook *E. coli* and dissolved pollutants throughout their drainages.

2022 Water Monitoring Locations – Coon Creek Watershed



Lake Level Monitoring

Description: Staff gauges were installed in lakes by ACD and surveyed by the MN DNR. Weekly water levels were recorded by local volunteers. The past five and twenty-five years of data for each lake are displayed below. All historical data are available on the Minnesota DNR website using the "LakeFinder" feature (www.dnr.mn.us.state\lakefind\index.html).

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

Locations:

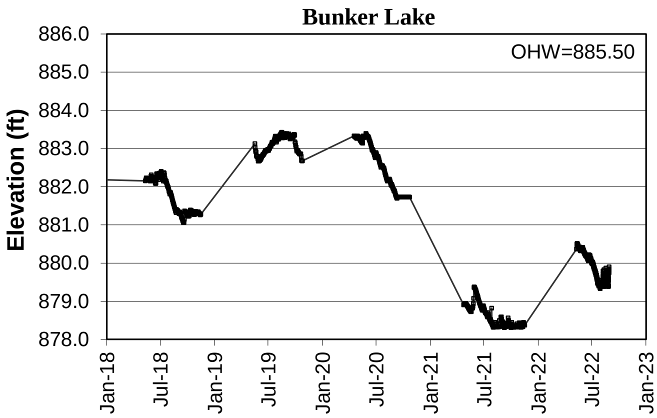
Site	City
Bunker Lake	Andover
Crooked Lake	Andover/Coon Rapids
Ham Lake	Ham Lake
Lake Netta	Ham Lake
Laddie Lake	Blaine

Results: Following a modest spring increase in lake levels, water levels on all lakes declined throughout the open water season due to drought conditions. At their lowest points, lakes were at the second or third lowest levels seen in the past 25 years. Very similar trends were observed between the lakes, highlighting their dependence on local shallow groundwater levels and susceptibility to drought. This was the second year of drought, with levels staying roughly 12-18" below historical averages. The low water levels made it difficult for staff to keep gauges in standing, accessible water.

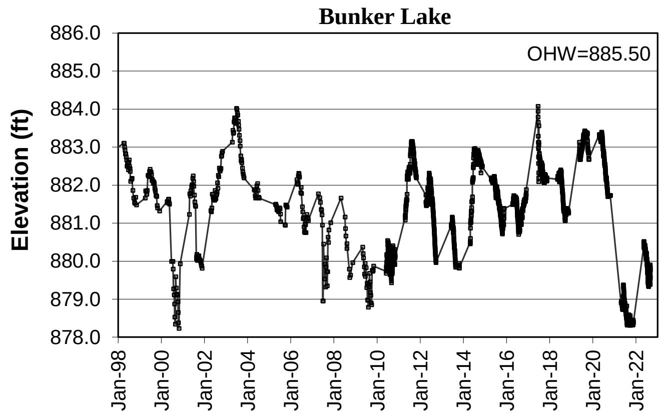
At Bunker Lake, an electronic datalogger was installed that took continuous water level readings. Equipment was moved multiple times throughout the season because of low water levels and eventually the basin went dry in late-summer and data was no longer able to be collected.

The Ordinary High Water Level (OHW) elevation is listed for each lake on the corresponding graphs below. Any work completed below this elevation requires a DNR permit.

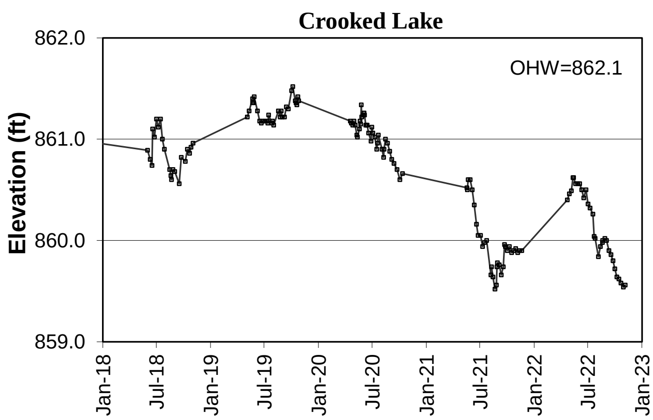
Bunker Lake Levels – last 5 years



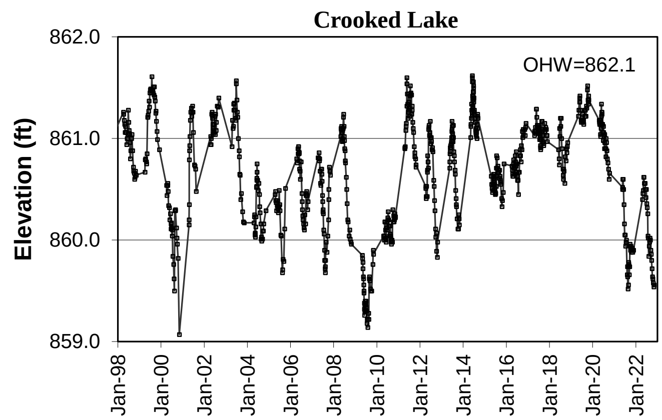
Bunker Lake Levels – last 25 years



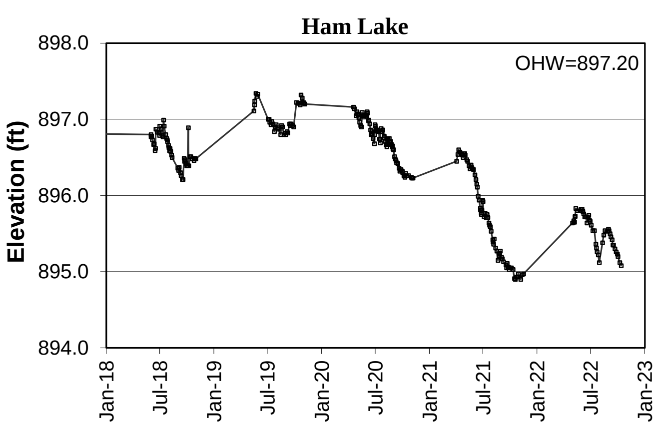
Crooked Lake Levels – last 5 years



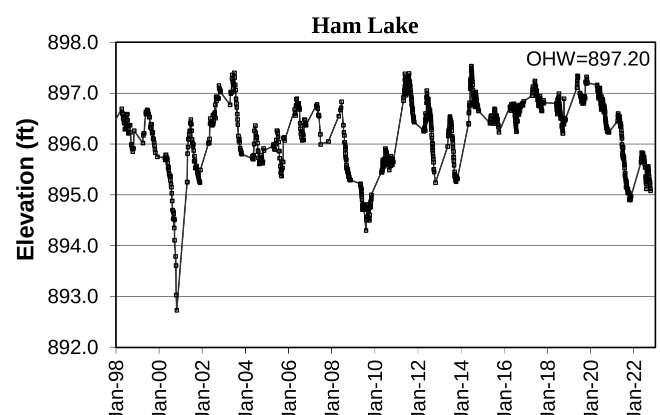
Crooked Lake Levels – last 25 years



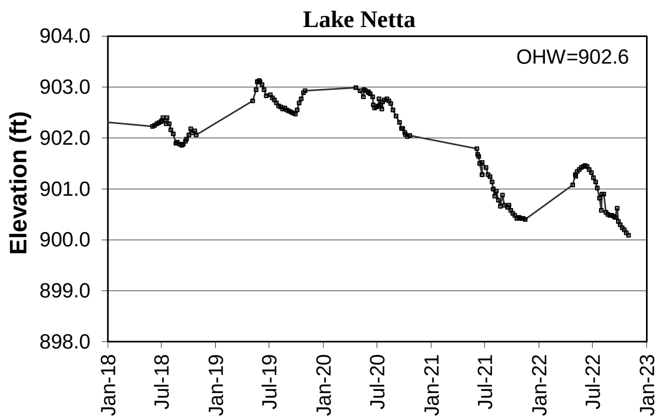
Ham Lake Levels – last 5 years



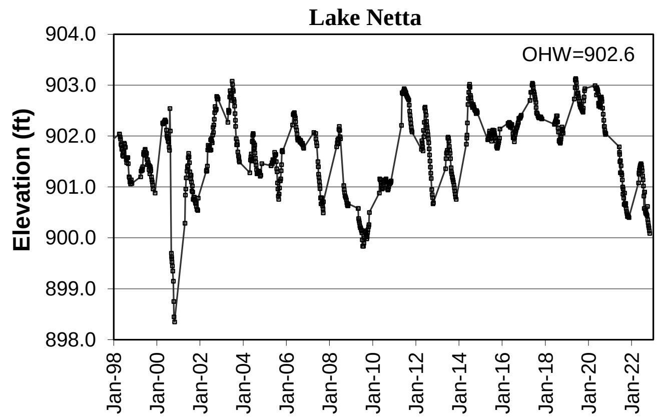
Ham Lake Levels – last 25 year



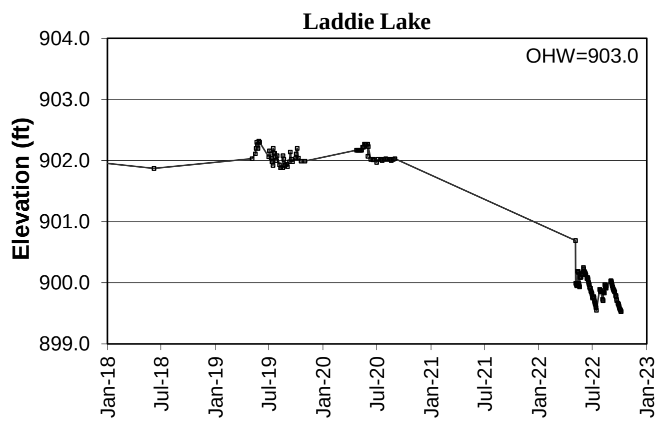
Lake Netta Levels – last 5 years



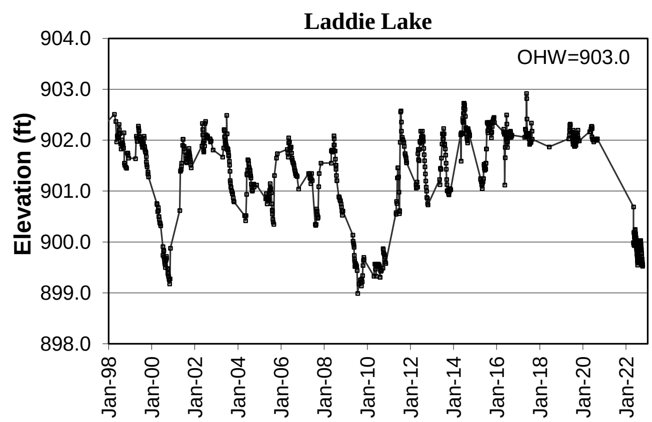
Lake Netta Levels – last 25 years



Lake Laddie Level – last 5 years



Lake Laddie Level – last 25 years



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

Lake	Year	Average	Min	Max
Bunker	2016	881.07	881.73	882.40
	2017	883.09	882.67	883.43
	2019	882.52	881.70	883.39
	2020	878.60	878.31	879.38
	2022	879.92	879.33	880.51

*No data was collected at Bunker Lake after 8/29/2022

Lake	Year	Average	Min	Max
Crooked	2018	860.87	860.56	861.20
	2019	861.28	861.14	861.52
	2020	861.04	860.60	861.34
	2021	859.97	859.52	860.60
	2022	860.12	859.54	860.62

Lake	Year	Average	Min	Max
Netta	2018	902.13	901.86	902.40
	2019	902.93	902.47	903.13
	2020	902.60	902.03	902.99
	2021	900.94	900.40	901.79
	2022	900.85	901.46	900.09

Lake	Year	Average	Min	Max
Ham	2018	896.60	896.21	896.99
	2019	897.02	896.80	897.34
	2020	896.80	896.32	897.16
	2021	895.70	894.90	896.60
	2022	895.53	895.08	895.83

Lake	Year	Average	Min	Max
Laddie	2016	902.07	901.12	902.50
	2017	902.16	901.92	902.92
	2019	902.05	901.88	902.32
	2020	902.11	901.97	902.27
	2022	899.91	899.53	900.69

Wetland Hydrology

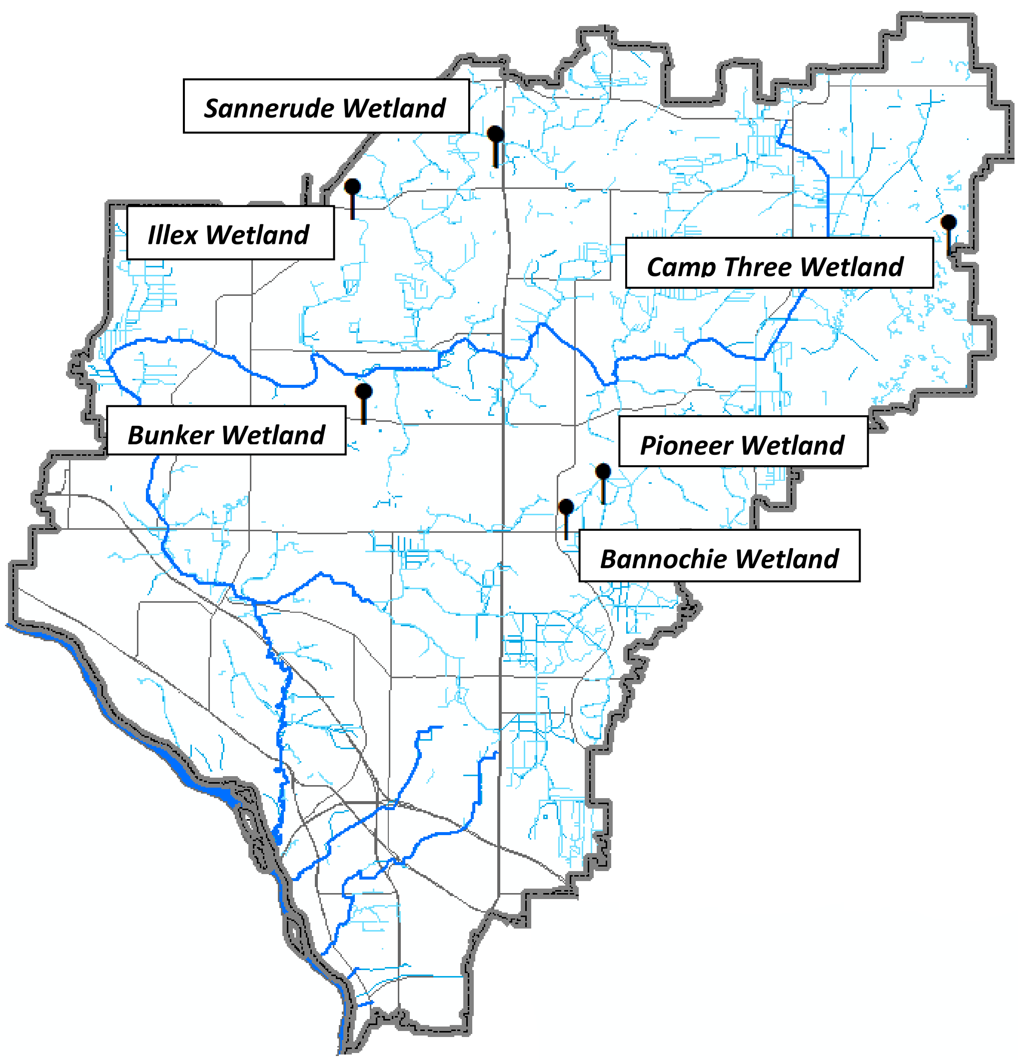
Description: Continuous groundwater level monitoring at a wetland boundary. Countywide, ACD maintains a network of 23 wetland hydrology monitoring stations.

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

Locations: Bannochie Wetland, Bunker Wetland, Camp Three Wetland, Ilex Wetland, Pioneer Park Wetland, Sannerud Wetland

Results: See the following pages.

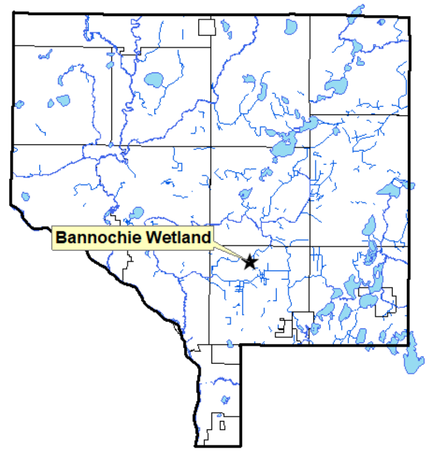
Coon Creek Watershed Wetland Hydrology Monitoring Sites



BANNOCHIE REFERENCE WETLAND

Radisson Road and Highway 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

Surrounding Soils: Rifle and some Zimmerman fine sand

Soils at Well Location:

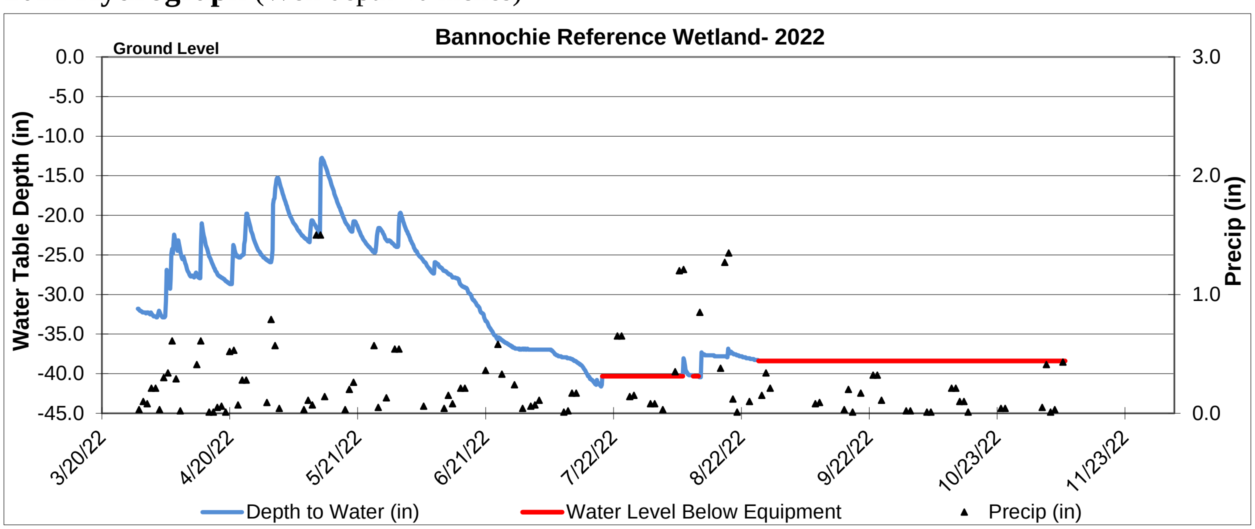
Horizon	Depth	Color	Texture	Redox
Oe1	0-6	10yr 2/1	Organic	-
Oe2	6-40	10yr 2/1-7.5yr2.5/1	Organic	-

Vegetation at Well Location:

Scientific	Common	% Coverage
Phragmites australis	Giant Reed	80
Rubus spp.	Dewberry	100
Onoclea sensibilis	Sensitive Fern	10

Notes: This boring is located within the wetland basin. Dense residential construction has occurred in recent years, including construction dewatering. Water levels at the site were below the equipment in late-summer and fall.

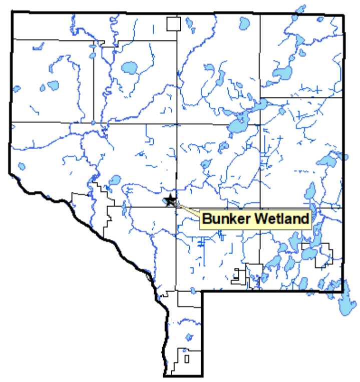
2022 Hydrograph (Well depth 40 inches)



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

Surrounding Soils: Zimmerman fine sand

Soils at Well Location:

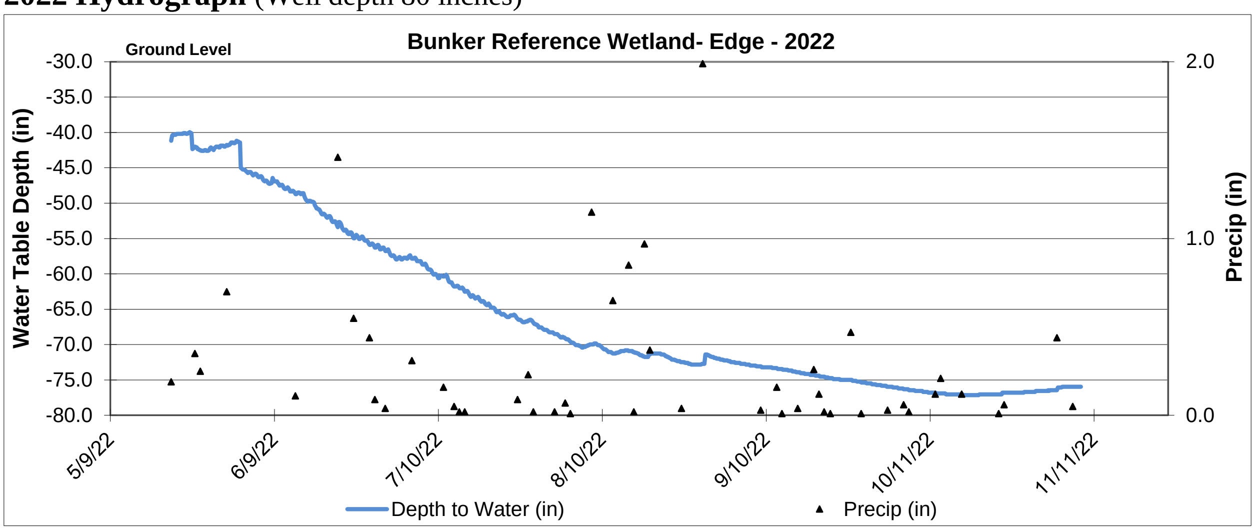
Horizon	Depth	Color	Texture	Redox
AC1	0-3	7.5yr3/1	Sandy Loam	50% 7.5yr 4/6
AC2	3-20	10yr2/1-5/1	Sandy Loam	-
2Ab1	20-31	N2/0	Mucky Sandy Loam	-
2Oa	31-39	N2/0	Organic	-
2Oe	39-44	7.5yr 3/3	Organic	-

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	100
Populus tremuloides(T)	Quaking Aspen	30

Notes: This is one of two monitoring sites at this wetland. This boring is located at the wetland boundary. In 2022, equipment was placed in a deeper boring at the same location, allowing for data collection even during periods of low water levels.

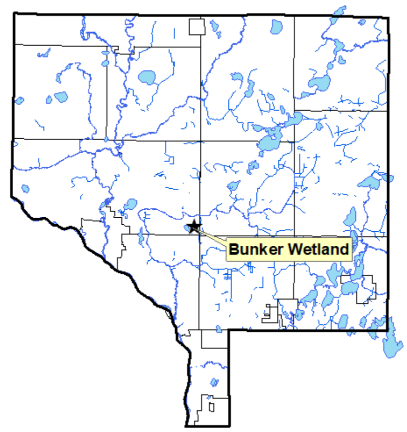
2022 Hydrograph (Well depth 80 inches)



Bunker Reference Wetland – Middle

Bunker Hills Regional Park, Andover

Site Information



Monitored Since:	2006
Wetland Type:	2
Wetland Size:	~1.0 acres
Isolated Basin:	Yes
Connected to a Ditch:	No
Surrounding Soils:	Zimmerman fine sand

Soils at Well Location:

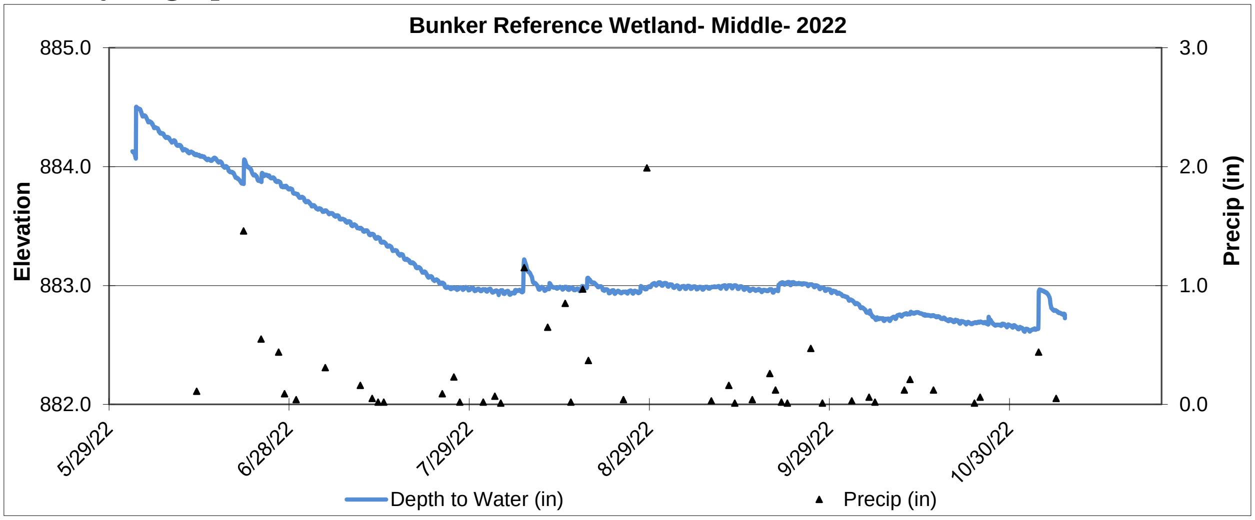
Horizon	Depth	Color	Texture	Redox
Oa	0-22	N2/0	Organic	-
Oe1	22-41	10yr2/1	Organic	-
Oe2	41-48	7.5yr3/4	Organic	-

Vegetation at Well Location:

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

Notes: This is one of two monitoring sites at this wetland. This boring is located in the middle of the basin. Equipment at this site was programmed to record elevation instead of depth below ground.

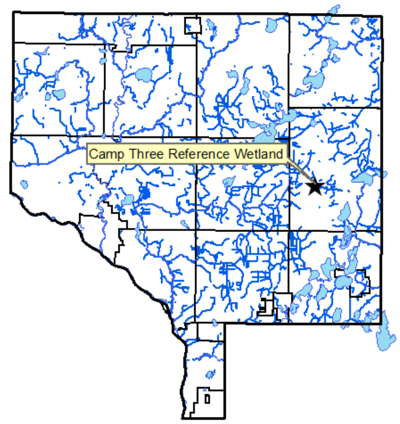
2022 Hydrograph (Well depth 40 inches)



Camp Three Reference Wetland

Carlos Avery Wildlife Management Area, Columbus Township

Site Information



Monitored Since: 2008

Wetland Type: 3

Wetland Size: >200 acres

Isolated Basin: No

Connected to a Ditch: Yes

Surrounding Soils: Markey Muck, Zimmerman fine sand

Soils at Well Location:

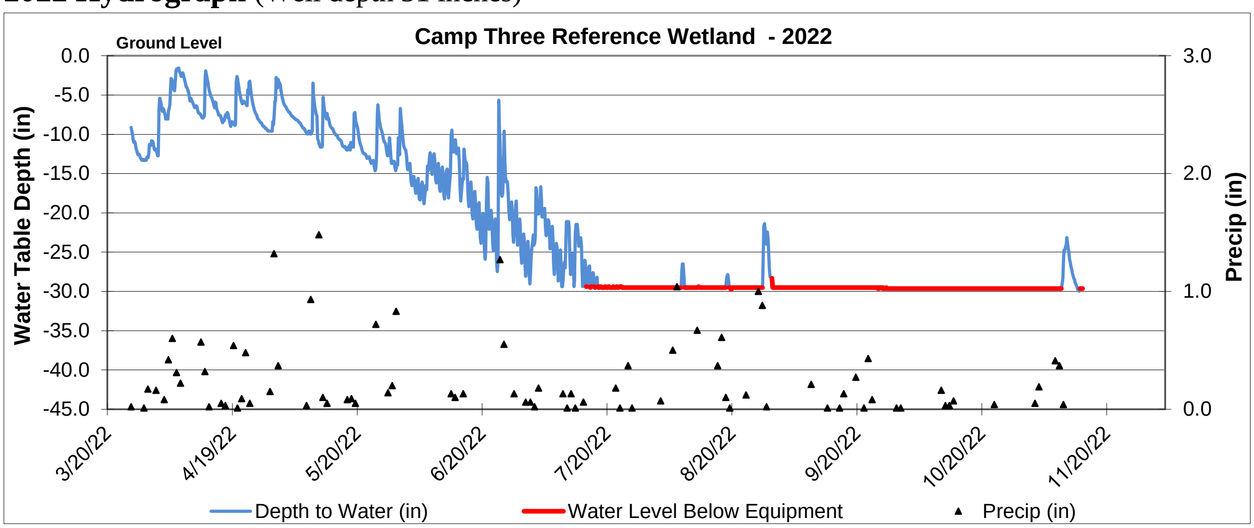
Horizon	Depth	Color	Texture	Redox
A	0-4	N2/0	Mucky Fine Sandy Loam	-
A2	4-13	10yr 3/1	Fine Sandy Loam	20% 5yr 5/6
Bg1	13-21	10yr 5/1	Fine Sandy Loam	2% 10yr 5/6
Bg2	21-39	10yr 5/1	Fine Sandy Loam	5% yr 5/6
Bg3	39-55	10yr 5/1	Very Fine Sandy Loam	10% 10yr 5/6

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

Notes: This boring is located at the wetland boundary. Water levels fluctuate rashly throughout the year. Water control structures in the Carlos Avery Wildlife Management Area likely influence water levels at this site.

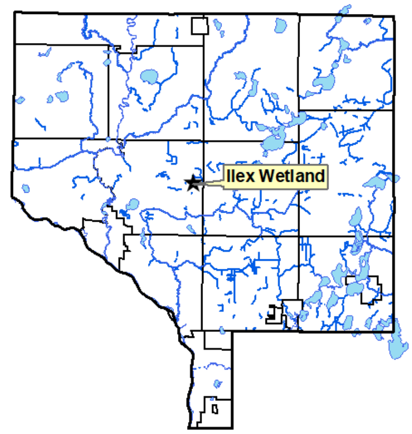
2022 Hydrograph (Well depth 31 inches)



ILEX REFERENCE WETLAND – EDGE

City Park at Ilex Street and 159th Avenue, Andover

Site Information



Monitored Since: 1996

Wetland Type: 2

Wetland Size: ~9.6 acres

Isolated Basin: Yes

Connected to a Ditch: No

Surrounding Soils: Loamy wet sand and Zimmerman fine sand

Soils at Well Location:

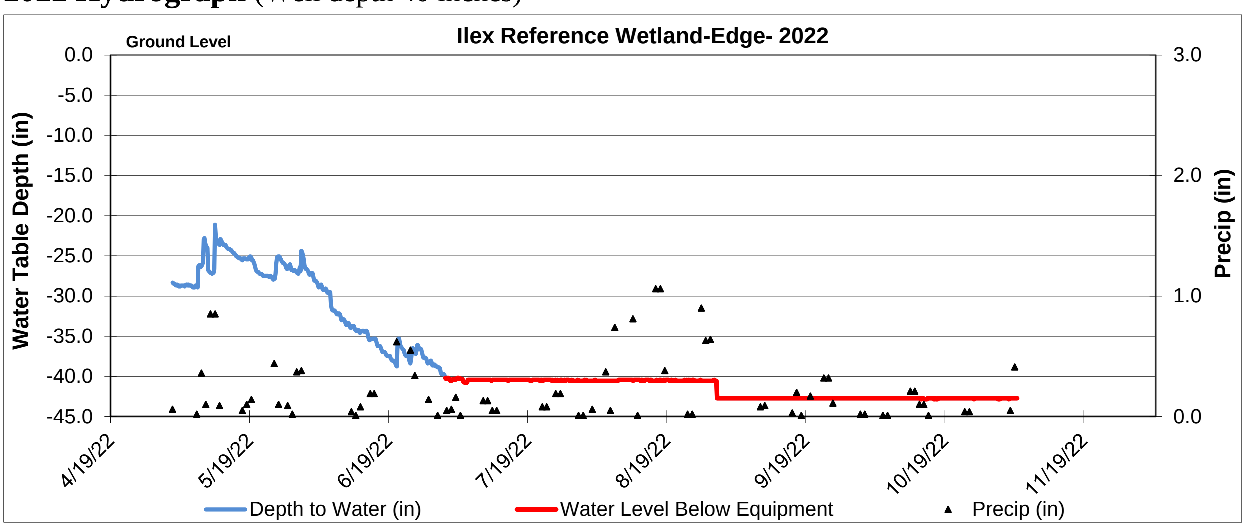
Horizon	Depth	Color	Texture	Redox
A	0-10	10yr2/1	Fine Sandy Loam	-
Bg	10-14	10yr4/2	Fine Sandy Loam	-
2Ab	14-21	N2/0	Sandy Loam	-
2Bg1	21-30	10yr4/2	Fine Sandy Loam	-
2Bg2	30-45	10yr5/2	Fine Sand	-

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

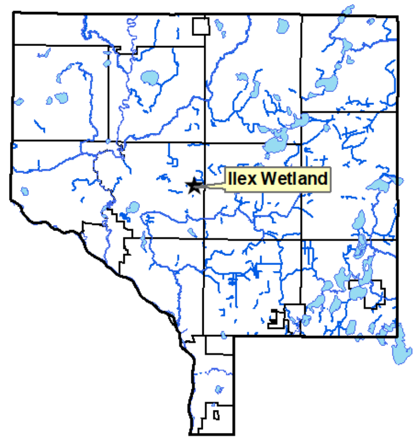
Notes: This is one of two monitoring sites at this wetland. This boring is located at the wetland boundary.

2022 Hydrograph (Well depth 40 inches)



ILEX REFERENCE WETLAND – MIDDLE

City Park at Ilex Street and 159th Avenue, Andover



Site Information

Monitored Since: 2006

Wetland Type: 2

Wetland Size: ~9.6 acres

Isolated Basin: Yes

Connected to a Ditch: No

Surround Soils: Loamy wet sand and Zimmerman fine sand

Soils at Well Location:

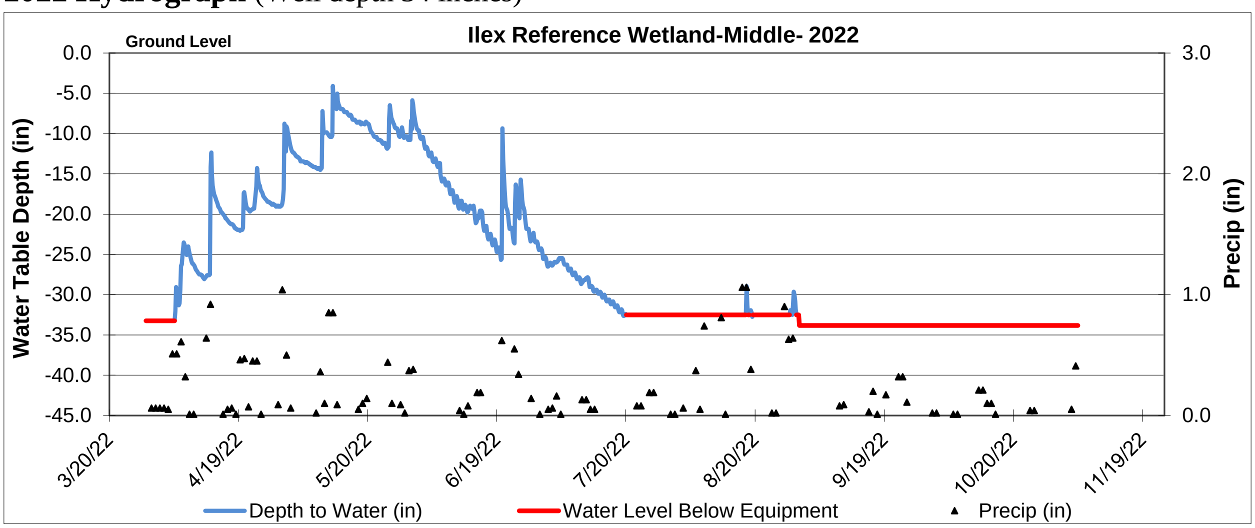
Horizon	Depth	Color	Texture	Redox
Oa	0-9	N2/0	Organic	-
Bg1	9-19	10yr4/2	Fine Sandy Loam	-
Bg2	19-45	10yr5/2	Fine Sand	-

Vegetation at Well Location:

Scientific	Common	% Coverage
Phalaris arundinacea	Reed Canary Grass	80
Typha angustifolia	Narrow-leaf Cattail	40

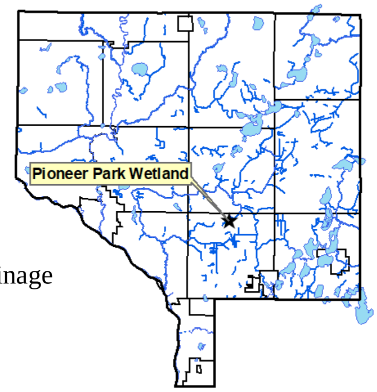
Notes: This is one of two monitoring sites at this wetland. This boring is located near the center of the wetland basin.

2022 Hydrograph (Well depth 34 inches)



PIONEER PARK REFERENCE WETLAND

Pioneer Park, 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, and nearby ditches.

Surround Soils: Rifle and loamy wet sand

Soils at Well Location:

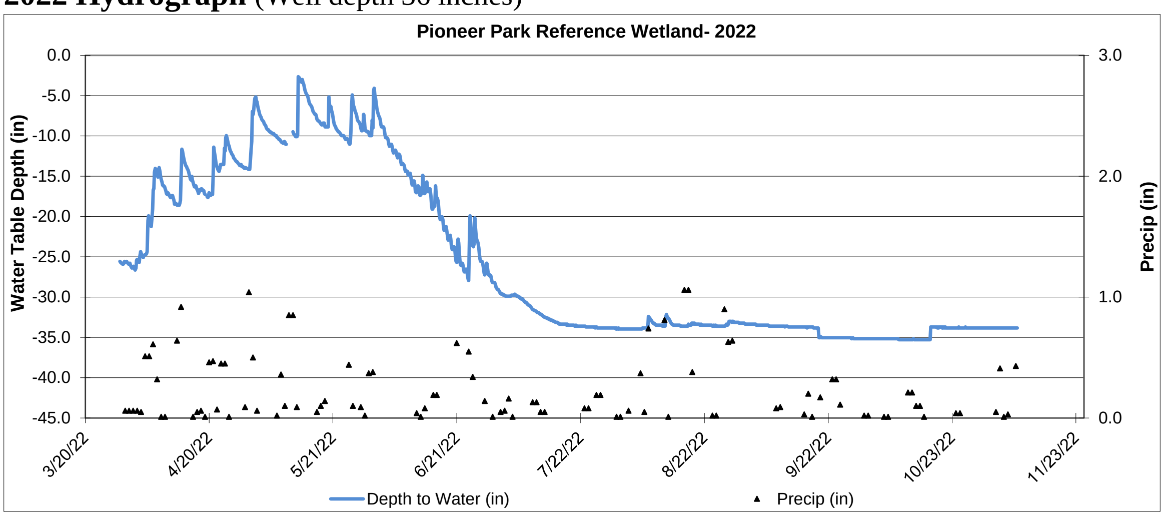
Horizon	Depth	Color	Texture	Redox
Oa1	0-4	10yr 2/1	Sapric	-
Oa2	4-8	N 2/0	Sapric	-
AB	8-12	10yr 3/1	Mucky Sandy Loam	-
Bw	12-27	2.5y 5/3	Loamy Sand	-
Bg	27-40	2.5y 5/2	Loamy Sand	-

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

Notes: This boring is located within the wetland basin.

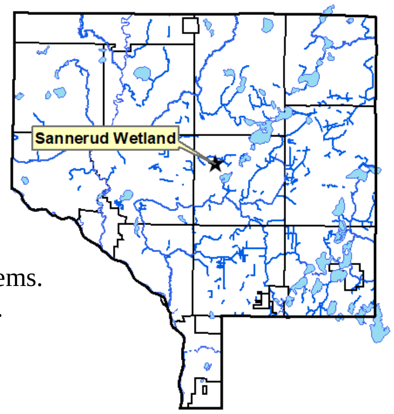
2022 Hydrograph (Well depth 36 inches)



Sannerud Reference Wetland – Edge

Highway 65 at 165th Avenue, 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.

Surrounding Soils: Zimmerman and Lino

Soils at Well Location:

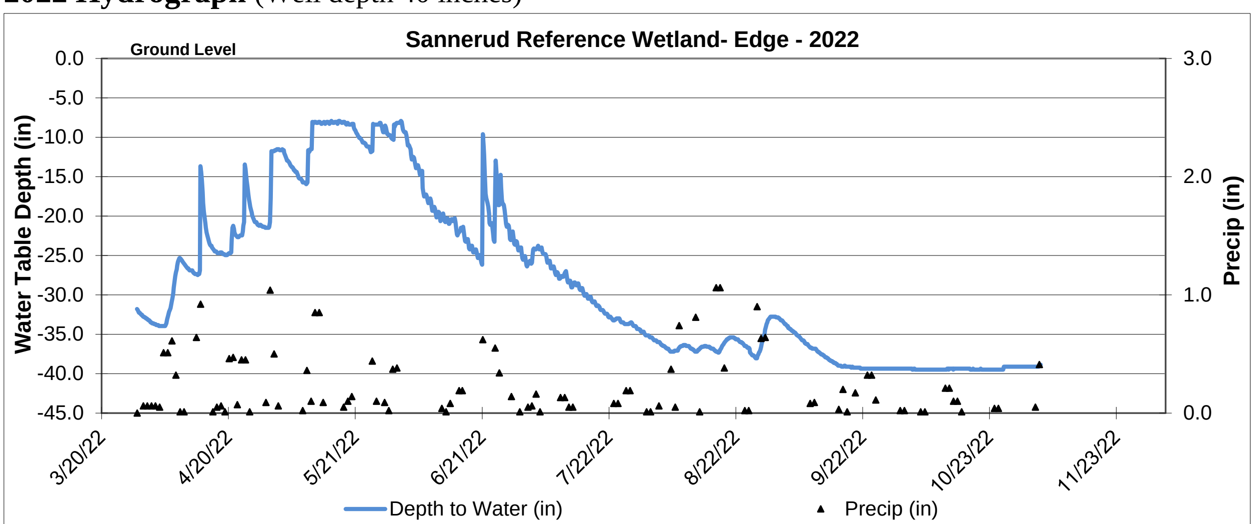
Horizon	Depth	Color	Texture	Redox
Oa	0-8	N2/0	Sapric	-
Bg1	8-21	10yr 4/1	Sandy Loam	-
Bg2	21-40	10yr 4/2	Sandy Loam	-

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

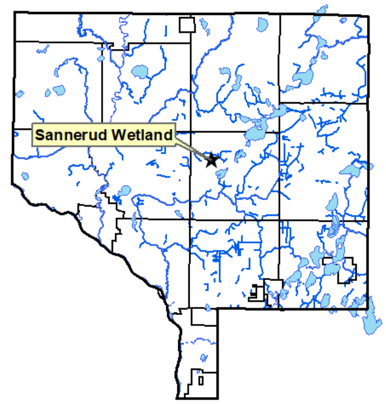
Notes: This is one of two monitoring sites at this wetland. This boring is located at the wetland's edge

2022 Hydrograph (Well depth 40 inches)



SANNERUD REFERENCE WETLAND – MIDDLE

Highway 65 at 165th Avenue, Ham Lake



Site Information

Monitored Since: 2005

Wetland Type: 2

Wetland Size: ~18.6 acres

Isolated Basin: Yes

Surrounding Soils: Zimmerman and Lino

Soils at Well Location:

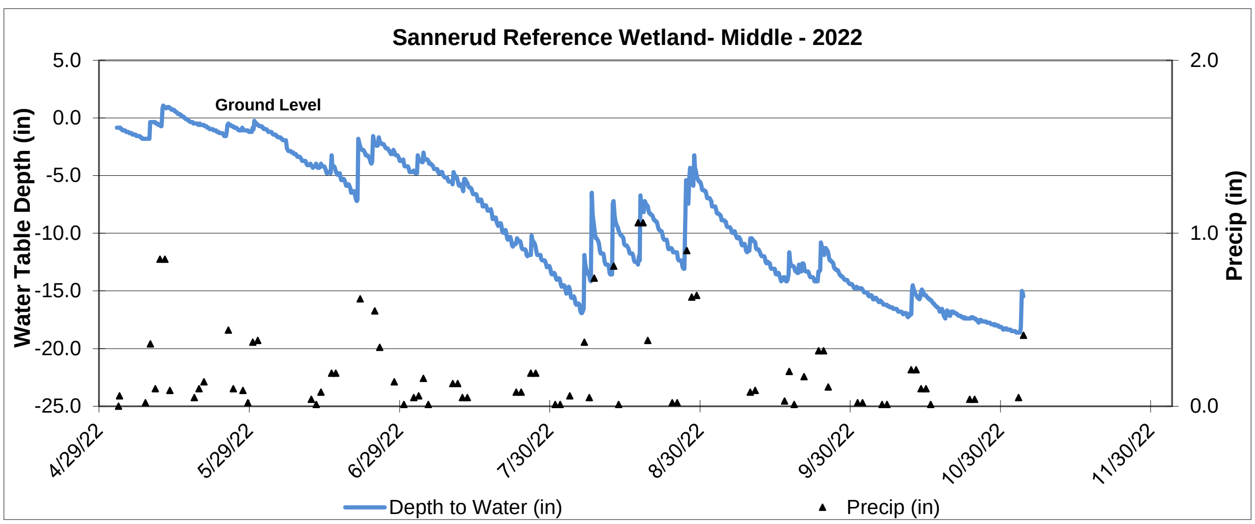
Horizon	Depth	Color	Texture	Redox
Oe	0-3	7.5yr 3/1	Organic	-
Oe2	18-Mar	10yr 2/1	Organic	-
Oa	18-48	10yr 2/1	Organic	-

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

Notes: This boring is located near the center of the wetland basin.

2022 Hydrograph (Well depth 40 inches)



Reference Wetland Analysis

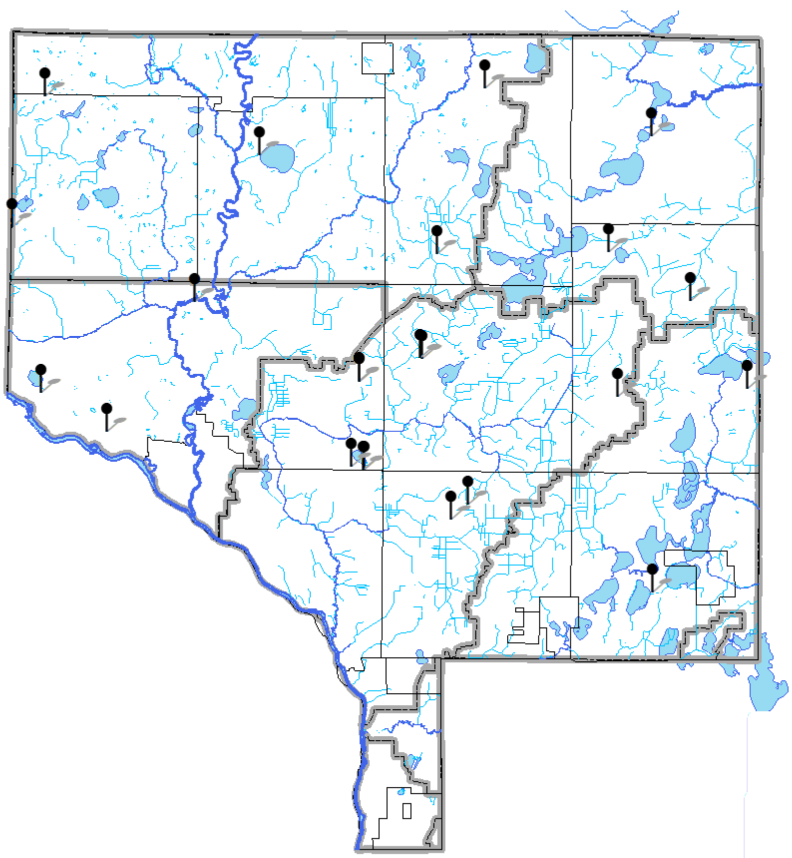
Description: This section includes analyses of wetland hydrology data for 19 reference wetlands collected from 22 monitoring sites. Groundwater levels at the edges or middle of these wetlands are recorded every four hours. Many of the sites have been monitored since 1996. These analyses summarize the enormous multi-year multi-wetland dataset. A database summarizing all of the data is now available online through the ACD website (https://maps.barr.com/Anoka/Home/Chart/). This database allows for additional, more specific, analyses to be done in order to answer questions as they arise, particularly through the wetland regulatory process.

Purpose: To provide a summary of the hydrological conditions in monitored wetlands across Anoka County that can be used to assist with wetland regulatory decisions. In particular, these data sets assist with deciding if an area is or is not a wetland by comparing the hydrology of an area in question to other known wetlands in the area.

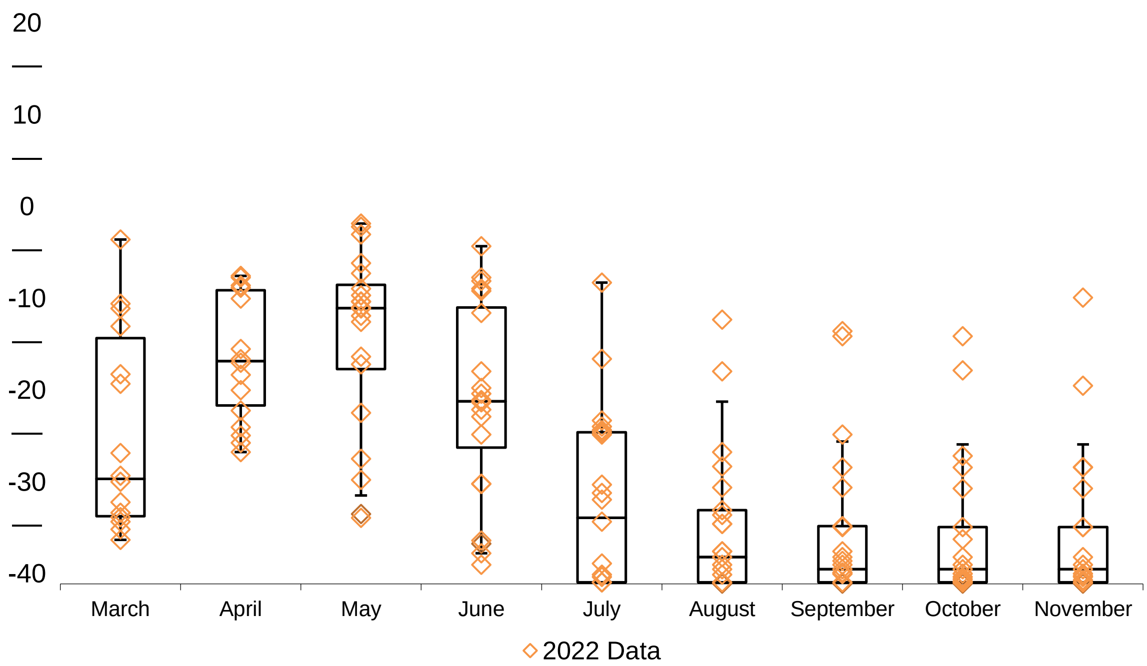
Locations: 19 reference wetland hydrology monitoring sites in Anoka County.

Results: On the following page, there is a summary of data for 2022, along with all years with available data.

Reference Wetland Hydrology Monitoring Sites – Anoka County



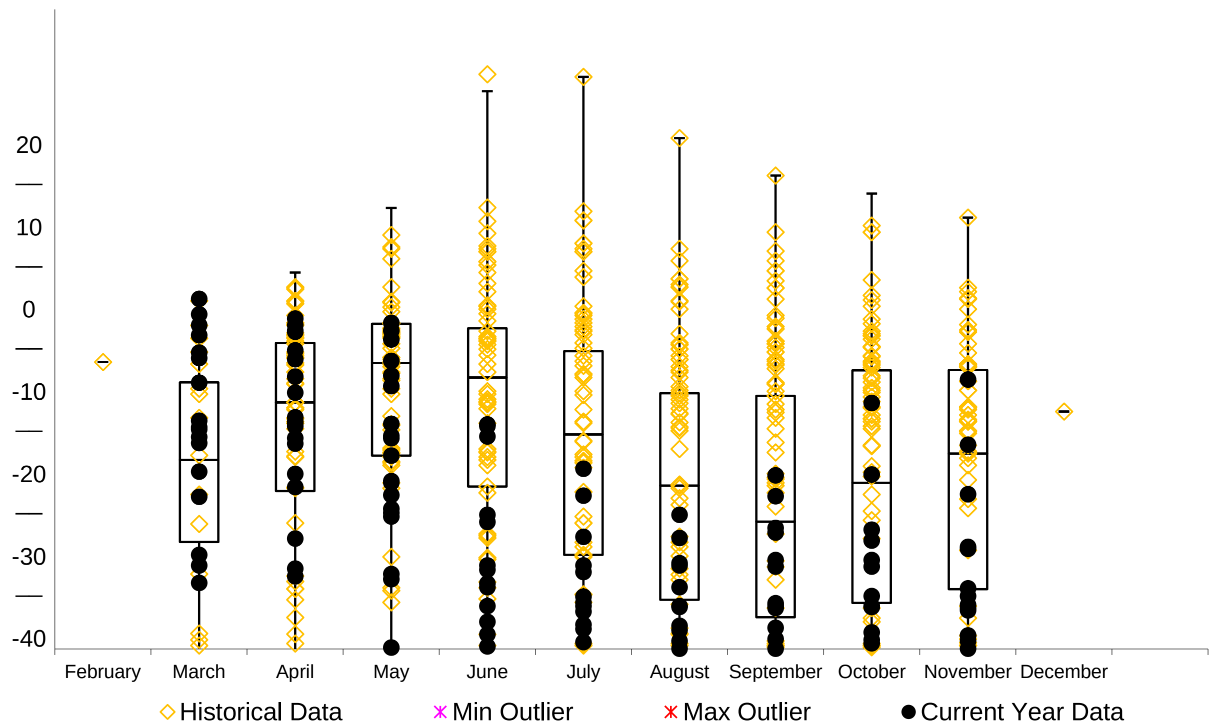
2022 Reference Wetland Water Levels Summary: Each marker represents the median depth to the water table at the edge of one reference wetland for a given month in 2022. The quantile boxes show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (floating horizontal lines). Maximum well depths were 40 to 45 inches, so a reading greater than -40 inches likely indicates water below the well at an unknown depth.



Quantiles

Month	Min	10%	25%	Median	75%	90%	Max
3	-35.2	-33.828	-32.6	-28.59	-13.3	-9.70	-2.6
4	-25.7	-24.2	-20.6	-15.8	-8.1	-7.0	-6.5
5	-32.4	-26.6	-16.7	-10.0	-7.5	-2.0	-0.8
6	-36.7	-35.3	-25.2	-20.2	-10.0	-7.0	-3.3
7	-46.6	-42.0	-39.8	-32.8	-23.5	-22.3	-7.3
8	-43.1	-42.1	-39.8	-37.1	-32.0	-25.7	-11.3
9	-43.4	-42.7	-39.8	-38.4	-33.7	-23.8	-12.5
10	-43.4	-42.1	-39.8	-38.4	-33.8	-26.1	-13.1
11	-43.4	-42.1	-39.8	-38.4	-33.8	-27.3	-8.9

1996 – 2022 Reference Wetland Water Levels Summary: Each dot represents the median depth to the water table at the edge of one reference wetland for a month between 1996 and 2022. The quantile boxes show the median (median line), 25th and 75th percentile (ends of box), and 10th and 90th percentile (floating horizontal lines). Maximum well depths were 40 to 45 inches, so a reading greater than -40 inches likely indicates water below the well at an unknown depth.



Discussion:

The purpose of reference wetland data is to help ensure that wetlands are accurately identified by regulatory personnel, and to provide a better understanding of shallow groundwater hydrology. State and federal laws place restrictions on filling, excavating, and other types of activities in wetland areas. Determining whether it meets the legal definitions of a wetland can require good data, particularly for locations that are occasionally wet. Complicating the issue is that conditions in wetlands are constantly changing; an area that is very wet and clearly a wetland may be completely dry only a few weeks later. As a result, regulatory personnel analyze a variety of environmental factors including soils, vegetation, and hydrological conditions. Reference wetland data provide a benchmark for comparing hydrological conditions, 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 monitored wetlands to water levels in a possible wetland area. The tables above are based upon percentiles of the water levels documented at known wetland boundaries. The quantile boxes in the figures delineate the 10th, 25th, 50th, 75th, and 90th percentiles. Water table depths outside of the box have a low likelihood of occurring, or may only occur under extreme circumstances such as abnormal climate conditions or in the presence of anthropogenic hydrologic alterations. If sub-surface water levels in an area are similar to those in reference wetlands, there is a 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 varying 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.

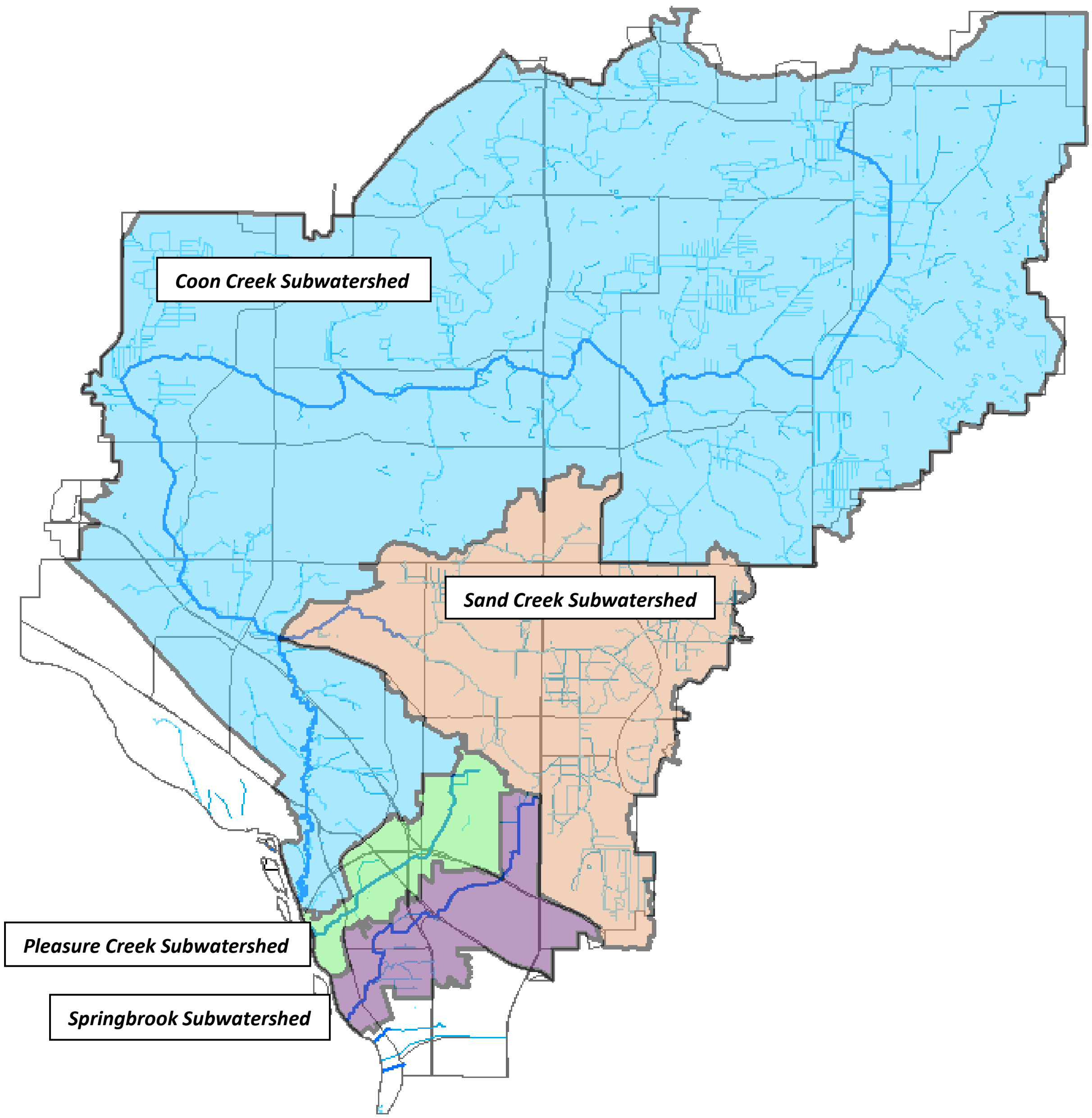
Water Quality & Stream Hydrology Monitoring

Description: Water chemistry grab sampling, discrete discharge measurements, and continuous stage monitoring

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

Locations: Watershed-wide

Each subwatershed is presented separately on the following pages.



METHODS

The methods described below were used in each of the monitored subwatersheds. This report includes historical 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 and 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. Data collection activities were split between ACD and CCWD staff; methodologies were consistent, and QA/QC was performed by both organizations.

Stream Hydrology

Continuous stage (water level) data was recorded using data loggers deployed at select monitoring sites during the open water season. The readings collected were converted to a mean sea level elevation. Stage readings are collected at regular intervals ranging from 15-minutes to 1-hour, depending on the flashiness of each stream. When the equipment was downloaded, stage was recorded manually and compared to the data logger reading, allowing for calibration. Starting in 2021, manual discharge (flow volume) measurements were also collected in conjunction with water chemistry grab samples. These discharge measurements allow for continual refinement of rating curves and aid in pollutant loading estimates.

Water Chemistry Sampling

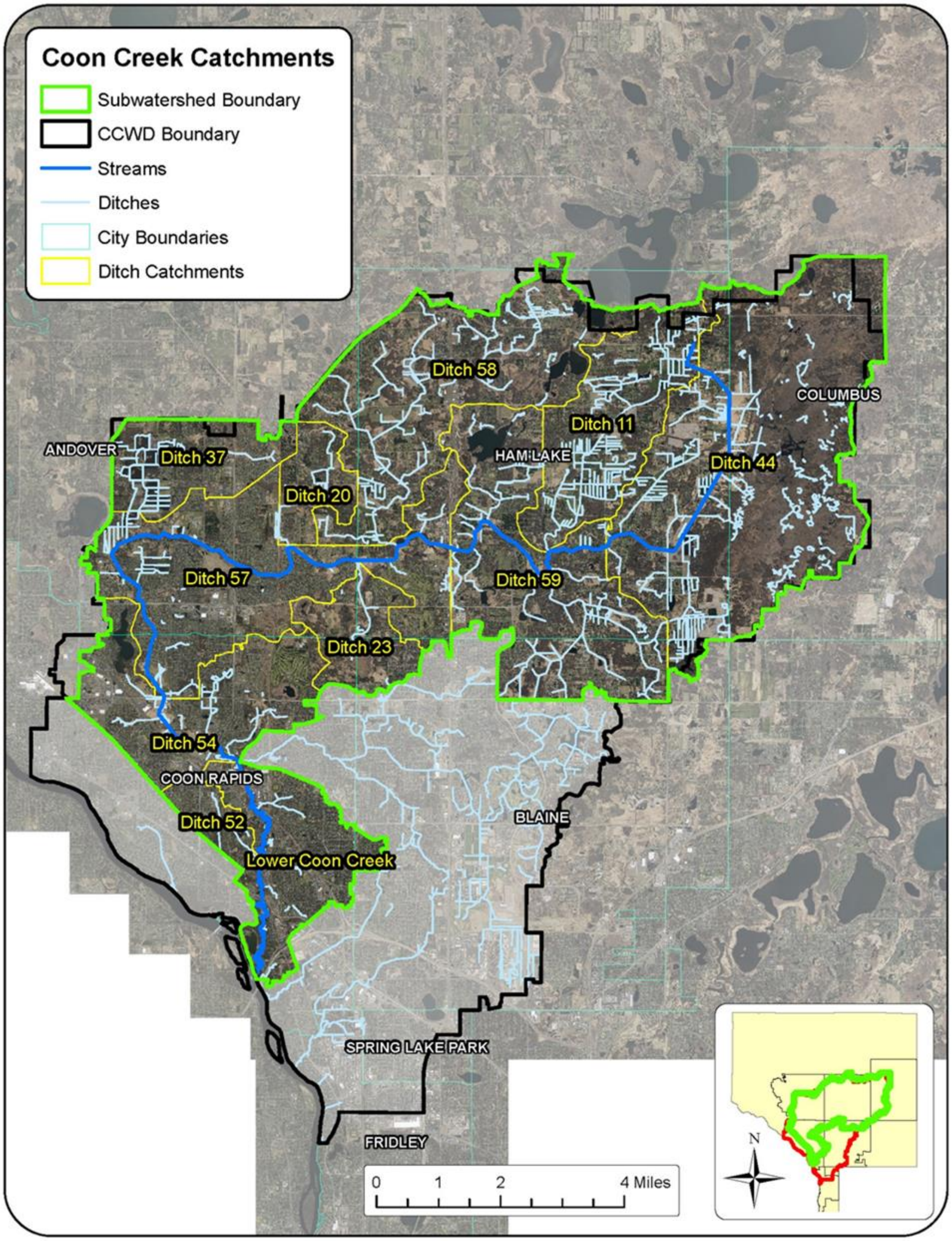
Regularly scheduled (Routine) and event-based (Storm) sampling occurred. Six regularly scheduled samples were collected on a monthly basis (May-Oct) to be representative of conditions over time regardless of flow level although antecedent precipitation was noted. An additional four samples during storm flows were collected, for an annual total of ten samples at each site. Storms are generally defined as one-inch or more of rainfall in 24 hours sufficient to produce runoff and were determined by the CCWD. In some years, fewer storm samples were collected due to unfavorable conditions.

Grab samples and sondes were used to measure water quality parameters. Grab samples were sent to a certified laboratory for analysis. Parameters analyzed by the lab included total phosphorus (TP), total suspended solids (TSS), *E. coli* bacteria, and periodically chlorides and ortho-phosphorus. Parameters measured with portable sondes included pH, specific Conductivity, turbidity, temperature, salinity, dissolved oxygen (DO), and Secchi transparency. Water level (stage) was recorded at each site using a staff gauge surveyed to mean sea level elevation or by measuring down from an established tape-down point such as a culvert top.

Precipitation

Precipitation data is provided alongside hydrology results. Precipitation totals were recorded daily from eleven Anoka County EMS Weather Stations, or using long-standing precipitation volunteers. The closest reliable precipitation record for each site was used.

WATER QUALITY & HYDROLOGY MONITORING - COON CREEK MAIN STEM AND TRIBUTARIES



Coon Creek Subwatershed Monitoring Sites		
Site Name/ SiteID	**Years Monitored**	**2022 Data Collected**
Ditch 44 at Lever St (tributary)	2021-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Coon Cr at Lexington Blvd S007-539	2013-2016	
Coon Cr at Naples St S007-057	2012-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Ditch 11 at Naples St (tributary)	2022	Water Chemistry Grab Samples, Flow Measurements
Ditch 11 at 149st Ave (tributary) S007-541	2013-2017, 2020-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Ditch 59-4 at Bunker Blvd (tributary) S005-262	2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Ditch 59 P-10 at 149st Ave (tributary) S016-392	2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Coon Cr at Aberdeen St S016-441	2021-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Coon Cr at Hwy 65 S005-259	2018-2020	
Ditch 58 at Andover Blvd (tributary) S005-830	2001-2018, 2020-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Coon Cr at Prairie Rd. S007-540	2013, 2017, 2018, 2020	
Ditch 20 at Andover Blvd (tributary) S016-392	2020-2021	
Coon Cr at 131st Ave S005-257	2010-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Coon Cr at Lions Park (Hanson Blvd) S004-171	2007-2017	
Coon Creek at 111th S007-559	2018-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Ditch 52 at Robinson (tributary) S015-117	2018, 2021-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Woodcrest Creek at Creekside Estates S016-393	2020, 2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Coon Cr at Vale St S003-993	2005-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements

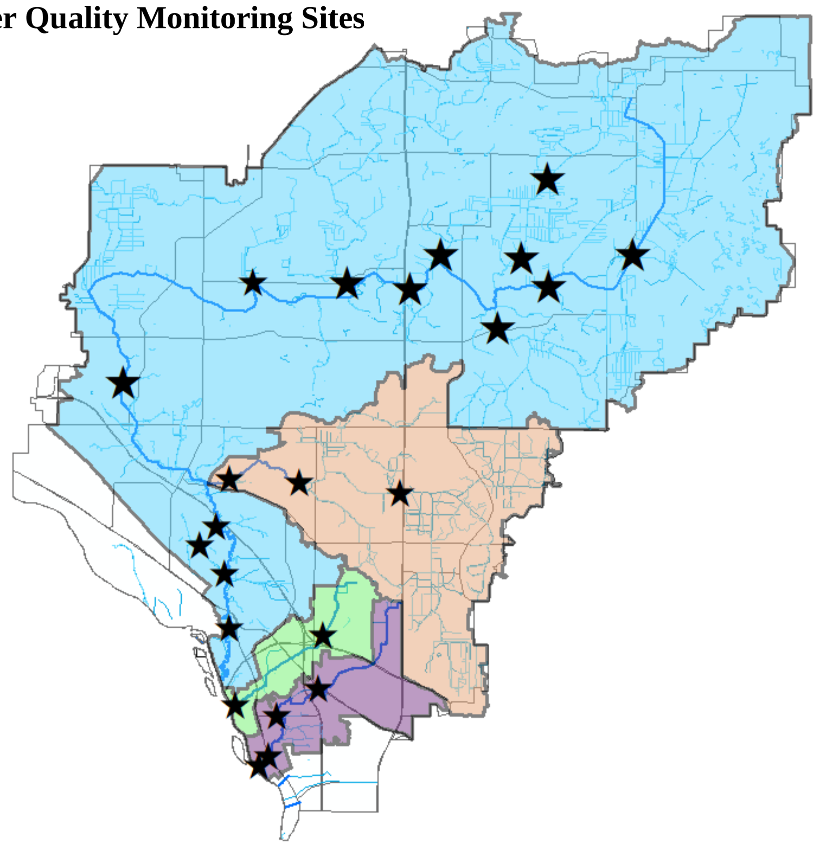
COON CREEK MAIN STEM AND TRIBUTARIES BACKGROUND

Coon Creek and its tributaries 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 northeast Ham Lake. The channel flows south and west approximately 27 miles, draining Ham Lake, southern Andover, western Blaine, and much of Coon Rapids, before joining the Mississippi River near the Coon Rapids Dam. Many tributary ditch systems join the Coon Creek system and drain a variety of land use and cover types. Land usage shifts from primarily rural agriculture and residential in the northern portions of Ham Lake, to denser suburban residential and commercial development through Andover and Coon Rapids. Open channel ditch systems drain the upstream portions of the watershed, while downstream primarily drains through subsurface stormwater infrastructure before out-letting to the creek itself.

The rural ditch systems that drain agricultural and residential lands to Coon Creek include the Ditch 44, 11, 59, 58, 20, 23 and 37 systems. The ditch systems draining the lower reaches of the watershed include the Ditch 52, Ditch 41 (Sand Creek), and Woodcrest 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 include the Ditch 54 and Lower Coon Creek drainage areas.

Coon Creek is listed as an impaired water for aquatic recreation due to elevated levels of *E. coli* bacteria and aquatic life due to poor invertebrate and fish communities. Total suspended solids (TSS) and total phosphorus (TP) have been identified as primary stressors to the local invertebrate and fish communities and concentrations of both often exceed established water quality standards. Poor habitat and altered hydrology have also been identified as stressors of the biotic community. Pending 2024 impairments include TSS and dissolved oxygen for Coon Creek, *E. coli* and dissolved oxygen for Ditch 11, and *E. coli* for Ditch 58.

2022 Stream Water Quality Monitoring Sites



SUMMARY

TP levels throughout the watershed often exceed state water quality standards, as do TSS levels during storm events. Water quality in Coon Creek declines significantly from upstream to downstream between Naples Street and 131st Avenue for both TP and TSS, as well as between Naples Street and Vale Street for TSS. The water quality declines are most pronounced in the upper portions of the watershed, which are more agricultural or rural residential. Many ditch systems join Coon Creek throughout this portion of the watershed. Not all of these ditch systems are monitored, but those that have been monitored have poor water quality. Middle portions of the watershed, which are suburban, have less pronounced water quality decline. Furthest downstream, in the more urbanized areas, there is no significant change in TP concentrations from the monitoring sites at 131st Ave to Vale Street although TSS during storms does increase significantly. This finding suggests that improvements to stormwater treatment and new development standards led by the CCWD and cities are having positive impacts on water quality.

There is no statistically significant change in water quality over time for TP or TSS. Historical monitoring data includes year 2005 to 2022.

E. coli is lowest upstream and highest downstream. The primary sources of *E. coli* bacteria in Coon Creek as identified by the TMDL, are livestock (51%) and domestic pets like dogs (37%). Livestock are more prevalent in the rural areas of the watershed (upstream) and are often present adjacent to the creek itself. Domestic pets are more populous in the lower watershed, which is more densely developed. Throughout the watershed, waterfowl congregate along the creek. New evidence from bacteria source tracking methods has recently shown that human sewage has also been detected in Coon Creek, particularly downstream of Prairie Rd which would indicate the source is more likely leaky sanitary infrastructure versus septic system pollution. Investigation and mitigation efforts are underway.

Analysis of individual parameters can be found below.

Results and Discussion

Specific Conductivity and Chlorides

Dissolved pollutant levels are higher in the downstream reaches of Coon Creek, where there is more impervious surface area with denser development. Median specific Conductivity increases gradually from upstream (0.437 mS/cm) to downstream (0.742 mS/cm) during baseflow conditions for all years. Median specific Conductivity (all years) following storm events shows a smaller change between upstream and downstream measurements, ranging from 0.410 to 0.531 mS/cm. The median specific Conductivity in Coon Creek at Vale Street (farthest downstream) is higher during baseflow conditions and above the countywide median for Anoka County streams of 0.561 mS/cm. Although after storm events the median at Vale Street is below the county median.

Modestly higher conductivity during baseflow lends some insight into the pollutant sources. If dissolved pollutants were only elevated after storm events, stormwater runoff would be suspected as the primary driver. Since dissolved pollutants are highest during baseflow conditions, pollution of the shallow groundwater table, which feeds the stream during baseflow, is likely a significant contributor. Storm events are likely both delivering additional pollutant load and offering mild dilution, and in this way, storm conductivity is only modestly lower than baseflow. Dissolved pollutant levels in the upstream portions of Coon Creek, during all conditions, are still above average compared to other local streams.

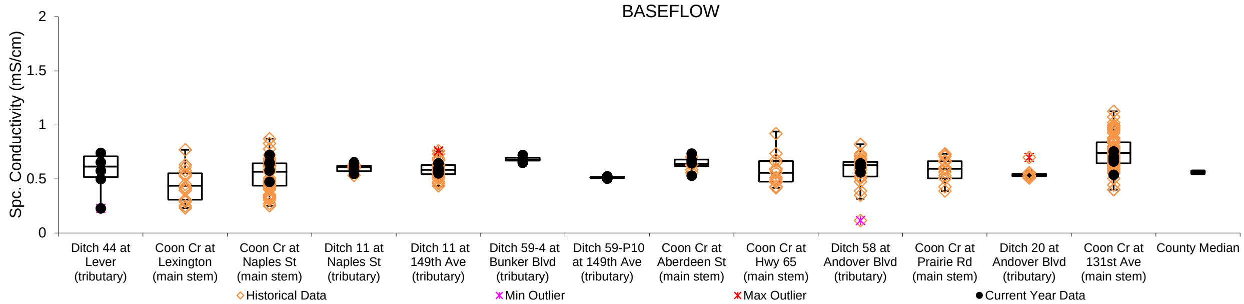
Management approaches may differ in the upper and lower watershed. In the upper watershed, fertilizer associated with agricultural operations may be a significant contributor to conductivity. In the middle and lower watershed where private wells are common, water softener salt may significantly contribute. Throughout the watershed. road deicing should be a management focus.

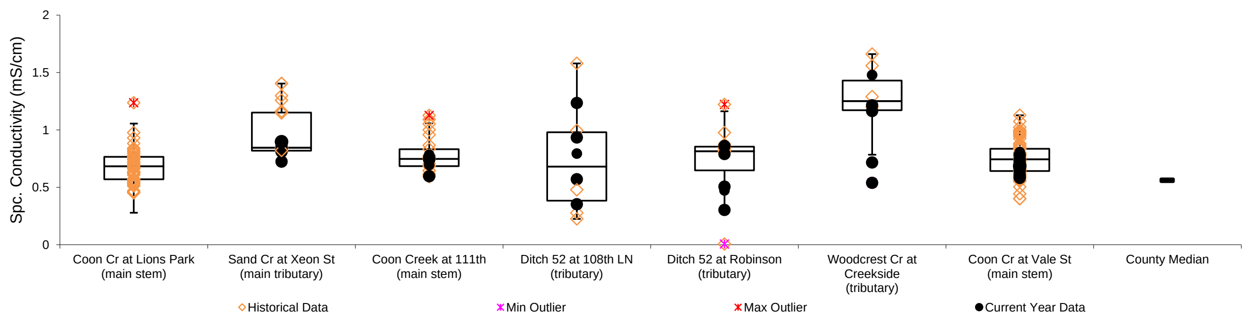
Chloride sampling has not occurred enough in Coon Creek for statistical analysis, but a general examination of historical data reveals an increase in chloride levels upstream-to-downstream through the Coon Creek system. The same inputs that are suspected contributors to conductivity as also likely chloride contributors. Although the concentrations of chlorides increase dramatically moving downstream, they are under the state standards (230 mg/L chronic and 860 mg/L acute). In 2022, chloride sampling was conducted at the Vale Street outlet and chloride concentrations averaged 61.75 mg/L during storm flow and 85.06 mg/L during baseflow conditions. These levels were higher than chloride averages recorded in 2019 and 2021, but still well below the state standards.

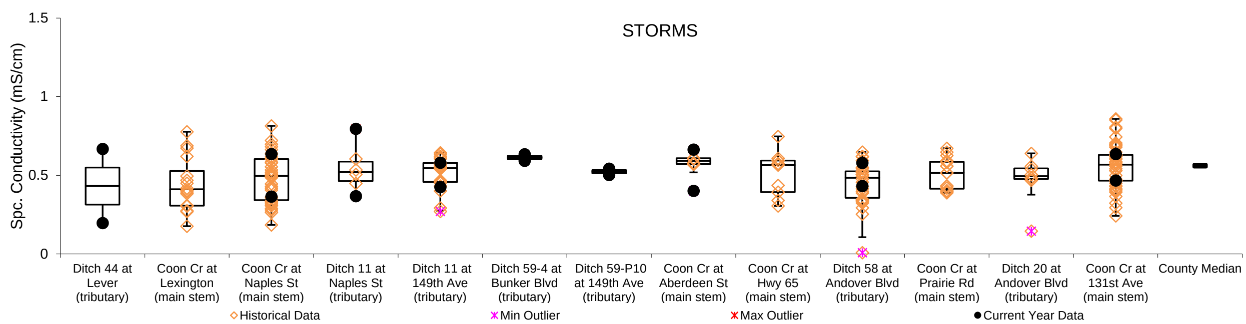
Average and median specific Conductivity and chlorides in Coon Creek. Data is from Vale St for all years through 2022.

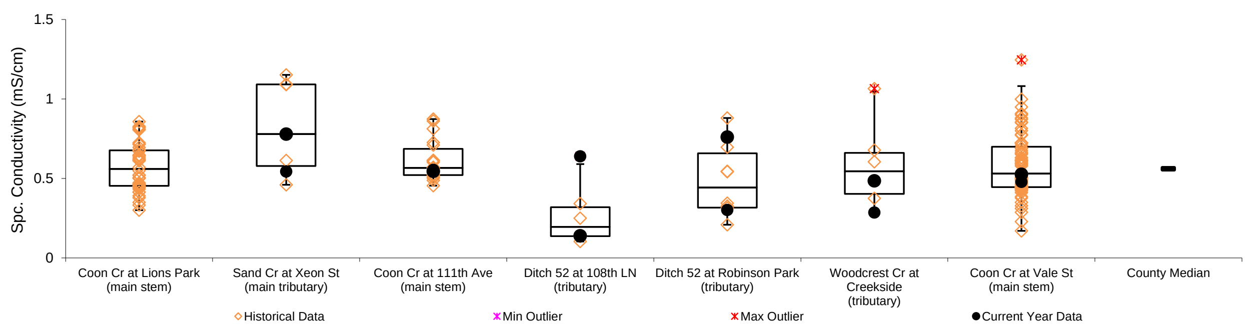
<table>
<tr><th></th><th>Average Specific Conductivity (mS/cm</th><th>Median Specific Conductivity (mS/cm)</th><th>Average Chlorides (mg/L)</th><th>Median Chlorides (mg/L)</th><th>State Standard</th><th></th><th>N</th></tr>
<tr><td>Baseflow</td><td>0.745</td><td>0.743</td><td>70.14</td><td>67</td><td rowspan="3">Specific Conductivity – none
Chlorides – 230 mg/L</td><td></td><td>82</td></tr>
<tr><td>Storms</td><td>0.585</td><td>0.531</td><td>55.01</td><td>54.25</td><td></td><td>71</td></tr>
<tr><td>All</td><td>0.670</td><td>0.663</td><td></td><td></td><td></td><td>153</td></tr>
</table>

Specific Conductivity at Coon Creek Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (end of box), and 10th and 90th percentile (floating outer lines) of all data collected at these sites.









TOTAL PHOSPHORUS

The state standard for total phosphorus (TP) for streams in this region is 100 µg/L. Coon Creek may eventually be designated as impaired for eutrophication because it often exceeds the standard, especially during storm events. Coon Creek has a TMDL in place for TP, even without the impaired designation for this pollutant, because it is identified as a primary stressor to Coon Creek's aquatic life impairments. Best management practices to address phosphorus loading would be beneficial throughout the entire Coon Creek system, but would be especially impactful 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 upstream-to-downstream during all conditions. There is also a significant increase from the headwaters to the approximate mid-point of the watershed (Naples St. to 131st Ave.) during baseflow conditions only. In both flow conditions, no significant increase is present between 131st Avenue to downstream at Vale Street.

In the upper portions of the watershed, the monitoring sites along the main stem at Lexington Ave, Naples St, and Aberdeen Street generally contain TP concentrations below the state standard during baseflow conditions and occasionally exceed the standards after storms. The three monitored ditch systems in 2022 that input to Coon Creek within the vicinity of these sites (Ditch 11, Ditch 58, Ditch 59) historically have higher phosphorus concentrations than what is observed in the main stem of Coon Creek. Average concentrations for TP samples collected in Ditch 11 at 149th Avenue, all years, was 136.72 µg/L during baseflow and 278.4 µg/L for storms, both exceeding the state standard. Similarly, at Ditch 58, the average concentration of TP was 96.5 µg/L during baseflow and 184.46 µg/L during storm events. Historically, TP levels at Ditch 20 at Andover Blvd have also been higher than the state standard during both baseflow (103 µg/L) and storm events (160.5 µg/L). Two tributary sites were monitored in the Ditch 59 system in 2022, and TP concentrations at both sites exceeded 100 µg/L. When readings at Ditch 59 sites were combined, TP levels averaged 143.33 µg/L during baseflow and 160.75 µg/L during storm flow. Based on findings of high TP loading from monitored ditch systems, it is likely that other unmonitored ditches in this region are also contributing to TP loads.

There is not a significant change in TP concentrations in the lower watershed between 131st Ave and Vale St during any conditions. Baseflow concentrations at 131st Ave average 108.60 µg/L and 93.52 µg/L at Vale Street. TP concentrations following storm events were 187.90 µg/L and 200.92 µg/L, respectively.

No significant increase was observed for baseflow or storm TP concentrations at Vale St. over time, although storm flow TP conditions have marginally improved. The Coon Creek Watershed District has made large financial investments into stormwater treatment practices and other types of stream improvement projects in this portion of the watershed, which seem to be indicating successes towards phosphorus reduction, especially during larger storm events.

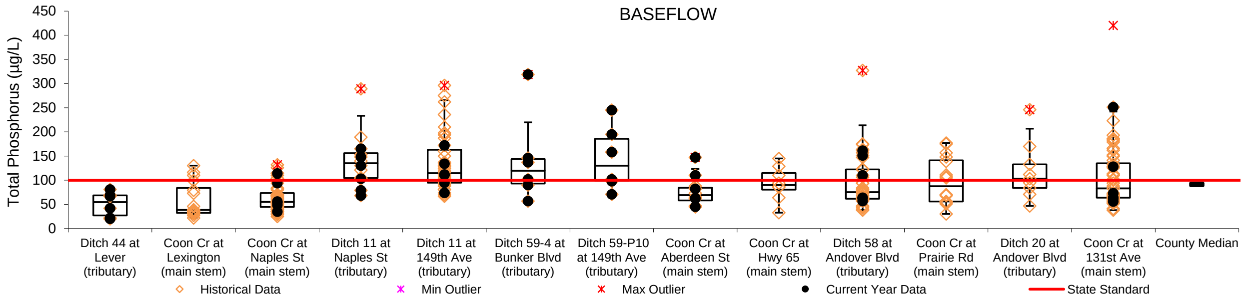
Supplemental ortho-phosphorus (OP) samples were collected in 2021-2022 at the outlet of Coon Creek (Vale St). The average OP concentration in 2022 during baseflow was 30% (range=16%-64%) of average TP. During storms, the average OP concentration was 12% (range=7%-18%) of average TP. The MN Stormwater Manual reports the national average OP concentration as a percentage of TP to be 26% indicating Coon Creek is in the normal range. This indicates that the majority of phosphorus in Coon Creek is particle-bound.

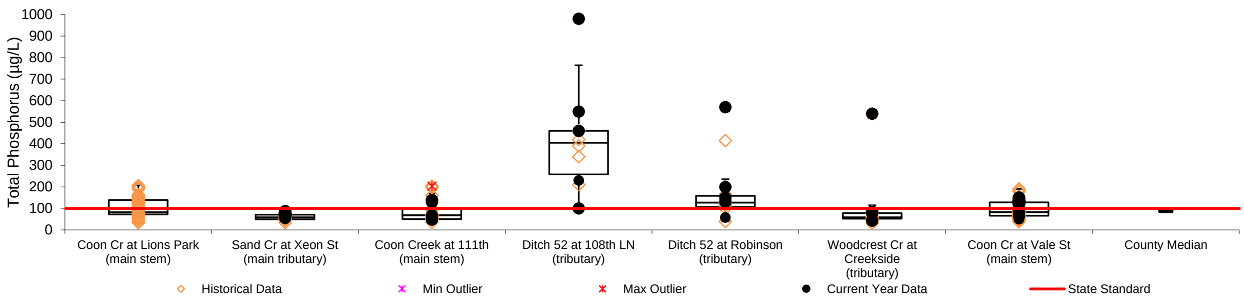
The Coon Creek TMDL delegates acceptable pollutant loads in Coon Creek on a load duration curve (LDC) instead of a fixed-daily or annual load per pounds. The LDC for Coon Creek is graphed on a plot with flow-weighted daily loads for phosphorus samples collected at Vale Street from 2005-2014 (Page 47, Figure 16). This plot shows that the creek exceeds its LDC for TP during high and very high flows nearly 100% of the time, while often maintaining acceptable TP loads during low and very low flows. Examining the LDC results with grab sample data inform that additional stormwater treatment in the upper portions of the watershed should be a high priority. A holistic management approach is likely required including the implementation of agricultural best management practices.

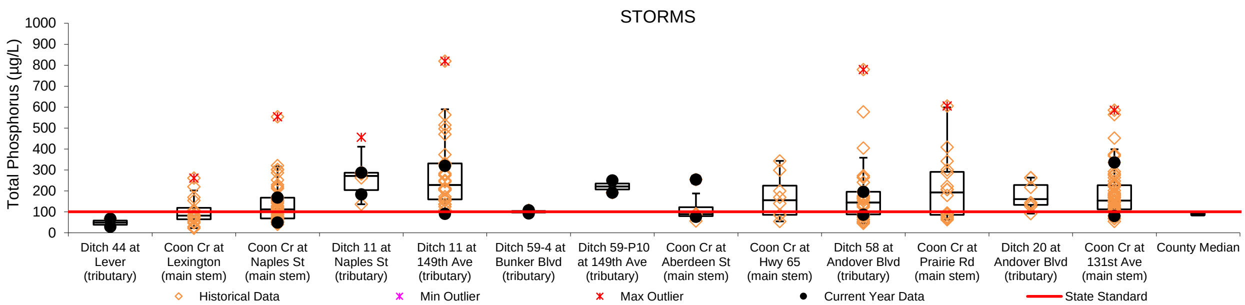
Average and median total phosphorus in Coon Creek Data is from Vale St for all years through 2022.

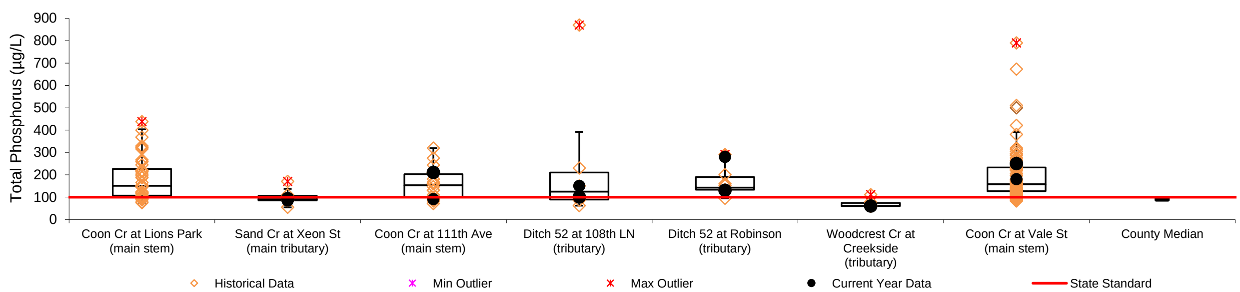
	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	95.68	83.00	100 µg/L	80
Storms	200.93	157.50		70
All	144.79	123.0		150
Occasions>state standard				29 (baseflow) 36% 63 (storm) 90%

Total Phosphorus at Coon Creek Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (median line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.



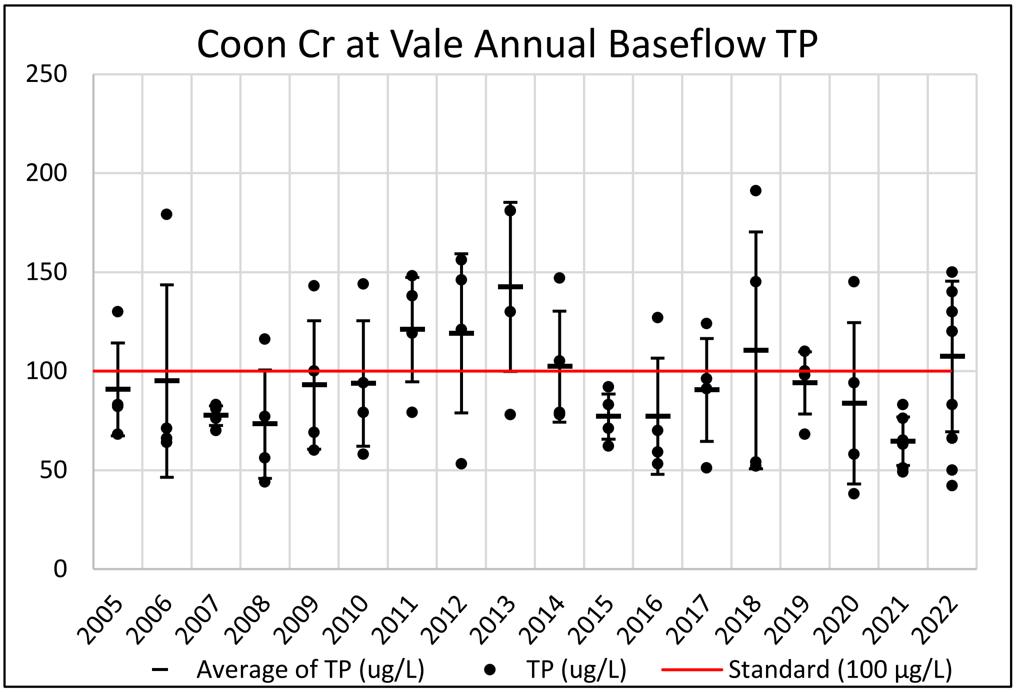


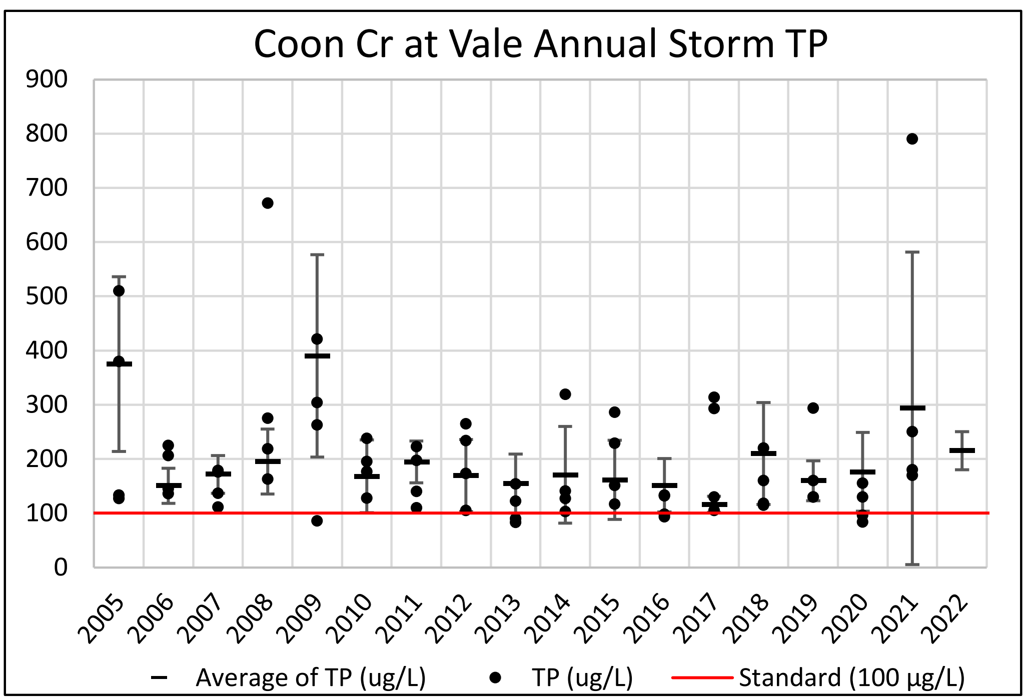




Coon Creek at Vale St. - Annual average TP concentration change – ANOVA regression 2005-2022

Parameters	Significant Change in Annual x̄ (2005-2022)	p-value	Standard Error of Means
Total Phosphorus – Baseflow	None	0.89	20.08
Total Phosphorus – Storm	None	0.36	75.81





ANOVA Matrix for Baseflow Total Phosphorus

	Coon Creek at Naples St. (2012-2022) 48 Samples Total	Coon Creek at 131st Ave. (2010-2022) 56 Samples Total	Coon Creek at Vale St. (2005-2022) 75 Samples Total
Coon Creek at Naples St.		Significant Increase Naples $\bar{X}$ = 63.04 µg/L 131st $\bar{X}$ = 108.60 µg/L p = < 0.001	Significant Increase Naples $\bar{X}$ = 63.04 µg/L Vale $\bar{X}$ = 93.52 µg/L p = < 0.001
Coon Creek at 131st Ave.			No Sig. Change 131st $\bar{X}$ = 108.60 µg/L Vale $\bar{X}$ = 93.52 µg/L p = 0.103
Coon Creek at Vale St.			

ANOVA Matrix for Storm Total Phosphorus

	Coon Creek at Naples St. (2012-2022) 42 Samples Total	Coon Creek at 131st Ave. (2010-2022) 50 Samples Total	Coon Creek at Vale St. (2005-2022) 70 Samples Total
Coon Creek at Naples St.		Significant Increase Naples $\bar{X}$ = 139.66 µg/L 131st $\bar{X}$ = 187.90 µg/L p = <0.05	Significant Increase Naples $\bar{X}$ = 139.66 µg/L Vale $\bar{X}$ = 200.92 µg/L p = <0.05
Coon Creek at 131st Ave.			No Sig. Change 131st $\bar{X}$ = 187.90 µg/L Vale $\bar{X}$ = 200.92 µg/L p = 0.575
Coon Creek at Vale St.			

Total Suspended Solids

Coon Creek has a TMDL for total suspended solids (TSS) because it is identified as a stressor for aquatic macroinvertebrates and fish in the creek, not because the creek is directly impaired for TSS although there is a TSS impairment pending for 2024. TSS concentrations in Coon Creek follow a similar pattern to the TP pollutant, but are generally below the state standard. The state water quality standard for TSS in the Central River Nutrient Region is 30 mg/L. The stream occasionally exceeds the state standard in its middle and lower reaches.

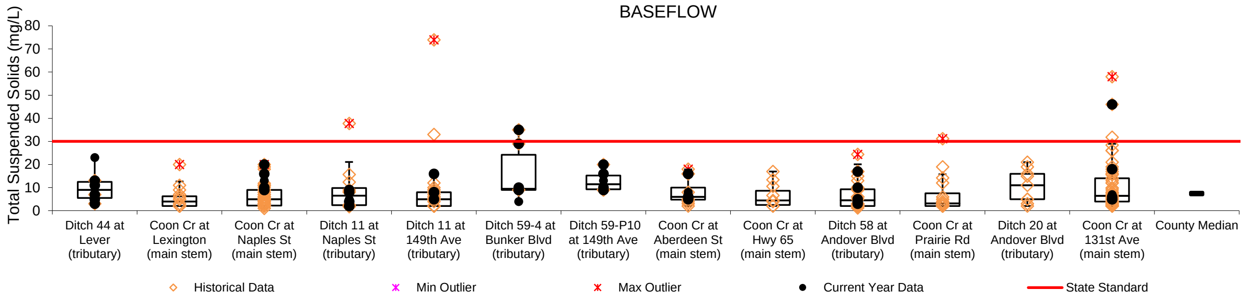
ANOVA analyses at three sites, upstream to downstream, (Coon Creek at Naples St, 131st Ave, and Vale St.) show a significant increase in TSS concentrations from the upstream site to the mid-point site (Naples St. to 131st Ave.) during all types of conditions. During storm flow a significant increase is also present from 131st Avenue to the downstream monitoring site at Vale St. There is no significant change in TSS levels at Vale Street over time. The LDC plot for TSS in the Coon Creek TMDL (Page 42, Figure 13) shows that allowable TSS loads are ordinarily only exceeded during high flows at Vale Street. Grab samples data provides similar evidence that TP concentrations only exceed the state standard occasionally following storm events.

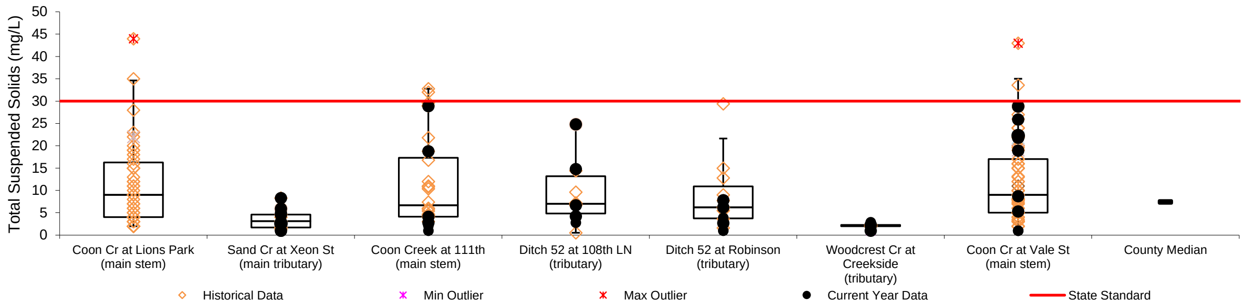
While TSS concentrations and daily flow-weighted loads generally meet state standards at the outlet site at Vale Street, it should be noted that significant increases in TSS concentrations, upstream to downstream, are occurring and should be a high priority for management in Coon Creek. In the TMDL report, it is estimated that 63% of all TSS loading to the creek is attributed to streambank erosion. Stabilizing eroding streambanks may offer a good starting point for reducing both TSS and TP loads in Coon Creek. Management efforts to reduce rapid increased in flow and discharge in the ditch systems during storm events should also be explored. Additionally, as the northern portion of the watershed develops, it is important to continue enforcing stringent stormwater regulations and ensuring compliance with construction best practices and post construction controls

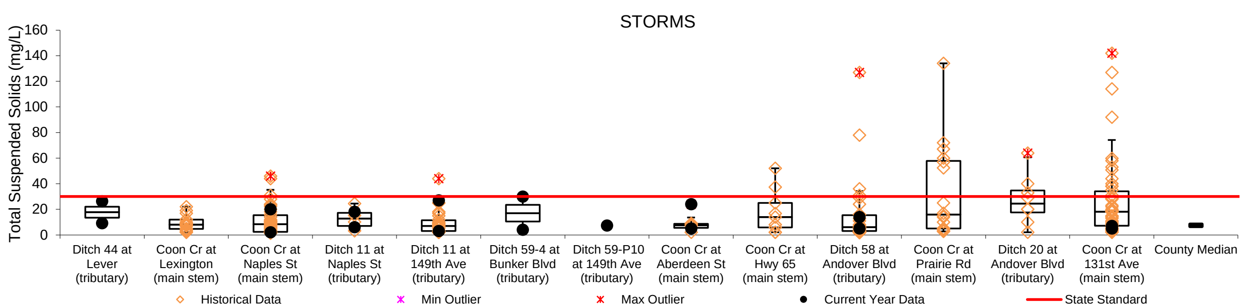
Average and median total suspended solids in Coon Creek Data is from Vale St for all years through 2022.

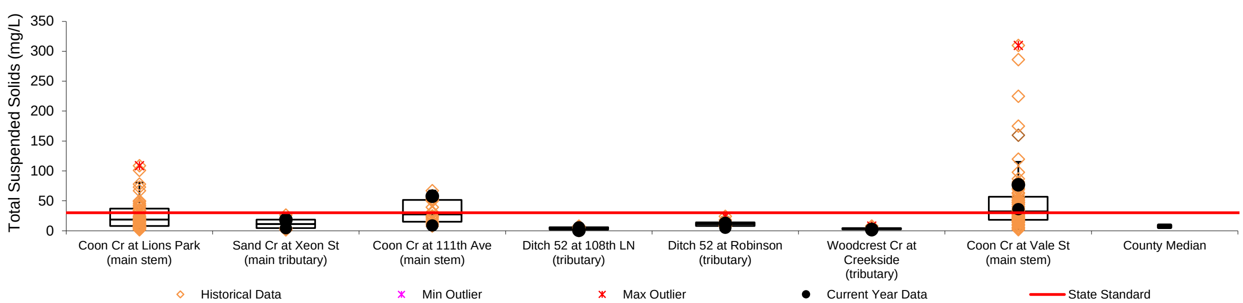
	Average TSS (mg/L)	**Median TSS (mg/L)**	**State Standard**	**N**
Baseflow	11.94	9.0	30 mg/L	80
Storms	50.52	32.50		70
All	29.83	17.0		150
Occasions > state TSS standard				2 (baseflow) 2.5% 36 (storm) 51%

Total Suspended Solids at Coon Creek Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) of all data collected at these sites.



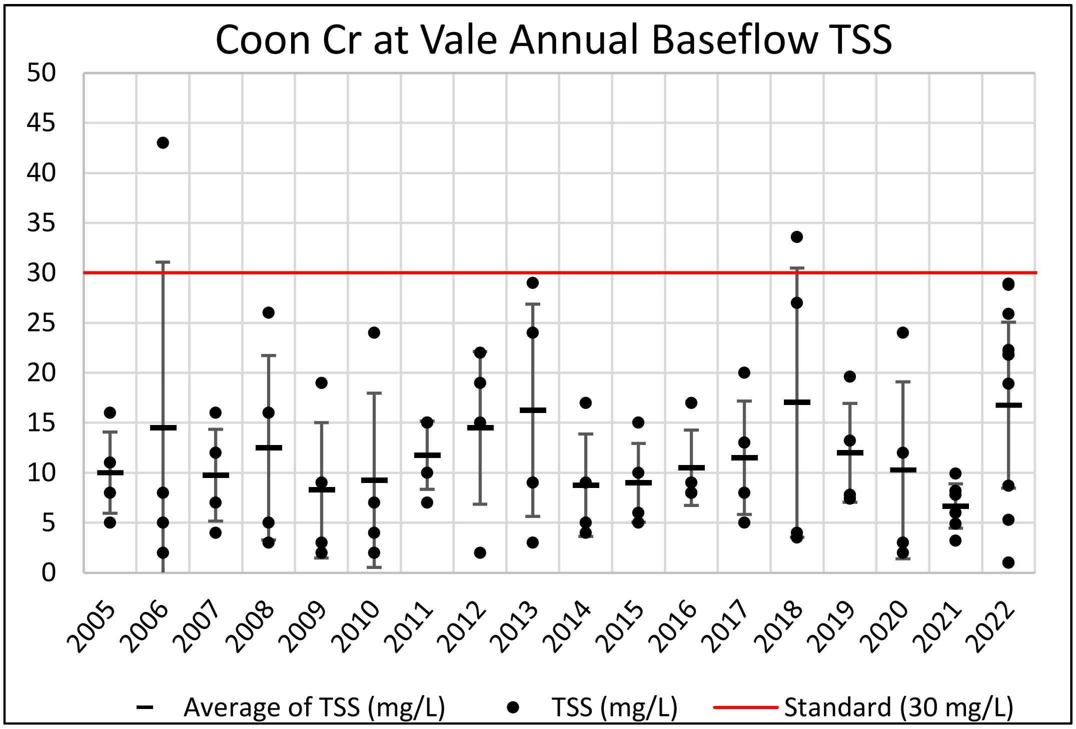


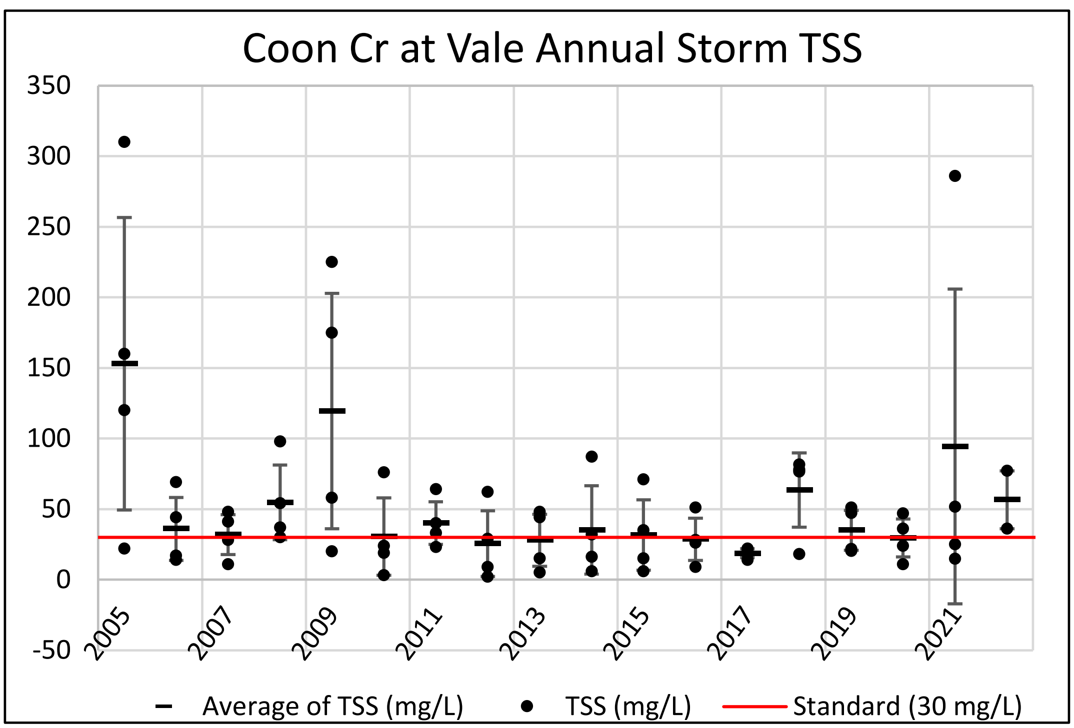




Coon Creek at Vale St. - Annual average ANOVA regression TSS 2005-2022

Parameters	Significant Change in Annual x̄ (2005-2022)	p-value	Standard Error of Means
Total Suspended Solids – Baseflow	None	0.65	3.14
Total Suspended Solids – Storm	None	0.32	36.21





ANOVA Matrix for Baseflow Total Suspended Solids

	Coon Creek at Naples St. (2012-2022) 48 Samples Total	Coon Creek at 131st Ave. (2010-2022) 58 Samples Total	Coon Creek at Vale St. (2005-2022) 76 Samples Total
Coon Creek at Naples St.		Significant Increase Naples $\bar{X}$ = 6.45 mg/L 131st $\bar{X}$ = 10.80 mg/L p = < 0.05	Significant Increase Naples $\bar{X}$ = 6.45 mg/L Vale $\bar{X}$ = 11.27 mg/L p = < 0.001
Coon Creek at 131st Ave.			No Sig. Change 131st $\bar{X}$ = 10.80 mg/L Vale $\bar{X}$ = 11.27 mg/L p= 0.781
Coon Creek at Vale St.			

ANOVA Matrix for Storm Total Suspended Solids

	Coon Creek at Naples St. (2012-2022) 42 Samples Total	Coon Creek at 131st Ave. (2010-2020) 50 Samples Total	Coon Creek at Vale St. (2005-2022) 70 Samples Total
Coon Creek at Naples St.		Significant Increase Naples $\bar{X}$ = 11.41 mg/L 131st $\bar{X}$ = 27.42 mg/L p = < 0.01	Significant Increase Naples $\bar{X}$ = 11.41 mg/L Vale $\bar{X}$ = 50.52 mg/L p = <0.001
Coon Creek at 131st Ave.			Significant Increase 131st $\bar{X}$ = 27.42 mg/L Vale $\bar{X}$ = 50.52 mg/L p = <0.05
Coon Creek at Vale St.			

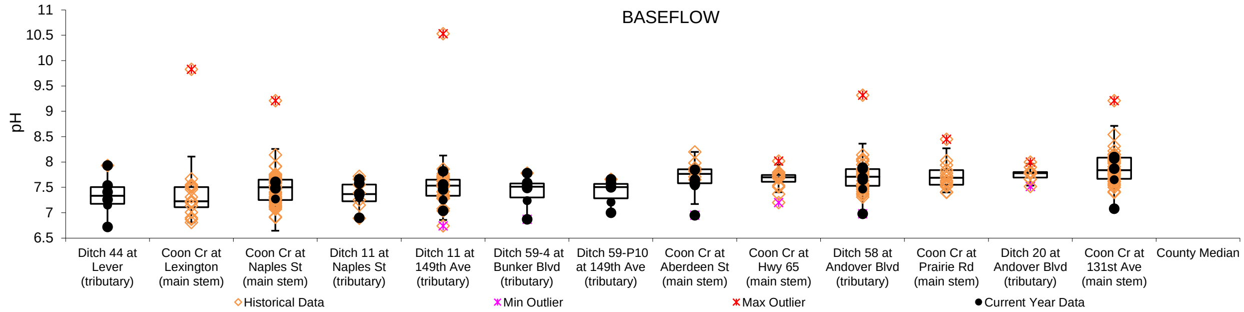
pH

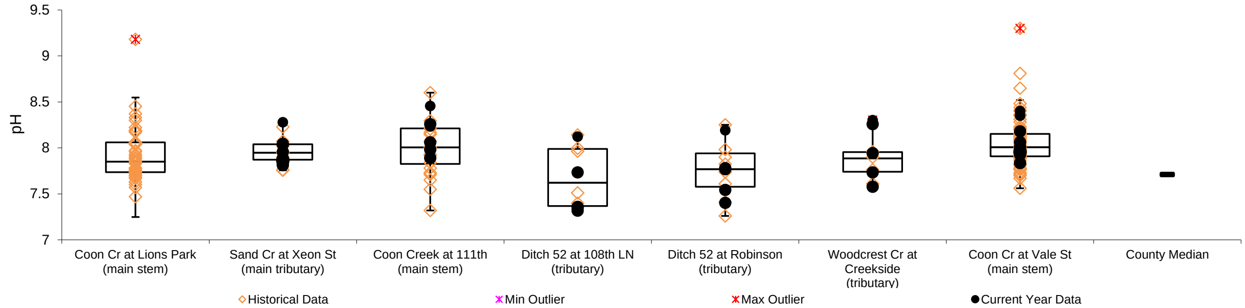
pH levels in Coon Creek are normally within the healthy range of 6.5-8.5. Typically, pH is lower during storm events because rainfall is more acidic. Exceedances of state standards have occurred, but they are rare and are not currently a management concern.

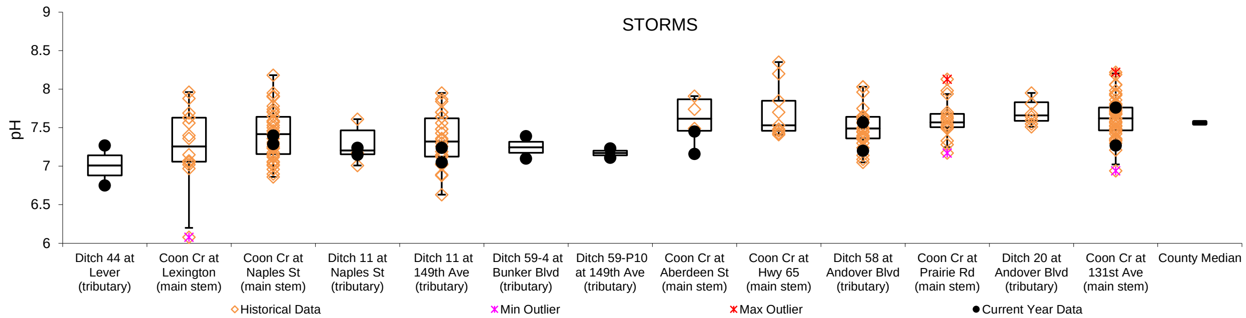
Average and median pH in Coon Creek Data is from Vale St for all years through 2022.

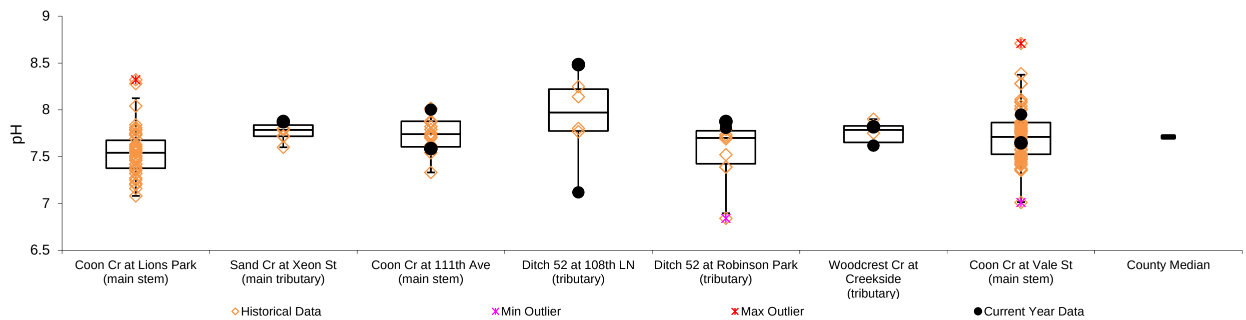
	Average pH	Median pH	State Standard	N
Baseflow	8.06	8.01	6.5-8.5	84
Storms	7.74	7.71		67
All	7.91	7.92		151
Occasions outside state standard				3 (baseflow) 4% 1 (storm) 1%

pH at Coon Creek Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines).









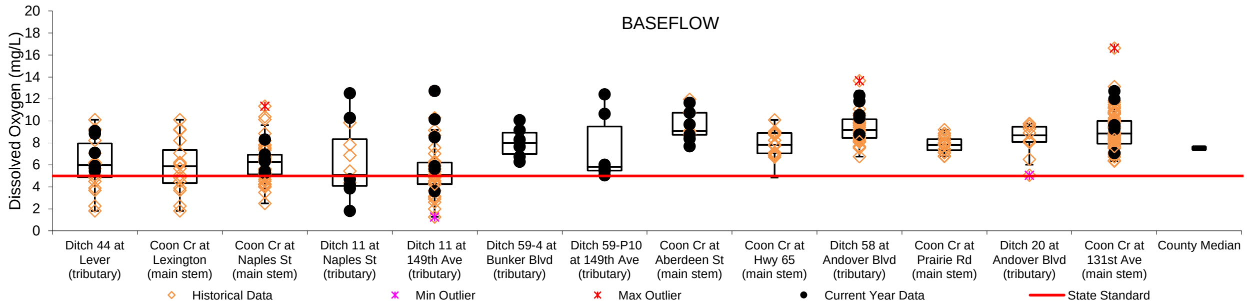
DISSOLVED OXYGEN

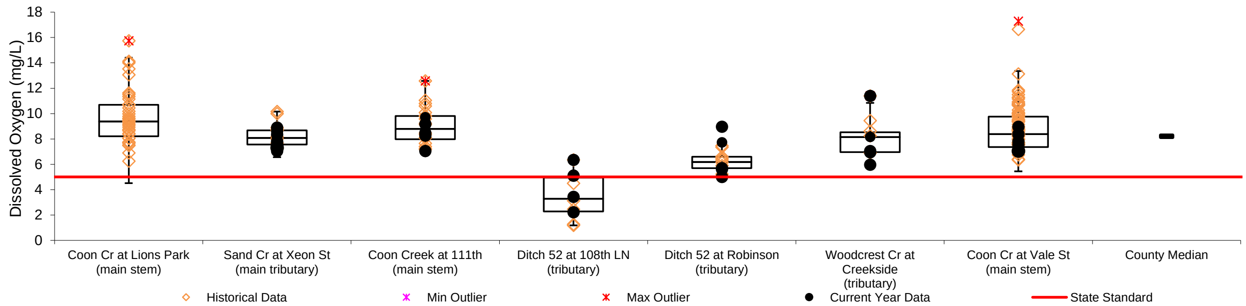
Low dissolved oxygen (DO) levels have generally not been observed in Coon Creek during day time measurements, but low DO was identified as a stressor to aquatic life in the headwaters. Coon Creek and Ditch 11 were listed for pending dissolved oxygen impairments in 2024. Low DO can also exacerbate phosphorus loading as it can create redox conditions where phosphate is released from sediments. Historically, low DO readings have occurred in the upstream ditched channels of the main stem and in Ditch 11. Higher DO is found in the more natural sections of the channel, further downstream. In 2022, DO levels fell below the state standard (5 mg/L) in Ditch 11 and Ditch 52. These lower DO levels may have been influenced by low water level drought conditions. Measurements must be taken prior to 9am for comparison with state standards, precluding robust analysis with our current dataset.

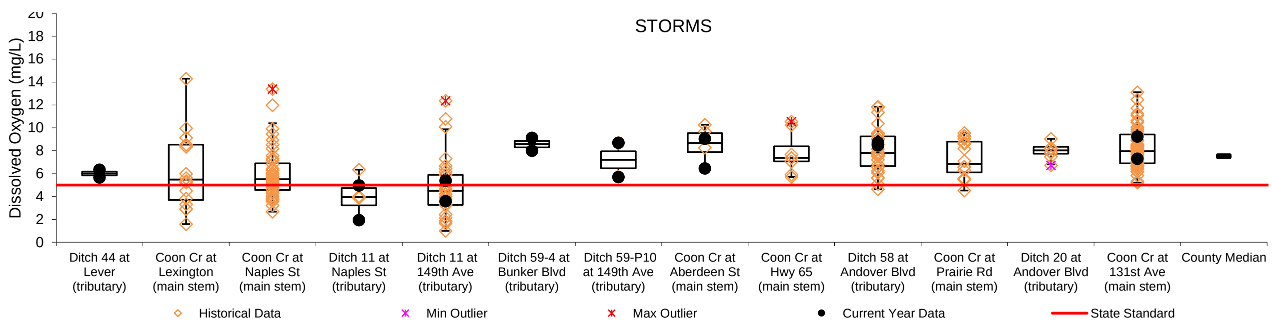
Average and median dissolved oxygen in Coon Creek Data is from Vale St for all years through 2022.

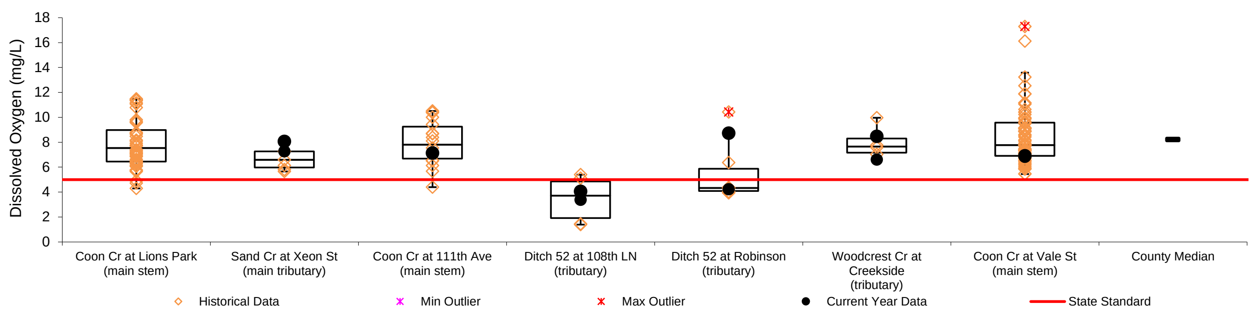
	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.90	8.65	5 mg/L daily minimum	79
Storms	8.46	7.78		69
All	8.69	8.37		148
Occasions <5 mg/L				0

Dissolved oxygen at Coon Creek Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) of all data collected at these sites.









E. COLI

The chronic state 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 geomean should not exceed 126 MPN (Most Probable Number). An additional acute standard is that not more than 10% of all samples in a given month should exceed 1260 MPN. The annual monitoring protocol of streams throughout the year is only to collect ten samples total and therefore does not provide a sufficient number of samples for any given calendar month to calculate geometric means or percentage-based exceedances comparable to these standards. It is however acceptable to group monthly data across years for impairment determinations and progress reporting.

During baseflow conditions, *E. coli* concentrations are typically lower in the upper reaches of the Coon Creek system and increase downstream. Median *E. coli* for all years, upstream to downstream, ranges from 77.5 MPN at Naples St. to 175 MPN at Vale Street during baseflow conditions. Sampling frequency requirements were not met for comparison to the chronic state standard benchmark of 126 MPN in the upper watershed. During baseflow conditions, all sites downstream of Naples Street exceeded 126 MPN on at least one occasion in 2022, with most sites exceeding the standard three to four times.

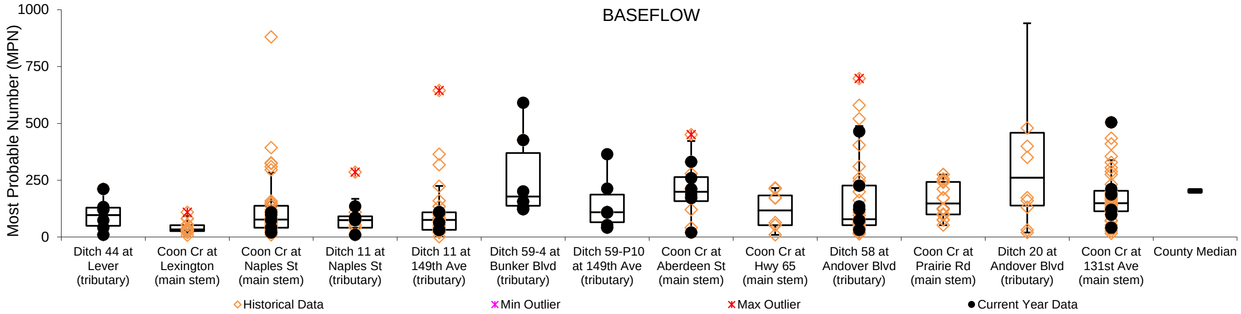
During storms, *E. coli* concentrations were significantly higher and more variable (note the order of magnitude difference in Y-axis scales in the graphs below). Median *E. coli* during storms, upstream to downstream, ranges from 433.5 MPN at Naples St to 1050 MPN at Vale Street. In 2022, most samples collected storm exceeded 126 MPN and in the lower portions of the system exceeded 1260 MPN.

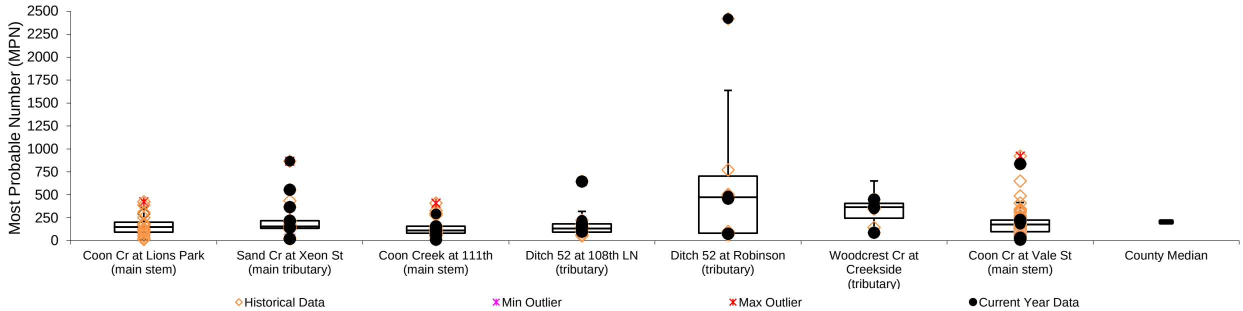
Coon Creek is listed as impaired for aquatic recreation due to *E. coli*. Ditch 11 and Ditch 58 have pending *E. coli* impairments for 2024. The *E. coli* load duration curve (LDC) in the Coon Creek TMDL (Page 51, Figure 20) shows that the creek often exceeds acceptable loads during all flow conditions. *E. coli* sources can be harder to pinpoint than sources of other pollutants because *E. coli* concentrations fluctuate rashly without requiring any additional inputs. This is because *E. coli* is a living organism that continues to grow and change. The TMDL estimates that livestock (51%) and domestic dogs (37%) contribute most of the *E. coli* loading to Coon Creek. Most of the livestock, primarily horses, occur in the upstream portions of the watershed. Domestic dogs are likely present throughout the watershed. It is also possible that waterfowl have a larger *E. coli* footprint in Coon Creek than the road surveys conducted for the TMDL suggest. Potential human sources of *E. coli* loading such as failing septic systems or leaky sanitary sewer infrastructure likely exist. While certain strategies to reduce *E. coli* exist, it is often the case that TSS and TP are targeted with secondary benefits to the more elusive *E. coli*.

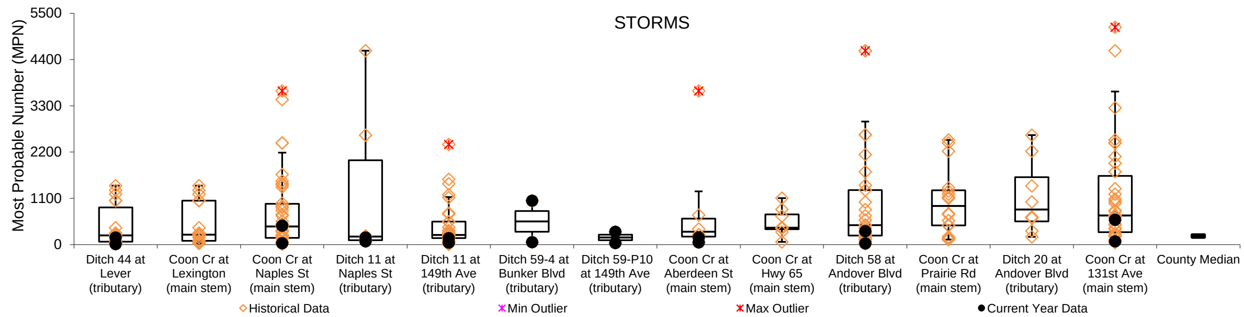
Average, Geomean and median *E. coli* in Coon Creek Data is from Vale St. 2013-2022.

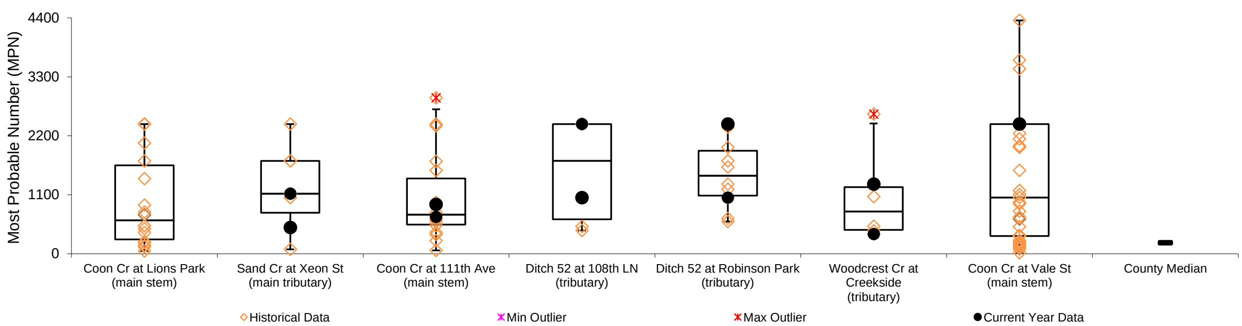
	Average *E. coli* (MPN)	**Geomean *E. coli* (MPN)**	**Median *E. coli* (MPN)**	**State Standard**	**N**
Baseflow	207.84	147.66	175.0	Monthly Geometric Mean >126	51
Storms	1,8381.25	800.24	1050.00		37
All	701.21	300.85	224.7	Monthly 10% average >1260	88
Occasions >126 MPN					34 baseflow (67%), 34 storm (92%)
Occasions >1260 MPN					0 baseflow, 16 storm (43%)

***E. coli* at Coon Creek** Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites. Extremely high outliers were excluded from box-plot graphs.



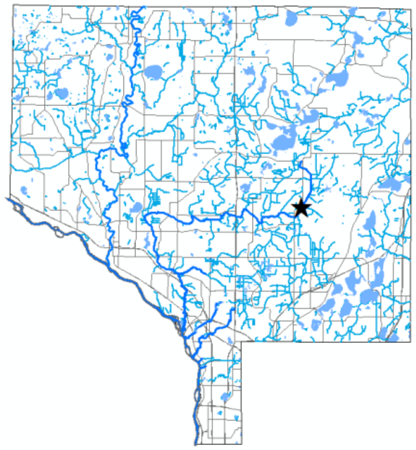






Stream Hydrology – Coon Creek

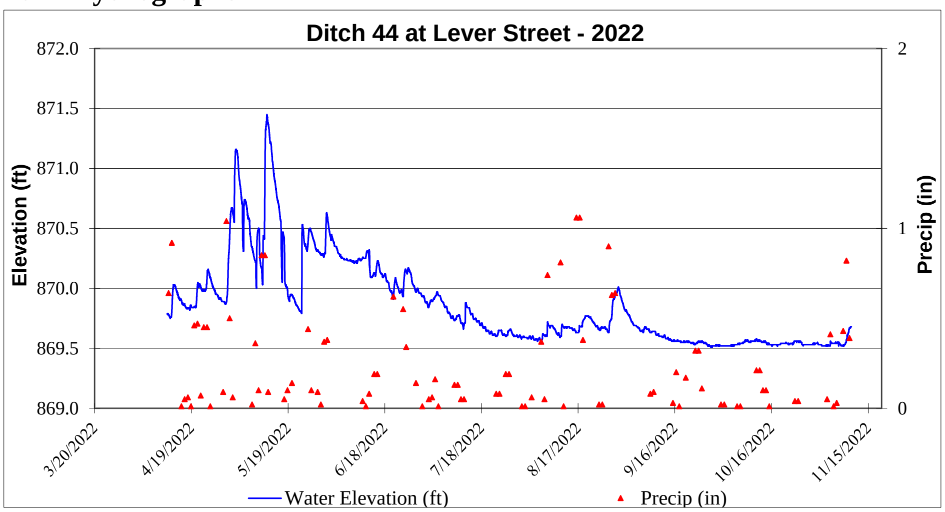
Ditch 44 At Lever St, Ham Lake

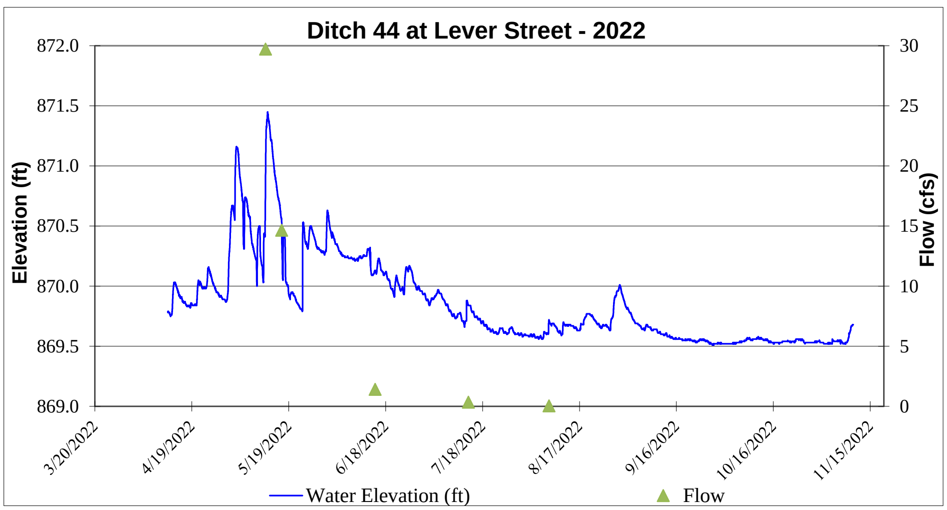


Notes

2022 was the first year stage was monitored at this site. Stage fluctuated 1.94ft between its minimum and maximum-recorded stage Discharge at this site was recorded at high volumes at the beginning of the season but then remained low and periodically absent.

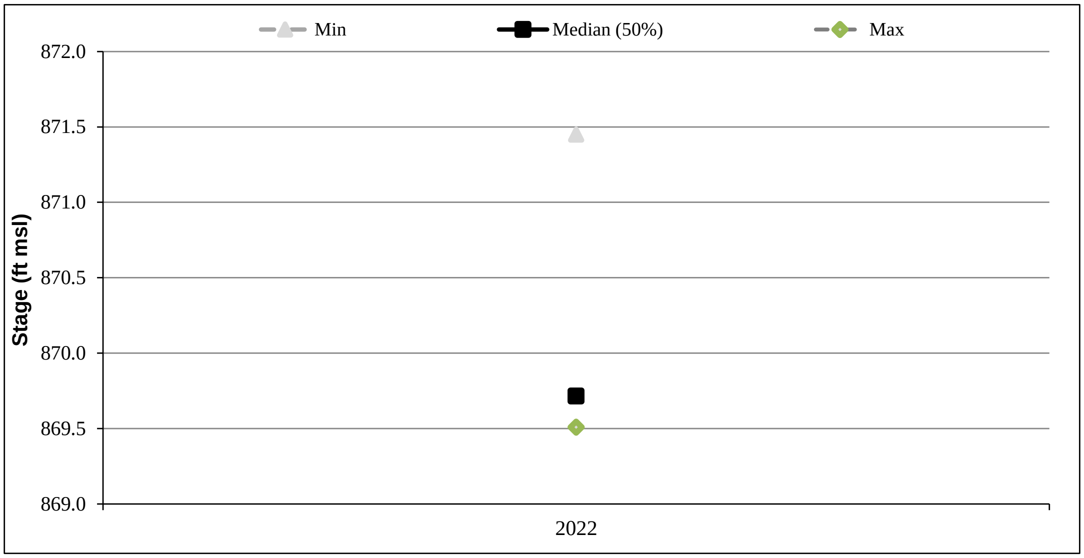
2022 Hydrographs



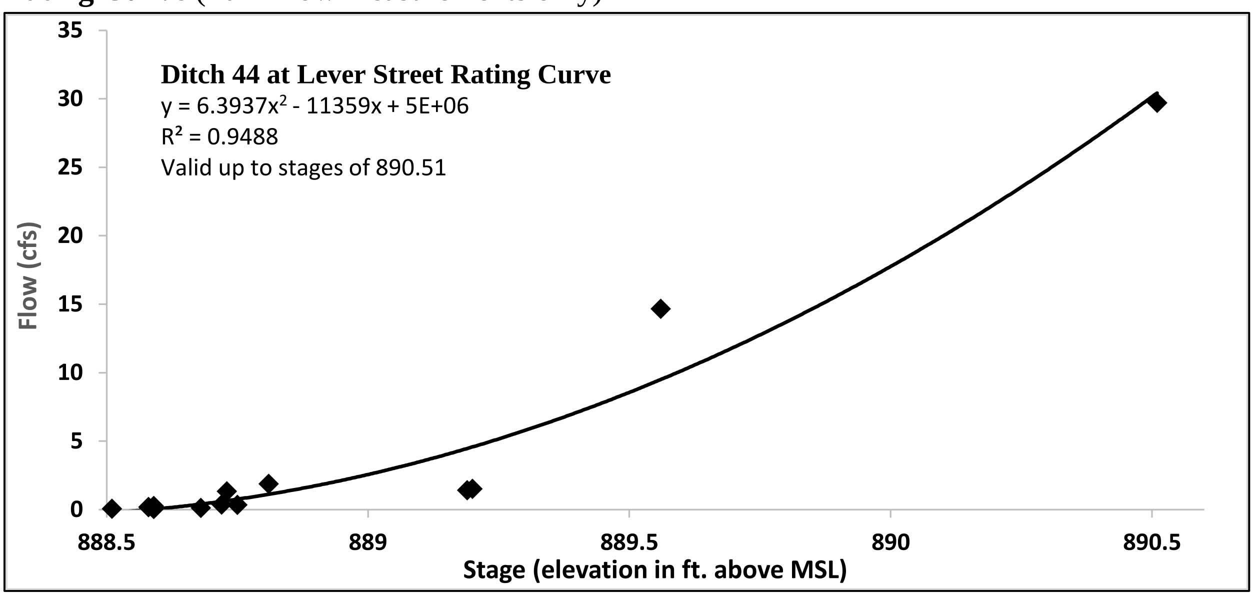


Summary of All Monitoring Years

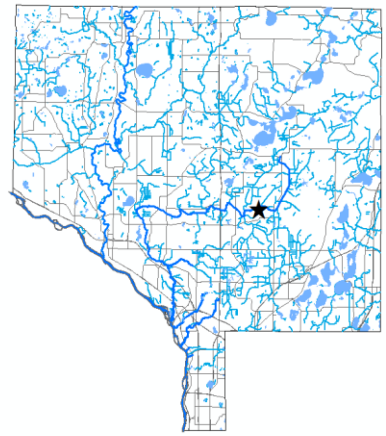
Percentiles	2022
Min	869.51
2.5%	869.52
10.0%	869.53
25.0%	869.56
Median (50%)	869.72
75.0%	870.02
90.0%	870.34
97.5%	870.84
Max	871.45



Rating Curve (2022 flow measurements only)



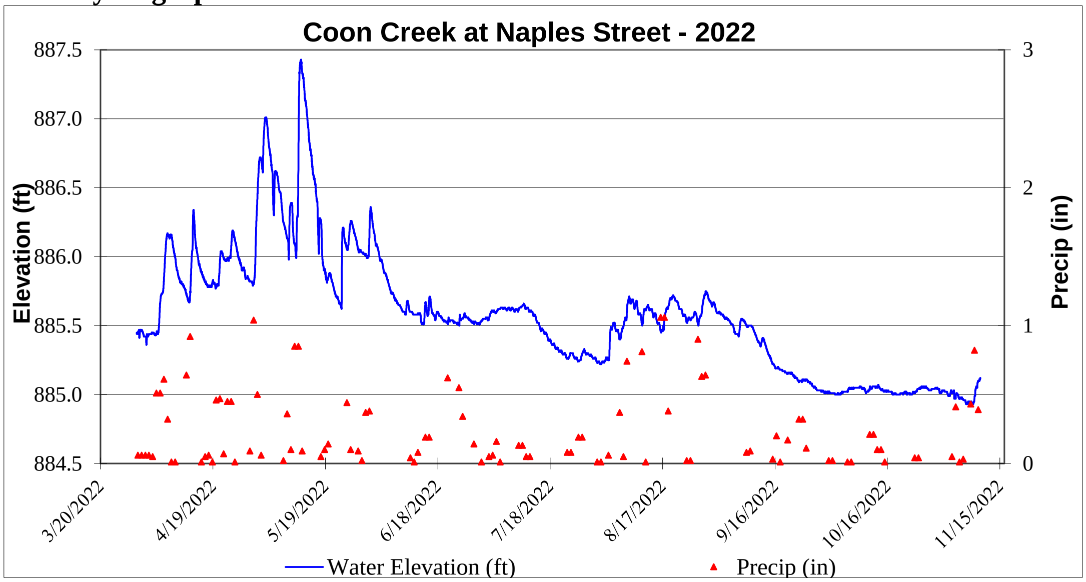
COON CREEK AT NAPLES STREET, HAM LAKE

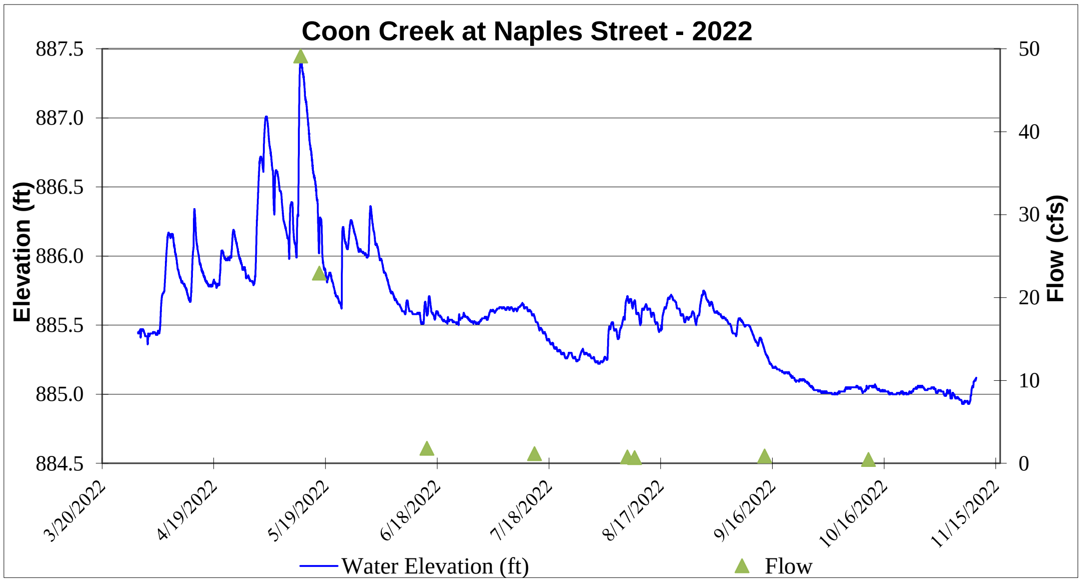


Notes

During 2022 Coon Creek at Naples Street fluctuated 2.50ft. between its minimum and maximum-recorded stage. This was a 1.62ft increase from 2021 water levels when the smallest range was recorded. Stage at this site changed little in response to rain events and had minimal flow throughout 2022.

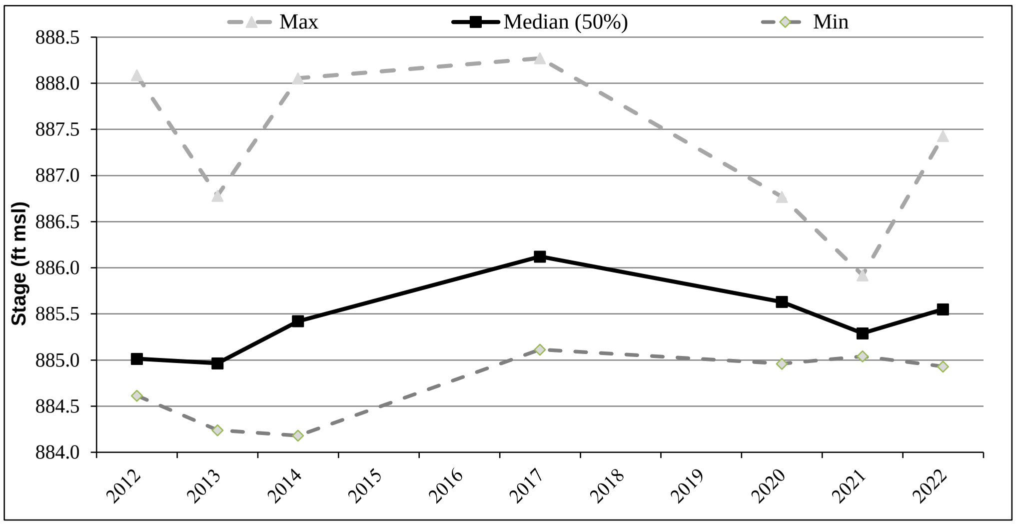
2022 Hydrographs



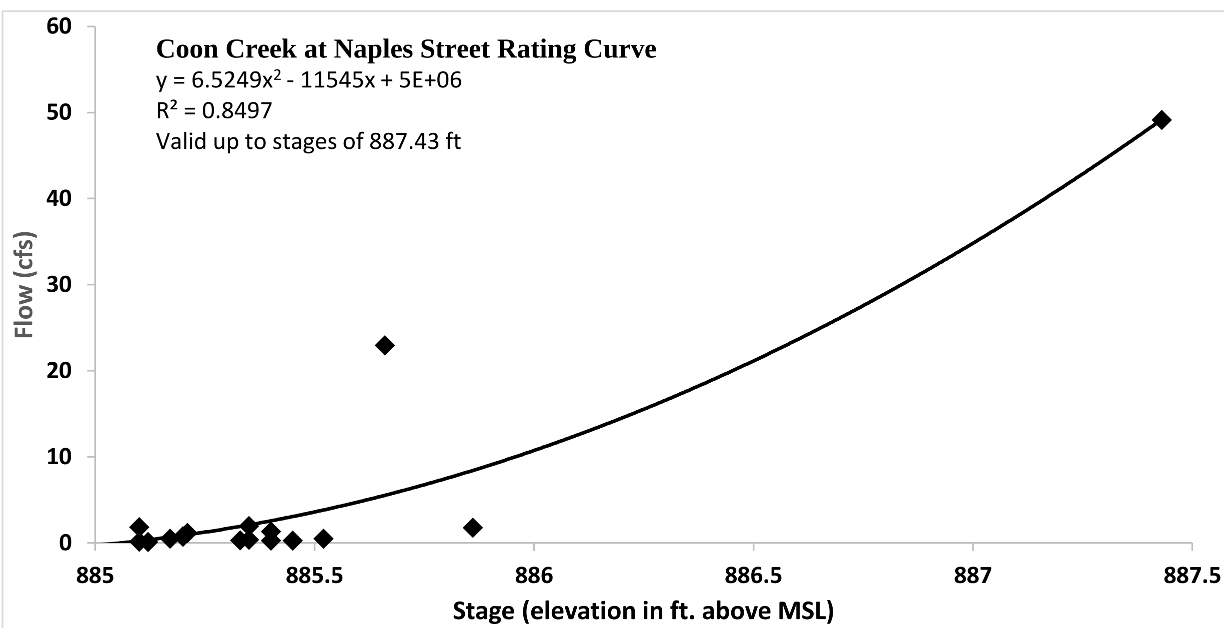


Summary of All Monitoring Years

Percentiles	2012	2013	2014	2017	2020	2021	2022
Min	884.61	884.24	884.18	885.11	884.96	885.04	884.93
2.5%	884.71	884.41	884.69	885.26	884.99	885.10	885.00
10.0%	884.81	884.46	884.88	885.65	885.04	885.12	885.02
25.0%	884.89	884.55	885.06	885.78	885.36	885.15	885.23
Median (50%)	885.01	884.97	885.42	886.12	885.63	885.29	885.55
75.0%	885.49	885.42	886.38	886.42	885.92	885.41	885.78
90.0%	885.89	885.84	887.76	886.92	886.23	885.49	886.14
97.5%	887.78	886.22	888.01	888.09	886.66	885.59	886.72
Max	888.09	886.78	888.06	888.27	886.77	885.92	887.43



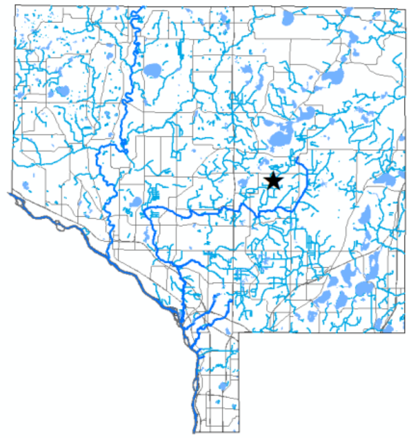
Rating Curve (flow measurements 2020-2022 included)



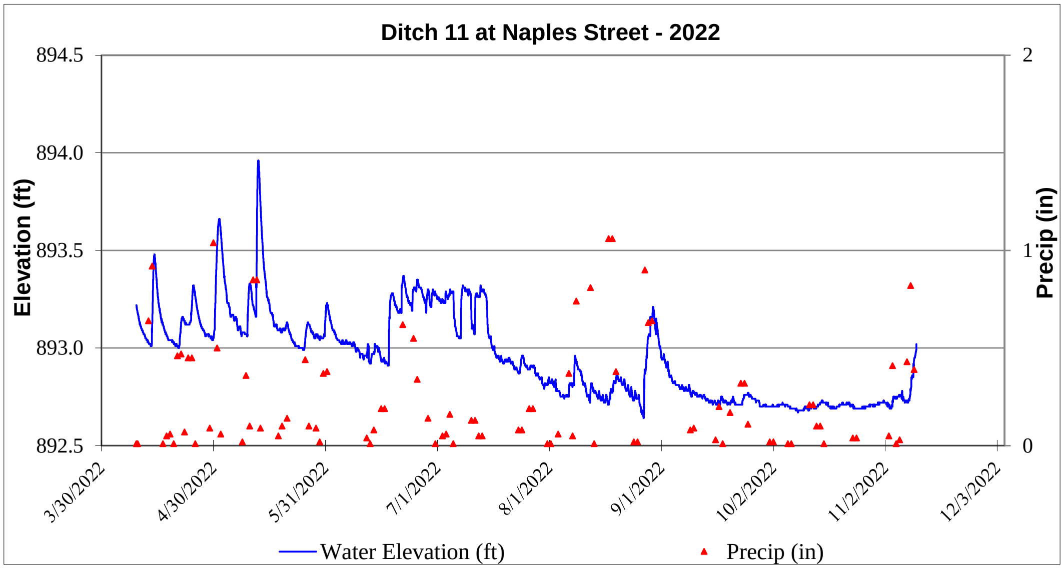
DITCH 11 AT NAPLES STREET, HAM LAKE

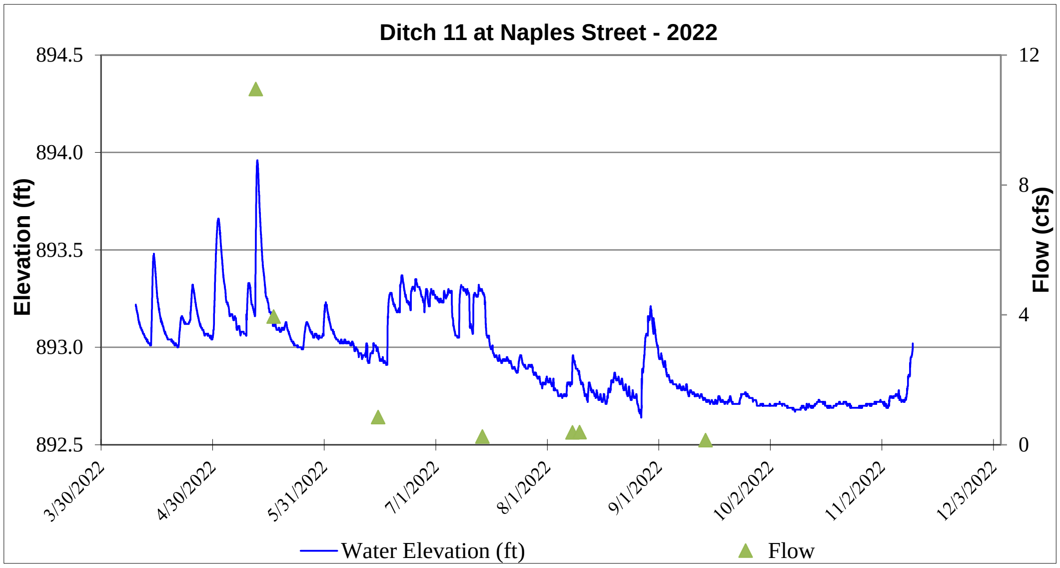
Notes

2022 was the first year stage was monitored at this site. Stage was flashy in response to rainfall, reacting quickly. Baseflow water elevation steadily declined throughout the season and stage at stage at this site fluctuated 1.32ft between its minimum and maximum recorded elevations. This ditch is likely influenced by water management being conducted in the ditch system by local agricultural producers for irrigation purposes.



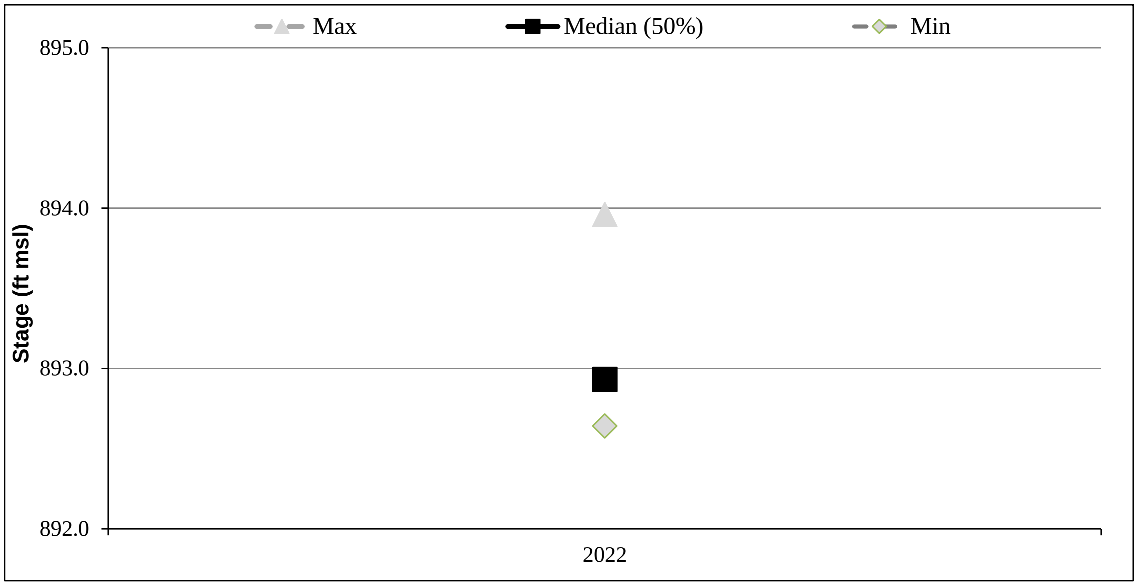
2022 Hydrographs



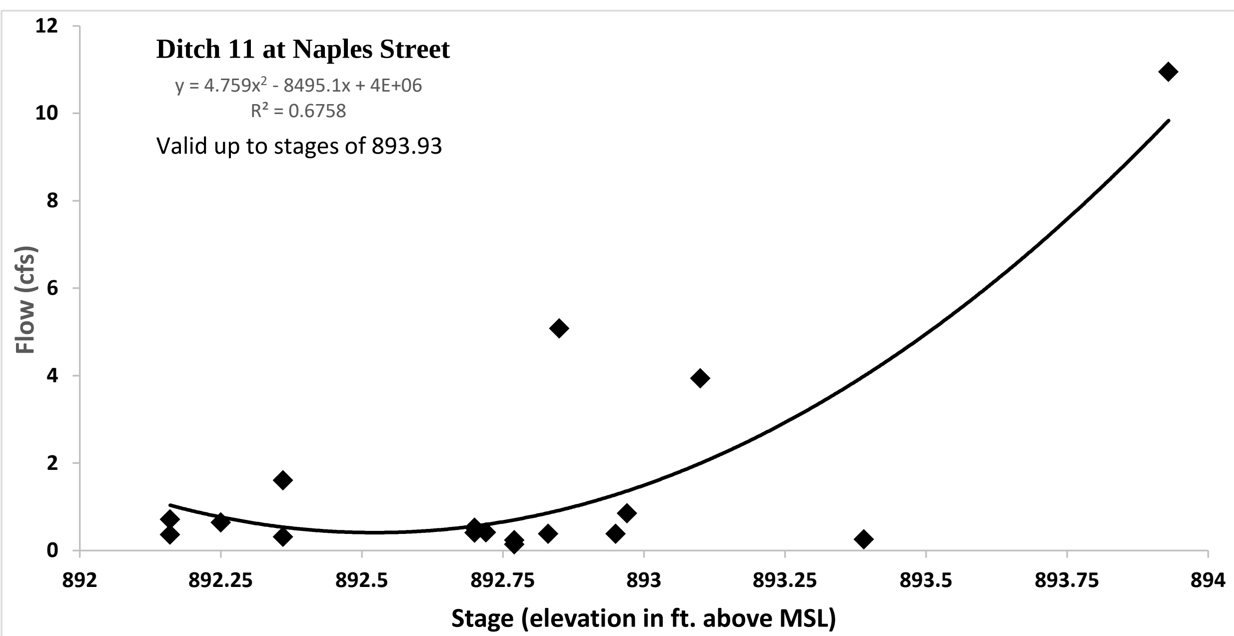


Summary of All Monitoring Years

Percentiles	2022
Min	892.64
2.5%	892.74
10.0%	885.86
25.0%	892.74
Median (50%)	892.93
75.0%	893.11
90.0%	893.27
97.5%	893.37
Max	893.96



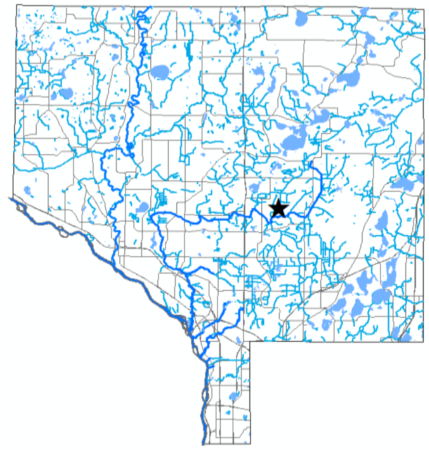
Rating Curve (flow measurements 2021-2022 included)



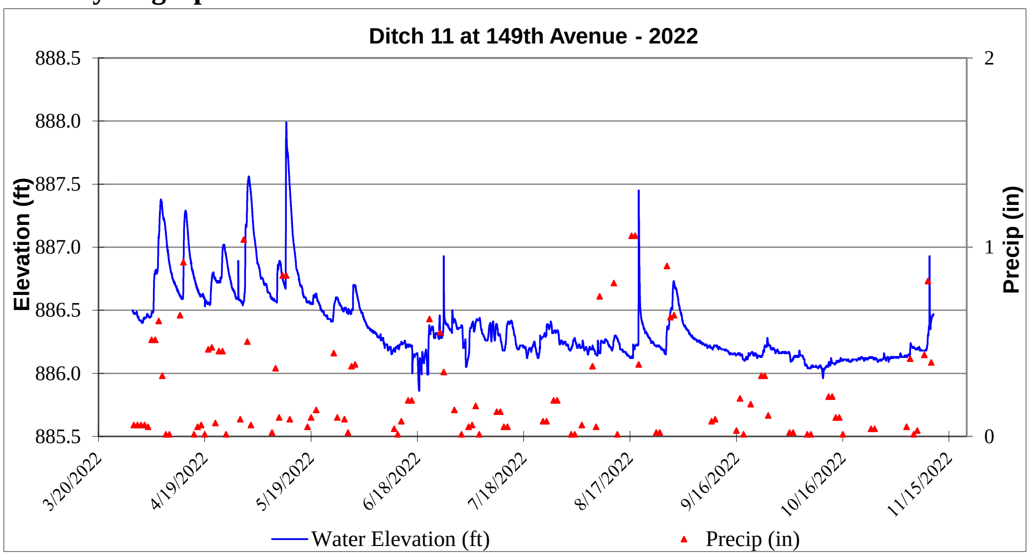
Ditch 11 at 149th Avenue, Ham Lake

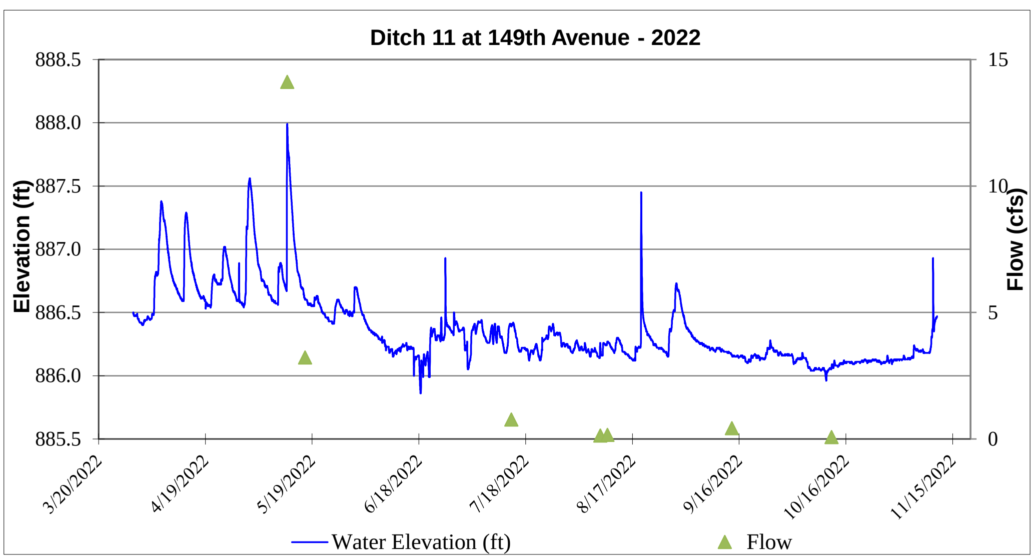
Notes

2022 was the third year monitoring was completed at this site. Stage at this site is typically flashy in response to storms, reacting quickly to rainfall. During the 2022 season, water levels fluctuated 2.13ft between its minimum and maximum-recorded stage. This site had relatively consistent water levels in 2022, despite drought conditions. The cause is unclear, but likely related to active water level management in the ditch system by local agricultural producers for irrigation purposes.



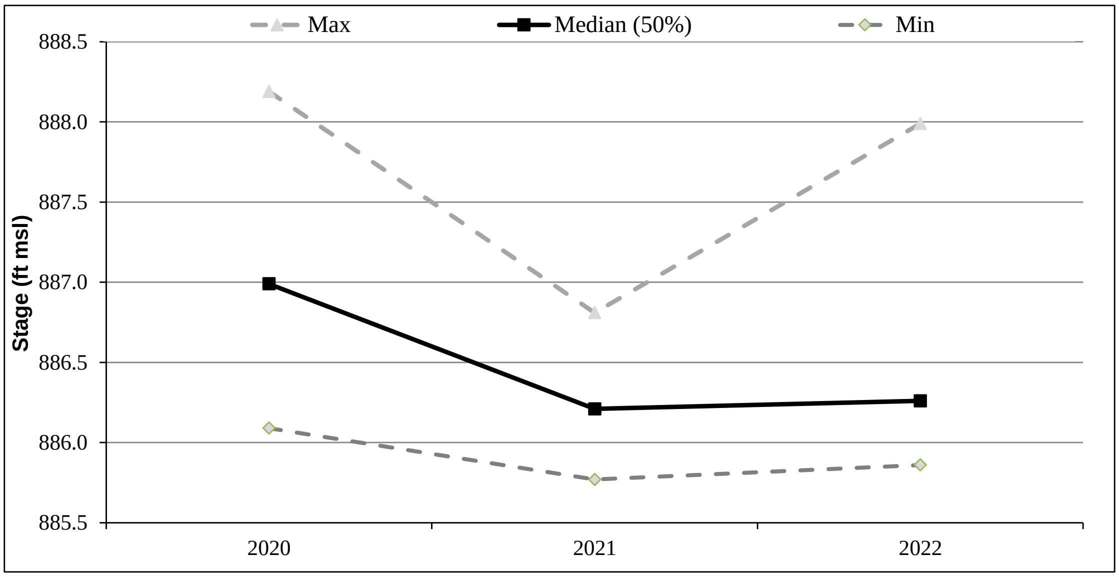
2022 Hydrographs





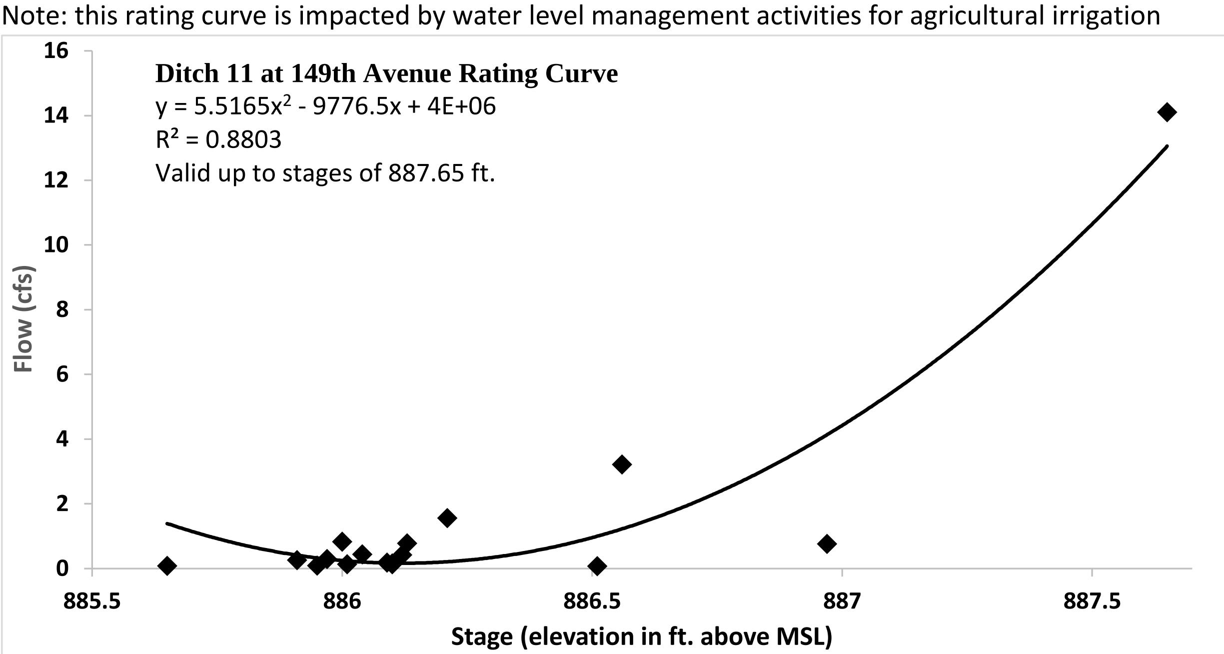
Summary of All Monitoring Years

Percentiles	2020	2021	2022
Min	886.09	885.77	885.86
2.5%	886.36	886.05	886.17
10.0%	886.66	885.86	885.86
25.0%	886.79	886.05	886.17
Median (50%)	886.99	886.21	886.26
75.0%	887.09	886.32	886.5
90.0%	887.33	886.38	886.75
97.5%	887.75	886.50	887.21
Max	888.19	886.81	887.99

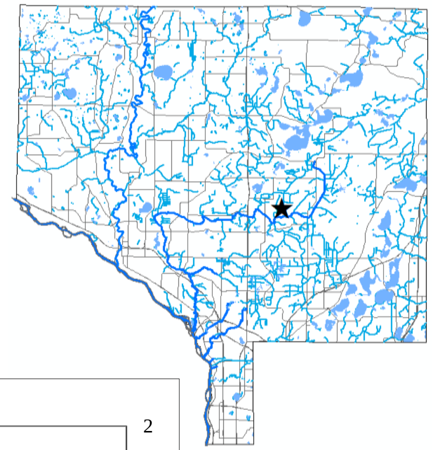


Rating Curve (2021-2022 flow measurements included)

Note: this rating curve is impacted by water level management activities for agricultural irrigation



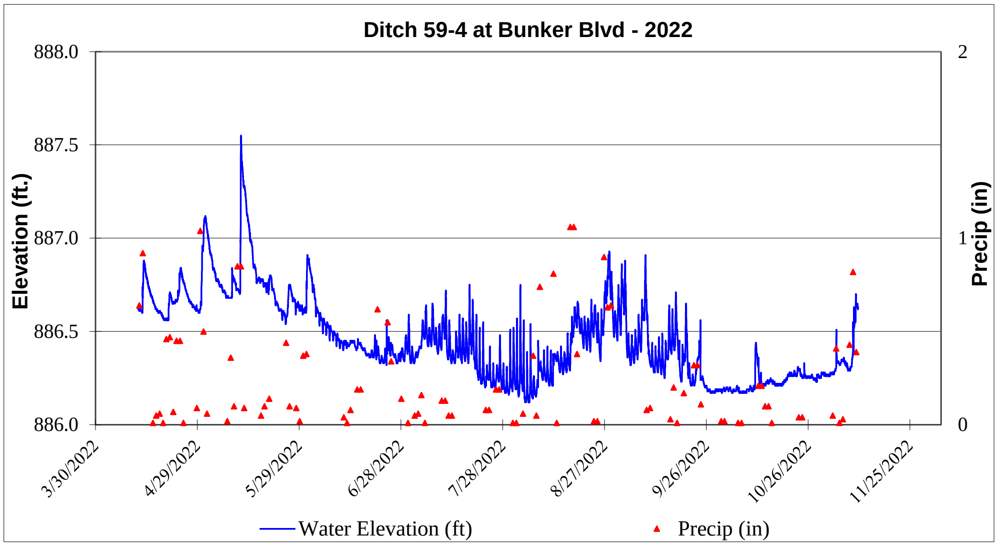
DITCH 59-4 AT BUNKER BLVD, HAM LAKE

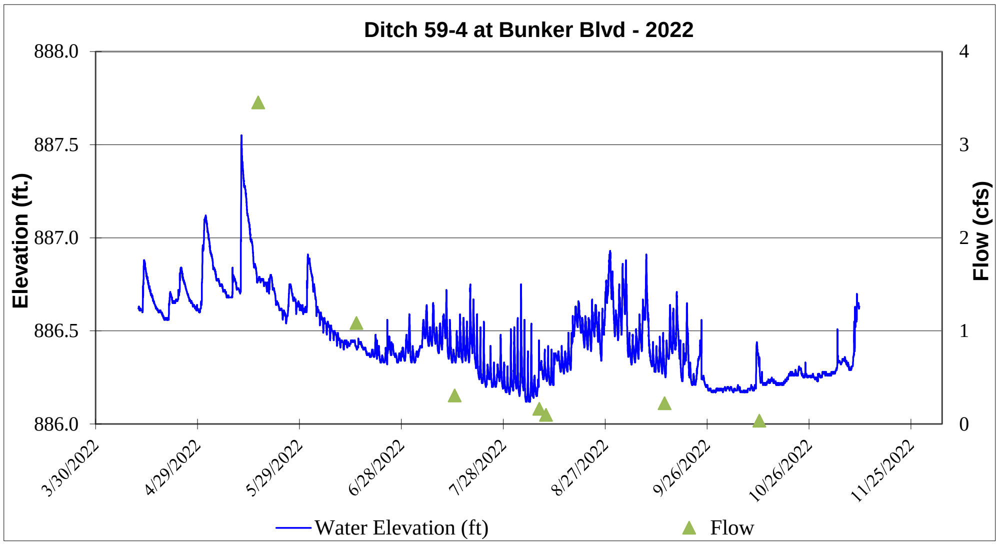


Notes

During the 2022 season, the creek only fluctuated by 1.43ft between its minimum and maximum recorded elevations and water levels were the lowest on record since the site was first monitored in 2008. This included the lowest average water level and the lowest maximum seasonal elevation. Stage at this site was flashy throughout the season and following most rainfall amounts stage usually only rose half a foot but in a short amount of time.

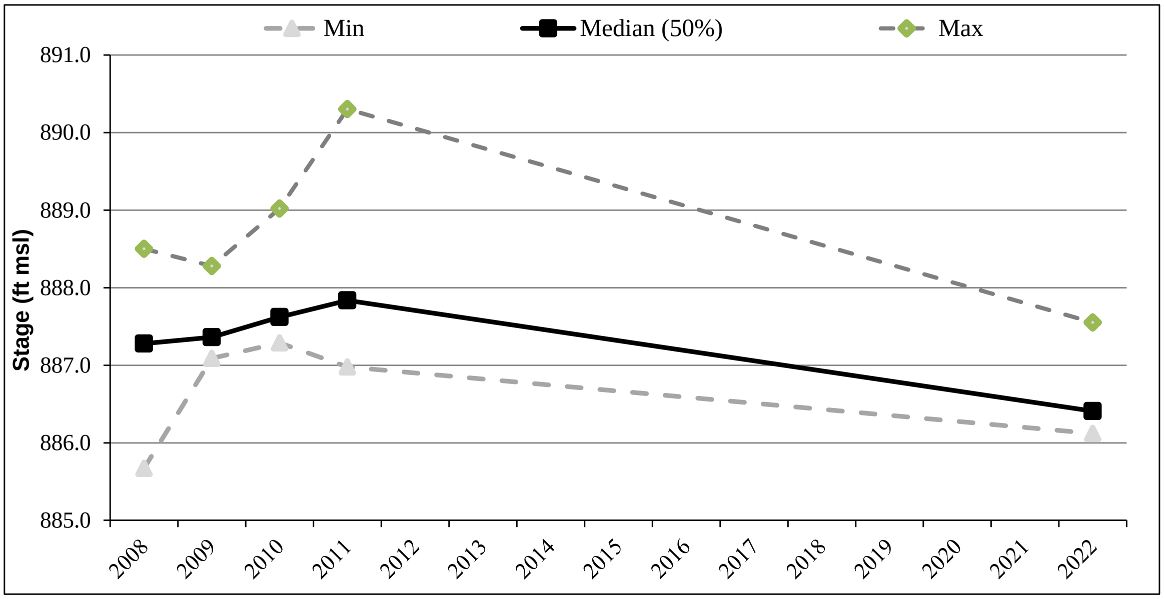
2022 Hydrographs



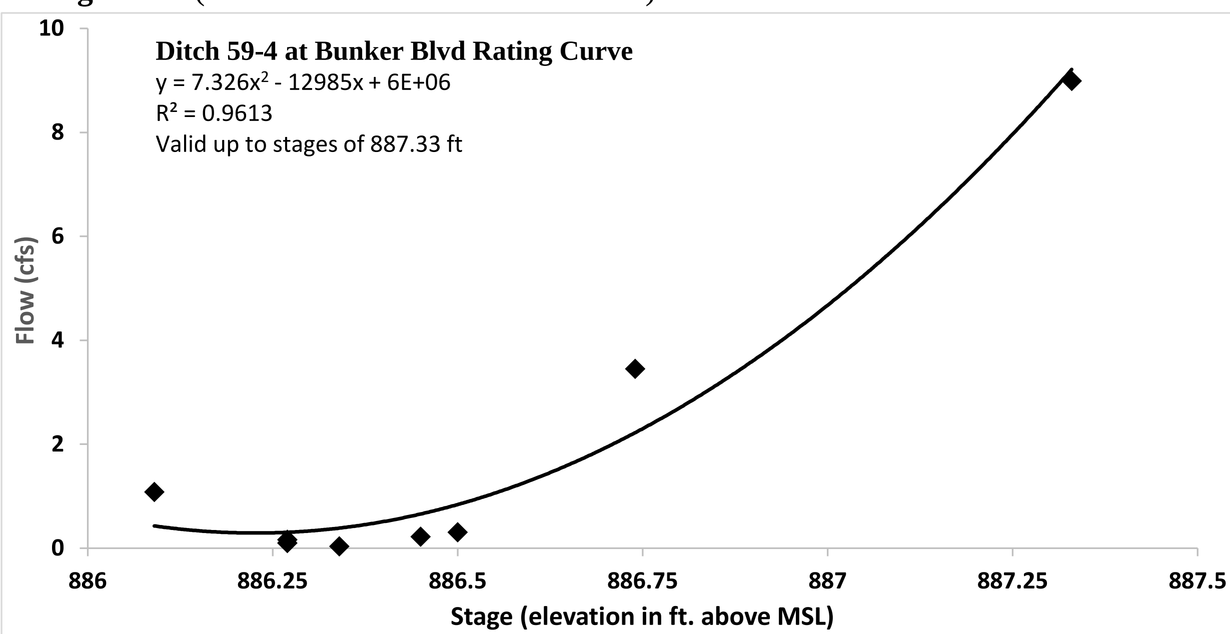


Summary of All Monitoring Years

Percentiles	2008	2009	2010	2011	2022
Min	885.67	887.09	887.29	886.98	886.12
2.5%	887.12	887.13	887.37	887.05	886.17
10.0%	887.16	887.16	887.43	887.11	886.21
25.0%	887.21	887.24	887.52	887.43	886.27
Median (50%)	887.28	887.36	887.62	887.84	886.41
75.0%	887.28	887.36	887.62	888.14	886.61
90.0%	887.95	887.62	887.77	888.37	886.75
97.5%	888.13	887.84	888.02	888.71	886.96
Max	888.50	888.28	889.02	890.30	887.55

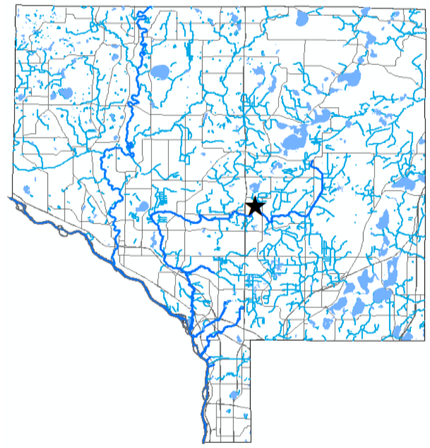


Rating Curve (2022 flow measurements included)



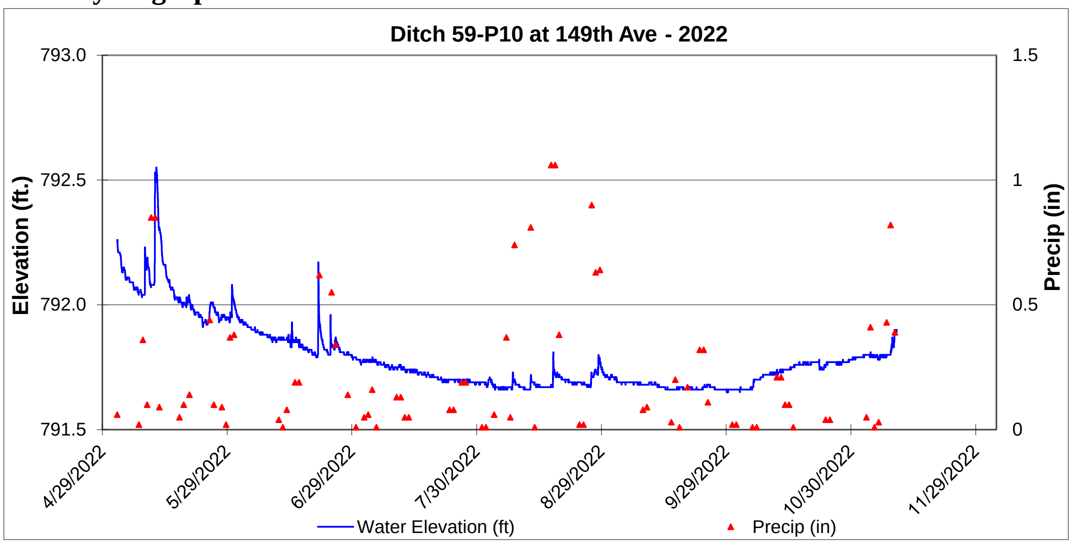
DITCH 59 P-10 AT 149TH AVENUE, HAM LAKE

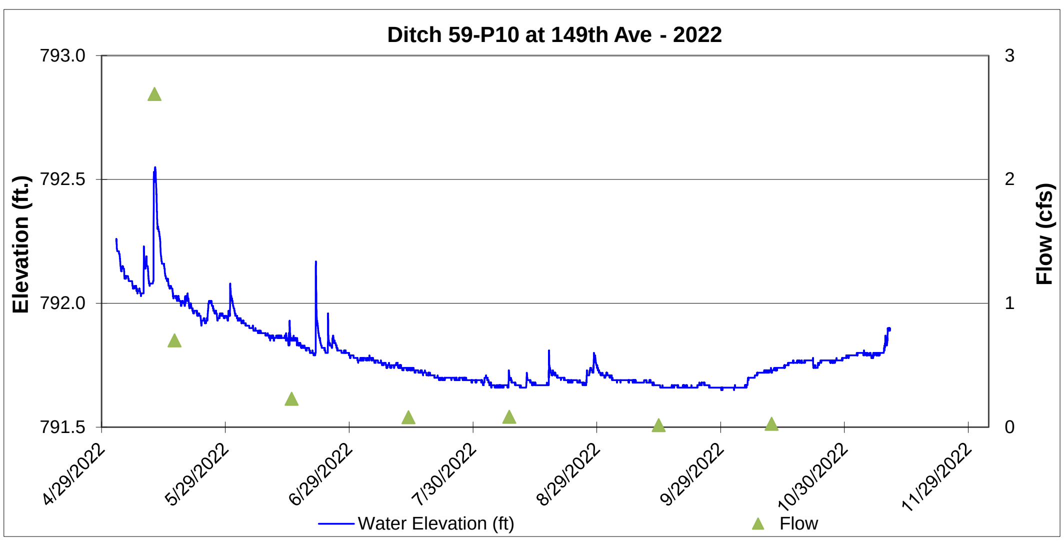
Notes



2022 was the first year of monitoring at this 149th Avenue site. This monitoring location was in a small tributary ditch that joins the main stem of Coon Creek just upstream from Aberdeen Street. During the season, water levels at this site fluctuated by only 0.90ft between its minimum and maximum and stage responded very little to rainfall. This site had higher than anticipated water levels in 2022 that remained consistent and increased slightly despite drought conditions.

2022 Hydrographs

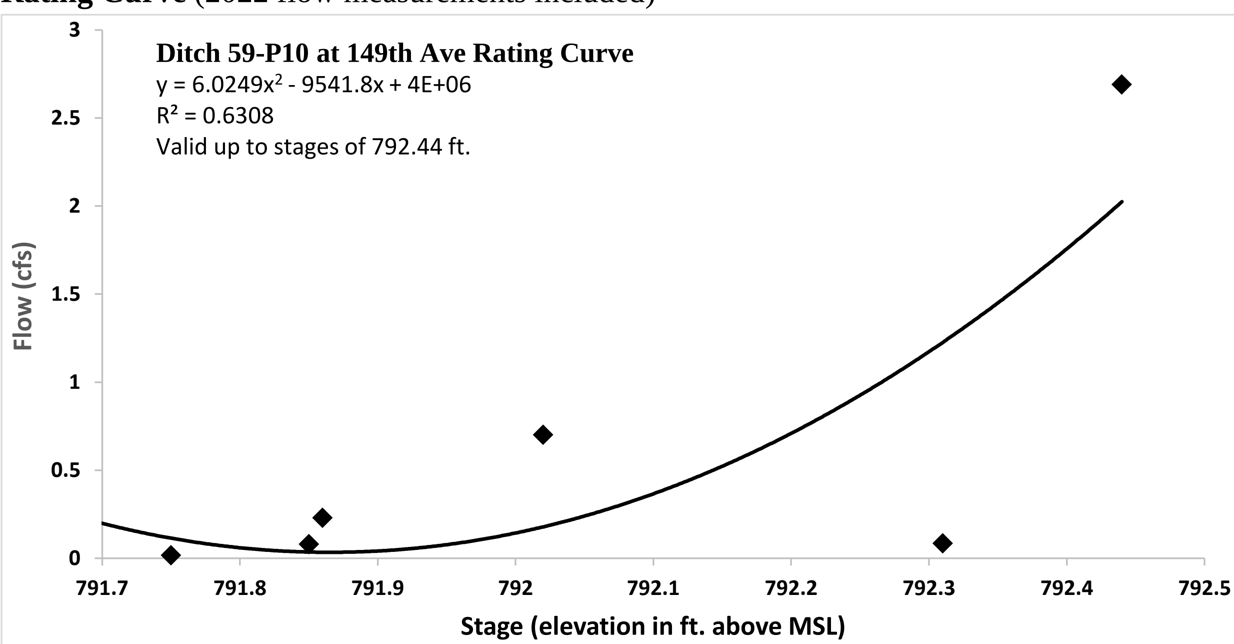




Summary of All Monitoring Years

Percentiles	2022
Min	791.65
2.5%	791.66
10.0%	791.66
25.0%	791.69
Median (50%)	791.75
75.0%	791.84
90.0%	792.00
97.5%	792.15
Max	792.55

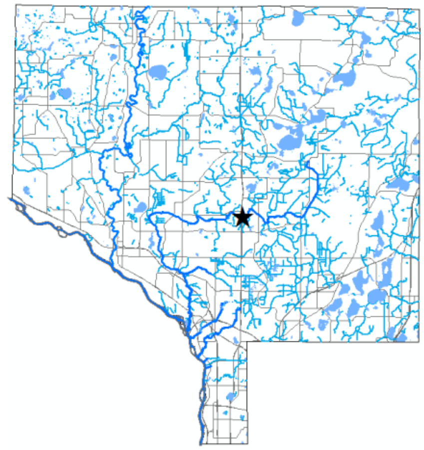
Rating Curve (2022 flow measurements included)



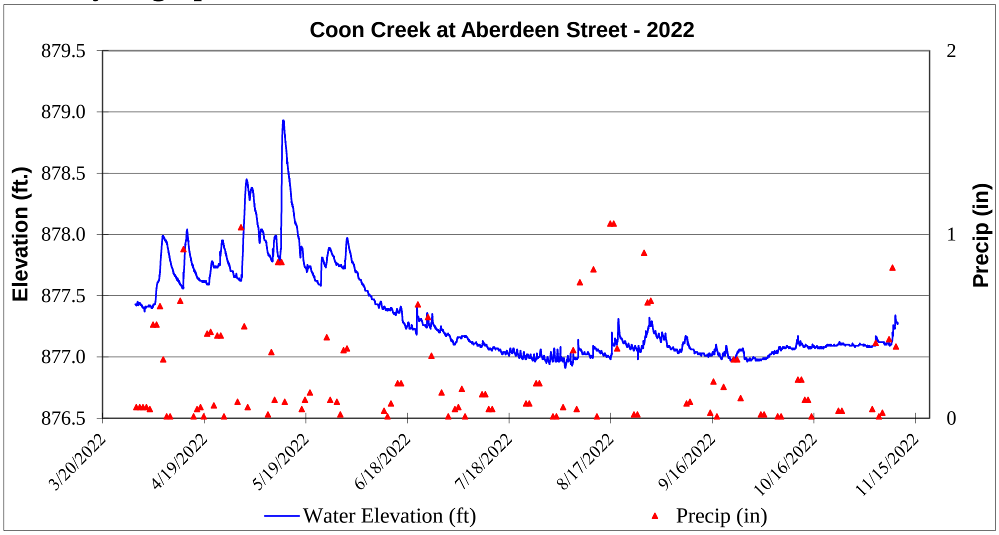
Coon Creek at Aberdeen Street, Ham Lake

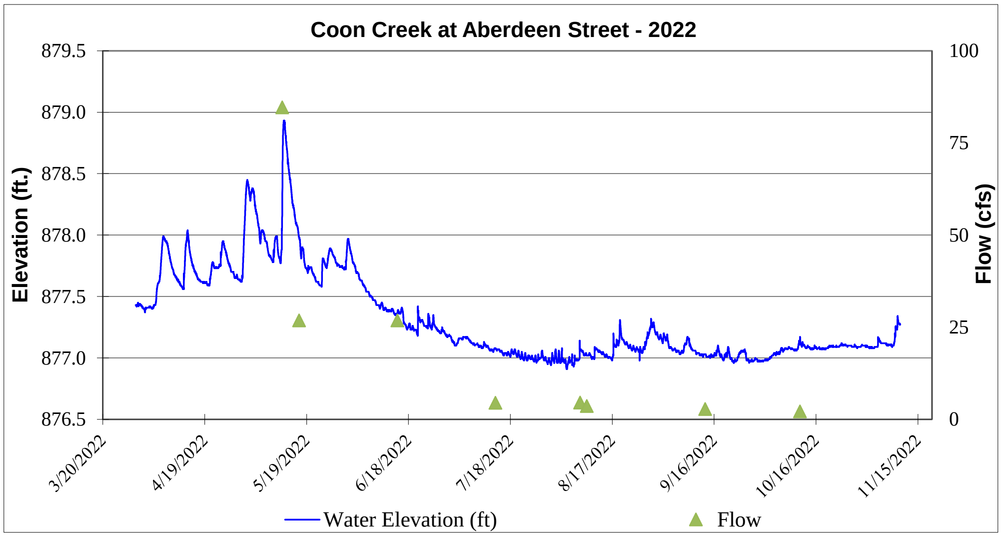
Notes

2022 was the second year monitoring was conducted at the Aberdeen Street site. This site is located at a newly constructed stream crossing, just upstream from Highway 65. During 2022 water levels fluctuated by 3.03ft between its minimum and maximum and reached a maximum 1.65ft higher than the previous year. Baseflow water elevation decreased through the first half of the season and then leveled out, fluctuating very little late in this drought season.



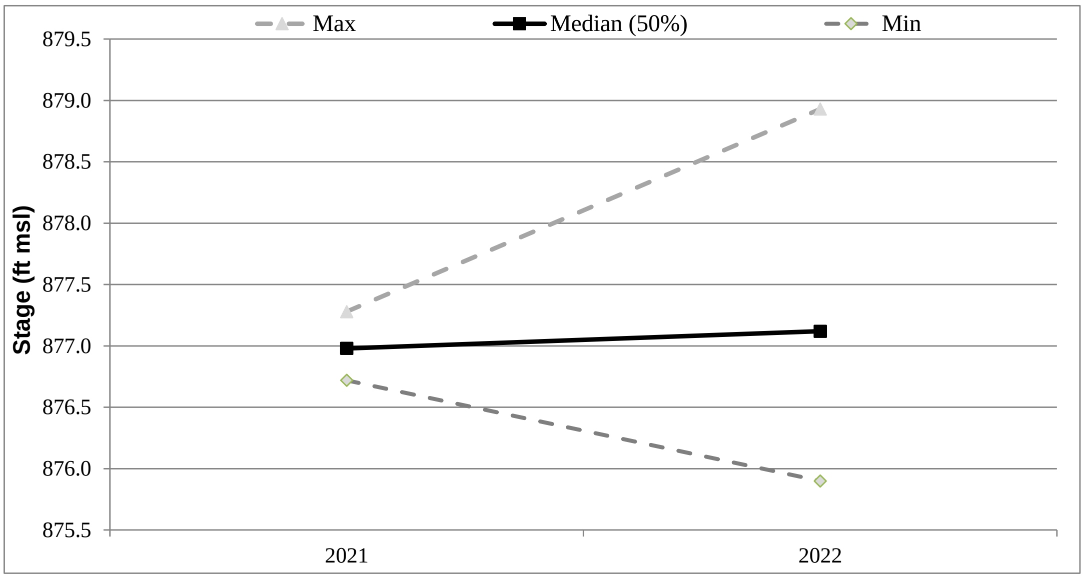
2022 Hydrographs



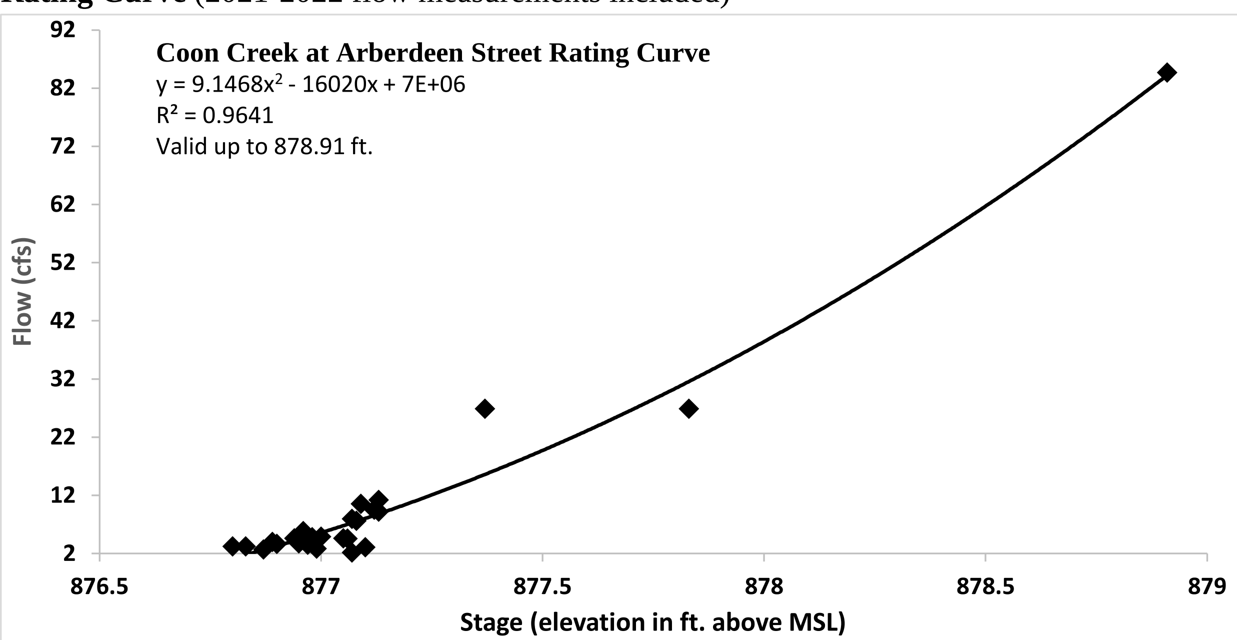


Summary of All Monitoring Years

Percentiles	2021	2022
Min	876.72	875.90
2.5%	876.75	876.97
10.0%	876.80	877.00
25.0%	876.87	877.06
Median (50%)	876.98	877.12
75.0%	877.11	877.61
90.0%	877.19	877.85
97.5%	8.77	878.28
Max	877.28	878.93



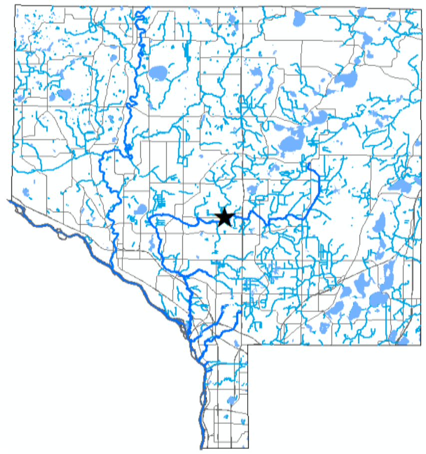
Rating Curve (2021-2022 flow measurements included)



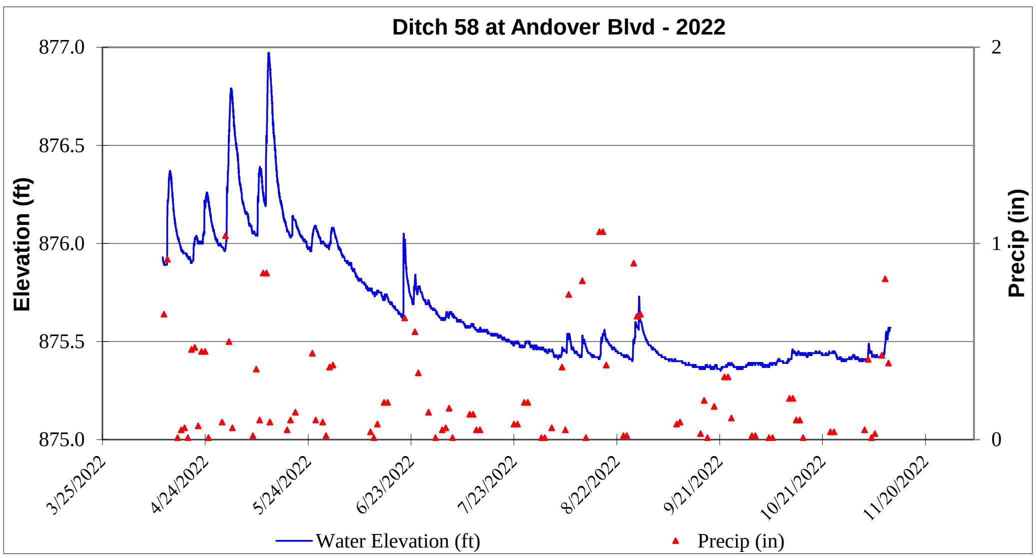
Ditch 58 at Andover Blvd, Ham Lake

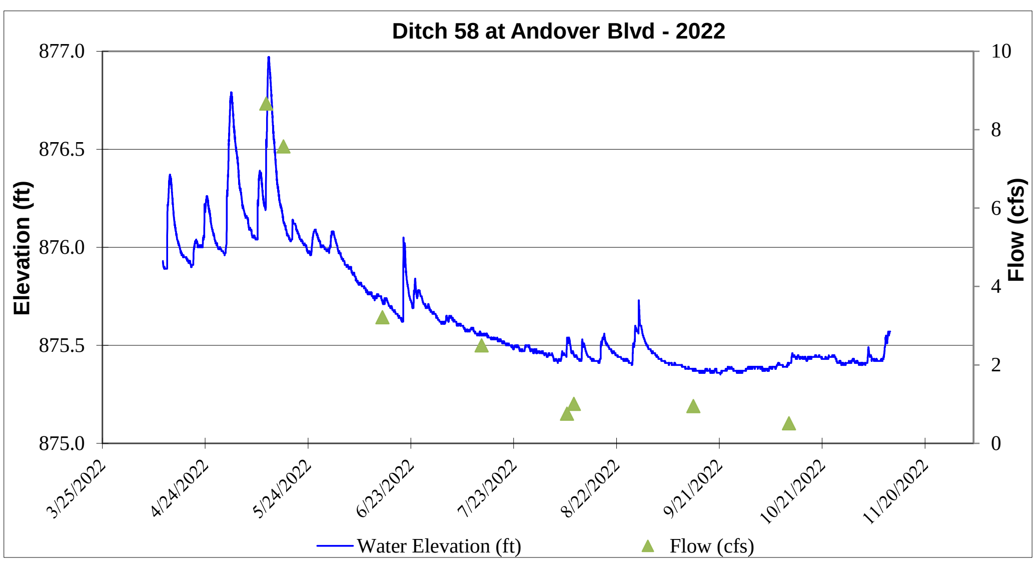
Notes

Ditch 58 at Andover Blvd has been monitored periodically since 2001. Baseflow water elevation steadily declined throughout the season due to drought and stage at this site fluctuated 1.62ft between its minimum and maximum. Water levels at this site averaged highest since 2014. Stage was quick to react to storm events at the beginning of the season but little fluctuation was observed late in the season in response to similar rain events.



2022 Hydrographs

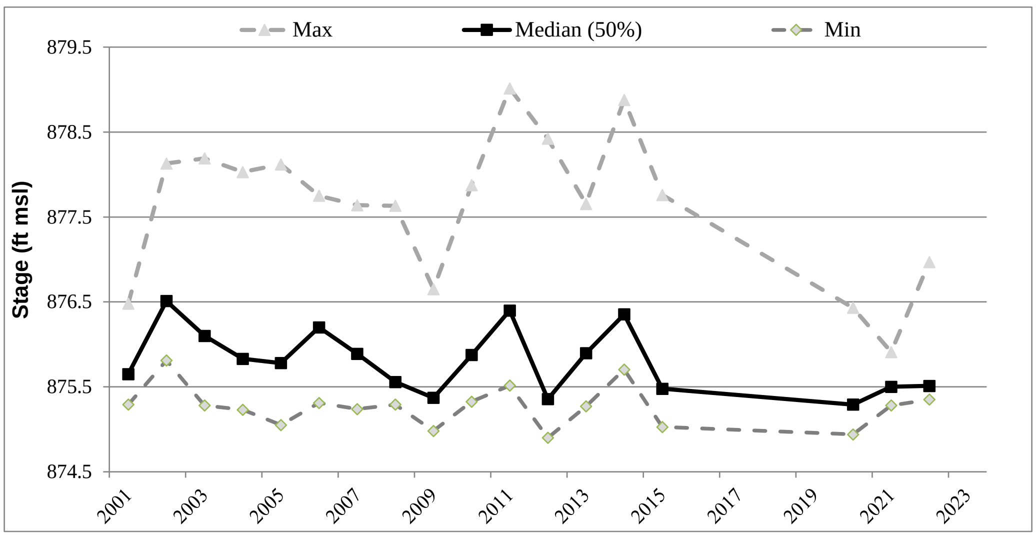




Summary of All Monitoring Years

Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009
Min	875.29	875.81	875.28	875.23	875.05	875.31	875.24	875.29	874.98
2.5%	875.35	876.18	875.57	875.63	875.54	875.91	875.29	875.33	875.01
10.0%	875.48	876.33	875.64	875.51	875.37	875.66	875.37	875.36	875.16
25.0%	875.58	876.41	875.74	875.63	875.54	875.91	875.49	875.39	875.29
Median (50%)	875.65	876.51	876.10	875.83	875.78	876.20	875.89	875.56	875.37
75.0%	875.77	876.73	876.59	876.05	876.04	876.35	876.16	876.06	875.46
90.0%	876.23	877.42	877.01	876.45	876.22	876.47	876.40	876.28	875.54
97.5%	876.30	878.13	878.16	877.04	876.98	876.89	876.90	876.61	875.79
Max	876.48	878.13	878.19	878.03	878.12	877.75	877.64	877.63	876.65

Percentiles	2010	2011	2012	2013	2014	2015	2020	2021	2022
Min	875.33	875.52	874.90	875.27	875.70	875.03	874.94	875.28	875.35
2.5%	875.39	875.62	875.02	875.52	876.07	875.19	874.99	875.28	875.37
10.0%	875.48	875.65	875.06	875.57	876.10	875.28	875.04	875.32	875.38
25.0%	875.58	875.79	875.12	875.64	876.16	875.36	875.12	875.4	875.42
Median (50%)	875.88	876.40	875.36	875.90	876.35	875.48	875.29	875.5	875.51
75.0%	876.25	876.92	875.51	876.24	877.05	875.63	875.51	875.57	875.91
90.0%	876.49	877.67	875.79	876.48	878.30	875.92	875.67	875.72	876.09
97.5%	877.13	878.55	877.02	877.00	878.80	876.77	875.88	875.79	876.45
Max	877.88	879.02	878.42	877.65	878.88	877.76	876.43	875.91	876.97



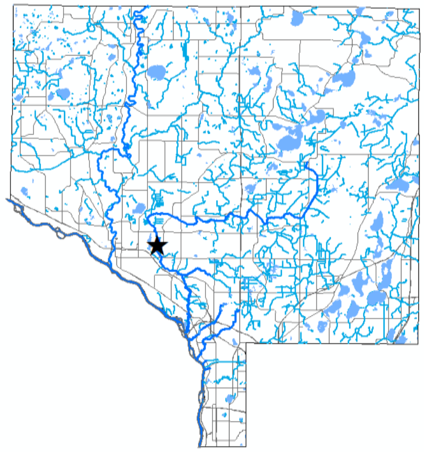
Flow Measurements

Date	Elevation	Discharge cubic ft/sec
6/9/2021	875.55	2.484
6/29/2021	875.69	4.239
7/14/2021	875.62	2.825
7/15/2021	875.68	4.278
8/11/2021	875.55	2.004
8/24/2021	875.64	3.028
8/27/2021	875.61	2.319
9/15/2021	875.6	2.584
10/13/2021	875.63	2.938
5/12/2022	876.03	8.665
5/17/2022	875.99	7.575
6/15/2022	875.8	3.215
7/14/2022	875.76	2.498
8/8/2022	875.6	0.755
8/10/2022	875.62	1.004
9/14/2022	875.65	0.949
10/12/2022	875.57	0.509

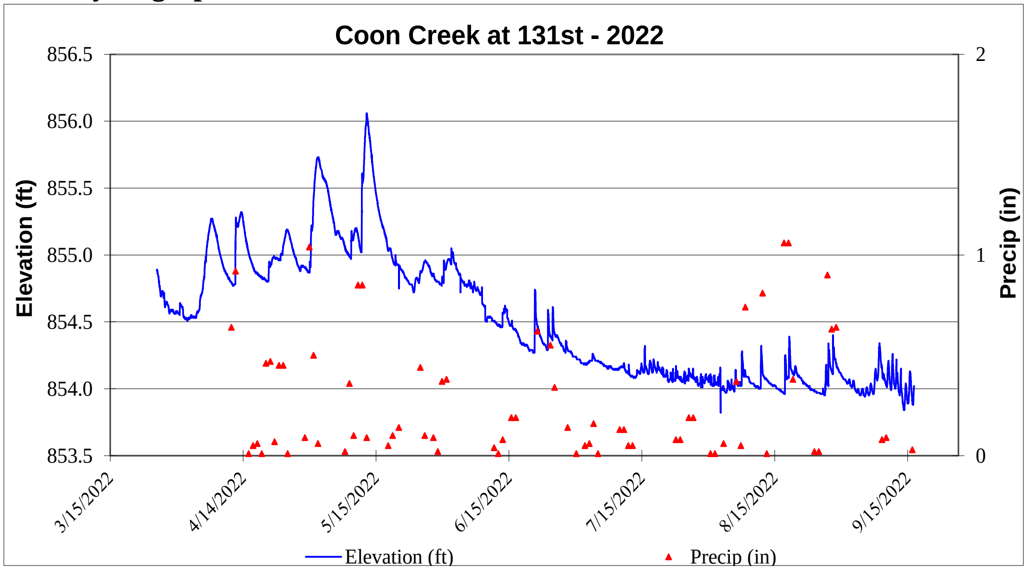
Coon Creek at 131st Avenue

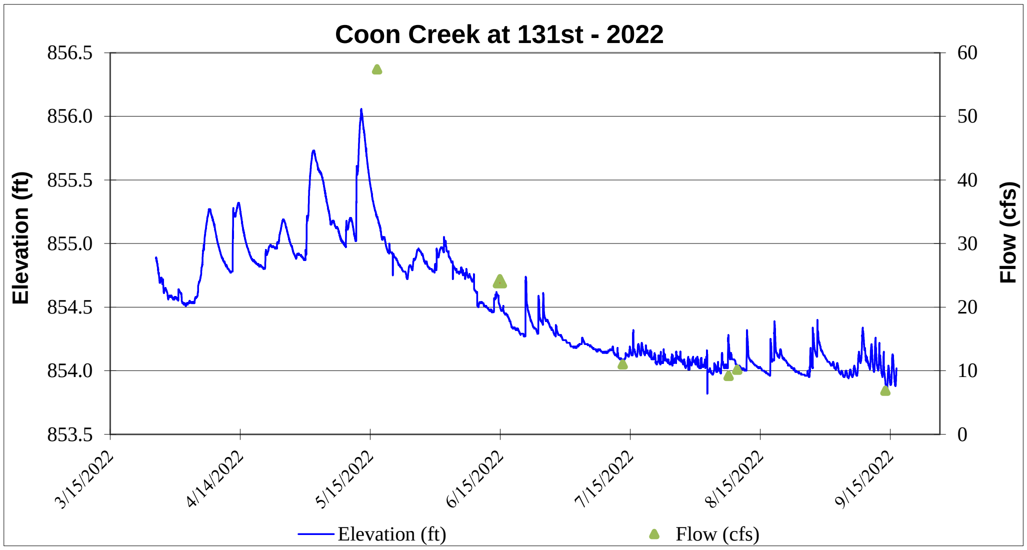
Notes

Throughout 2022, baseflow elevations at the 131st Ave site steadily decreased due to drought, with a slight rebound late in the fall. The water level at this site fluctuated 2.24 ft. between its maximum and minimum. Water levels at this site reached the lowest elevation on record since monitoring began in 2015.



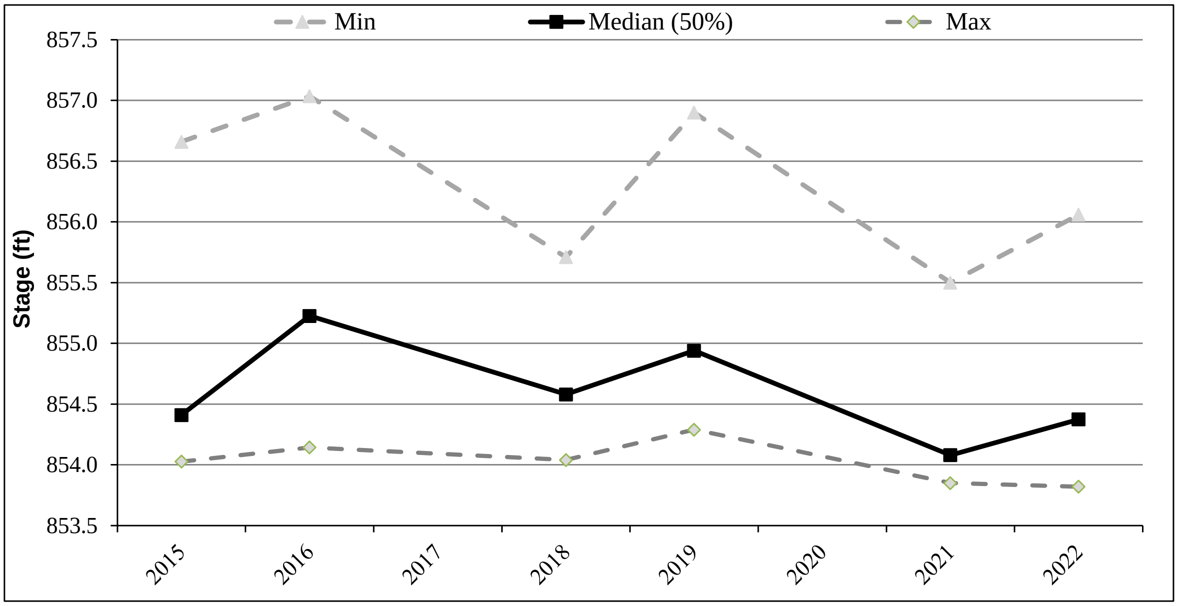
2022 Hydrographs



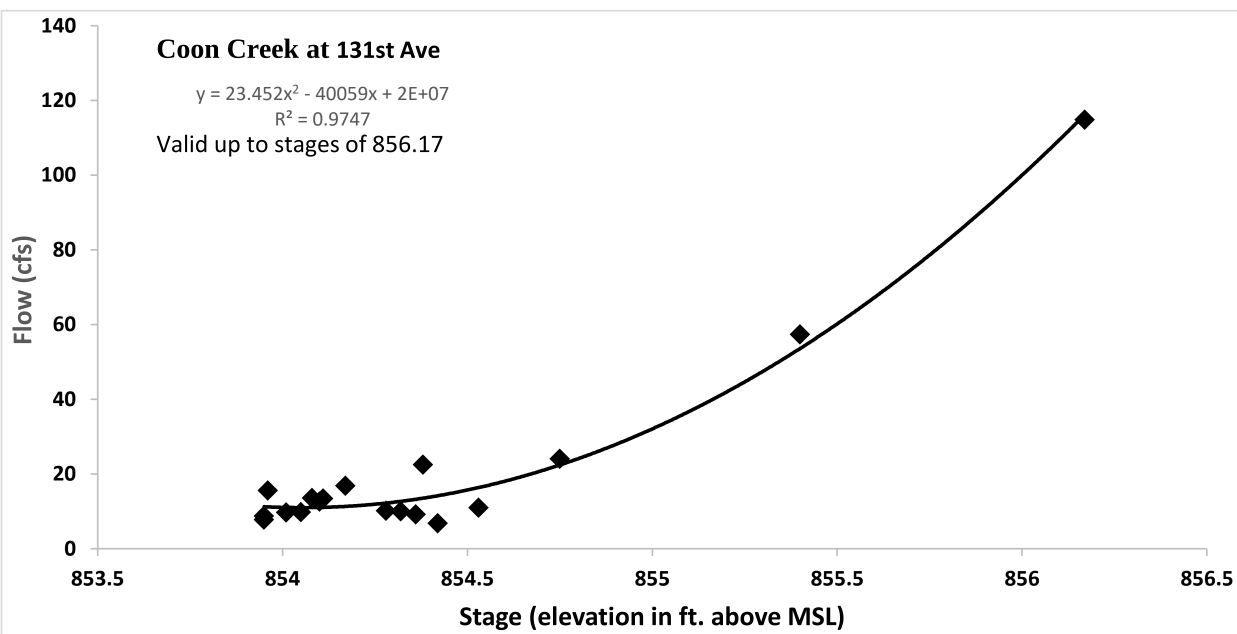


Summary of All Monitoring Years

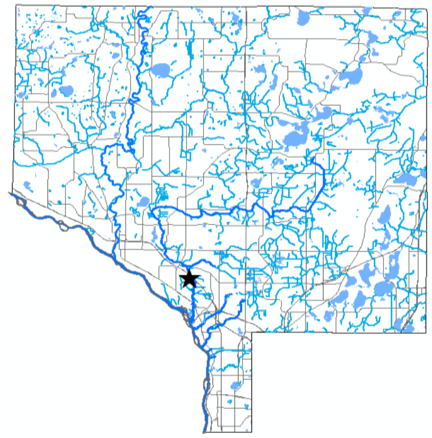
Percentiles	2015	2016	2018	2019	2021	2022
Min	854.03	854.14	854.04	854.29	853.85	853.82
2.5%	854.09	854.32	854.08	854.33	853.87	853.96
10.0%	854.16	854.45	854.13	854.43	853.9	854.02
25.0%	854.27	854.71	854.32	854.57	853.97	854.09
Median (50%)	854.41	855.23	854.58	854.94	854.08	854.38
75.0%	854.68	855.65	854.76	855.58	854.38	854.89
90.0%	855.03	855.88	855.02	856.09	854.77	855.15
97.5%	855.79	856.19	855.40	856.57	855.12	855.57
Max	856.66	857.04	855.71	856.90	855.5	856.06



Rating Curve (2021-2022 flow measurements included)



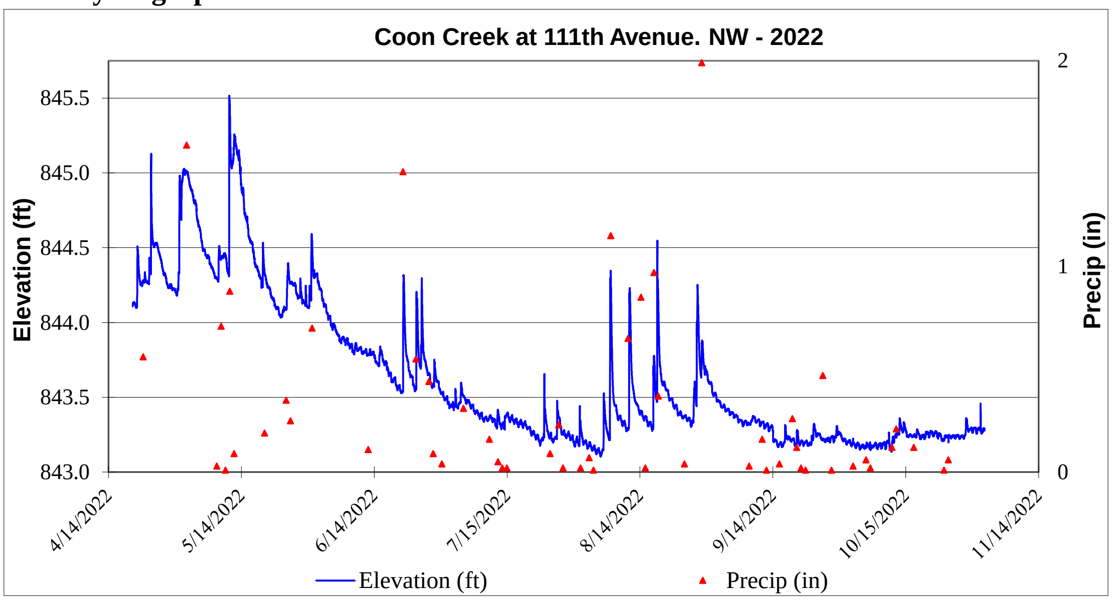
COON CREEK AT 111TH AVENUE

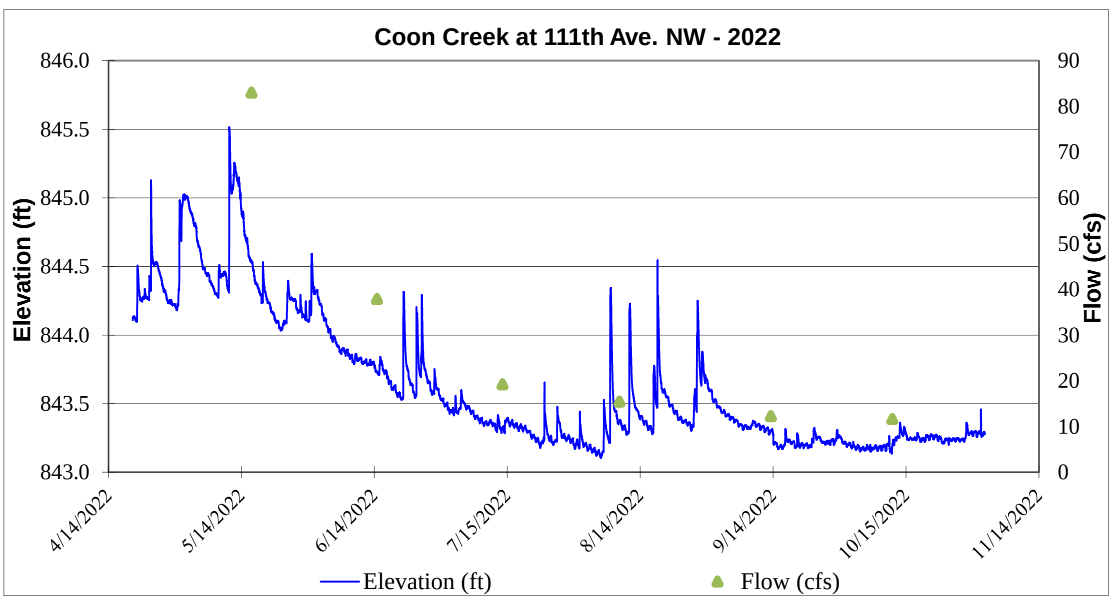


Notes

Water levels at this site were flashy in response to storms, with stage rising quickly after rainfall. During 2022, water levels at the 111th Avenue site fluctuated 2.41ft between its minimum and maximum. Baseflow water elevation decreased at the beginning of the season but fluctuated quickly in response to rain events later in the year.

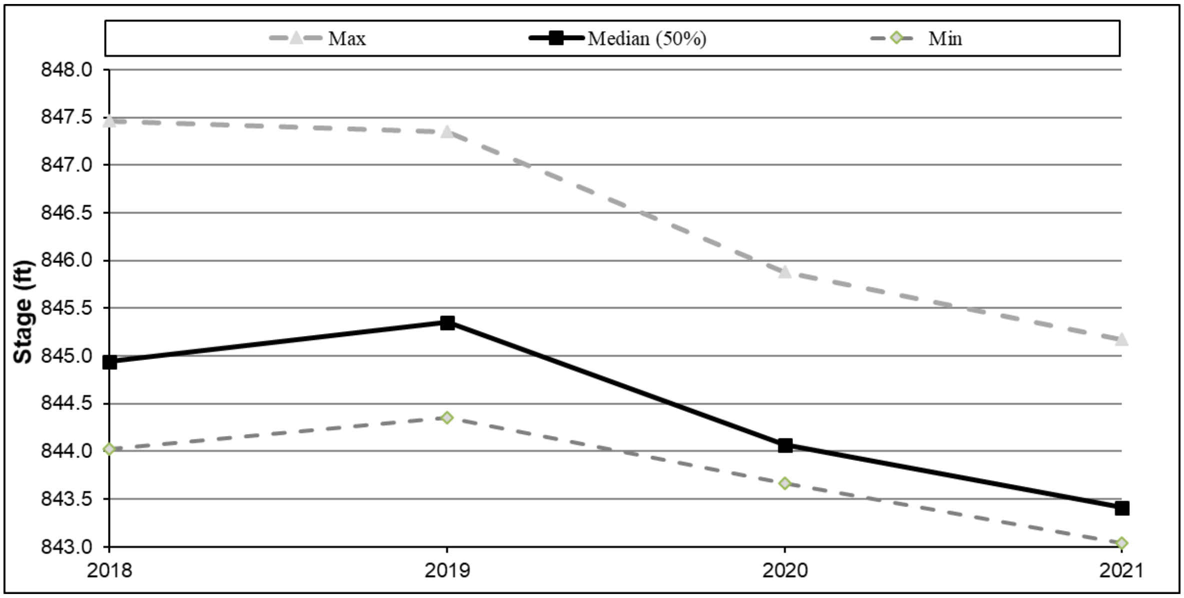
2022 Hydrographs



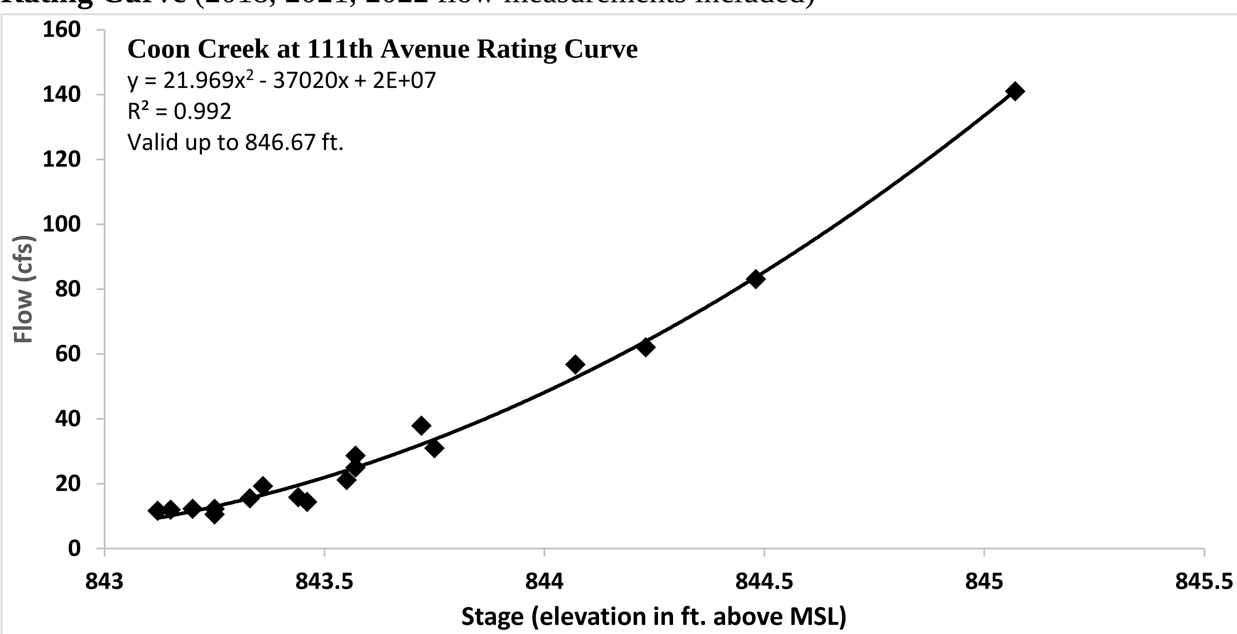


Summary of All Monitoring Years

Percentiles	2018	2019	2020	2021	2022
Min	844.02	844.35	843.67	843.04	843.10
2.5%	844.08	844.48	843.71	843.09	843.17
10.0%	844.24	844.58	843.76	843.15	843.20
25.0%	844.50	844.81	843.85	843.25	843.25
Median (50%)	844.94	845.35	844.07	843.41	843.40
75.0%	845.51	846.09	844.55	843.5	843.96
90.0%	845.88	846.75	844.93	843.7	844.37
97.5%	846.45	847.20	845.39	843.99	844.91
Max	847.46	847.35	845.88	845.17	845.52



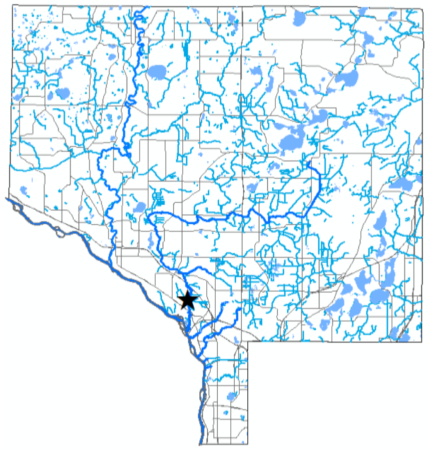
Rating Curve (2018, 2021, 2022 flow measurements included)



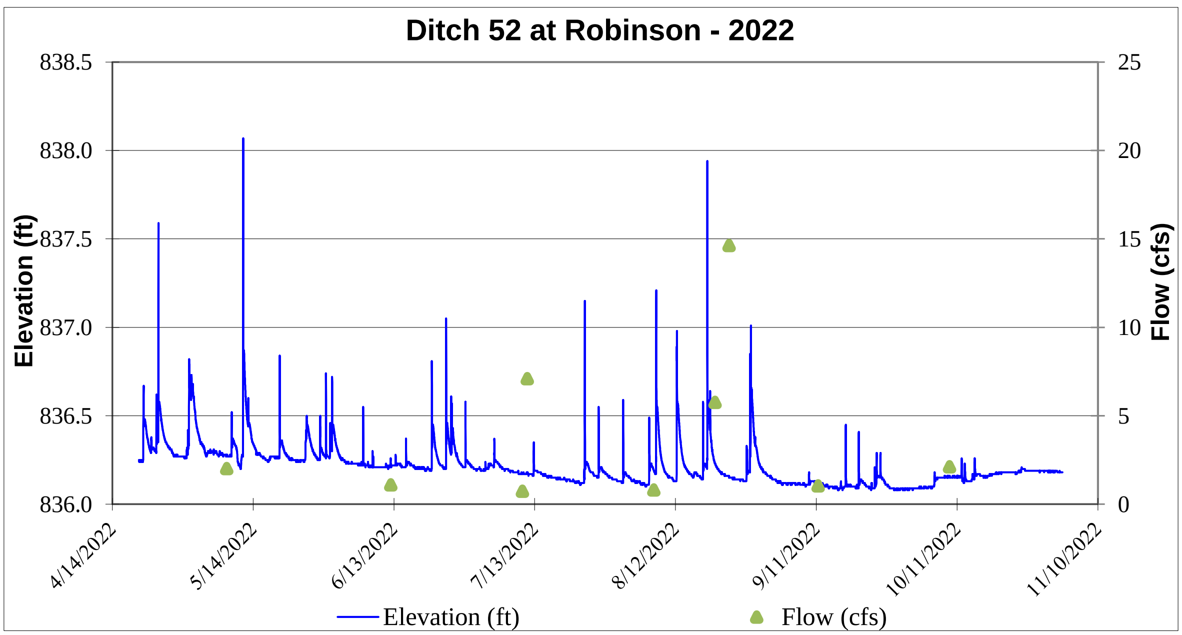
DITCH 52 AT ROBINSON STREET

Notes

2022 was the second year stage was monitored at this site. Baseflow water elevation remained consistent throughout the season even during periods of drought. Average stage was similar to when the site was last monitored in 2018. Ditch 52 is very flashy at this site and water levels rose quickly in response to rain fall, with examples of stage rising up to two feet during storm events. Stage responded to rain events in a similar fashion all season.

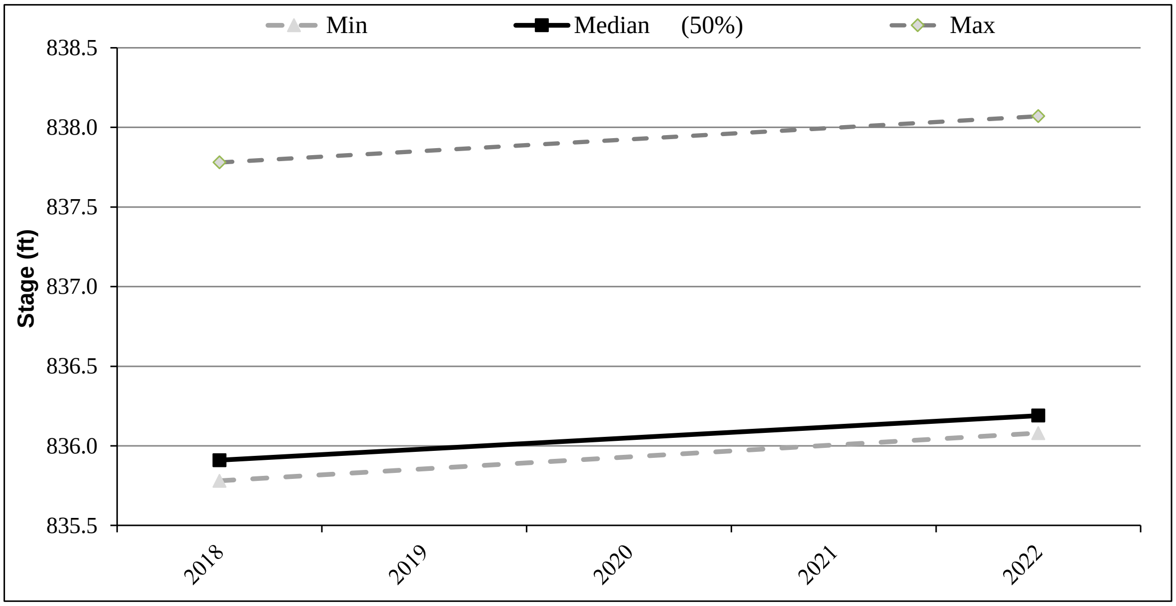


2022 Hydrograph

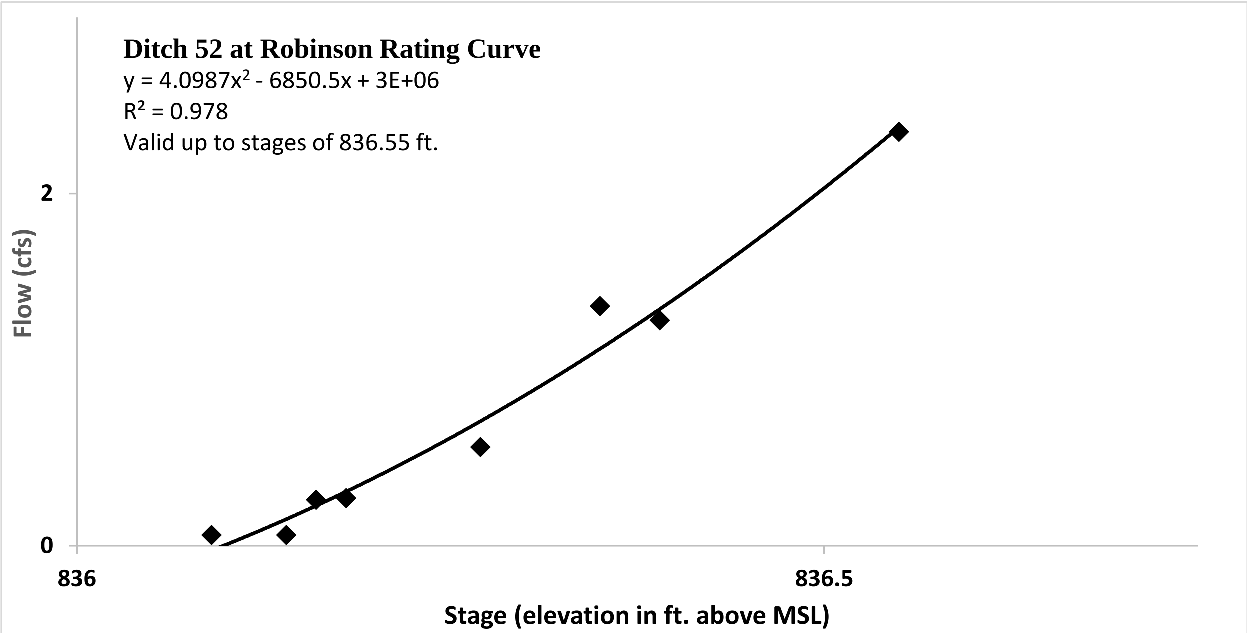


Summary of All Monitoring Years

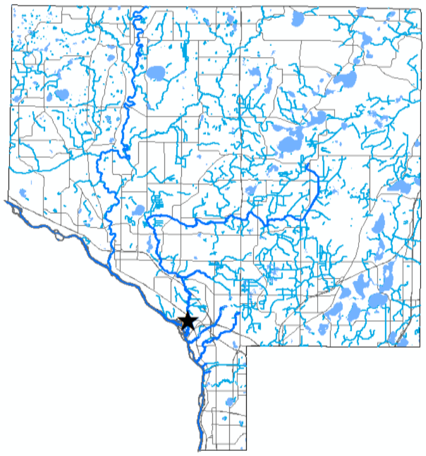
Percentiles	2018	2022
Min	835.78	836.08
2.5%	835.79	836.09
10.0%	835.84	836.11
25.0%	835.86	836.14
Median (50%)	835.91	836.19
75.0%	835.99	836.25
90.0%	836.39	836.33
97.5%	836.85	836.50
Max	837.78	838.07



Rating Curve (2022 flow measurements included)



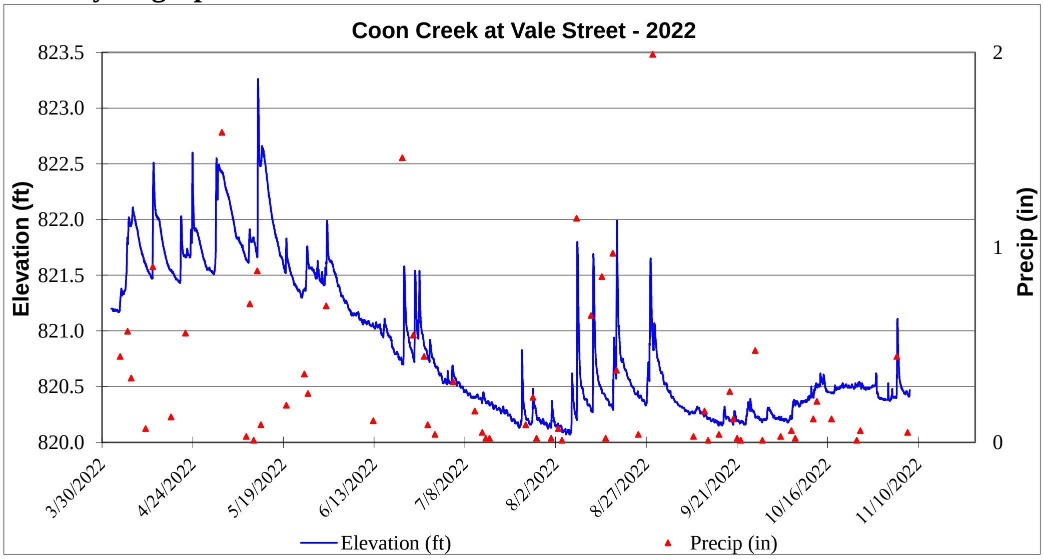
COON CREEK AT VALE STREET

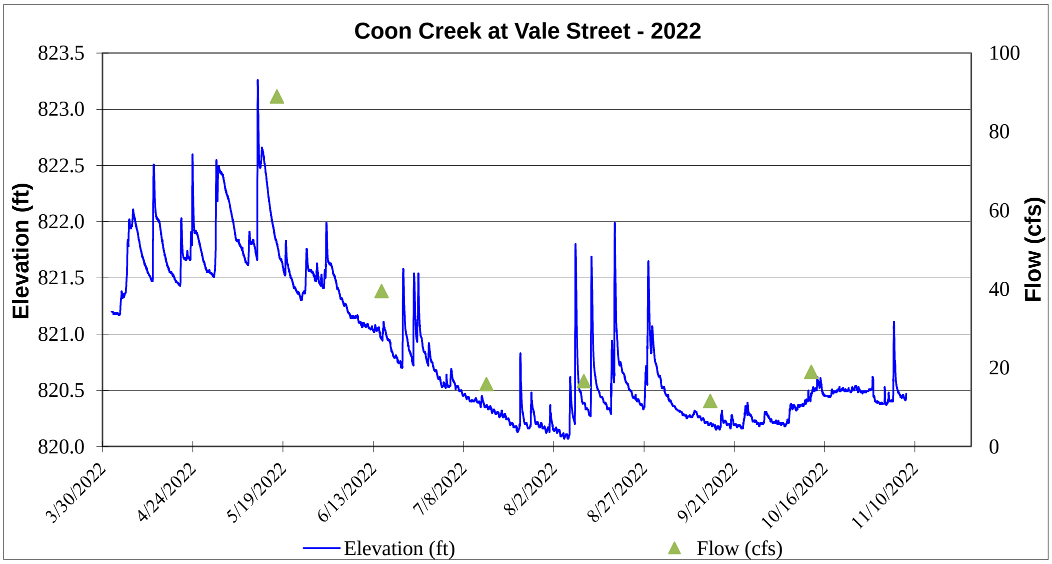


Notes

This site, nearest Coon Creek's outfall to the Mississippi River, has 17 years of data. In 2022, water levels fluctuated 3.19ft and stage reached its lowest elevation since 2009. Water levels averaged their lowest elevation since monitoring began in 2005. Coon Creek at this site is flashy in response to rain events, water levels rise quickly but return to baseflow conditions slowly. This quick response to rainfall is likely due to the large amount of stormwater infrastructure in the urbanized portions of the lower watershed. This site is also monitored by the United States Geological Survey with historical and daily stage and discharge data available online.

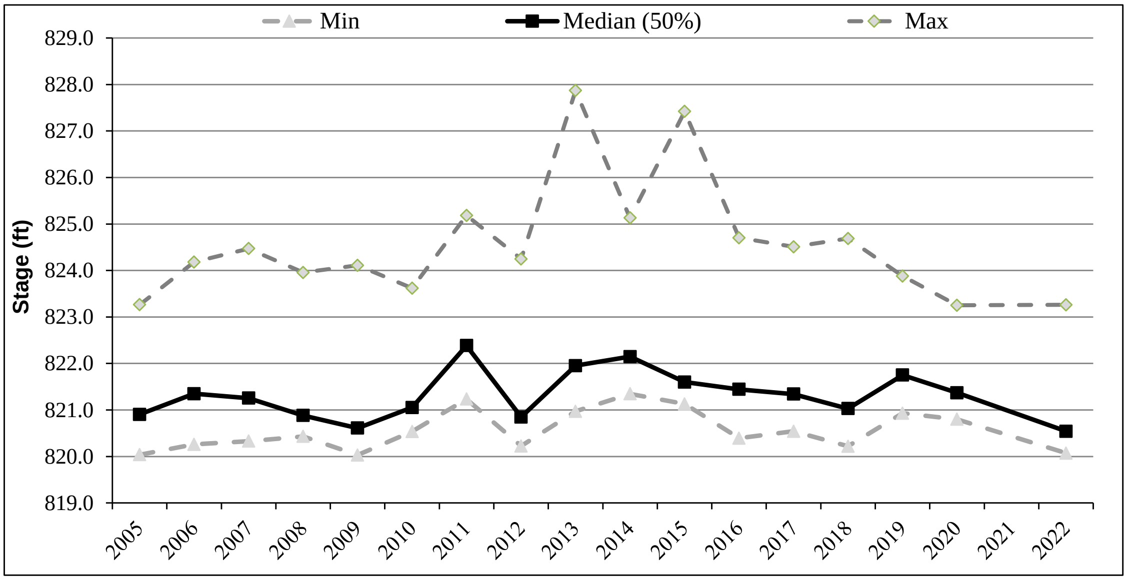
2022 Hydrographs



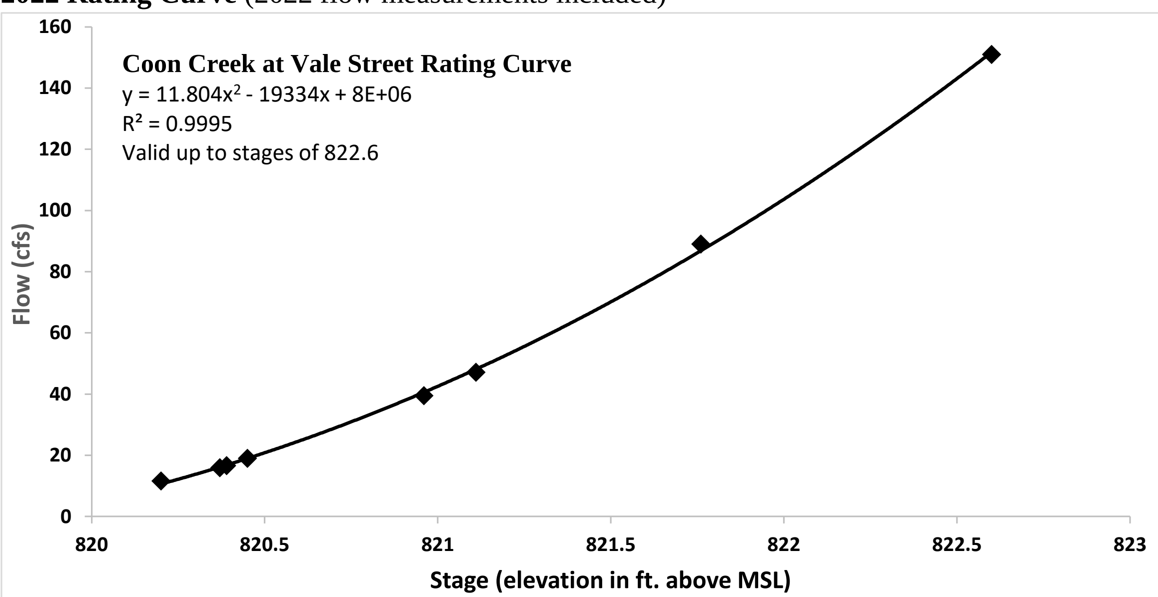


SUMMARY OF ALL MONITORED YEARS

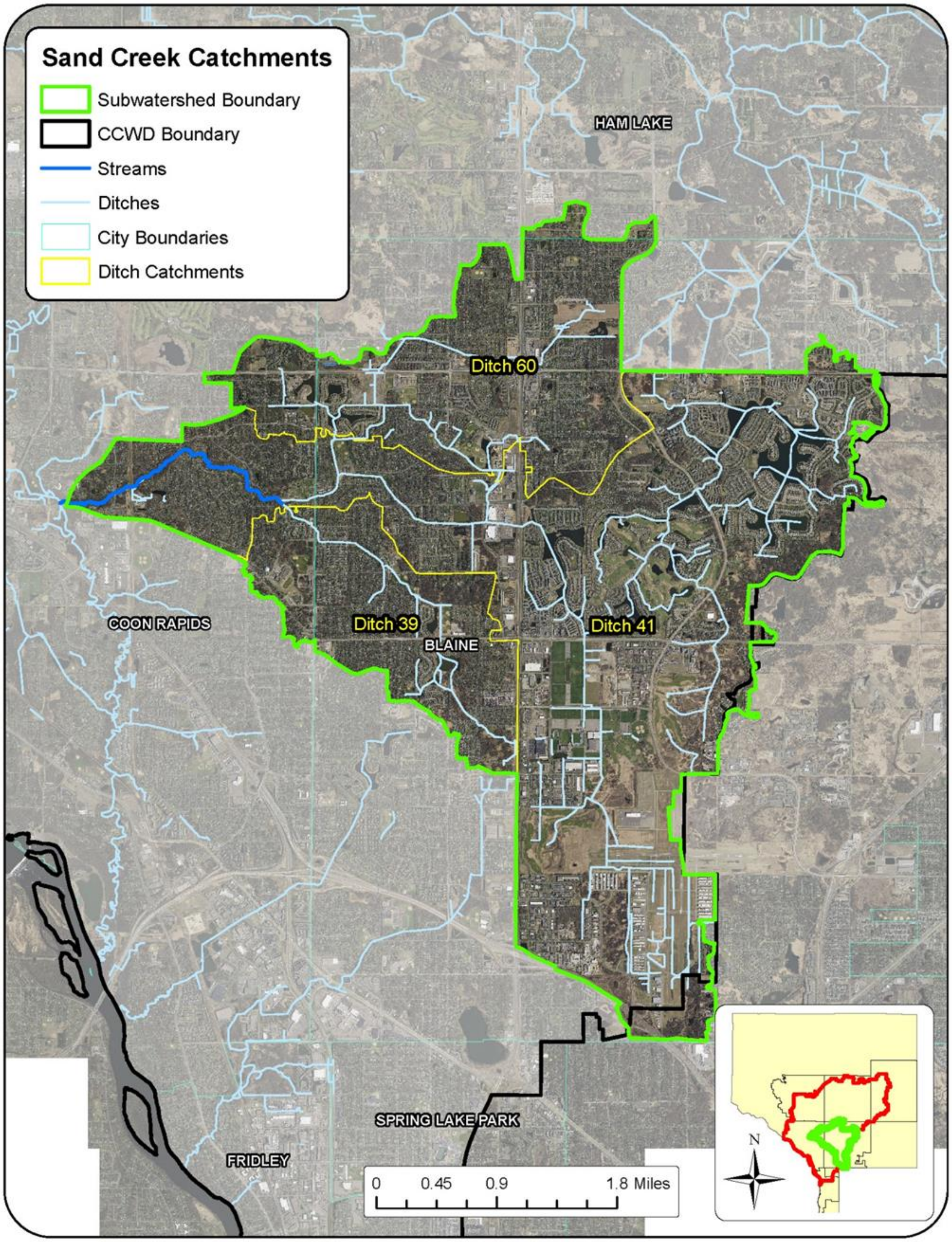
Percentiles	2005	2006	2007	2008	2009	2010	2011	2012	
Min	820.04	820.26	820.33	820.43	820.03	820.54	821.23	820.22	
2.5%	820.06	820.42	820.40	820.52	820.12	820.64	821.27	820.28	
10.0%	820.19	820.53	820.53	820.57	820.20	820.73	821.31	820.33	
25.0%	820.57	820.78	820.73	820.63	820.35	820.85	821.83	820.45	
Median (50%)	820.91	821.35	821.25	820.88	820.61	821.05	822.38	820.85	
75.0%	821.26	821.78	821.88	821.78	820.93	821.32	822.99	821.28	
90.0%	821.77	822.27	822.63	822.26	821.31	821.68	823.70	821.89	
97.5%	822.92	822.76	823.21	822.79	822.05	822.33	824.56	823.60	
Max	823.26	824.18	824.47	823.96	824.11	823.62	825.18	824.25	
Percentiles	2013	2014	2015	2016	2017	2018	2019	2020	2022
Min	820.97	821.35	821.13	820.39	820.54	820.22	820.93	820.80	820.07
2.5%	820.99	821.47	821.19	820.58	820.70	820.28	821.05	820.87	820.15
10.0%	821.00	821.51	821.31	820.78	820.84	820.40	821.16	820.97	820.20
25.0%	821.20	821.67	821.41	820.99	821.08	820.60	821.37	821.08	820.33
Median (50%)	821.95	822.15	821.60	821.44	821.34	821.03	821.75	821.37	820.54
75.0%	827.87	823.33	821.92	821.91	821.72	822.21	822.49	821.70	821.45
90.0%	827.87	824.38	822.30	822.24	822.25	822.56	823.19	822.09	821.81
97.5%	827.87	824.87	823.08	822.76	823.84	823.33	823.52	822.43	822.32
Max	827.87	825.13	827.42	824.70	824.51	824.69	823.88	823.25	823.26



2022 Rating Curve (2022 flow measurements included)

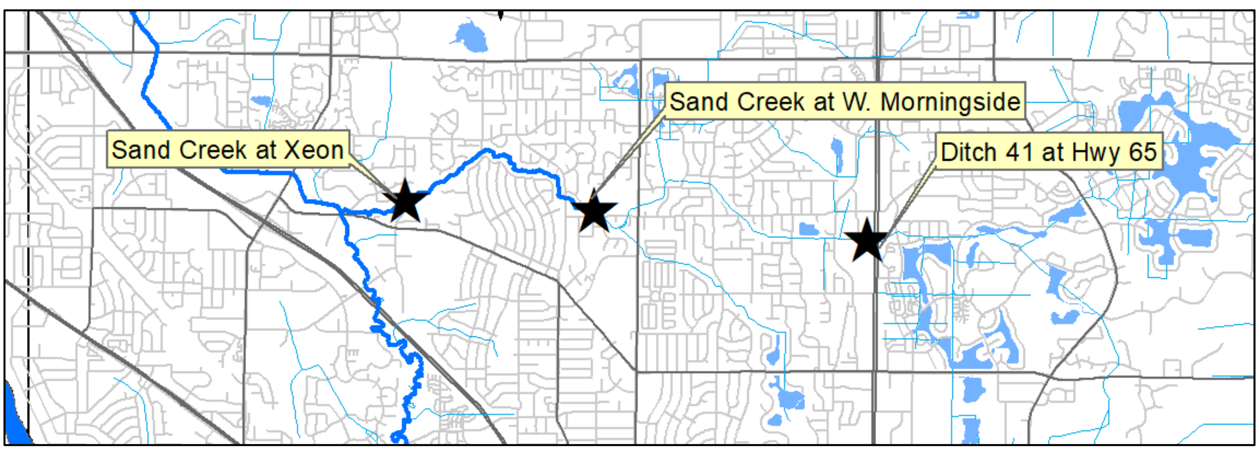


WATER QUALITY & HYDROLOGY MONITORING – SAND CREEK SUBWATERSHED



Sand Creek Subwatershed Monitoring Sites		
Site Name/ SiteID	**Years Monitored**	**2022 Data Collected**
Ditch 41 at Radisson Rd, Blaine S006-421	2010-2017	
Ditch 41 at Highway 65, Blaine S005-639	2009-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Ditch 41 at Happy Acres Park, Blaine S005-641	2009	
Ditch 60 at Happy Acres Park, Blaine S005-642	2009, 2019	
Ditch 41 at University Avenue, Coon Rapids S005-264	2008	
Ditch 39 at University Avenue, Coon Rapids S005-638	2009, 2019	
Sand Cr at Morningside Mem. Gardens, Coon Rapids S006-420	2010-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Sand Cr at Xeon Street, Coon Rapids S004-619	2007-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements

2022 Sand Creek Water Monitoring Sites



SAND CREEK SUBWATERSHED BACKGROUND

Sand Creek is the largest tributary to Coon Creek. It is comprised of three major ditch systems (Ditch 41, 60 & 39) that join near University Avenue on the border of Blaine and Coon Rapids. All of the ditches are in a suburban landscape, but each has unique features.

Ditch 41 is the primary ditch system comprising the Sand Creek watershed, which drains 6,658 acres of suburban residential, commercial, and retail areas throughout western Blaine. The upstream portion of this system (upstream of Highway 65) is comprised of a complex network of ditch tributaries and man-made basins providing stormwater treatment and landscape aesthetics. The northern portion of this network is largely comprised of The Lakes of the Radisson housing development, which includes dense single family "lakeshore" homes built around five large man-made basins. After flowing through these basins, the ditch system continues through a series of ponds in a golf course and finally through a network of ponds in the Club West Development.The southern portion of the Ditch 41 system drains primarily commercial areas of the eastern Highway 65 corridor, including shopping centers, sport complexes, schools, and small businesses. The ditch system 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.

The Ditch 60 system drains 2,279 acres of mainly residential housing in northwestern Blaine before consolidating into large stormwater ponds in the Crescent Ponds development. The downstream pond outlets to a short ditch channel that joins Ditch 41 at Happy Acres Park before flowing under University Avenue.

Ditch 39 drains 1,395 acres of general residential land before crossing University Avenue and emptying into a stormwater pond in the 116th Ave Loop. This stormwater pond outlets through a culvert connecting with Ditch 41 in the southwest corner of the West Morningside Memorial Gardens property, just west of University Avenue.

In this report, the section of stream between the confluence of these three ditch systems in West Morningside memorial Gardens to its outfall at Coon Creek at Lions Park will be called Sand Creek. Sand Creek flows west approximately two miles through residential neighborhoods. A wooded parkland trail corridor follows along the waterway for much of this reach. At its confluence with Coon Creek, Sand Creek is about 15 ft. wide and 2.5-3 ft. deep during baseflow conditions.

The creek recently has undergone a restoration project between Olive St and Xeon Blvd, including the re-meandering of 0.4 miles of previously straightened channel. Additional management included the stabilization of actively eroding streambank, implementing practices such as vegetated riprap, creating new cross vanes and rock riffles in the streambed, installing woody habitat, reconnecting floodplain, and restoring native riparian vegetation. This project reduces pollutant loading from eroding streambanks, allows for more sediment deposition, and enhances wildlife habitat along 1.1 miles of Sand Creek before its confluence with Coon Creek.

Sand Creek is listed as impaired for *E. coli* and invertebrate biota downstream of West Morningside Memorial Gardens. A TMDL study has been completed with required reductions for *E. coli*, TSS, and TP. Additionally, Ditch 41-1 at Radisson Road was recently listed with a pending 2024 impairment for *E. coli*.

SUMMARY

Water quality in Sand Creek meets state standards for most parameters other than *E. coli*. The waterway is listed as impaired for aquatic recreation due to *E. coli* and for aquatic life due to invertebrate biota and has a pending aquatic life impairment for fish. Load duration curves (LDC) and pollutant reduction targets for TP and TSS were developed in the Coon Creek TMDL due to their status as stressors to aquatic life. Pollutant loading into the Sand Creek system appears to vary throughout the watershed, and is different for each parameter.

High phosphorous concentrations observed in Ditch 60 and Ditch 39 are likely degrading water quality in Sand Creek. TP in both Ditch 60 and Ditch 39 are higher than levels observed in Ditch 41 at Hwy 65, or at Morningside Memorial Gardens, indicating a dilution component provided by Ditch 41. TP concentrations have not increased in the main channel of Sand Creek at Xeon St over time and they do not increase while moving downstream from Morningside Memorial Gardens to Xeon Street. In fact, baseflow TP concentrations have significantly declined over time at the Xeon St outlet site although this statistically significant trend is not shared for stormflow TP. This might be due to particle-bound phosphorus increasing during storms because stormflow TSS increases significantly between Morningside Memorial Gardens and Xeon St.

TSS is low throughout the system. It averages 12 mg/L has a median of 7mg/L across all conditions. In comparison, the state water quality standard is 30 mg/L. However, stormflow TSS levels do increase significantly between Morningside Memorial Gardens and Xeon Street, indicating there is more TSS loading in the downstream portion of the subwatershed. The highest TSS is found downstream of the three tributary ditches joining, around Morningside Memorial Gardens. Further upstream, large settling basins are suspected to keep TSS lower. TSS reductions are sought due to it being identified as a biotic stressor, and because TP and TSS reduction strategies can overlap.

The TMDL attributes only 13% of TSS loading in Sand Creek to streambank erosion, but this may be underestimated based on recent ditch inspections. A recent stream restoration project along Sand Creek between Olive St and Xeon Blvd was designed to help stabilize eroding streambanks in these lower reaches and dissipate erosive energy during high flow events, during which the creek periodically exceeds state TSS standards. There has not been an exceedance of the state water quality standard for TSS since construction was completed in 2020.

E. coli loading occurs throughout the Sand Creek watershed, with dog waste identified in the TMDL as the predominant source of the bacteria. The TMDL may be underestimating the impact that waterfowl have on *E. coli* levels in Sand Creek due to the transient nature of waterfowl. Staff have witnessed waterfowl by the hundreds in many areas of Sand Creek. It is also suspected that leaky sanitary infrastructure may be contributing to elevated *E. coli* levels because evidence of human sewage has recently been detected via bacterial source tracking methods.

Because pollutant loading is not consistent throughout the watershed, no single management strategy or project approach will simultaneously maximize reductions for all targeted pollutants. Targeted projects that reduce phosphorus from stormwater would be most beneficial in the upper portions of the tributary ditch systems, namely Ditch 60 and Ditch 39. Projects focused on TSS reduction should be targeted in the lower reaches of the stream channel, potentially through further implementation of streambank stabilization practices and additional re-meandering or rate control projects. *E coli* bacteria reduction likely cannot be accomplished at any single location, but rather through ongoing educational resources and offering dog-waste disposal resources to people who frequent the Sand Creek Trail system. Dog waste stations were installed along the trail system in fall 2021. Efforts are also underway to investigate and mitigate any human sewage pollution.

Results and Discussion

Specific Conductivity and Chlorides

Sand Creek's dissolved pollutant levels as measured by specific Conductivity are higher than levels found in Coon Creek, to which Sand Creek is tributary, and other streams in the county. The long-term median of specific Conductivity under all conditions in Sand Creek at Xeon St is 0.800 mS/cm compared to the median for all Anoka County streams of 0.561 mS/cm and 0.670 mS/cm at Coon Creek at Vale Street. Concentrations were similar during both baseflow conditions and following storm events, with baseflow having slightly increased conductivity. Previous chloride monitoring (2019) from the individual contributing ditch systems revealed that Ditch 60 consistently had the highest Conductivity of the three tributary ditches to Sand Creek.

Chlorides are a common driver of Conductivity levels in urban streams. In such a densely developed watershed, de-icing salts are used widely. Nine years of chloride sample collection have occurred at the downstream site at Xeon St, 2007-2012, 2019, 2021, and 2022. 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. Like previous years, chloride concentrations in 2022 at the Sand Creek at Xeon site were higher during baseflow conditions (104.43 mg/L) than during storm flow (80.1 mg/L) Chloride concentrations for all years, all conditions, averaged 78.1 mg/L at the outlet site. No individual samples on record have approached the 230 mg/L chronic state standard for chlorides during the growing-season.

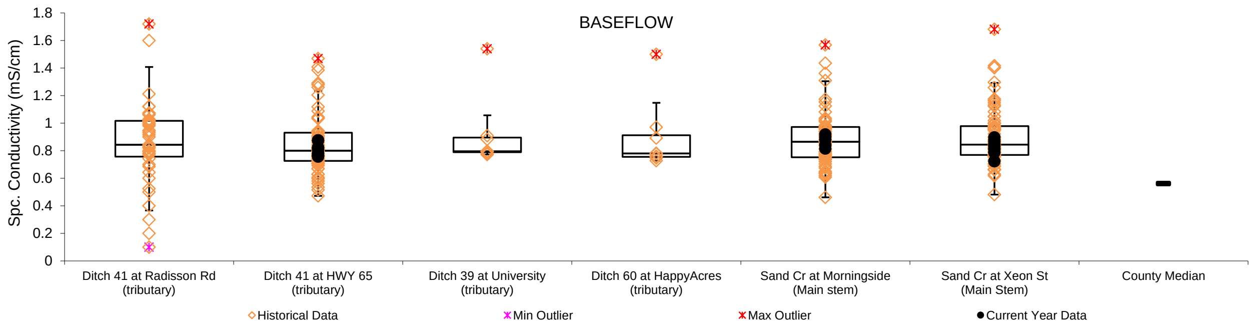
Sand Creek's watershed is mostly suburban residential. Urban stormwater runoff commonly contains high amounts of dissolved pollutants. This includes road deicing salts. Stormwater treatment practices such as catch basins and settling ponds are relatively ineffective at removing dissolved pollutants from the environment. Therefore, minimizing release into the environment is the best management strategy.

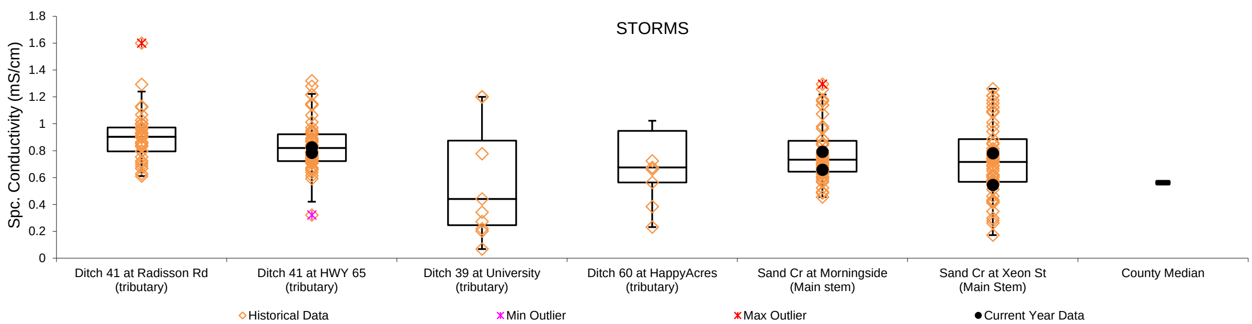
Dissolved pollutants can easily infiltrate into the shallow groundwater that feeds stream systems during baseflow conditions. This can result in high levels of specific Conductivity that decline during storm events when dilution occurs. If stormwater runoff were the primary source of dissolved pollutants in the creek, one indicator would be higher Conductivity observed during storm events. The opposite was the case for specific Conductivity at Xeon Street which was higher during baseflow conditions. Storm runoff still contains dissolved pollutants, but the concentration is lower than what is found in the 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 the same, and preventing the pollutants' initial release into the environment should be a high priority.

Average and median specific Conductivity in Sand Creek Data is from Xeon St for specific Conductivity and all years through 2022

	Average Specific Conductivity (mS/cm)	Median Specific Conductivity (mS/cm)	State Standard	N (Sp Cond.)
Baseflow	0.898	0.845	Specific Conductivity – none	76
Storms	0.732	0.716		63
All	0.823	0.800		139
Occasions > state standard				0

Specific Conductivity at Sand Creek Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.





TOTAL PHOSPHORUS

Sand Creek is not listed as impaired for TP directly, but does have an approved TMDL for the pollutant as a result of the aquatic life impairment. Grab samples show TP concentrations in Sand Creek routinely remain below the state standard of 100 µg/L. The long-term average TP levels at the Sand Creek at Xeon Street site (all years) is 63.0 µg/L during baseflow and 105 µg/L during storm events, slightly higher than the state standard. Since 2007, storm samples collected at Xeon St. have exceeded the state standard 35% of the time. In the past 5 years, only 20% of samples have exceeded the standard compared to 45% of samples the first 5 years on record.

Phosphorus loading occurs throughout the Sand Creek watershed, but the Ditch 39 and Ditch 60 systems seem to degrade the water quality in Sand Creek more than Ditch 41. TP levels at the Ditch 41 at Hwy 65 site are mostly low during both baseflow and storm events. Minimal water quality data is available for Ditch 39 and Ditch 60. These ditches have only been monitored in 2009 and 2019. Both systems exceeded 100 µg/L during baseflow and storm sampling events.

After the confluence of all three ditch systems, TP concentrations at the Morningside Gardens site are usually below the state standard (100 µg/L), though exceedances during storm events are more prevalent. All 2022 readings at the Memorial Gardens site, for all conditions, remained below 100 µg/L, an improvement from 2021 results. Sand Creek at Xeon Street flows more as a natural meandering channel with an adjacent protective park system. TP concentrations do not significantly increase through this stretch during any conditions, although TP levels are close to having a significant increase from Morningside Gardens to Xeon St after storm events. There is a significant decrease in TP levels during baseflow over time at the Xeon Street site. Recent work in this portion of the watershed includes construction of a new stormwater pond, installation residential rain gardens, and a large channel restoration and re-meander project that stabilized eroding banks and enhanced habitat.

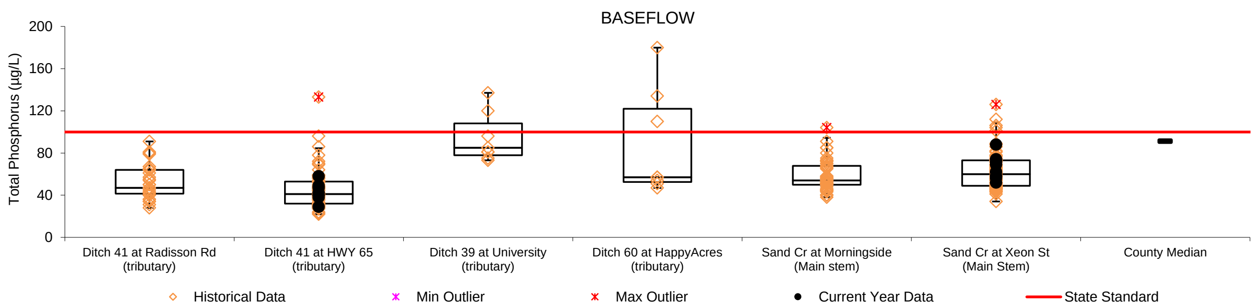
Supplemental ortho-phosphorus (OP) samples were collected 2021-20222 at the outlet of Sand Creek. The average OP concentration during baseflow was 27% (range=11%-79%) of average TP. During storms, the average OP concentration was 18% (range=3%-33%) of average TP. Compared to the main stem of Coon Creek, OP loading during storms appears to be elevated indicating extra sources of OP in the system. Additional OP samples were collected at the Ditch 41 at Hwy 65 site in 2022, which is upstream of where Ditch 60 and Ditch 39 enter Sand Creek. Ditch 41 at this site had average OP concentrations during baseflow 19% of average TP. During storms, the average OP concentration was 14% of average TP. The MN Stormwater Manual reports the national average OP concentration as a percentage of TP to be 26% indicating Sand Creek is slightly lower than the national average.

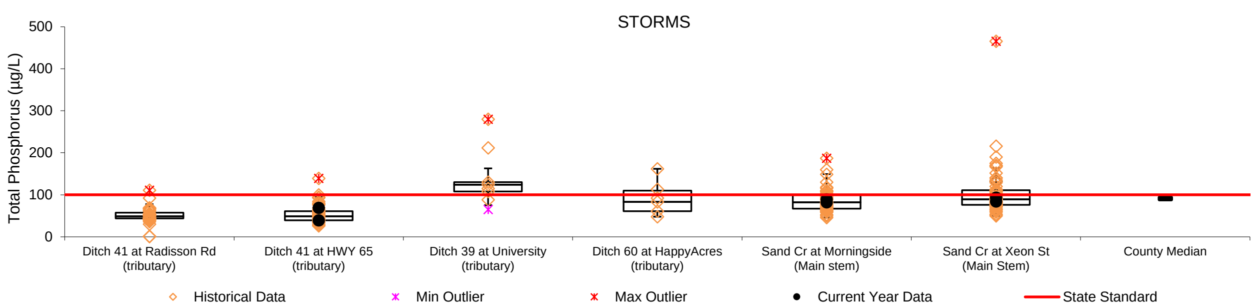
The Coon Creek TMDL delegates acceptable levels of pollutants in Sand Creek using a load duration curve (LDC) approach. The LDC for Sand Creek is graphed with flow-weighted daily loads for phosphorus samples collected at Xeon Street (Page 48, Figure 17). This plot shows that Sand Creek exceeds its LDC for TP occasionally and during all flow conditions from low to very high. Analyzing the LDC results, with grab sample concentrations, inform that additional stormwater treatment, especially in the 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 2022.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	63.30	60.00	100	73
Storms	105.00	89.00		61
All	82.28	73		134
Occasions > state standard				21 (35%) storm 5 (7%) baseflow

Total phosphorus at Sand Creek Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.

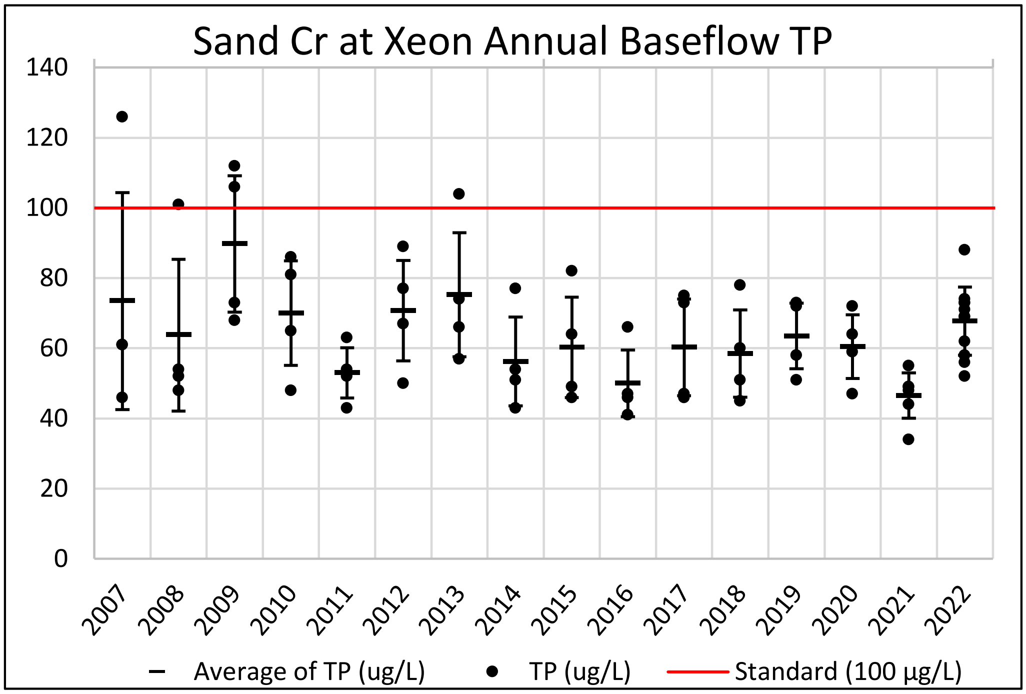


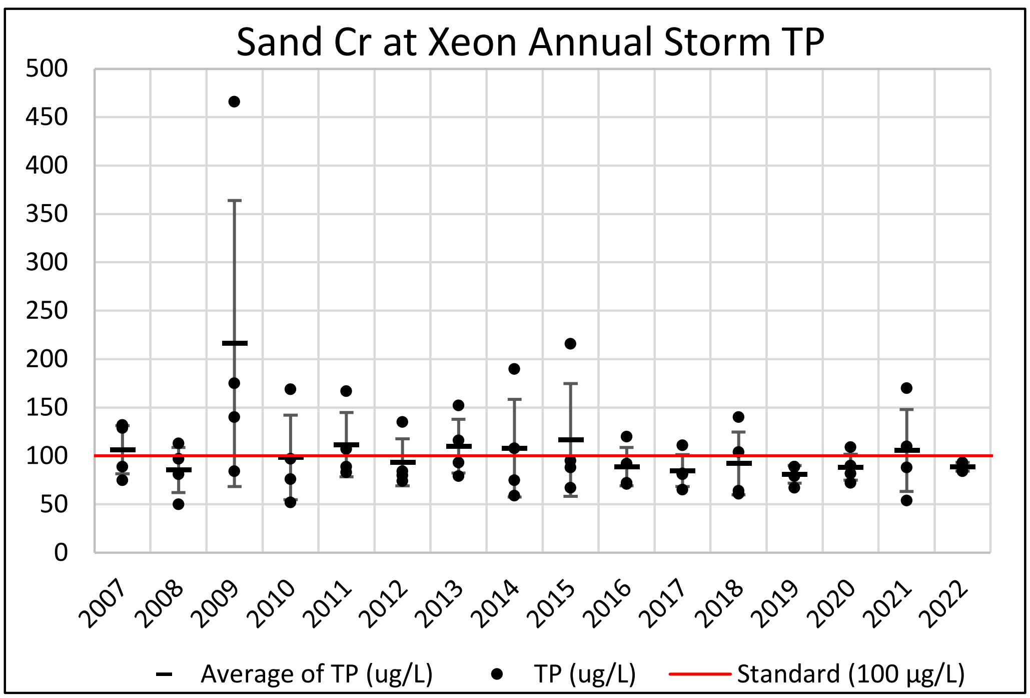


Total Phosphorus Trend Analysis

Parameter	Significant Change in Annual $\bar{x}$ (2007-2022)	P=	Standard Error of Means
Total Phosphorus – Baseflow	Yes, improving trend	0.042	9.53
Total Phosphorus – Storm	No	0.127	30.16

Sand Creek at Xeon St. – Annual average ANOVA regression TP 2007-2022





ANOVA Matrix for Baseflow Total Phosphorus

	Sand Cr at West Morningside Memorial Gardens (WMMG) (2010-2022) - 56 Samples	Sand Cr at Xeon St. (2007-2022) – 68 Samples
Sand Cr at Morningside Memorial Gardens		No Sig. Change WMMG $\bar{X}$ = 59.33 µg/L Xeon $\bar{X}$ = 62.58 µg/L p = 0.277
Sand Cr at Xeon St.		

ANOVA Matrix for Storm Total Phosphorus

	Sand Cr at West Morningside Memorial Gardens (WMMG) (2010-2022) – 49 Samples	Sand Cr at Xeon St. (2007-2022) – 61 Samples
Sand Cr at Morningside Memorial Gardens		No Sig. Change (close Significant Increase) WMMG $\bar{X}$= 87.00 µg/L Xeon $\bar{X}$= 105.00 µg/L p= 0.052
Sand Cr at Xeon St.		

TOTAL SUSPENDED SOLIDS

Total Suspended Solids (TSS) concentrations are regularly low in Sand Creek, increasing slightly during storm flow especially in the downstream sections of the creek. TSS does not appear to follow the same loading pattern as TP through the Sand Creek system. Unlike TP, TSS concentrations are generally low during all conditions in each of the three monitored ditch tributaries before their confluences. At baseflow, TSS concentrations remain low through the remainder of the Sand Creek channel, averaging 9.37 mg/L for all baseflow samples at Xeon Street, well below state standard for TSS (30 mg/L). However, during storm events, TSS concentrations are elevated starting at Morningside Memorial Gardens and continuing to Xeon Street downstream, where the state standard has been exceeded in 8% of the storm samples collected. It should be noted that all of these exceedances occurred prior to 2016. TSS concentrations increase significantly between Morningside and Xeon St during storm flow, though no significant increase in TSS is present at the Xeon Street site over time. Interestingly, storm flow TSS concentrations remain low in all of the ditches upstream of their confluences, likely the effect of large stormwater basins allowing for particles to settle out of the water column.

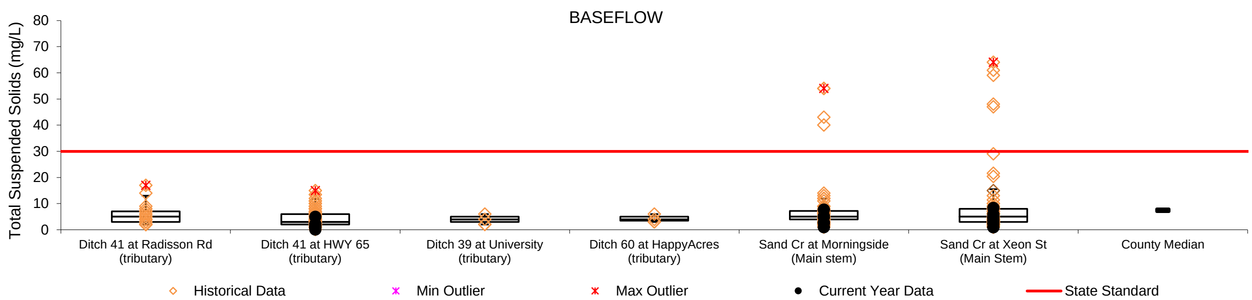
The approved Coon Creek TMDL contains a Load Duration Curve for TSS in Sand Creek at Xeon St (Page 43, Figure 14). The results show only a couple of exceedances for TSS, only occurring during high to very high flows. TSS loading in Sand Creek appears to be occurring in the main channel after the confluence of the three ditches, and primarily during larger storm events that cause high flows. This is in contrast to TP loading, which appears to be at highest levels in the Ditch 39 and Ditch 60 tributaries. This may advocate that high flows are causing excessive erosion on streambanks in the lower Sand Creek channel, increasing the TSS load through this portion of the system. The recent stabilization and re-meander projects near Xeon and Olive Streets should help stabilize this stretch of the creek.

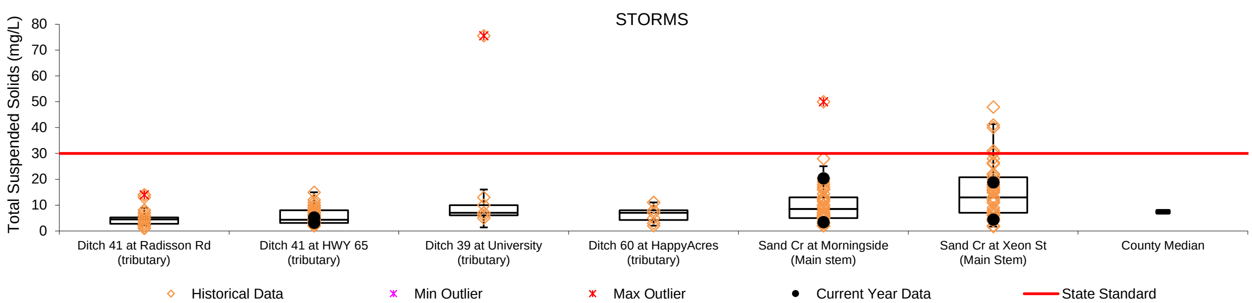
The Coon Creek TMDL identified bank erosion as just 13% of TSS loading to Sand Creek. If accurate, there may be some large source(s) of TSS loading into the system in the lower portion of the watershed especially during storm events. This additional TSS load does not seem to be contributing additional phosphorus in an equivalent manner. Any large contributions of particulates into the creek may be identifiable by conducting field inspections of storm drain inlets or other stormwater infrastructure. Rain gardens installed in these areas in the last 10 years may have addressed such inputs. Additional street sweeping in the middle and lower catchments of Sand Creek could be considered to reduce TSS at its source and to bolster the longevity of rain gardens.

Average and median total suspended solids in Sand Creek Data is from Xeon St for all years through 2022

	Average Total Suspended Solids (mg/L)	Median Total Suspended Solids (mg/L)	State Standard	N
Baseflow	9.37	5.0	30 mg/L TSS	73
Storms	16.54	13.0		62
All	12.67	7.0		135
Occasions > state TSS standard				5 (8%) storm 5 (7%) baseflow

Total suspended solids at Sand Creek Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.

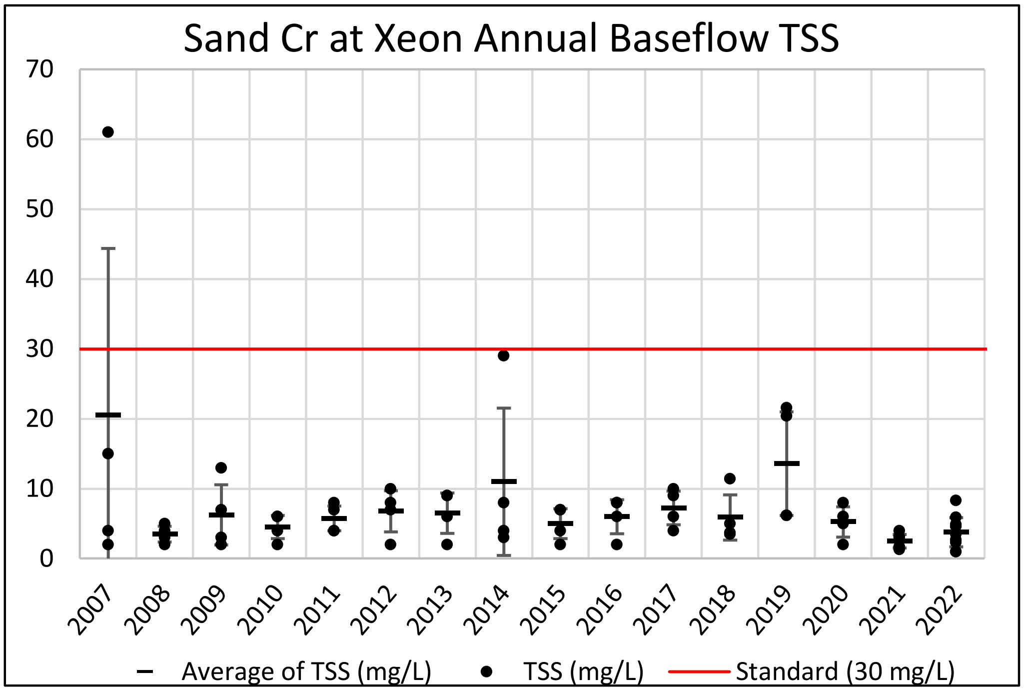


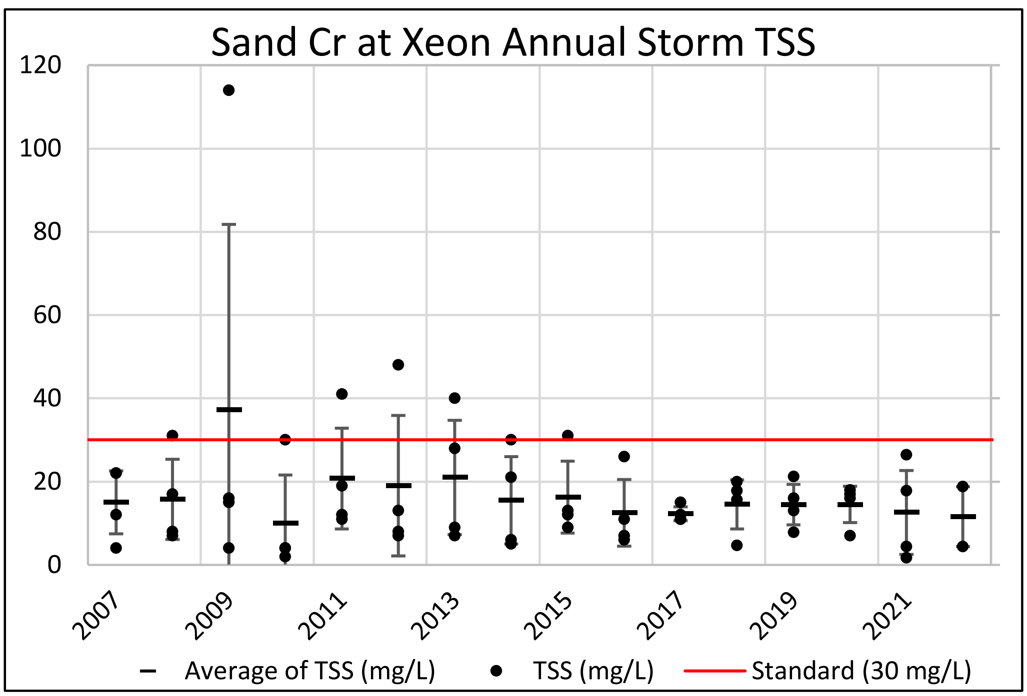


Total Suspended Solids Trend Analysis

Parameter	Significant Change in Annual $\bar{x}$ (2005-2022)	P=	Standard Error of Means
Total Suspended Solids – Baseflow	None	0.246	4.42
Total Suspended Solids – Storm	None	0.084	5.89

Sand Creek at Xeon St. – Annual Average ANOVA regression TSS 2007-2022





ANOVA Matrix for Baseflow Total Suspended Solids

	Sand Cr at West Morningside Memorial Gardens (2010-2022) - 56 Samples	Sand Cr at Xeon St. (2007-2022) – 68 Samples
Sand Cr at Morningside Memorial Gardens		No Sig. Change WMMG $\bar{X}$ = 8.53 mg/L Xeon $\bar{X}$ = 9.80 mg/L p = 0.589
Sand Cr at Xeon St.		

ANOVA Matrix for Storm Total Suspended Solids

	Sand Cr at West Morningside Memorial Gardens (2010-2022) - 50 Samples	Sand Cr at Xeon St. (2007-2022) – 62 Samples
Sand Cr at Morningside Memorial Gardens		Significant Increase WMMG $\bar{X}$ = 10.24 mg/L Xeon $\bar{X}$ = 16.54 mg/L p = <0.05
Sand Cr at Xeon St.		

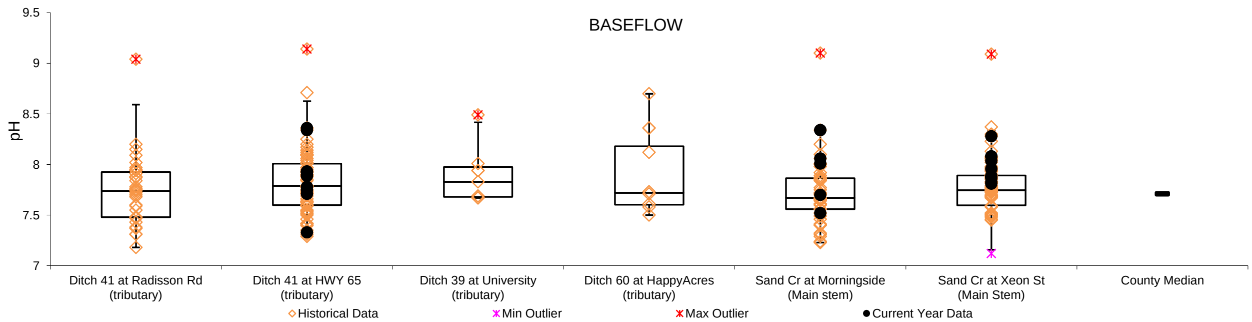
pH

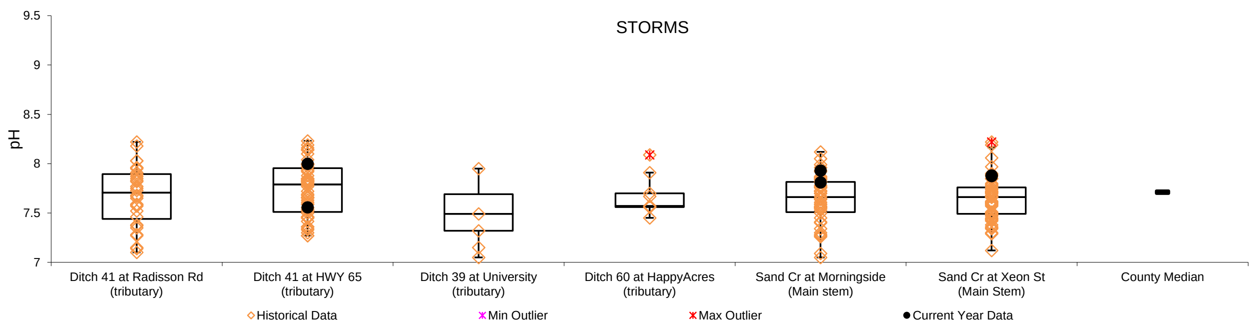
In 2022, pH in Sand Creek remained within the acceptable range (6.5-8.5). Historically, individual outliers have included a few readings in excess of 9.0. The median for all conditions, all years, at Xeon St is 7.61. There is no water quality concern.

Average and median pH in Sand Creek Data is from Xeon St for all years through 2022.

	Average pH	Median pH	State Standard	N
Baseflow	7.87	7.85	6.5-8.5	75
Storms	7.81	7.66		63
All	7.84	7.75		138
Occasions outside state standard				1 baseflow (1%) 2 storm (3%)

pH at Sand Creek Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.





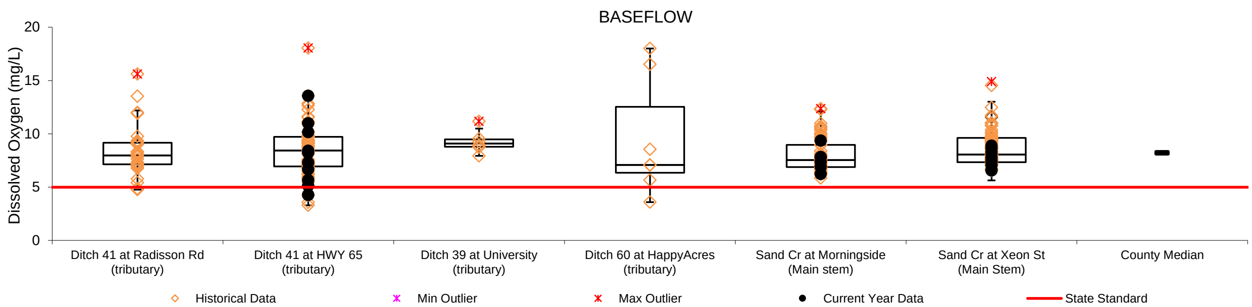
Dissolved Oxygen

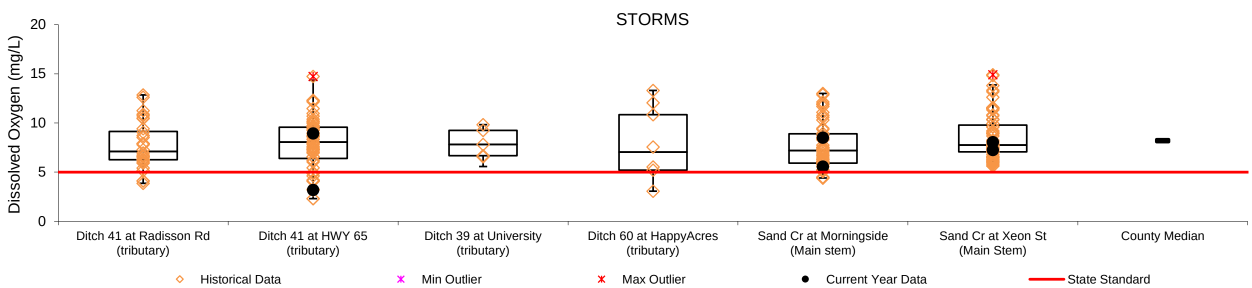
Dissolved oxygen is within a healthy range in the lower reaches of Sand Creek, and has never been recorded below 5 mg/L at Xeon Street. However, DO was recorded below 5 mg/L in 8% of sampling occasions across all years, all conditions, at upstream sites. Overall, there are no significant management concerns about DO levels in Sand Creek, but it should continue to be monitored since there are invertebrate and fish impairments in place. It should be noted that very few measurements were taken prior to 9:00 am, when the water quality standards applies. It is also possible that low DO in the headwater systems could be contributing to phosphorus loading if select ponds are not functioning as designed and are instead leaching phosphorus under low oxygen conditions.

Average and median dissolved oxygen in Sand Creek. Data is from Xeon St for all years through 2022.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.64	8.22	5 mg/L daily minimum	72
Storms	8.65	7.75		63
All	8.64	8.05		135
Occasions <5 mg/L				0 baseflow 0 storms

Dissolved Oxygen at Sand Creek. Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating lines) for all data collected at these sites.





E. COLI

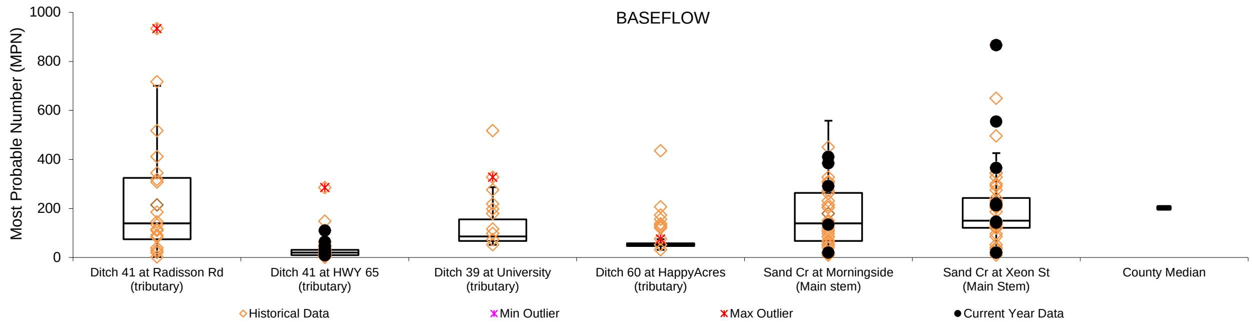
E. coli levels in Sand Creek are high enough to warrant an impairment designation for bacteria, and subsequently, a TMDL exists for *E. coli* in Sand Creek. The Load Duration Curve plot (CCWD TMDL; Page 51, Figure 21) shows exceedances of acceptable flow-weighted loads of *E. coli* in most samples and across all flow ranges at Xeon Street. The TMDL lists domestic pets as the primary source of *E. coli* to Sand Creek, accounting for 89% of all input. Considering the entire Sand Creek system drains principally residential neighborhoods, identifying target areas for addressing *E. coli* loading could be a challenge.

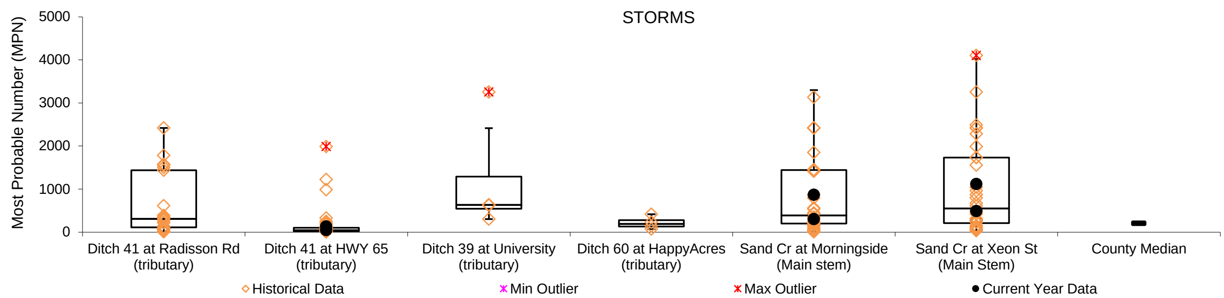
Monitoring data does not concretely identify any one of the tributary ditches as the largest *E. coli* source, and *E. coli* varies widely even within the same waterway. It appears that Ditch 41 is contributing high levels of *E. coli* during both baseflow and storm events at the furthest upstream monitoring site at Radisson Road in previous monitored years (last monitored in 2018), followed by a consistently sharp decline at the next site downstream at Highway 65. Ditch 41 at Highway 65 once again had very low levels of *E. coli* in 2022. This could possibly be influenced by possible chemical treatment occurring in the TPC and/or Club West ponds just upstream of Highway 65. Ditch 60 generally had low *E. coli* levels. Ditch 39 saw higher levels, especially after storm events.

Average, Geomean and median *E. coli* in Sand Creek. Data is from Xeon St. for all years through 2022.

	Average *E. coli* (MPN)	Geomean *E. coli* (MPN)	Median *E. coli* (MPN)	State Standard	N
Baseflow	208.98	151.99	150.00	Monthly Geometric Mean >126	49
Storms	1,012.91	504.37	548.70		36
All	549.47	252.77	218		85
Occasions >126 MPN				Monthly 10% average >1260	34 (69%) baseflow, 29 (81%) storm
Occasions >1260 MPN					0 baseflow, 11 (31%) storm

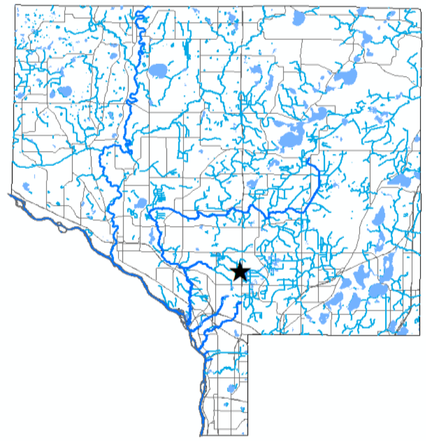
***E. coli* at Sand Creek.** Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating lines) for all data collected at these sites. Abnormally high outliers are not included in box-plots.





STREAM HYDROLOGY – SAND CREEK

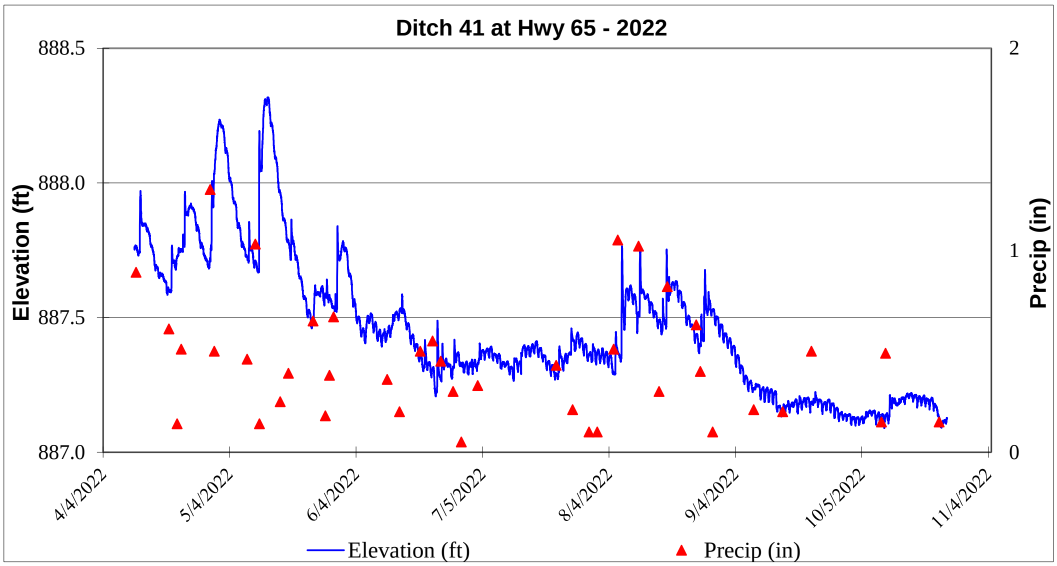
DITCH 41 AT HIGHWAY 65, COON RAPIDS

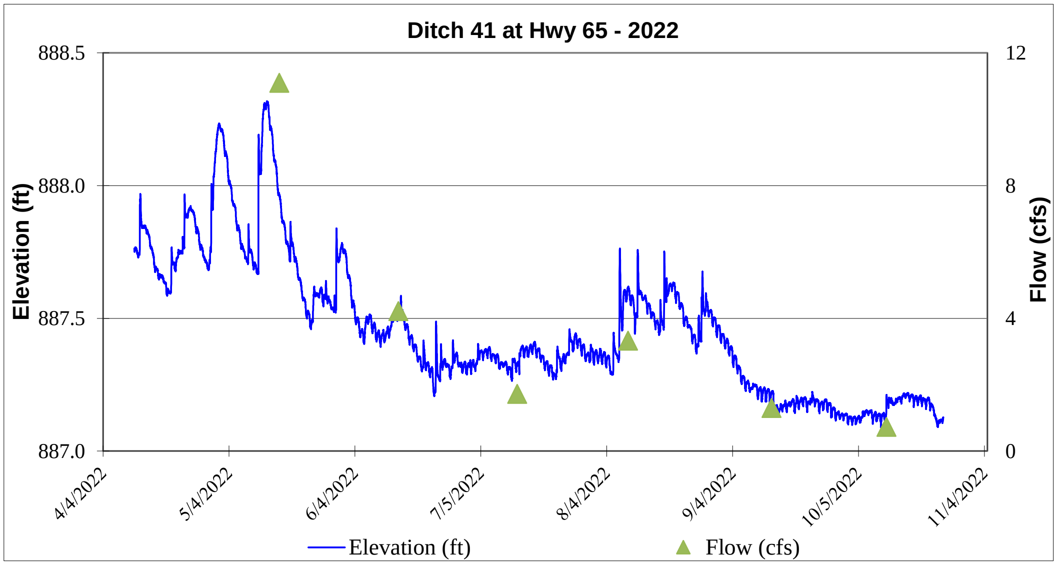


Notes

2022 was the second year that stage was monitored at this site. Water levels at the Ditch 41 at Hwy 65 site fluctuated 1.23ft throughout the season. Baseflow water elevations decreased steadily during drought. Stage at this site averaged nearly a foot lower then when it was last monitored in 2018.

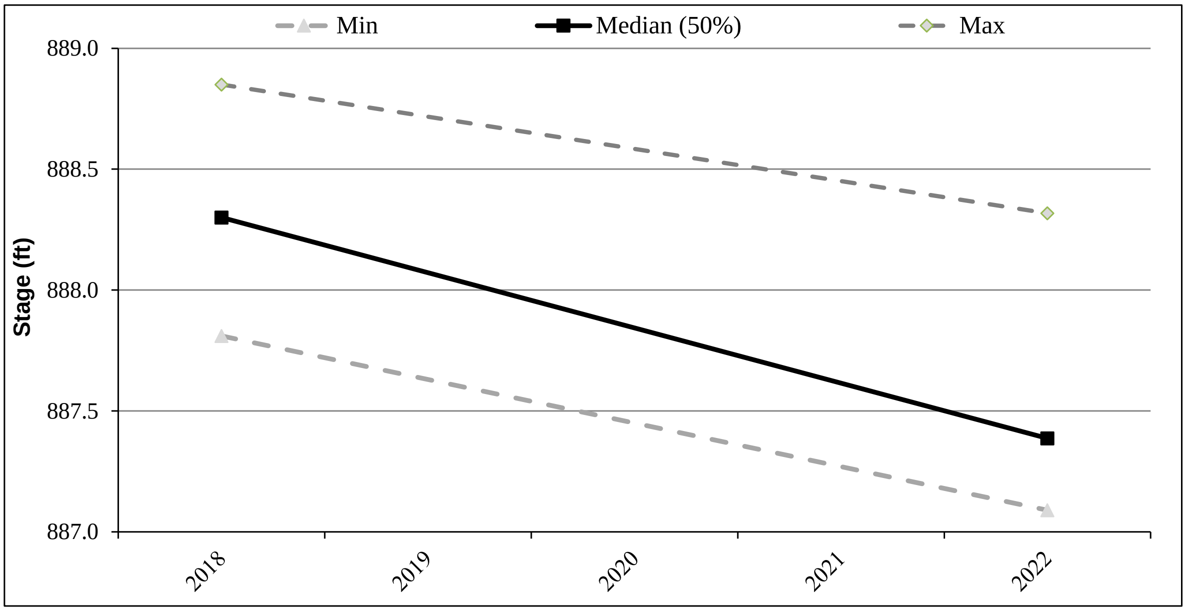
2022 Hydrographs



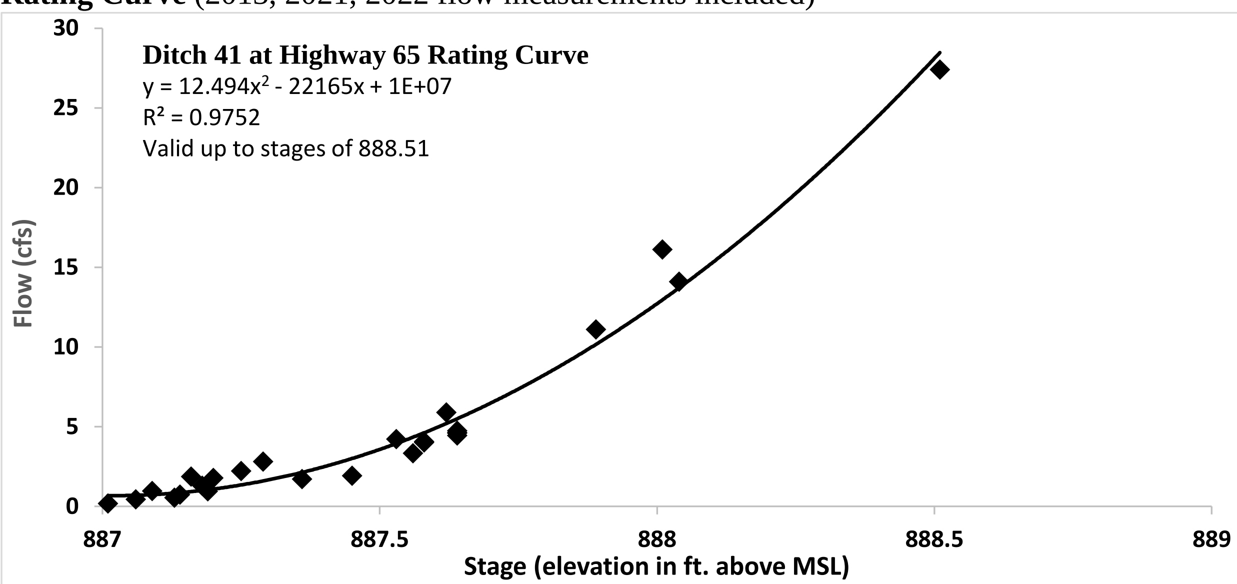


Summary of All Monitored Years

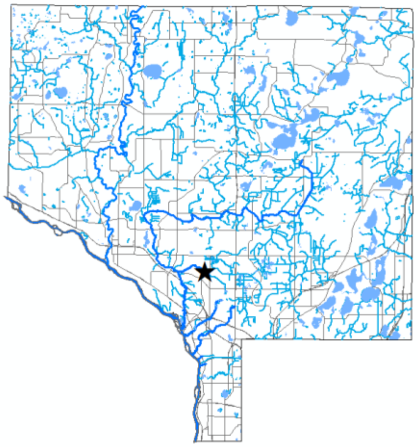
Percentiles	2018	2022
Min	887.81	887.09
2.5%	887.86	887.12
10.0%	887.96	887.17
25.0%	888.11	887.24
Median (50%)	888.30	887.39
75.0%	888.46	887.59
90.0%	888.59	887.79
97.5%	888.72	888.13
Max	888.85	888.32



Rating Curve (2013, 2021, 2022 flow measurements included)



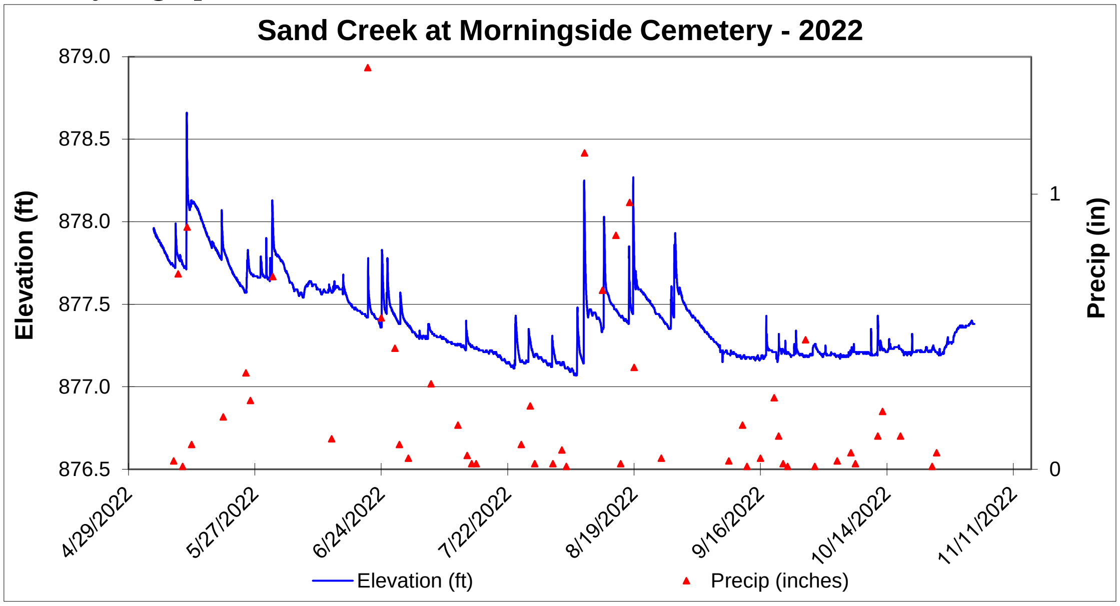
Sand Creek at Morningside Cemetery, Coon Rapids

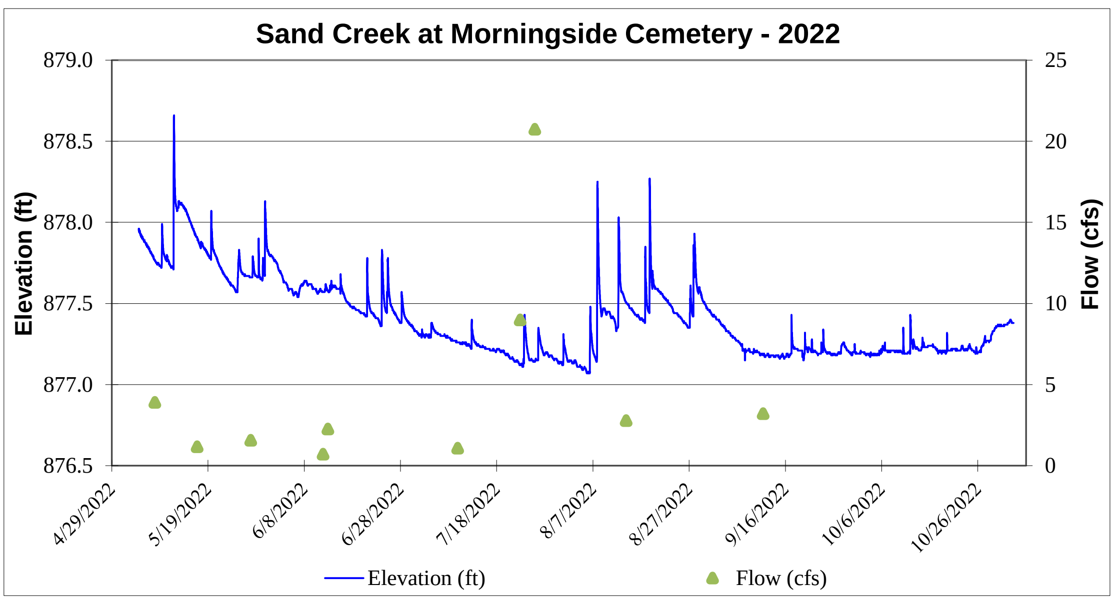


Notes

This site has been monitored for 12 years. Water levels fluctuated 1.59ft throughout the 2022 season, the second lowest range since monitoring began in 2010. Baseflow elevations decreased early in the season with a slight rebound observed in late-summer and fall. The creek is narrow at this site causing water levels to be flashy in response to rain events. Maximum stage at this site in 2022 was the second lowest on record.

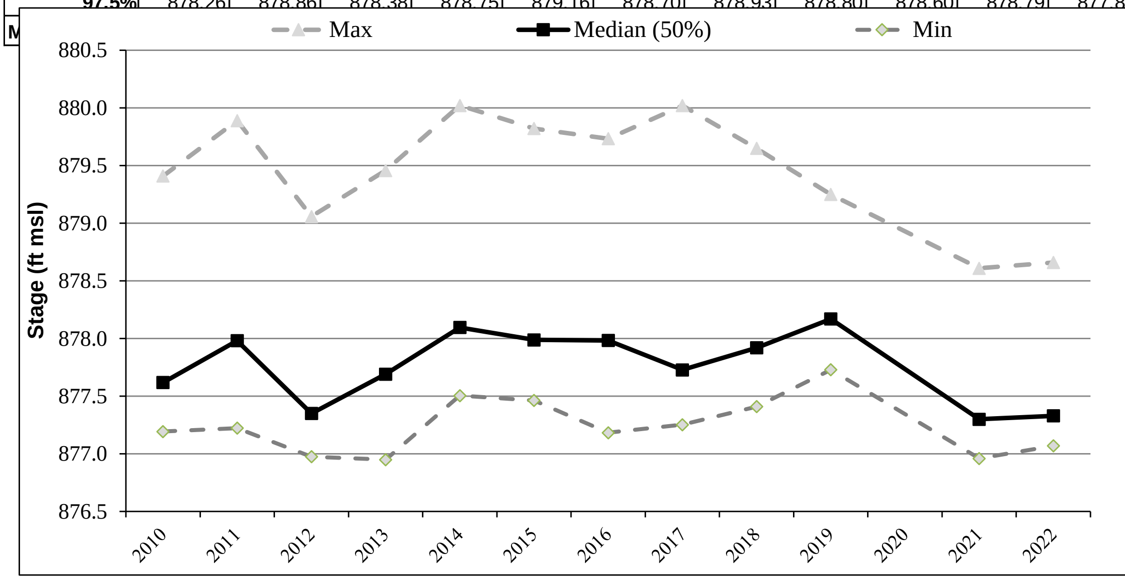
2022 Hydrographs



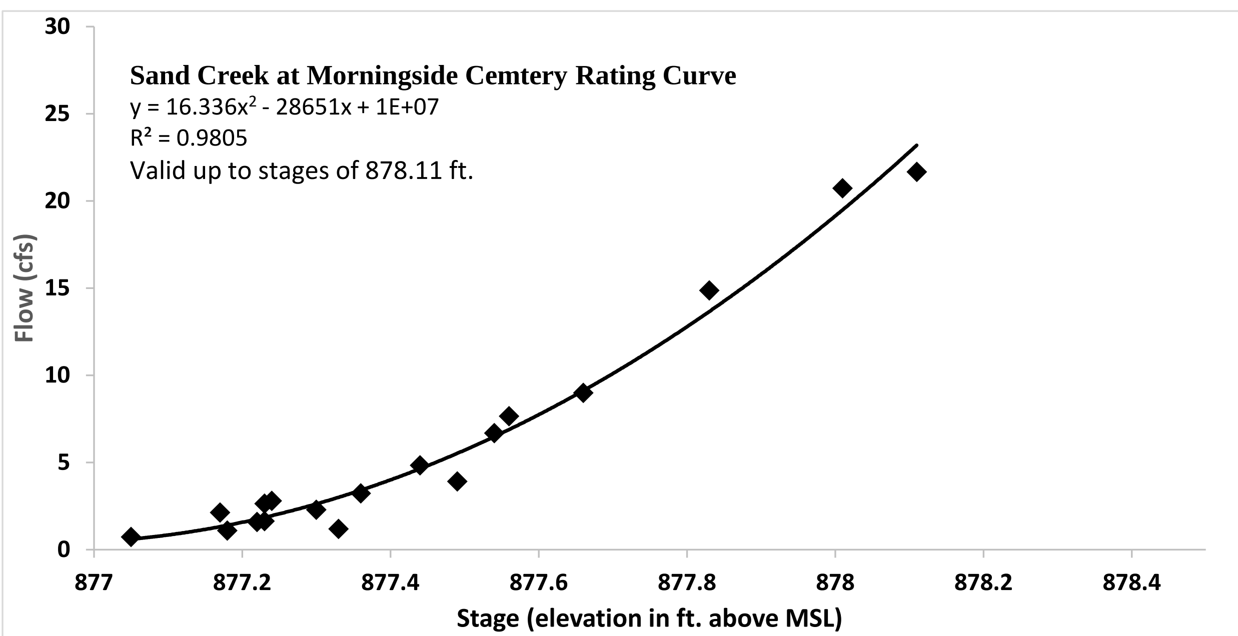


Summary of All Monitored Years

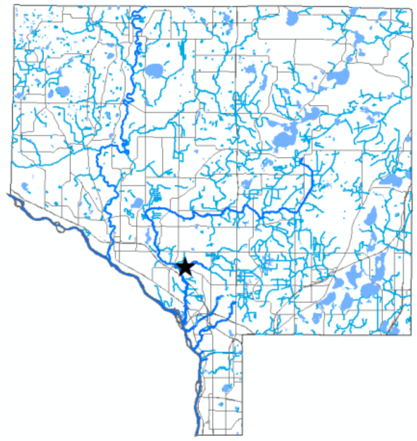
Percentiles	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2021	2022
Min	877.19	877.22	876.98	876.95	877.51	877.46	877.18	877.25	877.41	877.73	876.96	877.07
2.5%	877.27	877.28	877.00	877.18	877.56	877.52	877.49	877.34	877.49	877.81	877	877.13
10.0%	877.36	877.36	877.03	877.28	877.62	877.66	877.58	877.41	877.68	877.91	877.06	877.18
25.0%	877.45	877.72	877.15	877.38	877.81	877.80	877.70	877.53	877.80	878.00	877.13	877.21
Median (50%)	877.62	877.98	877.35	877.69	878.10	877.99	877.98	877.73	877.92	878.17	877.3	877.33
75.0%	877.79	878.22	877.65	877.93	878.43	878.19	878.26	877.96	878.10	878.38	877.42	877.57
90.0%	877.95	878.55	877.94	878.42	878.72	878.39	878.54	878.27	878.34	878.60	877.56	877.76
97.5%	878.26	878.86	878.38	878.75	879.16	878.70	878.93	878.80	878.60	878.79	877.81	877.98
M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	878.66



Rating Curve (2021-2022 flow measurements included)



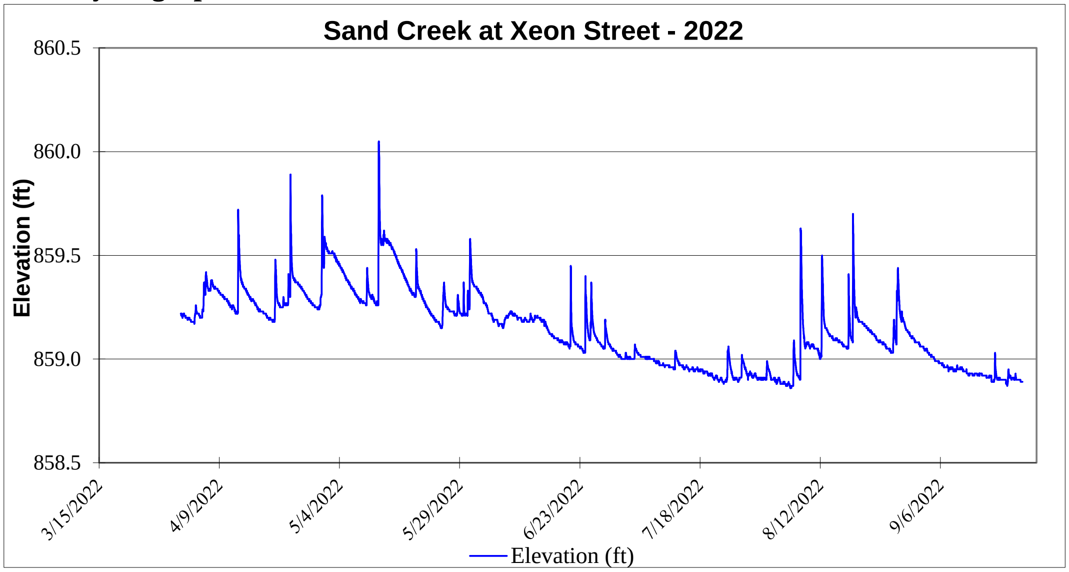
SAND CREEK AT XEON STREET, COON RAPIDS

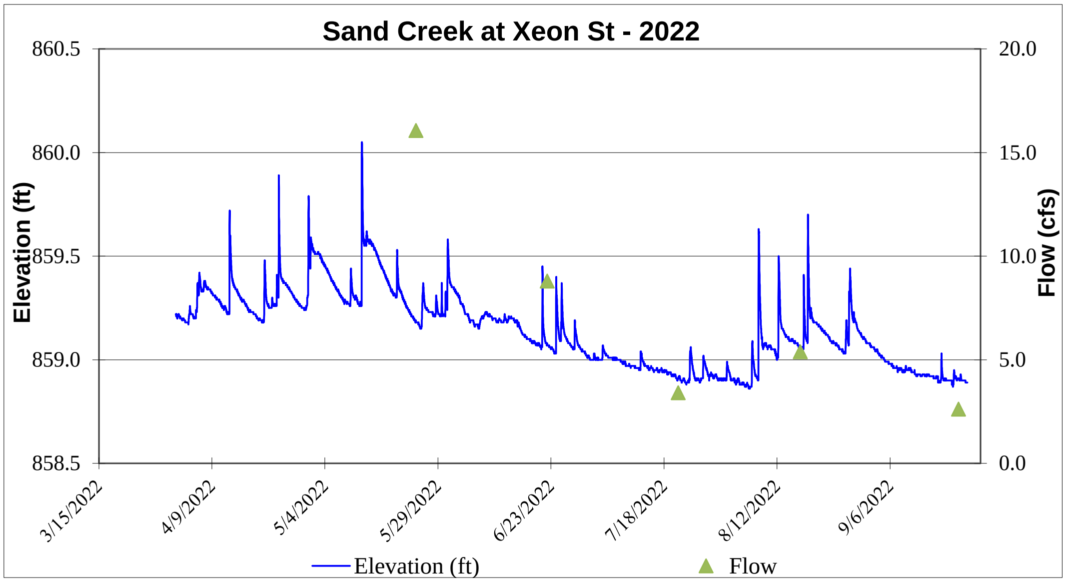


Notes

This site has been monitored for 20+years. Water levels at the Sand Creek at Xeon Street site fluctuate less than stage at the Morningside Gardens site just upstream. This is likely because Sand Creek widens considerably between the two monitoring sites Restoration projects have occurred at the site in recent years included channel stabilization and reconnection to the flood plain. These activities have changed base water elevations in the channel compared to previous monitoring years.

2022 Hydrographs

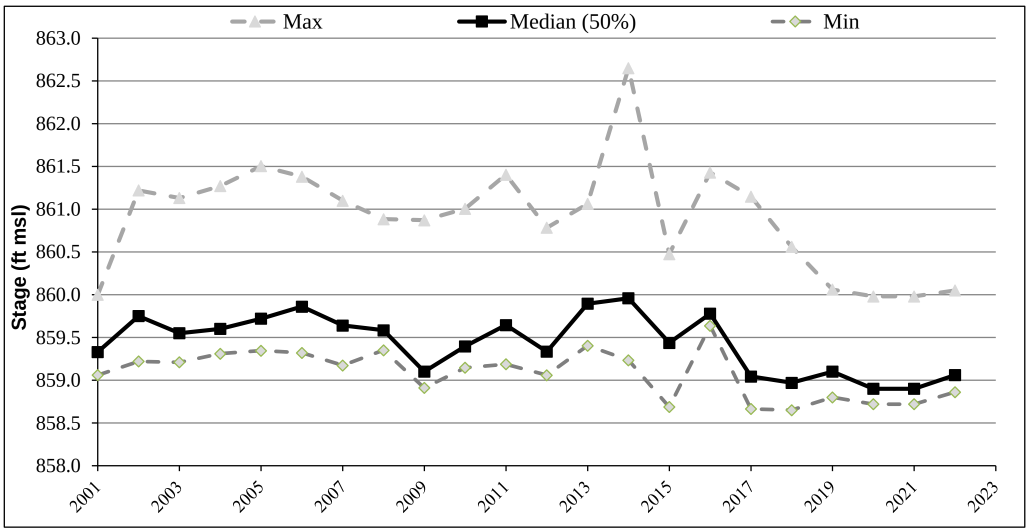




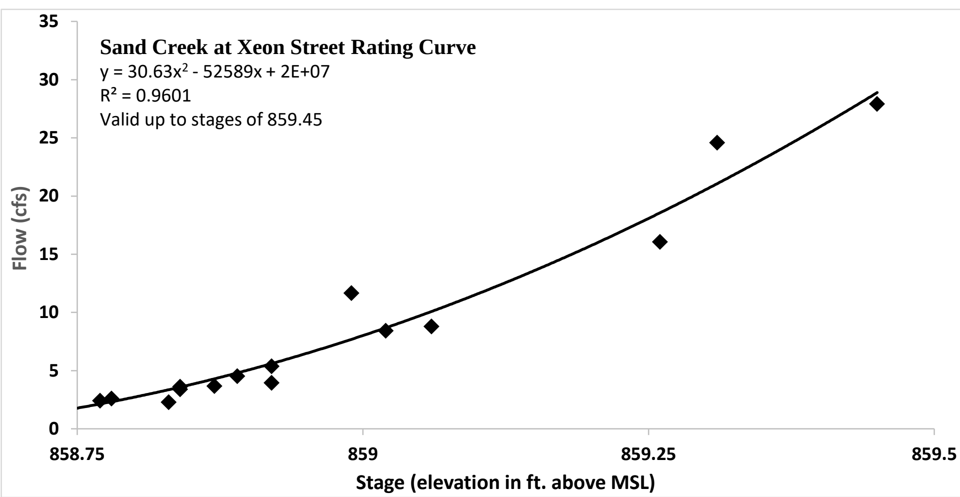
Summary of All Monitored Years

Percentiles	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Min	859.06	859.22	859.21	859.31	859.35	859.32	859.17	859.35	858.91	859.15	859.19
2.5%	859.09	859.44	859.26	859.33	859.41	859.43	859.30	859.44	858.99	859.24	859.22
10.0%	859.15	859.48	859.32	859.40	859.45	859.54	859.41	859.48	859.03	859.28	859.28
25.0%	859.23	859.61	859.41	859.46	859.55	859.70	859.47	859.53	859.05	859.33	859.47
Median (50%)	859.33	859.75	859.55	859.60	859.72	859.86	859.64	859.58	859.10	859.40	859.65
75.0%	859.49	859.93	859.75	859.80	859.97	860.01	859.81	859.78	859.29	859.52	859.89
90.0%	859.54	860.09	860.00	860.03	860.21	860.12	859.98	859.94	859.38	859.60	860.08
97.5%	859.65	860.32	860.28	860.32	860.51	860.27	860.11	860.13	859.54	859.75	860.33
Max	860.00	861.22	861.13	861.27	861.50	861.38	861.10	860.88	860.87	861.01	861.40

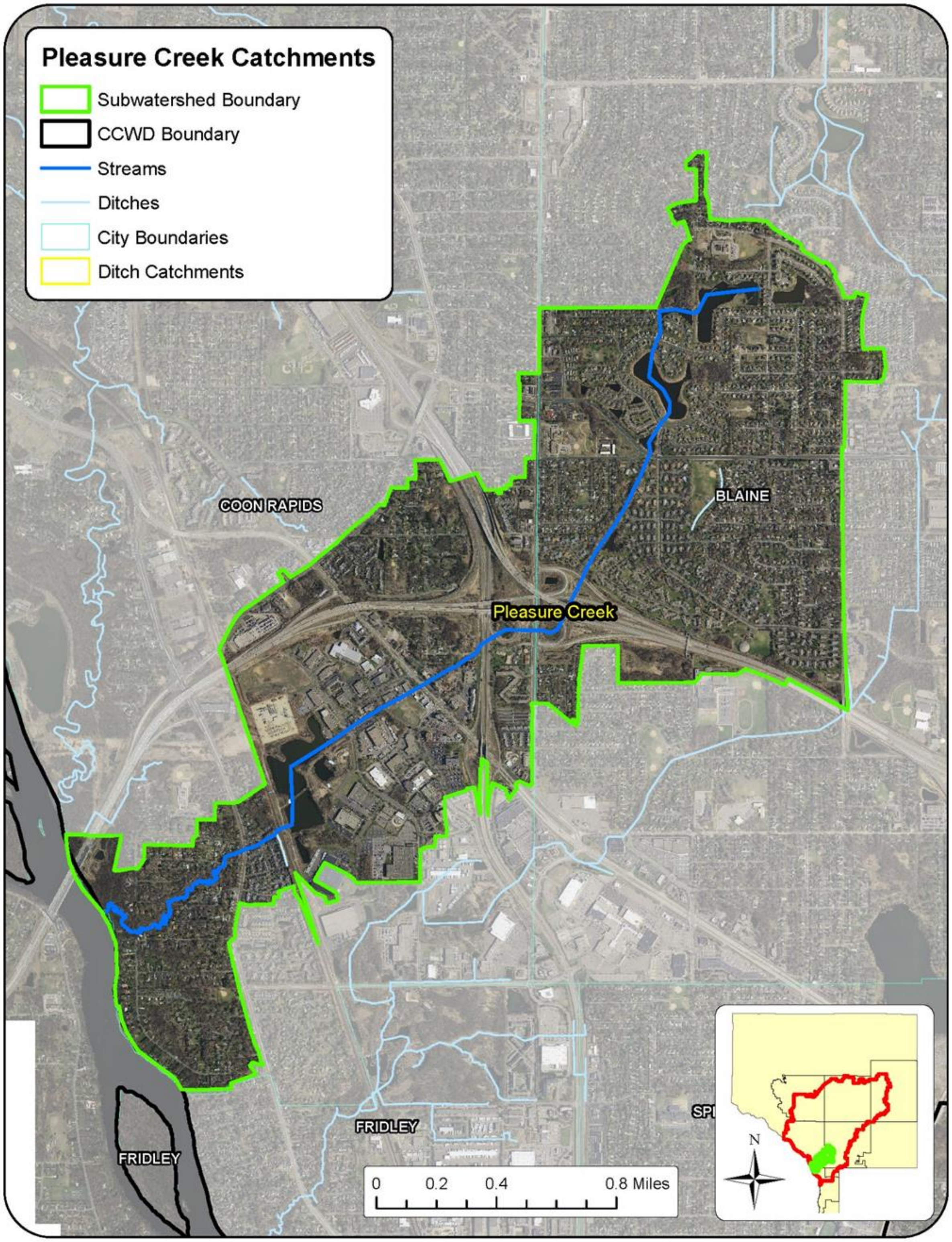
Percentiles	2012	2013	2014	2015	2016	2017	2018	2019	2020	2022
Min	859.06	859.40	859.23	858.69	859.64	858.66	858.65	858.80	858.72	856.99
2.5%	859.07	859.53	859.42	858.96	859.67	858.69	858.69	858.85	858.75	857.02
10.0%	859.11	859.60	859.61	859.03	859.70	858.84	858.80	858.91	858.77	857.05
25.0%	859.18	859.70	859.79	859.16	859.73	858.94	858.85	858.98	858.82	857.13
Median (50%)	859.33	859.90	859.96	859.44	859.78	859.04	858.97	859.10	858.90	857.30
75.0%	859.53	860.04	860.28	859.66	859.84	859.36	859.11	859.23	859.02	857.40
90.0%	859.76	860.18	861.08	859.82	860.00	859.57	859.26	859.36	859.14	857.50
97.5%	860.11	860.37	861.93	860.04	860.38	859.96	859.47	859.50	859.31	857.67
Max	860.78	861.06	862.65	860.48	861.43	861.15	860.56	860.06	859.98	858.18



Rating Curve (2021, 2022 flow measurements included)



Water Quality & Hydrology Monitoring – Pleasure Creek Subwatershed

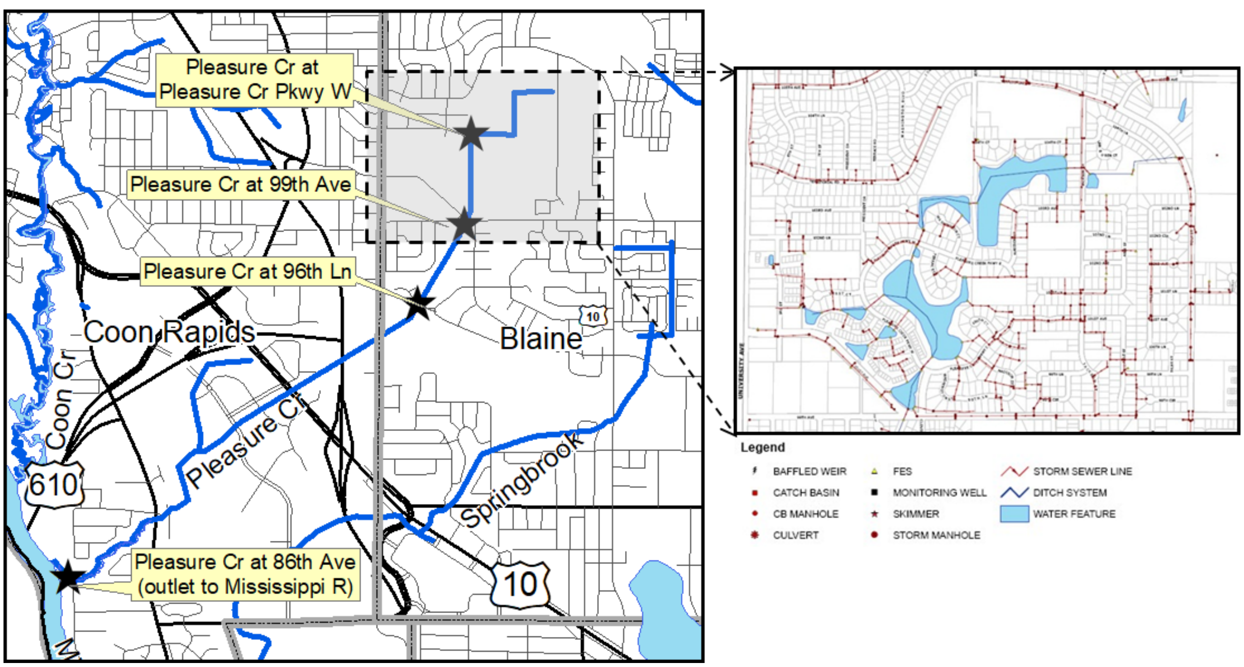


PLEASURE CREEK SUBWATERSHED BACKGROUND

Pleasure Creek drains 1,880 acres through southwestern Blaine and southern Coon Rapids. The watershed consists mainly of suburban residential and commercial land use. Pleasure Creek begins as the outlet channel for a series of stormwater ponds in the Blaine Haven housing development. The creek flows as a straightened ditch for approximately 1.5 miles before outletting into a large stormwater pond in the commercial area between East River Road and Coon Rapids Boulevard in southern Coon Rapids. This stormwater pond outlets through a culvert running under 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 0.5-1.0 ft. deep near its outlet at baseflow. Pleasure Creek is listed as impaired for invertebrate biota and *E. coli* bacteria and has a pending 2024 chloride impairment

Pleasure Creek (Ditch 17) Monitoring Sites		
Site Name/ SiteID	**Years Monitored**	**2022 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, 2018-2022	Water Chemistry Grab Samples, Flow Measurements
Pleasure Creek at 86th Avenue S003-995	2006-2022	Water Chemistry Grab Samples, Continuous Stage, Flow measurements

Pleasure Creek Monitoring Sites



SUMMARY

Pleasure Creek is listed as impaired for poor invertebrate biota and high *E. coli* and also has a pending 2024 chloride impairment. The Coon Creek TMDL contains load duration curves (LDC) for TSS and TP in Pleasure Creek because these pollutants are identified as stressors for aquatic life in this stream system. Neither TP or TSS are especially problematic in Pleasure Creek, only occasionally exceeding state standards mostly during storm events. Exceedances of the LDC for each of these parameters in Pleasure Creek are also rare and typically only occur during very high flows. Poor habitat, flashy flows, and high dissolved pollutants like chlorides may be more important stressors to aquatic biota.

E. coli levels are extremely high in Pleasure Creek. The chronic standard concentration of 126 MPN is exceeded 74% of the time at baseflow and 87% of the time during storms at the 86th Avenue outlet monitoring site. 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. The TMDL attributes over 90% of *E. coli* loading in Pleasure Creek to domestic dogs, but this assumption may be underrepresenting the contribution of local waterfowl or possible leaky sanitary infrastructure.

Chlorides were sampled in CCWD streams in 2019, 2021 and 2022, with Pleasure Creek having higher concentrations than other streams in the watershed. Chloride levels at Pleasure Creek at 86th Avenue exceeded the chronic state standard (230 mg/L) during 4 of the 8 sampling events. These exceedances occurred during both baseflow conditions and after storms. Chlorides averaged 229.87 mg/L over the 8 samples collected in 2022. This was an increase from the 2019 average of 185.5 mg/L and similar to 2021 levels. Pleasure Creek has not exceeded the acute standard of 860 mg/L in any sample collected, but sampling has not occurred during snowmelt when chloride might be highest. Pleasure Creek has been assigned a pending 2024 impairment for chlorides. Chlorides are a particularly problematic pollutant to aquatic life and in drinking water.

RESULTS AND DISCUSSION

SPECIFIC CONDUCTIVITY AND CHLORIDES

Specific Conductivity in Pleasure Creek is high. The long-term median for specific Conductivity during baseflow conditions at the 86th Avenue site is 1.163 mS/cm and 1.170 mS/cm during storms. By comparison, the median for all Anoka County streams is 0.561 mS/cm. There is a notable increase in specific Conductivity between 96th lane to 86th Avenue. 96th lane is more consistent and has a smaller range of concentrations than 86th Avenue, which fluctuates to a greater degree.

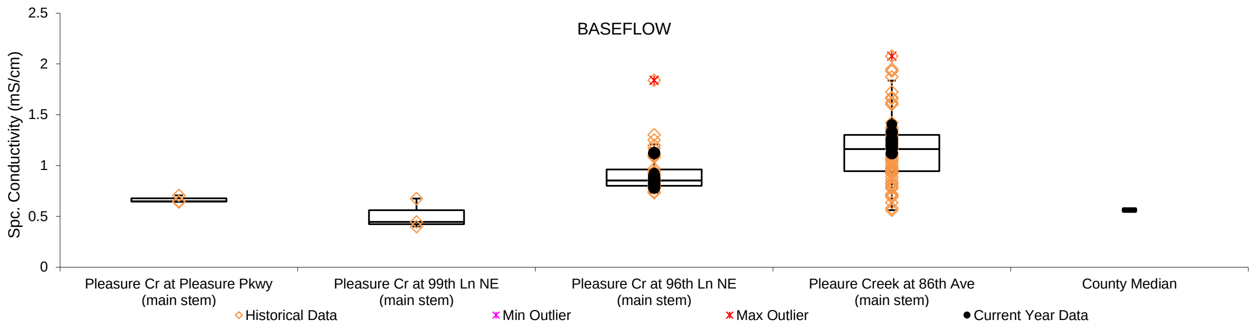
Specific Conductivity is slightly higher during baseflow conditions, except at the 99th Lane site. Road deicing salts, infiltration to the shallow water table that feeds stream baseflows is an often-suspected source of dissolved pollutants. This is likely the case in Pleasure Creek, based on the high specific Conductivity frequently observed during baseflow conditions. However, high specific Conductivity has also been observed following storm events, revealing that stormwater runoff to Pleasure Creek is also a source of dissolved pollutants or is getting flushed out of in-line ponds during events.

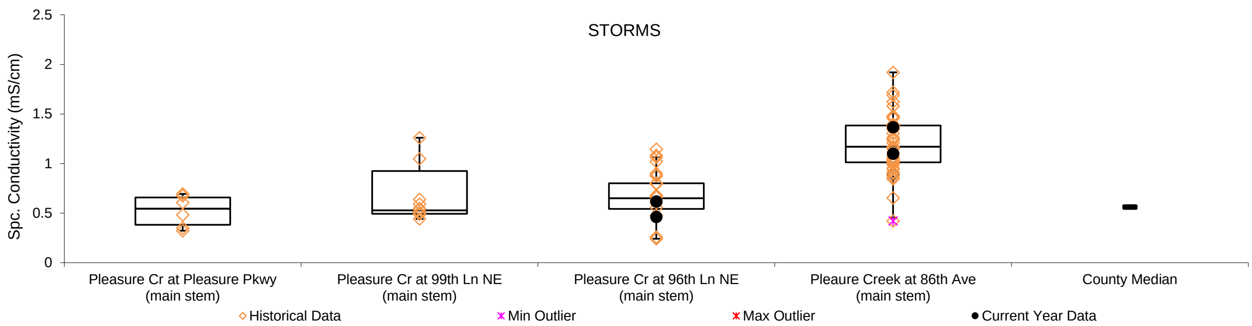
Dissolved pollutants are especially difficult to manage once released into the environment and are not readily removed by stormwater settling ponds. Infiltration practices can provide some treatment through biological processes in the soil, but also runs the risk of contaminating groundwater. The first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

Average and median specific Conductivity in Pleasure Creek at 86th Ave. for specific Conductivity and chlorides all years through 2022.

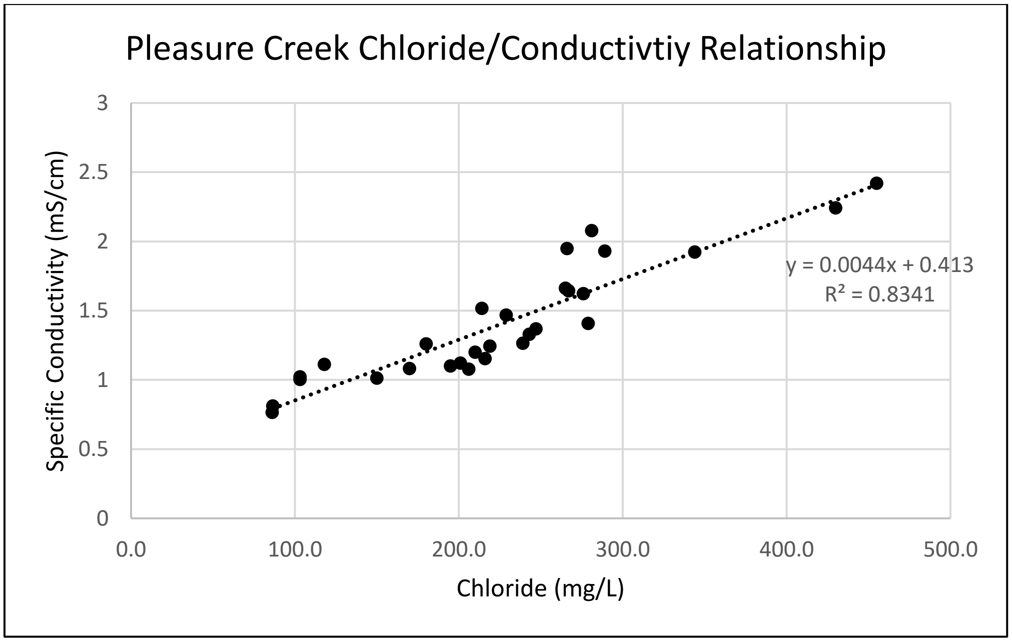
	Average specific Conductivity (mS/cm)	Median specific Conductivity (mS/cm)	State Standard	N
Baseflow	1.167	1.163	Specific Conductivity – none	73
Storms	1.209	1.170		53
All	1.185	1.170		126

Specific Conductivity at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.





Specific Conductivity/Chloride Relationship at Pleasure Creek. In the Pleasure Creek system, conductivity measurements equal to or greater than 1.425 mS/cm indicate an exceedance of the State standard for Chloride (230 mg/L).



Total Phosphorus

Total phosphorus (TP) is generally low in Pleasure Creek during baseflow conditions and elevated slightly during storms. In all conditions, TP concentrations in Pleasure Creek are lower than the median for Anoka County streams (91.0 µg/L). Pleasure Creek exceeded the state standard (100 µg/L) during 27% of storm samples historically collected at the 86th Avenue site. The exceedance rate during stormflow during the past 5 years of sampling was 22% compared to 48% during the first 5 years on record. TP levels at 96th Lane were also in excess of 100 µg/L 32% of the time since 2018.

Phosphorus loading into this system seems to be occurring primarily in the upstream portions of the watershed, unlike chlorides and dissolved pollutants. It is possible that one or more ponds in the headwaters are loading phosphorus to the system under certain conditions. Interestingly, ANOVA results indicate a significant decrease in average TP concentrations during baseflow conditions in the lower watershed, between the 96th Lane and the 86th Avenue sites. Stormwater ponds in that region seem to be capturing some of the upstream phosphorus.

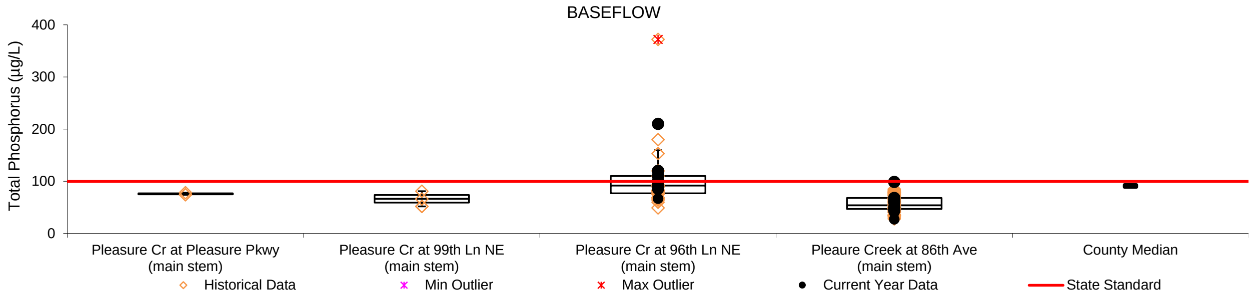
Supplemental ortho-phosphorus (OP) samples were collected in 2022. At the Pleasure Creek at 96 Ln site the average OP concentration during baseflow was 26% (range=12%-102%) of average TP. During storms, the average OP concentration was 15.7% (range=8%-23%) of average TP. At the Pleasure Creek at 86th Avenue site the average OP concentration during baseflow was 15.5% (range=8%-70%) of average TP. During storms, the average OP concentration was 7.25% (range=6%-8%) of average TP. The MN Stormwater Manual reports the national average Ortho Phosphorus concentration as a percentage of Total Phosphorus to be 26% indicating Pleasure Creek is slightly below the national average.

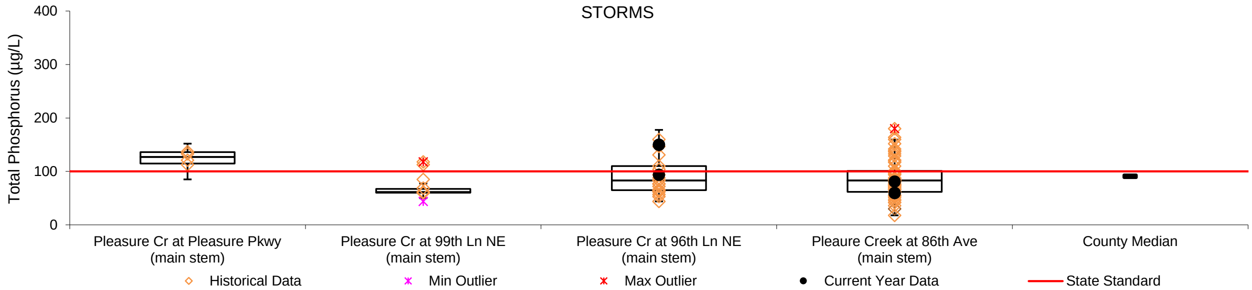
The Pleasure Creek LDC for TP in the Coon Creek TMDL (Page 48, Figure 18) shows that Pleasure Creek does not often exceed acceptable TP loads, and usually only happens during very high flows. This hints that current stormwater infrastructure in the watershed is effectively treating stormwater for TP during all but the largest storm events.

Median TP in Pleasure Creek. Data is from the 86th Avenue site and all years through 2022.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	56.55	54.0	100	65
Storms	86.69	83.0		62
All	71.27	66.0		127
Occasions > state standard				0 baseflow 17 (27%) storms

Total phosphorus at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.





ANOVA Matrix for Baseflow Total Phosphorus

	Pleasure Creek at 96th Lane (2008-2022) - 28 Samples	Pleasure Creek at 86th Ave (2001-2022) - 60 Samples
Pleasure Creek at 96th Lane		Significant Decrease 96th Ln X= 102.82 µg/L 86th Ave X= 56.76 µg/L p= <0.0001
Pleasure Creek at 86th Ave		

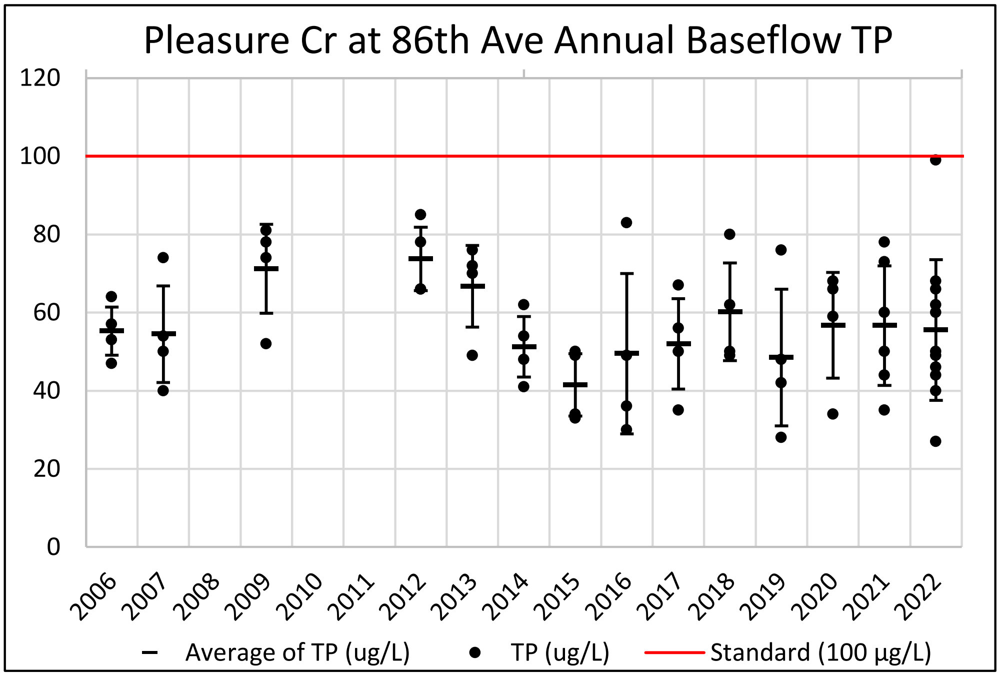
ANOVA Matrix for Storm Total Phosphorus

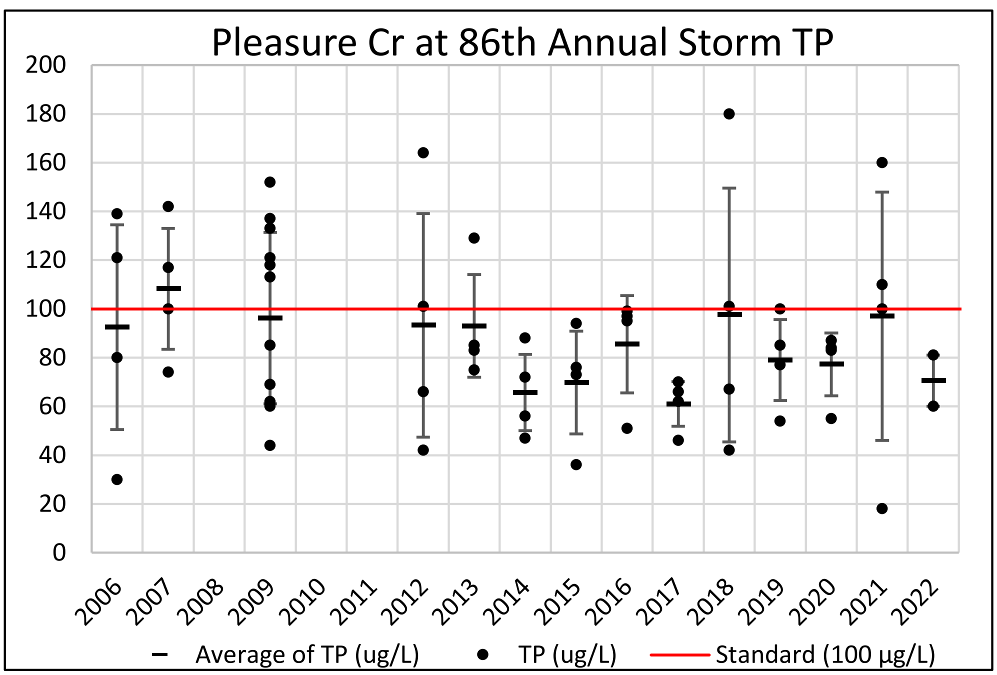
	Pleasure Creek at 96th Lane (2008-2022) - 21 Samples	Pleasure Creek at 86th Ave (2001-2022) - 62 Samples
Pleasure Creek at 96th Lane		No Sig. Change 96th Ln X = 111.95 µg/L 86th Ave X = 86.69 µg/L p= 0.11
Pleasure Creek at 86th Ave		

Pleasure Creek Trend Analysis

Parameter	Significant Change in Annual $\bar{X}$ (2006-2022)	p=	Standard Error of Means
Total Phosphorus - Baseflow	None	0.316	8.85
Total Phosphorus - Storm	None	0.087	13.06

Pleasure Creek at 86th Ave - Annual average ANOVA regression TP 2006-2022





TOTAL SUSPENDED SOLIDS

TSS concentrations are commonly low during baseflow conditions and has never exceeded the state standard (30 mg/L) at any of the monitoring sites. However, during storm events, TSS for all years, all sites, exceeded the state standard 37% of the time. The exceedance rate during stormflow during the past 5 years of sampling was 30% compared to 40% during the first 5 years on record. Only one sample collected in 2022 slightly exceeded the state standard and was following a storm event (30.1 mg/L).

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 only during periods of very high flow. ANOVA results indicate a significant increase in TSS concentrations between the 96th Lane site and the 86th Avenue site during storm events. This illustrates that TSS loading to the system is occurring downstream of Highway 10 during storms. It is worth noting that this is opposite of the pattern observed for TP where loading seems to be occurring upstream of the 96th Lane site.

Low TSS (and TP levels) likely reflect the effectiveness of a stormwater pond system located just upstream of East River Road. Additional stormwater treatment near and downstream of East River Road would likely be the most effective way to improve water quality in Pleasure Creek since treatment upstream is already robust. Mitigating the source of excess TP upstream of 96th Lane would also be beneficial.

Average and median total suspended solids in Pleasure Creek. Data is from the 86th Avenue site and all years through 2022.

	Average Total Suspended Solids (mg/L)	**Median Total Suspended Solids (mg/L)**	**State Standard**	**N**
Baseflow	8.55	6.30	30 mg/L TSS	65
Storms	27.96	21.00		62
All	18.02	10.60		127
Occasions > state TSS standard				0 baseflow 23 (37%) storm

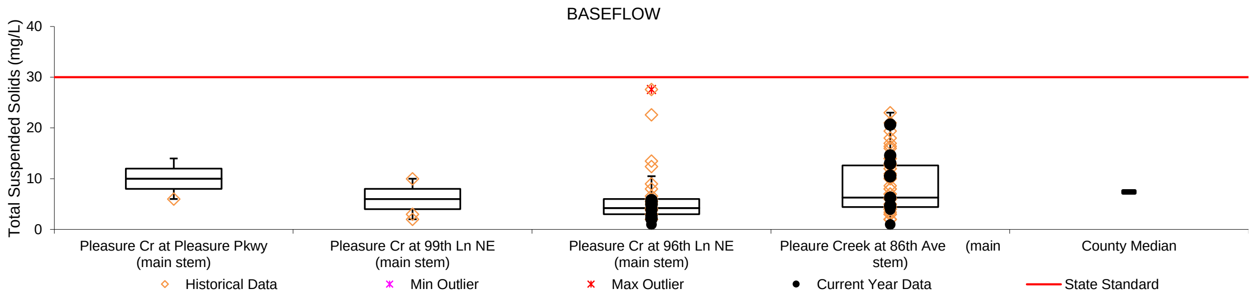
ANOVA Matrix for Storm TSS

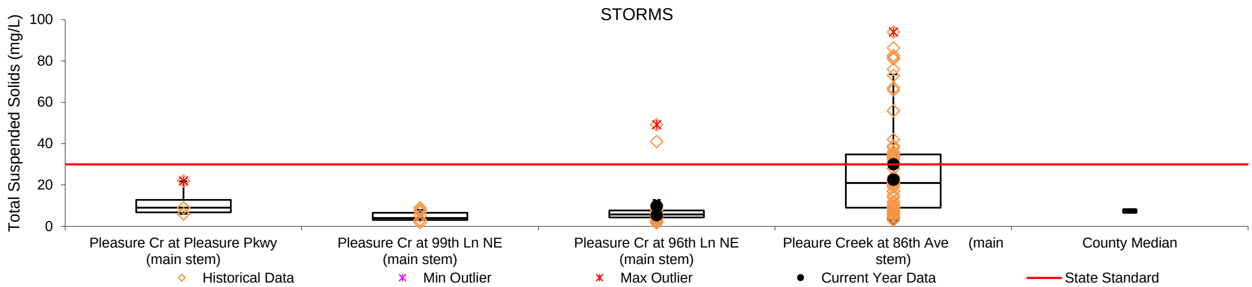
	Pleasure Creek at 96th Lane (2008-2022) - 22 Samples	Pleasure Creek at 86th Ave (2001-2022) - 62 Samples
Pleasure Creek at 96th Lane		Significant Increase 96th Ln X = 9.88 mg/L 86th Ave X = 27.95 mg/L p = <0.01
Pleasure Creek at 86th Ave		

ANOVA Matrix for Baseflow TSS

	Pleasure Creek at 96th Lane (2008-2022) - 28 Samples	Pleasure Creek at 86th Ave (2001-2022) - 60 Samples
Pleasure Creek at 96th Lane		No Sig. Change 96th Ln X = 6.41 mg/L 86th Ave X = 8.22 mg/L p = 0.15
Pleasure Creek at 86th Ave		

Total suspended solids at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.

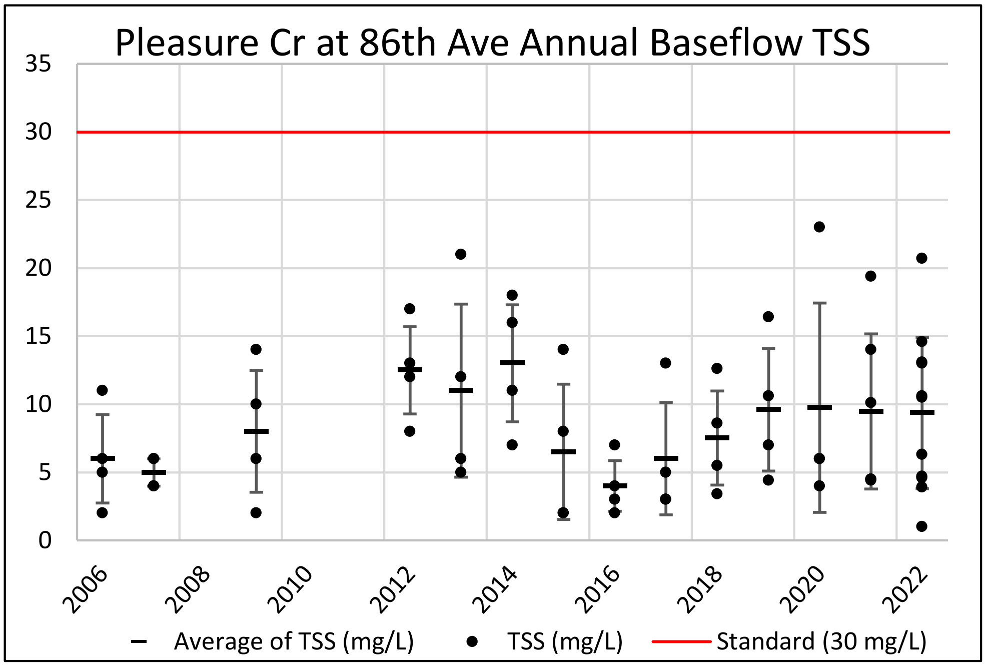


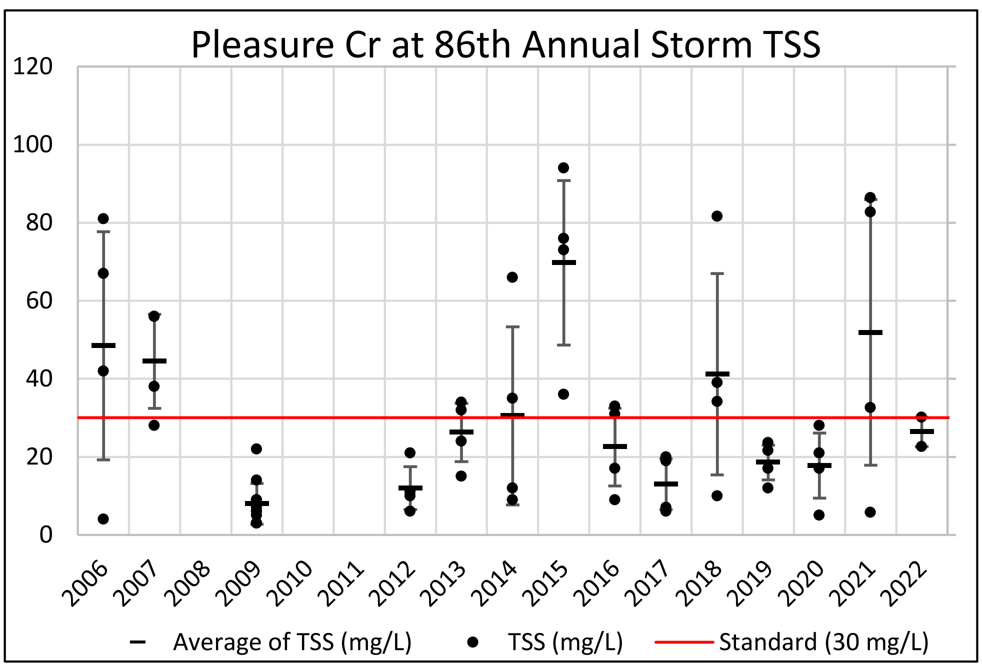


Pleasure Creek Trend Analysis

Parameter	Significant Change in Annual $\overline{X}$ (2006-2022)	p=	Standard Error of Means
Total Suspended Solids - Baseflow	None	0.422	2.76
Total Suspended Solids - Storm	None	0.779	18.63

Pleasure Creek at 86th Avenue - Annual average ANOVA regression TSS 2006-2022





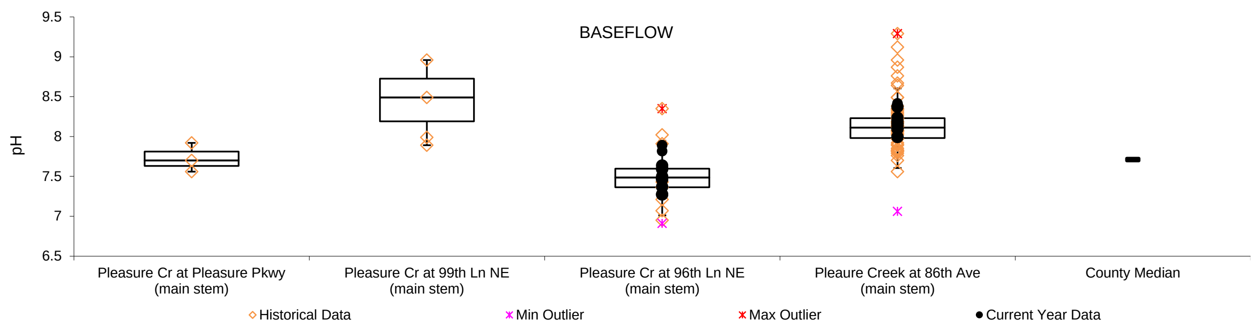
pH

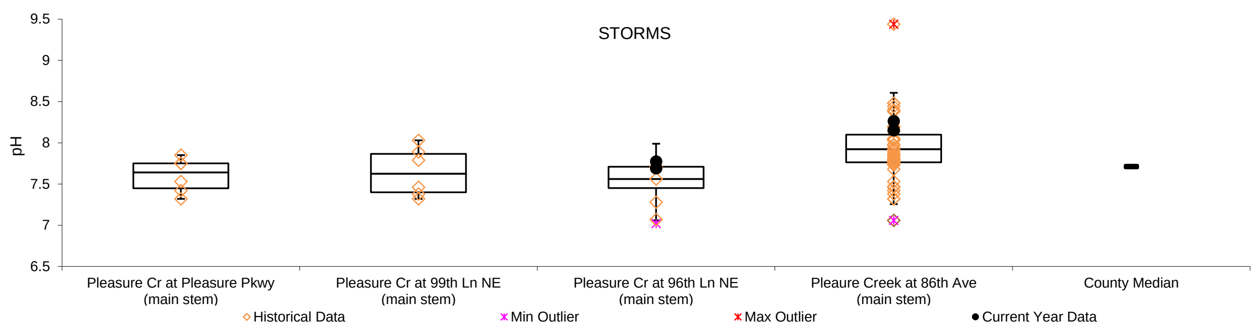
pH levels in Pleasure Creek have mostly remained within the healthy range of 6.5-8.5, but median and average values are at the high end of that range and exceed the long-term median for all Anoka County streams (7.71). Only three exceedances of the healthy range have occurred at the 86th Ave site since 2007, occurring during baseflow conditions. This is not a surprise, given that rain is typically more acidic that water on the landscape and often reduces pH during storms. Rare elevated pH readings are normal and there is currently no management concern at this time.

Average and Median pH in Pleasure Creek. Data is from the 86th Avenue site and all years through 2022.

	Average pH	Median pH	State Standard	N
Baseflow	8.15	8.12	6.5-8.5	80
Storms	7.94	7.92		62
All	8.06	8.04		142
Occasions outside state standard				7 (9%) baseflow 1 (2%) storm

pH at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.





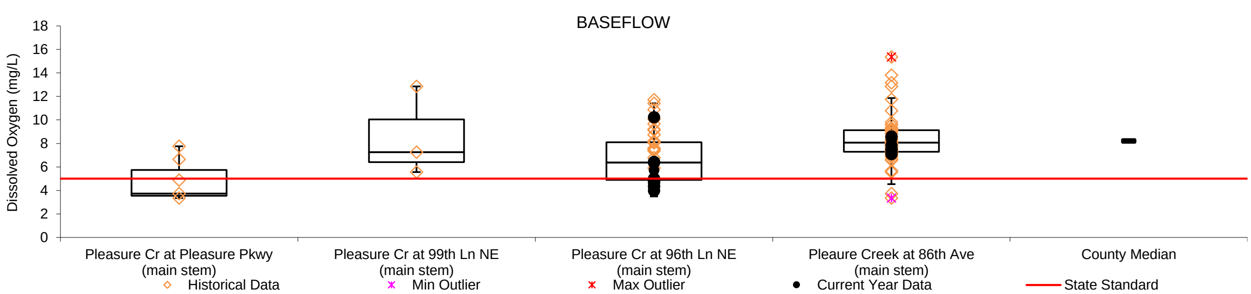
DISSOLVED OXYGEN

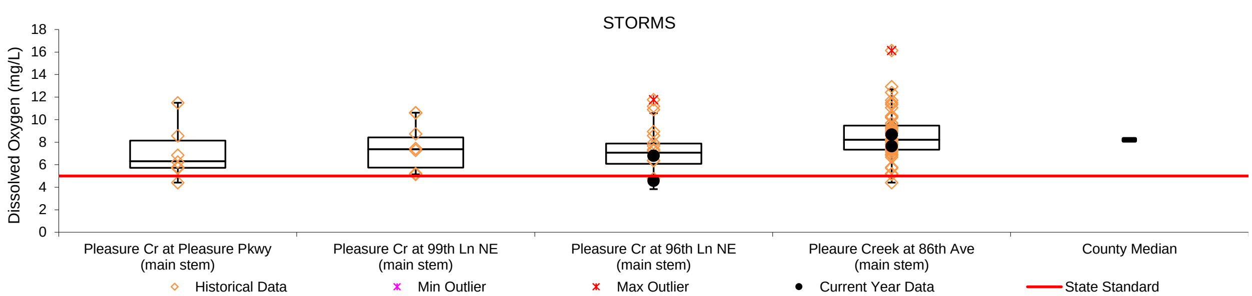
Dissolved oxygen (DO) levels in Pleasure Creek are usually within the acceptable range, only falling below the state standard (5 mg/L) on 3 of the 139 samples collected since 2002 at the 86th Avenue site. DO levels have routinely fallen below 5 mg/L at the 96th Ln site further upstream. Low DO in the upstream reaches of Pleasure Creek may cause internal loading of TP which could explain the occurrence of high TP levels during baseflow in this area.

Average and median dissolved oxygen in Pleasure Creek. Data is from the 86th Avenue site and all years through 2022.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.33	8.03	5 mg/L daily minimum	75
Storms	8.53	8.23		64
All	8.42	8.13		139
Occasions <5 mg/L				2 (3%) baseflow 1 (2%) storm

Dissolved Oxygen at Pleasure Creek. Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.





E. COLI

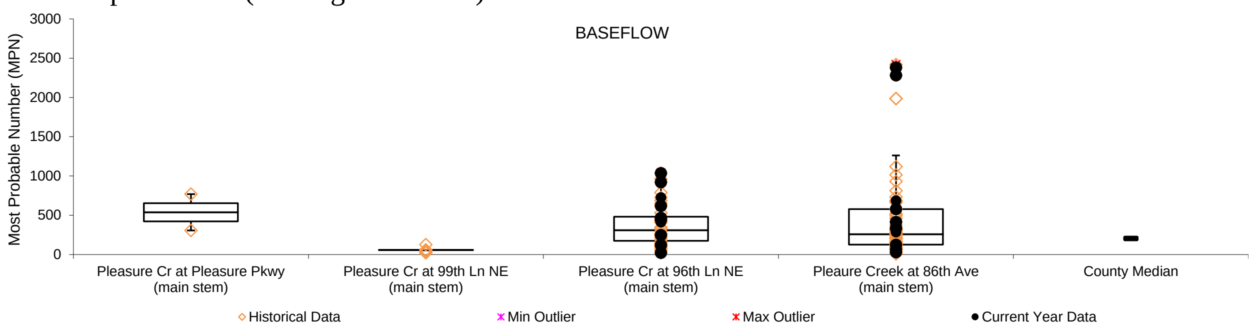
Pleasure Creek is listed as impaired for aquatic recreation due to excessive *E. coli*, and the Coon Creek TMDL contains a Load Duration Curve (LDC) for this parameter (CCWD TMDL; Page 52, Figure 22). The LDC chart shows exceedances of acceptable levels for the majority of samples collected. High *E. coli* still persists today, so people should be wary about contact, and any consumption of water from Pleasure Creek. 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 or other sources such as leaky sanitary infrastructure are underrepresented in the report.

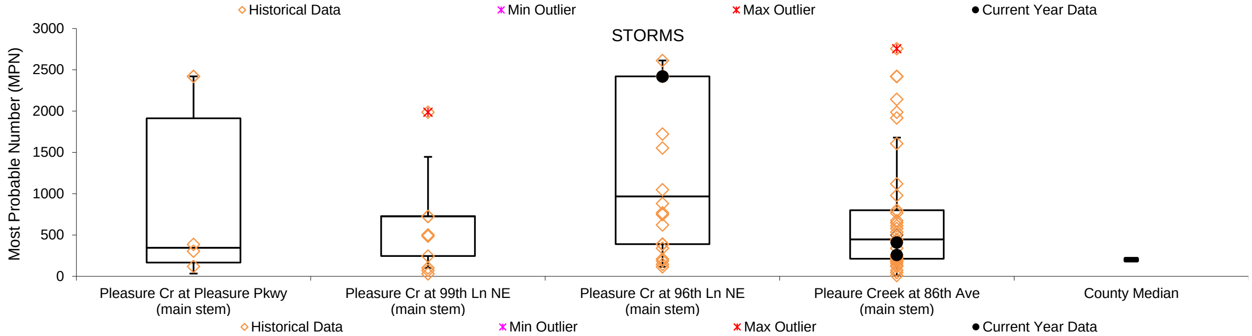
While current sampling frequency does not allow calculations to determine compliance with state standards on an annual basis, *E. coli* measurements collected in 2022 are still informative. In 2022, 9 of the 12 samples collected during all conditions at the 86th Avenue site exceeded the chronic standard of 126 MPN. Two of these samples exceeded the acute standard of 1260 MPN, both during baseflow conditions. *E. coli* concentrations in the Pleasure Creek system seem to increase, upstream to downstream, during baseflow conditions and slightly decrease, upstream to downstream, after storm events.

Average and median *E. coli* in Pleasure Creek. Data is from the 86th Avenue site only, all data through 2022.

	Average *E. coli* (MPN)	**Median *E. coli* (MPN)**	**Geometric Mean**	**State Standard**	**N**
Baseflow	483.87	259.00	252.84	Monthly Geometric Mean >126	57
Storms	761.20	488.00	417.97		45
All	606.22	320.50	314.94		102
Occasions >126 MPN				Monthly 10% average >1260	42 (74%) baseflow, 39 (87%) storm
Occasions >1260 MPN					5 (7%) baseflow, 9 (20%) storm

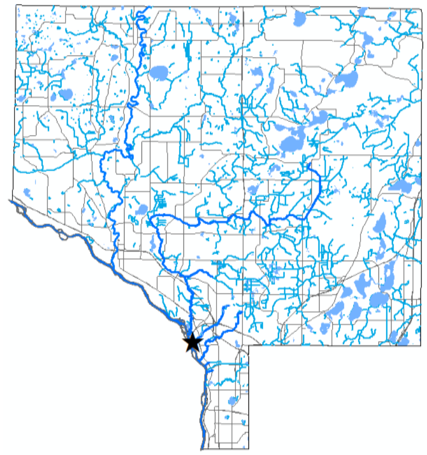
***E. coli* at Pleasure Creek.** Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.





Stream Hydrology – Pleasure Creek

Pleasure Creek at 86th Avenue

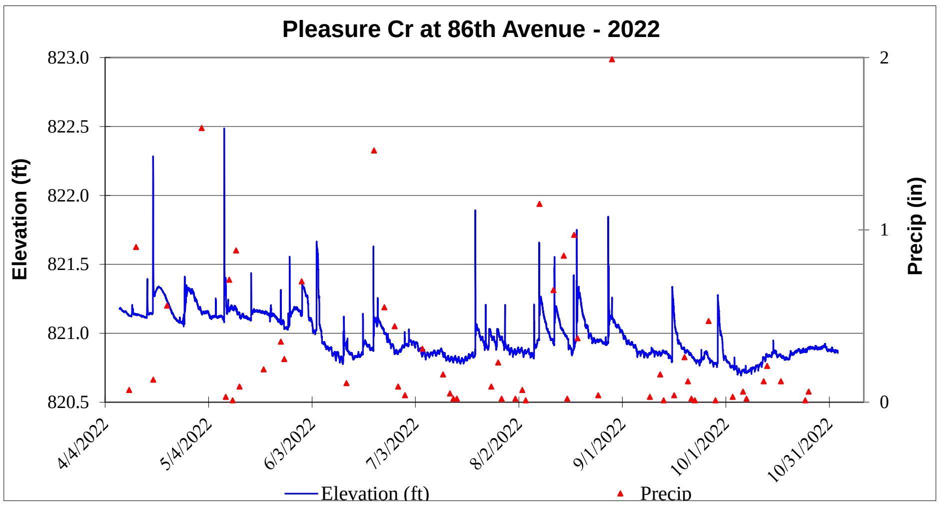


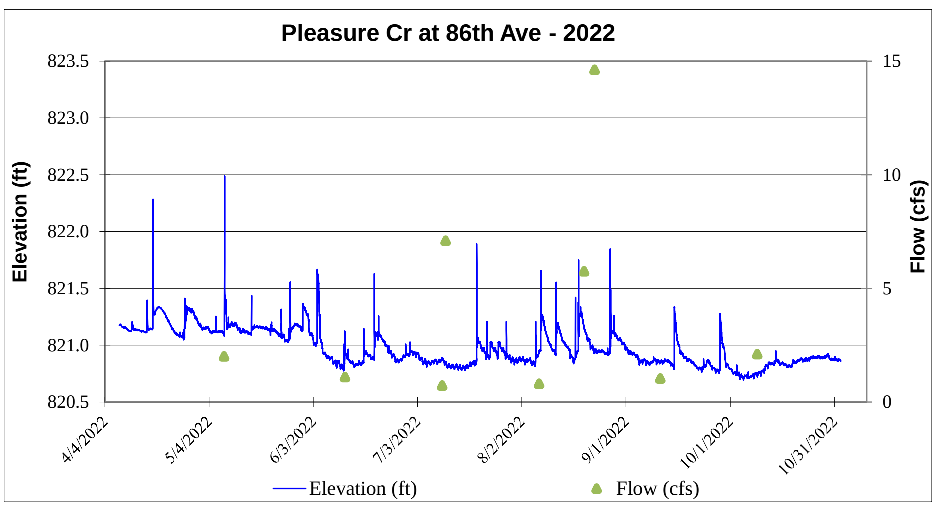
Notes

Stage at the Pleasure Creek at 86th Avenue suite fluctuated 1.79ft throughout the 2022 season. Water levels in the creek responded quickly to rain events and the creek maintained consistent water levels throughout most of the season, even during drought conditions.

There was a streambank stabilization project installed at this site in 2019. Streambanks and the streambed were both regraded during the project, changing the characteristics of the channel. These activities changed the base water levels compared to other monitoring years.

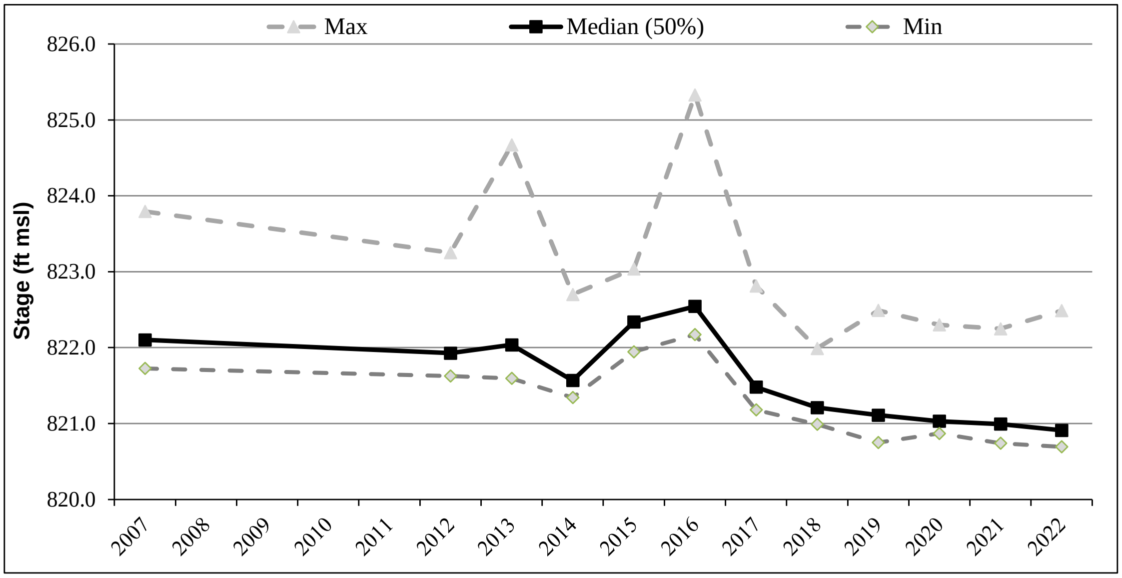
2022 Hydrographs



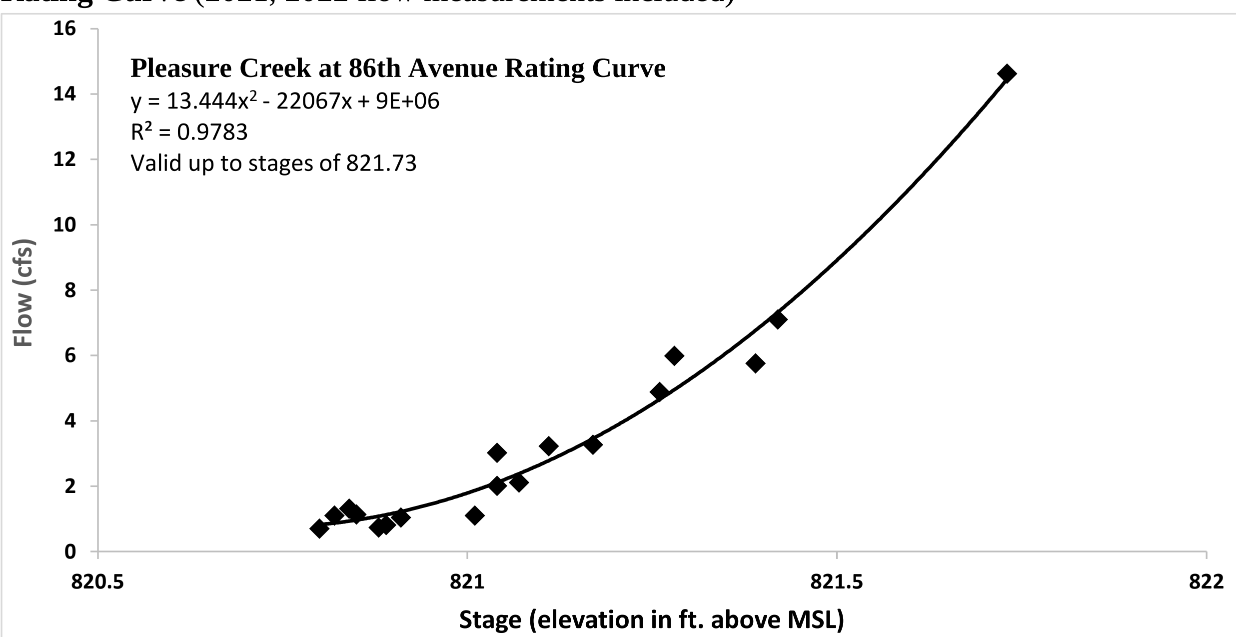


Summary of All Monitored Years

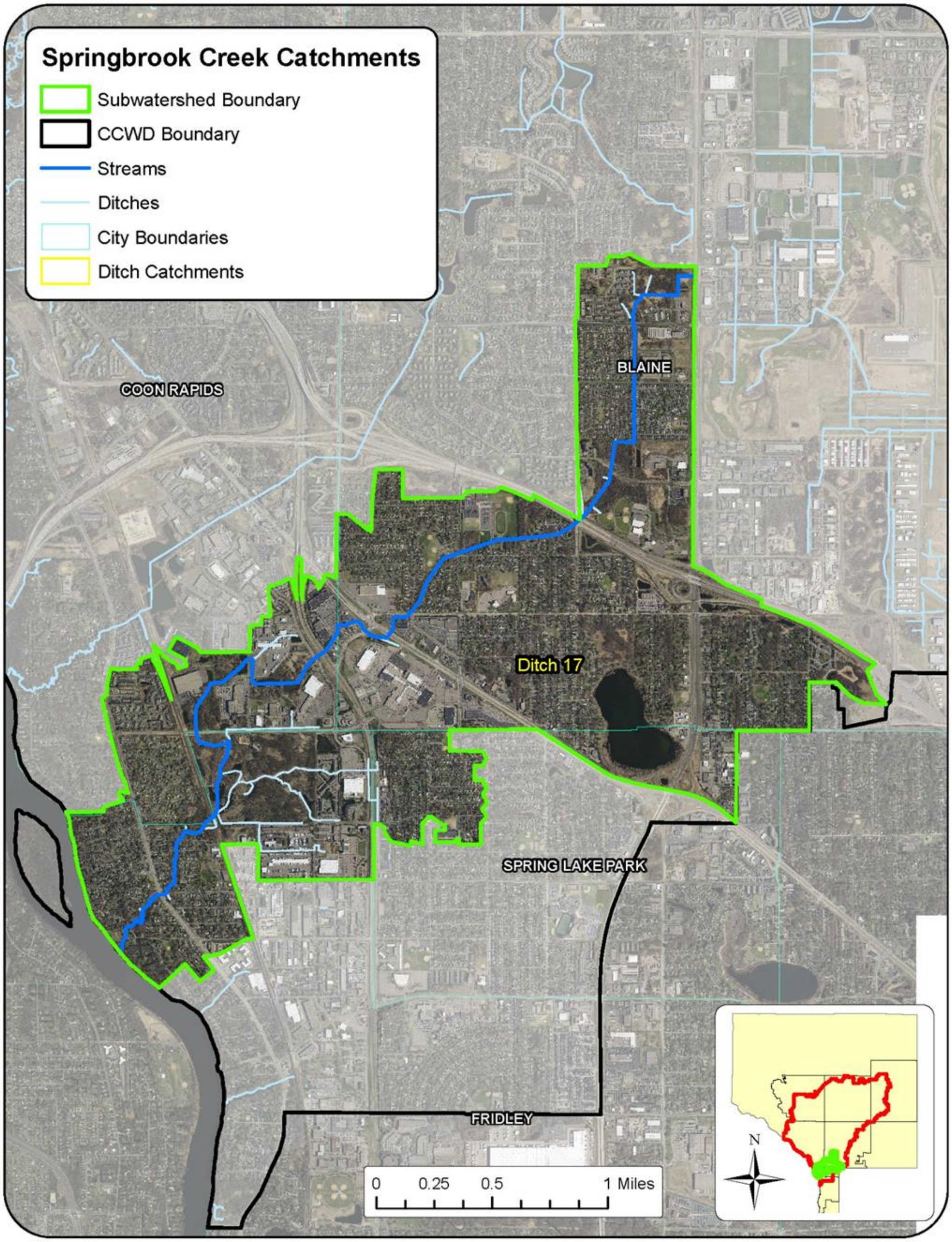
Percentiles	2007	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Min	821.73	821.63	821.60	821.34	821.95	822.17	821.18	820.99	820.75	820.87	820.74	820.69
2.5%	821.77	821.69	821.63	821.38	821.98	822.20	821.26	821.01	820.91	820.89	820.78	820.74
10.0%	821.84	821.77	821.73	821.42	822.02	822.27	821.31	821.06	820.97	820.93	820.86	820.81
25.0%	821.95	821.80	821.78	821.45	822.26	822.46	821.40	821.13	821.03	820.98	820.91	820.85
Median (50%)	822.10	821.93	822.04	821.57	822.34	822.54	821.48	821.21	821.11	821.03	820.99	820.91
75.0%	822.32	822.04	824.67	821.82	822.46	822.61	821.59	821.29	821.20	821.18	821.06	821.09
90.0%	822.49	822.19	824.67	821.98	822.56	822.70	821.69	821.43	821.27	821.27	821.14	821.16
97.5%	822.63	822.33	824.67	822.19	822.61	822.81	821.82	821.52	821.69	821.43	821.37	821.30
Max	823.79	823.25	824.67	822.70	823.04	825.33	822.81	821.99	822.49	822.30	822.25	822.49



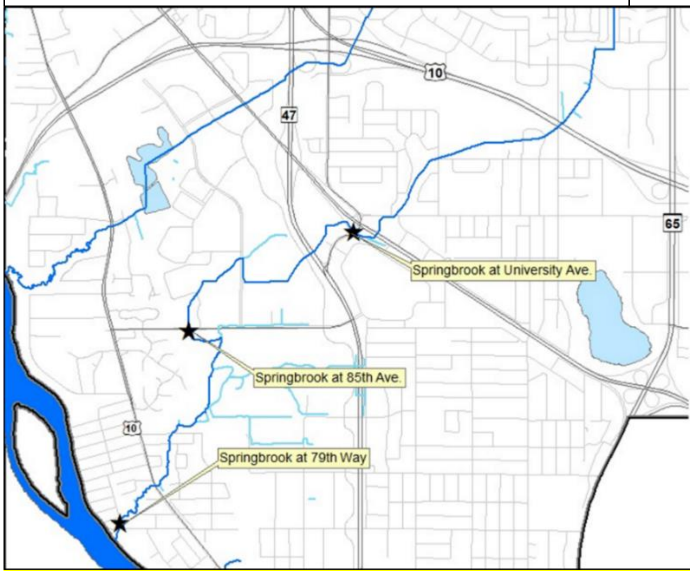
Rating Curve (2021, 2022 flow measurements included)



Water Quality & Hydrology Monitoring – Springbrook Creek Subwatershed



Springbrook Creek (Ditch 17) Monitoring Sites		
Site Name/ SiteID	**Years Monitored**	**2022 Data Collected**
Springbrook at University S007-542	2013-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements
Springbrook at 85th Avenue S007-543	2013-2020	
Springbrook at 79th Way S006-140	2012-2022	Water Chemistry Grab Samples, Continuous Stage, Flow Measurements



SPRINGBROOK CREEK SUBWATERSHED BACKGROUND

Springbrook Creek (Ditch 17) is a small waterway draining a highly urbanized and 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 Blaine, Coon Rapids, Spring Lake Park and Fridley. The main channel of Springbrook Creek flows approximately 5 miles from a small ditched wetland north of 99th Ave. (Blaine), through the southeastern corner of Coon Rapids, a wetland impoundment in the Springbrook Nature Center (northern Fridley), and finally to the Mississippi River. Several small ditch tributaries and numerous subsurface stormwater conveyance systems contribute to Springbrook Creek, with many branches joining at the Springbrook Nature Center. From the outlet of the nature center, the creek flows approximately 1 mile in a meandering channel to its confluence with the Mississippi River. At its outlet, Springbrook Creek is about 10 ft. wide and 1 ft. 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 part 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 the MPCA and the City of Fridley. During this large-scale effort, several projects to improve stormwater treatment and rehabilitate the nature center were installed. Water quality monitoring efforts during this time period produced only a small amount of usable data, but still indicated water quality and hydrology problems within the system. Routine monitoring of this creek has taken place since 2012 at the three monitoring sites mapped above, and the CCWD has installed additional water quality improvement projects.

SUMMARY

Springbrook Creek, like other creeks in the watershed, is impaired for aquatic recreation (due to *E. coli*) and invertebrate biota (with TP, altered hydrology, and poor habitat identified as the main stressors). Unlike the other streams in the Coon Creek TMDL, Springbrook Creek does not have TSS identified as a stressor to stream biota and therefore does not have a load duration curve (LDC) for that parameter. Springbrook Creek was also assigned a pending 2024 impairment for chlorides.

TP concentrations are high in Springbrook Creek, especially during storms events. The average concentration for all TP samples collected at 79th way is 101.5 µg/L, slightly exceeding the state standard of 100 µg/L. The average TP concentration for all storm samples collected at this site is 136 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 of 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 if regularly assessed.

E. coli levels are high in Springbrook Creek. The chronic standard concentration of 126 MPN is exceeded at the 79th Way site 64% of the time during baseflow conditions and 92% of the time during storms. 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. The TMDL attributes the majority (89%) of *E. coli* loading in Springbrook Creek to domestic dogs, but this assumption may be underrepresenting the contribution of waterfowl or other sources such as leaky sanitary sewer infrastructure.

Chlorides were sampled at CCWD stream outlet monitoring sites in 2019, 2021 and 2022, with Springbrook Creek having higher concentrations than other streams in the watershed. Springbrook Creek at 79th Way did not exceed the state standard (230 mg/L) in any of the grab samples in 2022. In 2022 chloride concentrations at the 79th Way site averaged 191.75 mg/L during all conditions. Chloride concentrations averaged 176.85 mg/L for all years and all conditions. 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; winter and spring samples were in exceedance of state standards, prompting a 2024 impairment designation by MPCA. Chlorides are a particularly problematic pollutant to aquatic life and in drinking water.

RESULTS AND DISCUSSION

SPECIFIC CONDUCTIVITY AND CHLORIDES

Springbrook Creek dissolved pollutant levels as measured by specific Conductivity are higher than other streams in the Coon Creek Watershed. The long-term median for specific Conductivity in Springbrook at 79th Way during all conditions is 0.97 mS/cm. By contrast, the median for Coon Creek at Vale St. is 0.663 mS/cm. Median specific Conductivity at 79th Way (all years) is lower during storm events (0.863 mS/cm) compared to baseflow conditions (1.043 mS/cm).

Chlorides are one likely significant component of of dissolved pollutants that cause high Conductivity. In 2022 chloride concentrations averaged 180.26 at the 79th Way site and never exceeded the chronic (230 mg/L) or acute (860 mg/L) state standard, during baseflow conditions or storm. It is worth noting that no monitoring occurred during active snowmelt when chlorides are usually at their highest concentrations following the winter season. 2019 winter and spring data did reveal exceedances.

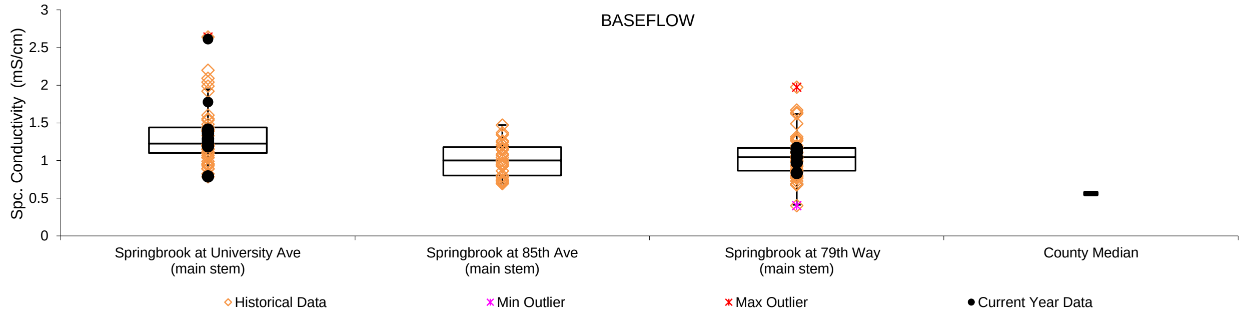
Dissolved pollutants in Springbrook Creek are lower during storm flows, suggesting that the local shallow groundwater is a contributing pollutant source during baseflow conditions. Chlorides in the shallow groundwater that feeds Springbrook Creek appear to be a problem, causing higher concentrations in this creek compared to other waters in the watershed. Greater road densities and a long history of aggressive road salting practices contribute to high chloride levels. Chlorides are persistent in the environment and not effectively removed by stormwater treatment. They migrate into the shallow groundwater that feeds the stream during baseflow. The fact that high concentrations of dissolved pollutants are found during storm flows in Springbrook Creek, suggest that stormwater runoff from impervious surfaces into the stream is also problematic or mixing and release from in-line ponds.

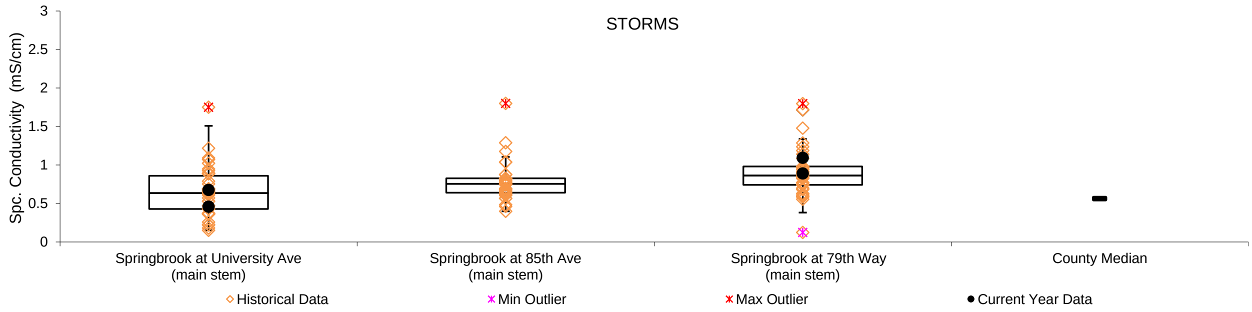
Dissolved pollutants are especially difficult to manage once released into the environment. They are not removed by stormwater settling ponds and infiltration practices can provide some treatment through biological processes in the soil, but this risks contaminating groundwater. The first priority for dissolved pollutant management must be to minimize their release into the environment.

Average and median specific Conductivity in Springbrook Creek. Data is from 79th Way for specific Conductivity and chlorides all years through 2022.

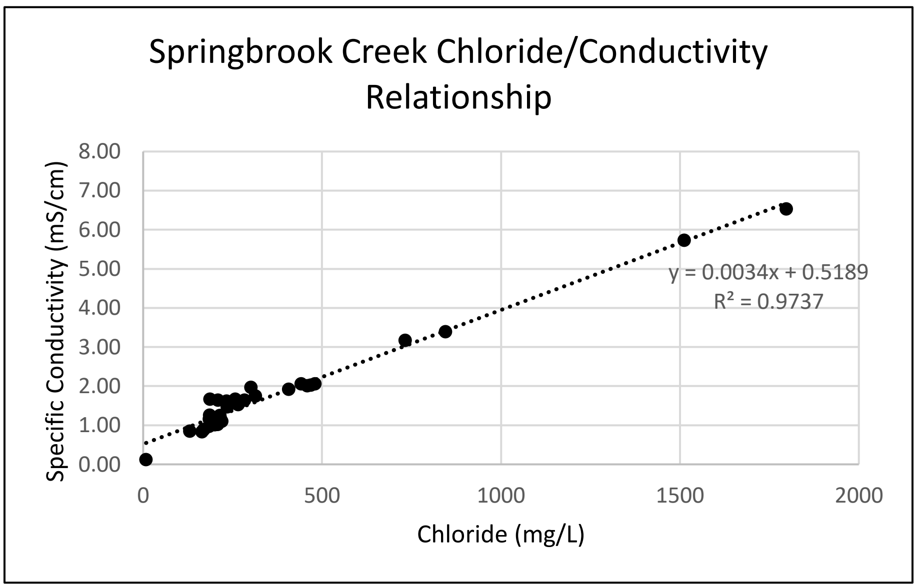
	Average Specific Conductivity (mS/cm)	Median Specific Conductivity (mS/cm)	Average Chlorides (mg/L)	Median Chlorides (mg/L)	State Standard	N
Baseflow	1.05	1.04			Specific Conductivity – none	57
Storms	0.92	0.86				42
All	0.99	0.97				99
Occasions > State Standard						0

Specific Conductivity at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.





Specific Conductivity/Chloride Relationship at Springbrook Creek. In the Springbrook Creek system, conductivity measurements equal to or greater than 1.301 mS/cm indicate an exceedance of the State standard for Chloride (230 mg/L).



TOTAL PHOSPHORUS

Springbrook Creek often exceeds the TP state standard (100 µg/L) during storm events across its entire length. The average of all storm TP samples collected at the 79th Way site is 136 µg/L. During baseflow conditions, TP levels exceed 100 µg/L most of the time at Springbrook at University Avenue, but are typically below 100 µg/L further downstream, averaging 75 µg/L.

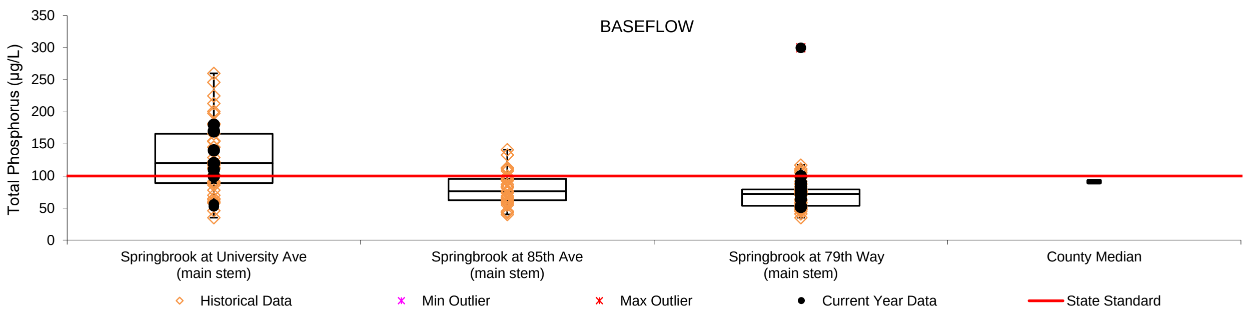
There is an apparent decrease in TP levels moving upstream to downstream during baseflow conditions. Long-term median concentrations at baseflow for the three sites are 120 µg/L, 70 µg/L, and 83.5 µg/L respectively. This suggests that implemented water quality projects are effectively removing phosphorus from the Springbrook Creek system. One likely source providing a large amount of stormwater treatment is the expansive pond and wetland complex located in the vicinity of Evergreen Blvd and within Springbrook Nature Center. Overall, the Springbrook Creek system is doing a decent job of maintaining healthy TP levels and remaining below the state standard during baseflow at the outlet site. However, during stormflow, TP levels often exceed the state standard and are consistently high at both the upstream and downstream monitoring sites, with a slight decline in the middle portion of the watershed at 85th Avenue. These data infer that the Springbrook Nature Center wetland complex and other stormwater treatment practices in the area are possibly undersized or underperforming for the volume of water and pollutant loading during the larger storm events. Phosphorus-rich stormwater may also be entering the system downstream of the Springbrook Nature Center. It is possible that one or several of the basins are leaching phosphorus by the process of internal loading and flushing. Adding additional capacity for stormwater treatment is advised, but the limited available space in this already developed area presents a challenge. Following storm events, TP concentrations at the 79th Way site exceed state standards 69% of the time.

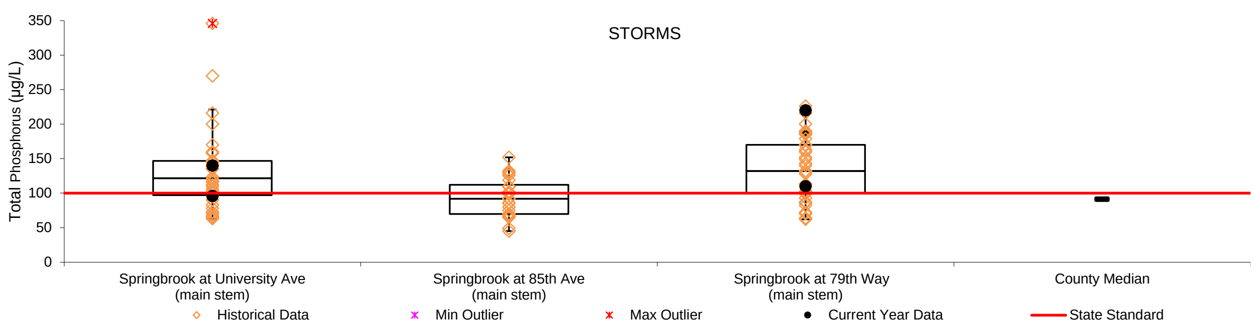
Supplemental ortho-phosphorus (OP) samples were collected 2021- 2022 at the outlet of Springbrook Creek. The average OP concentration during baseflow was 50% (range=17-78%) of average TP. During storms, the average OP concentration was 8% (range=3%-13%) of average TP. OP was also recorded at high levels at the Springbrook at University Avenue site in 2022, with an average OP concentration during baseflow of 62% of average TP and 37% during storms. In previous years' samples for OP and TP have also been collected at the outlet of Springbrook Nature Center revealing an average OP concentration of TP to be only 20%, indicating the OP issue may be occurring both upstream of University Ave and between the Springbrook Nature Center and the outlet of Springbrook Creek. The MN Stormwater Manual reports the national average Ortho Phosphorus concentration as a percentage of TP to be 26% indicating Springbrook Creek is considerably higher than the national average. Excess dissolved oxygen may point to release from sediments, leaching from organic matter (e.g. organic debris on roads or in sumps), or leaky sanitary infrastructure.

Average and median total phosphorus in Springbrook Creek. Data is from 79th Way for all years through 2022.

	Average Total Phosphorus (µg/L)	Median Total Phosphorus (µg/L)	State Standard	N
Baseflow	74.67	72.0	100	54
Storms	135.98	132.00		42
All	101.49	83.50		96
Occasions > state standard				5 (9%) baseflow 29 (69%) storm

Total phosphorus at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.

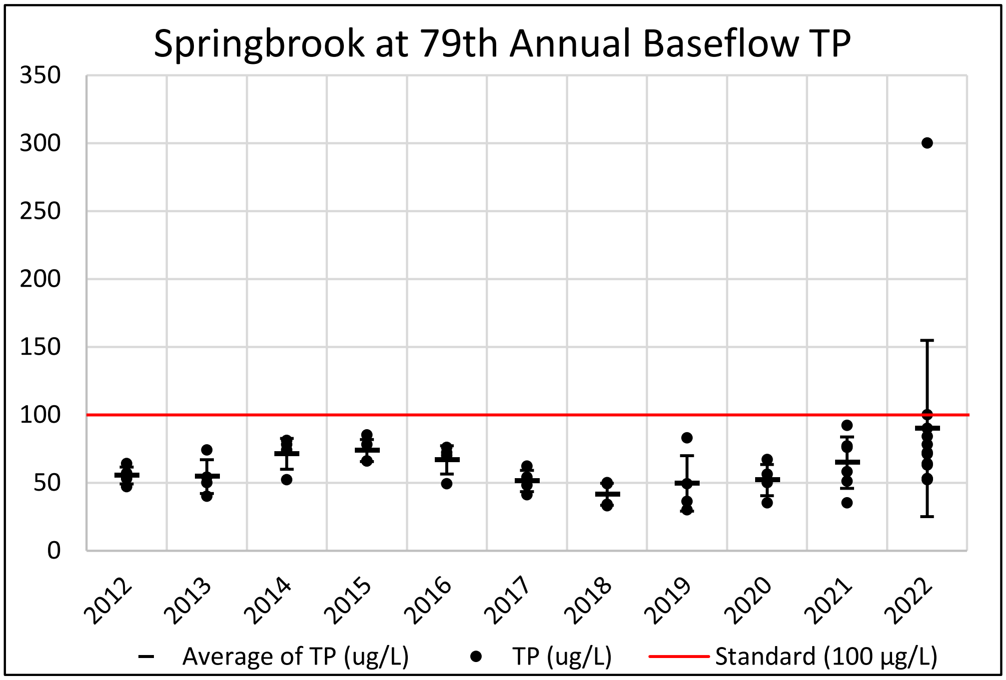


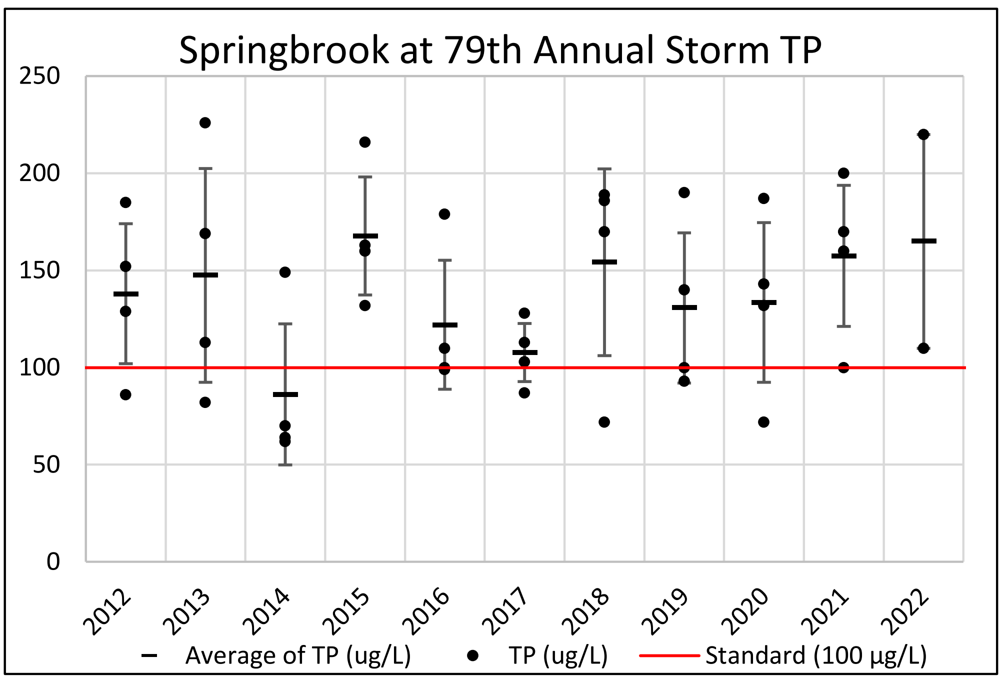


Springbrook Trend Analysis

Parameter	Significant Change in Annual $\bar{X}$ (2012-2022)	p=	Standard Error of Means
Total Phosphorus - Baseflow	None	0.59	14.36
Total Phosphorus - Storm	None	0.31	24.45

Springbrook at 79th - Annual average ANOVA regression TP 2012-2022





Total Suspended Solids

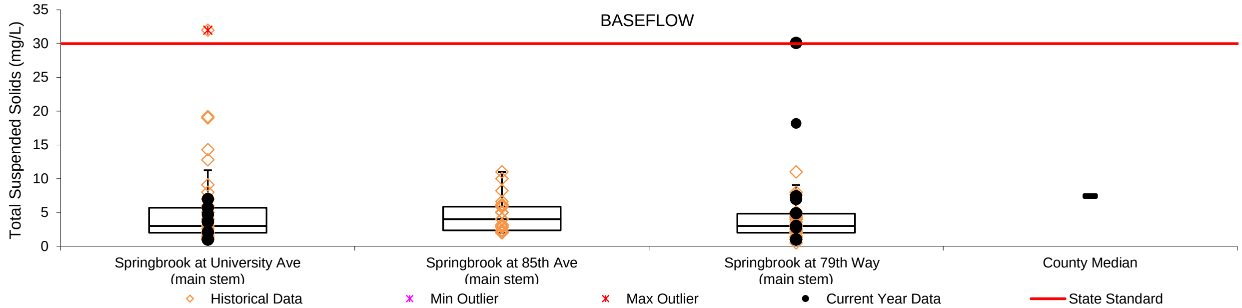
TSS levels in Springbrook Creek are typically low during baseflow conditions and elevated following storm events. During baseflow conditions TSS concentrations are low at all of the Springbrook monitoring sites, and remain low following storm events at the two upstream sites. Interestingly, there is a large increase in TSS concentrations during stormflow between the 85th Ave and the 79th Way sites. The area between the sites contains a wetland complex that is potentially being filled in with sediment that is then re-suspended and flushed through the system during larger storm events. Undertreated stormwater runoff and/or bank and streambed erosion downstream of the Springbrook Nature Center could also be influencing the elevated TSS levels at the 86th Ave site. After storms, TSS concentrations at 79th way exceed the 30 mg/L state standard 26% of the time.

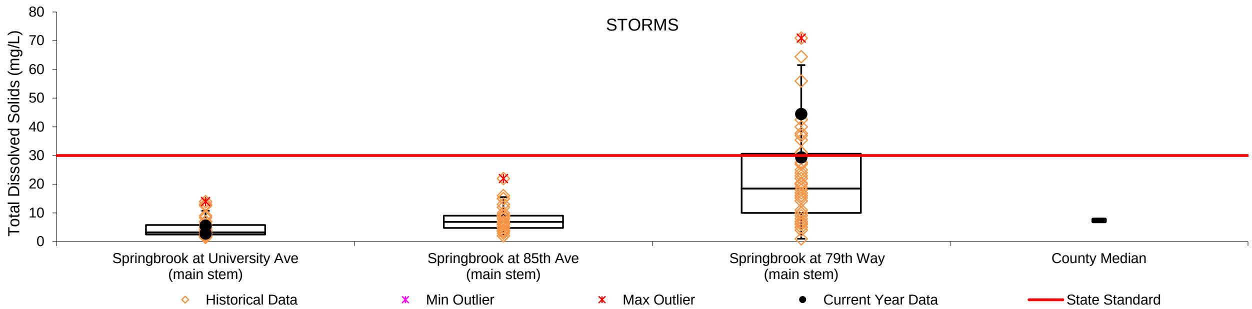
Based on long-term average concentrations, TSS does not increase upstream-to-downstream during baseflow but does increase during storm flow. The long-term (all years) medians for TSS concentrations storms are 3.2 mg/L, 6.9 mg/L, and 18.50 mg/L, moving upstream to downstream. The largest likely contributor of TSS loading to Springbrook Creek are solids transported by stormwater conveyances from impervious surfaces. There are no significant trends in long-term TSS concentrations at the outlet monitoring site over time.

Average and median total suspended solids in Springbrook Creek. Data is from 79th Way for all years through 2022.

	Average Total Suspended Solids (mg/L)	Median Total Suspended Solids (mg/L)	State Standard	N
Baseflow	3.98	3.00	30 mg/L TSS	54
Storms	22.42	18.50		42
All	12.05	5.00		96
Occasions > state TSS standard				1 (2%) baseflow 11 (26%) storm

Total suspended solids at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.

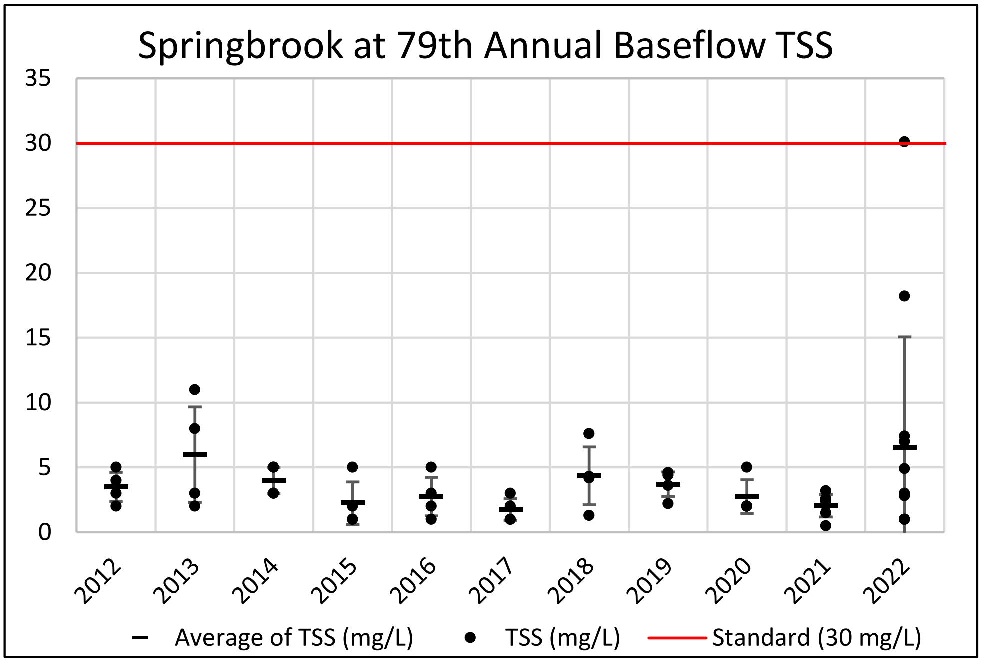


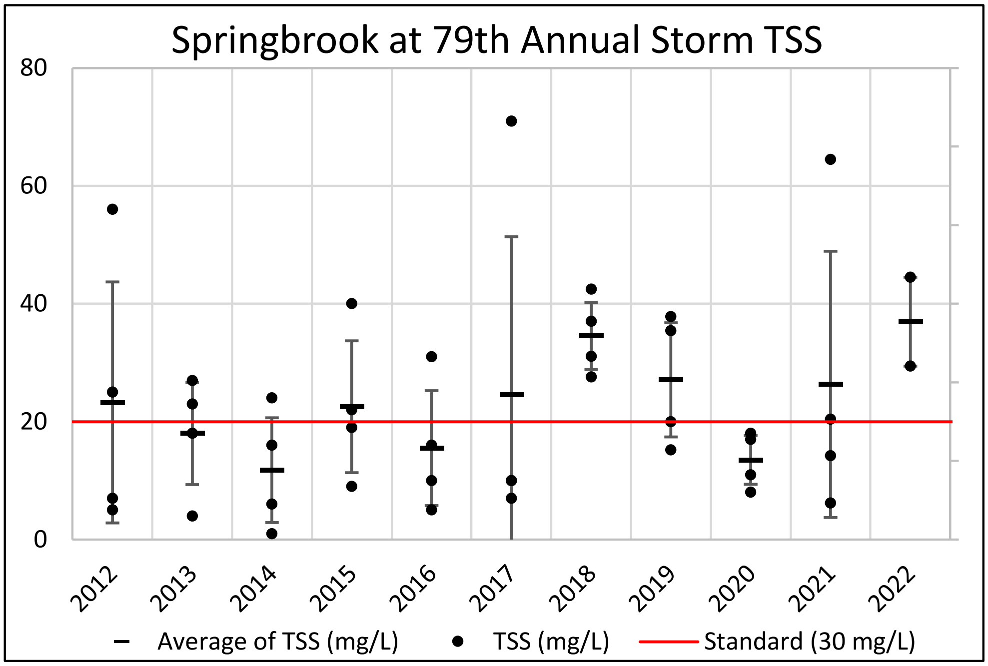


Springbrook Trend Analysis

Parameter	Significant Change in Annual $\bar{X}$ (2012-2022)	p=	Standard Error of Means
TSS - Baseflow	None	0.46	4.28
TSS - Storm	None	0.58	17.50

Springbrook at 79th - Annual average ANOVA regression TSS 2012-2022





pH

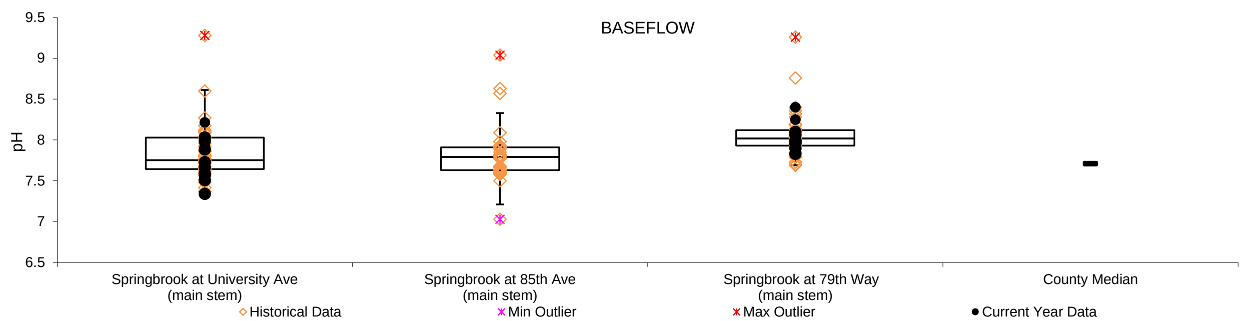
Springbrook Creek generally maintains healthy pH levels within the range of 6.5-8.5. A few readings have exceeded 8.5 but these have been rare and are not a management concern at this time.

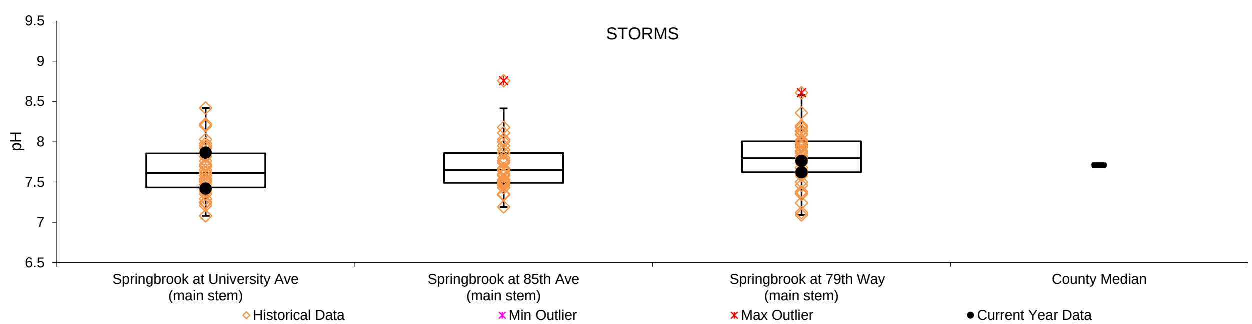
Average and median pH in Springbrook Creek. Data is from 79th Way for all years through 2022.

	Average pH	Median pH	State Standard	N
Baseflow	8.05	8.02	6.5-8.5	57
Storms	7.80	7.80		42
All	7.94	7.96		99
Occasions outside state standard				*****2 (4%) Baseflow 1 (2%) Storm

**one result questionable*

pH at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.





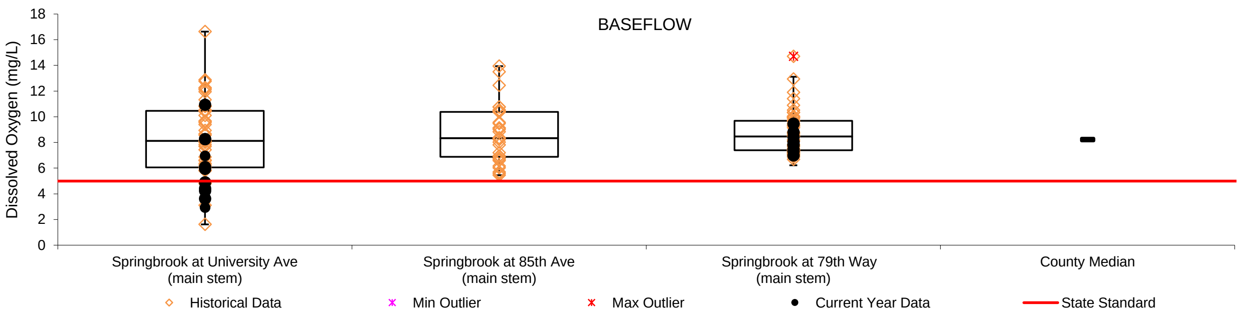
DISSOLVED OXYGEN

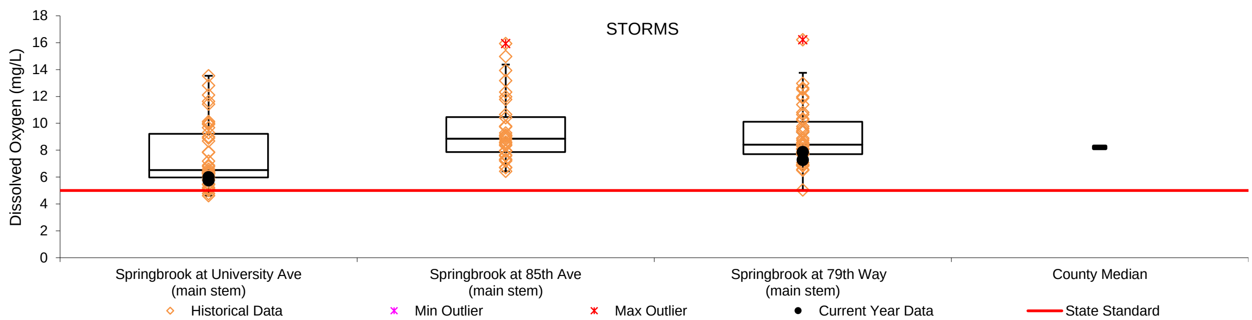
Dissolved Oxygen levels in Springbrook Creek are generally high, but not within Springbrook Nature Center basins. Within the creek, the only instances of low oxygen have been a few measurements furthest upstream (University Ave.) in which DO has been recorded below or near 5 mg/L. CCWD has collected supplemental DO measurements at the outlet of the Springbrook Nature Center as part of their BMP performance monitoring program; here, DO levels routinely fall below the 5 mg/L standard and have been observed below 1 mg/L. Low DO levels in the reservoirs at the Springbrook Nature Center could lead to internal TP loading and release.

Median dissolved oxygen in Springbrook Creek. Data is from 79th Way for all years through 2022.

	Average Dissolved Oxygen (mg/L)	Median Dissolved Oxygen (mg/L)	State Standard	N
Baseflow	8.71	8.46	5 mg/L daily minimum	55
Storms	9.01	8.42		42
All	8.84	8.46		97
Occasions <5 mg/L				0

Dissolved Oxygen at Springbrook Creek. Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites.





E. COLI

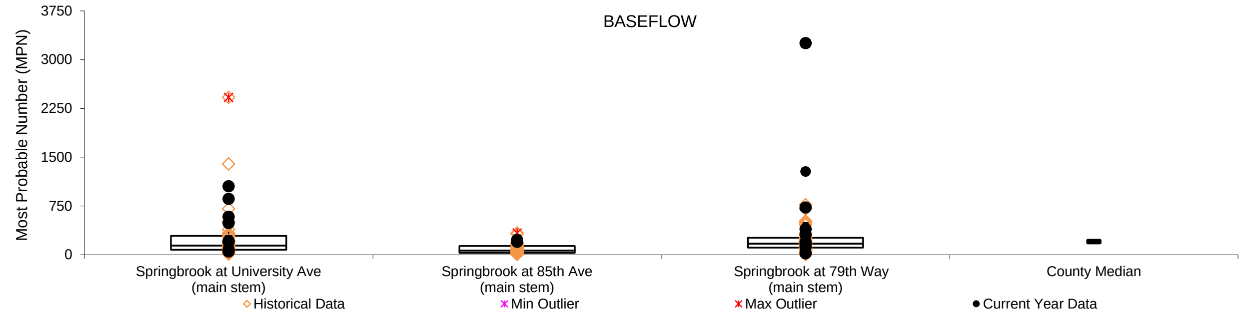
E. coli concentrations during baseflow conditions are usually near the chronic standard of 126 MPN at all of the Springbrook Creek monitoring sites. Only 2 of the 141 baseflow samples collected since 2013, have exceeded the acute standard of 1260 MPN (Springbrook at University Ave). Interestingly, during baseflow conditions, median *E. coli* concentrations since 2013 decrease between University Ave. (140 MPN) and 85th Ave (68.5 MPN). Ponds and wetlands between the two sites seem to be providing some level of treatment during baseflow conditions. However, *E. coli* concentrations tend to rebound again between the 85th Ave and 79th Way sites (171.45 MPN).

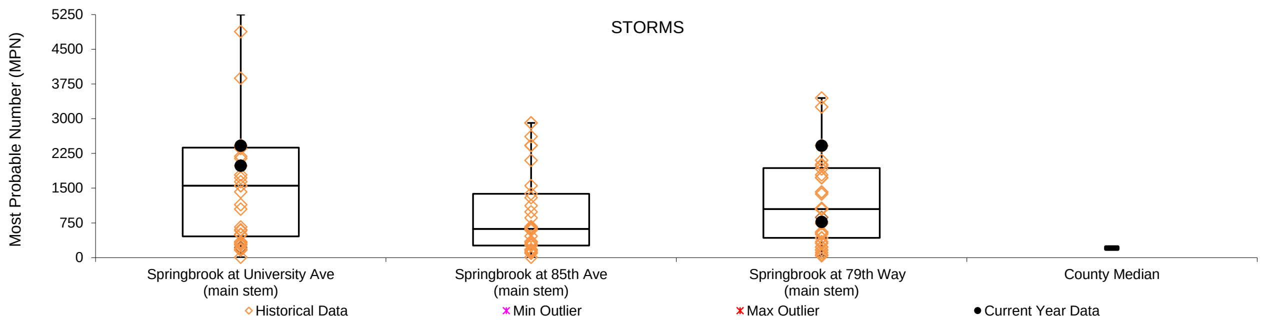
After storm events, *E. coli* tends to be significantly higher (note the difference in scale on the charts below), but the same pattern remains between the sites with the middle site (85th Ave) having lower levels than the upstream site (University Ave) and downstream site (79th Way). Median *E. coli* concentrations following storm events, all years upstream to downstream, were 1553.1 MPN, 620 MPN, and 1046 MPN, respectively. These levels are all quite high and should be concerning. Storm samples collected at 79th Way site has exceeded 126 MPN 93% of the time and nearly half (43%) of the samples have exceeded the acute standard of 1260 MPN.

Average and median *E. coli* in Springbrook Creek. Data is from 79th Way for all years through 2022.

	Average *E. coli* (MPN)	**Median *E. coli* (MPN)**	**Geometric Mean**	**State Standard**	**N**
Baseflow	287.92	171.45	156.71	Monthly Geometric Mean >126	54
Storms	1,212.94	1,046.00	789.80		40
All	681.54	260.50	312.20	Monthly 10% average >1260	94
Occasions >126 MPN					35 (65%) baseflow, 37 (93%) storm
Occasions >1260 MPN					2 (3%) baseflow, 17 (43%) storm

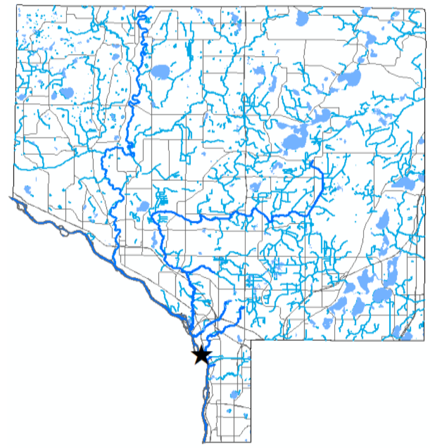
***E. coli* at Springbrook.** Orange diamonds are historical data from previous years and black circles are 2022 readings. Box plots show the median (middle line), 25th and 75th percentile (ends of box), and 10th and 90th percentiles (floating outer lines) for all data collected at these sites. Extremely high outliers were not included in the box-plots





STREAM HYDROLOGY – SPRINGBROOK CREEK

SPRINGBROOK AT 79TH WAY



Notes

Springbrook Creek at this site is flashy, with water levels rising quickly during rainfall and receding quickly. Throughout the 2022 season, the creek at this site only fluctuated 2.56ft between its highest and lowest recorded stage. This was the second smallest fluctuation on record. Stage units are displayed in decimal feet for this site because a survey elevation was unable to be collected where the sensor was located. Stage data for 2022 was intermittent due to low water level and equipment failure

2022 Hydrograph