BROWN'S CREEK WATERSHED DISTRICT

455 HAYWARD AVE N
OAKDALE, MN
55128

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WWW.BCWD.ORG

REGULAR MEETING OF THE BOARD OF MANAGERS
Wednesday, May 10, 2023 at 6:30 PM

NOTE MEETING LOCATION
Regular Board Meeting will be held at
Family Means
1875 Northwestern Ave, Stillwater, MN 55082

1) Call Regular Meeting to order @ 6:30PM

2) Approve Regular Meeting Agenda and Discussion Agenda **-Board Action**

3) Public Comments

4) Consent Agenda – **Board Action** (*all items listed under the consent agenda are considered to be routine by the Board of Managers and will be enacted by one motion. There will be no separate discussion on these items unless a Manager removes an item from the consent agenda for discussion or there is a request to remove the item from the consent agenda, in which event the board will consider whether to remove the item from the consent agenda and consider it separately*.)
   a) Approve Board Meeting Minutes of the April 12, 2023 Regular Meeting
   b) Accept Permit Fee Statement
   c) Approve flood risk assessment and community meetings scope for Benz, North School Section, South School Section, and Goggins Lakes
   d) Approve scope to develop Applewood Hills reuse project operations and maintenance plan
   e) Approve registration and expenses for staff, as well as per diems for managers for MN Watershed Summer Tour June 20-21 in Albert Lea, MN
   f) Approve registration and expenses for staff, as well as per diems for managers for the St. Croix River workshops on the water

5) Treasurer's Report
   a) Review Authorized Funds Spreadsheet
   b) Current Items Payable-**Board Action (Roll Call Vote)**

6) Permitting
   a) BCWD Permit 23-03 Boutwell Farms/Greenhalo Builds LLC – Violation Hearing – **Board Action**

7) Project
   a) Water Quality Monitoring Summary – 2022 data and long term trends presentation – Aaron DeRusha, WCD
   b) Biological Stream Monitoring
      (1) Presentation 2022 data and long term trends- Joel Chirhart, MPCA & Mike Majeski, EOR
      (2) 2023 Scope – **Board Action**
   c) Brown's Creek Stream Assessment: Headwaters to Manning Avenue – Mike Majeski, EOR
   d) THPP infiltration trench inspection results and next steps **- Board Action**

8) Discussion Agenda - No Action Required
   a) Updates
      (1) Administrator –Board/CAC Tour August 30th at 5:30-8pm
      (2) Legal
      (3) Engineer
         (a) BCWD Permit 23- Stillwater Oaks – initial proposed project presentation
         (b) Permit Inspection Update
      (4) Managers
   b) May 2023 Regular Meeting BCWD Board Agenda

9) Adjournment

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DRAFT Minutes of the workshop and regular meeting of the Brown's Creek Watershed District Board of Managers, Wednesday April 12, 2023

ROLL CALL

Managers Present:	**Others Present:**
Klay Eckles, President	Karen Kill, BCWD administrator
Celia Wirth, Vice President	Camilla Correll, EOR, BCWD engineer
Charles LeRoux, Secretary	Michael Welch, Smith Partners, BCWD counsel
Gerald Johnson, Treasurer	Cameron Blake, BCWD staff
	Matt Hegland, EOR, BCWD engineer
	John Sarafolean, EOR, BCWD engineer
	Stu Grubb, EOR, BCWD engineer
	Michael Givens, Mikden of Stillwater
	Shari Ahrens, Westwood
	Tyler See, Abdo, BCWD auditor

1) Call Regular Meeting to order

Vice President Celia Wirth called the regular meeting to order at 6:30 p.m.

2) Approve Regular Meeting Agenda and Discussion Agenda

Manager Johnson moved, seconded by Manager LeRoux, to approve the agenda as presented. Motion carried, vote 4/0.

3) Public Comments

There were no public comments.

4) Consent Agenda

Michael Welch noted a couple of nonsubstantive corrections and edits needed for the newsletter and annual report. Manager Eckles commented that he was happy to see another new member for the Citizen Advisory Committee.

Manager Eckles moved, seconded by Manager Johnson, to approve the consent agenda with the recommended changes to the newsletter and annual report:

a) Approve minutes of the February 8, 2023 workshop & regular meeting
b) Approve minutes of the March 8, 2023 regular meeting
c) Accept permit fee statement
d) Appoint Aimee Eberle to the Citizen Advisory Committee
e) Approve newsletter for distribution

f) Approve annual report for distribution
g) Approve community event scope
Motion carried 4/0.

5) Treasurer's Report

a) Review Authorized Funds Spreadsheet

Manager Johnson moved, seconded by Manager LeRoux, to accept the authorized funds spreadsheet as presented. Motion carried, vote 4/0.

b) Current Items Payable

Manager Johnson moved, seconded by Manager Wirth, to approve the payment of bills as presented in the amount of $76,795.14.

	Yea	Nay	Abstain	Absent
Manager Eckles	X			
Manager Johnson	X			
Manager LeRoux	X			
Manager Wirth	X			

Motion carried 4/0.

c) 2022 Audit Presentation

Tyler See presented the results of the 2022 audit. The auditor has drafted an unmodified opinion, which Mr. See explained indicates no violation findings. There were two internal control findings. First was preparation of the financial statements are done by the auditor and not separately audited, which is common for an organization of BCWD's size. The second was for a material audit adjustment resulting from a change in the recommended approach to capital asset valuation. A previous auditor had recommended all capital improvement projects be added to BCWD's capital-asset list, but this is being changed to only those elements that the BCWD owns, which is significantly fewer.

Manager Wirth moved, seconded by Manager Johnson, to accept the 2022 audit and authorize Administrator Kill to instruct the auditor to submit the final report to the Board of Water and Soil Resources. Motion carried, vote 4/0.

6) Permitting

a) BCWD Permit 23-05 Rocket Carwash

Camilla Correll presented the BCWD engineer's report on permit 23-05. The plan includes stormwater basins and landscaping that will provide volume control through evapotranspiration. Stormwater reuse is not being proposed due to limited green space to utilize the water for irrigation on site. Ms. Correll clarified the applicant's evapotranspiration values assume plants at full maturity.

Manager Eckles stated that he felt comfortable with assuming full maturity for the calculation even though it may take more than 10 years for the plants to reach that stage. The board expressed interest in the landscaping have a significant native plant composition. The board discussed the benefits the green space would provide to this area. Manager Eckles inquired as to the snow management plan for the site noting that this

could impact the long-term success of the landscape and plantings. Michael Givens, the property owner, explained the snow would be managed on a different part of the site. The board discussed the need for a long-term maintenance plan for the plantings.

The board proposed requesting that 50% of the planting plan be native species. Mr. Welch recommend the board include this as a recommendation rather than a condition of approval.

Mr. Welch clarified the definition of "the site" for this project and the overall re-development is the 9.52-acre property of record at the time of the initial application for work on the property. If redevelopment surpasses 50 percent of the site in the future, the applicant will be required to manage stormwater for the entire site. The work for both Caribou and the Rocket Carwash will be included in the total redevelopment calculation. Mr. Givens acknowledged his understanding of this basis for future review and permitting. He also noted that the maintenance declaration for this permit will need to include performance metrics that would ensure the landscaping is achieving the proposed evapotranspiration benefits.

Manager Eckles moved, seconded by Manager Johnson, to approve permit 23-05 and the variances, with the stipulations and conditions in the engineer's report, and to recommend the landscape plan include 50 percent native species. Motion carried 4/0.

Mr. Givens thanked the board and confirmed his long-term interest in making sure the landscaping is maintained.

7) Projects

a) Groundwater Pump Test – initial findings and recommendations

Stu Grubb presented that groundwater and pumping data near Brown's Creek was being analyzed to identify a strategy for the groundwater pumping test the board approved in 2022. Engineers discovered a drawdown effect of Oak Glen Golf course's high capacity wells on the aquifer that provides groundwater to Brown's Creek.

Manager Eckles questioned why engineers are proposing further investigation and why the district would get further involved in this issue. He suggested this issue may already be being addressed with the stormwater reuse project that was operational for the first time last year. Mr. Grubb explained the drawdown effect could be more impactful than just the removal of a certain volume of groundwater and could explain some unusual measurements of groundwater leaving Brown's Creek in the lower reaches of the gorge. Ms. Correll explained that because Brown's Creek is a groundwater-dependent natural resource with a thermal impairment, the baseflow of groundwater to the creek is of high importance to the health of the creek and its coldwater fishery. There could be opportunity to work with Oak Glen in developing a pumping and irrigation management strategy that would lower the impact of these high-capacity wells on Brown's Creek and benefit the resource. The proposed analysis would provide data that would refine the district's understanding of the groundwater in this area and lead to greater understanding of effective projects and management techniques for the creek.

The board agreed there could be a mutual benefit for the golf course and BCWD to work together with these data to benefit the creek. Manager Eckles explained his hesitation on looking for an issue that is not currently a major problem and his concern that collecting data for a groundwater model could be a bigger investment than makes practical sense for the district. He is also reluctant to alienate the golf course, which has been a good partner in working with the district on current and previous projects and wondered why other high-capacity wells in the aquifer were not being proposed for analysis. Ms. Kill clarified that she already confirmed the Department of Natural Resources is not interested in getting involved with this from a groundwater-appropriations perspective. DNR is interested in understanding more about the groundwater system in this area.

The board inquired as to next steps. Mr. Grubb agreed the engineers could look into the cumulative effect of other high-capacity wells in the area and provide ideas for management strategies that could be implemented to lessen the impact of these wells on the aquifer and Brown's Creek. The district could also reach out to the DNR to see if staff there are interested in installing another observation well in this area.

District staff confirmed they were not approaching this as an investigation into the golf course with intent to address this from a regulatory perspective. Mr. Welch agreed that this would not be his recommendation. The goal would be to identify management options the golf course could choose to apply which would also benefit the creek. Ms. Correll stated that the board direction is clear.

8) Discussion Agenda

a) Updates

(1) Administrator

a. Permit Fee Structure

Ms. Kill said she met with the board treasurer to discuss some of the current permitting fee policies of the district. Staff have begun analysis comparing the BCWD policies to other watershed districts in the metro area. The next step would be meeting with legal counsel to bring recommendations for the board to consider.

b. 72nd Street Road Improvements

Ms. Kill updated the board regarding the city of Stillwater's permit application for 72nd Street road improvements, which will be an erosion control permit subject to administrative approval. The project does not trigger stormwater management. Staff are not applying the buffer rule because the 2017 lot rearrangement, which delineated the city's right-of-way along 72nd Street, was a process of formalizing an existing prescriptive easement over a road that was in place prior the BCWD establishing rules.

c. Citizen Advisory Committee Watershed Tour

The Citizen Advisory Committee has requested a tour of historic projects in the watershed. The board was interested in attending as well. Ms. Kill will find a date.

d. Other

Ms. Kill updated the board that the Carnelian Marine St. Croix Watershed District/Brown's Creek Watershed District boundary update is on the Board of Water and Soil Resources May 24 agenda. County commissioners are meeting next Tuesday to discuss all vacant board positions, including the vacant position on the BCWD board. She suggested board members reach out to anyone they know who may be interested in applying. EOR and DNR staff met to discuss design of the Brown's Creek restoration project and the DNR provided good feedback. Ms. Kill will be following up with Mr. Welch to determine if an Environmental Assessment Worksheet will be needed.

(2) Legal

Mr. Welch explained the limited liability chloride state legislation is not going forward this session due to concerns with the operation of the liability limitation. The plan is to reconvene after this legislative session and strategize about a different way to approach chloride-use reductions.

(3) Engineer

No discussion.

(4) Managers

The board discussed flooding projections for the St. Croix River and whether the district could expect any impact on any capital infrastructure. Manager Eckles discussed the diversion drainage structure and the background of city management of the control structure at the end of McKusick Lake.

9) Adjournment

Manager Johnson moved, seconded by Manager Wirth, to adjourn the regular meeting at 8:57 p.m. Motion carried 4/0.

Respectfully submitted by
Cameron Blake, BCWD staff and Charles LeRoux, Secretary

BROWN'S CREEK WATERSHED DISTRICT 5/4/2023 APPLICANT/PERMIT NO.	PERMIT DATE	RULES							TYPE				FEES OWED	
		2	3	4	5	6	7	Decomp action	GOV	SF RES	RES DEV	COM	EXEMPT	AMT DUE
Bergmann Development/Sanctuary Permit No. 05-12	10/14/2005	X	X	X			X				X			$ -
Cannon Parking - Trellis Weddings & Events Permit 11-14		X	X									X		($2,480.25)
Brown's Creek Preserve Permit 13-10		X	X	X			X				X			$10,954.70
Stillwater Medical Center Parking Permit 13-26		X	X				X					X		$3,039.10
Brown's Creek Cove Permit 15-07		X	X	X			X				X			$163.41
Heifort Hills Permit 16-03		X	X	X	X		X				X			$741.74
Farms of Grant/White Oaks Savannah Permit 17-01		X	X	X			X				X			$16,104.85
The Lakes of Stillwater Permit 17-04		X	X	X			X					X		$645.15
West Ridge Permit 17-17		X	X	X			X	X			X			($1,554.63)
Heifort Hills Estates Permit 18-02		X	X	X			X	X			X			$38,735.37
Boutwell Farms Permit 18-04A		X	X	X			X	X			X			($1,178.20)
Hazel Place/Hertiage Ridge Permit 18-05 (Was 17-09)		X	X	X			X	X			X			($2,694.60)
Nottingham Village Permit 18-06		X	X	X			X				X			$539.78
Ridgecrest Permit 18-11		X	X				X	X				X		$16.68
St Croix Valley Recreation Center Expansion Permit 18-14			X				X	X	X				$6,970.28	
Rogness Residence Permit 18-15	7/26/2018		X							X				$73.69
Central Commons Permit 19-05	11/11/2025	X	X	X			X	X				X		($5,000.00)
TC_Orthopedics Permit 20-03	8/24/2020											X		$1,388.08
Neal Ave Road Reconstruction Permit 20-05	(around June 2020?)	X	X						X				$19,029.81	
CSAH 15-36 Interchange Permit 20-08	3/24/2021 3 year approval		X			X	X		X				$19,160.35	
Wahlquist Permit 20-10	9/10/2022		X								X			($1,078.88)
White Pine Ridge	6/7/2021		X					X			X			($631.32)

APPLICANT/PERMIT NO.	PERMIT DATE	RULES						TYPE				FEES OWED	
		2	3	4	5	6	7 Decompaction	GOV	SF RES	RES DEV	COM	EXEMPT	AMT DUE
Permit 20-12	surety redution request 1/12/23												
Boutwell Farms Lot 2 Permit 21-05	5/13/2021		X				x		x				($436.54)
Boutwell Farms Lot 4 Permit 21-06	5/13/2021		X				x		x				($788.82)
Brown's Creek Cove Lot 11 Permit 21-07	5/13/2021		X						x				$238.36
Brown's Creek Cove Lot 14- 1855 White Pine Ct Permit 21-08	5/13/2021		X						x				$260.64
Westridge Block 1 Lot 1 Permit 21-09 - NOPV, no permit received	8/6/2021		X				x		x				$2,399.83
White Oak Savannah Lot 107 Permit 21-11 -Sharkey	4/8/2022		X						x				($95.36)
Maryland Gateway Addition Permit 21-13	9/29/2021	x	x				x				x		$2,535.11
Divine Custom - Heritage Ridge Lot 3- Permit 21-14	3/1/2022		x				x		x				($406.60)
Schwartz Residence Permit 21-15	5/6/2021 erosion control only	x	x						x				($319.38)
Ignagni Residence WOS B1L2 Permit 21-16	5/6/2021		x						x				($2.79)
Boutwell Farm (Lot 8)- Sharkey Permit 21-18	3/28/2022		x				x		x				($479.25)
Meron Residence-7950 Minar Ave Permit 21-19	no application		x						x			$302.57	
Westridge (Block 2, Lot 2) - Sharkey Permit 21-20	3/28/2022		x				x		x				($491.82)
Millbrook Park- City of Stillwater Permit 21-21	8/25/2021	x	x	x				x				$5,449.15	
Bond Residence Permit 21-22	8/12/2021		X	X					x				($198.11)
White Oak Savannah Lot 105- 7120 Lone Oak Trail Permit 21-24	8/18/2021		x						x				($260.56)
Juliene/Guerinno Permit 21-28	no permit fee		x						x				$469.62
Lakeview EMS Permit 21-32	pre-application		x								x	$15.50	
Fahey Permit 21-34	11/4/2021		x						x				($743.78)
White Oak Savannah B2L2 Permit 21-35	12/8/2021		x				?		x				($810.98)
White Oak Savannah B2L5 Permit 21-36	12/8/2021		x				?		x				($1,046.23)
White Pine Ridge 152 Northland Terrace Permit 21-38	sent repeatedly march/april 2022, called/made contact		x				x		x				($509.46)

APPLICANT/PERMIT NO.	PERMIT DATE	RULES						TYPE				FEES OWED	
		2	3	4	5	6	7	Decompaction	GOV	SF RES	RES DEV	COM	EXEMPT	AMT DUE
White Pine Ridge 454 Northland Terrace Permit 21-39	sent repeatedly march/april 2022, called/made contact		x					x		x				($904.46)
White Pine Ridge 507 Northland Terrace Permit 21-40	sent repeatedly march/april 2022, called/made contact		x					x		x				($906.19)
White Pine Ridge 256 Northland Terrace Permit 21-41	sent repeatedly march/april 2022, called/made contact		x					x		x				($906.19)
White Pine Ridge 559 Northland Terrace Permit 21-42	sent repeatedly march/april 2022, called/made contact		x					x		x				($906.19)
MNDOT TH-36 Permit 21-43	1/19/2022		x						x				$2,123.00	
Norell Ave N Improvements Permit 21-45	*(Fall 2022 BMP still needs to be finalized spring 2023)*	x	x				x		x				$10,183.74	
Wash Co. CSAH 15 Permit 22-01	3/142022		x						x				$971.22	
Gonyea (8 lots) Permit 22-02	sent repeatedly march/april 2022, called/made contact		x								x			($1,763.37)
Wetridge (12 lots) - Sharkey/GreenHalo Permit 22-03 (Transferred 21-30 and 21-31)	3/25/2022		x								x			($1,076.66)
Boutwell Farm Lot 9 - Sharkey/GreenHalo Permit 22-04	3/25/2022		x								x			($263.26)
13290 Boutwell Road N - Sharkey/GreenHalo Permit 22-05	3/25/2022		x								x			($619.76)
Heritage Ridge Lot 2 (605 Heritage Place) - Sharkey/GreenHal Permit 22-06	3/25/2022		x								x			($545.73)
Liberty Classical Academy Permit 22-07	6/15/2022	x	x											($2,478.25)
Boutwell Farm- Sharkey remaining lots- Transferred to 23-03 Permit 22-08	placeholder, no app received		x								x			$818.72
Helmer Residence (Thomas Building Co.) Permit 22-09	8/15/2022		x							x				($1,493.31)
Caribou (Herberger's Redevelopment) Permit 22-10	9/29/2022	x	x									x		($4,192.75)
7125 Lone Oak Trail (WOS L106) Permit 22-11	9/25/2022		x							x				$1,829.56
7171 Mid Oaks Ave N Permit 22-12	7/15/2022		x							x				($799.74)
Cahill Residence Permit 22-14	8/1/2022		x							x				$217.23
13199 Dellwood Rd Permit 22-15	???		x							x				$169.37
Stillwater Streets Imrpovement- paving 72nd st Permit 22-16	pre-application		x						x				$0.00	
Read Residence	11/7/2022	x	x							x				$1,022.57

APPLICANT/PERMIT NO.	PERMIT DATE	RULES						TYPE				FEES OWED	
		2	3	4	5	6	7	Decompaction	GOV	SF RES	RES DEV	COM	EXEMPT	AMT DUE
Permit 22-17														
Stillwater Oaks Permit 22-18	new submittal 4/12/2023	x	x								x			$19,814.00
Miller Flood Protection Permit 22-19	10/20/2022						x				x		$2,816.00	
Popeyes OPH Permit 22-20	11/9/2022		x									x		($604.50)
3837 Tending Green Permi 22-21	10/20/2022	x	x							x				($5,252.32)
Fanberg Residence - Manning Estates L4B3 Permi 22-22	10/21/2022		x							x				($885.00)
Carl Lee Builder - Heritage Ridge L4B1 Permi 22-23	11/3/2022		x							x				($702.27)
7138 Lone Oak Trl N (WOS L109) Permit 22-24	12/6/2022		x							x				($577.48)
7164 Lone Oak Trl (WOS L113) Permit 22-25	12/6/2022		x							x				($723.50)
Gagne Tending Green Permit 22-26	12/6/2022		x							x				($843.64)
WOS L102 Permit 22-27 transfer to 2023 permit #?	pre-permit - reviewed new lowest floor elevation		x							x				$0.00
WOS L118 Permit 22-29 transfer to 2023 permit #23-07	pre-permit-reviewed new lowest floor elevation		x							x				$121.50
Wash Co. CSAH 5 Phase II Permit 22-30	1/19/2023		x						x				$121.50	
Wash Co. CSAH 57 culverts Permit 22-31	2/2/2023		x						x				$0.00	
Cty Rd 61 Re-alignment Permit 23-01	4/12/2023	x	x						x				$7,263.00	
WOS L114 - Cates (7211 Lone Oak Trail Tweden) Permit 23-02	administrative - but awaiting revised restoration plan and financial conditions 4/13/2023		x	x			x			x				$29.75
Boutwell Farm Lot 1 (2545 Boutwell Farm Rd) Permit 23-03	app 2/9/2023 decompaction needs to be added, NOPV stockpile in infiltration basin		x											$772.69
Westridge B1L4 (986 Creekside) Permit 23-04	app 2/9/2023 decompaction needs to be added		x											($755.25)
Rocket Carwash Permit 23-05	conditional approval 4/12/2023	x	x											$4,774.50
Stillwater Street Improvements 2023 Permit 23-06	3/8/2023 submittal - sent city comments on erosion control plan 4/18/23		x						x				$1,111.50	
7239 Lone Oak Trail (WOS L118)	3/21/2023 submittal with check		x											($168.00)

APPLICANT/PERMIT NO.	PERMIT DATE	RULES						TYPE				FEES OWED	
		2	3	4	5	6	7	Decompaction	GOV	SF RES	RES DEV	COM	EXEMPT	AMT DUE
Permit 23-07	sent bob appert comments to address 4/13/23													
72nd St Road and Trail Improvements Permit 23-08	3/27/2023 submittal determined admin erosion control only - draft engineer report 4/13/23												$2,419.25	
Kirn Residence (McLafferty 8000 Neal Ave) Permit 23-09	waiting on application and permit fee		x							x				$73.50
TOTAL NON-EXEMPT DUE BCWD:		90	326	34	15	27	160		71	153	13	119	$77,618.80	**$112,324.16**
Total due back to applicants if closed:														**$ (400,849.18)**

Project Name |	Benz & School Section Chain of Lakes Management	**Date** |	05/03/2023
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, District Administrator		
From / Contact info |	Pat Conrad and Ryan Fleming		
Regarding |	Scope of Services		

Background

The District developed a lake management plan for Benz Lake in May 2009. The plan included an assessment of the lake and its watershed and an implementation plan for proposed improvements. The plan was developed using a stakeholder engagement process that included a series of meetings with lakeshore residents. The District conducted a follow up investigation of the wetland areas west of Benz Lake as a potential source of phosphorus to the lake but did not implement an improvement project. Since development of the original lake management plan Benz Lake has 'flipped' from a turbid, algae-dominated system to a more desirable clear water, plant-dominated ecosystem.

In 2016, the District developed a watershed restoration and protection strategy (WRAPS) for the northern chain of lakes which included Goggins, North and South School Section, Plaisted, and Lynch Lakes. The WRAPS report followed a similar format as the Benz Lake plan including a watershed and lake assessment and development of management strategies to restore the impaired lakes and protect the non-impaired lakes. The effort also included a stakeholder engagement effort with lakeshore residents. Follow up efforts from the WRAPS project have focused primarily on aquatic invasive management.

At this time, District staff has identified the need to re-engage with residents living on Benz Lake. Many of the residents that were involved in the original planning effort are no longer living on the lake. District staff have noted that the new residents moving on to the lake have not been educated on shallow lake dynamics and have expressed interest in managing the aquatic plants within the lake.

Also. the District has updated their approach to developing lake management plans since the development of these two plans to include a flood risk assessment element. This element was first conducted for the Bass Lake East and West management plan and more recently was conducted for the large ponds throughout the district.

The following is a scope of services to facilitate education/outreach meetings with residents, to conduct the flood risk assessment for the lakes and to incorporate the lakes into the District's web-based Story Map interface.

Scope of Services

Lake & Watershed Assessment

This task will mainly consist of bringing past assessment information up to date for use in the stakeholder engagement process and for incorporation into the District's Story Map interface. The main datasets to be updated will be water quality summaries and any vegetation surveys that have been conducted. We are recommending one additional assessment that was not previously conducted, a shoreline assessment. This assessment will establish the degree to which the shorelines

have been modified by property owners and the impact that may have on water quality. EOR will coordinate with the District Administrator and WCD Staff in the data collection task.

This task will include summarizing findings and developing content for the Story Map.

Public Engagement

EOR and District Staff will conduct a public outreach effort after updating the assessment work and the preliminary screening process of the H&H Modeling and Flood Risk Assessment. The objectives for the public engagement will be to solicit input from the public on specific issues/concerns about the waterbody on which they reside, to convey findings from the assessment & analysis work and to coordinate any additional site visits that may be needed. Public engagement meetings will use an online meeting format similar to what was used successfully for the Bass Lakes management planning effort. A separate meeting will be held for Benz Lake and the chain of lakes. An additional in-person meeting will also be held for a total of 3 meetings.

H&H Modeling and Flood Risk Analysis

EOR will update the District H&H Model to better understand hydrologic conditions of each of the lakes in the study. The model update will consist primarily of refining catchments, depressional storage in the landscape, and overland conveyances using LiDAR elevation data. The recently compiled Washington County culvert database will also be added to the model where appropriate.

The updated model will be run to determine the critical events producing peak water elevations for each of the ponds, e.g., 100-year 24-hour, or 100-year snowmelt events. Based on the flood elevations, EOR will determine risk factors for infrastructure within the critical event footprint. The evaluation will look at buildings, wells, septic systems, and roads/driveways. Infrastructure elevations will be determined via desktop by intersecting the features (publicly available point and polygon GIS data) with the LiDAR to estimate the degree of flooding by the critical event. The outcome will be a list of potentially vulnerable infrastructure. Well and septic locational data is not entirely dependable, so a site visit will be needed for confirmation. This task will be conducted following the public engagement effort so coordination with landowners can be facilitated.

The final deliverable for this task will be an update to the District H&H Model for each of the lake watersheds, determination of peak water elevations for critical events, and identification of flood vulnerable infrastructure. Recommended flood risk mitigation strategies will be developed for each of the ponds and vulnerable infrastructure.

Story Map Development

The final deliverable for the project will be a memo summarizing the flood risk assessment and incorporation of content for each lake into the district Story Map

Task	Estimated Hours	Estimated Cost
Lake/Watershed Assessment	10	$1,580
H&H Model Update and Flood Risk Analysis	50	$7,404
Public Engagement	28	$6,048

Story Map Development	18	$2,542
Totals	**300**	**$17,574**

Requested Action

1. Consider approval of this scope of services for an estimated cost of $17,574 from the following accounts
    a. $10,6684 from account 923-0002 (flood risk analysis)
    b. $6,890 from account 950-0001 (remaining tasks)

memo

Project Name |	Applewood Hills Golf Course Stormwater Reuse	**Date** |	5/03/2023
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, BCWD Administrator		
From / Contact info |	Derek R. Iash, PE, CPESC		
Regarding |	Operations and Maintenance (O&M) Manual for Applewood Hills Golf Course Stormwater Reuse Project		

Background

Construction for the Applewood Hills Golf Course (AHGC) Stormwater Reuse project was started in late November 2022. Pipes, structures, and valves were installed between November 21 and December 20, 2022. The remaining work includes installation of the pump station, electrical connections to the existing golf course control panel, and restoration work, which is currently under way. It is also anticipated Xcel Energy will be installing the transformer in the spring or summer of 2023. All this work should be completed by the Summer of 2023 with a "soft" start-up of the pump following this final work. The contract currently requires the work to be substantially complete by June 1st, with a readiness for final payment on June 30, 2023. On another note, the golf course is planning to reconstruct their irrigation system in June 2023, which will most likely negate the use of the reuse-system until 2024.

The on-going operation and maintenance of the project will be completed by AHGC staff. However, the first two years of operation EOR will coordinate with AHGC to operate and maintain the pump station.

Scope

The following table outlines the cost and hours anticipated for the 2023 season.

Task	Description	Hours	Cost
1. Prepare the Operations and Maintenance Manual	Collect and organize data from the engineer's plans and specifications, the contractor's material and manufacturer submittals, and the as-built record of the project. Prepare the Operations and Maintenance Manual for the Golf Course and Watershed District to operate and maintain the stormwater irrigation reuse system.	58	$9,385.00
2. Perform a late Spring or early Summer Startup and Observation	Coordinate with the Contractor and Golf Course to perform a "soft" system start-up. Document the process and include information in the O&M Manual.	19	$3,457.75
3. Perform a Fall Shutdown	Coordinate with the Contractor and Golf Course to shut the system down for the fall and winterize it. Document the process and include information in the O&M Manual.	19	$3,457.75
	Total	**96**	**$16,300.50**

Requested Action

Consider approval of this scope of services ~~for an estimated cost~~not to exceed ~~of~~ $16,300.50 from BCWD account 929-0010.

BROWN'S CREEK WATERSHED DISTRICT
455 HAYWARD AVE N
OAKDALE, MN
55128
651.330.8220
WWW.BCWD.ORG

MEMORANDUM

TO: Brown's Creek Watershed District Board
FROM: Karen Kill
RE: Minnesota Watersheds Summer Tour June 20-21, 2023
DATE: May 5, 2023

Background
The MN Watersheds (formerly MN Association of Watersheds) is holding a summer tour June 20-21 in Albert Lea, MN.

Expenses:
- Registration $99
- Hotel $119-$149/night

Recommended Action:
Authorize staff to attend and expenses for MN Watersheds summer tour. Authorize managers at attend with paid per diem and expenses.

Managers:
Klayton Eckles, President • Celia Wirth, Vice-President • Chuck LeRoux, Secretary • Gerald Johnson, Treasurer

MINNESOTA WATERSHEDS SUMMER TOUR

Albert Lea, MN | June 20-21, 2023

MINNESOTA WATERSHEDS
Connecting People. Protecting Water.

SRRWD Shell Rock River Watershed District

CRWD CEDAR RIVER WATERSHED DISTRICT
REVIVING OUR RIVER

TCWD TURTLE CREEK WATERSHED DISTRICT

Tuesday, June 20
Location: Wedgewood Cove Golf Club, 2200 W 9th St, Albert Lea, MN 56007

9:00—12:00	MAWA Meeting
12:00—12:30	Grab and Go Lunch
12:25—12:30	Welcome
12:30—1:30	Agency Partner Updates
1:30—5:00	Educational Workshops
1:30—2:15	Common Carp TBD, Minnesota Aquatic Invasive Species Research Center
2:15—3:00	Developing Stewardship Grant Opportunities for Enhanced Street Sweeping Paige Ahlborg, Ramsey Washington Metro Watershed District Michael McKinney, Barr Engineering Co.
3:00—4:15	Multi-purpose Drainage Management Mark Origer, ISG
4:15—5:00	Partnerships with Private Industry Brad Kramer, Shell Rock River Watershed District
5:00—5:45	Welcome Reception and Cash Bar
6:00—6:45	Dinner
6:45—8:00	Opening Remarks and Tour Overview

Wednesday, June 21
Bus Tour Itinerary
8am – 4:30pm

8:30 a.m. Buses depart from Hotel (Country Inn and Suites, 2214 E. Main Street, Albert Lea, MN)
The project stops included in the tour are listed below in no particular order.

Albert Lea Lake Dam
The existing outlet structure and access bridge for Albert Lea Lake was installed in 1922 and needed repair. The SRRWD saw the opportunity to not only build a new dam but manage rough fish populations and aquatic vegetation by creating a 3-in-1 project. Groundbreaking for the construction of the new Albert Lea Lake Dam and Fish Barrier Project began in August of 2014, and consists of a dam, fish barrier, and draw down structure. The $2 million-dollar project was funded by the Lessard-Sams Outdoor Heritage Fund.

Upper Twin Lake Pump Station
The pump station is intended to allow conjoined Upper and Lower Twin Lake's water levels to be managed independently of each other which can simulate drought conditions for rough fish management. Construction included the removal and installation of a box culvert under County Road 80. This project is funded by the Lessard-Sams Outdoor Heritage Council (LSOHC) and is a partnership between U.S. Fish & Wildlife Service, MN Department of Natural Resources, and Freeborn County. The pump station was commissioned on June 16, 2020.

Miller, Orr, IC&E Project
Building on a U.S. Fish & Wildlife Service acquisition and using funds from Lessard Sams Outdoor Heritage Council (LSOHC), the restored property, east of Alden, will add to over 250 acres of continuous native prairie and wetlands. Project plans include abandoning and rerouting public tile systems, creating wetlands via tile modifications, wetland scrapes, berm installations, and native prairie plantings.

Confined Disposal Facility
A Confined Disposal Facility (CDF) is a dewatering site in the dredging process. When dredging takes place, a mixture of water and sediment is pumped to the disposal facility and the CDF will be used to settle and siphon off the water. The Shell Rock River Watershed District (SRRWD) purchased the properties for the CDF in 2016. These properties are located adjacent to each other, north of Interstate 90 and 1 1/2 miles north of Fountain Lake.

Edgewater Bay Pavilion and Fountain Lake Restoration Presentation **Lunch will be served at this location**
The restoration of Fountain Lake is a multi-phased project. The SRRWD began active dredging in 2018, utilizing $7.5 million in state funds and $9.5 million in local option sales tax funds. Leveraged funding provided dredging and disposal of the first two phases of the project through 2021 and the removal of approximately 1.2 million cubic yards of accumulated sediment. The SRRWD is requesting $9 million from the Minnesota Legislature in 2023 to complete the third and final phase of the Fountain Lake Restoration Project. In 2023, SF172 (Sen. Gene Dornink) and HF277 (Rep. Peggy Bennett) introduced bills to provide funding for the project, Phase 3 - Main Bay (East Basin), Bancroft Creek and parts of Bancroft Bay. It is critical for the success of the project to complete Phase 3, in the heart of Albert Lea.

Van Erkel Farms
The rich history of the Hollandale area, including early drainage management activities and the scope of vegetable production operations that existed here in the 1900's will be explained, as well as the critical role of the Turtle Creek Watershed District in guiding water management within the Hollandale basin and associated uplands.

Dobbins Capital Improvement Projects (CIPs) and EPA 319 Grant Water Quality Research
The Dobbins Creek watershed's high local priority for flood reduction and water quality will be described, as well as CIPs and best management practices (BMP) targeting that have improved water quality and reduced flows.

The water monitoring efforts that have and are currently taking place to evaluate the effects of intensive targeted BMP adoption in the Dobbins Creek watershed including surface water, macroinvertebrate IBI and fish IBI monitoring. The amount of work in Dobbins along with the monitoring makes this one of the most studied watersheds in the Midwest.

Jay C. Hormel Nature Center and Discover Austin

We will visit Austin's city-owned Jay C. Hormel Nature Center, which was started more than 50 years ago and opened a $7 million interpretive center in 2017. A naturalist will give a presentation about the center's vibrant history and activities, including its growth from 123 acres to nearly 530 today. The Nature Center offers a sanctuary for people and features native prairie, woods, wetlands and wildlife. The Nature Center offers an environmentally based curriculum for preschool through high school students. Classes and courses are available for families, home school groups, and other public and private schools outside of Austin.

Nancy Schnable, Executive Director of Discover Austin, will give a presentation about what makes our community special in so many ways. Welcome bags will be provided that contain materials highlighting different attractions in the community. We will have some time to tour the nature center's exhibit room that highlights many things, including soil health, wetlands, local animals, and a new exhibit on native mussels and the DNR's efforts to restore them in the Cedar River State Water Trail.

On the drive back to Albert Lea a *Discover Austin* tour guide will introduce you to local points of interest and lesser-known quirky sites around Austin that may merit further attention.

4:30 p.m. Arrive back at the hotel (Country Inn and Suites)

Special THANKS to the Minnesota Watersheds 2023 Summer Tour Sponsors

50 Years ISG OF MAKING A DIFFERENCE

HOUSTON engineering, inc.

moore engineering, inc.

BARR

BROWN'S CREEK WATERSHED DISTRICT
455 HAYWARD AVE N
OAKDALE, MN
55128
651.330.8220
WWW.BCWD.ORG

MEMORANDUM

TO: Brown's Creek Watershed District Board
FROM: Karen Kill
RE: St. Croix River Workshops on the Water: June 27 & July 25
DATE: May 5, 2023

Background
St. Croix River Workshops on the Water: June 27 in Taylor's Falls (5-9pm) & July 25 in Stillwater (5-9pm)

Expenses:
Register at www.mnwcd.org/shop - $30 per person, includes dinner and cash bar

Join local community leaders from Minnesota and Wisconsin for an educational workshop and networking event aboard the Taylor's Falls Princess or Stillwater River Boat.
This year's St. Croix River Workshops on the Water will focus on:

1) Economic Value of Clean Lakes and Rivers;
2) Vanishing Shorelines & Importance of Shoreland Rules; and
3) Success Stories from Recently "De-listed" Lakes, featuring North & South Center and Lily Lakes (panel discussions)

There will also be ample time to enjoy the river and talk with other local leaders from the region.

This signature event is specifically designed for local community leaders, including city council members, county commissioners, watershed district and SWCD supervisors, lake and river association board members, and members of planning commissions and citizen advisory committees.

Hosted by the East Metro Water Resource Education Program, Lower St. Croix Watershed Partnership, National Park Service, Minnesota DNR, Wisconsin DNR, Wild Rivers Conservancy of the St. Croix and Namekagon, Carnelian-Marine-St. Croix Watershed District, Chisago SWCD, Isanti SWCD, Middle St. Croix WMO, Polk County, St. Croix County, and Washington County.

Recommended Action:
Authorize staff to attend and expenses for St. Croix River Workshops on the Water. Authorize managers at attend with paid per diem and expenses.

Managers:
Klayton Eckles, President • Celia Wirth, Vice-President • Chuck LeRoux, Secretary • Gerald Johnson, Treasurer

Brown's Creek Watershed District
2023 Budget
Revised 5-10-23

		Revised 2022 Carry Forward for Approval	2023 Grants	2023 Levy	2023 Total Budget	Allocated	Available
100-2910	Designated Funds - Management Plan Projects	*$ 1,230,373.90*			$ 1,230,374		$ 1,175,778
					$ -		$ -
Revenue					$ -		$ -
100-3700	Interest Income				$ -		$ -
100-3601	Metropolitan Council Outlet Monitoring Grant		$ 5,000		$ 5,000		$ 5,000
100-3627	BWSR Clean Water Fund 2019 - Stormwater Reuse OG				$ -		$ 36,010
100-3628	BWSR Clean Water Fund 2020 - Stormwater Reuse SCC				$ -		$ -
100-3629	BWSR Clean Water Fund 2019 - Millbrook Riparian Restoration				$ -		$ 39,380
100-3630	Washington County Cost-share Applewood Reuse				$ -		$ 66,800
100-3631	MPCA Small Watershed Grant 2023-2026		$ 320,706		$ 320,706		$ -
100-3400	Permits				$ -		$ -
100-3100	Tax Levy			$ 1,150,415	$ 1,150,415		$ 1,122,277
TOTAL, ESTIMATED Sources of Funding		***$ 1,230,374***	***$ 325,706***	***$ 1,150,415***	**$ 2,706,494**	**$ -**	**$ 2,445,245**

ACCT. #	General Expenses	Revised 2022 Carry Forward for Approval	2023 Grants	2023 Levy	2023 Total Budget	Allocated	Available
200-4000	Manager Per Diem and Expense	*$ -*		$ 10,000	$ 10,000	$ 10,000	$ -
200-4220	Secretarial Services	*$ -*		$ 4,000	$ 4,000		$ 4,000
200-4250	Dues & Subscriptions (MAWD 5000 and LMCIT 2000)	*$ -*		$ 7,000	$ 7,000	$ 7,000	$ -
200-4270	Bonding & Insurance	*$ -*		$ 5,500	$ 5,500	$ 4,000	$ 1,500
200-4280	Postage & Delivery	*$ -*		$ 1,000	$ 1,000		$ 1,000
200-4290	Printing & Notices	*$ -*		$ 1,000	$ 1,000		$ 1,000
200-4330	Accounting	*$ -*		$ 4,305	$ 4,305	$ 4,100	$ 205
200-4331	Audit	*$ -*		$ 9,350	$ 9,350	$ 8,500	$ 850
200-4949	Misc., Other Expense	*$ -*		$ 2,000	$ 2,000	$ 1,000	$ 1,000
200-4320	Wash. Conservation District--Admin	*$ -*		$ 55,640	$ 55,640	$ 55,640	$ -
200-4265	Admin Conference Registrations	*$ -*		$ 2,000	$ 2,000		$ 2,000
200-4410	Legal Fees - General	*$ (1,000.00)*		$ 25,480	$ 24,480	$ 24,480	$ -
200-4500	Staff Engineer	*$ -*		$ 27,090	$ 27,090	$ 27,090	$ -
	Diversity, Equity and Inclusion Training	*$ -*		$ 5,000	$ 5,000		$ 5,000
	Contingency Reserve	*$ 68,401.48*		$ -	$ 68,401		$ 68,401
TOTAL GENERAL FUND EXPENSES:		***$ 67,401.48***	***$ -***	***$ 159,365***	**$ 226,766**	**$ 141,810**	**$ 84,956**

ACCT. #	MANAGEMENT PLAN EXPENSES	Revised 2022 Carry Forward for Approval	2023 Grants	2023 Levy	2023 Total Budget	Allocated	Available
300-4320	Wash. Conservation District--Administrator	*$ 3,610.00*		$ 166,400	$ 170,010	$ 170,010	$ -
300-4410	Legal Fees - Mgmt Plan	*$ -*		$ 52,000	$ 52,000		$ 52,000
300-4501	Staff Engineer	*$ 5,841.00*		$ 80,325	$ 86,166	$ 86,166	$ -
300-4702	Permitting, Legal Review	*$ -*		$ 13,000	$ 13,000		$ 13,000
300-4703	Permitting, Engineering Review	*$ -*		$ 52,500	$ 52,500		$ 52,500
300-4704	Permitting, Inspection Database	*$ -*		$ 1,000	$ 1,000		$ 1,000
300-4710-1	Baseline Monitoring	*$ 13,215.00*	$ 5,000	$ 125,000	$ 143,215	$ 143,215	$ -
300-4640	Equip. Maint. and Upgrades	*$ -*		$ 27,500	$ 27,500	$ 4,580	$ 22,920
300-4810	Shared Educator Position	*$ -*		$ 20,500	$ 20,500	$ 20,500	$ -
300-4950	Management Plan Implementation -future projects	*$ 20,992.83*		$ -	$ 20,993		$ 20,993
903-0001	Trout Habitat Preservation Project: Monitoring,	*$ 2,231.00*		$ 6,300	$ 8,531	$ 8,531	$ (0)
909-0000	Rules Review/Evaluation	*$ 17,123.00*		$ 10,000	$ 27,123		$ 27,123
909-0001	Groundwater Dep Nat Resource Inventory update	*$ 10,000.00*		$ -	$ 10,000		$ 10,000
909-0002	Permitting Program Internal Procedure updates	*$ -*		$ 25,000	$ 25,000		$ 25,000
910-0000	Education & Outreach	*$ 6,537.00*		$ 10,000	$ 16,537	$ 7,562	$ 8,975
911-0000	Volunteer Stream Monitoring	*$ (203.50)*		$ 4,160	$ 3,957	$ 3,957	$ -
912-0000	Grant Preparation	*$ -*		$ 5,000	$ 5,000		$ 5,000
914-0000	Homeowner BMP Program	*$ 8,000.00*		$ 60,000	$ 68,000	$ 17,692	$ 50,308
922-0000	Plan Reviews - LGU/LWMP			$ -	$ -		$ -
923-0000	H & H Model Maintenance	*$ 5,000.00*		$ 5,250	$ 10,250		$ 10,250
923-0002	Flood Risk Assessment	*$ 108,000.00*		$ (8,000)	$ 100,000		$ 100,000
927-0000	Management Plan Update	*$ 57,000.00*		$ 90,000	$ 147,000	$ 10,000	$ 137,000
929-0000	Long Lake Plan Implementation-shoreline management	*$ -*		$ 3,700	$ 3,700		$ 3,700
929-0010	Long Lake -Implementation - regional treatmen	*$ 273,750.00*		$ (35,000)	$ 238,750	$ 211,933	$ 26,817
929-0011	Long Lake - 62nd Street Pond Retrofit Feasibility	*$ 15,773.00*		$ 3,350	$ 19,123		$ 19,123
929-0012	Long Lake - Marketplace Reuse Feasibility	*$ 1,919.07*		$ 164,900	$ 166,819	$ 1,919	$ 164,900
931-0001	Benz Lake Management Plan Implementation			$ 15,500	$ 15,500		$ 15,500
932-0004	Iron Enhanced Sand Filter/Performance Monitoring	*$ (9,000.00)*		$ 9,000	$ -		$ -
935-0000	Land Conservation Program	*$ 50,000.00*		$ 50,000	$ 100,000		$ 100,000
935-0002	110th Street Property Implementation	*$ 23,456.71*		$ 25,000	$ 48,457		$ 48,457
935-0003	Develop Land Conservation Priorities	*$ 20,000.00*		$ -	$ 20,000		$ 20,000
940-0000	BMP Program – LGU/Community Demonstration Projects	*$ 10,000.00*		$ -	$ 10,000		$ 10,000
940-0001	Flood Prevention Grant Program	*$ 100,000.00*		$ (100,000)	$ -		$ -
942-0004	Measuring Trends in GW Elevations & Flow	*$ 1,662.00*		$ 12,600	$ 14,262	$ 8,686	$ 5,576
942-0007	Groundwater - Browns Creek piezometers	*$ 11,200.00*		$ (2,240)	$ 8,960		$ 8,960
942-0011	Groundwater - Coordination with users	*$ 1,215.00*		$ 4,725	$ 5,940	$ 5,940	$ -
942-0012	Groundwater - Install Monitoring Wells	*$ 33,901.00*		$ 31,900	$ 65,801	$ 7,440	$ 58,361
942-0013	Groundwater - Pump Test	*$ 8,000.00*		$ 13,300	$ 21,300	$ 5,952	$ 15,348
947-0011	Countryside Auto BMP-performance monitoring	*$ (2,080.00)*		$ 2,080	$ -		$ -
947-0016	Brown's Creek - BC Trails Park Parking Lot Perfm Mon	*$ (2,600.00)*		$ 2,600	$ -		$ -
947-0017	Brown's Creek Implementation - Ecoli site visits/cost-share	*$ 10,000.00*		$ -	$ 10,000		$ 10,000
947-0018	Brown's Creek - Biological Survey (Macroinvert & Fish)	*$ 810.31*		$ 8,000	$ 8,810	$ 810	$ 8,000
947-0020	Brown's Creek - Stream Channel Survey	*$ -*		$ -	$ -		$ -
947-0022	Brown's Creek - Buffer and Stream Restoration	*$ 83,845.88*	$ 320,706	$ -	$ 404,551	$ 30,714	$ 373,837
947-0023	Brown's Creek - Golf Course Reuse - Oak Glen	*$ -*		$ 6,300	$ 6,300		$ 6,300
947-0025	Brown's Creek - Golf Course Reuse - SCC	*$ 44,000.00*		$ (44,000)	$ -		$ -
948-0000	CIP Maintenance	*$ 18,500.00*		$ 99,100	$ 117,600	$ 79,966	$ 37,634
950-0001	South School Curly Leaf Treatment			$ 8,000	$ 8,000		$ 8,000
950-0002	Lynch Lake Fish/Veg Management	*$ 466.00*		$ 4,500	$ 4,966	$ 4,966	$ -
951-0001	Woodpile Lake Management Plan Implementation	*$ 10,000.00*		$ -	$ 10,000		$ 10,000
953-0000	Fen Management Plan Implementation	*$ (100.00)*		$ 4,100	$ 4,000	$ 4,000	$ -
956-0000	Bass East & West Management Plan	*$ -*		$ -	$ -		$ -
957-0000	Weather Station	*$ -*		$ 3,700	$ 3,700	$ 3,622	$ 78
959-0002	Resource Assessment - Diversion Tribs - Head cut Repairs	*$ 125,000.00*		$ (65,000)	$ 60,000		$ 60,000
959-0003	Resource Assessment - Brown's Creek Gorge Bluff	*$ 1,797.50*		$ -	$ 1,798	$ 1,798	$ -
960-0000	St Croix Phosphorus Reduction	*$ 10,000.00*		$ -	$ 10,000		$ 10,000
961-0000	Mendel Wetland Restoration Feasiblity	*$ 29,952.87*		$ 6,000	$ 35,953	$ 3,985	$ 31,968
962-0000	District-Wide Pond Management Planning/Implementation	*$ 24,156.75*		$ 10,500	$ 34,657	$ 24,157	$ 10,500
963-0000	District-Wide Vegetation Surveys	*$ 10,000.00*		$ -	$ 10,000		$ 10,000
964-0000	District-Wide Chloride Source Assessment			$ 2,500	$ 2,500		$ 2,500
TOTAL MANAGEMENT PLAN PROJECT EXPENSES:		***$ 1,162,972.42***	***$ 325,706***	***$ 991,050***	***$ 2,479,728***	***$ 868,101***	***$ 1,611,627***
TOTAL, OPERATING EXP. & MGMT. PLAN PROJECTS:		***$ 1,230,373.90***	***$ 325,706***	***$ 1,150,415***	***$ 2,706,494***	***$ 1,009,911***	***$ 1,696,584***

Brown's Creek Watershed District

Treasurer's Report

05-10-23

Checking balance (9903)	$634,092.96
Money Market balance (6671) :	$2,447.89
Permit balance (6614) :	$400,853.88
Certificate of Deposit balance:	$204,879.62
Total :	$1,242,274.35
Accounts payable:	$105,362.88
Unrecorded deposits:	
Total balance :	$1,136,911.47

I certify that the bank statements have been reviewed for consistency with the previously approved checks.

Gerald Johnson, BCWD Treasurer

BROWN'S CREEK WATERSHED DISTRICT
5/10/2023
CURRENT ITEMS PAYABLE-PAGE 1 of 2

	YES	NO	ABSTAIN	ABSENT
ECKLES	_____	_____	_____	_____
JOHNSON	_____	_____	_____	_____
LEROUX	_____	_____	_____	_____
WIRTH	_____	_____	_____	_____

VENDOR		**ACCOUNT #**		ITEMS	TOTAL	**CK NO**
Emmons & Olivier Resources,	Invoices April 2023					
	Inv. 41-0000-209 Retainer	300-4500	$	7,078.50		
	Inv. 41-0000-209 Retainer	200-4500	$	2,359.50		
	Inv. 41-0001-212 Permits 2000-2007	300-4703	$	4,566.50		
	Inv. 41-0307-74 Permits 2017					
	Permitting #17-01 Grant Holdings Subd	300-4703	$	203.25		
	Permitting #17-04 Stillwater Senior Living	300-4703	$	36.75		
	Inv. 41-0330-63 Permits 2018					
	Permitting #18-02 Heifort Hills Estate	300-4703	$	190.16		
	Permitting #18-05 Hazel Place	300-4703	$	73.50		
	Inv. 41-0365-37 Permits 2020					
	Permitting #20-12 White Pine Ridge	300-4703	$	190.16		
	Inv. 41-0384-25 Permits 2021					
	Permitting #21-09 Westridge	300-4703	$	336.41		
	Permitting #21-18 Boutwell Farm (Lot 8)	300-4703	$	52.84		
	Permitting #21-22 Bond Residence	300-4703	$	156.66		
	Permitting #21-28 Guerrino Residence Juiliann	300-4703	$	52.84		
	Permitting #21-35 WOS Lot 104	300-4703	$	190.16		
	Permitting #21-36 WOS Lot 110	300-4703	$	173.41		
	Inv. 41-0402-15 Permits 2022					
	Permitting #22-02 Gonyea at White Pine Ridge	300-4703	$	366.46		
	Permitting #22-03 Sharkey/Westridge (4 lots)	300-4703	$	173.41		
	Permitting #22-04 Boutwell Farm Lot 9	300-4703	$	52.84		
	Permitting #22-08 Sharkey Boutwell Farms	300-4703	$	190.16		
	Permitting #22-11 WOS Lot 106	300-4703	$	642.41		
	Permitting #22-12 7171 Mid Oaks Ave	300-4703	$	70.32		
	Permitting #22-14 Cahill Heritage Ridge L5	300-4703	$	156.66		
	Permitting #22-17 Read Residence	300-4703	$	187.57		
	Permitting #22-18 Stillwater Oaks	300-4703	$	9,448.50		
	Permitting #22-23 Ferguson, Heritage Ridge L4	300-4703	$	173.41		
	Permitting #22-24 WOS Lot 109	300-4703	$	173.41		
	Inv. 41-0420-4 Permits 2023					
	Permitting #23-01 CR 61	300-4703	$	73.50		
	Permitting #23-02 WOS Lot 114	300-4703	$	404.50		
	Permitting #23-03 Boutwell Farm Lot 1	300-4703	$	459.44		
EOR (Cont.)	Permitting #23-05 Rocket Carwash	300-4703	$	3,628.25		

	Permitting #23-06 2023 Street Improvements	300-4703	$ 234.00		
	Permitting #23-07 WOS Lot 118	300-4703	$ 438.75		
	Permitting #23-08 72nd Street	300-4703	$ 1,857.00		
	Permitting #23-09 Kirn Residence, 8000 Neal	300-4703	$ 73.50		
	Inv. 41-0421-4 IESF OM 2023	948-4500	$ 3,498.11		
	Inv. 41-0400-12 District-wide Pond Management	962-0000	$ 292.50		
	Inv. 41-0429-1 2023 GW Elevations and Management	942-0011	$ 4,437.00		
	Inv. 41-0418-5 Brown's Ck Pk Restoration	947-0022	$ 3,068.00		
	Inv. 41-0297-15 BCWD Boundary Review	923-0000	$ 43.25		
	Inv. 41-0406-7 BCWD 2022 Bio Survey	947-0018	$ 2,892.25		
	Inv. 41-0425-1 2023 THPP	903-0001	$ 389.25	$	49,085.09
Washington Conservation Dist	Inv. 6009 March 2023- Water Monitoring				
	Baseline Water Monitoring- labor	300-4710	$ 10,133.33		
	Baseline Water Monitoring- equipment	300-4640	$ 764.87		
	Metropolitan Council- lab	300-4710	$ 553.25		
	Inv. 6027 March 2023- BMP Program	914-0000	$ 542.00		
	Inv. 6024 Volunteer Stream Monitoring	911-0000	$ 275.00	$	12,268.45
Smith Partners	April 2023 Invoices				
	Inv. 43991 Retainer - Meetings, Preparation	200-4410	$ 2,071.48		
	Inv. 43992 General Legal Services	300-4410	$ 323.25		
	Inv. 43993 Planning	300-4410	$ 215.20		
	Inv. 43994 Boundary Changes	300-4410	$ 26.90		
	Inv. 43996 Lake McKusick Iron-Sand Infiltration	300-4410	$ 215.20		
	Inv. 43995 Permits	300-4703	$ 1,830.73		
	Inv. 43997 Highway 36/Manning Reuse	300-4410	$ 53.80	$	4,736.56
Xcel Energy	Inv. 825467256- Iron Enhanced Sand Filter pump operation	948-4500	$ 57.53	$	57.53
Dave McCord	Inv. 4076 March 2023 Accounting Services	200-4330	$ 380.00	$	380.00
Steven Merchant	BCWD Stewardship Grant Reimbursement Merchant-07	914-0000	$ 300.00	$	300.00
Heritage Embroidery	Inv. 53199 BCWD Apparel Order	910-0000	$ 64.00	$	64.00
Abdo	Inv. 470577 2022 Audit	200-4331	$ 2,500.00	$	2,500.00
Dimke Excavating, Inc.	Inv. 23-419 IESF Harvest Pond Cleanout	948-0000	$ 35,971.25	$	35,971.25
Total Amount Disbursed				**$**	**105,362.88**

BROWN'S CREEK WATERSHED DISTRICT
5/10/2023
MONTHLY ITEMS DEPOSITED - Page 1 of 1

VENDOR	INVOICE/DESCRIPTION	ACCOUNT #	CK NO	DEPOSIT DATE		TOTAL
Cates Fine Homes, LLC	Permit Fee #23-02 7211 Lone Oak Trail (WOS L1	300-4703	33201	5/2/2023	$	3,000.00
TOTAL AMOUNT DEPOSITED:					**$**	**3,000.00**

Brown's Creek Watershed District
Board of Managers

In the matter of deposition of fill, damage to a stormwater infiltration basin at and near 2545 Boutwell Farm Road North, Stillwater, Washington County

FINDINGS OF FACT, CONCLUSIONS OF LAW and ORDER

Property Owner: GreenHalo Builds LLC
Address: 107 Chestnut Street East, Suite 100, Stillwater MN 55042
BCWD Permit No.: 23-03 Permittee: GreenHalo Builds LLC,
Paul Przybylowski, project manager

FINDINGS OF FACT

1. An enforcement hearing on the above-captioned matter was held as part of the regular meeting of the Brown's Creek Watershed District Board of Managers at 6:XX p.m., May 10, 2023, at Family Means, 1875 Northwestern Avenue South, Stillwater, Washington County, Minnesota.

2. BCWD managers Klayton Eckles … were in attendance. Also attending were BCWD administrator Karen Kill, BCWD engineer Camilla Correll and BCWD inspector Paul Nation, BCWD assistant Cameron Blake and BCWD counsel Michael Welch.

3. Paul Przybylowski, the project manager for GreenHalo Builds, and John Sharkey, chief executive officer for GreenHalo Builds, were notified of the hearing by notice of probable violation, delivered via email sent at 9:47 a.m., May 2, 2023, by BCWD inspector Paul Nation. [ATTENDANCE OF PERMITTEE, PROPERTY OWNERS, REPRESENTATIVES]

4. The matter concerns ineffective erosion and sediment control, and the filling with excavated soil of an established infiltration basin (the Basin) at a single-family home property at 2545 Boutwell Farm Road North in Stillwater (the Property). The Basin was constructed and vegetation established to contribute stormwater-management capacity for the Boutwell Farm project, a 10-home redevelopment project authorized by BCWD under permit 18-04 in 2018. The Basin is protected and ongoing maintenance of its capacity is required under a maintenance declaration recorded as document number 4168013 in the Office of County Recorder, Washington County, Minnesota, on September 11, 2018 (the Declaration). The owner of the Property – Greenhalo Builds – applied for a specific-lot permit from BCWD for excavation and grading to construct the home on the Property on February 9, 2023, but began land-disturbing activities April 5, 2023, prior to satisfying conditions precedent on issuance of the permit. On April 5,

2023, BCWD inspector Paul Nation observed a soil stockpile within the infiltration basin on the Property. After BCWD issued a notice of probable violation on April 13, 2023, and a followup notice on May 2, 2023, GreenHalo representatives submitted revised erosion and sediment control plans necessary to satisfy the outstanding conditions and BCWD Administrator Karen Kill issued permit 23-03 May 3, 2023. The fill within the infiltration area has been removed, but steps necessary to restore the stormwater-management capacity of the basin – which provides stormwater treatment for several properties in the 10-home Boutwell Farms subdivision – have not been initiated.

5. Mr. Nation presented the following at the hearing:

   a. Engineer's Report, Permit 18-04 (June 8, 2018).

   b. Maintenance declaration, Permit 18-04, document number 4168013, (September 11, 2018).

   c. Photos of completed infiltration basin (August 25, 2020).

   d. Site inspection photos (April 5, 2023).

   e. Notice of Probable Violation (April 13, 2023).

   f. Email correspondence from Paul Przybylowski to Paul Nation (April 26, 2023).

   g. Site inspection photos (April 28, 2023).

   h. Updated Notice of Probable Violation (May 2, 2023).

   i. Permit 23-03 (May 3, 2023).

   j. Email correspondence from Paul Przybylowski to Paul Nation (May 5, 2023).

These materials, along with the testimony of Mr. Nation and [OTHER] provided during the hearing, constitute the record in this matter.

6. Mr. Nation presented the following summary of the basis for the proposed order:

   a. The BCWD Board of Managers conditionally approved Permit 18-04 for a 10-lot single-family home development on April 11, 2018, and conditions of the permit, which included recording the Declaration, were satisfied and the BCWD administrator issued the permit on September 28, 2018. The infiltration basin was subsequently constructed in fall 2019 and vegetation was found to have been established August 25, 2020. The basin appears to have functioned as designed since.

   b. On February 9, 2023, Paul Przybylowski, project manager for GreenHalo Builds, applied for an erosion control permit for the Property. BCWD conditionally approved the permit on February 22, 2023; among the conditions of approval was revision of the proposed erosion and sediment

control plan to ensure that construction-site perimeter silt fence protected the Basin from construction disturbance.

c. On April 5, 2023, Paul Nation observed during a site inspection that a soil stockpile had been placed within the Basin. Mr. Nation explained that despite the removal of soil from the Basin, fine sediment from the stockpile appears to have clogged soil pores in the Basin, which will prevent vegetation re-growth, reducing the infiltration capacity of the Basin such that it no longer provides infiltration of stormwater at the rate and volume necessary for compliance with BCWD rules and breeching the Declaration. The non-functional infiltration basin will increase the likelihood of overflow from the basin, potentially onto neighboring properties and resulting in increased frequency of stormwater flows to the south central tributary to Brown's Creek and a groundwater-dependent manage 1 wetland along the banks of the tributary.

d. BCWD issued a notice of probable violation to Mr. Przybylowski and John Sharkey, chief executive officer of GreenHalo Builds, by email on April 13, 2023, notifying them of the filling of the Basin and the actions and timelines required to restore the functionality of the Basin. GreenHalo Builds did not sign the notice or confirm to BCWD that it had been received. However subsequent email, telephone and in-person interactions confirmed Mr. Pryzbylowski's awareness of the notice.

e. On April 25, 2023, Mr. Przybylowski indicated that the soil had been removed from the Basin, which was confirmed May 2, 2023, by Mr. Nation. Mr. Nation observed, however, no action had been taken to restore functionality of the Basin.

f. BCWD issued an updated notice of probable violation to Mr. Przybylowski and Mr. Sharkey by email on May 2, 2023, notifying them that a violation hearing would be conducted May 10, 2023, as part of the regular meeting of the BCWD Board of Managers because the functionality of the Basin had not been restored, nor had plans and specification for restoration of the Basin been provided to BCWD. Mr. Przybylowski confirmed receipt of the NOPV May 2, 2023, via telephone with Mr. Nation.

g. On May 2, 2023, Mr. Przybylowki provided revised erosion and sediment control plans, addressing the conditions for permit 23-03 issuance. BCWD administrator Karen Kill issued the permit by email May 3, 2023.

h. While communications regarding submission of plans for restoration of the Basin have continued and grading and other earthwork necessary to restore the Basin took place May 10, 2023, GreenHalo Builds has not submitted an as-built survey, infiltration-testing results or a timeline for seeding the Basin or a plan to manage vegetation until establishment to BCWD for review and approval.

i. Ms. Kill provided Mr. Przybylowski and Mr. Sharkey with a draft copy of this order via email at 5:35pm on May 8, 2023.

7. At the hearing, Mr. Przybylowski presented …

8. The BCWD Board of Managers finds the above-stated testimony of Mr. Nation and Ms. Kill, as well as the evidence, facts and statements set forth in the above-cited documents, to be credible and adopts them as its factual findings in this matter.

9. The board of managers finds that the noncompliant conditions on the Property constitute a real and present threat of increased frequency of stormwater runoff to the south central tributary to Brown's Creek and adjacent wetland.

CONCLUSIONS OF LAW

1. BCWD possesses authority under Minnesota Statutes sections 103D.335 and 103D.341 to adopt rules applicable to disturbances of land for wetland protection, to require permits and to issue orders for compliance with those rules and permits, including orders requiring remediation of noncompliant conditions and restoration of property to a compliant condition.

2. BCWD Rule 3.0 – Erosion Control was duly adopted and was in force pursuant to BCWD's statutory authority and applicable provisions of law, and BCWD has a private right of enforcement of the Declaration, duly recorded on the title to Property.

3. Mr. Przybylowski, on behalf of GreenHalo Builds, received due and adequate notice of the May 10, 2023, hearing. The board of managers may hear the evidence of violation and issue a compliance order on the basis of that evidence.

4. Mr. Przybylowski or parties acting at his direction undertook excavation and grading on the Property and filling of an infiltration basin on and extending off of the Property without a duly issued BCWD permit and caused the placement of excavated soils in the infiltration basin in violation of BCWD Rule 3.0 and breeching section 2 and Exhibit B of the Declaration, which require ongoing maintenance of the infiltration capacity of the basin.

5. While GreenHalo Builds has removed excavated soils from the basin, the infiltration capacity of the basin has not been restored and details for restoration have not been finalized as necessary to document restoration of the Basin to design capacity and compliance with the Declaration.

ORDER

Accordingly, the Brown's Creek Watershed District Board of Managers hereby ORDERS GreenHalo Builds to:

1. Provide a plan to establish and maintain vegetation within the Basin for review and approval by BCWD by **May 17, 2023**.

2. Provide monthly updates to BCWD on the status of Basin vegetation, beginning **June 1, 2023**.

3. Submit to BCWD necessary documentation of completion of the necessary grading and earthwork by close of business **June 7, 2023**, including double-ring infiltrometer results (to document capacity) and an as-built grading survey.

4. Advise BCWD of successful reestablishment of vegetation in the Basin by [DATE] for confirmation by inspection by BCWD.

5. Replenish the BCWD fee deposit for permit 23-03 to [AMOUNT] by May 24, 2023.

This order may be enforced in district court through criminal misdemeanor prosecution, civil injunction or other appropriate order pursuant to Minnesota Statutes sections 103D.545 and 103D.551.

_____ Date: May 11, 2023
Klayton Eckles, President
BCWD Board of Managers

Delivered via:

[ ] Email (email: _____**) Date:**
[ ] IN PERSON Date:
[ ] OTHER (specify: _____**) Date:**

ISSUED TO/RECEIVED BY:

_____ Date: _____
Name/Title (Print)

_____ _____
Title/Organization (Print) _____
_____
Address & Telephone

_____
Signature

Your signature here indicates only that you received this order.

BROWN'S CREEK WATERSHED DISTRICT

455 Hayward Ave North, Oakdale, MN 55128
651-330-8220 x 26 karen.kill@mnwcd.org

NOTICE OF PROBABLE VIOLATION

Subject Property Address: 2545 Boutwell Farm Rd N, Stillwater, MN 55082
Property Owner: Paul Przybylowski, GreenHalo Builds LLC
Address: 107 Chestnut St E, Suite 100, Stillwater, MN 55082
BCWD Permit No.: 23-03 (not issued) Permit Applicant: Paul Przybylowski, GreenHalo Builds LLC
Contractor:
Date and Time: 4/5/2023 2:39 PM; updated 8:25 am, May 2, 2023
Activity: Construction without proper BCWD permit; stockpiling of soil within established infiltration basin

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The following apparent violations have been observed by BCWD staff:

Rule/Permit/Other	Description
1. BCWD Rule 1.1, 3.2	Observed construction of a single family residence without a BCWD permit, required under BCWD Rule 1.1 & 3.2. Construction appears to have involved movement of more than fifty (50) cubic yards of earth during excavation of the house foundation. Note that BCWD staff have reviewed a permit application for this project but have not issued the permit as the applicant has not addressed the conditions of approval. Conditions have still not been met as of May 2, 2023.
2. BCWD Rule 3.2.2	Observed stockpiling of soil within an established infiltration basin, which must be maintained to its design functionality under the maintenance declaration recorded on the property as Doc. No. 4168013. Fine sediment from this stockpile will clog the soil pores in the infiltration basin and prevent vegetation growth, reducing the infiltration rate from the basin such that it no longer meets the approved design. The non-functional infiltration basin will increase the likelihood of overflow from the basin, potentially onto neighboring properties and resulting in increased frequency of stormwater flows to the south central tributary to Brown's Creek and a groundwater-dependent manage 1 wetland along the banks of the tributary. Stockpiled soil was removed on April 26,

2023, but no other actions have been taken to restore the infiltration basin to its approved design.

You hereby are directed to take the following actions to address the conditions described above:

Action	Requested Date/Time of Compliance
1. Address conditions on approval of BCWD permit application 23-03. Provide a draft plan to BCWD outlining process for addressing actions 2-4 below.	**4/20/2023, 5:00 PM** NOT MET
2. Remove sediment stockpile from infiltration basin footprint.	**5/1/2023, 5:00 PM** MET 4/26/2023
3. Restore infiltration basin to match permit 18-04 design and comply with maintenance declaration. This includes backfilling with approved planting media to match design grades, soil ripping to loosen media, and planting with design native seed mix.	**5/1/2023, 5:00 PM** NOT MET
4. Immediately after removal of sediment in the infiltration basin, reestablish and maintain vegetation within basin until 70% of expected vegetated condition is reached, including de-watering as necessary.	**Continuing** NOT MET

This is not a legally binding order of the Brown's Creek Watershed District. **However, ~~if~~ since you ~~do~~ did not complete ~~the~~ all actions requested above by the indicated deadline(s) and the site remains out of compliance, BCWD staff ~~will schedule~~has scheduled an enforcement hearing before the BCWD Board of Managers at ~~its regular meeting of~~6:30 p.m., May 10, 2023, at Family Means, 1875 Northwestern Avenue South, Stillwater. You ~~will be provided with notice of the time of the scheduled hearing and, at the hearing,~~will have an opportunity to appear before and be heard by the managers, and you may be represented by counsel if you wish.** The timeliness and completeness of your actions will be considered by the board in deciding whether to take further enforcement steps. The board may issue an order requiring remedial, corrective, preventative or other actions to achieve compliance with applicable BCWD requirements.

The listing of apparent violations above does not prevent the board from finding additional or other violations on the basis of evidence presented. Under Minnesota

Statutes section 103D.545, failure to comply with BCWD rules, the conditions of your permit or an order of the board of managers subjects you to possible civil and criminal penalties. Pursuant to BCWD Rule 8.0, you will be liable for all costs incurred by BCWD in obtaining and monitoring your compliance with applicable BCWD rules, permit terms and conditions, and orders of the Board of Managers, including consultants' costs and attorneys' fees.

This notice does not affect the ability of any other federal, state or local body of government to take enforcement action against you pursuant to its own laws and regulations.

ISSUED BY:

Paul Nation / BCWD Inspector Date: May 2, 2023

Name/Title (Print)

Paul Nation

Signature

ISSUED VIA:

[X] EMAIL (email: paul@greenhalobuilds.com, john@greenhalobuilds.com)

[ ] IN PERSON

[ ] OTHER (specify: _____)

ISSUED TO/RECEIVED BY:

Paul Przybylowski / Project Specialist

Name/Title (Print)

GreenHalo Builds LLC

Title/Organization (Print)

Date: _____

107 Chestnut St E, Suite 100

Stillwater, MN 55082

612-364-3004

Address & Telephone

_____

Signature

John Sharkey / CEO

Name/Title (Print)

GreenHalo Builds LLC

Title/Organization (Print)

Date:

107 Chestnut St E, Suite 100

Stillwater, MN 55082

612-327-4457

Address & Telephone

Signature

Your signature here indicates only that you received this notice. Your signature does not constitute an admission of any kind with respect to the apparent violations listed above.

cc (via email):
Karen Kill, BCWD administrator; John Sarafolean, BCWD inspector; BCWD legal counsel; Dillon McClung, Reabar Abdullah, City of Stillwater; Kevin von Riedel, Developer

cc (via mail):
William & Aubrey Lewis, neighbors at 2555 Boutwell Farm Rd, Stillwater

BROWN'S CREEK WATERSHED DISTRICT
2022 WATER MONITORING SUMMARY

Prepared for:

Brown's Creek Watershed District
Preserving the integrity of the watershed for future generations

Prepared by:

Washington Conservation District

ACKNOWLEDGMENTS

Several agencies and individuals were directly involved in many aspects of this project including data collection and analysis, as well as technical and administrative assistance.

Brown's Creek Watershed District (BCWD) Board of Managers
Klayton Eckles, President
Celia Wirth, Vice President
Gerald Johnson, Treasurer
Charles LeRoux, Secretary
Rob McKim, 2nd Vice President

Brown's Creek Watershed District
Karen Kill, BCWD Administrator

Watershed Engineer
Emmons and Olivier Resources, Inc.

Watershed Legal Council
Smith Partners, P.L.L.P.

Metropolitan Council
Cassie Champion
Brian Johnson
Dan Henley
Mallory Vanous
Sarah Voth

Minnesota Department of Natural Resources (MN DNR)
Sandy Fecht
Kurt Woodrich
Mark Nemeth

Stillwater Area High School
Andy Weaver
Glenn Boettcher
SAHS Students

Minnesota Trout Unlimited- Trout in the Classroom
Evan Griggs
Amber Taylor

Washington Conservation District
The BCWD and WCD would also like to thank those volunteers and landowners who assist with data collection and allow property access.

ABBREVIATIONS, ACRONYMS, AND SYMBOLS

Bi-weekly	Every two weeks
CaCO3	Calcium Carbonate
CAMP	Citizen-Assisted Lake Monitoring Program
cfs	cubic feet per second
Chl-α	Chlorophyll-α
BCWD	Brown's Creek Watershed District
COD	Total Chemical Oxygen Demand
DO	Dissolved Oxygen
EIMS	Environmental Information Management System
E. coli	*Escherichia coli*
FAV	Final Acute Value
IESF	Iron Enhanced Sand Filter
MCES	Metropolitan Council Environmental Services
mg/L	milligrams per liter
MN DNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
MPN	most probable number
NTU	nephelometric turbidity units
OHWL	Ordinary High Water Level
Ortho-P	Ortho-phosphorus
THPP	Trout Habitat Preservation Project
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TP	Total Phosphorus
TSI	Trophic State Index
TSMP	Trout Stream Mitigation Project/Diversion Structure
TSS	Total Suspended Solids
µg/L	micrograms per liter
µm	micrometers
µmhos/cm	micromhos per centimeter
VSS	Volatile Suspended Solids
WCD	Washington Conservation District

2022 Brown's Creek Watershed District Baseline Water Quality Monitoring

MONITORING SUMMARY

This report focuses on the summary of lake and stream water quality data collected by the Washington Conservation District (WCD) in 2022. References will also be made to the Brown's Creek and Long Lake 2020 Trend Analysis completed by Brown's Creek Watershed District's engineer, Emmons & Olivier Resources, Inc. (EOR). Additional information on the natural and cultural resources, improvement projects, and challenges related to water resources within the Brown's Creek Watershed District (BCWD) can be found in the BCWD 2017-2026 Watershed Management Plan, the 2010 Brown's Creek Biota TMDL, and past monitoring summaries.

The drought conditions observed in 2021 continued into 2022; a stark contrast to the extreme wet conditions of the late 2010's. Spring conditions were cooler than average, with overnight freezing temperatures persisting until the end of April. Most lakes in the district were ice-free one to two weeks later than historic median dates, and cool temperatures delayed significant algae growth into May. Summer precipitation patterns were very dry, with only ten inches of rain falling from June through October, compared to the thirty year average of 20.2 inches for this period. Of that ten inches, over half came in August alone, the only summer month with near average rainfall. Overall, precipitation was about seven inches below the thirty year average of 33.98 inches. According to the U.S. Drought Monitor, the watershed area entered moderate drought conditions in mid-July, and severe drought conditions by early August, which generally persisted until the end of the year. Existing high water levels in the district from recent years continued to recede throughout the year. Warm temperatures also impacted water conditions with eight days over 90 ºF recorded by the National Weather Service in Stillwater. Ice-in was somewhat delayed due to warm temperatures extending into November, and heavy snow cover was present by mid-December. Despite the severe conditions, overall lake and stream water qualities were some of the best ever recorded, with some exceptions.

Lake Monitoring

BCWD monitored eighteen basins for nutrients, chlorophyll-α, Secchi disk transparency, temperature and dissolved oxygen profiles, elevation, and user perception rankings. Bass Lake East, Bass Lake West, Benz Lake, Goggins Lake, Jackson WMA Pond, Kismet Basin, Long Lake, Lynch Lake South, Masterman Lake, Plaisted Lake, South School Section Lake, and Woodpile Lake were monitored every other week, while Brewer's Pond, Heifort's Pond, July Avenue Wetland, Lynch Lake North, North School Section Lake, and Pat Lake were monitored every four weeks. Volunteers also monitored Brewer's Pond and Heifort's Pond every four weeks on an offset schedule with WCD, such that samples were collected every other week. All

lakes and an additional two ponds, Highway 12 & Kimbro Wetland and Highway 96 Wetland, were also sampled for chloride in spring and fall.

Most lakes experienced a slight improvement in water quality as measured by lake grade over the previous year. Four lakes experienced a decline in lake grade; Bass West, Benz, July Avenue Wetland, and Plaisted Lake. Goggins Lake, Lynch Lake North, Lynch Lake South, Masterman Lake, South School Section Lake, and Woodpile Lake maintained their grade from the year prior, and all other lakes improved in lake grade.

Of the eighteen lakes monitored, Brewer's Pond, Heifort's Pond, July Avenue Wetland, and Lynch Lake North summer averages exceeded (were poorer than) state impairment thresholds for total phosphorus, chlorophyll-α, and Secchi disk transparency. South School Section Lake exceeded the impairment threshold for chlorophyll-α only.

Peak elevation for the year on most lakes occurred in April or early May. Due to drought conditions, nearly every lake consistently declined in elevation, rising only for a major storm series in August. In 2022 nine basins had elevations early in the season above their Ordinary High Water (OHW) level, and by the end of the monitoring period six of those basins had receded below their OHW.

Stream and Stormwater Monitoring

Brown's Creek

Consistent with past years, Brown's Creek was monitored at four locations; Highway 15, McKusick Road, Stonebridge, and the Outlet. Automated storm composite and manual grab samples during storm and base flow conditions were collected at all sites and analyzed for nutrients, sediment, metals, and *Escherichia coli* (*E.coli*). Continuous (15 minute) stage, discharge, temperature, dissolved oxygen, turbidity, and specific conductivity were collected at all four stations, and continuous pH was also collected McKusick Road, Stonebridge and the Outlet.

<u>Nutrients & Discharge</u>

The total discharge to the St. Croix River in 2022 was 220,440,000 cubic feet of water, as recorded at the Outlet. The total phosphorus (TP) and total suspended solids (TSS) loads to the St. Croix River at the Outlet were 1,219 pounds of phosphorus (0.264 lbs/ac) and 172,589 pounds of sediment (37.32 lbs/ac), as calculated by Metropolitan Council Environmental Services (MCES). These were the second lowest and lowest totals, respectively, since load calculations began in 2000. The sampling strategy at the Outlet was changed by MCES in 2017 to a manual grab collected on the same weekday every other week, and composite samples collected in major storm events. This change in sampling method has resulted in an apparent

shift to lower annual loads, as the strategy is not biased towards runoff events as it was in the past, and the method used to calculate annual loads was altered to comply with MCES standard operating procedures. The creek exceeded the state standard of 0.100 mg/L of TP for parts of March, June, and July, but was below the standard for the majority of the year. Five of 28 applicable samples exceeded the TP standard. The creek met the TMDL goal of 23 mg/L of TSS during base flow, but exceeded the state standard of 10 mg/L from April 1 to September 30 in April, May, and July for a total of three of 13 applicable samples. TSS loading was well below the TMDL goal of 74 pounds per acre, primarily due to the lack of significant runoff events in 2022. Loading and conditions at individual sites are discussed in greater detail later in this summary.

Metals

One chronic standard exceedance of lead was recorded at McKusick Road, Stonebridge, and the Outlet on May 11, and one chronic standard exceedance of copper was recorded at the Outlet, also on May 11. The number and severity of metals standards exceedances in 2022 was very low compared to past years.

Bacteria

Samples taken during base flow at each station were above state standards for *E.coli*. Based on long term monitoring, bacteria concentrations at all stations are above the standard June through September, and at McKusick Road in the month of May. Sufficient data has not been collected at Highway 15, McKusick Road, or Stonebridge to compare to the standard in April.

Temperature & Dissolved Oxygen

Temperature and dissolved oxygen regimes were most suitable for trout survival at McKusick Road, Stonebridge and the Outlet. Although the threat level threshold of 18.3 ºC was exceeded at McKusick Road, Stonebridge, and the Outlet 31, 37, and 6 days as measured by daily average temperature, respectively, the critical level threshold at which trout could not survive of 23.9 ºC was never exceeded at any site. The number of threat level exceedances at all sites were the lowest in the last ten years when a full season of data was available, and the third lowest recorded at the Outlet since continuous temperature monitoring began in 2006. Dissolved oxygen concentrations were better than the state standard of 7 mg/L as a daily minimum for the entire season at Stonebridge and the Outlet, and were poorer than the standard only three days at McKusick Road, although some data in August was missing at this site due to sensor failure. Highway 15 is not suitable for trout during summer months due to low dissolved oxygen and warm temperatures. In past years McKusick Road has not typically had consistently favorable conditions for both temperature and dissolved oxygen, but high groundwater levels and possibly increased riparian shading and thermal load reduction projects appear to be improving conditions in this reach. The upper reaches of the creek around Highway 15 have been found to contain

invasive curly-leaf pondweed, which will hinder trout suitability by slowing the water, allowing for warmer temperatures and sediment deposition over spawning gravel.

Turbidity

Continuous turbidity and specific conductivity were monitored at each of the four stations on the creek. Average daily turbidity exceeding the TMDL goal of 10 NTU ranged from 0.5% to 7.9% of the days monitored across the four monitoring stations, although sensor failure influenced the analysis at McKusick Road. In 2022 the Outlet was the most turbid site, with 7.9% of the days monitored exceeding the 10 NTU goal. Specific conductivity data are not discussed, but are available upon request.

Biology

The MN DNR has a management plan to stock 1,000 yearling rainbow trout in the creek each spring. Due to difficulties of raising brown trout at state hatcheries to stock-able size, the agency shifted to stocking rainbow trout in 2019. Stillwater Area High School and the Minnesota Trout Unlimited – Trout in the Classroom program also raised and released several hundred fingerling rainbow trout into the creek. The rainbow trout thrive in similar conditions as brown trout, but grow faster and will provide better recreational opportunities to anglers.

Diversion Drainage

The diversion drainage was again monitored at the Trout Stream Mitigation Project (TSMP) Diversion Structure for nutrients, sediment, and metals, as well as continuous stage and discharge. A secondary level logger installed at the diversion weir shows no water overtopped the weir in 2022. A very small volume of water directly discharges via a small hole in the base of the structure designed to allow groundwater base flow into Brown's Creek. Total discharge to McKusick Lake was 41,610,620 cubic feet of water. The TP load was 389 pounds (0.101 lbs/ac) and the TSS load was 75,429 pounds (19.57 lbs/ac). Total discharge was below the ten year average, while the TP and TSS loads were the third and second lowest recorded, respectively, since load calculations began in 2006. The site is meeting the state standard for 2B waters for TSS, and for TP with some exceptions at base flow, but has historically had an extremely high storm loading rate. Erosional head cuts in the drainage tributaries have been identified as the source of the excessive loading rates through drone flights and surveys conducted by the District's engineer. Rock vanes and stabilization projects have been implemented by the District to reduce erosion and restore floodplain connectivity. Annual TSS and TP reductions as a result of these projects are estimated to be 70 pounds of sediment and 76 pounds of phosphorus per year.

Concentrations of metals were low in 2022 due to drought conditions. One chronic standard exceedance of lead was recorded, which is tied for the lowest amount of metals exceedances observed since metals analysis began in 2007. No bacteria samples were collected at the site in

2022, and previously collected samples have become too outdated to assess impairment status in this reach.

Long Lake Drainages

The Tributary to Long Lake at Marketplace Pond was monitored for nutrients, sediment, metals, and continuous stage and discharge, while the Tributary to Long Lake at 62nd Street was monitored for stage only. The total discharge to Long Lake at Marketplace Pond was 7,753,526 cubic feet, while the discharge at 62nd Street was estimated based on prior data at 274,469 cubic feet during the monitoring period. These were the second lowest and lowest annual discharge volumes, respectively, since monitoring began in 2005. The tributary at Marketplace Pond contributed 79 pounds of phosphorus (0.192 lbs/ac) and 7,112 pounds of sediment (17.35 lbs/ac). Although not classified as a 2B water, the state standard for TP was exceeded during base flow conditions in June and July, and the TSS standard is being met at the Marketplace Pond for all samples at base flow. Storm events at the tributary at Marketplace Pond exceeded the maximum standard for copper twice, and the chronic standard for lead one time.

McKusick Wetland Outlet

McKusick Wetland Outlet was added to the monitoring network in 2017. The outlet was monitored at its discharge point to Brown's Creek 100 feet upstream of the McKusick Road site for continuous stage, discharge, and temperature, as well as nutrients, sediment, and metals. Discharge to Brown's Creek during the period of monitoring (May 11 – October 26) was calculated at 5,153,850 cubic feet. The TP load for this period contributed 69.1 pounds of phosphorus, while the TSS load contributed 2,868 pounds of sediment. Although not a 2B water, when compared to state standards for TP and TSS the site meets the standard for TSS, but was well above the TP standard for three of four samples collected.

The Oak Glen Golf Course Irrigation Reuse project was completed in 2021, and directs flow from the wetland away from Brown's Creek to a pond to be used as irrigation water. This helps reduce thermal and nutrient loads to Brown's Creek and increases the suitability of the creek to support cold water species. As such, the outlet was intermittently or not discharging for a considerable portion of the season, from approximately June 23 to August 5. Continuous temperature data collected at the site show water discharged to the creek exceeded the TMDL threat level threshold 31.2% of the monitored period when flow was present, and the critical level threshold 3.5% of the period. This is substantially lower than recent years when water discharging from the wetland routinely exceeded the threat level threshold for more than 50% of the monitoring period.

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I. INTRODUCTION

Knowledge of the changes to water quality and quantity of our water resources through monitoring guides when, where, and how management activities should be implemented to protect or restore those resources. The Brown's Creek Watershed District (BCWD) utilizes monitoring and the data collected to make such decisions as outlined in its watershed management plan. In 2022 BCWD monitored 23 basins (lakes), four stations on Brown's Creek, a tributary to Brown's Creek, two stations in the Long Lake subwatershed, and one station in the diversion drainage at the Diversion Structure. A summary of monitoring locations and monitored parameters can be found in Table 1 and Figure 1.

The Washington Conservation District (WCD) also conducted special project and maintenance monitoring at several locations including the Iron Enhanced Sand Filter (IESF) on Morgan Avenue, Brown's Creek Rock Crib, Countryside Auto sediment chamber, McKusick Road sediment chambers, and the Oak Glen Golf Course Irrigation Reuse project. Comparable levels of data collection versus baseline sites occurred at each project, such as collection of continuous stage, discharge, and temperature, and measurement of sediment depths in complex monitoring situations. As this summary focuses on baseline monitoring data, special project monitoring will not specifically be discussed, although the locations of several projects are described. Individual monitoring summaries for each project will be prepared and made available in separate reports.

Table 1. Monitoring Site Location, Description, and Parameter(s) Monitored

Site Description	Map Site ID#	Site Name	General Site Location	Monitored Parameters
Stream Monitoring	**1**	Brown's Creek at Hwy 15	Hwy 15	Discharge and Water Quality Composite/Grab Samples
Stream Monitoring	**2**	Brown's Creek at McKusick Road	McKusick Road	Discharge and Water Quality Composite/Grab Samples
Stream Monitoring	**3**	Brown's Creek at Stonebridge Trail	Stonebridge Trail	Discharge and Water Quality Composite/Grab Samples
Stream Monitoring	**4**	Brown's Creek Outlet	Hwy 95 & 96	Discharge and Water Quality Composite/Grab Samples
Stream Monitoring	**5**	Brown's Creek Diversion	Neal Ave.	Discharge and Water Quality Composite/Grab Samples
Stream Monitoring	**6**	Tributary to Long Lake at 62nd St.	62nd St.	Stage
Stream Monitoring	**7**	Tributary to Long Lake at Marketplace Pond	Market Dr.	Discharge and Water Quality Composite/Grab Samples
BMP Effectiveness	**8**	Iron Enhanced Sand Filter (IESF)-1 Outlet	Morgan Ave. N.	Discharge and Water Quality Composite/Grab Samples
Stream Monitoring	**9**	McKusick Wetland Outlet	McKusick Road	Discharge and Water Quality Grab Samples
BMP Effectiveness	**10**	Brown's Creek Park Rock Crib (5 In-Crib Temperature Loggers and Outlet Discharge, 2 In-Stream Temperature Loggers)	Neal Ave.	Continuous Temperature, Discharge, Sediment Depth and Maintenance Requirements
BMP Maintenance	**11**	McKusick Road and Countryside Auto Sediment Chambers	McKusick Road	Sediment Depth and Maintenance Requirements
BMP Effectiveness	**12**	Oak Glen Pond Water Reuse	McKusick Road	Stage
			DNR ID	
Lake Monitoring	**13**	Kismet Basin	82-033400	Surface Water Quality Samples, Elevation
Lake Monitoring	**14**	Long Lake (North Basin)	82-002100	Surface Water Quality Samples, Elevation
Lake Monitoring	**15**	Goggins Lake	82-007700	Surface Water Quality Samples, Elevation
Lake Monitoring	**16**	South School Section Lake	82-015100	Surface Water Quality Samples, Elevation
Lake Monitoring	**17**	Benz Lake	82-012000	Surface Water Quality Samples, Elevation
Lake Monitoring	**18**	Masterman Lake	82-012600	Surface Water Quality Samples, Elevation
Lake Monitoring	**19**	Woodpile Lake	82-013200	Surface Water Quality Samples, Elevation
Lake Monitoring	**20**	Lynch Lake (North Basin)	82-004200	Surface Water Quality Samples, Elevation
Lake Monitoring	**21**	Lynch Lake (South Basin)	82-004202	Surface Water Quality Samples, Elevation
Lake Monitoring	**22**	Bass Lake (West)	82-012300	Surface Water Quality Samples, Elevation
Lake Monitoring	**23**	Bass Lake (East)	82-012400	Surface Water Quality Samples, Elevation
Lake Monitoring	**24**	July Avenue Pond	82-031800	Surface Water Quality Samples, Elevation
Lake Monitoring	**25**	Pat Lake	82-012500	Surface Water Quality Samples, Elevation
Lake Monitoring	**26**	Plaisted Lake	82-014800	Surface Water Quality Samples, Elevation
Lake Monitoring	**27**	Jackson Wildlife Management Area Pond (Sinnits Pond)	82-030500	Surface Water Quality Samples, Elevation
Lake Monitoring	**28**	Brewer's Pond	82-002200	Surface Water Quality Samples, Elevation
Lake Monitoring	**29**	Heifort's Pond	82-048500	Surface Water Quality Samples, Elevation
Lake Monitoring	**30**	North School Section	82-014900	Surface Water Quality Samples, Elevation
Lake Monitoring	**31**	Highway 12 & Kimbro Pond	82-034900	Chloride, Elevation
Lake Monitoring	**32**	Brown's Creek at Gateway Trail	82-030300	Elevation
Lake Monitoring	**33**	55th St. Pond	82-031600	Elevation
Lake Monitoring	**34**	Vanzwol Pond	82-012800	Elevation
Lake Monitoring	**35**	Highway 96 Wetland	82-033500	Chloride

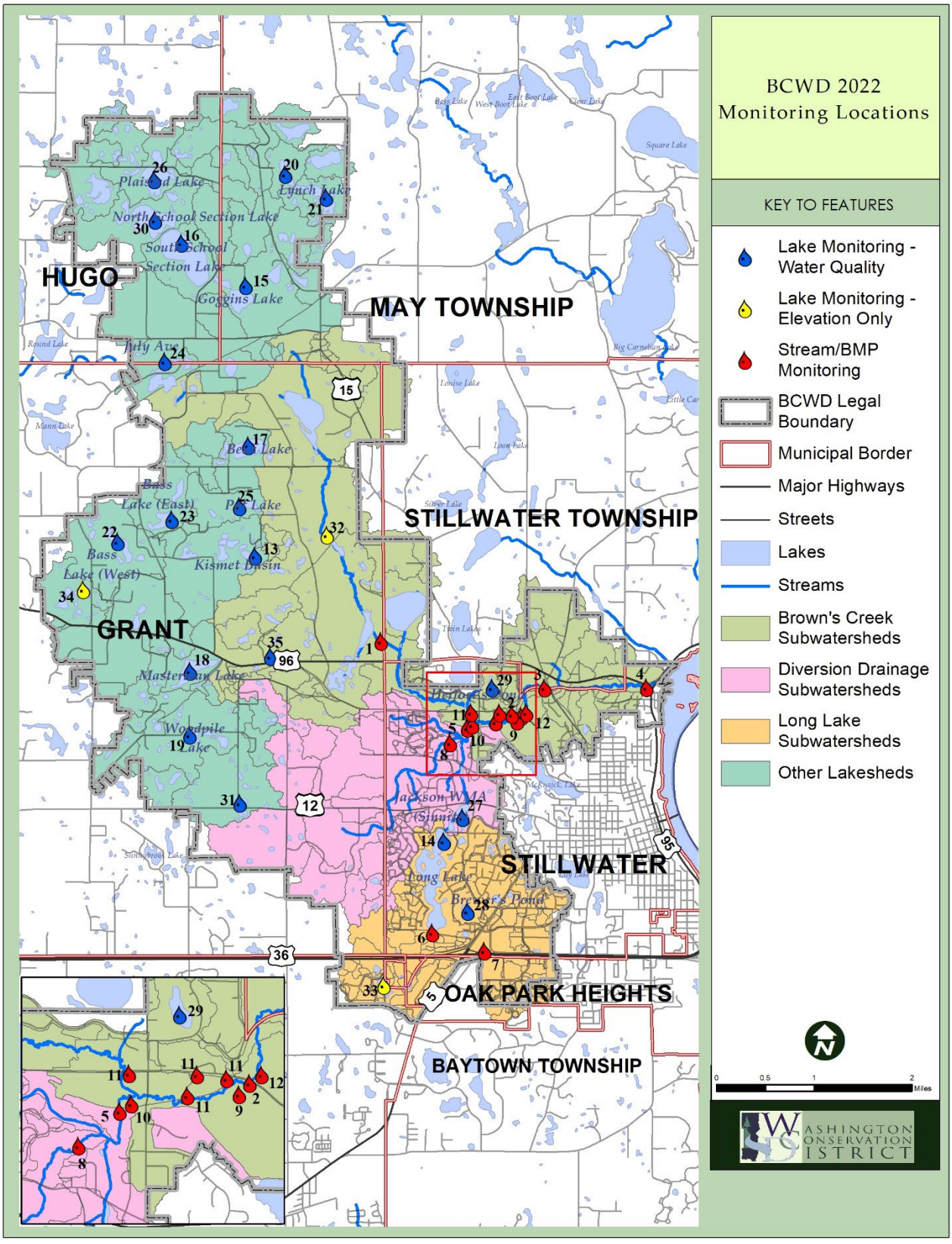


Figure 1. Brown's Creek Watershed District 2022 Sampling Locations

II. PURPOSE AND GOALS

BCWD uses a monitoring network to assess the quality of its water resources and maintains partnerships with the Minnesota Department of Natural Resources (MN DNR), Metropolitan Council, Washington Conservation District (WCD), Stillwater Area High School, and volunteers to collect and manage data. The general purpose of the baseline water monitoring program is to collect long term data to identify issues within the watershed and track changes towards meeting water quality goals described in the 2017-2026 Watershed Management Plan and the Brown's Creek TMDL Implementation Plan. The goals specific to this monitoring summary include the collection of useful data about the water resources of the District, production of an annual assessment of monitoring data, and the use of that data to determine the performance of District programs and regulations. Additional policies, goals, and implementation strategies related to monitoring data are more fully described in the watershed management plan.

III. LAKE MONITORING

III.A. Locations and Parameters

In 2022 water quality data were collected by the WCD on eighteen basins (lakes) (Table 1 and Figure 1). Each lake was sampled for total phosphorus (TP), total Kjeldahl nitrogen (TKN), chlorophyll-α, and Secchi disk transparency. A complete listing of nutrient and Secchi data by lake is available in Appendix A. One meter increment temperature and dissolved oxygen profiles as well as a user perception ranking (physical and recreational suitability) were also recorded. These data are available via request or on the Metropolitan Council's Environmental Information Management System (EIMS) Water Quality Database website (https://eims.metc.state.mn.us).

III.B. Methods

Each basin was sampled over seven consecutive months (April-October) using a two-meter (6.56 feet) integrated surface water column sampler from a watercraft, except for Brewer's Pond and Heifort's Pond, which were sampled from the surface only using a bucket to match citizen volunteer protocols. Bass Lake East, Bass Lake West, Benz Lake, Goggins Lake, Jackson WMA Pond, Kismet Basin, Long Lake, Lynch Lake South, Masterman Lake, Plaisted Lake, South School Section Lake, and Woodpile Lake were monitored bi-weekly, while Brewer's Pond, Heifort's Pond, July Avenue Wetland, Lynch Lake North, North School Section Lake, and Pat Lake were monitored every four weeks. Volunteers monitored Brewer's Pond and Heifort's Pond on an offset schedule with WCD so that samples were collected every other week. Chlorophyll-α samples were obtained by filtering water from the integrated sample through a 1.5 µm fiberglass filter using a hand pump. Samples collected for TP, TKN, and chlorophyll-α were analyzed by the Metropolitan Council Environmental Services Lab. The sampling methods above were developed by and consistent with Metropolitan Council's Citizen Assisted Monitoring Program (CAMP). Measurements obtained during the sampling season were averaged to allow comparison of individual lake dynamics from year to year. Trend analysis for

long term Secchi disk transparency, TP, and chlorophyll-α (corrected for pheophytin) trends were completed using a Kendall's Tau statistical test, presented in Appendix A, and only data collected by professional agencies were used to assess for trends. All other data were quality assured, quality controlled, and reviewed by WCD staff. Detailed standard operating procedures used by WCD for water sampling, monitoring, and data management are available on the WCD website (https://www.mnwcd.org/water-monitoring).

III.C. Results and Discussion

III.C.1. Lake Grades

The lake water quality grading system was developed following the 1989 sampling season by Metropolitan Council. This grading system ranks water quality characteristics by comparing summer averages to those of other lakes specific to the metro area. The grading curve represents percentile ranges for the May through September averages of total phosphorus concentration, uncorrected trichromatic chlorophyll-α concentration, and Secchi disk transparency for 119 lakes sampled from 1980 to 1988, and the ranges were re-confirmed in 2000 using more recent data. Percentile ranges for each parameter can be found in Table 2. A benefit of the lake grade system is that it was developed specifically for lakes in the metro area, and serves as a convenient way to compare water quality between lakes. Current grades for each lake can be found in Figure 2, and the latest ten years of grades for each lake can be found in Appendix A. In addition, comparison of June through September water quality averages (total phosphorus concentration, pheophytin-corrected chlorophyll-α, and Secchi disk transparency) will be made to state eutrophication standards for each lake as the Minnesota Pollution Control Agency (MPCA) uses this timeframe to assess impairment status. Beginning in 2019 volunteer data collected through the CAMP program on Brewer's Pond and Heifort's Pond were incorporated into lake grade and summer averages. June through September averages and impairment thresholds can be found in Table 3.

Table 2. Lake Grade Ranges

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

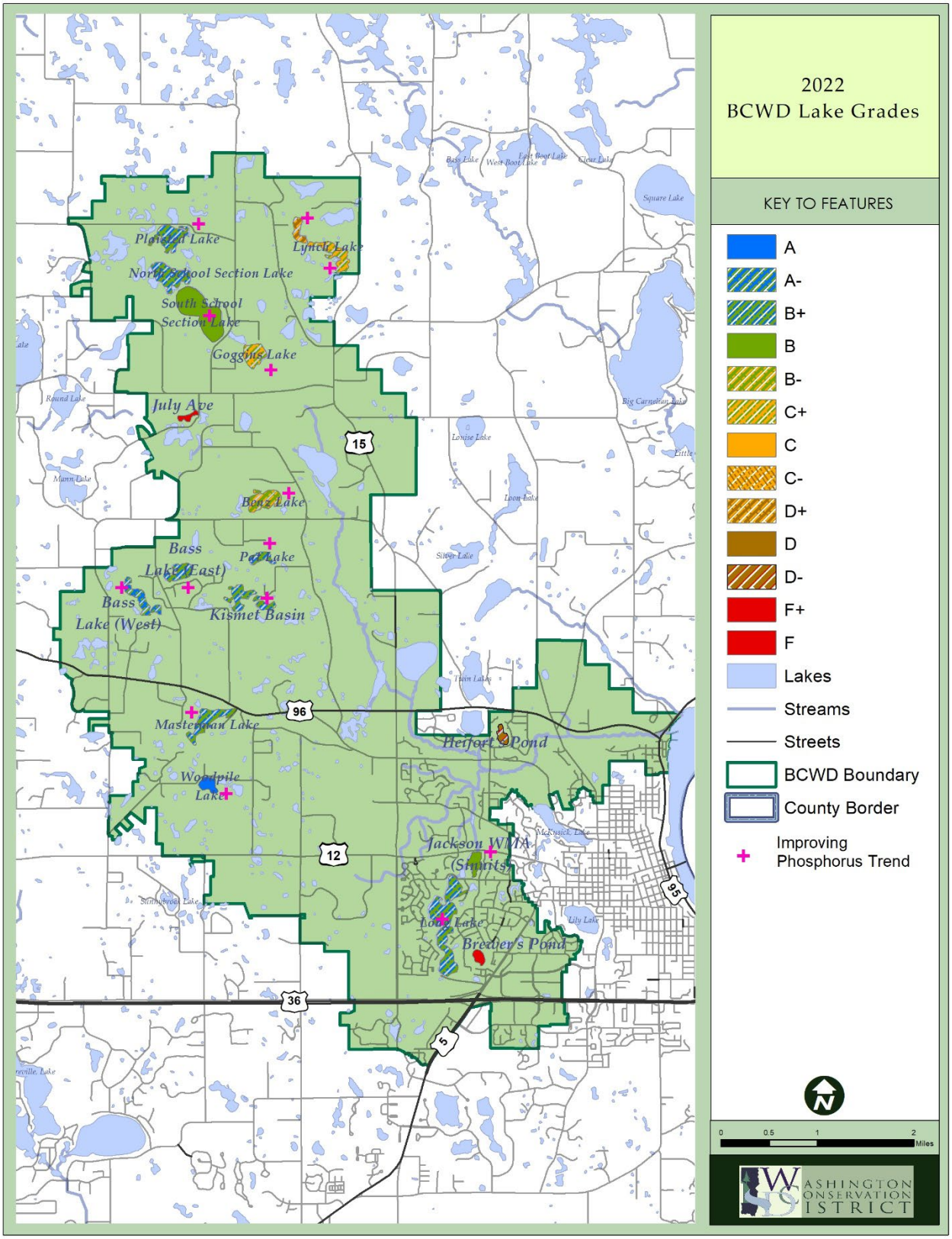


Figure 2. Brown's Creek Watershed District 2022 Lake Grades

Table 3. Impairment Thresholds and June Through September Average 2022 Parameters

Lake	Total Phosphorus (mg/L)	Pheophytin Corrected Chlorophyll-α (µg/L)	Secchi (meters)	Total Kjeldahl Nitrogen (mg/L)
Impairment Threshold- Shallow	*0.060*	*20.0*	*1.00*	*N/A*
Impairment Threshold- Deep	*0.040*	*14.0*	*1.40*	*N/A*
Bass East	0.030	2.9	2.79	0.66
Bass West	0.023	5.2	2.79	0.62
Benz	0.028	3.2	1.12	0.57
Brewer's	0.090	94.9	0.31	3.31
Goggins	0.039	15.1	1.74	0.93
Heifort's	0.068	81.4	0.44	2.59
Jackson WMA	0.024	3.0	1.61	0.68
July Ave	0.197	128.3	0.23	4.35
Kismet	0.018	4.4	1.69	0.51
Long	0.025	3.6	2.68	0.71
Lynch North	0.070	36.5	0.72	1.38
Lynch South	0.037	14.4	1.71	0.91
Masterman	0.019	4.4	1.34	0.51
North School Section	0.027	8.9	2.51	0.73
Pat	0.030	7.3	2.17	0.70
Plaisted	0.021	4.0	2.00	0.51
South School Section*	0.034	18.8	2.24	0.85
Woodpile*	0.023	5.2	3.13	0.66

Exceeds impairment threshold

*Indicates deep lake. All others are classified as shallow.

Lake grades slightly improved for most lakes in the District when compared to 2021. Four lakes experienced a decline in lake grade; Bass Lake East, Brewer's Pond, July Avenue Wetland, and Plaisted Lake. Goggins Lake, Lynch Lake North, Lynch Lake South, Masterman Lake, South School Section Lake, and Woodpile Lake maintained their grade from the year prior, and all other lakes improved in lake grade. Conditions were similar to 2021 with warm temperatures and drought conditions, however the open water season started in mid-April for most waterbodies, which was likely a contributing factor to slight improvement in lake grades. An increased period of open water from early spring ice out can encourage algal growth, as seen in 2021.

The most notable shift in lake grade occurred on Long Lake with continued improvements in water quality from an F+ grade in 2016, to a B+ grade in 2022. This appears to be the result of lower chlorophyll-α concentrations and higher water clarity, which may be the product of a robust community of aquatic vegetation. South School Section Lake also continues to respond positively to treatments to remove curly-leaf pondweed. The lake was treated in 2017 and May of 2021, and has improved from a D+ grade in 2018 to a B grade in 2021-2022. The decline to a D+ grade in 2018 after the initial treatment was likely the result of a release in nutrients stored in the curly-leaf pondweed, before the remaining vegetative community recovered. Curly-leaf pondweed was also found in a small area of Goggins Lake near the connection between Goggins Lake and South School Section Lake. Goggins Lake was also treated for curly-leaf pondweed in 2021, but no significant changes in water quality have been observed.

III.C.2. Total Phosphorus

Phosphorus is a major nutrient involved in eutrophication and is generally associated with the growth of aquatic plants and algal blooms. Common sources of phosphorus include runoff from agricultural fields, livestock areas, urban areas, lakeshore lawns and improperly operating septic systems. In most lakes in this region, phosphorus is the least available nutrient; therefore, its abundance or scarcity controls the extent of algal growth. Algal growth in turn affects the clarity of the water and light penetration, and can control the extent of aquatic vegetation by shading out plants. The phosphorus flow path through the watershed can be found in Appendix C.

The state impairment threshold for total phosphorus (TP) is 0.060 mg/L in shallow lakes (generally greater than 50 acres and less than 15 feet deep, or more than 80% littoral area) and 0.040 mg/L in deeper lakes. In 2022 Brewer's Pond, Heifort's Pond, July Avenue Wetland, and Lynch Lake North summer average TP concentrations exceeded impairment standards (Table 3).

Trend analyses were completed on lakes where eight or more years, with at least six years occurring in the last ten years, of TP measurements had been collected to determine if lakes are improving, declining, or stable in terms of average summer TP. A two-tailed Kendall's Tau statistical test was completed using a p-value of <0.05 to determine statistical significance of the trend. Bass Lake East, Bass Lake West, Benz Lake, Goggins Lake, Jackson WMA Pond, Kismet Basin, Long Lake, Lynch Lake North, Lynch Lake South, Masterman Lake, Pat Lake, Plaisted Lake, South School Section Lake, and Woodpile Lake have improving trends for TP, meaning the average summer TP concentration is decreasing (Figure 2 and Appendix A). No statistically significant trend exists on July Avenue Wetland, and Brewer's Pond, Heifort's Pond, and North School Section Lake do not have enough years of data to calculate trends. South School Section Lake shifted from no trend in recent years to an improving TP trend starting in 2022. The Brown's Creek and Long Lake 2020 Trend Analysis completed by the District's engineer, Emmons & Oliver Resources, Inc. (EOR) also show an improving short term trend from 2011-2020, and a statistically significant improving trend over the long term, from 1995-2020, on Long Lake.

III.C.3. Chlorophyll-α

Chlorophyll-α is a photosynthetic compound found in algae and aquatic plants, and is a direct indicator of algal productivity. Lakes with high chlorophyll-α concentrations are often eutrophic or hypereutrophic. These lakes tend to have excessive algal growth, shading out rooted plants. Lakes with low chlorophyll-α concentrations can be mesotrophic or even oligotrophic, and tend to have more rooted plants to take up phosphorus, rather than phosphorus being used by algae within the water column which produces more chlorophyll-α.

The impairment threshold for chlorophyll-α is 20 µg/L in shallow lakes and 14 µg/L in deeper lakes. Brewer's Pond, Heifort's Pond, July Avenue Wetland, Lynch Lake North, and South

School Section Lake summer average concentrations exceeded the impairment threshold (Table 3).

Trend analyses were completed on lakes where eight or more years, with at least six years occurring in the last ten years, of chlorophyll-α measurements had been collected to determine if lakes are improving, declining, or stable in terms of algal productivity. A two-tailed Kendall's Tau statistical test was completed using a p-value of <0.05 to determine statistical significance of the trend. Bass Lake East, Benz Lake, Goggins Lake, Jackson WMA Pond, Kismet Basin, Long Lake, Lynch Lake North, Lynch Lake South, Masterman Lake, Pat Lake, Plaisted Lake, and Woodpile Lake show statistically significant long term trends for improving chlorophyll-α concentrations, meaning less algae is being produced (Appendix A). No statistically significant trends were present on Bass Lake West, July Avenue Wetland, or South School Section Lake. No lakes showed an increasing trend for chlorophyll-α concentration. There are not enough years of collected data to calculate trends on Brewer's Pond, Heifort's Pond, and North School Section Lake. EOR's trend analysis also shows a short term improving trend and a statistically significant long term improving trend on Long Lake.

III.C.4. Transparency

The measurement of depth of light penetration using a Secchi disk provides a simple measure of water transparency, or clarity. It can also serve as a proxy for turbidity in the water, as well as an indication of the trophic state of the lake. A reduction in water transparency is usually the result of turbidity composed of suspended sediments, organic matter and/or phytoplankton (algae). Several lakes in the district, such as Benz Lake and Masterman Lake, are clearer than they are deep, meaning an accurate measure of transparency cannot be achieved because the disk rests on the lake bottom or is obscured by vegetation instead of reaching a depth where it is no longer visible. This can give the false appearance of low water clarity when considering average transparency, when in reality the true Secchi depth is much higher. Lakes which experience this phenomenon are noted in the summary points sections of Appendix A.

The impairment threshold for Secchi disk transparency is 1.00 meter in shallow lakes and 1.40 meters in deep lakes. Brewer's Pond, Heifort's Pond, July Avenue Wetland, and Lynch Lake North summer average transparencies were poorer than the state standard (Table 3).

Trend analyses were completed on lakes where eight or more years, with at least six years occurring in the last ten years, of Secchi disk measurements had been collected to determine if lakes are improving, declining, or stable in terms of average summer clarity. A two-tailed Kendall's Tau statistical test was completed using a p-value of <0.05 to determine statistical significance of the trend. Goggins Lake, Long Lake, Lynch Lake North, Lynch Lake South, and Woodpile Lake show statistically significant long term trends for improving water clarity (Appendix A). No significant trends have been observed on Pat Lake or South School Section

Lake. Bass Lake East, Bass Lake West, Benz Lake, Jackson WMA Pond, Kismet Basin, Masterman Lake, and Plaisted Lake are too shallow to determine an accurate trend, since the lakes are often clearer than they are deep. July Avenue Wetland is the only lake exhibiting a declining trend for clarity. There are not enough years of collected data to calculate trends on Brewer's Pond, Heifort's Pond, and North School Section Lake. EOR's trend analysis shows an improving short term trend and a statistically significant long term improving trend on Long Lake.

III.C.5. Total Kjeldahl Nitrogen

Total Kjeldahl nitrogen (TKN) measures the sum of ammonia and organic nitrogen present in the water column. An abundance of this nutrient can lead to excess plant growth and increase the rate of eutrophication, especially if it is the limiting nutrient in a lake. Sources of TKN are similar to those of TP. Although eutrophication standards do not exist at this time for TKN, June through September averages can be compared to the North Central Hardwood Forest ecoregion to assess if lakes may have excessive amounts of nitrogen. The ecoregion range for TKN is 0.60-1.20 mg/L. Brewer's Pond, Heifort's Pond, July Avenue Wetland, and Lynch Lake North were poorer than the ecoregion range, while Bass Lake East, Bass Lake West, Benz Lake, Goggins Lake, Jackson WMA Pond, Long Lake, Lynch Lake South, North School Section Lake, Pat Lake, South School Section Lake and Woodpile Lake were within the ecoregion range (Table 3). Kismet Basin, Masterman Lake, Plaisted Lake were better than the ecoregion range.

III.C.6. Temperature and Dissolved Oxygen

In addition to surface water measurements, temperature and dissolved oxygen data were recorded during each sampling event. Temperature and dissolved oxygen were recorded at one-meter increments from the surface to the lake bottom. The data collected from these profiles are housed by WCD and are available upon request, or are available via the MPCA website (https://webapp.pca.state.mn.us/wqd/surface-water).

These data show the extent of summer stratification and are useful in identifying the thermocline (the layer of water in which the temperature rapidly declines), if one exists. As a lake stratifies, the water column becomes more stable and mixing is less likely to occur. If mixing occurs during the growing season, benthic nutrients become available and can result in increased algal production. As a rule of thumb, shallow lakes are constantly mixed by wind, wave action, and precipitation, while lakes deeper than 20 feet often stratify. Shallow lakes can loosely stratify if they are protected from wind, during calm weather periods, or if enough algae and aquatic plants exist near the surface to block out solar radiation near the bottom.

In 2022 Bass Lake East, Long Lake, Lynch Lake South, Pat Lake, and Woodpile Lake stratified to some degree during the monitoring season. These lakes may have benefited from reduced internal loading due to the lack of mixing of nutrient-rich waters near the lake bottom. Details on

the depth of the thermocline for each lake that stratified can be found in Appendix A. The other thirteen lakes in the district did not significantly stratify in 2022, meaning nutrients from internal loading were available for algal growth during the entire growing season.

III.C.7. Elevations

Lake elevations throughout the watershed started high in 2022 due to snowmelt and spring precipitation events, but dropped rapidly throughout the monitoring season due to dry and drought conditions. Peak elevation for the year on nearly every lake occurred in April, after which water levels consistently dropped for the rest of the year, rising only briefly in late August. In 2020, twelve basins maintained elevations above their regulated Ordinary High Water (OHW) level. In contrast, only three basins were above their OHW by the end of the season in 2022; North School Section Lake, Plaisted Lake, and South School Section Lake. Goggins Lake, South School Section Lake, July Avenue Wetland, and an unnamed pond at County Road 12 and Kimbro Avenue had risen over ten feet from lows around 2010, and peaked in 2020 due to a series of wet years. By the end of the 2022 monitoring season these basins receded 4.92 feet, 3.94 feet, 7.84 feet, and 6.62 feet, respectively, since their recent peak, highlighting the impact of the drought. Also notable were the water level declines at Bass Lake East of 5.46 feet and Plaisted Lake of 3.79 feet since their peaks in 2020. Elevation charts for each lake monitored can be found in Appendix A or using the MN DNR's Lake Finder (http://www.dnr.state.mn.us/lakefind/index.html).

III.C.8. Chloride

In 2022 two rounds of chloride samples were collected on twenty waterbodies in the District, with one sample collected in the spring and another in the fall. All chloride sample results were below the state chronic standard of 230 mg/L.

Table 4. Chloride Lake Sample Results 2022

Lake	Spring Chloride Result (mg/L)	Fall Chloride Result (mg/L)	Lake	Spring Chloride Result (mg/L)	Fall Chloride Result (mg/L)
Bass East	6.7	8.5	Lynch North	< 5.0	< 5.0
Bass West	8.7	8.3	Lynch South	< 5.0	< 5.0
Benz	11.1	13.2	Masterman	16.4	20.3
Brewer's	23.8	30.3	North School Section	15.6	14.6
Goggins	14.4	15.7	Pat	< 5.0	< 5.0
Heifort's	28.2	30.6	Plaisted	27.5	26.1
Jackson WMA (Sinnits)	101.0	152.0	South School Section	12.6	14.7
July Ave	8.9	9.5	Wood Pile	15.5	19.1
Kismet	8.1	8.0	12 & Kimbro Pond	40.1	45.3
Long	89.4	154.0	Highway 96 Wetland	38.2	52.7

IV. STREAM AND STORMWATER MONITORING

IV.A. Locations and Parameters

In 2022, BCWD monitored four stations on Brown's Creek, two stations in the Long Lake subwatershed, one station at the Diversion Structure in the diversion drainage, and one tributary to Brown's Creek (Table 1 and Figure 1). The stations on Brown's Creek were located at Manning Avenue (Highway 15), McKusick Road, Stonebridge Trail (Stonebridge), and the intersection of Minnesota State Highways 95 & 96 (the Outlet). The two tributaries to Long Lake were monitored at 62nd Street and the Marketplace Pond. The tributary to Brown's Creek (McKusick Wetland Outlet) was monitored approximately 100 feet upstream of the McKusick Road station.

The four stations on Brown's Creek were monitored for continuous (15 minute) stage and discharge, total phosphorus (TP), dissolved phosphorus, total Kjeldahl nitrogen (TKN), total suspended solids (TSS), volatile suspended solids (VSS), copper, nickel, lead, zinc, cadmium, chromium, chloride, calcium, magnesium, nitrate, nitrite, ammonia, hardness, and *Escherichia coli* (*E.coli*). These sites were also monitored for continuous temperature, dissolved oxygen, specific conductivity, and turbidity, and continuous pH at Stonebridge and the Outlet. The Outlet was additionally sampled for sulfate, alkalinity, and ortho-phosphorus. The Tributary to Long Lake at Marketplace Pond was monitored for continuous stage and discharge, TP, dissolved phosphorus, TKN, TSS, VSS, copper, nickel, lead, zinc, cadmium, chromium, chloride, calcium, magnesium, nitrate, nitrite, ammonia, and hardness. The Tributary to Long Lake at 62nd Street was monitored for continuous stage only. The station at the Diversion Structure was monitored for continuous stage and discharge, TP, dissolved phosphorus, TKN, TSS, VSS, copper, nickel, lead, zinc, cadmium, chromium, chloride, calcium, magnesium, nitrate, nitrite, ammonia, and hardness. An additional level logger was placed at the base of the diversion structure weir to determine if water overtopped it and was discharged directly to Brown's Creek. A tributary to Brown's Creek, McKusick Wetland Outlet, was monitored for continuous stage, discharge, and temperature, and TP, dissolved phosphorus, TKN, TSS, VSS, copper, nickel, lead, zinc, cadmium, chromium, chloride, calcium, magnesium, nitrate, nitrite, ammonia, *E.coli,* and hardness. Continuous precipitation was monitored at Highway 15 and the tributary to Long Lake at Marketplace Pond.

IV.B. Methods

The Highway 15, McKusick Road, Stonebridge, Outlet, Marketplace Pond, and Diversion Structure monitoring stations utilized automated water quality samplers consisting of a stage/velocity sensor, data logger, bottle carousel containing 24 sample bottles, strainer, intake tubing, solar panel, deep cycle marine battery, and steel enclosure. Discharge was calculated using a rating curve based on permanent staff gauges at Highway 15, McKusick Road, Stonebridge, and the Outlet, while discharge at Marketplace Pond and the Diversion Structure

was calculated using an area-velocity relationship. Continuous precipitation data were collected at Highway 15 and Marketplace Pond using tipping bucket rain gauges to assist in loading calculations, but are not discussed in this summary. The samplers were programmed to collect automated flow weighted storm composite samples triggered by a rise in stage. Manual grab samples were taken during storm conditions if it was determined the automated sampler had malfunctioned or had not yet been installed. Monthly manual grab samples during base flow conditions were attempted at these sites, although the Tributary to Long Lake at Marketplace Pond is often dry or stagnant during non-event periods. *E.coli* samples were collected at the time as the base grab samples when possible. Continuous temperature, dissolved oxygen, specific conductivity, and turbidity at the four stations on Brown's Creek were collected using long term deployed sondes, and secondary temperature loggers were deployed to fill data gaps created by malfunctions of the primary sonde. Sondes were also used to collect continuous pH at McKusick Road, Stonebridge and the Outlet.

It must be noted the sampling strategy at the Outlet, at the direction of Metropolitan Council Environmental Services's (MCES) Watershed Outlet Monitoring Program (WOMP), was changed to a manual grab sample on the same day every other week regardless of flow conditions, and the composite sampler was to be programmed to capture only major events. MCES installed a new data logger and refrigerated sampler in 2019, and four storm composite samples were collected in 2022. Some analytes such as metals, sulfate, ortho phosphorus, alkalinity, and hardness were changed to be analyzed quarterly. The goal of this strategy is to create a more robust dataset that is better suited for long term statistical trend analysis and impairment assessment. However, the change in sampling methods causes an apparent shift to lower nutrient loading totals due to differences in load calculation methods, as well as the timing of samples with respect to precipitation events. A limitation of grab sampling is the sample occurs at a discrete point in time and often misses the peak load which is most likely to occur on the rising limb or at the peak flow of a storm. This can lead to artificially low loading estimates, whereas composite sampling captures multiple samples throughout the storm and can provide more accurate data for loading calculations but is less appropriate for trend analysis due to bias and variation in each storm event.

The Tributary to Long Lake at 62nd Street station was monitored using a stage sensor only, and discharge during the monitoring period was estimated based on stage and discharge data collected in previous years. The McKusick Wetland Outlet station was monitored using a stage/velocity sensor, and discharge was calculated using an area-velocity relationship. Similar to other stations, monthly manual grab samples were collected during base flow conditions, and grab samples were attempted during storm events.

All samples collected were analyzed by the MCES Lab and reviewed by WCD staff. All continuous data were quality assured, quality controlled, and analyzed by WCD staff, with the

exception of the Outlet stage, discharge, and loading, which were reviewed and analyzed by MCES. More detailed standard operating procedures used by WCD and MCES for water sampling, monitoring, and data management are available online (http://www.mnwcd.org/water-quality-water-monitoring/ and https://eims.metc.state.mn.us/Documents).

IV.C. Results and Discussion

IV.C.1. Brown's Creek

Brown's Creek is classified as a 2A water by the State of Minnesota, meaning it is designated for aquatic life and recreation, and should support a cold water fishery, aquatic life, and their habitats. The creek is listed as impaired by the MPCA due to a lack of cold water fish assemblages and low scores for indices of biological integrity (IBI) as described in the 2010 Brown's Creek Biota TMDL, and two reaches are impaired for *E.coli*. The stressors identified which contribute to these conditions are high total suspended solids (TSS), high temperature, low dissolved oxygen, high copper concentrations, and high nitrate-nitrite concentrations. The lower reaches of the creek where groundwater inputs help to cool the stream do support a trout fishery with some natural reproduction, and is annually stocked by the MN DNR. The following sections will make comparisons between the parameters monitored and state standards for 2A waters as described in the Minnesota Administrative Rules Part 7050.0222, as well as recommendations and goals set forth in the TMDL study. A summary of the standards and goals can be found in Table 5**.**

Table 5. State Standards for 2A and 2B Waters and Brown's Creek Biota TMDL Goals

Parameter	Class 2A Waters	Class 2B Waters	TMDL Goal
Total Phosphorus (TP)	0.100 mg/L	0.100 mg/L	N/A
Total Suspended Solids (TSS)	10 mg/L (Apr 1 to Sept 30)	30 mg/L (Apr 1 to Sept 30)	23 mg/L (10 NTU equivalent)
Chloride (Chronic)	>230 mg/L	>230 mg/L	N/A
Dissolved Oxygen (Daily Minimum)	7 mg/L	5 mg/L	7 mg/L
pH	<6.5 or >8.5	<6.5 or >8.5	N/A
Temperature	N/A	N/A	18.3 ºC (Threat), 23.9 ºC (Critical)

1a. Discharge

Total discharge decreased from the year prior at each station on Brown's Creek. The total amount of water discharged to the St. Croix River as measured at the Outlet was 220,440,000 cubic feet, and is the second lowest annual discharge over the last ten years. Calculated discharge for each site can be seen in Table 10. The Brown's Creek and Long Lake 2020 Trend Analysis completed by EOR shows there is a statistically significant increasing trend in overall streamflow at all stations except the Outlet, after construction of the Diversion Structure. Base flow also shows a statistically significant increasing trend at all sites except the Outlet. Increased base flow is considered beneficial for cooling the stream and maintaining dissolved oxygen concentrations.

According to the National Weather Service (NWS) station in Stillwater the total precipitation for 2022 was 27.03 inches; 6.95 inches below the thirty year average. Precipitation was well below average in June, July, September, and October, during which only roughly one-quarter of average precipitation was recorded. Drought conditions persisted for much of the summer, reaching the severe drought classification by August, according to the U.S. Drought Monitor. Minor temporary drought relief came in August during a series of storm events. The most significant precipitation event occurred from August 27 to 29, where a storm total of 2.27 inches of precipitation was recorded.

1b. Phosphorus & Sediment

The total phosphorus (TP) and total suspended solids (TSS) loads decreased at all sites when compared to 2021 (Table 10, Figure 3, and Figure 4). The TP load discharged to the St. Croix River at the Outlet was 1,219 pounds, which equates to 0.264 pounds per acre of watershed land. For reference, the load at the Outlet was the second lowest since load calculations began in 2000. The state standard for TP is 0.100 mg/L; monthly manual grab samples exceeded the standard for sites during snowmelt and storms in March, and following storm events in June and July. Nutrient water chemistry results for each site and sample can be found in Table 6-Table 9. TP flow weighted mean concentrations show a significant decreasing trend over the most recent ten year period at Stonebridge and the Outlet according to EOR's trend analysis. There are no significant long term trends, although the overall pattern for TP concentrations appears to be improving in the lower reaches of the creek. Short term trends show statistically significant improving conditions at Stonebridge and the Outlet

The TSS load exported to the St. Croix River was 172,589 pounds, or 37.32 pounds per acre of watershed land. The TMDL goal for the creek is 74 pounds per acre, which was met for the second year in a row since 2010. It is important to note that similar to 2021, the drought conditions significantly influenced this value, and efforts to reduce storm loading rates should continue. While the state standard for TSS is 10 mg/L from April 1 to September 30, the target concentration identified in the TMDL is 23 mg/L. The target concentration specific to Brown's Creek of 23 mg/L correlates to the former state standard for turbidity of 10 NTU, but has since been replaced by the river eutrophication standards which use TSS concentration to assess impairment status. The state TSS standard was exceeded at Stonebridge in June, and at the Outlet in April, May, and July. The TMDL goal was met at all sites under base flow conditions. Site and sample specific results can be found in Table 6-Table 9. No statistically significant long term trends in TSS exist at any station according to EOR's trend analysis. However, the most recent ten year period does show significant trends for decreasing flow weighted mean concentrations for TSS at McKusick Road, Stonebridge, and the Outlet.

A summary of site specific total loads and loading per acre of watershed area can be found in Table 10 and detailed loading tables describing hourly intervals for the year can be found in Appendix B. Discrete measurements of dissolved oxygen, temperature, pH, specific conductivity, and transparency can also be found in Appendix B. TP concentrations and loads moving on flow paths through the watershed can be seen in Appendix C.

Table 6. Brown's Creek at Highway 15 2022 Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	*E. coli* (mpn/100 mL)	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L _CaCO3)
Snowmelt Grab	3/16/2022 14:11	3/16/2022 14:11	4	3	0.66	0.117	0.074		<0.00050	<0.00050	<0.00050	<0.00500	<0.00010	<0.00100	14.4	<0.06	1.03	0.18	161
Storm Composite	5/11/2022 22:10	5/12/2022 13:52	213	110	1.50	0.203	~0.049		0.00280	0.00110	0.00091	0.00780	0.00018	<0.00100	11.5	<0.06	<0.20	<0.06	84
Storm Composite	8/19/2022 5:32	8/20/2022 18:29	16	9	1.00	0.169	0.053		0.00130	0.00064	<0.00050	0.00590	0.00010	<0.00100	10.8	<0.06	0.23	<0.06	149
Storm Composite	8/29/2022 1:00	8/29/2022 9:14	18	12	1.20	0.148	0.082		0.00120	0.00069	0.00058	<0.00500	0.00015	<0.00100	10.5	<0.06	0.23	<0.06	156
Base Grab	5/6/2022 8:43	5/6/2022 8:43	<3	<3	0.44	~0.045	~0.036	22							19.8	<0.06	0.36	<0.06	
Base Grab	6/17/2022 8:30	6/17/2022 8:30	6	<6	0.59	0.160	0.053	291							13.5	<0.06	0.69	0.10	
Base Grab	7/8/2022 8:14	7/8/2022 8:14	4	<3	0.41	0.113	0.070	404							14.7	<0.06	0.99	<0.06	
Base Grab	7/27/2022 13:28	7/27/2022 13:28	9	5	0.48	0.106	0.092	228							14.2	<0.06	0.99	<0.06	
Base Grab	8/26/2022 8:15	8/26/2022 8:15	3	3	0.26	0.090	0.066	236							12.9	<0.06	1.05	<0.06	
Base Grab	9/12/2022 13:03	9/12/2022 13:03	3	<3	0.30	~0.047	<0.020	98							13.7	<0.06	1.02	<0.06	
Base Grab	10/13/2022 9:26	10/13/2022 9:26	5	3	0.31	0.051	~0.031	255							15.8	<0.06	0.90	<0.06	

Exceeds Water Quality Standard
No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard
Exceeds Final Acute Standard

Table 7. Brown's Creek at McKusick Road 2022 Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	*E. coli* (mpn/100 mL)	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L _CaCO3)
Snowmelt Grab	3/16/2022 14:41	3/16/2022 14:41	17	8	1.50	0.273	0.140		0.00150	0.00071	<0.00050	<0.00500	<0.00010	<0.00100	38.8	<0.06	0.86	0.49	154
Storm Composite	5/11/2022 21:13	5/12/2022 2:02	153	42	6.40	0.897	0.062		0.00760	0.00570	0.00590	0.03160	0.00021	0.00690	19.5	<0.06	0.35	0.09	98
Storm Composite	8/18/2022 18:45	8/19/2022 4:47	331	75	2.60	0.530	0.109		0.00340	0.00300	0.00310	0.02240	0.00018	0.00430	23.2	<0.06	0.71	<0.06	176
Storm Composite	8/29/2022 0:30	8/29/2022 9:40	258	72	3.60	0.767	0.081		0.00540	0.00400	0.00420	0.01850	0.00012	0.00560	23.8	<0.06	0.30	<0.06	151
Base Grab	5/6/2022 9:16	5/6/2022 9:16	3	<3	0.54	~0.039	~0.042	22							24.7	<0.06	0.25	<0.06	
Base Grab	6/17/2022 8:58	6/17/2022 8:58	6	<6	0.50	0.129	0.057	614							21.5	<0.06	0.70	<0.06	
Base Grab	7/8/2022 9:03	7/8/2022 9:03	6	3	0.40	0.134	0.071	1,414							24.2	<0.06	0.88	<0.06	
Base Grab	7/27/2022 14:00	7/27/2022 14:00	4	<3	0.31	0.078	~0.046	387							22.7	<0.06	0.90	<0.06	
Base Grab	8/26/2022 9:03	8/26/2022 9:03	4	3	0.25	0.075	0.061	228							22.0	<0.06	0.90	<0.06	
Base Grab	9/12/2022 14:14	9/12/2022 14:14	3	<3	0.21	0.079	0.057	178							22.5	<0.06	0.88	<0.06	
Base Grab	10/13/2022 10:48	10/13/2022 10:48	<3	<3	0.22	0.050	~0.035	210							24.3	<0.06	0.78	<0.06	

Exceeds Water Quality Standard
No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard
Exceeds Final Acute Standard

Table 8. Brown's Creek at Stonebridge 2022 Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	*E. coli* (mpn/100 mL)	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L _CaCO3)
Snowmelt Grab	3/16/2022 14:57	3/16/2022 14:57	21	9	1.50	0.239	0.131		0.00170	0.00075	<0.00050	0.00300	<0.00010	<0.00100	36.9	<0.06	0.80	0.55	146
Storm Composite	5/11/2022 21:24	5/12/2022 2:43	339	94	4.60	0.771	~0.042		0.00730	0.00510	0.00490	0.02570	0.00017	0.00640	16.5	<0.06	0.37	0.10	94
Storm Composite	8/19/2022 19:49	8/20/2022 14:09	55	29	1.40	0.266	0.074		0.00140	0.00120	0.00083	0.00740	0.00014	0.00160	18.4	<0.06	0.22	<0.06	164
Storm Composite	8/29/2022 0:30	8/29/2022 10:08	247	79	3.40	0.678	0.083		0.00530	0.00380	0.00380	0.01790	0.00016	0.00510	20.5	<0.06	0.27	<0.06	135
Base Grab	5/6/2022 9:31	5/6/2022 9:31	3	<3	0.63	0.053	~0.032	15							26.8	<0.06	0.33	<0.06	
Base Grab	6/17/2022 9:18	6/17/2022 9:18	15	<6	0.60	0.145	0.061	250							21.7	<0.06	0.72		217
Base Grab	7/8/2022 8:43	7/8/2022 8:43	7	4	0.38	0.106	0.070	1,553							23.7	<0.06	0.81	<0.06	
Base Grab	7/27/2022 14:11	7/27/2022 14:11	4	<3	0.39	0.081	0.050	387							22.9	<0.06	0.84	<0.06	
Base Grab	8/26/2022 8:38	8/26/2022 8:38	6	3	0.27	0.094	0.058	438							22.2	<0.06	0.93	<0.06	
Base Grab	9/12/2022 14:45	9/12/2022 14:45	3	<3	0.26	0.053	<0.020	99							24.0	<0.06	0.86	<0.06	
Base Grab	10/13/2022 11:28	10/13/2022 11:28	14	4	0.33	0.105	~0.040	219							48.9	<0.06	0.56	<0.06	

Exceeds Water Quality Standard
No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard
Exceeds Final Acute Standard

Table 9. Brown's Creek Outlet 2022 Primary Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	Sulfate (mg/L)	Ortho P (mg/L as P)	Alkalinity (mg/L_CaCO3)	*E. coli* (mpn/100 mL)
Scheduled Grab	1/4/2022 9:30	1/4/2022 9:30	3	~1	~0.14	~0.030	~0.027		0.023		1
Scheduled Grab	1/19/2022 12:05	1/19/2022 12:05	8	~2	0.22	~0.043	<0.020		0.020		2
Scheduled Grab	2/2/2022 11:53	2/2/2022 11:53	4	<3	0.34	0.054	0.050		0.031		4
Scheduled Grab	2/16/2022 11:02	2/16/2022 11:02	4	<3	<0.08	~0.042	<0.020		0.021		2
Scheduled Grab	3/2/2022 11:15	3/2/2022 11:15	3	<3	0.30	~0.041	~0.028	9.23	0.026	204	13
Scheduled Grab	3/16/2022 9:03	3/16/2022 9:03	9	3	0.90	0.106	0.077		0.066		365
Scheduled Grab	3/23/2022 10:50	3/23/2022 10:50	61	18	1.50	0.209	0.073		0.051		150
Scheduled Grab	3/30/2022 14:52	3/30/2022 14:52	8	3	0.51	0.066	~0.029		0.025		150
Scheduled Grab	4/13/2022 14:32	4/13/2022 14:32	14	5	0.66	0.096	~0.041		0.035		26
Scheduled Grab	4/25/2022 13:41	4/25/2022 13:41	8	3	0.50	0.059	~0.026		0.031		4
Scheduled Grab	5/10/2022 8:24	5/10/2022 8:24	8	3	0.48	0.066	~0.036		0.033		4
Storm Composite	5/11/2022 22:02	5/11/2022 23:43	170	33	7.30	1.370	~0.029				46
Scheduled Grab	5/25/2022 8:53	5/25/2022 8:53	19	6	<0.08	0.099	0.085		0.046		125
Scheduled Grab	6/7/2022 8:35	6/7/2022 8:35	10	5	0.52	0.110	0.052	6.24	0.049	195	84
Scheduled Grab	6/21/2022 15:15	6/21/2022 15:15	10	<3	0.28	0.107	0.063		0.057		276
Scheduled Grab	7/6/2022 14:09	7/6/2022 14:09	14	6	0.48	0.122	0.053		0.048		242
Scheduled Grab	7/20/2022 9:40	7/20/2022 9:40	5	<3	0.28	0.075	0.051		0.045		
Scheduled Grab	8/3/2022 10:00	8/3/2022 10:00	4	<3	0.20	0.069	0.051		0.062		345
Storm Composite	8/7/2022 22:32	8/8/2022 4:20	103	33	0.91	0.190	0.051				
Scheduled Grab	8/17/2022 9:40	8/17/2022 9:40	3	3	0.22	0.055	0.052		0.059		131
Storm Composite	8/19/2022 21:15	8/20/2022 7:03	32	13	1.10	0.189	0.095				
Storm Composite	8/27/2022 22:45	8/28/2022 0:29	159	52	2.10	0.528	0.074				
Scheduled Grab	9/2/2022 9:13	9/2/2022 9:13	5	<3	0.23	0.086	0.071	7.35	0.043	208	261
Scheduled Grab	9/14/2022 14:10	9/14/2022 14:10	3	<3	0.22	0.081	~0.048		0.038		111
Scheduled Grab	9/28/2022 9:41	9/28/2022 9:41	3	<3	~0.14	~0.044	~0.038		0.034		107
Scheduled Grab	10/12/2022 8:45	10/12/2022 8:45	3	<3	~0.18	~0.048	~0.031		0.035		46
Scheduled Grab	10/24/2022 11:18	10/24/2022 11:18	3	<3	~0.19	~0.028	~0.037		0.033		23
Scheduled Grab	11/8/2022 13:56	11/8/2022 13:56	3	<3	0.32	~0.043	~0.025		0.024		23
Scheduled Grab	11/22/2022 9:01	11/22/2022 9:01	<3	<3	~0.19	~0.027	~0.047		0.020		40
Scheduled Grab	12/7/2022 9:48	12/7/2022 9:48	<3	<3	~0.15	~0.043	~0.032	9.56	0.019	212	25
Snowmelt Grab	12/14/2022 11:28	12/14/2022 11:28	4	<3	0.22	~0.032	~0.023		0.027		
Scheduled Grab	12/27/2022 10:45	12/27/2022 10:45	5	<3	0.38	0.068	~0.021		0.020		12

Exceeds Water Quality Standard

Table 10. Brown's Creek Historic Loading- Latest Ten Years

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Brown's Creek at Highway 15										
Discharge (cf)	84,243,848	160,221,727	97,159,132	152,081,358	135,660,983	129,764,024	201,962,562	148,727,410	117,049,943	98,760,517
Total pounds of Phosphorus exported	658	1,210	1,450	1,736	831	1,182	1,406	1,072	690	567
TP (lbs/ac/yr)	0.186	0.343	0.410	0.492	0.235	0.335	0.398	0.303	0.195	0.161
Total pounds of TSS exported	37,105	245,954	211,364	239,237	105,900	132,765	136,203	128,722	46,409	59,093
TSS (lbs/ac/yr)	10.51	69.64	59.84	67.73	29.98	37.59	38.56	36.44	13.14	16.73
Brown's Creek at McKusick Road										
Discharge (cf)	119,479,669	282,264,777	152,913,065	229,482,654	192,485,489	179,429,476	340,391,004	234,134,803	196,267,817	163,409,449
Total pounds of Phosphorus exported	1,292	2,460	2,248	3,059	1,766	1,602	4,062	2,204	1,386	1,282
TP (lbs/ac/yr)	0.323	0.615	0.562	0.765	0.442	0.401	1.016	0.551	0.347	0.321
Total pounds of TSS exported	701,242	1,464,447	728,640	1,646,798	638,650	404,296	978,014	471,464	234,226	172,292
TSS (lbs/ac/yr)	175.35	366.20	182.21	411.80	159.70	101.10	244.56	117.90	58.57	43.08
Brown's Creek at Stonebridge										
Discharge (cf)	136,723,177	203,037,716	Not Calculated	224,138,246	232,701,338	225,604,711	368,848,809	235,850,584	192,272,282	168,072,167
Total pounds of Phosphorus exported	1,297	1,978	Not Calculated	2,778	2,229	1,946	3,948	2,186	1,556	1,363
TP (lbs/ac/yr)	0.310	0.472	Not Calculated	0.663	0.532	0.465	0.942	0.522	0.371	0.325
Total pounds of TSS exported	604,065	1,419,775	Not Calculated	1,187,547	718,290	515,386	825,635	437,876	256,270	241,966
TSS (lbs/ac/yr)	144.20	338.93	Not Calculated	283.49	171.47	123.03	197.10	104.53	61.18	57.76
Brown's Creek Outlet										
Discharge (cf)	202,719,259	303,513,260	241,784,443	284,583,206	278,020,037	267,105,859	447,411,048	386,269,467	249,448,143	220,440,000
Total pounds of Phosphorus exported	1,755	2,233	3,156	3,514	2,275*	2,315*	4,833*	4,289*	1,566*	1,219*
TP (lbs/ac/yr)	0.380	0.483	0.683	0.760	0.492	0.501	1.045	0.928	0.339	0.264
Total pounds of TSS exported	454,456	1,123,783	1,119,632	1,114,674	498,032*	400,729*	1,286,424*	1,137,017*	317,962*	172,589*
TSS (lbs/ac/yr)	98.28	243.03	242.13	241.06	107.71	86.66	278.21	245.89	68.76	37.32
	*Sampling regime and load estimation method changed									

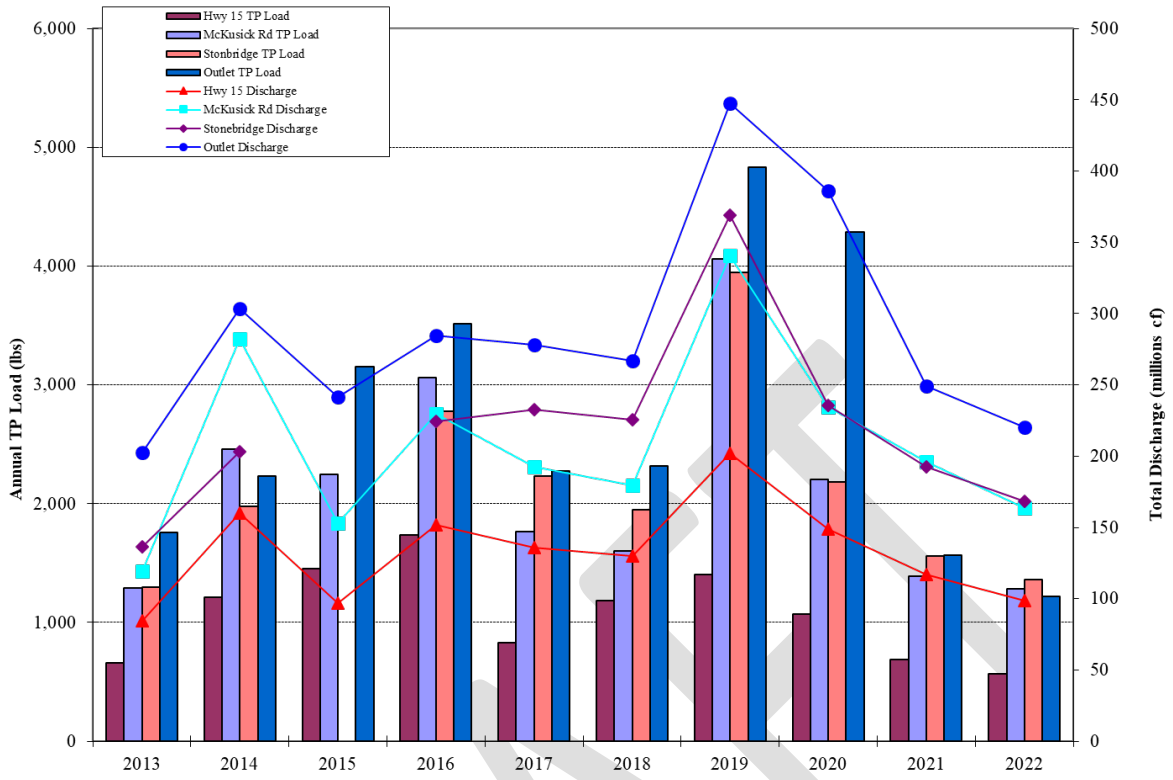


Figure 3. Brown's Creek Phosphorus Loading- Latest Ten Years

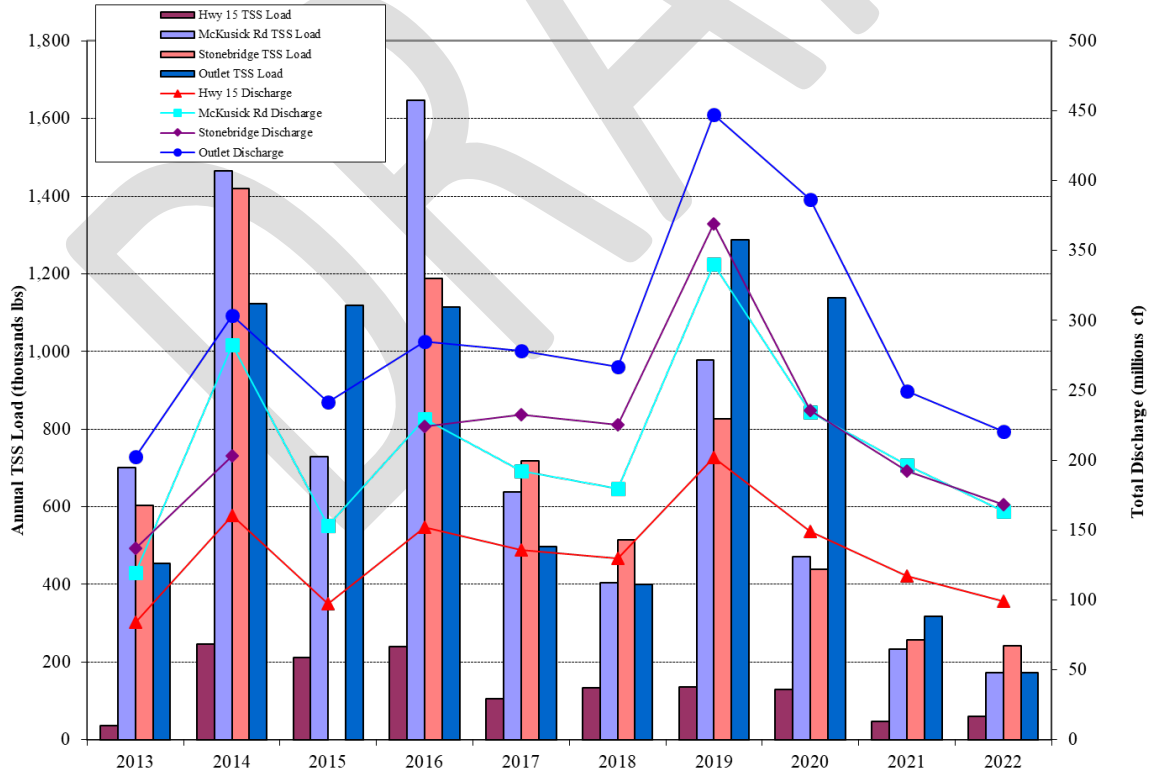


Figure 4. Brown's Creek Sediment Loading- Latest Ten Years

1c. Metals

One of the stressors identified in the TMDL study is high concentrations of copper, which are harmful to aquatic life. Additionally, other metals such as lead and zinc can be toxic to aquatic organisms. Standards for such metals are variable based on the hardness of the water which affects the level of toxicity a given concentration has. Under soft water conditions (low hardness) metals are more readily taken up by aquatic organisms, increasing the toxicity of the concentrations of metals in the water. Calculation of metals standards are described in the Minnesota Administrative Rules Part 7050.0222 and are divided into three categories of toxicity; chronic, maximum, and final acute value (FAV). The chronic standard protects organisms from long term exposure to a pollutant with minimal effects, the maximum standard from short term exposure with no or little mortality, and the FAV is the concentration at which mortality can be expected.

Heavy metals exceedances for each site and sample can be found in Table 6 through Table 8, and Table 11. No exceedances of any metal were detected at Highway 15. One chronic standard exceedance of lead was detected at McKusick Road, Stonebridge, and the Outlet during a storm event on May 11, and a chronic standard exceedance of copper was also recorded at the Outlet during the same event. The number and severity of metals exceedances in 2022 was very low compared to past years.

Chloride concentrations have not exceeded the state standard for chronic exposure of 230 mg/L, but the trend analysis completed by EOR shows there are statistically significant increasing loads for chloride at all monitoring stations. For reference, the highest chloride concentration recorded on the creek occurred at Stonebridge on October 13 at 48.9 mg/L. Unlike most other pollutants, chloride has no natural attenuation once it is in water, and there are no known cost-effective ways to treat water contaminated with chloride. The District should continue to investigate ways to promote reductions in salt use and smart salt management, especially for water softener and road de-icer applications.

Table 11. Brown's Creek Outlet 2022 Secondary Chemistry Results

Sample Type	Start	End	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L_CaCO3)
Scheduled Grab	1/4/2022 9:30	1/4/2022 9:30							31.2	<0.06	1.32	<0.06	
Scheduled Grab	1/19/2022 12:05	1/19/2022 12:05							32.5	<0.06	1.32	<0.06	
Scheduled Grab	2/2/2022 11:53	2/2/2022 11:53							29.3	<0.06	1.22	<0.06	
Scheduled Grab	2/16/2022 11:02	2/16/2022 11:02							27.0	<0.06	1.10	<0.06	
Scheduled Grab	3/2/2022 11:15	3/2/2022 11:15	0.00070	<0.00050	<0.00050	<0.00500	<0.00010	<0.00100	34.4	<0.06	1.26	<0.06	236
Scheduled Grab	3/16/2022 9:03	3/16/2022 9:03							33.1	<0.06	1.00	0.38	
Scheduled Grab	3/23/2022 10:50	3/23/2022 10:50							27.7	<0.06	0.36	0.33	
Scheduled Grab	3/30/2022 14:52	3/30/2022 14:52							27.7	<0.06	0.82	0.12	
Scheduled Grab	4/13/2022 14:32	4/13/2022 14:32							34.0	<0.06	0.56	0.07	
Scheduled Grab	4/25/2022 13:41	4/25/2022 13:41							22.2	<0.06	0.54	<0.06	
Scheduled Grab	5/10/2022 8:24	5/10/2022 8:24							26.7	<0.06	0.72	0.06	
Storm Composite	5/11/2022 22:02	5/11/2022 23:43	0.01670	0.01140	0.01100	0.07100	0.00040	0.01600	30.0	<0.06	0.40	0.23	148
Scheduled Grab	5/25/2022 8:53	5/25/2022 8:53							24.8	<0.06	0.23	<0.06	
Scheduled Grab	6/7/2022 8:35	6/7/2022 8:35	0.00053	0.00053	<0.00050	<0.00500	<0.00010	<0.00100	34.2	<0.06	0.91	<0.06	216
Scheduled Grab	6/21/2022 15:15	6/21/2022 15:15							28.0	<0.06	1.06	<0.06	
Scheduled Grab	7/6/2022 14:09	7/6/2022 14:09							29.1	<0.06	1.09	<0.06	
Scheduled Grab	7/20/2022 9:40	7/20/2022 9:40							32.0	<0.06	1.07	<0.06	
Scheduled Grab	8/3/2022 10:00	8/3/2022 10:00							32.8	<0.06	1.02	<0.06	
Storm Composite	8/7/2022 22:32	8/8/2022 4:20							25.2	<0.06	0.70	<0.06	
Scheduled Grab	8/17/2022 9:40	8/17/2022 9:40							28.3	<0.06	1.06	<0.06	
Storm Composite	8/19/2022 21:15	8/20/2022 7:03	<0.00100	0.00087	0.00071	0.02180	<0.00010	0.00130		<0.06	0.46	0.06	183
Storm Composite	8/27/2022 22:45	8/28/2022 0:29							20.6	<0.06	0.72	<0.06	
Scheduled Grab	9/2/2022 9:13	9/2/2022 9:13	<0.00050	<0.00050	<0.00050	<0.00500	<0.00010	<0.00100	28.6	<0.06	0.88	<0.06	232
Scheduled Grab	9/14/2022 14:10	9/14/2022 14:10							28.6	<0.06	0.96	<0.06	
Scheduled Grab	9/28/2022 9:41	9/28/2022 9:41							33.2	<0.06	1.02	<0.06	
Scheduled Grab	10/12/2022 8:45	10/12/2022 8:45							17.2	<0.06	1.03	<0.06	
Scheduled Grab	10/24/2022 11:18	10/24/2022 11:18							30.0	<0.06	0.78	<0.06	
Scheduled Grab	11/8/2022 13:56	11/8/2022 13:56							30.3	<0.06	0.99	<0.06	
Scheduled Grab	11/22/2022 9:01	11/22/2022 9:01							28.8	<0.06	1.37	<0.06	
Scheduled Grab	12/7/2022 9:48	12/7/2022 9:48	0.00610	0.00062	<0.00050	<0.00500	<0.00010	<0.00300	31.9	<0.06	1.28	<0.06	240
Snowmelt Grab	12/14/2022 11:28	12/14/2022 11:28							32.8	<0.06	1.07	<0.06	
Scheduled Grab	12/27/2022 10:45	12/27/2022 10:45							30.8	<0.06	1.16	<0.06	

No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard
Exceeds Final Acute Standard

1d. Bacteria (*E.coli*)

The sites on Brown's Creek are not meeting the state standard for *E.coli* for nearly all months regulated by the standard, and two reaches of the creek have been listed as impaired for bacteria. In 2022 samples collected at Stonebridge and the Outlet brought the geometric means below the standard for the month of May, which were previously above the standard. This was most likely due to cooler than average spring temperatures. A summary table by month and site can be found in Table 12. The standard is defined as follows, and is based on the latest ten years of data as per MPCA protocol:

"*Not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31.*"

Table 12. Monthly Geometric Means of *E.coli*- Latest Ten Years

Site	April	May	June	July	August	September	October
Highway 15	Insufficient Data	105	327	225	339	210	92
McKusick Road	Insufficient Data	129	542	528	308	219	73
Stonebridge	Insufficient Data	121	402	417	292	187	83
Brown's Creek Outlet	18	105	426	311	160	216	70
Diversion	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
Trib at 62nd St	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data

Exceeds geometric mean of 126 #/100mL from not less than 5 samples in a calendar month

10% of samples taken in the last 10 years exceed 1,260 #/100mL (Doesn't necessarily exceed geometric mean standard)

Previous studies have excluded human borne *E.coli* as a significant source of bacteria, indicating failing septic systems and illegal straight pipes are not contributing to the high levels of bacteria. Likely sources of bacteria include large congregations of geese around the McKusick Road area, beavers and muskrat in the upper reaches of the creek, and nearby livestock operations. Further studies will focus on species of wildlife and livestock to determine sources of bacteria. The trend analysis completed by EOR has shown statistically significant long term trends for decreasing *E.coli* concentrations at McKusick Road and Stonebridge, and an increasing trend at the Outlet over the most recent ten year period.

1e. Temperature & Dissolved Oxygen

The 2010 Brown's Creek Biota TMDL indicates a threat level temperature of 18.3 ºC and a critical level temperature of 23.9 ºC for trout survivability. The threat level impact as defined as physiological stress, reduced growth, and egg mortality. The critical level impact is defined as the point at which direct mortality can be expected. For the purposes of this summary, daily average temperatures are used to determine if impact levels have been reached.

Consistent with previous years, multi-parameter sondes were deployed at all four stations on the creek. Due to battery and logger malfunctions in years prior, secondary temperature loggers were deployed to minimize gaps in the temperature data created by the primary loggers. However, these gaps still exist in the dissolved oxygen period of record, as no secondary dissolved oxygen sensors were available.

The number of daily average threat level temperature exceedances in the creek in 2022, when excluding years with significant data gaps, was the lowest in the last ten years at all sites (Table 13). When excluding years with data gaps the number of threat level exceedances were the lowest recorded since continuous temperature monitoring began in 2006 at Highway 15 and Stonebridge, second lowest at McKusick Road, and third lowest at the Outlet. No daily average temperature at any site exceeded the critical level temperature. Cool groundwater inputs to the creek and increased base flow due to plentiful groundwater recharge from the recent wet years help regulate water temperatures even when air temperatures swelter. According to the NWS station in Stillwater air temperatures were in excess of 90 ºF eight days of the season.

A Riparian Shading Study was completed in 2018 and describes the relationship of thermal loading via solar radiation and shade producing objects along the stream corridor. The study identified the least shaded (less than 60% shaded) reaches of the creek as immediately downstream of Highway 15, immediately west of Millbrook Park, a reach between Millbrook Park and McKusick Road, and the reach flowing through Oak Glen Golf Course north of McKusick Road. This study and the increase in the number of threat level temperature exceedances moving downstream from McKusick Road to Stonebridge indicate the buffer strip installations within the golf course have not reached full maturity. They are expected to provide up to 80% shade coverage when the final growth is achieved, but the District should continue to seek opportunities to improve stream shading in all areas identified by the study. The full Riparian Shading Study report is available on the District's website.

The cool temperatures recorded in 2022 are likely due to a combination of factors including plentiful groundwater recharge from wet years in the late 2010's, a colder than average spring, and restoration efforts in the watershed. It is especially encouraging that despite low flows and drought conditions, temperature regimes were some of the best ever recorded in terms of trout survival. This may also indicate thermal load reduction practices including riparian shade restorations, the Brown's Creek Park Rock Crib, and surface water diversions such as the Diversion Drainage and the Oak Glen Golf Course Irrigation Reuse projects are beginning to positively impact the creek.

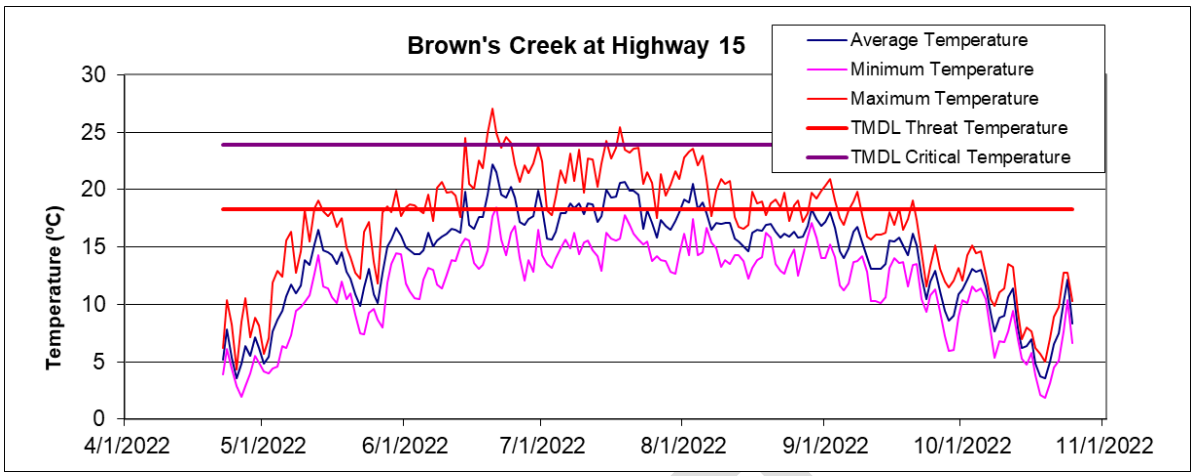


Figure 5. Brown's Creek at Highway 15 2022 Daily Temperature Summary

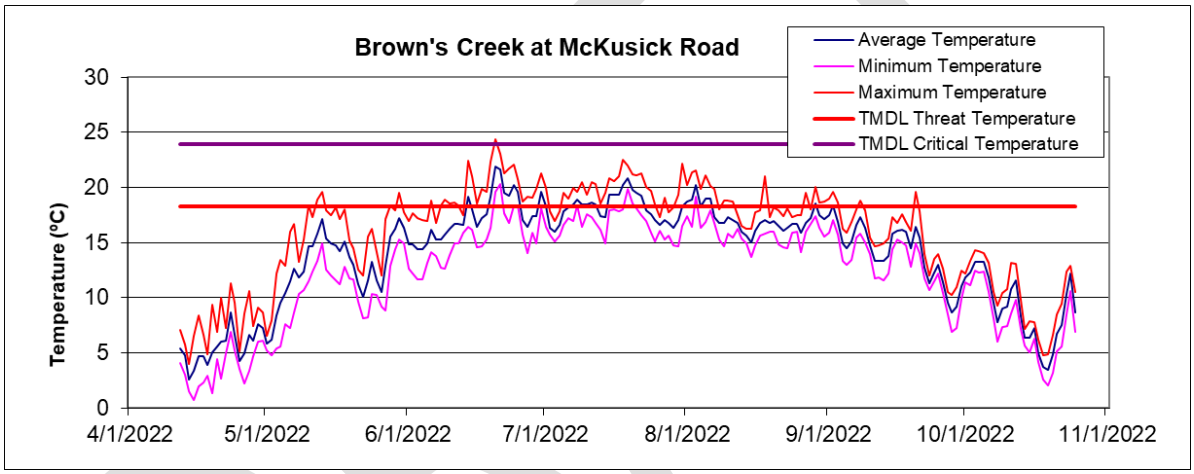


Figure 6. Brown's Creek at McKusick Road 2022 Daily Temperature Summary

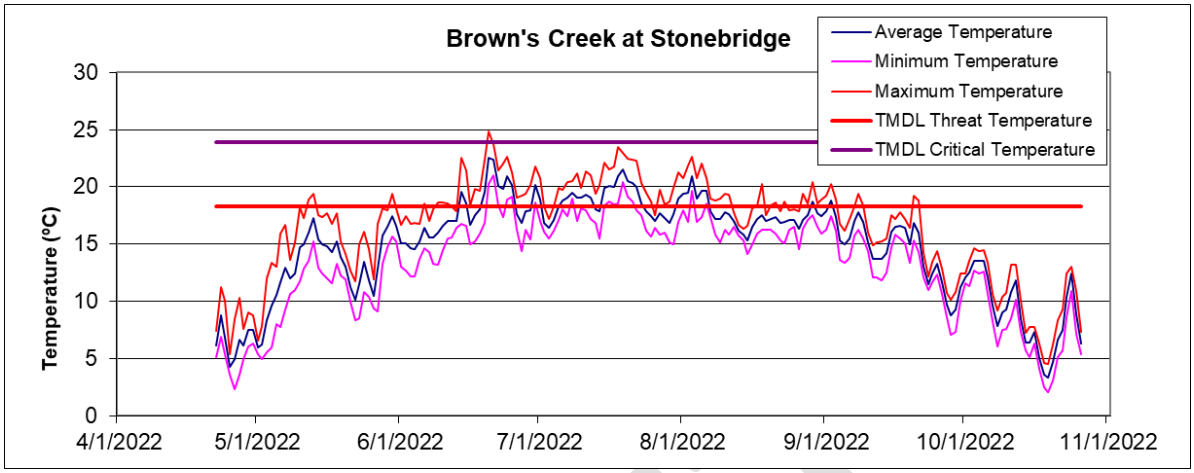


Figure 7. Brown's Creek at Stonebridge 2022 Daily Temperature Summary

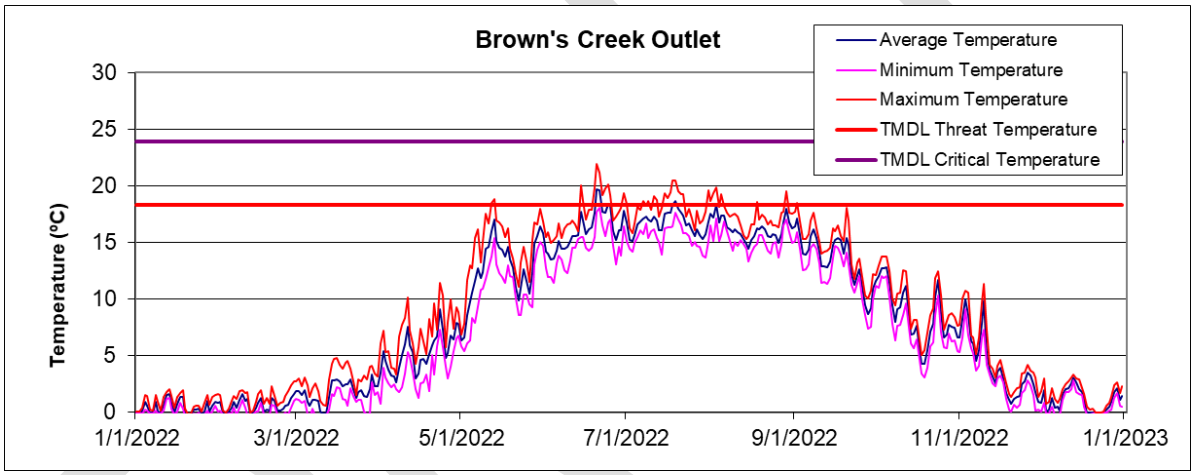


Figure 8. Brown's Creek Outlet 2022 Daily Temperature Summary

Table 13. Annual Occurrences of Brown's Creek Daily Average Temperature Greater than Threat and Critical Level Thresholds

	Exceedances at Highway 15		Exceedances at McKusick		Exceedances at Stonebridge		Exceedances at Outlet	
Year	18.3°C	23.9°C	18.3°C	23.9°C	18.3°C	23.9°C	18.3°C	23.9°C
2013	69	3	57	1	62	1	25	0
2014	54	0	46	0	59	0	17	0
2015	28*	0*	65	0	26*	0*	22	0
2016	14*	0*	17*	0*	71	0	35	0
2017	54	0	43	0	48	0	8	0
2018	61	0	54	0	66	0	19	0
2019	31	0	36	0	42	0	20	0
2020	38	0	42	0	48	0	23	0
2021	47	0	39	0	54	0	11	0
2022	28	0	31	0	37	0	6	0

* Based on severely limited period of record

The state standard for dissolved oxygen in 2A waters is 7 mg/L as a daily minimum. Logger malfunctions were minimal except at all sites except for McKusick Road, when the dissolved oxygen sensor failed August 1, and was not able to be replaced until September 9. Oxygen concentrations at Highway 15 were below the state standard 51% of the days monitored, and are unsuitable for trout survival (Table 14, Figure 9). The data collected show daily swings high above 7 mg/L at Highway 15 due to intense macrophyte growth, but drops well below the threshold at night.

Dissolved oxygen levels at McKusick Road tended to be higher than previous years likely due to cool groundwater contributions and stream shading, and the only times oxygen levels dropped below the standard were short periods immediately following major storm events. The redirection of warm, oxygen poor water inputs from McKusick Wetland Outlet to be used for the Oak Glen Golf Course Irrigation Reuse project also may have positively impacted conditions at McKusick Road, as the number of days below the standard in 2022 was the lowest ever recorded for the second year in a row. The data collected at the McKusick Wetland Outlet site are discussed later in this summary.

Stonebridge continues to exhibit better conditions for trout survival, with none of the days monitored below the standard. However, temperatures at Stonebridge were above the threat level threshold six days more than McKusick Road, indicating a slightly higher level of temperature stress as the creek flows through the golf course (Table 13 and Figure 7). Increased shading in the Oak Glen Golf Course buffer area will help to cool the water between the McKusick Road and Stonebridge sites, as well as increase oxygen levels.

Table 14. Daily Minimum Dissolved Oxygen Exceedances

Site	Days Monitored	Dissolved Oxygen Daily Minimum Below 7 mg/L	Percent of Days Exceeded	Record Completeness
Highway 15	187	95	50.8%	99.5%
McKusick Road	116	3	2.6%	61.7%
Stonebridge	188	0	0.0%	100.0%
Outlet	188	0	0.0%	100.0%

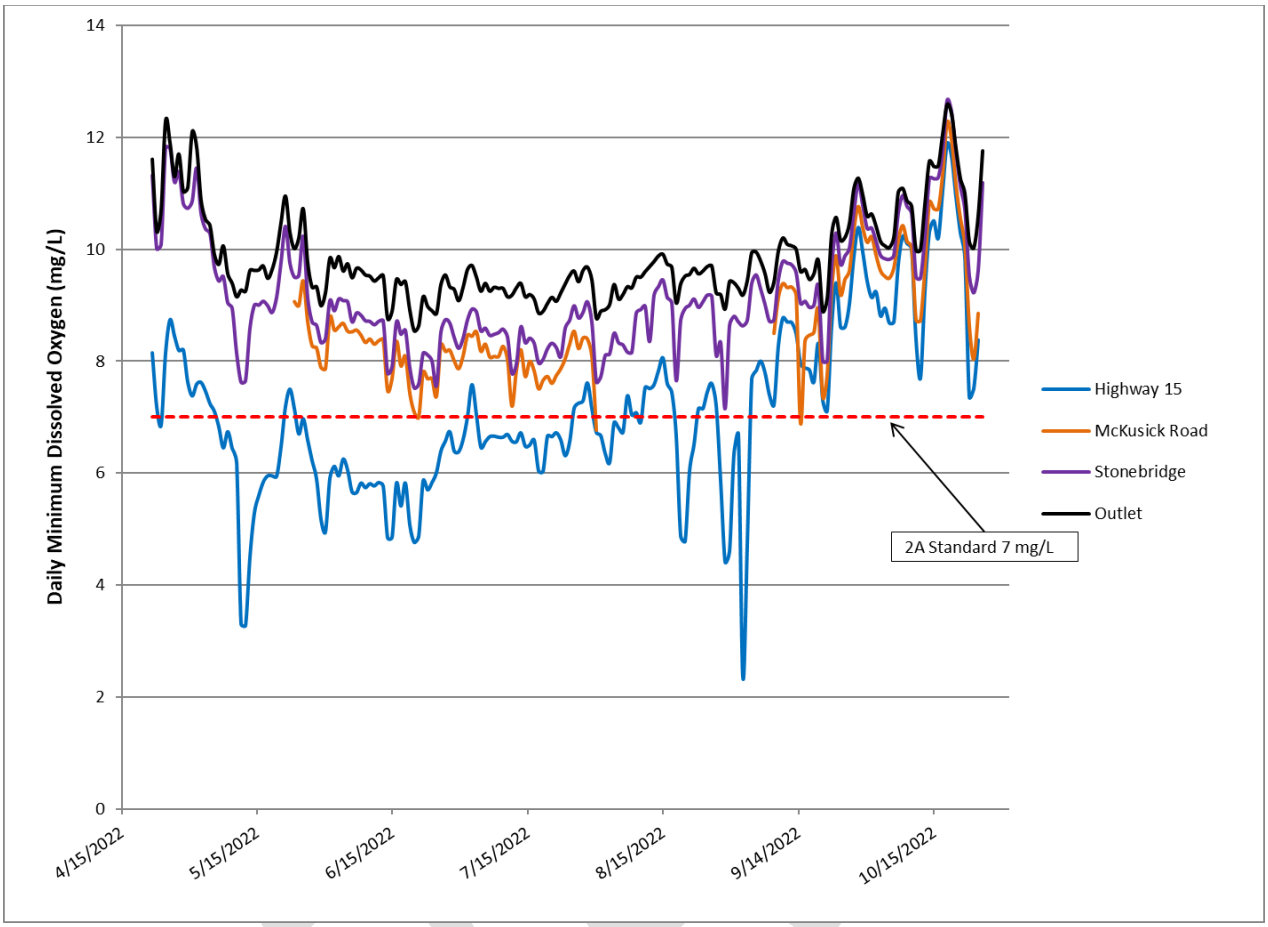


Figure 9. Daily Minimum Dissolved Oxygen in Brown's Creek

The Outlet continues to be the best location on Brown's Creek for trout survival. The average daily temperature exceeded the threat level threshold only six days during the season (Table 13). This is due to cold groundwater inputs in the gorge upstream of the Outlet and a robust tree canopy to shade the stream. Daily minimum oxygen concentrations were suitable for trout for the entire season (Figure 9 and Appendix B).

The trend analysis completed by EOR shows there is a statistically significant long term cooling trend at the Outlet, and a long term cooling pattern at Stonebridge that is not statistically significant. The study also shows a long term statistically significant warming trend at McKusick Road. Dissolved oxygen concentrations show no statistically significant trends at any site, except the Outlet since construction of the Diversion Structure.

1f. Turbidity & Specific Conductivity

Turbidity and specific conductivity can be helpful for determining the amount of particles and dissolved materials in a stream. Turbidity measures the amount of light scattered by particles such as suspended sediment, phytoplankton, and bacteria while specific conductivity measures electrical conductance of the water and is influenced by the amount

of dissolved ions in the water. Excess turbidity can be detrimental to trout, since they are primarily sight feeders. It also typically indicates a high sediment load which can clog gills and cover spawning areas.

Continuous turbidity and specific conductivity were monitored at all four stations on Brown's Creek. Turbidity sensors on the multi-parameter sondes have the tendency to be covered by bedload sediment during storm events and can be fouled by algae growth on the sensor itself, and as such gaps in the record exist at some sites. To account for fouling continuous turbidity data were converted to a daily average where at least three quarters of a day was successfully logged for comparison to a 10 NTU threshold which correlates to the TMDL goal of 23 mg/L of TSS. Specific conductivity data are not discussed in this report as they do not directly apply to state standards or TMDL goals, but are available upon request. Turbidity data is also used to evaluate sediment and nutrient loading in the creek. A summary of days successfully monitored for turbidity at each site can be found in Table 15 and average daily turbidity can be viewed in Figure 10.

Table 15. Brown's Creek Turbidity Standard Exceedances

Site	Days Monitored	Days Over 10 NTU	Percent of Days Exceeded	Record Completeness
Highway 15	188	1	0.5%	99.5%
McKusick Road	132	9	6.8%	69.8%
Stonebridge	189	5	2.6%	100.0%
Outlet	189	15	7.9%	100.0%

It is worth noting the creek tends to meet the 10 NTU goal during nearly all periods of base flow, indicating the majority of sediment and other sources of turbidity are being contributed during storm events (Figure 10). The percent of days monitored over the 10 NTU goal were the some of the lowest recorded since continuous turbidity monitoring began in 2015 and 2016. The highest daily average turbidity at Highway 15, McKusick Road, Stonebridge, and the Outlet were recorded during storms on May 11 (14 NTU), August 18 (28 NTU), May 12 (24 NTU), and August 29 (33 NTU), respectively.

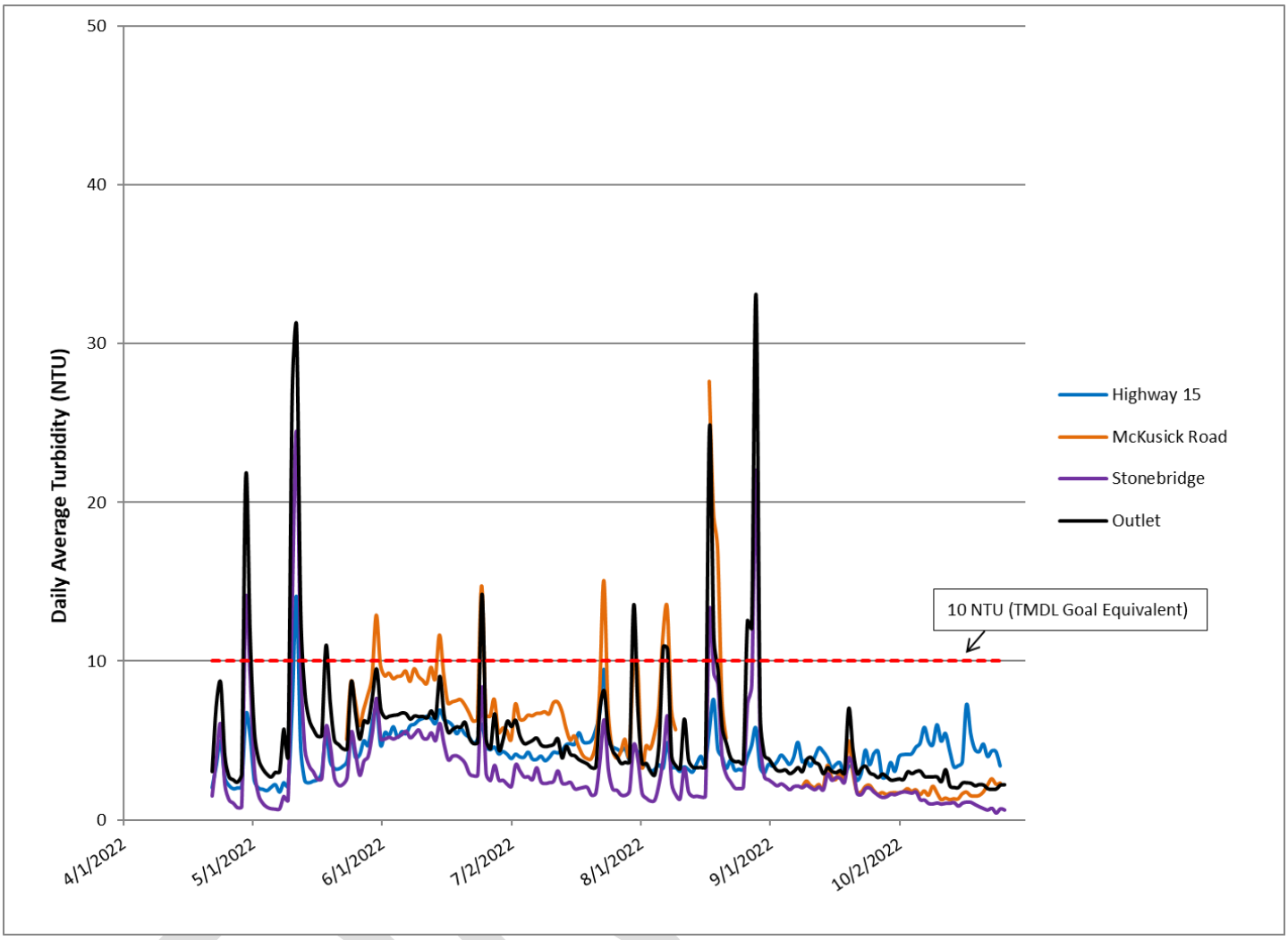


Figure 10. Brown's Creek Daily Average Turbidity

1g. Fisheries & Aquatic Invasive Species

Brown's Creek currently supports a brown and rainbow trout fishery dependent upon stocking in the lower reaches of the creek. Brown trout have been shown to have a limited amount of natural reproduction, and rainbow trout rely on stocking efforts. In 2020 the MN DNR switched from stocking brown trout to rainbow trout because they are easier to produce, grow larger and faster, and are stocked at a size that provides better recreational opportunity to anglers. Additionally, neither species is native to Minnesota, but they are considered naturalized and non-deleterious, and provide ecosystem and recreational benefits where native brook trout cannot survive. MN DNR has a management plan to stock 1,000 yearling rainbows at the Outlet annually. Stillwater Area High School (SAHS) and the Minnesota Trout Unlimited – Trout in the Classroom program also reared and stocked several hundred fingerling rainbow trout into the stream.

Fish and macroinvertebrate sampling conducted by the District's engineer and SAHS have identified many varieties of organisms present in the creek that need high quality, well oxygenated water to survive, such as rainbow darters. Results of fish and macroinvertebrate samplings can be found on the District's website or are available upon request.

Field staff continue to observe heavy growth of invasive curly-leaf pondweed in the upper reaches of the creek at Highway 15 and above McKusick Road. Dense mats of vegetation can alter flow rates, nutrient transport in the stream, hinder efforts to make stream improvements by slowing the water, and create conditions for warmer temperatures and increased sediment deposition on potential spawning areas. The BCWD should continue to work with partners to limit or prevent or manage the spread of curly-leaf pondweed downstream.

IV.C.2. Diversion Drainage

The Trout Stream Mitigation Project (TSMP), also known as the Diversion Structure, has been functioning since 2003 to divert warm water flows away from Brown's Creek through McKusick Lake to the St. Croix River (Table 1 and Figure 1). Diverting the water away from the creek protects it from additional thermal and sediment loads, improving conditions for trout and other cold water organisms. However, the water diverted away from the creek impacts its receiving waters: McKusick Lake and the wetland complex at the inlet to the lake. Therefore, monitoring is important to determine the load of pollutants discharged to the lake.

2a. Discharge

Discharge decreased from the year prior to 41,610,620 cubic feet exported to McKusick Lake, due to a second consecutive year of drought (Table 17). This volume of water is below the ten year average of roughly 57 million cubic feet. No water overtopped the Diversion Structure in 2022. The structure was designed to divert events up to the 1.5-year storm event under fully developed conditions. Since 2014 there have been five known events during which water has overtopped the structure and discharged directly to Brown's Creek, ranging from a few hours to a half-day. Although noteworthy, the volume of direct discharges has been minimal and have only occurred during major storm events, and likely have little impact on thermal and nutrient loads in the creek when the creek is already high with runoff. More importantly, the structure diverts the significantly warmer base flow and all moderate and minor events in the drainage away from the creek, reducing thermal loads to Brown's Creek.

2b. Phosphorus & Sediment

The TP load to McKusick Lake was 389 pounds, or 0.101 pounds of phosphorus per acre of watershed land (Table 17). The TP load was the third lowest since load calculations began in 2006. Water flowing through the site met the 2B phosphorus standard at base

flow for all but one sample, while storm event concentrations tended to be much higher (Table 16). However, the trend analysis study shows significant increasing concentrations of TP over both the short and long term in the drainage.

The TSS load was 75,429 pounds of sediment, equating to 19.57 pounds per acre of watershed land (Table 17). The state standard for 2B waters is 30 mg/L of TSS from April 1 to September 30. Water flowing through the site during this period met the standard during base flow conditions, and storm concentrations were much lower than previous years when concentrations sometimes exceeded 2,000 mg/L (Table 16). The TSS load was the second lowest recorded since calculations began in 2006. No significant trends exist for TSS in the drainage, although the overall pattern over the period of record appears to show increasing TSS concentrations.

A source of TP and TSS loading in the drainage are a number of erosional head cuts on the tributary branches of the creek, causing the tributaries to cut deeper into the stream bed and disconnect them from their floodplains. Erosion and channel incision was further aggravated by a cycle of above average precipitation in recent years. The District has worked since 2018 to repair head cuts and increase floodplain connectivity through the installation of rock vanes. The practices are estimated to reduce the TP load by 76 pounds per year, and the sediment load by 70 tons per year. Additionally, a beaver dam was noted immediately upstream of the monitoring site in August of 2022. The dam has further increased floodplain connectivity and settling of nutrients while improving habitat, and a resulting reduction in TP and TSS loads is likely reflected in the annual load. Due to these considerations the District opted to leave the dam in place. The Iron Enhanced Sand Filter (IESF) upstream of the monitoring site also continues to operate to reduce TP loads in the drainage. Monitoring data from the IESF is analyzed by EOR and summarized in an annual maintenance memo for the sand filter.

Table 16. Brown's Creek Diversion 2022 Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L _CaCO3)
Snowmelt Grab	3/16/2022 14:31	3/16/2022 14:31	30	9	1.40	0.215	0.107	0.00180	0.00120	0.00073	0.00360	<0.00010	<0.00100	81.2	<0.06	0.45	0.37	125
Storm Composite	5/11/2022 21:27	5/12/2022 8:08	176	45	3.00	0.517	0.097	0.00820	0.00530	0.00400	0.01940	0.00023	0.00500	44.0	<0.06	0.54	0.21	84
Storm Composite	8/18/2022 18:46	8/19/2022 8:26	301	87	2.90	0.793	0.115	0.00570	0.00630	0.00530	0.02340	0.00018	0.00630	43.7	<0.06	0.50	0.06	204
Storm Composite	8/29/2022 1:16	8/29/2022 9:42	132	40	2.10	0.474	0.093	0.00410	0.00370	0.00210	0.01210	0.00012	0.00320	36.0	<0.06	0.28	<0.06	115
Base Grab	5/6/2022 9:00	5/6/2022 9:00	3	<3	0.64	0.074	~0.025	<0.00050	<0.00050	<0.00050	<0.00500	<0.00010	<0.00100	93.9	<0.06	<0.20	<0.06	87
Base Grab	6/17/2022 8:47	6/17/2022 8:47	4	<3	0.63	0.092	~0.039	0.00050	0.00069	<0.00050	<0.00500	<0.00010	<0.00100	92.8	<0.06	0.29	0.06	171
Base Grab	7/8/2022 9:22	7/8/2022 9:22	16	5	0.56	0.158	0.068	0.00068	0.00098	<0.00050	<0.00500	<0.00010	<0.00100	50.8	<0.06	0.64	0.06	268
Base Grab	7/27/2022 13:52	7/27/2022 13:52	7	<3	0.33	0.089	~0.048	<0.00050	0.00061	<0.00050	<0.00500	<0.00010	<0.00100	43.9	<0.06	0.75	<0.06	268
Base Grab	8/25/2022 14:33	8/25/2022 14:33	7	3	0.37	0.096	0.070	<0.00050	0.00140	<0.00050	<0.00500	<0.00010	<0.00100	49.2	<0.06	0.72	<0.06	273
Base Grab	9/12/2022 13:50	9/12/2022 13:50	12	4	0.36	0.066	0.067	<0.00050	0.00074	<0.00050	<0.00500	<0.00010	<0.00100	46.6	<0.06	0.65	0.07	259
Base Grab	10/13/2022 9:58	10/13/2022 9:58	3	<3	0.25	0.052	~0.039	<0.00050	0.00095	<0.00050	<0.00500	<0.00010	<0.00100	23.5	<0.06	0.73	<0.06	235

Exceeds Water Quality Standard
No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard
Exceeds Final Acute Standard

Table 17. Brown's Creek Diversion Historic Loading- Latest Ten Years

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Brown's Creek Diversion Structure										
Discharge (cf)	46,435,271	53,519,017	46,276,327	70,780,581	39,625,672	45,453,990	112,468,888	68,165,935	46,792,341	41,610,620
Total pounds of Phosphorus exported	527	392	1,837	1,574	784	964	3,598	760	446	389
TP (lbs/ac/yr)	0.137	0.102	0.447	0.408	0.203	0.250	0.933	0.197	0.116	0.101
Total pounds of TSS exported	211,977	99,532	1,008,346	1,533,496	596,382	505,314	2,707,186	246,238	401,069	75,429
TSS (lbs/ac/yr)	54.99	25.82	261.57	397.79	154.70	131.08	702.25	63.87	104.01	19.57

2c. Metals

Heavy metals exceedances at the Diversion site can be seen in Table 16. The export of water high in metals to McKusick Lake and its wetland complex are particularly concerning due to the potential to destroy aquatic life in a short period of time, as opposed to nutrient or sediment loading which typically degrades habitat and populations of aquatic life over time. The chronic standard for lead was exceeded once, and no other exceedances were recorded in 2022. The number and severity of exceedances of metals standards in the drainage were tied for the lowest observed since metals analysis began in 2007. A lack of major runoff events due to drought conditions and improvements made to reduce erosion are the most likely drivers of this. In most cases, severe exceedances of metals seem to be associated with extreme TSS concentrations in this drainage. Sources of metals in the drainage may include improperly disposed wastes, such as deep cycle batteries. The combination and concentration of metals observed over time appear to point to this as a possible source.

2d. Bacteria (*E.coli*)

Historically, the diversion drainage has not met the standard for *E.coli* from June through September. A bacterial source assessment excluded anthropogenic sources of *E.coli* in the drainage, meaning wildlife and livestock are the likely culprits of the high levels of bacteria. No bacteria samples were collected in 2022, and historical results have become too dated to use in assessments after sampling ceased in 2017.

IV.C.3. Long Lake Drainage

The tributaries to Long Lake at 62nd St. and Marketplace Pond drain a high percentage of impervious surface and developed areas upstream of Long Lake (Table 1 and Figure 1). For the purposes of this report, the Tributary to Long Lake at Marketplace Pond will be compared to 2B water quality standards. The Tributary at Marketplace Pond is not classified as a 2B water, although its receiving water, Long Lake, is. The Tributary at 62nd Street will not be compared to state standards as water chemistry sampling at the site ceased following the 2016 monitoring season; only stage has been recorded since. The water discharged to Long Lake directly affects the quality of the lake, which has had significant issues caused by excess nutrients. Water from Long Lake makes its way downstream to Jackson WMA Pond, the diversion drainage, McKusick Lake and its wetland complex, and eventually to the St. Croix River. Monitoring subwatershed contributions to Long Lake can help determine locations for targeted management, as well as track improvements made upstream.

3a. Discharge

Annual discharge to Long Lake from the tributary at Marketplace Pond was 7,753,526 cubic feet. Only stage data was collected at the tributary at 62nd Street, and discharge was estimated during the period of logged data based on stage and discharge data from 2014.

Data from 2014 was used because it covered the widest range of observed stages and was representative of the average of other years of data collection. Discharge outside of logged data was not estimated, although the total volume outside of the period of record is likely negligible as the site freezes in the winter. Discharge to Long Lake from the tributary at 62nd Street was estimated at 274,469 cubic feet (Table 19). Flow in both systems is almost entirely event based, and flow often ceases during dry or winter conditions. Discharge was the second lowest in the last ten years at the tributary to Marketplace Pond, and the lowest at 62nd Street.

3b. Phosphorus & Sediment

The TP load at Marketplace Pond was 0.192 pounds per acre for a total of 79 pounds of phosphorus, and the TSS load was 17.35 pounds per acre for a total of 7,112 pounds of sediment (Table 19). It appears the tributary at Marketplace Pond is meeting the standard of 30 mg/L of TSS at base flow, but was above the 0.100 mg/L TP standard for two of three base flow samples (Table 18). Although storm composite samples are generally not compared to state standards, the concentrations of TSS were generally below the standard, and the TP concentrations were well above the standard. It should be noted the tributary at Marketplace Pond flows through several small settling ponds before discharging to Long Lake, and some additional settling of sediment and uptake of nutrients likely occurs. Sampling of the tributary at 62nd Street ceased after the 2016 monitoring season.

3c. Metals

Heavy metal exceedances for the tributary at Marketplace Pond can be found in Table 18. There were two chronic standard exceedances of copper and one chronic standard exceedance of lead recorded during storm events. Metals exceedances at this site were the lowest recorded since metals sampling began in 2007. The amount of heavy metals in the subwatershed is influenced by development and impervious surfaces, such as parking lots and Highway 36 where materials from vehicle leaks and brake dust tend to collect. The hardness of water in the subwatershed also tends to be very low, increasing the toxicity of metals. Metals contributed from this subwatershed have the potential to degrade aquatic life near the point of discharge to Long Lake before the water is fully integrated into the lake.

Table 18. Tributary to Long Lake at Marketplace Pond 2022 Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L _CaCO3)
Storm Composite	5/25/2022 10:26	5/26/2022 4:25	26	12	1.40	0.219	0.067	0.00630	0.00140	0.00075	0.02090	0.00026	0.00120	166.0	<0.06	<0.20	0.11	40.2
Storm Composite	8/8/2022 0:00	8/8/2022 14:53	12	5	1.40	0.164	~0.032	0.00540	0.00150	0.00077	0.02420	0.00012	0.00450	118.0	<0.06	0.40	0.20	47.9
Storm Composite	8/18/2022 18:27	8/19/2022 0:06	47	14	1.10	0.206	0.054	0.00590	0.00170	0.00120	0.03110	0.00014	0.00350	55.4	0.17	0.26	0.12	38.6
Storm Composite	8/29/2022 0:20	8/29/2022 3:55	10	5	1.30	0.146								30.4				
Base Grab	6/16/2022 9:05	6/16/2022 9:05	7	<6	1.60	0.225	0.053	0.00310	0.00130	0.00051	0.00960	<0.00010	0.00110	99.3	<0.06	<0.20	0.15	55.2
Base Grab	7/25/2022 15:44	7/25/2022 15:44	5	4	1.10	0.114	0.060	0.00240	0.00083	<0.00050	<0.00500	<0.00010	<0.00100	206.0	<0.06	<0.20	<0.06	55.4
Base Grab	8/25/2022 14:11	8/25/2022 14:11	<3	<3	0.77	0.093	0.083	<0.00100	0.00068	<0.00050	<0.00500	<0.00010	<0.00100	73.2	<0.06	0.34	0.09	53.0

Exceeds Water Quality Standard
No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard
Exceeds Final Acute Standard

Table 19. Long Lake Drainage Historic Loading- Latest Ten Years

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Tributary to Long Lake at Marketplace Pond										
Discharge (cf)	18,276,274	7,444,468	22,983,609	23,534,188	15,250,645	16,492,464	28,970,261	14,353,605	13,899,568	7,753,526
Total pounds of Phosphorus exported	85	70	137	137	77	70	150	83	121	79
TP (lbs/ac/yr)	0.208	0.172	0.335	0.333	0.187	0.170	0.367	0.202	0.296	0.192
Total pounds of TSS exported	10,825	6,622	15,797	18,278	15,162	16,473	15,882	10,645	9,593	7,112
TSS (lbs/ac/yr)	26.40	16.15	38.53	44.58	36.98	40.18	38.74	25.96	23.40	17.35
Tributary to Long Lake at 62nd Street										
Discharge (cf)	2,922,109	3,687,553	1,413,178	2,824,017	1,811,811*	957,234*	3,403,761*	2,842,101*	584,566*	274,469*
Total pounds of Phosphorus exported	36	57	32	49	NA	NA	NA	NA	NA	NA
TP (lbs/ac/yr)	0.063	0.100	0.056	0.086	NA	NA	NA	NA	NA	NA
Total pounds of TSS exported	4,202	15,227	6,115	20,956	NA	NA	NA	NA	NA	NA
TSS (lbs/ac/yr)	7.31	26.48	10.63	36.45	NA	NA	NA	NA	NA	NA
	*Flow not estimated outside of logged data									

IV.C.4. McKusick Wetland Outlet

The tributary to Brown's Creek at McKusick Wetland Outlet discharges water through a pipe approximately 100 feet upstream of the McKusick Road monitoring station from a wetland complex at the headwaters of McKusick Lake. Based on aerial photo evidence it may also provide a "short circuit" for warm, nutrient rich water diverted by the Diversion Structure to be introduced into Brown's Creek after flowing through the wetland complex at the headwaters of McKusick Lake. In 2021 the Oak Glen Golf Course Irrigation Reuse Project was completed, which redirects water from the outlet to a holding pond. This reduces warm, nutrient rich and oxygen poor inputs of water to Brown's Creek. Although not classified as a 2B water, for the purposes of this summary, the data collected will be compared to 2B TP and TSS standards.

4a. Discharge

Discharge at McKusick Wetland Outlet was calculated using an area velocity relationship during the period of recorded data. Periods of flow outside of recorded data were not estimated due to the site freezing during winter months. The recorded discharge to Brown's Creek was 5,153,850 cubic feet (Table 21). High water levels in Brown's Creek occasionally created tailwater conditions at the site, making discharge calculations difficult during some periods. The outlet was also not flowing or intermittently flowing from approximately June 23 to August 5 due to the irrigation reuse project, except for brief periods following storm events.

4b. Phosphorus & Sediment

The TP load during recorded data was estimated at 69.1 pounds of phosphorus, while the estimated TSS load was 2,868 pounds of sediment (Table 21). The concentrations of TSS and TP were not precipitation or stage dependent, indicating the wetland complex "pulses" nutrients following storm events. As such, TP and TSS loads were calculated by averaging samples with similar concentrations based on seasonality, and applying the average concentration to the recorded discharge for the time period, which is consistent with past years. It is important to note the characteristics of the site and sampling strategy do not allow for load calculations as precise as other monitored strategies, i.e. composite sampling.

Samples collected show the site meets the 2B standard of 30 mg/L of TSS for all samples, but exceeds the standard of 0.100 mg/L of TP for nearly every sample (Table 20). The water discharging from the wetland is low in suspended sediment and other materials, but quite high in phosphorus, a large fraction of which is often dissolved phosphorus. This is typical of wetlands, which break down organic materials while filtering particulate matter, but can have negative effects on receiving waters by contributing nutrients that are readily available to organisms like algae.

Table 20. McKusick Wetland Outlet 2022 Chemistry Results

Sample Type	Start	End	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L _CaCO3)
Storm Grab	5/12/2022 15:06	5/12/2022 15:06	9	4	1.20	0.156	0.061	0.00052	0.00091	<0.00050	<0.00500	<0.00010	<0.00100	31.0	<0.06	<0.20	<0.06	85
Base Grab	5/25/2022 13:25	5/25/2022 13:25	12	6	1.60	0.304	~0.027	<0.00050	0.00066	<0.00050	<0.00500	<0.00010	<0.00100	38.8	<0.06	<0.20	<0.06	136
Base Grab	6/17/2022 9:12	6/17/2022 9:12	9	<6	2.20	0.291	~0.045	<0.00050	0.00054	<0.00050	0.00680	<0.00010	<0.00100	21.1	<0.06	0.47	0.55	242
Base Grab	10/13/2022 11:18	10/13/2022 11:18	5	<3	0.33	0.088	<0.020	<0.00050	<0.00050	<0.00050	<0.00500	<0.00010	<0.00100	28.8	<0.06	<0.20	<0.06	245

Exceeds Water Quality Standard
No Exceedance Determinable
Exceeds Chronic Standard
Exceeds Max Standard
Exceeds Final Acute Standard

Table 21. McKusick Wetland Outlet 2022 Discharge and Loading Estimates

Site	Period	Total Flow (cf)	Total Flow (ac-ft)	Average TP Concentration (mg/L)	TP Range (mg/L)	Average TSS Concentration (mg/L)	TSS Range (mg/L)	TP Load (lbs.)	TSS Load (lbs.)
McKusick Wetland Outlet	5/11-9/1	4,033,410	92.64	0.250	0.156-0.304	10	9-12	62.9	2,518
McKusick Wetland Outlet	9/1-10/26	1,120,440	25.74	0.088	N/A	5	N/A	6.2	350
Total		**5,153,850**	**118.38**					**69.1**	**2,868**

Table 22. McKusick Wetland Outlet Historic Loading Data

	2017	2018	2019	2020	2021	2022
McKusick Wetland Outlet						
Discharge (cf)	18,610,746	8,319,145	43,988,560	18,179,910	5,072,806	5,153,850
Total pounds of Phosphorus exported	298.2	138.5	453.1	284.6	68.3	69.1
Total pounds of TSS exported	9,055	5,072	13,275	10,927	2,327	2,868
Values reported are totals during the monitoring period only.						

4c. Temperature

Historic thermal data recorded at McKusick Wetland Outlet show temperatures roughly 2.5 ^{o}C higher, on average, than those recorded at McKusick Road during similar time periods. The wetland is warmed by solar radiation and frequently reaches high temperatures. Although the wetland outlet is not intended to be suitable for trout, when compared to TMDL thresholds of 18.3 ^{o}C (threat level) and 23.9 ^{o}C (critical level), water temperatures exceeded the thresholds 31.2% and 3.5%, respectively, of the monitoring period when flow was present. It is important to compare temperatures to these thresholds because they directly influence temperatures in Brown's Creek when discharged upstream of the McKusick Road site. Trout have been observed and stocked in the reach of Brown's Creek the wetland outlet discharges to, but only during spring and fall when water temperatures are cooler. The redirection of water for use as irrigation appears to have had positive impacts on the McKusick Road monitoring site by reducing the number of days dissolved oxygen concentrations were below the state standard to the lowest recorded, and limiting the number of days temperatures were above the threat level threshold to the ten year average, even during severe droughts. The wetland outlet was effectively "offline" during some of the warmest parts of summer from approximately June 23 to August 5, significantly reducing thermal loading. Continuous temperature data can be seen in Figure 11, where temperature data has been removed during periods of zero water discharge, alongside the daily average temperature at McKusick Road.

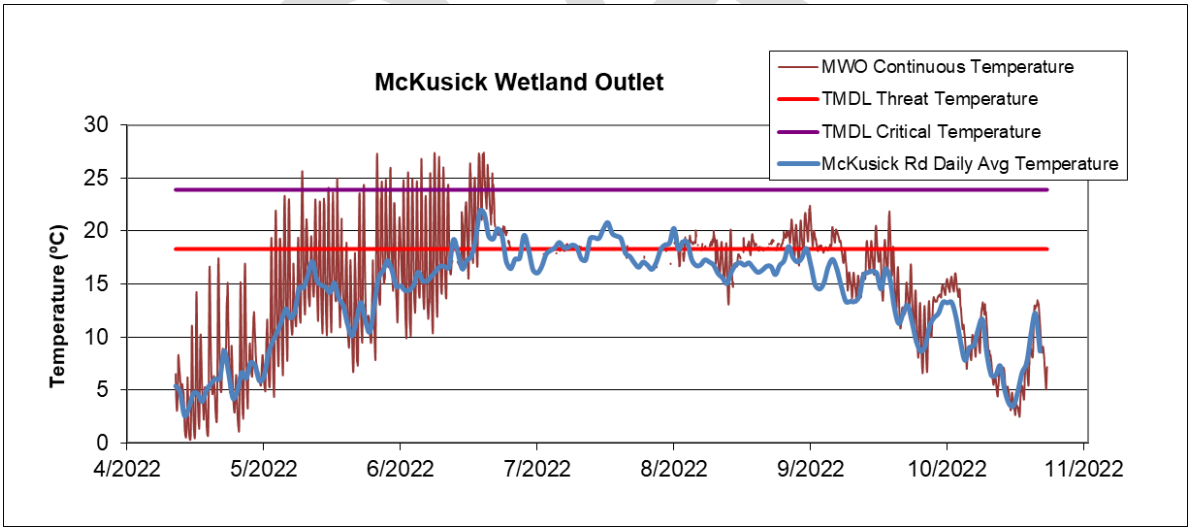


Figure 11. McKusick Wetland Outlet 2022 Continuous Temperature

V. RECOMMENDATIONS

- Continue chloride monitoring on lakes likely to be impacted by salt use.
- Perform macrophyte surveys on lakes that are lacking data.
- Continue collecting water quality and continuous discharge data at existing monitoring stations to track changes in the watershed and provide baseline data for modeling and other uses.
- Continue identifying salt use reduction strategies to limit chloride loading.
- Continue identifying cooperative opportunities with landowners to implement stream shading projects.
- Continue monitoring repairs to erosional issues in the diversion drainage to prevent degradation of McKusick Lake.
- Consider modifying sampling on Brown's Creek to match Metropolitan Council's WOMP program using unbiased sampling regimes as opposed to storm/event based sampling to allow for more rigorous statistical trend analysis.

APPENDIX A - WATER QUALITY DATA – BY LAKE

Brown's Creek Watershed Lakes: Bass East, Bass West, Benz, Brewer's Pond, Goggins, Heifort's Pond, Jackson WMA (Sinnits Pond), July Avenue, Kismet, Long (North Basin), Lynch North, Lynch South, Masterman, North School Section, Pat, Plaisted, South School Section, and Woodpile

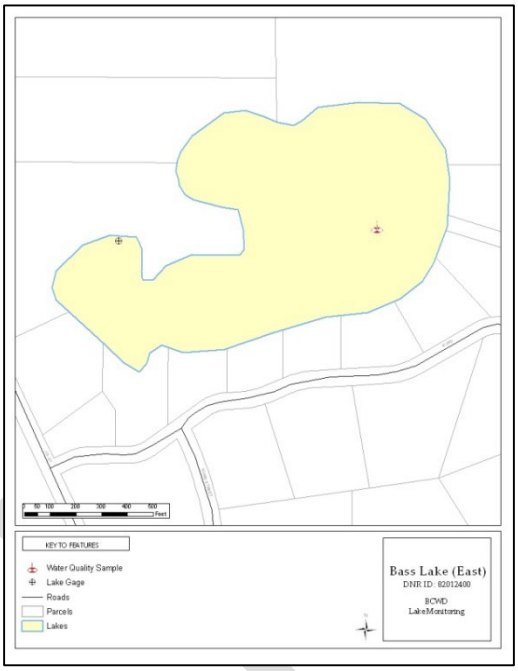
Lake grades are assessed using the Metropolitan Council's lake grade system. Grades are determined based on May through September averages of total phosphorus concentration, uncorrected trichromatic chlorophyll-α concentration, and Secchi disk transparency.

The Minnesota Pollution Control Agency (MPCA) uses the June through September average to assess impairment status of a lake based on total phosphorus concentration, pheophytin-corrected chlorophyll-α concentration, and Secchi disk transparency. The MPCA sets lake eutrophication standards for aquatic life and recreation. The standard for TP is 0.040 mg/L for deep lakes and 0.060 mg/L for shallow lakes. In general, shallow lakes are defined as less than 15 feet deep, with greater than 80% littoral area, and less than 10 acres.

Bass Lake (East)

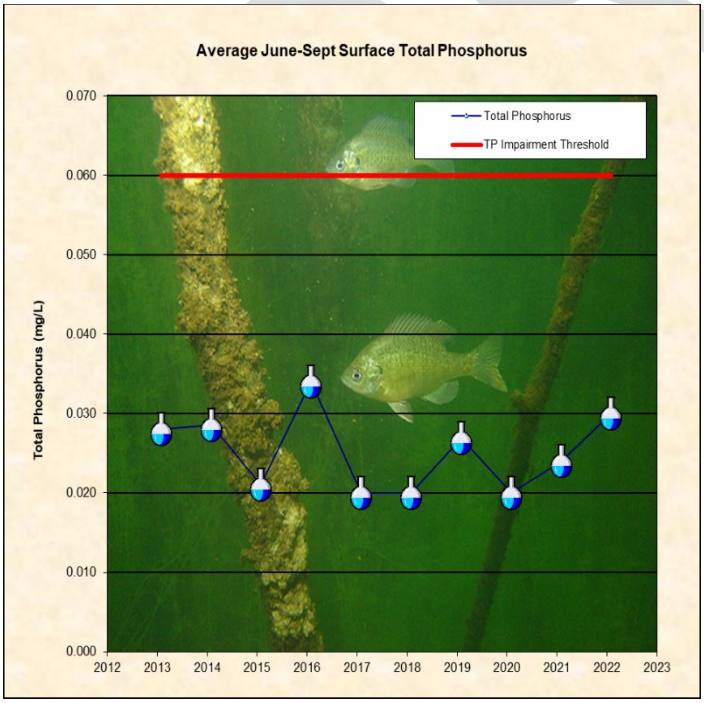
2022 Lake Grade: B+

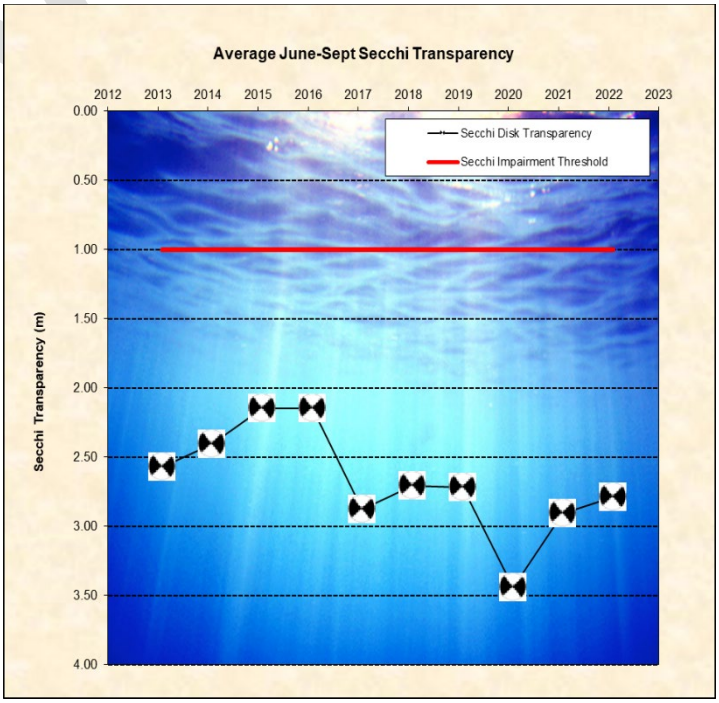
- DNR ID #: 820124
- Municipality: City of Grant
- Location: Section 10, T30N-R21W
- Lake Size: 29 Acres
- Maximum Depth (2022): 18 ft
- Ordinary High Water Mark: 960.20 ft
- 100-Year High Water Level: 960.40 ft
- 99% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as mesotrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for average total phosphorus and average chlorophyll-α, and the trend for the average Secchi transparency is skewed due to vegetation limiting the transparency.
- The major land use is rural/agricultural.
- The lake stratified in 2022 with a thermocline around 3 meters.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.





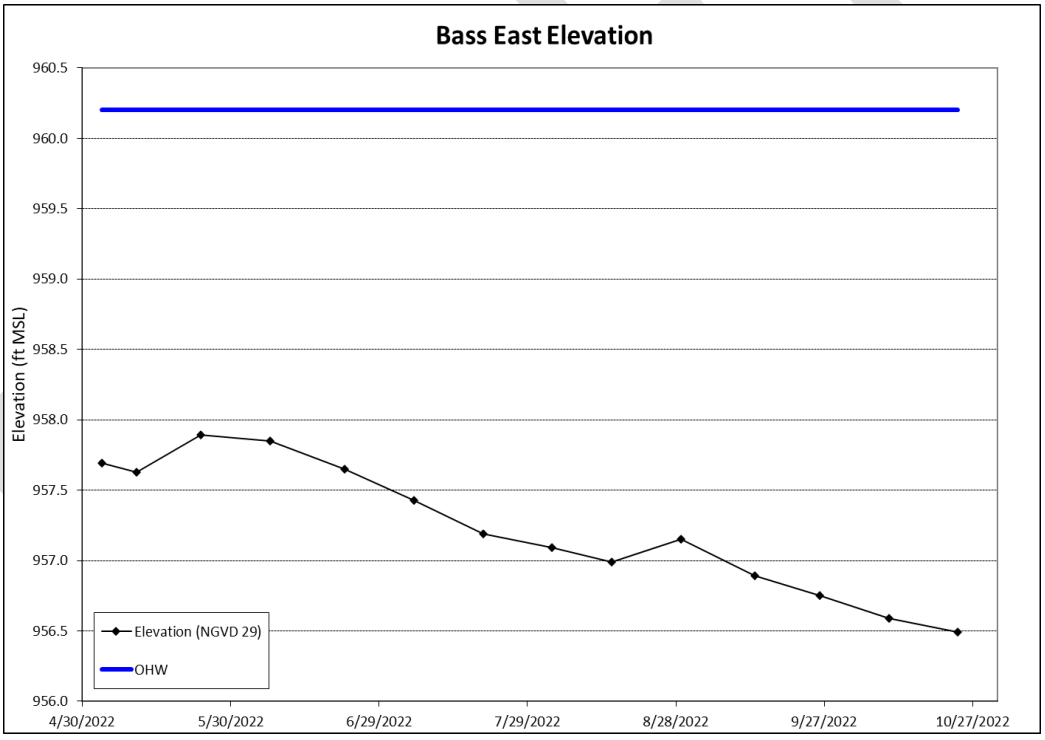
Date/Time	Total Phosphorus (mg/L)	Trichromatic Uncorrected Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 13:44	0.022	5.6	4.3	0.62	2.74	8.6	11.66
5/11/2022 13:23	0.012	4.7	3.7	0.67	2.90	18.1	9.93
5/24/2022 14:40	0.019	1.6	1.3	0.51	3.20	19.1	9.44
6/7/2022 10:34	0.023	1.4	1.6	0.66	3.51	21.6	8.97
6/22/2022 11:15	NA	2.4	2.1	NA	2.59	26.7	7.98
7/6/2022 9:05	0.037	3.8	3.0	0.80	2.44	25.2	7.49
7/20/2022 10:04	0.015	2.5	2.0	0.66	2.29	26.3	6.16
8/3/2022 13:46	0.050	3.9	3.8	0.82	2.29	27.3	12.71
8/15/2022 11:36	0.035	4.6	3.8	0.61	2.90	23.3	11.38
8/29/2022 13:40	0.027	3.0	3.4	0.54	2.74	24.0	10.10
9/13/2022 9:09	0.034	3.9	3.5	0.63	3.20	21.5	9.65
9/26/2022 10:58	0.017	3.6	2.7	0.59	3.20	17.2	6.75
10/10/2022 9:56	0.022	5.8	4.5	0.58	4.11	14.1	9.62
2022 Average	0.026	3.6	3.1	0.64	2.93	21.0	9.37
2022 Summer Average	0.030	3.2	2.9	0.66	2.79	23.7	9.02

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	957.89	5/24/2022	956.49	10/24/2022	957.23

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

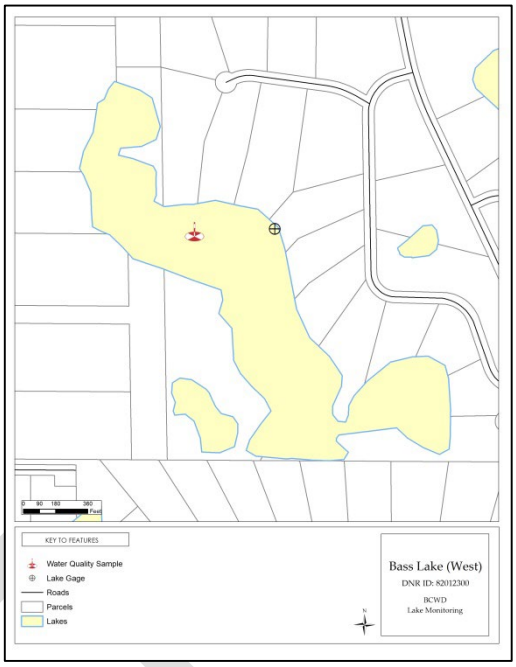


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	B	A	A	B	A	A	C	A	B	B
Chlorophyll-*a* (ug/l)	A	A	A	A	A	A	A	A	A	A
Secchi depth (ft)	B	B	A	B	B	B	B	C	B	B
Overall	**B+**	**A-**	**A**	**B+**	**A-**	**A-**	**B**	**B+**	**B+**	**B+**

Bass Lake (West)

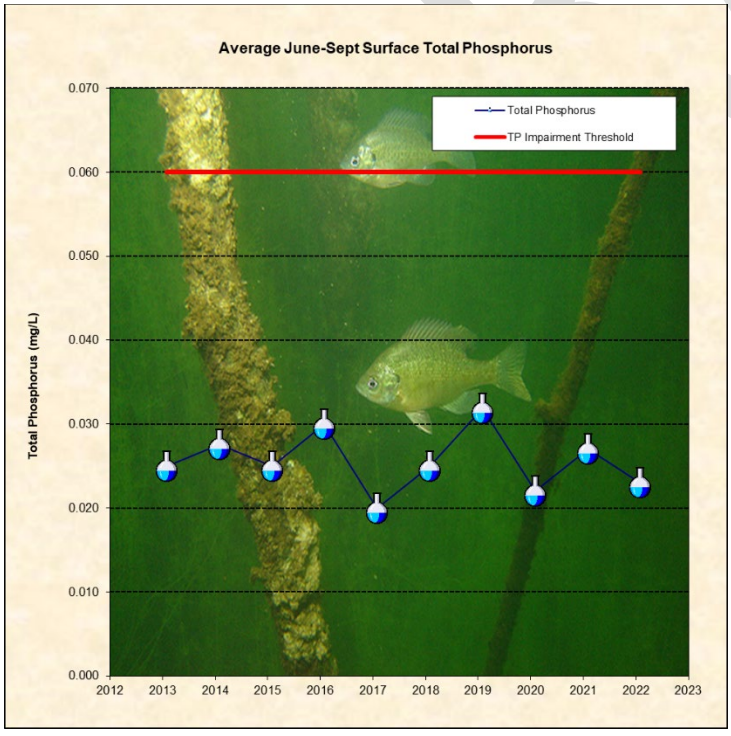
2022 Lake Grade: A-

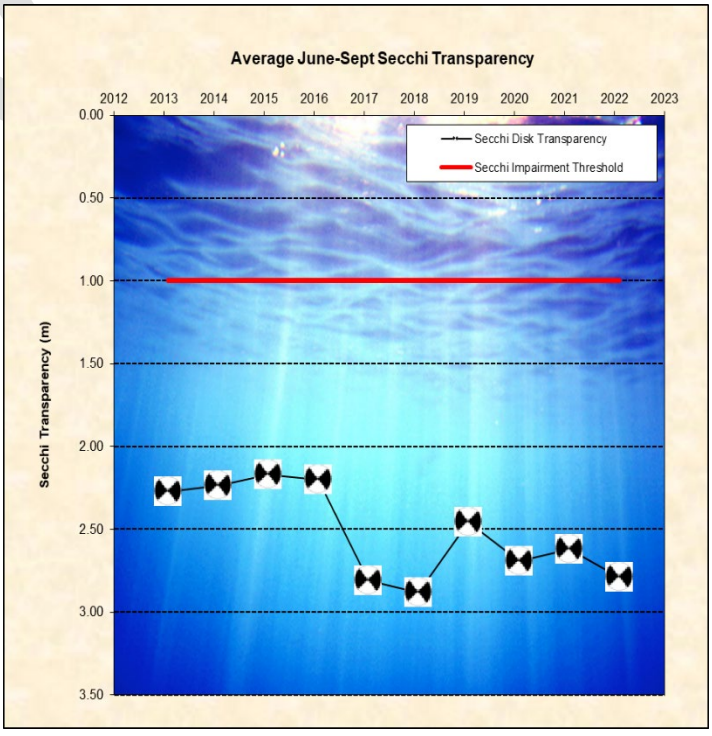
- DNR ID #: 820123
- Municipality: City of Grant
- Location: Section 10, T30N-R21W
- Lake Size: 72 Acres
- Maximum Depth (2022): 16 ft
- Ordinary High Water Mark: 952.60 ft
- 100-Year High Water Level: 955.90 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as mesotrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for average total phosphorus, no trend for average chlorophyll-α, and the trend for the average Secchi transparency is skewed due to vegetation limiting the transparency.
- The major land use is rural/agricultural.
- The lake did not stratify in 2022.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.





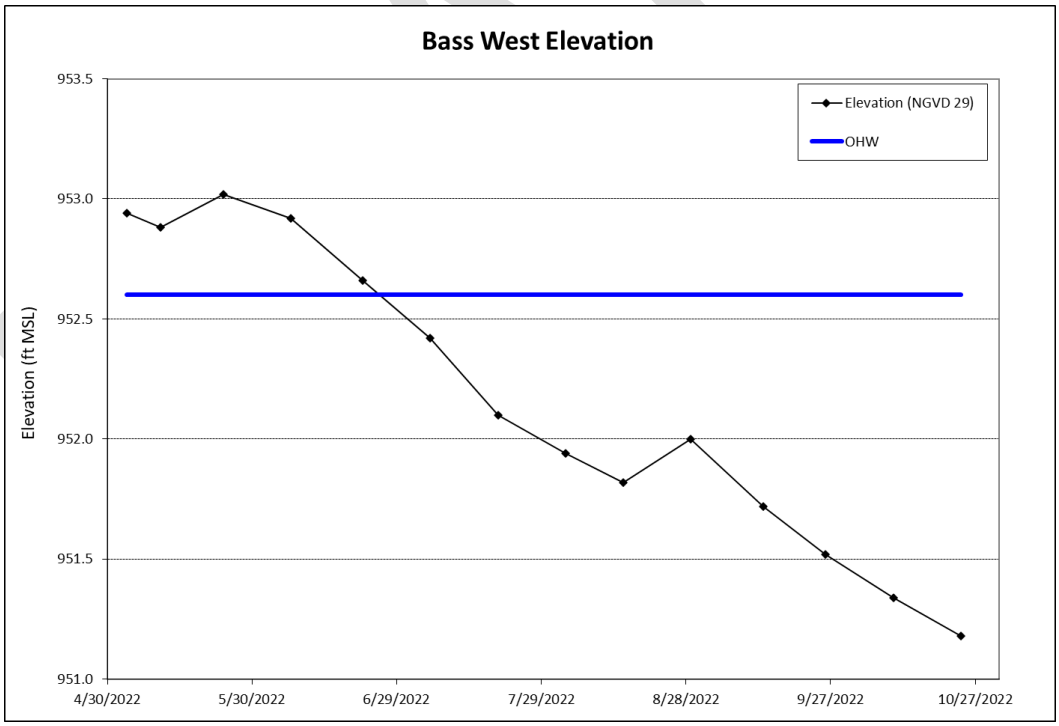
Date/Time	Total Phosphorus (mg/L)	Trichromatic Uncorrected Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 13:19	0.021	5.7	4.5	0.55	2.74	8.1	11.05
5/11/2022 12:56	0.017	4.6	4.0	0.55	2.29	17.5	9.45
5/24/2022 14:11	0.028	3.4	2.7	0.64	2.29	18.4	9.53
6/7/2022 11:00	0.025	2.4	1.9	0.62	3.96	21.2	9.09
6/22/2022 10:54	0.024	4.4	4.4	0.54	2.74	26.2	7.93
7/6/2022 8:43	0.022	5.1	4.5	0.58	2.74	25.2	7.75
7/20/2022 9:42	0.028	6.7	6.4	0.65	1.83	26.4	7.34
8/3/2022 13:18	0.022	5.5	5.3	0.60	2.90	26.6	12.96
8/15/2022 11:07	0.029	10.0	9.6	0.71	1.22	22.9	9.22
8/29/2022 13:17	0.019	3.5	3.3	0.54	3.66	23.8	10.48
9/13/2022 8:49	0.018	4.5	3.5	0.64	3.35	21.5	8.36
9/26/2022 11:22	NA	8.3	7.7	0.74	2.74	17.3	7.49
10/10/2022 10:23	0.028	6.1	5.1	0.60	2.59	14.3	9.40
2022 Average	0.023	5.4	4.8	0.61	2.70	20.7	9.23
2022 Summer Average	0.023	5.6	5.2	0.62	2.79	23.5	8.96

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	953.02	5/24/2022	951.18	10/24/2022	952.18

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

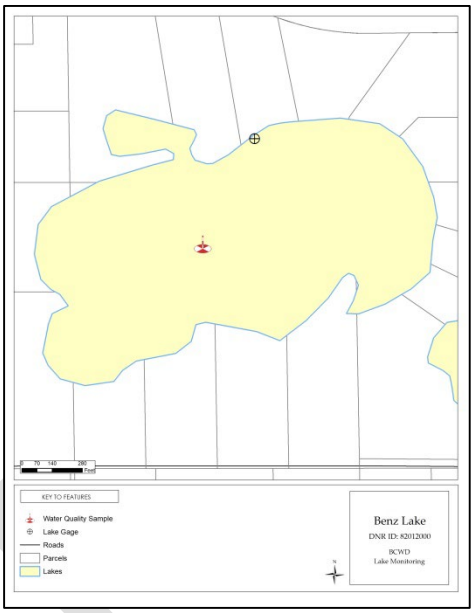


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	A	B	A	B	B	A	B	B	B	B
Chlorophyll-*a* (ug/l)	A	A	A	A	A	A	A	A	A	A
Secchi depth (ft)	B	B	A	B	B	B	B	C	B	B
Overall	**A-**	**B+**	**A**	**B+**	**B+**	**A-**	**B+**	**B**	**B+**	**B+**

Benz Lake

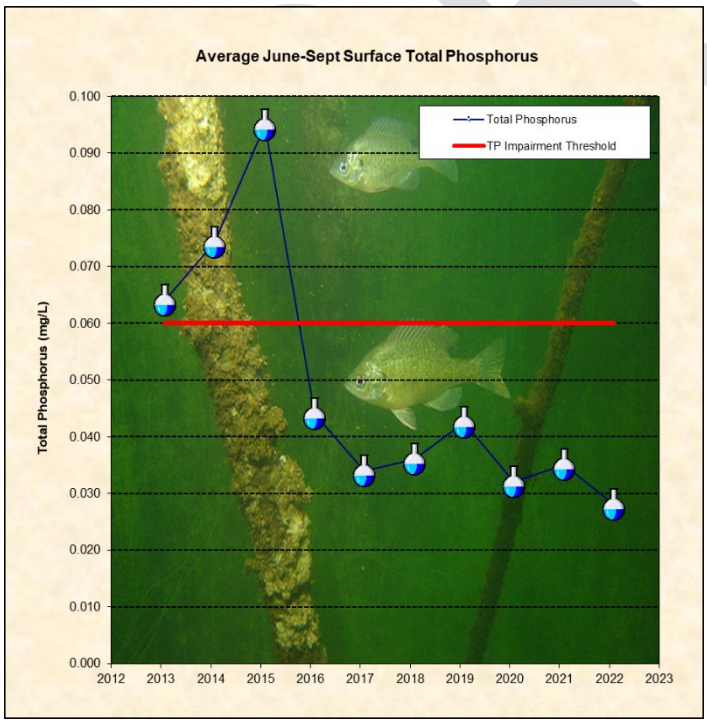
2022 Lake Grade: B-

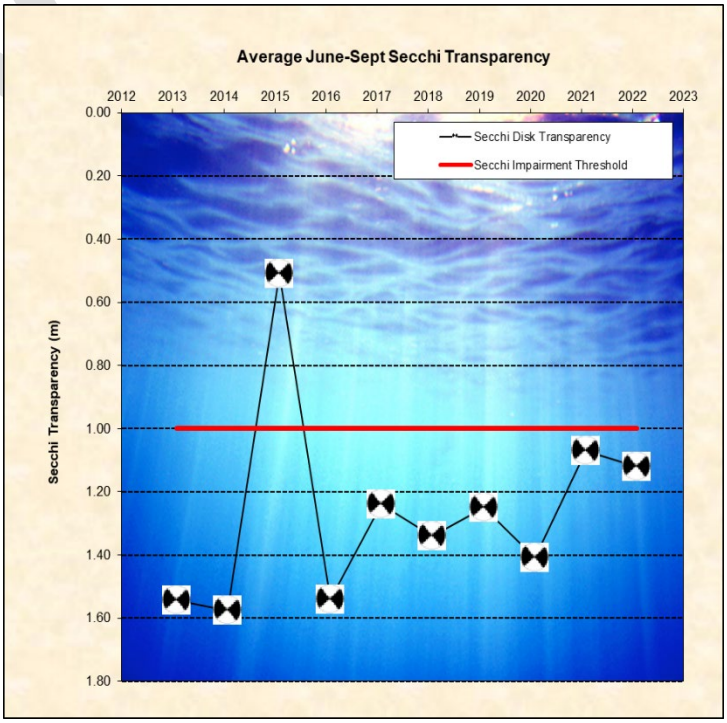
- DNR ID #: 820120
- Municipality: City of Grant
- Location: SE$^{1/4}$ Section 2, T30N-R21W
- Lake Size: 40 Acres
- Maximum Depth (2022): 7 ft
- Ordinary High Water Mark: 958.90 ft
- 100-Year High Water Level: 956.20 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as mesotrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for average total phosphorus and average chlorophyll-α, and the trend for the average Secchi transparency is skewed due to vegetation limiting the transparency.
- The major land use is rural/agricultural.
- The lake did not stratify in 2022.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.
- Benz Lake is listed as impaired for nutrients on the Minnesota Pollution Control Agency's Impaired Waters List.





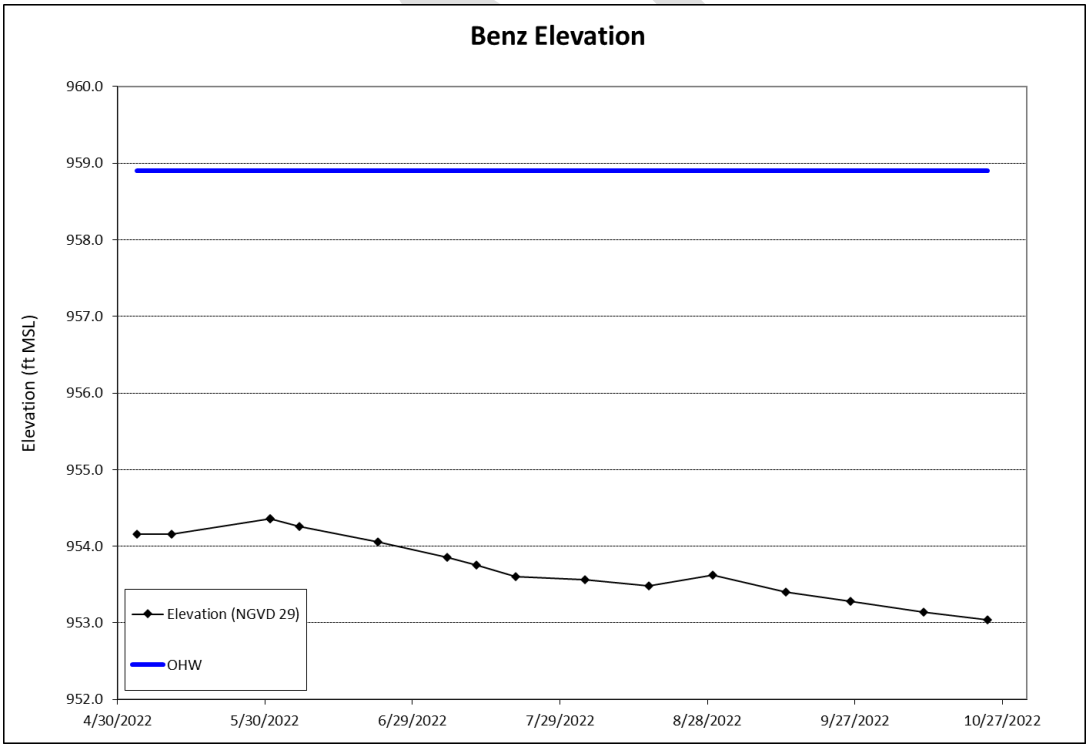
Date/Time	Total Phosphorus (mg/L)	Trichromatic Uncorrected Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 11:21	0.017	5.2	4.5	0.45	1.07	7.6	11.67
5/11/2022 14:20	0.020	5.1	4.3	0.56	1.07	19.0	9.90
5/26/2022 9:42	0.035	3.4	2.7	0.48	1.07	15.7	8.03
6/6/2022 11:49	0.036	2.5	2.7	0.48	1.68	21.8	10.48
6/22/2022 13:00	0.041	3.5	3.1	0.54	1.68	26.4	8.91
7/6/2022 10:05	0.030	NA	NA	0.67	1.07	24.5	10.20
7/20/2022 11:28	0.045	3.1	2.2	0.70	1.07	25.4	6.67
8/3/2022 11:50	0.024	8.2	7.5	0.70	1.52	26.5	14.96
8/16/2022 10:53	0.023	4.8	4.4	0.58	0.76	22.4	14.31
8/29/2022 11:49	0.024	2.3	1.9	0.48	0.76	23.4	12.39
9/13/2022 10:30	0.021	2.8	1.9	0.46	0.76	20.7	10.74
9/26/2022 10:34	0.011	2.2	1.6	0.50	0.76	15.9	6.89
10/11/2022 9:17	0.081	2.8	2.1	0.63	1.22	13.1	12.22
2022 Average	0.031	3.8	3.2	0.56	1.11	20.2	10.57
2022 Summer Average	0.028	3.7	3.2	0.57	1.12	23.0	10.62

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	954.36	5/31/2022	953.04	10/24/2022	953.76

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

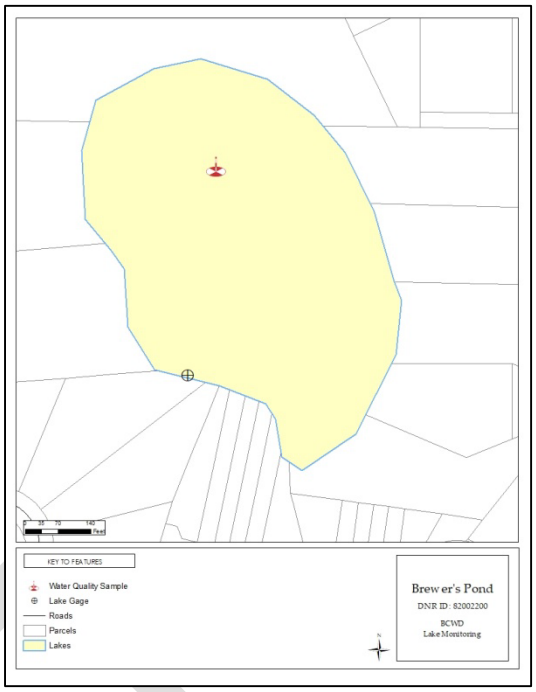


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	B	C	B	C	C	C	C	D	D	C
Chlorophyll-*a* (ug/l)	A	A	A	C	A	A	A	D	B	B
Secchi depth (ft)	D	D	C	C	C	D	C	F	C	C
Overall	**B-**	**C+**	**B**	**C**	**B-**	**C+**	**B-**	**D-**	**C**	**C+**

Brewer's Pond

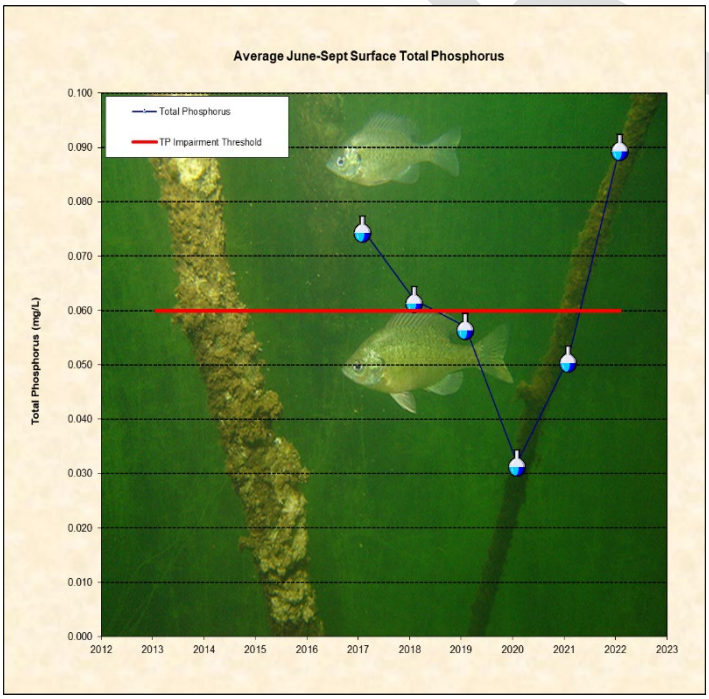
2022 Lake Grade: F+

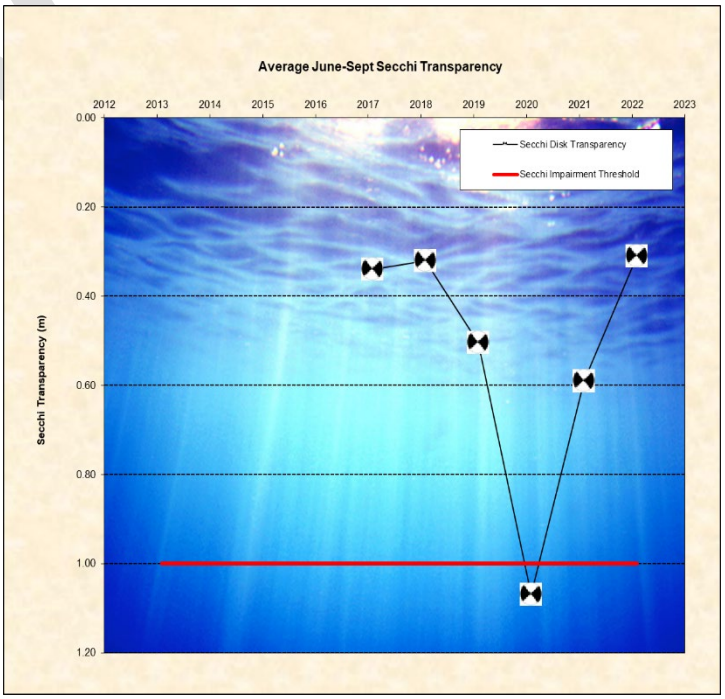
- DNR ID #: 820022
- Municipality: City of Stillwater
- Location: SE$^{1/4}$ Section 31, T30N-R20W
- Lake Size: 9 Acres
- Maximum Depth (2022): 15 ft
- Ordinary High Water Mark: 891.90 ft
- 100-Year High Water Level: 893.85ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as hypereutrophic according to the Carlson Trophic State Index.
- There are an insufficient number of years of data to determine a trend for the average total phosphorus, average chlorophyll-α, and the average Secchi transparency.
- The major land use is urban/residential.
- The lake stratified in 2022 with a thermocline around 3 meters.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.





Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 14:46	0.096	110.0	100.0	2.90	0.15	10.7	12.02
5/18/2022 14:00	0.073	47.0	44.0	2.10	0.50	22.2	NA
5/26/2022 13:13	0.092	54.0	52.0	2.40	0.15	15.7	9.42
6/7/2022 19:00	0.078	27.0	26.0	2.00	0.90	23.2	NA
6/22/2022 9:41	0.116	35.0	33.0	2.10	0.46	26.7	7.68
7/19/2022 16:05	0.117	130.0	130.0	3.80	0.15	28.3	12.32
8/4/2022 16:30	0.115	180.0	180.0	4.10	0.20	32.4	NA
8/16/2022 11:30	0.087	150.0	150.0	4.00	0.15	22.8	18.52
8/30/2022 19:30	0.059	96.0	94.0	3.40	0.20	24.3	NA
9/12/2022 13:49	0.051	67.0	64.0	3.00	0.15	21.7	10.94
9/30/2022 9:45	0.094	80.0	82.0	4.10	0.30	15.9	NA
10/11/2022 11:20	0.108	43.0	44.0	4.00	0.15	14.2	8.80
2022 Average	0.091	84.9	83.3	3.16	0.29	21.5	11.39
2022 Summer Average	0.090	95.6	94.9	3.31	0.31	24.4	12.37

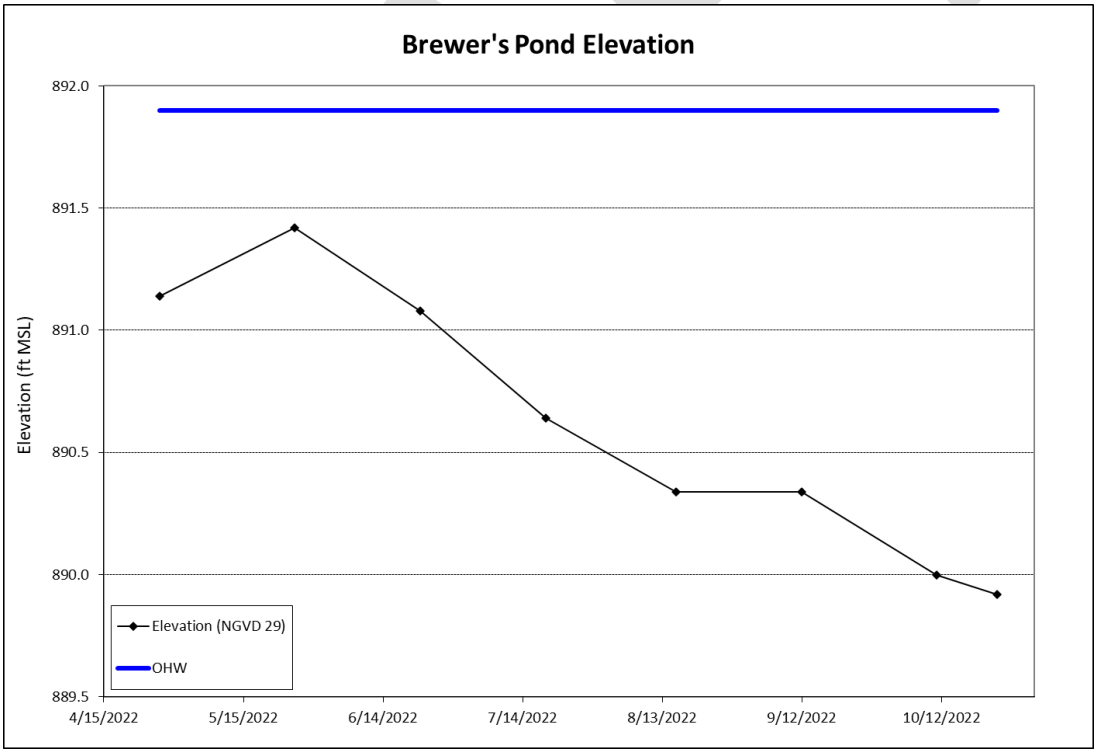
Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

Samples collected by a volunteer

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	891.42	5/26/2022	889.92	10/24/2022	890.61

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

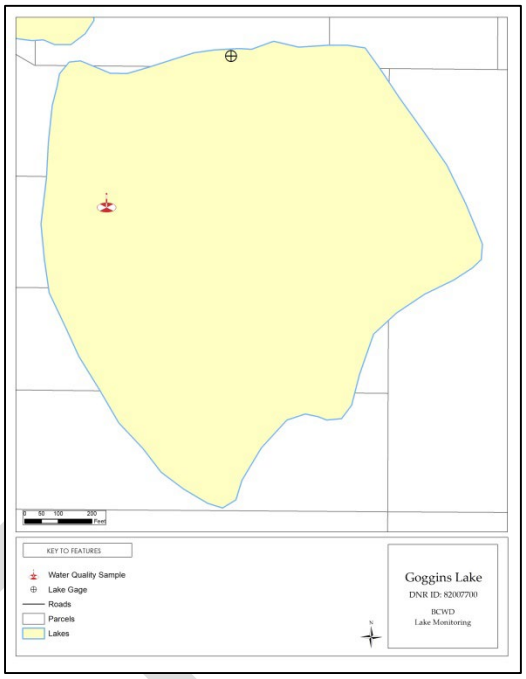


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	D	C	C	C	C	D	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	F	C	C	C	D	D	NA	NA	NA	NA
Secchi depth (ft)	F	F	D	F	F	F	NA	NA	NA	NA
Overall	**F+**	**D+**	**C-**	**D+**	**D**	**D-**	**NA**	**NA**	**NA**	**NA**

Goggins Lake

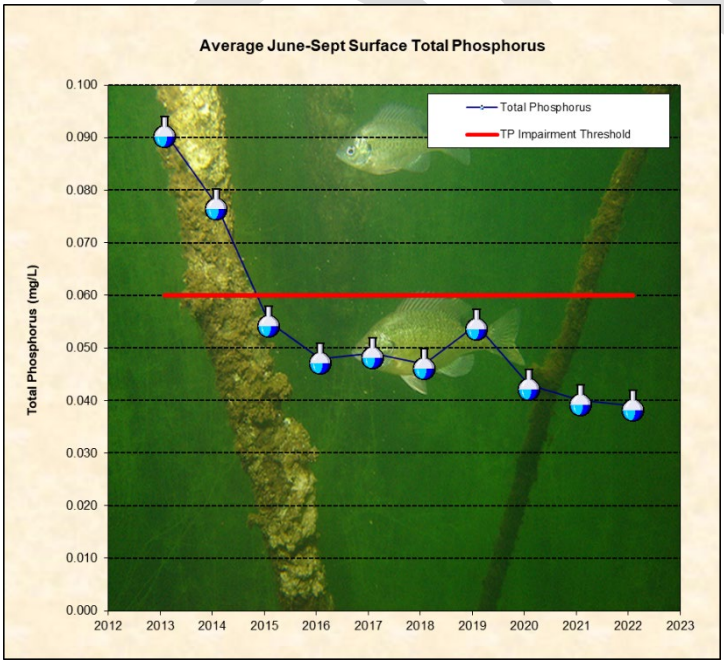
2022 Lake Grade: C+

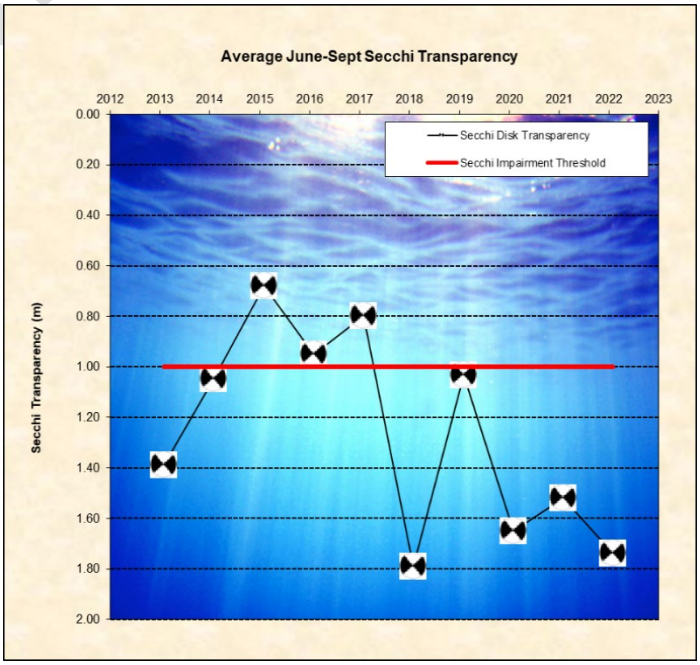
- DNR ID #: 820077
- Municipality: May Township
- Location: NW$^{1/4}$ Section 31, T31N-R20W
- Lake Size: 85 Acres
- Maximum Depth (2022): 15 ft
- Ordinary High Water Mark: 966.50 ft
- 100-Year High Water Level: 972.20 ft
- 99% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as eutrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for the average total phosphorus, average chlorophyll-α, and average Secchi transparency.
- The major land use is rural/agricultural.
- The lake did not stratify in 2022.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.
- Goggins Lake is listed as impaired for nutrients on the Minnesota Pollution Control Agency's Impaired Waters List.





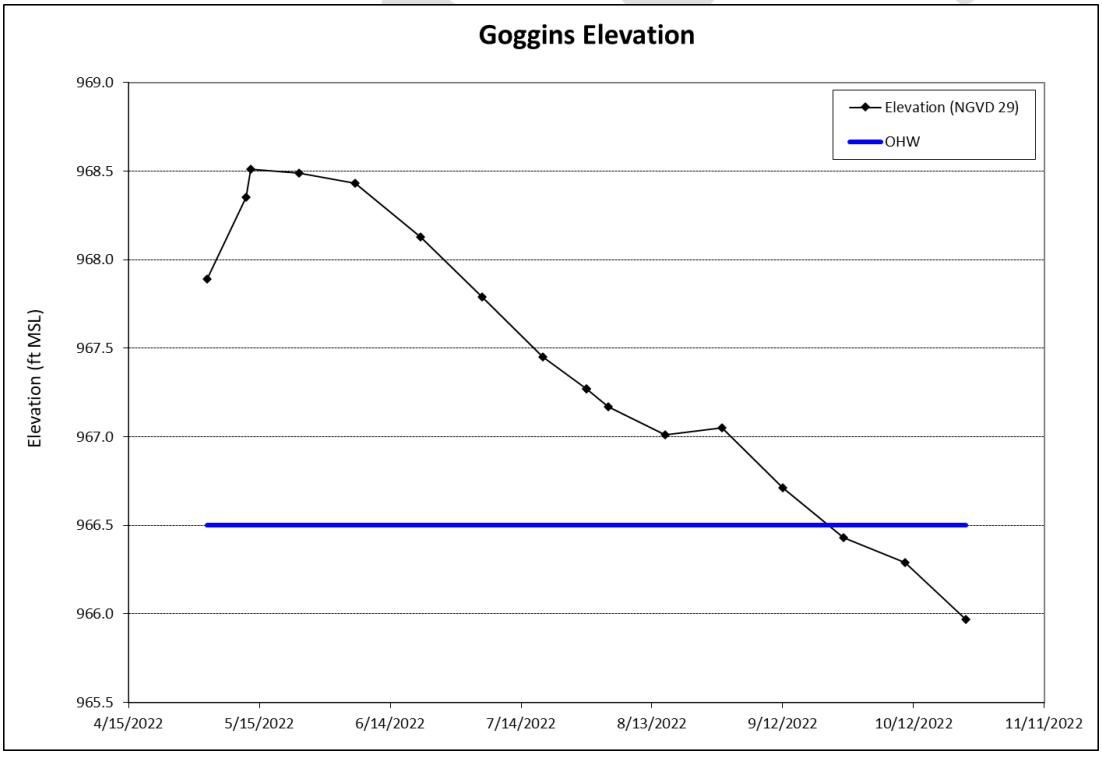
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 8:45	0.043	13.0	12.0	1.00	1.22	7.2	11.63
5/12/2022 9:30	0.045	12.0	10.0	0.91	1.37	16.8	8.70
5/24/2022 10:32	0.044	2.5	2.1	0.88	3.66	17.4	8.11
6/6/2022 10:30	0.049	7.7	7.2	0.86	3.05	20.8	9.43
6/21/2022 11:33	0.040	6.8	6.1	0.85	1.83	26.4	8.24
7/5/2022 12:23	0.032	12.0	11.0	0.84	1.83	25.0	8.93
7/19/2022 11:03	0.030	6.1	5.7	0.82	2.44	27.6	8.90
8/3/2022 10:27	0.031	16.0	15.0	0.99	1.68	25.9	12.48
8/16/2022 14:00	0.038	17.0	15.0	1.00	1.22	24.0	13.31
8/29/2022 10:45	0.045	30.0	28.0	0.95	1.52	23.5	11.12
9/12/2022 10:58	0.048	23.0	20.0	1.00	1.22	21.9	9.90
9/26/2022 14:35	0.040	30.0	28.0	1.10	0.91	17.4	9.53
10/10/2022 14:11	0.047	16.0	14.0	1.10	1.07	14.8	11.74
2022 Average	0.041	14.78	13.39	0.95	1.77	20.7	10.16
2022 Summer Average	0.039	16.51	15.11	0.93	1.74	23.6	10.20

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	968.51	5/13/2022	965.97	10/24/2022	967.42

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

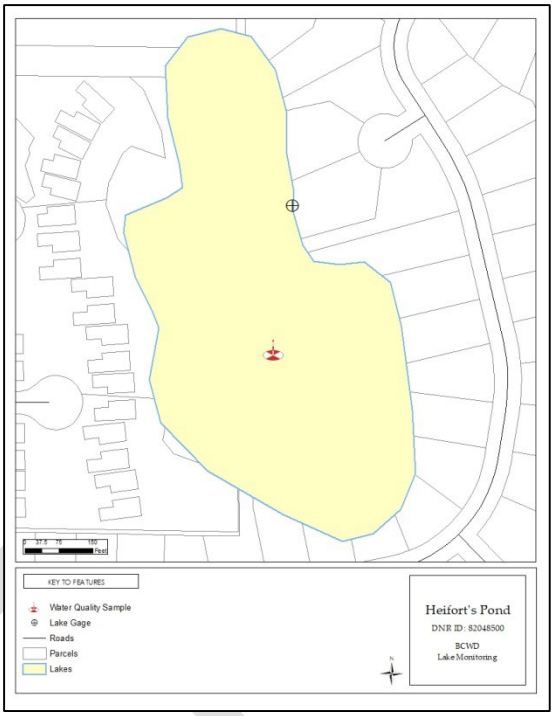


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	C	C	C	C	C	C	C	C	D	D
Chlorophyll-*a* (ug/l)	B	B	B	C	B	C	C	C	C	C
Secchi depth (ft)	C	C	C	C	C	D	D	F	D	C
Overall	**C+**	**C+**	**C+**	**C**	**C+**	**C-**	**C-**	**D+**	**D+**	**C-**

Heifort's Pond

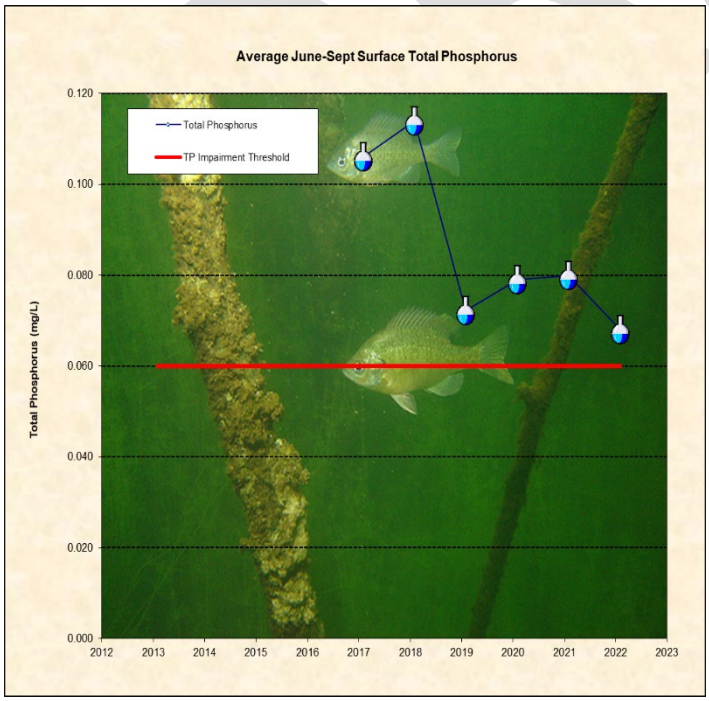
2022 Lake Grade: D-

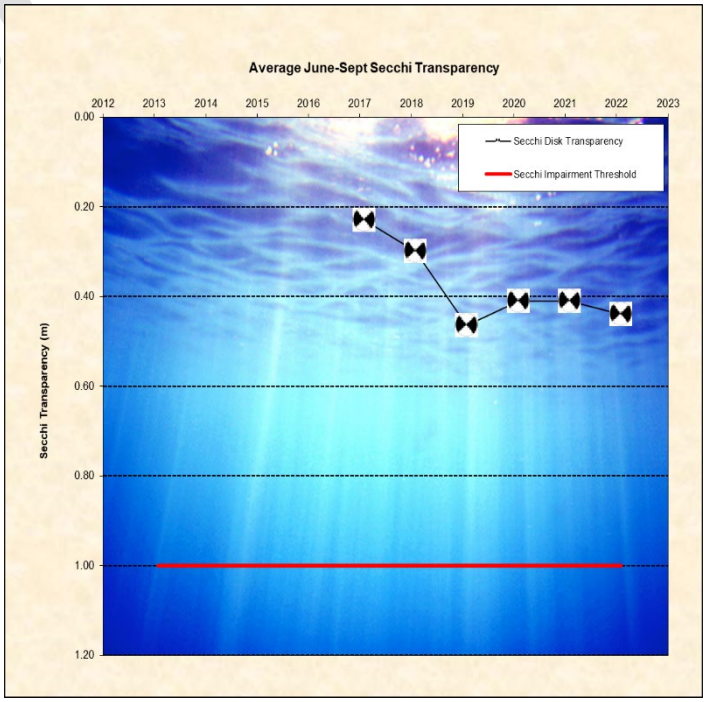
- DNR ID #: 820485
- Municipality: City of Stillwater
- Location: NW$^{1/4}$ Section 20, T30N-R20W
- Lake Size: 6 Acres
- Maximum Depth (2022): 9 ft
- Ordinary High Water Mark: 883.9 ft
- 100-Year High Water Level: 885.42 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as hypereutrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there are an insufficient number of years of data to determine a trend for the average total phosphorus, average chlorophyll-α, and the average Secchi transparency.
- The major land use is urban/residential.
- The lake did not stratify in 2022.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.





Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/22 14:13	0.090	53.0	49.0	1.90	0.61	9.3	12.08
5/10/22 12:44	0.082	44.0	41.0	1.90	0.70	17.0	NA
5/26/22 9:03	0.067	27.0	23.0	1.70	0.61	15.5	6.70
6/6/22 13:32	0.056	21.0	18.0	1.60	0.90	22.7	NA
6/22/22 11:55	0.055	34.0	32.0	2.00	0.46	27.1	8.07
7/6/22 11:15	0.085	150.0	150.0	2.80	0.40	25.2	NA
7/19/22 14:45	0.063	120.0	120.0	2.80	0.15	29.2	12.85
8/2/22 11:35	0.054	110.0	100.0	2.90	0.30	26.2	NA
8/16/22 13:30	0.062	110.0	100.0	3.00	0.15	24.1	18.05
8/29/22 12:43	0.106	90.0	85.0	2.70	0.40	24.5	NA
9/13/22 11:03	0.048	61.0	59.0	2.70	0.61	21.2	8.71
9/28/22 15:25	0.080	71.0	69.0	2.80	0.60	16.9	NA
10/11/22 13:50	0.054	61.0	58.0	2.60	0.46	14.8	12.53
2022 Average	0.069	73.2	69.5	2.42	0.49	21.1	11.28
2022 Summer Average	0.068	85.2	81.4	2.59	0.44	24.1	11.92

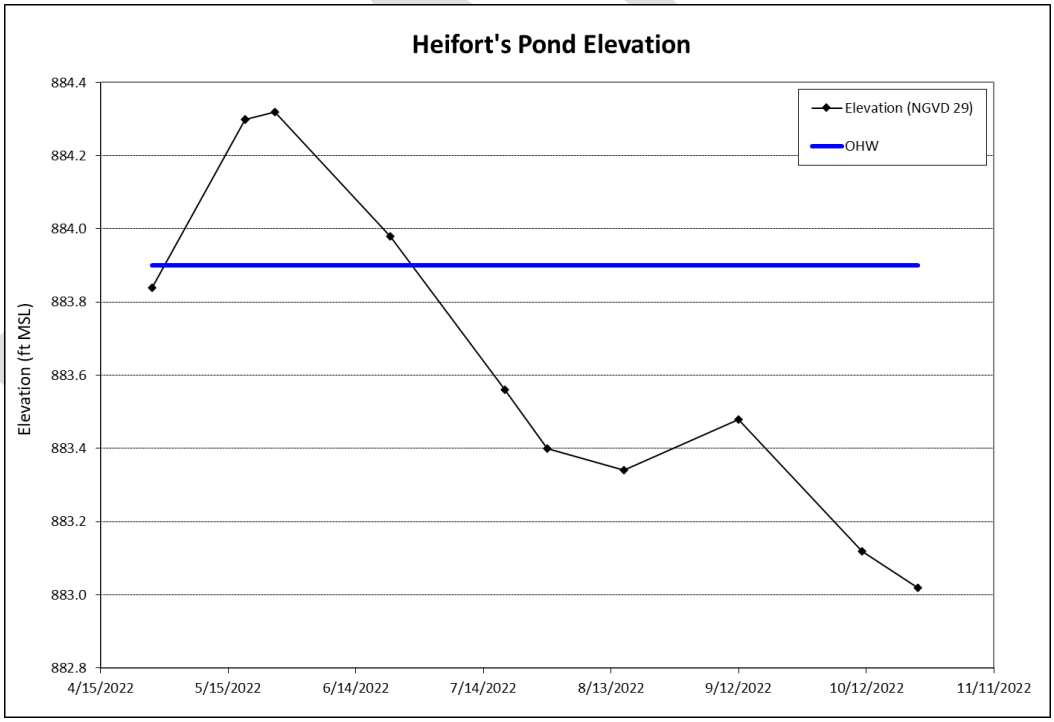
Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

Samples collected by a volunteer

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	884.32	5/26/2022	883.02	10/24/2022	883.70

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

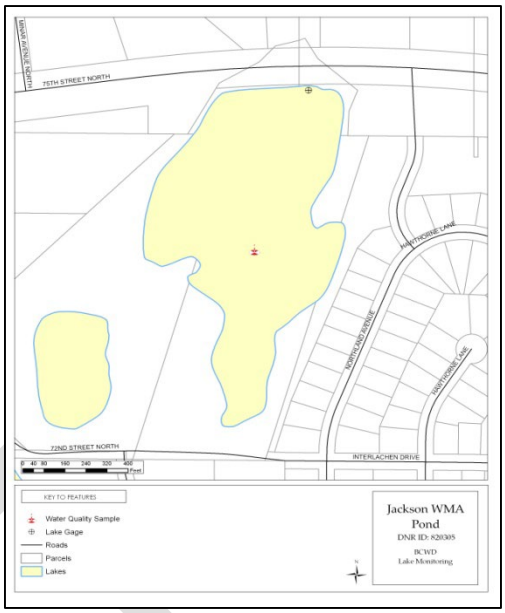


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	D	D	D	D	D	D	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	D	F	D	D	F	F	NA	NA	NA	NA
Secchi depth (ft)	F	F	F	F	F	F	NA	NA	NA	NA
Overall	**D-**	**F+**	**D-**	**D-**	**F+**	**F+**	**NA**	**NA**	**NA**	**NA**

Jackson WMA (Sinnits) Pond

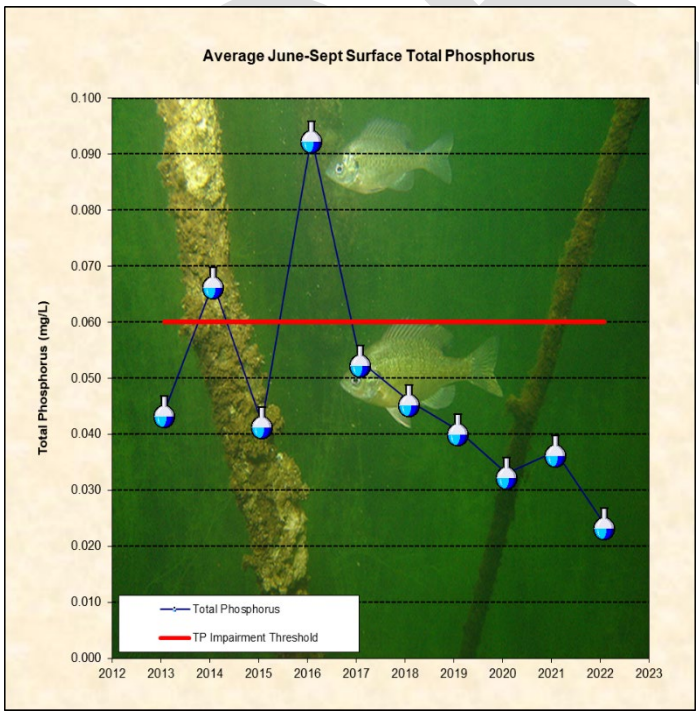
2022 Lake Grade: B

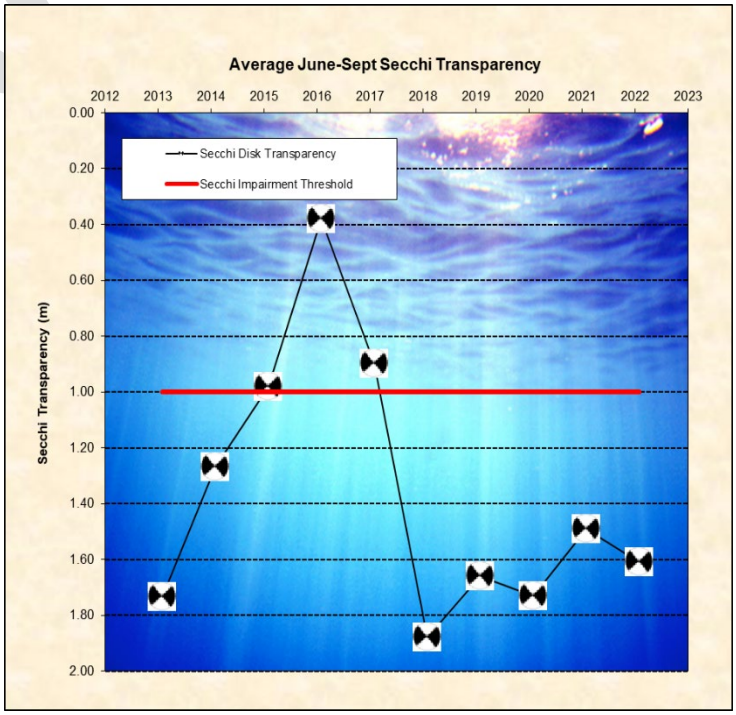
- DNR ID #: 820305
- Municipality: City of Stillwater
- Location: SE$^{1/4}$ Section 30, T30N-R20W
- Lake Size: 14.3 Acres
- Maximum Depth (2022): 9 ft
- Ordinary High Water Mark: NA
- 100-Year High Water Level: NA
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as eutrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for average total phosphorus and for average chlorophyll-α, and the trend for the average Secchi transparency is skewed due to vegetation limiting the transparency.
- The major land use is urban/residential.
- The lake did not stratify in 2022.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.





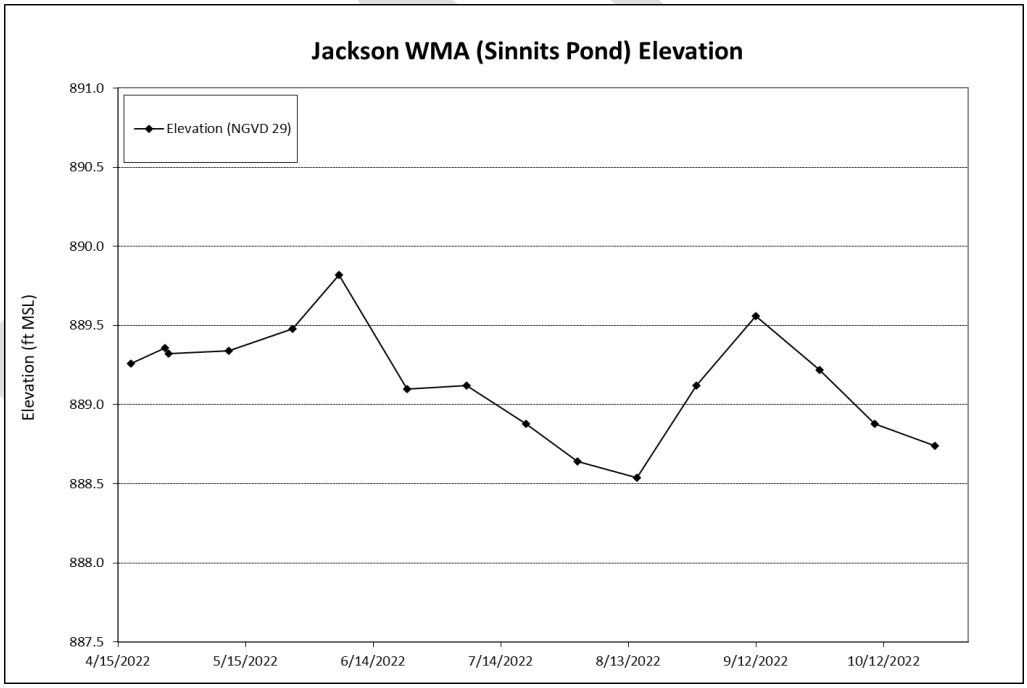
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/26/2022 13:01	0.039	15.0	13.0	0.75	1.98	8.1	11.07
5/11/2022 14:51	0.027	8.2	7.2	0.80	1.07	19.5	8.53
5/26/2022 13:58	0.040	9.1	12.0	0.75	1.68	16.2	7.32
6/6/2022 14:38	0.026	2.7	2.7	0.57	2.13	23.6	8.95
6/22/2022 14:24	0.021	2.6	2.6	0.64	2.29	27.4	9.47
7/6/2022 11:11	0.027	3.8	3.2	0.58	1.52	25.0	9.88
7/20/2022 15:11	0.026	2.3	2.0	0.77	0.91	28.1	8.34
8/1/2022 15:10	0.028	2.7	2.3	0.70	1.52	26.4	15.81
8/15/2022 14:45	0.025	3.5	3.3	0.72	1.52	22.6	8.62
8/29/2022 14:12	0.024	3.9	4.0	0.73	1.22	24.1	10.73
9/12/2022 14:38	0.019	3.8	3.2	0.68	1.52	22.5	12.26
9/27/2022 9:26	0.022	4.1	3.5	0.77	1.83	16.1	6.17
10/10/2022 14:53	0.037	9.5	8.8	0.72	2.13	14.7	10.84
2022 Average	0.028	5.5	5.2	0.71	1.64	21.1	9.85
2022 Summer Average	0.024	3.3	3.0	0.68	1.61	24.0	10.03

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	889.82	6/6/2022	888.54	8/15/2022	889.15

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

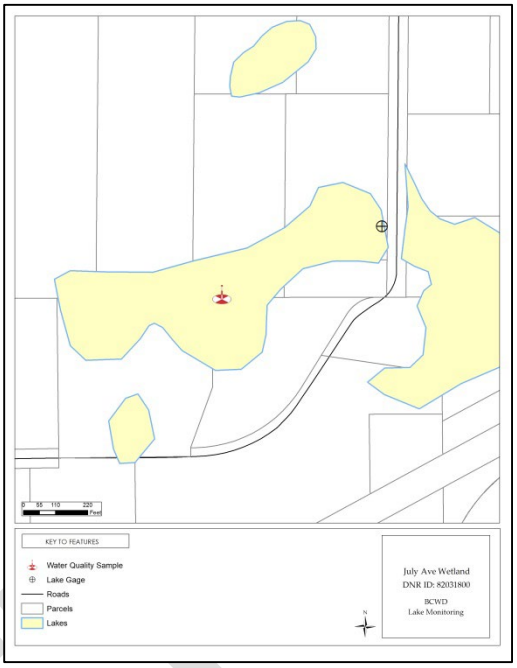


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	B	C	C	C	C	C	D	C	C	C
Chlorophyll-*a* (ug/l)	A	A	A	C	A	B	F	B	D	B
Secchi depth (ft)	C	C	C	C	C	D	F	D	C	C
Overall	**B**	**B-**	**B-**	**C**	**B-**	**C**	**F+**	**C**	**C-**	**C+**

July Ave Wetland

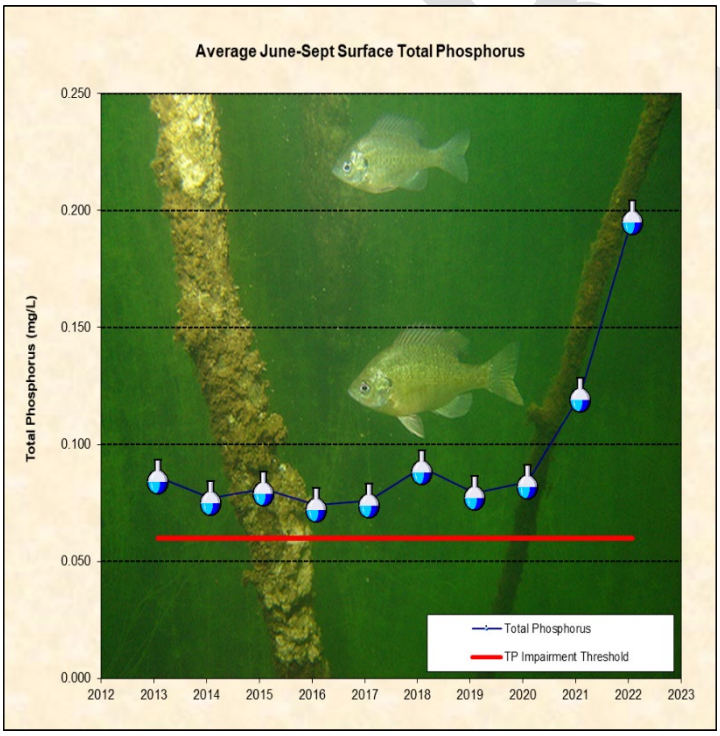
2022 Lake Grade: F

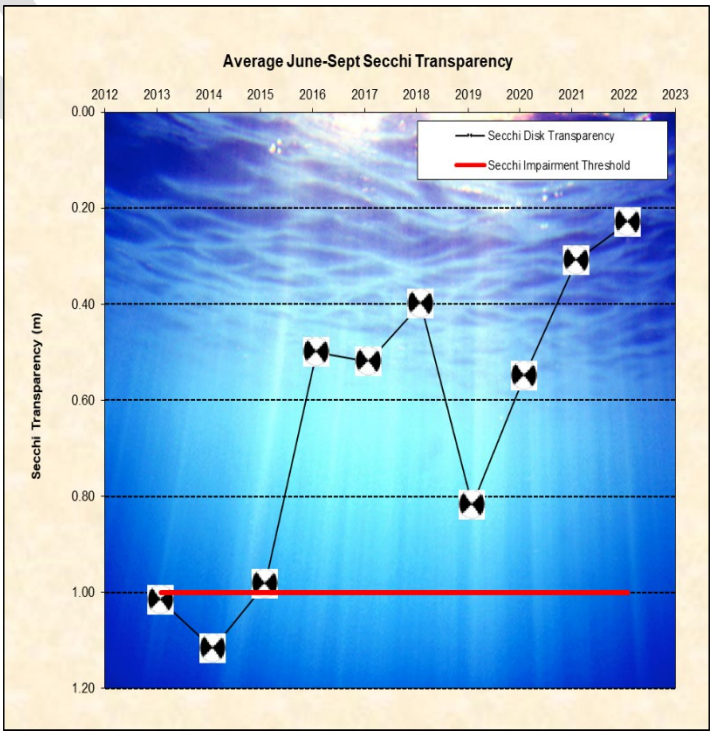
- DNR ID #: 820318
- Municipality: City of Grant
- Location: Section 3, T30N-R21W
- Lake Size: 12 Acres
- Maximum Depth (2022): 9 ft
- Ordinary High Water Mark: NA
- 100-Year High Water Level: 979.20 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as hypereutrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **declining** trend for the average Secchi transparency, and no trend for average total phosphorus and average chlorophyll-α.
- The major land use is rural/agricultural.
- The lake did not stratify in 2022.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.





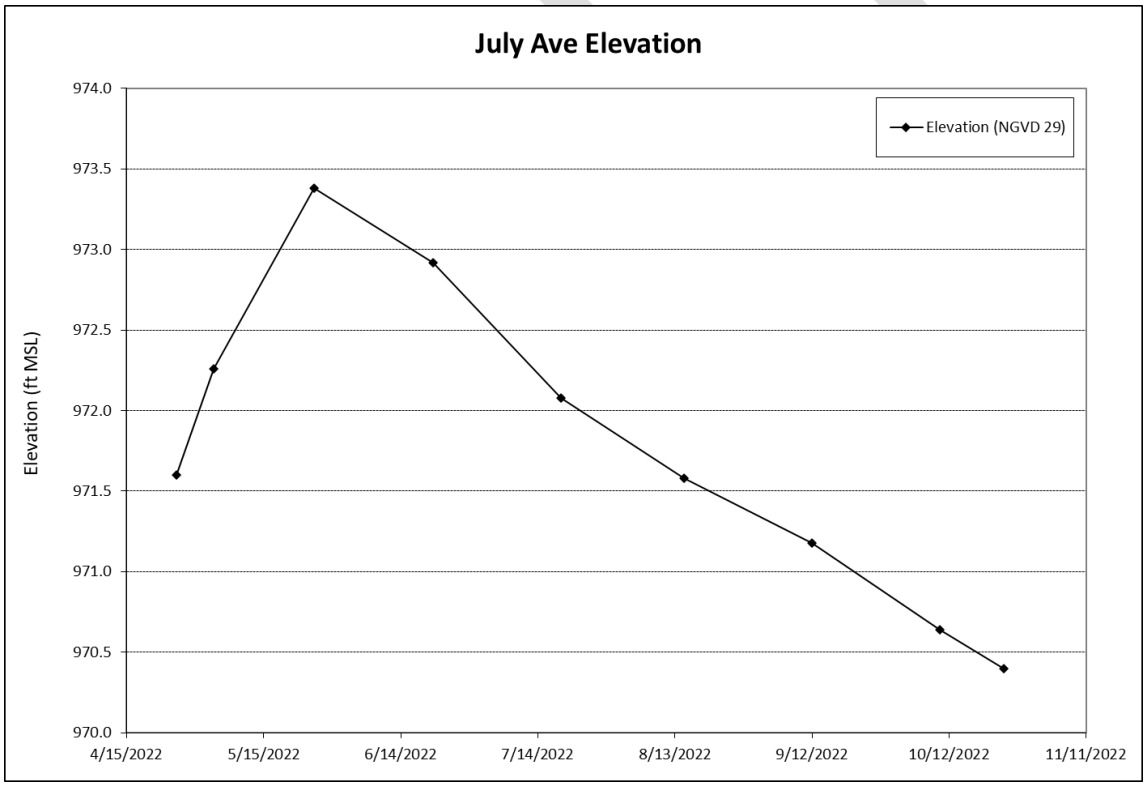
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 9:57	0.125	81.0	73.0	2.00	0.46	7.7	11.91
5/26/2022 10:06	0.108	29.0	24.0	1.90	0.46	15.6	5.40
6/21/2022 12:00	0.227	65.0	61.0	2.70	0.61	28.0	8.23
7/19/2022 11:45	0.173	170.0	12.0	3.60	0.08	26.9	4.12
8/15/2022 10:23	0.212	250.0	230.0	5.60	0.15	22.5	14.44
9/12/2022 11:21	0.175	220.0	210.0	5.50	0.08	21.4	12.12
10/10/2022 9:28	0.124	81.0	74.0	5.10	0.15	12.4	6.34
2022 Average	0.163	128.0	97.7	3.77	0.28	19.2	8.94
2022 Summer Average	0.197	176.3	128.3	4.35	0.23	24.7	9.73

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	973.38	5/26/2022	970.40	10/24/2022	971.78

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

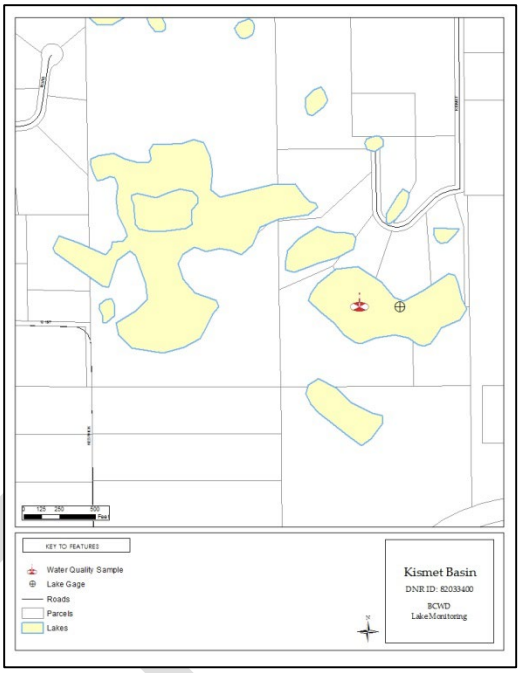


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	F	D	D	D	D	C	D	D	D	D
Chlorophyll-*a* (ug/l)	F	F	D	D	D	D	D	D	C	C
Secchi depth (ft)	F	F	F	D	F	F	F	F	D	D
Overall	**F**	**F+**	**D-**	**D**	**D-**	**D**	**D-**	**D-**	**D+**	**D+**

Kismet Basin

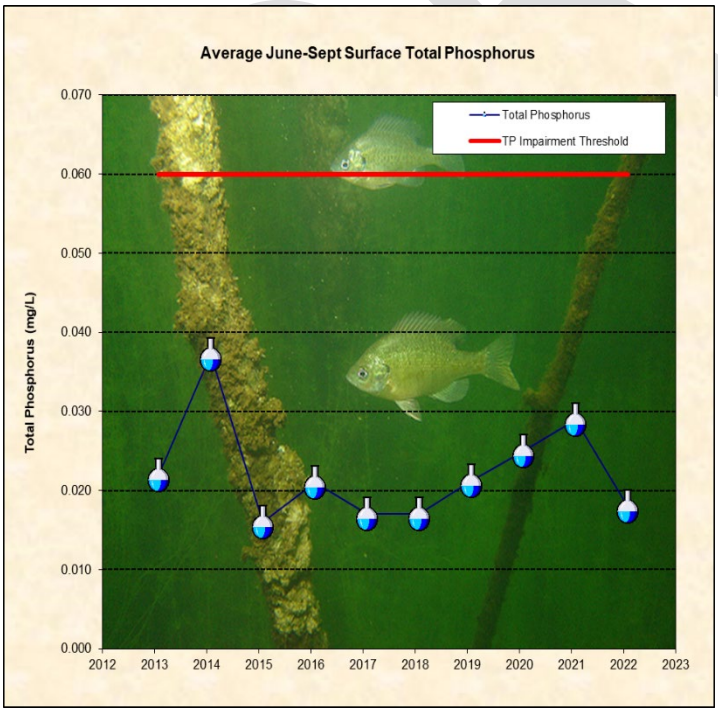
2022 Lake Grade: B+

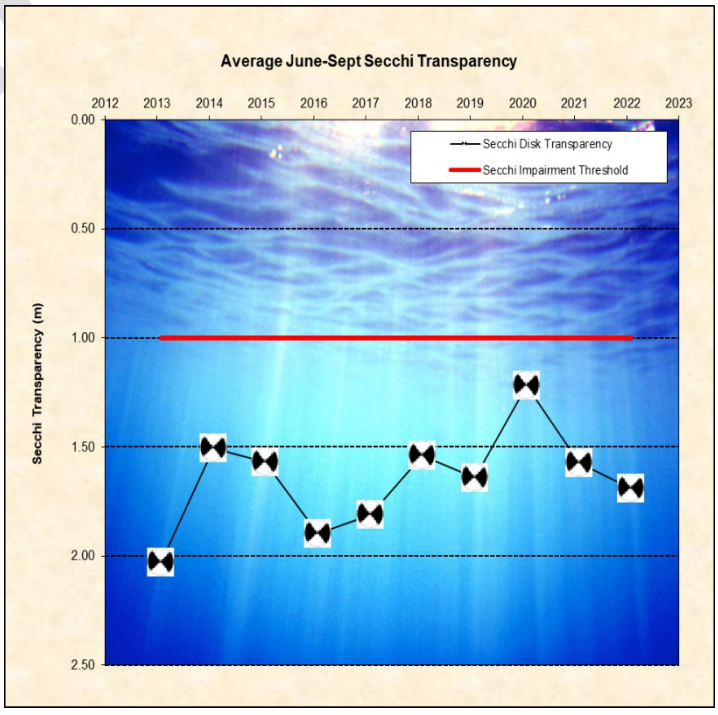
- DNR ID #: 820334
- Municipality: City of Grant
- Location: $S^{1/2}$ Section 11, T30N-R21W
- Lake Size: 70 Acres
- Maximum Depth (2022): 11 ft
- Ordinary High Water Mark: 943.50 ft
- 100-Year High Water Level: 944.90 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as mesotrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for the average total phosphorus and the average chlorophyll-α, and the trend for the average Secchi transparency is skewed due to vegetation limiting the transparency.
- The major land use is rural/agricultural.
- The lake did not stratify in 2022.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.





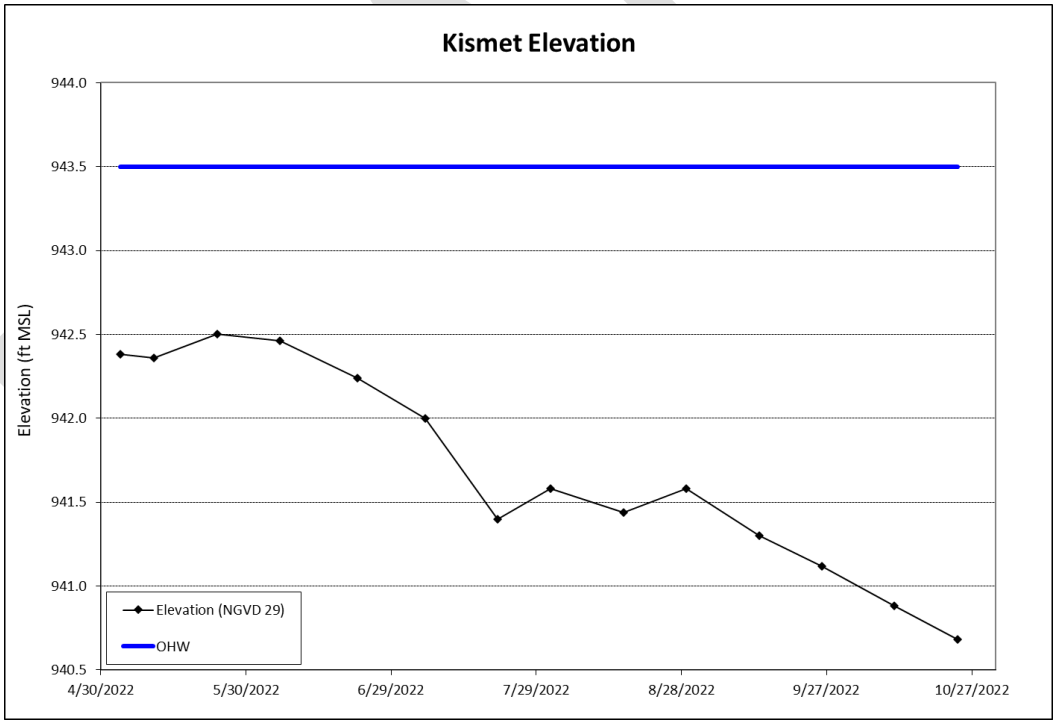
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 12:14	0.038	5.7	4.8	0.48	2.13	8.3	10.70
5/11/2022 13:56	0.015	4.6	3.7	0.53	2.29	18.7	8.31
5/24/2022 13:40	0.023	4.8	4.0	0.51	1.98	18.6	8.70
6/6/2022 12:15	0.015	3.0	5.1	0.45	2.13	22.2	9.44
6/22/2022 13:55	0.016	4.0	3.4	0.53	1.98	27.1	7.89
7/6/2022 9:40	0.019	4.8	4.0	0.51	1.68	24.5	6.59
7/21/2022 8:45	0.029	2.9	1.9	0.58	1.37	25.7	8.22
8/1/2022 11:45	0.017	5.4	4.8	0.50	1.98	24.4	9.51
8/16/2022 9:22	0.017	5.4	4.7	0.53	1.52	21.8	6.49
8/29/2022 12:12	0.028	8.7	7.9	0.51	0.91	23.2	8.37
9/13/2022 10:07	0.010	5.9	5.3	0.53	1.98	20.0	4.11
9/26/2022 10:02	0.013	3.7	2.7	0.46	1.68	15.4	4.66
10/11/2022 10:24	0.020	6.3	5.3	0.56	1.83	13.2	8.33
2022 Average	0.020	5.0	4.4	0.51	1.81	20.2	7.79
2022 Summer Average	0.018	4.9	4.4	0.51	1.69	22.7	7.25

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	942.50	5/24/2022	940.68	10/24/2022	941.71

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

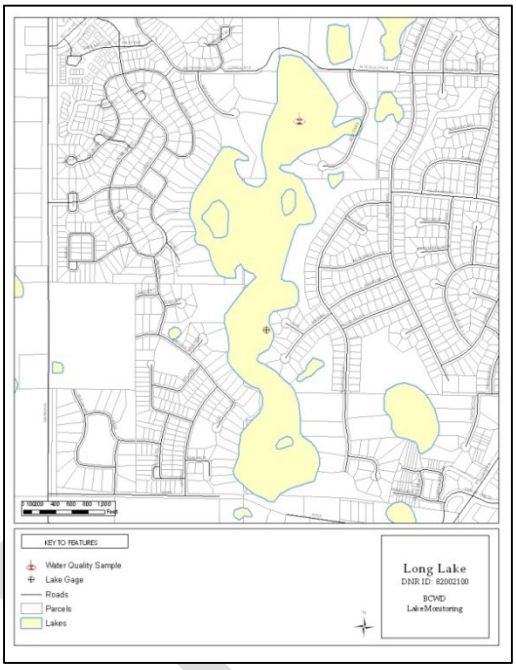


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	A	B	B	A	A	A	B	A	C	A
Chlorophyll-*a* (ug/l)	A	C	A	A	A	A	A	B	C	A
Secchi depth (ft)	C	C	C	C	C	C	C	C	C	C
Overall	**B+**	**C+**	**B**	**B+**	**B+**	**B+**	**B**	**B**	**C**	**B+**

Long Lake

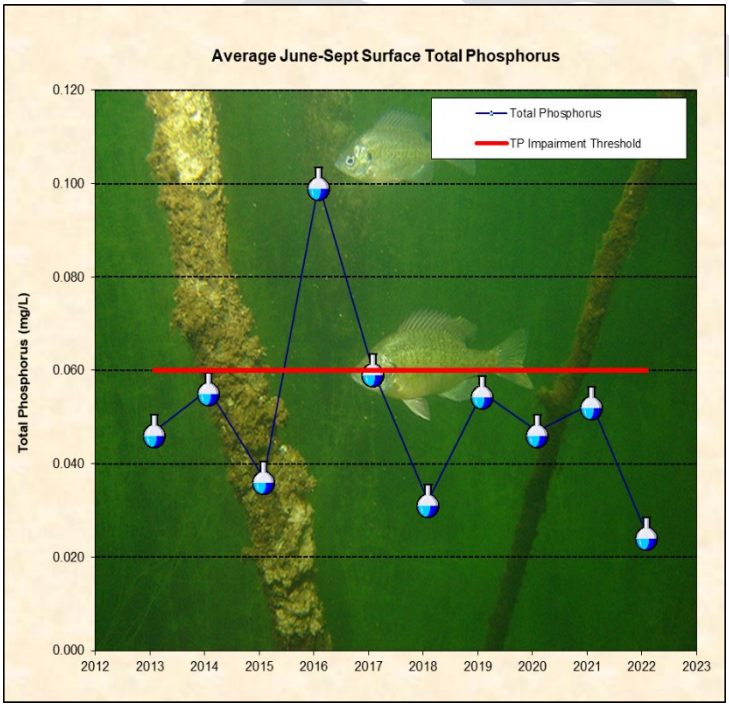
2022 Lake Grade: B+

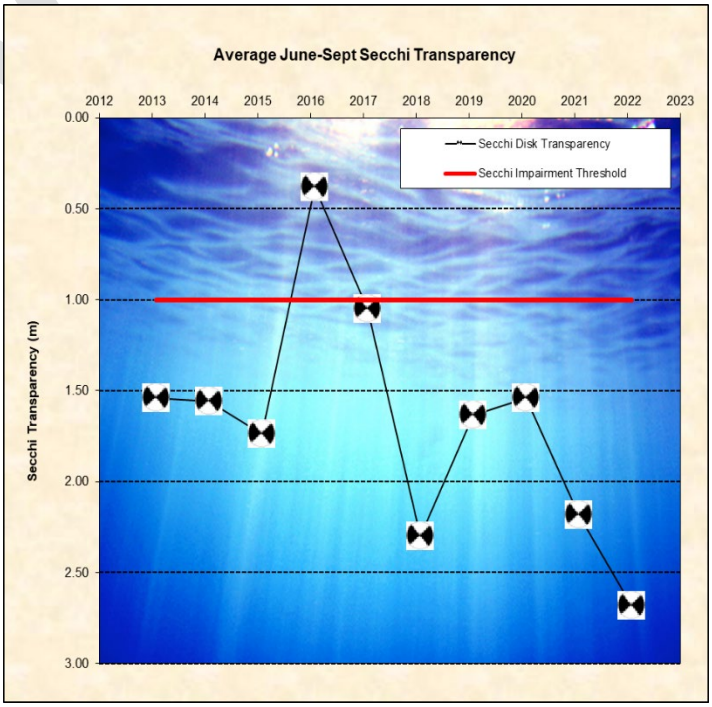
- DNR ID #: 820021
- Municipality: City of Stillwater
- Location: Section 30, T30N-R20W
- Lake Size: 110 Acres
- Maximum Basin Depth (2022): 21 ft
- Ordinary High Water Mark: 891.50 ft
- 100-Year High Water Level: 893.20 ft
- 95% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as mesotrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for the average Secchi transparency, average chlorophyll-α, and average total phosphorus.
- The major land use is urban/residential.
- The lake stratified in 2022 with a thermocline around 4 meters.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.
- Long Lake is listed as impaired for nutrients on the Minnesota Pollution Control Agency's Impaired Waters List.





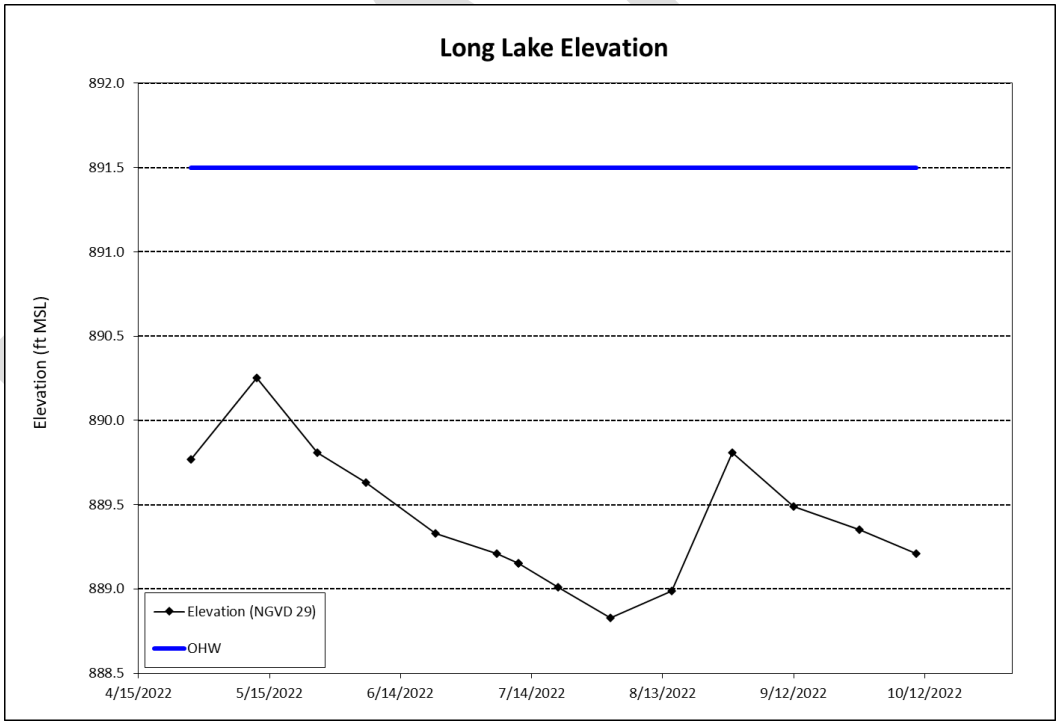
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/26/2022 12:33	0.072	34.0	32.0	0.87	1.52	7.7	9.87
5/12/2022 10:49	0.041	13.0	12.0	0.84	1.07	18.7	8.14
5/26/2022 13:36	0.039	6.2	5.3	0.77	2.44	16.3	7.51
6/6/2022 14:17	0.044	4.7	3.7	0.81	1.83	22.7	8.95
6/22/2022 14:45	0.021	2.4	1.9	0.64	2.74	27.6	8.60
7/6/2022 11:30	0.025	4.7	4.1	0.64	2.44	25.1	8.73
7/20/2022 14:00	0.021	2.1	1.7	0.59	2.13	27.1	7.47
8/1/2022 14:38	0.034	2.8	2.7	0.74	3.66	26.6	13.91
8/15/2022 14:15	0.028	8.0	7.7	0.84	2.74	22.9	11.74
8/29/2022 14:40	0.016	5.1	4.3	0.64	3.05	24.2	10.72
9/12/2022 14:15	0.020	3.3	2.7	0.72	3.35	22.3	12.47
9/27/2022 9:47	0.016	4.2	3.5	0.75	2.13	18.9	7.55
10/10/2022 15:23	0.033	4.5	4.3	0.92	1.98	15.1	10.55
2022 Average	0.032	7.3	6.6	0.75	2.39	21.2	9.71
2022 Summer Average	0.025	4.1	3.6	0.71	2.68	24.2	10.02

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	890.25	5/12/2022	888.83	8/1/2022	889.40

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

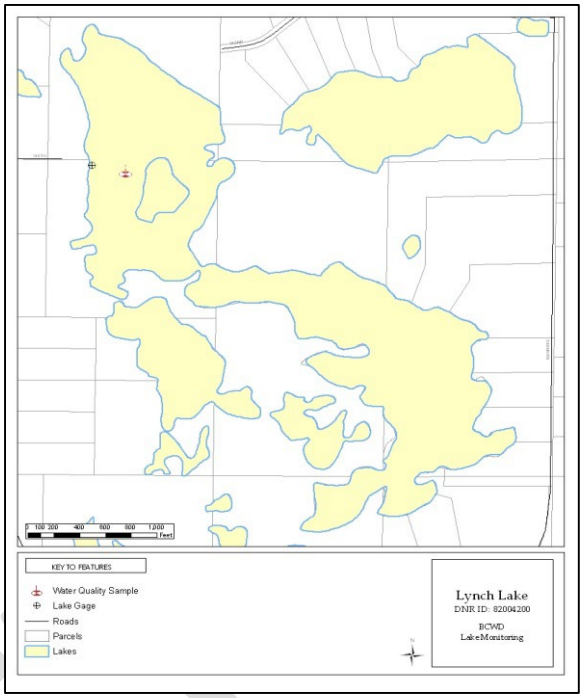


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	B	C	C	C	C	C	D	C	C	C
Chlorophyll-*a* (ug/l)	A	A	B	C	A	B	F	B	C	B
Secchi depth (ft)	B	B	C	C	B	D	F	C	C	C
Overall	**B+**	**B**	**C+**	**C**	**B**	**C**	**F+**	**C+**	**C**	**C+**

Lynch Lake – North Basin

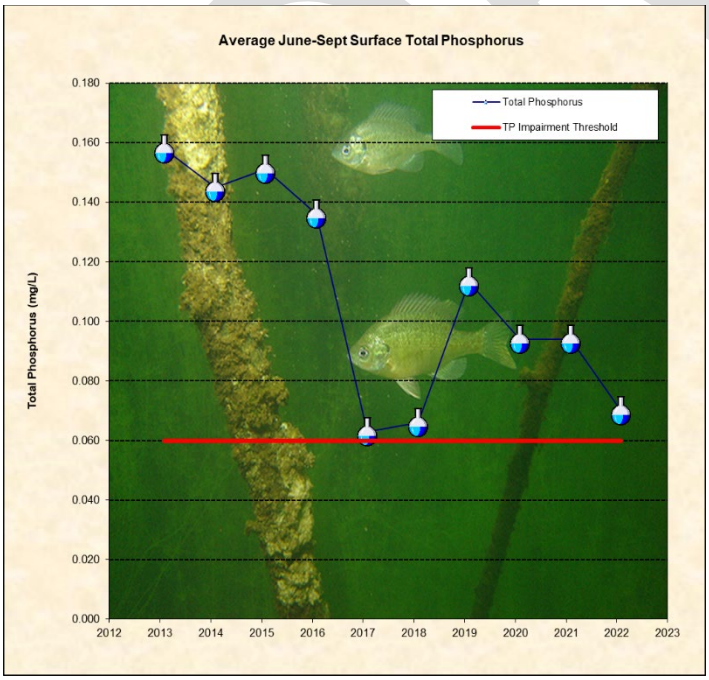
2022 Lake Grade: D+

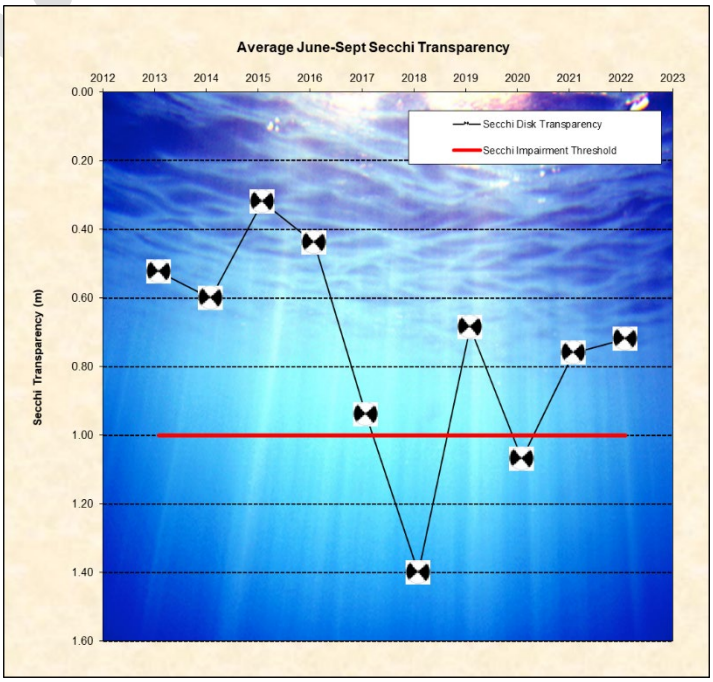
- DNR ID #: 820042
- Municipality: May Township
- Location: Section 30, T31N-R20W
- Lake Size: 87 Acres
- Maximum Depth (2022): 6 ft
- Ordinary High Water Mark: 1005.30 ft
- 100-Year High Water Level: 1008.10 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as eutrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for the average Secchi transparency, average chlorophyll-α, and average total phosphorus.
- The major land use is rural/agricultural.
- The lake did not stratify in 2022.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.
- Lynch Lake is listed as impaired for nutrients on the Minnesota Pollution Control Agency's Impaired Waters List.





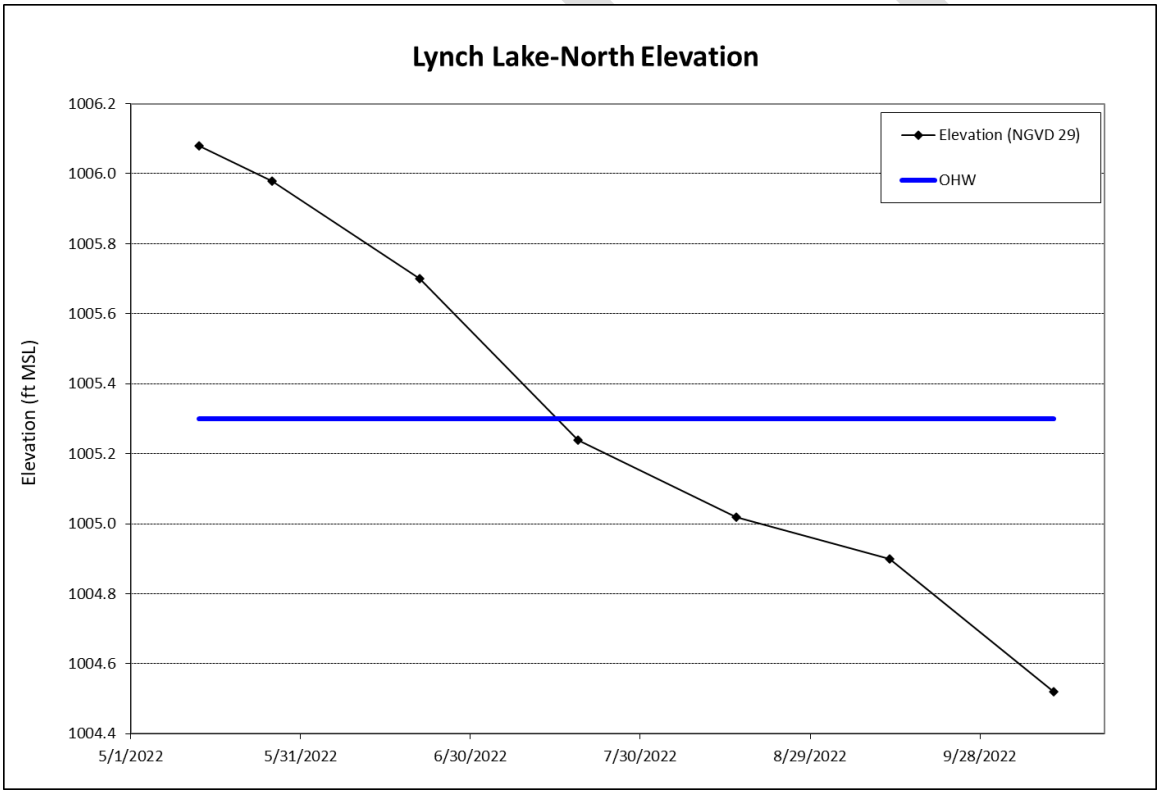
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 10:28	0.081	22.0	19.0	1.10	0.76	7.2	11.01
5/26/2022 10:28	0.089	28.0	22.0	1.20	0.61	15.0	8.79
6/21/2022 14:20	0.089	35.0	32.0	1.40	0.76	28.3	9.79
7/19/2022 14:07	0.090	40.0	36.0	1.40	0.61	28.1	10.29
8/16/2022 8:49	0.055	54.0	51.0	1.50	0.61	21.7	17.77
9/12/2022 13:13	0.046	30.0	27.0	1.20	0.91	20.7	14.60
10/11/2022 8:12	0.074	24.0	20.0	1.30	0.61	12.7	9.24
2022 Average	0.075	33.3	29.6	1.30	0.70	19.1	11.64
2022 Summer Average	0.070	39.8	36.5	1.38	0.72	24.7	13.11

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	1006.08	5/13/2022	1004.52	10/11/2022	1005.348571

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

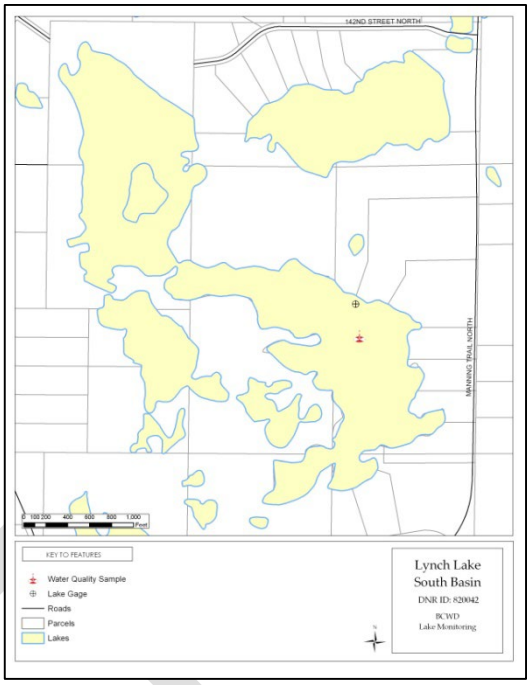


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	D	D	D	D	C	C	D	D	D	F
Chlorophyll-*a* (ug/l)	C	C	C	D	B	C	D	F	F	F
Secchi disk (ft)	D	D	D	D	C	D	F	F	F	F
Overall	**D+**	D+	D+	D	C+	C-	D-	F+	F+	F

Lynch Lake – South Basin

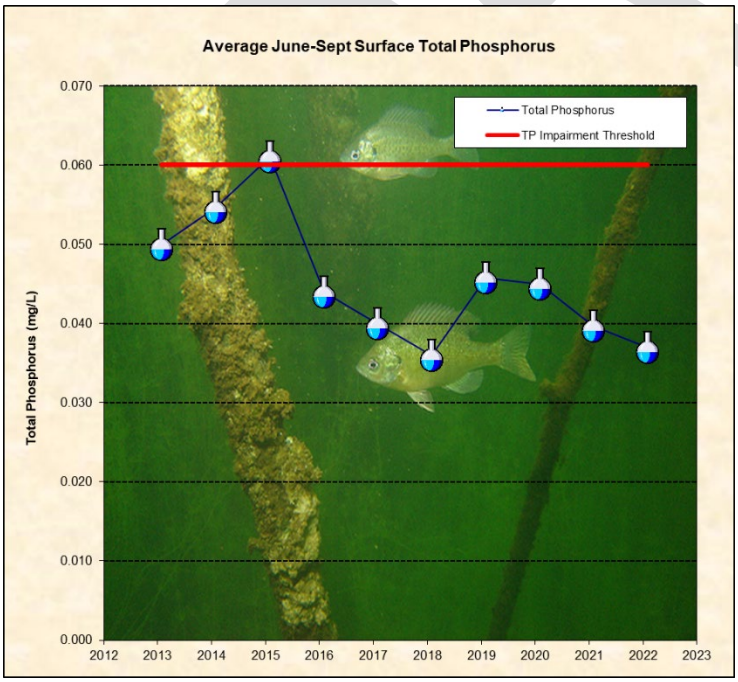
2022 Lake Grade: C+

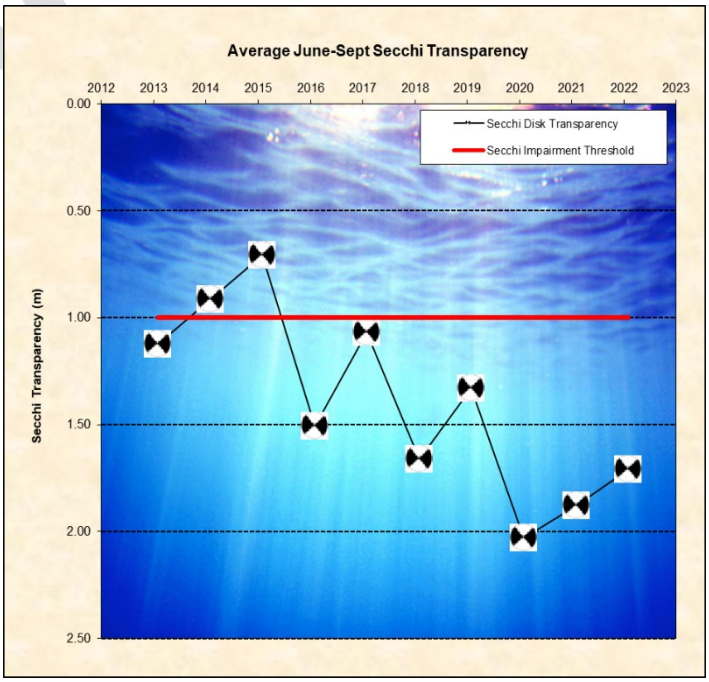
- DNR ID #: 820042
- Municipality: May Township
- Location: Section 30, T31N-R20W
- Lake Size: 87 Acres
- Maximum Depth (2022): 18 ft
- Ordinary High Water Mark: 1005.30 ft
- 100-Year High Water Level: 1008.10 ft
- 99% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as eutrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for the average Secchi transparency, average chlorophyll-α, and average total phosphorus.
- The major land use is rural/agricultural.
- The lake stratified in 2022 with the thermocline around 4 meters.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.
- Lynch Lake is listed as impaired for nutrients on the Minnesota Pollution Control Agency's Impaired Waters List.





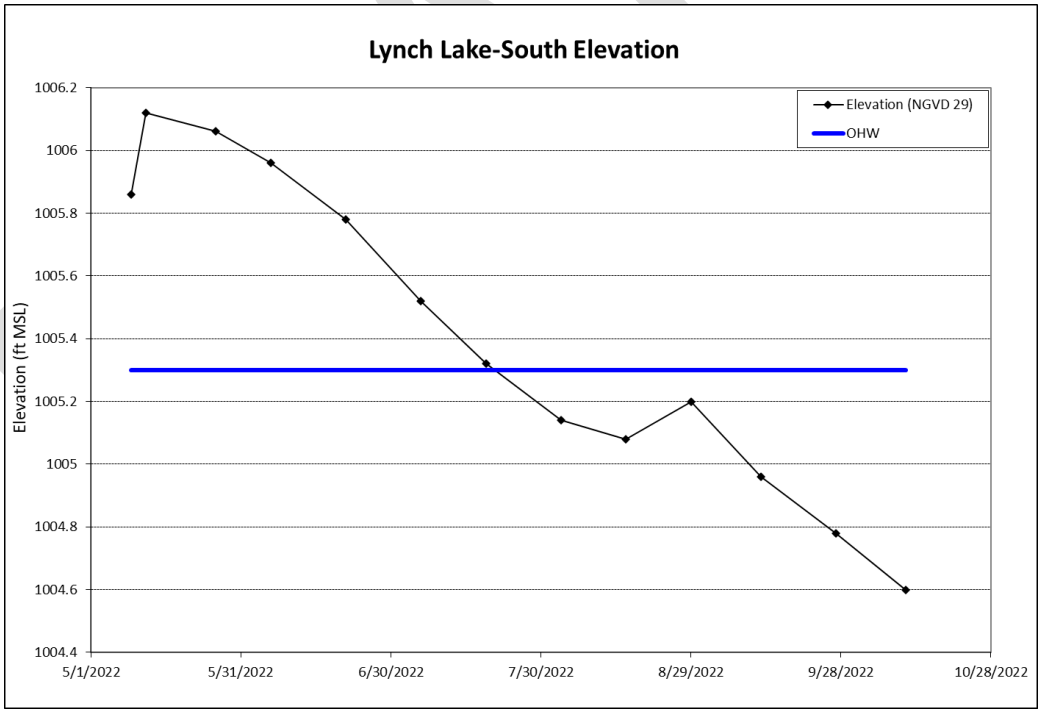
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 10:52	0.038	11.0	8.5	1.00	1.83	7.5	10.97
5/12/2022 9:58	0.040	6.5	4.8	0.87	1.07	17.3	8.48
5/26/2022 10:52	0.040	11.0	8.8	0.88	1.22	16.0	7.97
6/6/2022 11:21	0.043	12.0	11.0	0.80	1.83	21.3	9.17
6/21/2022 13:52	0.057	6.4	5.9	1.10	2.13	27.6	8.30
7/6/2022 10:32	0.036	13.0	12.0	0.94	1.68	24.8	9.41
7/19/2022 13:35	0.034	11.0	11.0	0.95	1.52	28.4	9.12
8/3/2022 11:08	0.030	12.0	11.0	0.90	2.13	26.0	13.09
8/16/2022 10:21	0.036	15.0	14.0	0.87	1.68	23.1	13.60
8/29/2022 11:18	0.025	17.0	16.0	0.81	1.68	23.4	12.44
9/12/2022 11:45	0.027	26.0	26.0	0.88	1.22	22.1	13.68
9/27/2022 8:54	0.048	26.0	23.0	0.95	1.52	16.7	8.06
10/11/2022 8:42	0.048	20.0	17.0	1.10	1.37	14.2	9.23
2022 Average	0.039	14.4	13.0	0.93	1.61	20.6	10.27
2022 Summer Average	0.037	15.4	14.4	0.91	1.71	23.7	10.76

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	1006.12	5/12/2022	1004.60	10/11/2022	1005.41

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

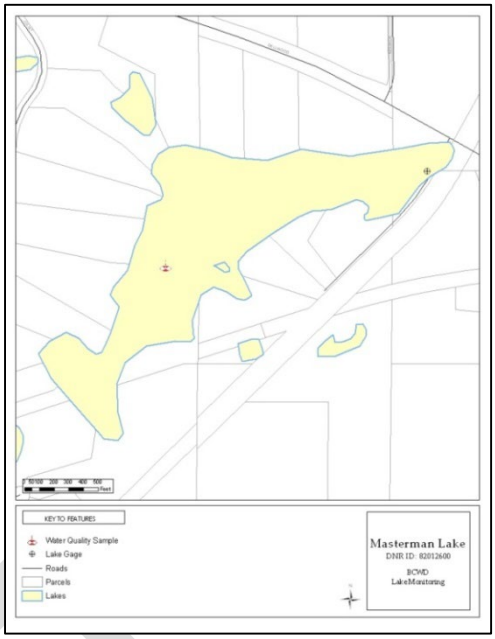


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	C	C	C	C	C	C	C	C	C	C
Chlorophyll-*a* (ug/l)	B	B	A	C	B	B	C	C	C	B
Secchi depth (ft)	C	C	C	C	C	D	C	D	D	D
Overall	**C+**	**C+**	**B-**	**C**	**C+**	**C**	**C**	**C-**	**C-**	**C**

Masterman Lake

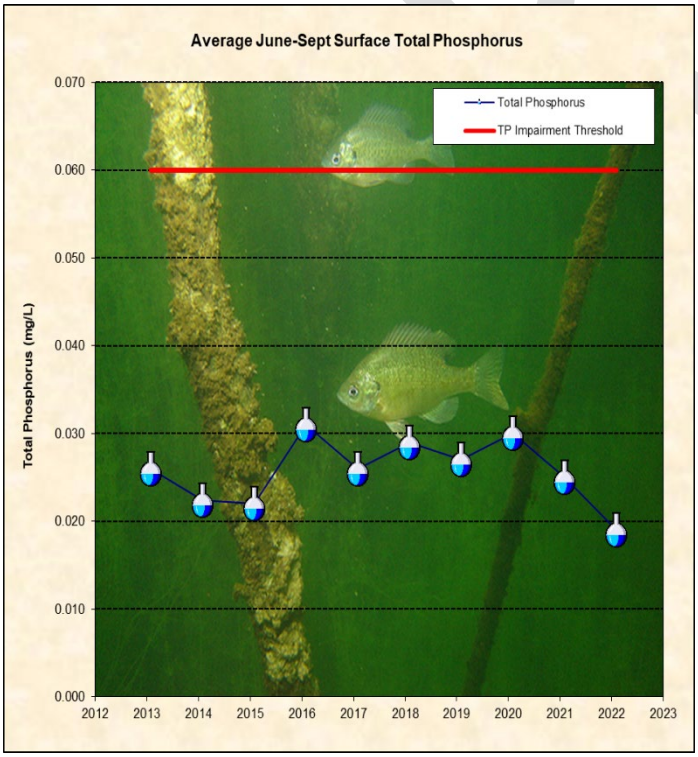
2022 Lake Grade: B+

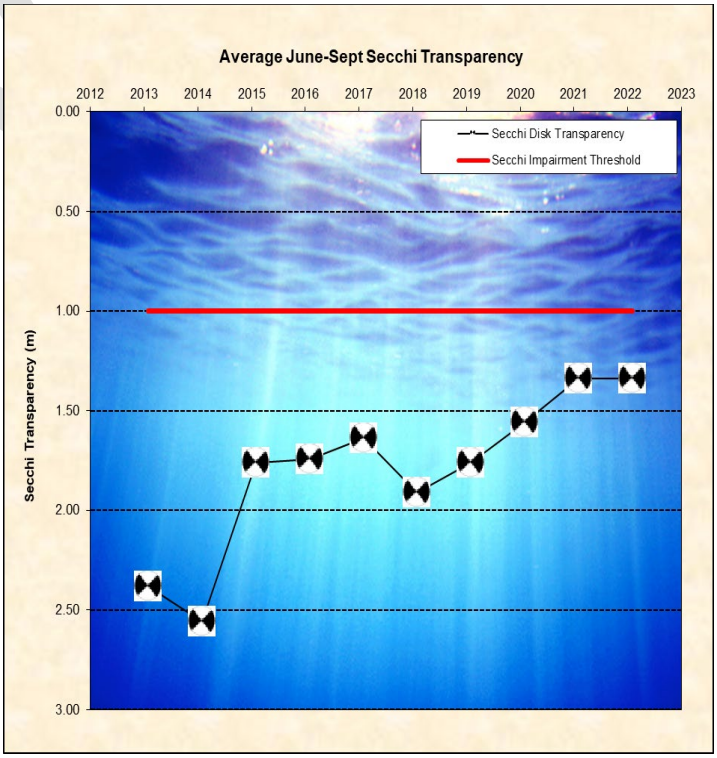
- DNR ID #: 820126
- Municipality: City of Grant
- Location: Section 23, T30N-R21W
- Lake Size: 40 Acres
- Maximum Depth (2022): 8 ft
- Ordinary High Water Mark: 955.70 ft
- 100-Year High Water Level: 955.90 ft
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as mesotrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for the average total phosphorus and average chlorophyll-α, and the trend for the average Secchi transparency is skewed due to vegetation limiting the transparency.
- The major land use is rural/agricultural.
- The lake did not stratify in 2022.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.





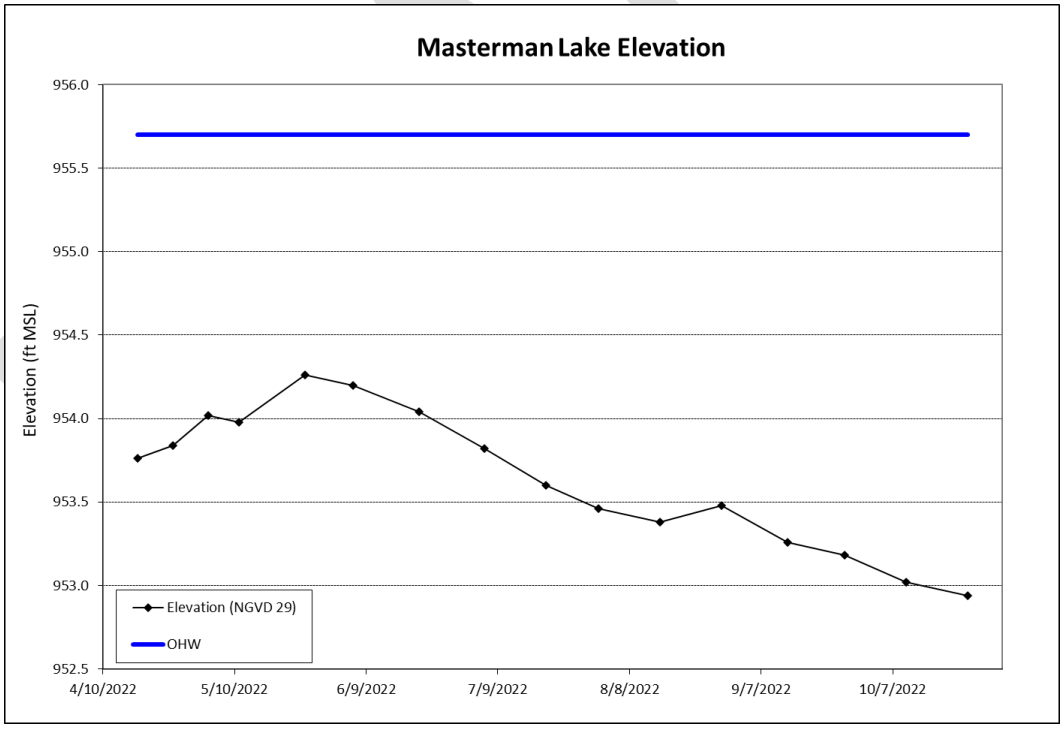
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/26/2022 8:43	0.047	4.8	3.5	0.60	1.68	6.5	10.48
5/11/2022 11:52	0.017	3.8	3.2	0.47	1.52	18.1	9.33
5/26/2022 8:39	0.018	3.5	2.7	0.42	1.52	16.3	7.16
6/6/2022 13:45	0.024	2.1	1.6	0.44	1.52	22.5	9.35
6/21/2022 14:49	0.018	2.0	1.9	0.51	1.98	28.3	8.14
7/6/2022 8:19	0.022	5.4	4.5	0.54	1.52	24.4	7.24
7/20/2022 10:30	0.024	9.9	8.5	0.53	1.22	25.4	6.28
8/1/2022 11:06	0.010	4.6	3.8	0.56	1.22	24.8	12.70
8/15/2022 13:36	0.023	3.2	2.8	0.53	1.22	22.2	8.37
8/29/2022 8:57	0.024	7.5	10.0	0.52	1.07	22.0	8.46
9/13/2022 8:27	0.013	5.3	4.5	0.54	1.37	20.2	6.69
9/26/2022 9:38	0.014	2.3	1.9	0.46	0.91	16.2	4.82
10/10/2022 10:57	0.029	3.5	2.9	0.45	1.22	13.1	7.36
2022 Average	0.022	4.5	4.0	0.51	1.38	20.0	8.18
2022 Summer Average	0.019	4.7	4.4	0.51	1.34	22.9	8.01

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	954.26	5/26/2022	952.94	10/24/2022	953.64

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

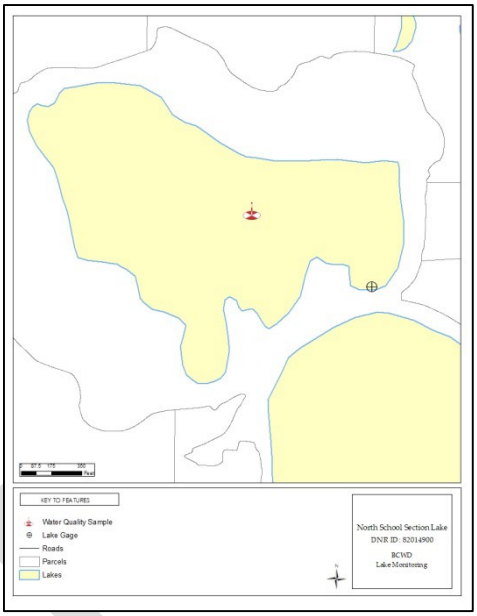


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	A	A	B	B	B	B	B	A	A	B
Chlorophyll-*a* (ug/l)	A	A	B	A	A	B	B	A	A	A
Secchi depth (ft)	C	C	C	C	C	C	C	C	B	B
Overall	**B+**	B+	B-	B	B	B-	B-	B+	A-	B+

North School Section Lake

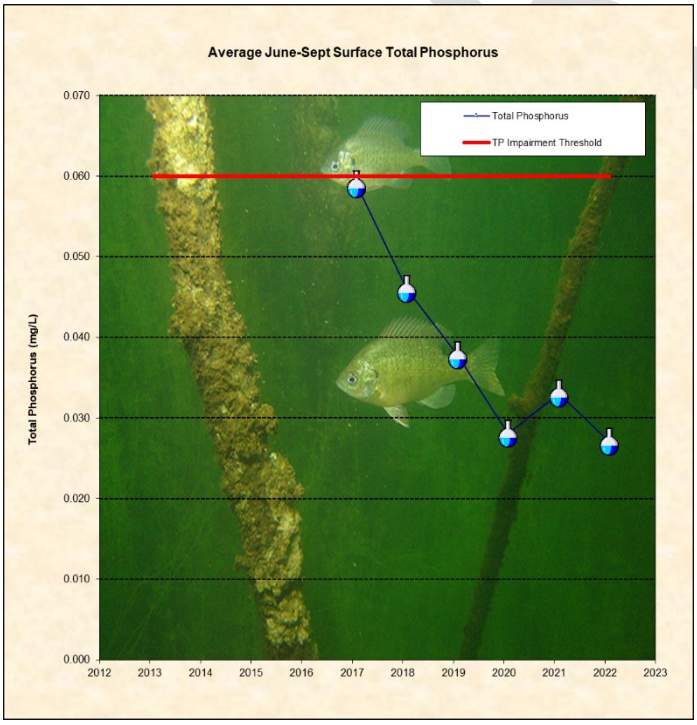
2022 Lake Grade: B+

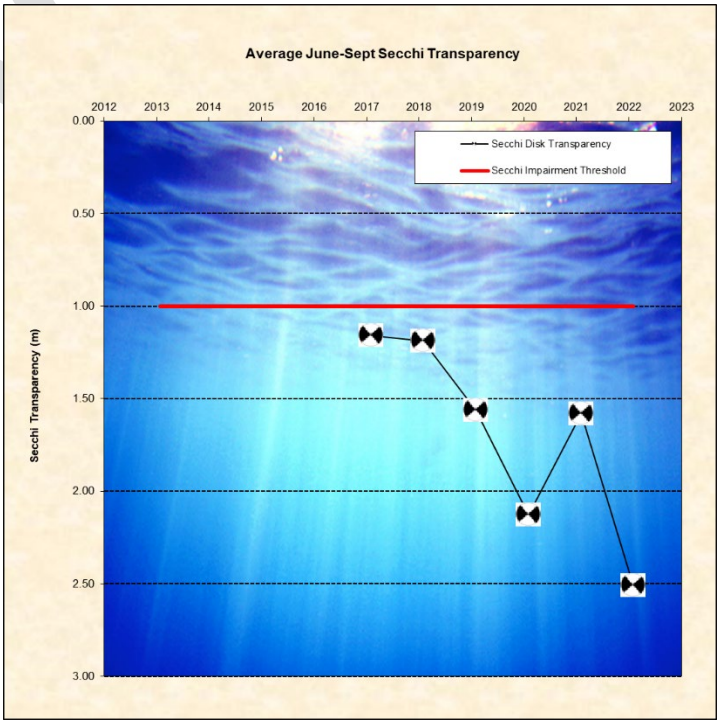
- DNR ID #: 820149
- Municipality: City of Hugo
- Location: SW ¼ Section 25, T31N-R21W
- Lake Size: 40 Acres
- Maximum Depth (2022): 15 ft
- Ordinary High Water Mark: 963.2 ft
- 100-Year High Water Level: 970.42
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as eutrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there are an insufficient number of years of data to determine a trend for the average total phosphorus, average chlorophyll-α, and average Secchi transparency.
- The major land use is rural/agricultural.
- The North and South School Section basins were connected in 2022.
- The lake did not stratify in 2022.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.





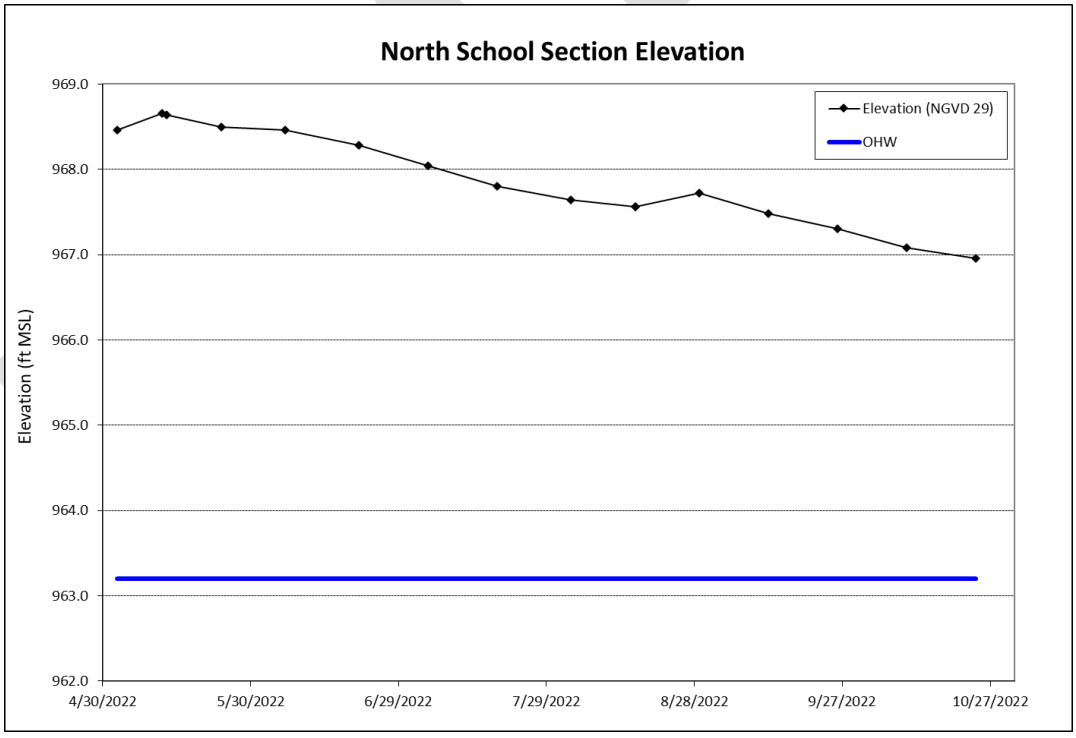
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 9:25	0.026	7.6	6.1	0.72	2.44	7.1	10.66
5/24/2022 11:30	0.034	3.2	2.4	0.72	3.66	17.3	9.12
6/21/2022 10:55	0.020	6.3	6.0	0.66	3.05	25.9	8.47
7/19/2022 10:30	0.028	5.7	5.3	0.72	2.90	27.2	8.36
8/16/2022 14:42	0.029	10.0	9.3	0.74	2.29	23.4	12.66
9/12/2022 10:30	0.031	16.0	15.0	0.79	1.83	21.6	9.39
10/10/2022 13:30	0.024	6.5	5.9	0.66	3.35	14.3	11.99
2022 Average	0.027	7.9	7.1	0.72	2.79	19.5	10.09
2022 Summer Average	0.027	9.5	8.9	0.73	2.51	24.5	9.72

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	968.66	5/12/2022	966.96	10/24/2022	967.88

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

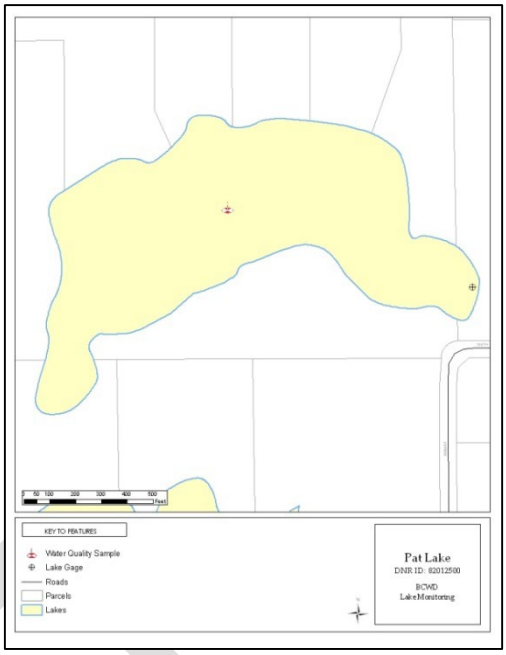


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	B	B	C	C	C	C	NA	NA	NA	NA
Chlorophyll-*a* (ug/l)	A	B	A	C	C	C	NA	NA	NA	NA
Secchi depth (ft)	B	C	B	C	C	C	NA	NA	NA	NA
Overall	**B+**	**B-**	**B**	**C**	**C**	**C**	**NA**	**NA**	**NA**	**NA**

Pat Lake

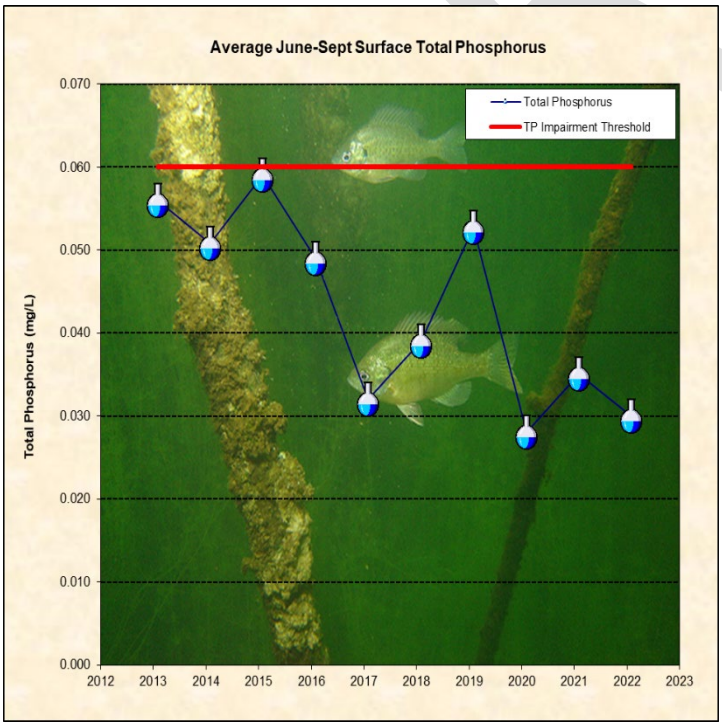
2022 Lake Grade: B+

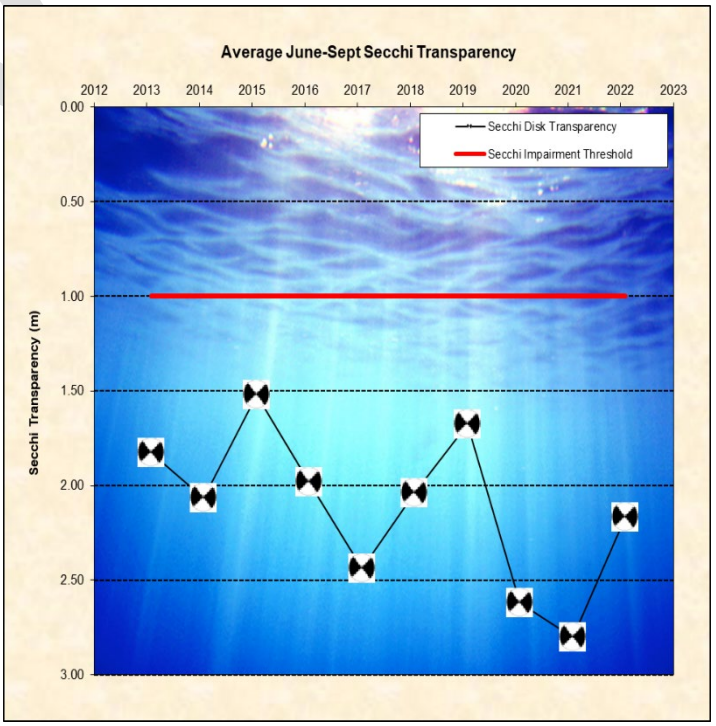
- DNR ID #: 820125
- Municipality: City of Grant
- Location: Section 11, T30N-R21W
- Lake Size: 20 Acres
- Maximum Depth (2022): 18 ft
- Ordinary High Water Mark: 941.80 ft
- 100-Year High Water Level: 949.10 ft
- 99% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as mesotrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for the average total phosphorus and average chlorophyll-α, and no trend for average Secchi transparency at this time.
- The major land use is rural/agricultural.
- The lake stratified in 2022 with a thermocline around 3 meters.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.





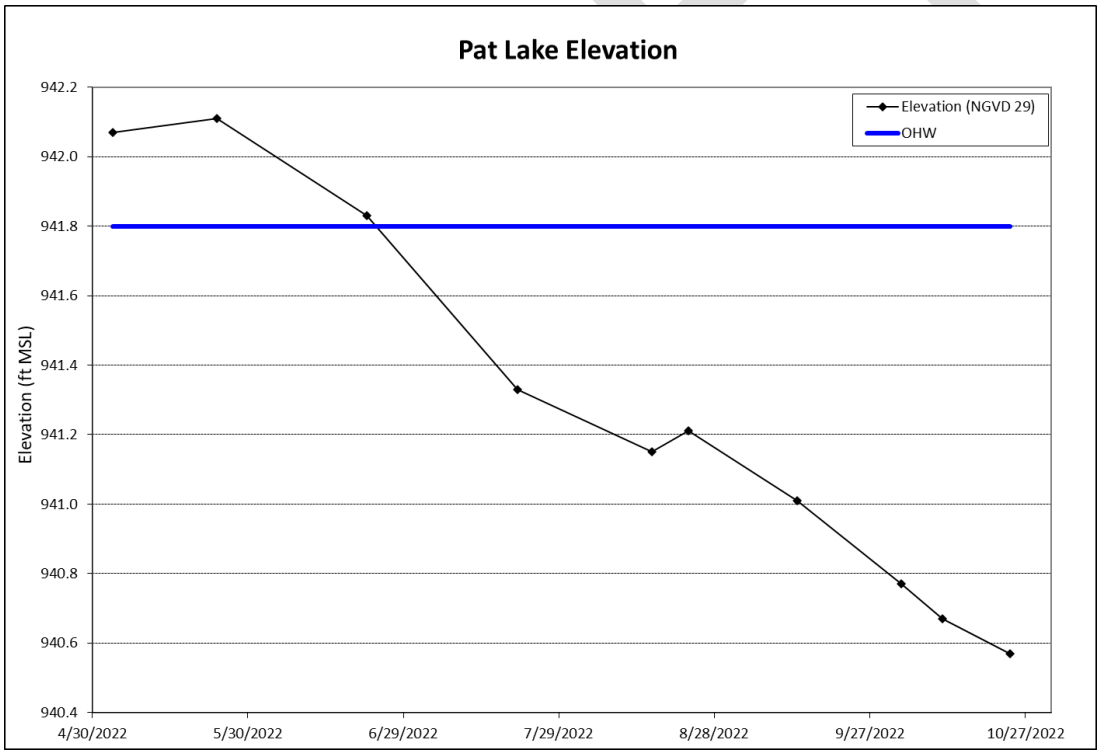
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 11:48	0.020	5.1	4.3	0.54	3.35	7.9	11.37
5/24/2022 13:11	0.031	2.1	1.3	0.60	3.35	18.6	9.19
6/22/2022 13:28	0.027	8.5	7.4	0.76	1.98	27.1	8.65
7/21/2022 10:50	0.042	6.1	5.4	0.78	2.13	26.7	9.95
8/16/2022 9:45	0.024	8.9	8.0	0.66	2.13	22.9	10.42
9/13/2022 9:45	0.028	9.5	8.3	0.60	2.44	21.4	11.29
10/11/2022 9:50	0.134	4.7	3.7	2.00	3.96	14.0	11.59
2022 Average	0.044	6.4	5.5	0.85	2.76	19.8	10.35
2022 Summer Average	0.030	8.3	7.3	0.70	2.17	24.5	10.08

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	942.11	5/24/2022	940.57	10/24/2022	941.27

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

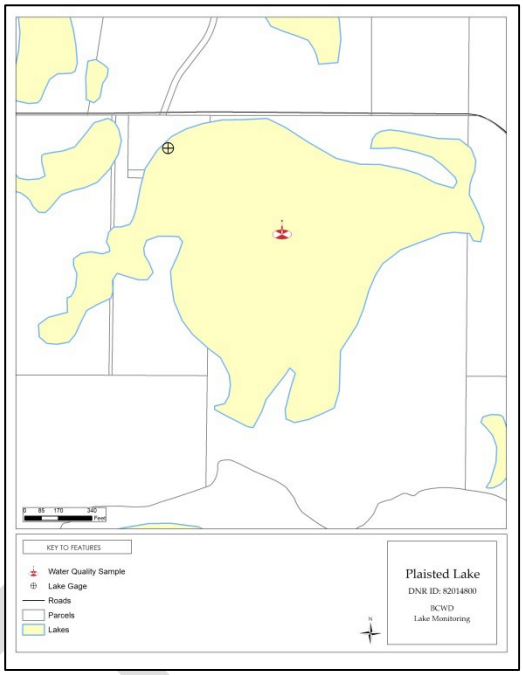


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	B	C	B	C	C	B	C	C	C	C
Chlorophyll-*a* (ug/l)	A	A	A	B	B	A	B	C	B	B
Secchi depth (ft)	B	B	B	C	C	B	C	C	C	C
Overall	**B+**	**B**	**B+**	**C+**	**C+**	**B+**	**C+**	**C**	**C+**	**C+**

Plaisted Lake

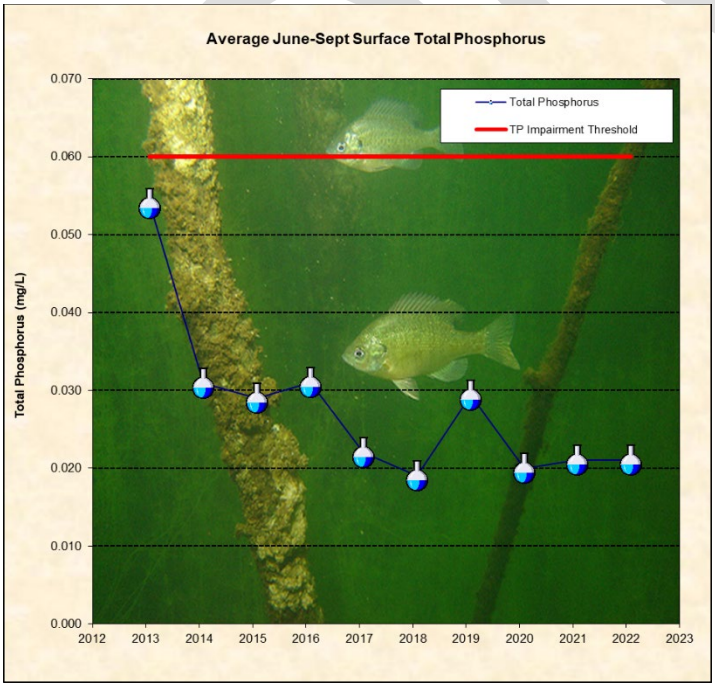
2022 Lake Grade: B+

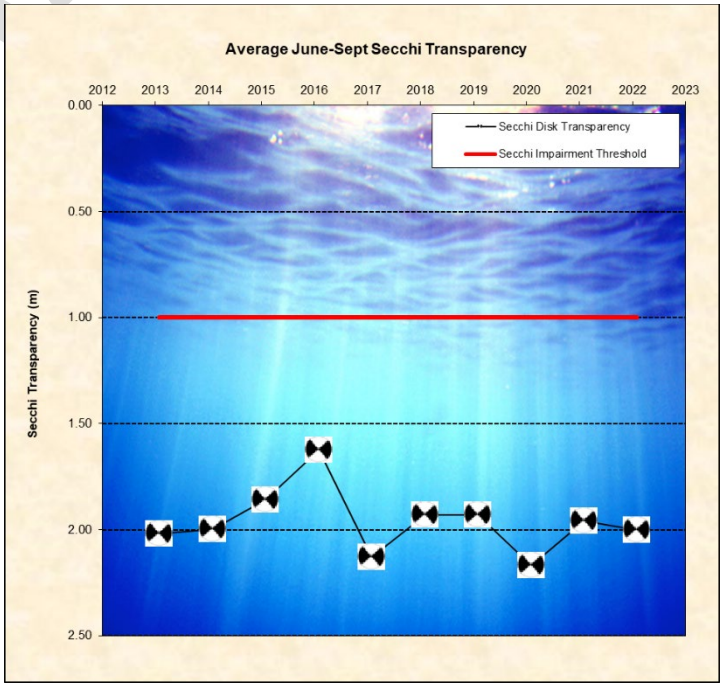
- DNR ID #: 820148
- Municipality: City of Hugo
- Location: Section 25, T31N-R21W
- Lake Size: 70 Acres
- Maximum Depth (2022): 12 ft
- Ordinary High Water Mark: 966.00 ft
- 100-Year High Water Level: NA
- 100% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as mesotrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for the average total phosphorus and average chlorophyll-α, and the trend for the average Secchi transparency is skewed due to vegetation limiting the transparency.
- The major land use is rural/agricultural.
- The lake did not stratify in 2022.
- This lake is categorized as shallow according to the Minnesota Pollution Control Agency's standards.
- Plaisted Lake is listed as impaired for nutrients on the Minnesota Pollution Control Agency's Impaired Waters List.





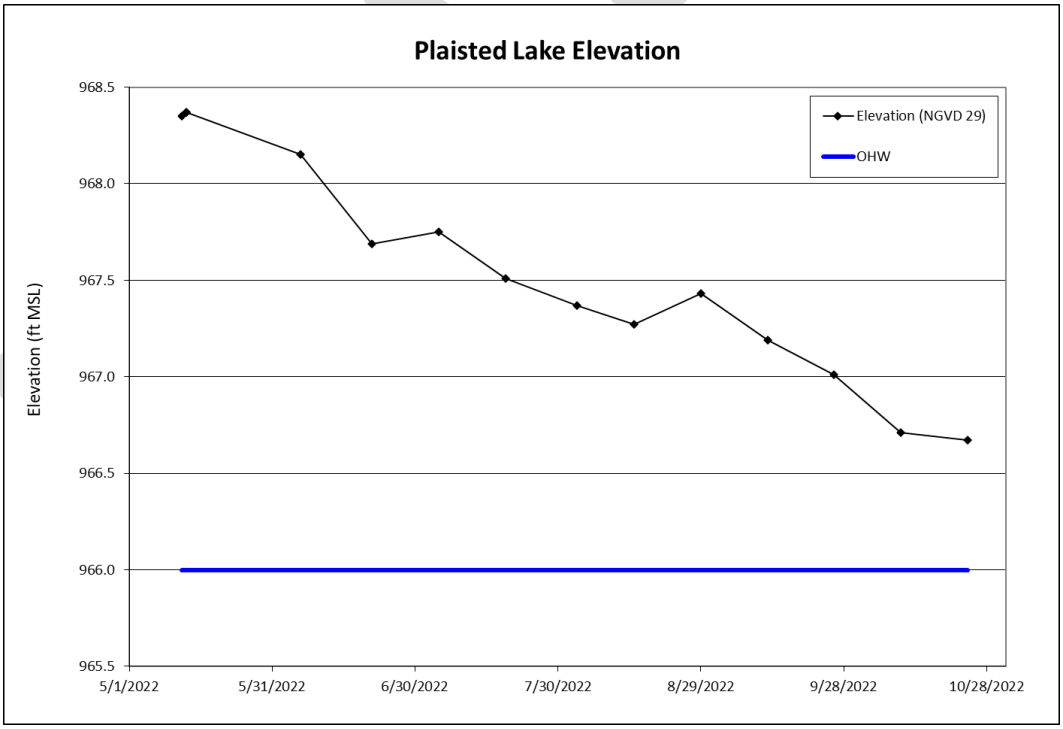
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 8:24	0.027	3.9	3.2	0.56	2.74	7.2	10.59
5/12/2022 8:45	0.017	2.8	2.1	0.42	2.74	17.2	8.42
5/24/2022 10:02	0.021	2.1	1.6	0.42	2.29	17.8	9.36
6/6/2022 9:43	0.030	1.8	1.6	0.45	2.44	21.0	9.88
6/21/2022 10:19	0.032	11.0	11.0	0.63	2.13	26.8	9.19
7/5/2022 11:24	0.023	12.0	10.0	0.62	2.13	25.3	8.15
7/19/2022 9:45	0.019	2.9	2.4	0.54	2.29	28.2	9.05
8/3/2022 9:24	0.023	2.6	2.4	0.56	1.83	26.1	12.74
8/15/2022 9:45	0.021	2.6	2.1	0.46	1.98	22.6	8.81
8/29/2022 9:53	0.017	3.0	2.9	0.45	1.83	23.0	9.27
9/12/2022 9:45	0.012	2.4	1.9	0.45	1.83	21.4	6.60
9/26/2022 13:45	0.014	2.0	1.9	0.45	1.52	17.4	5.69
10/10/2022 12:03	0.034	3.2	2.7	0.42	2.44	14.2	10.77
2022 Average	0.022	4.0	3.5	0.49	2.17	20.6	9.12
2022 Summer Average	0.021	4.5	4.0	0.51	2.00	23.5	8.82

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	968.37	5/13/2022	966.67	10/24/2022	967.56

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

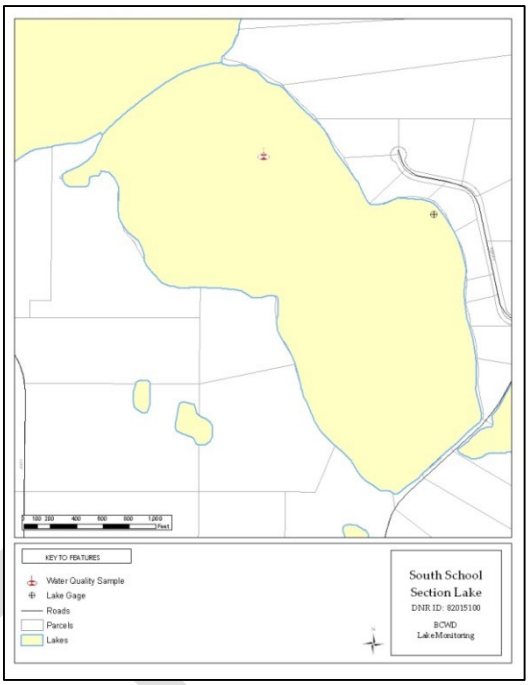


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	A	A	A	B	A	A	B	B	B	C
Chlorophyll-*a* (ug/l)	A	A	A	A	A	A	B	A	A	C
Secchi depth (ft)	C	B	B	C	C	C	C	C	C	C
Overall	**B+**	**A-**	**A-**	**B**	**B+**	**B+**	**B-**	**B**	**B**	**C**

South School Section Lake

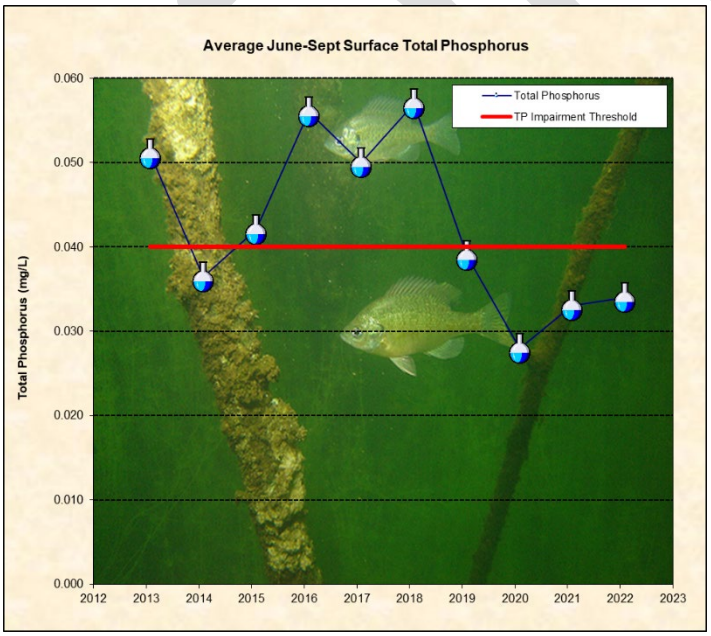
2022 Lake Grade: B

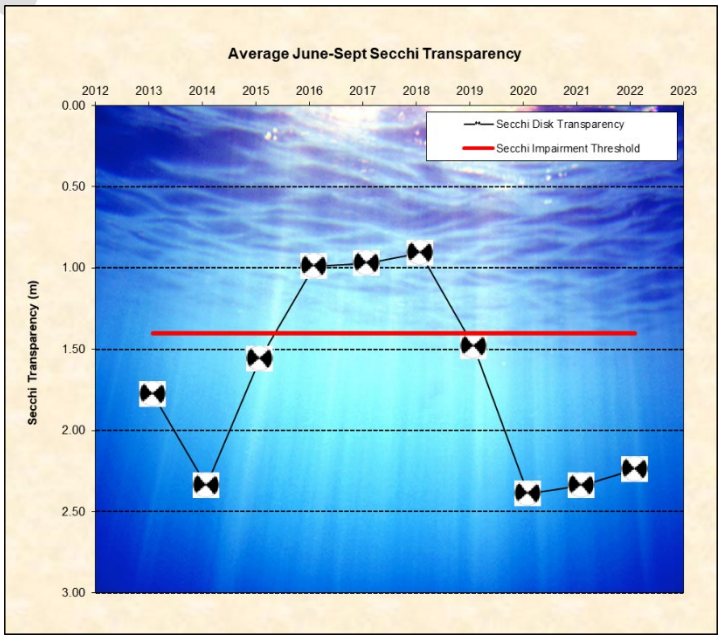
- DNR ID #: 820151
- Municipality: City of Hugo
- Location: S ½ Section 25, T31N-R21W
- Lake Size: 115 Acres
- Maximum Depth (2022): 23 ft
- Ordinary High Water Mark: 965.30 ft
- 100-Year High Water Level: 972.20 ft
- 41% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as eutrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) there is a statistically significant **improving** trend for the average total phosphorus and average chlorophyll-α, and no trend for average Secchi transparency at this time.
- The major land use is rural/agricultural.
- The lake did not stratify in 2022.
- The North and South School Section basins were connected in 2022.
- This lake is categorized as a deep lake according to the Minnesota Pollution Control Agency's standards.
- South School Section Lake is listed as impaired for nutrients on the Minnesota Pollution Control





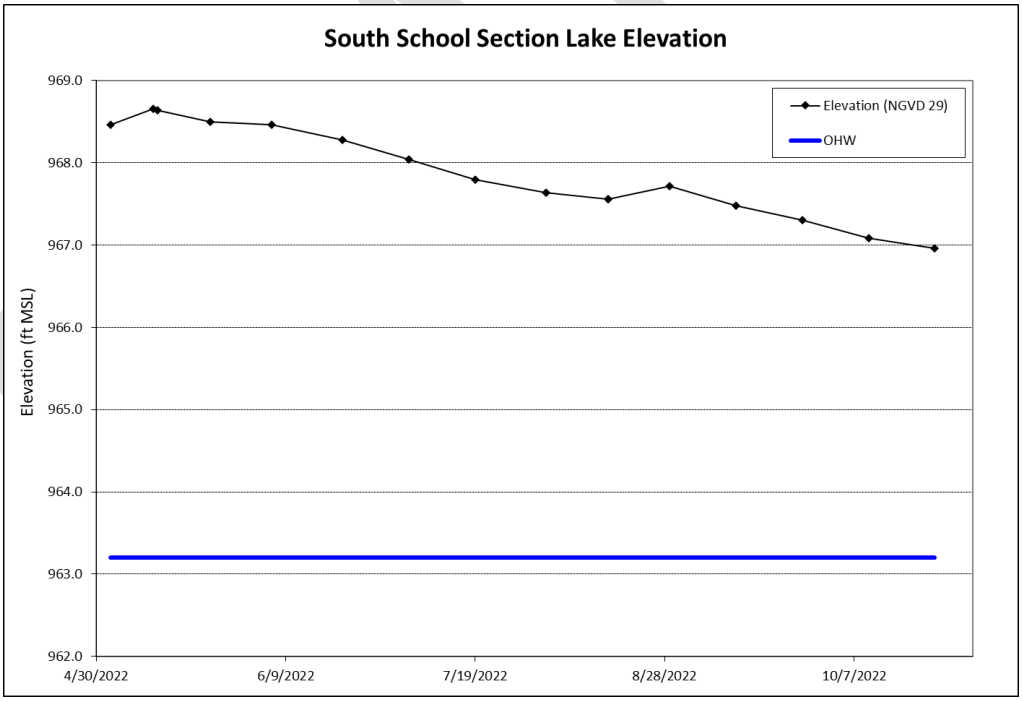
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/27/2022 9:10	0.025	6.1	4.8	0.72	3.05	6.4	11.57
5/12/2022 9:08	0.032	11.0	9.3	0.79	2.29	14.9	10.06
5/24/2022 11:11	0.019	3.3	3.5	0.64	3.96	16.8	9.30
6/6/2022 10:06	0.023	4.6	4.0	0.72	4.27	19.8	9.14
6/21/2022 11:05	0.013	5.2	5.1	0.63	3.35	25.4	8.57
7/5/2022 11:55	0.040	8.7	7.8	0.72	2.29	24.8	8.06
7/19/2022 10:15	0.052	5.3	5.1	0.72	3.35	27.5	8.39
8/3/2022 9:56	0.032	15.0	14.0	0.82	2.13	25.2	12.31
8/16/2022 14:26	0.037	25.0	24.0	0.94	1.07	24.3	13.16
8/29/2022 10:19	0.032	36.0	36.0	0.97	1.22	23.0	9.77
9/12/2022 10:15	0.047	43.0	40.0	1.00	1.22	21.9	8.93
9/26/2022 14:11	0.029	34.0	33.0	1.10	1.22	17.9	8.42
10/10/2022 13:15	0.053	23.0	21.0	0.99	1.68	15.1	9.95
2022 Average	0.033	16.9	16.0	0.83	2.39	20.2	9.82
2022 Summer Average	0.034	19.6	18.8	0.85	2.24	23.3	9.64

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	968.66	5/12/2022	966.96	10/24/2022	967.88

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."

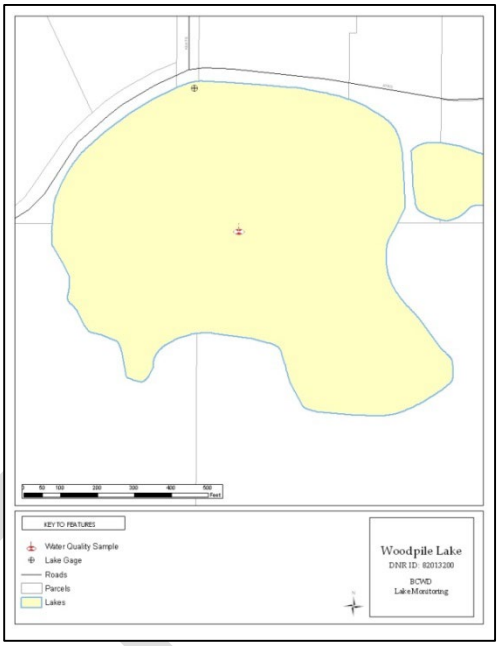


Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	B	B	B	C	C	C	C	C	C	C
Chlorophyll-*a* (ug/l)	B	B	B	C	D	C	C	C	B	C
Secchi depth (ft)	B	B	B	C	D	D	C	C	B	C
Overall	**B**	**B**	**B**	**C**	**D+**	**C-**	**C**	**C**	**B-**	**C**

Woodpile Lake

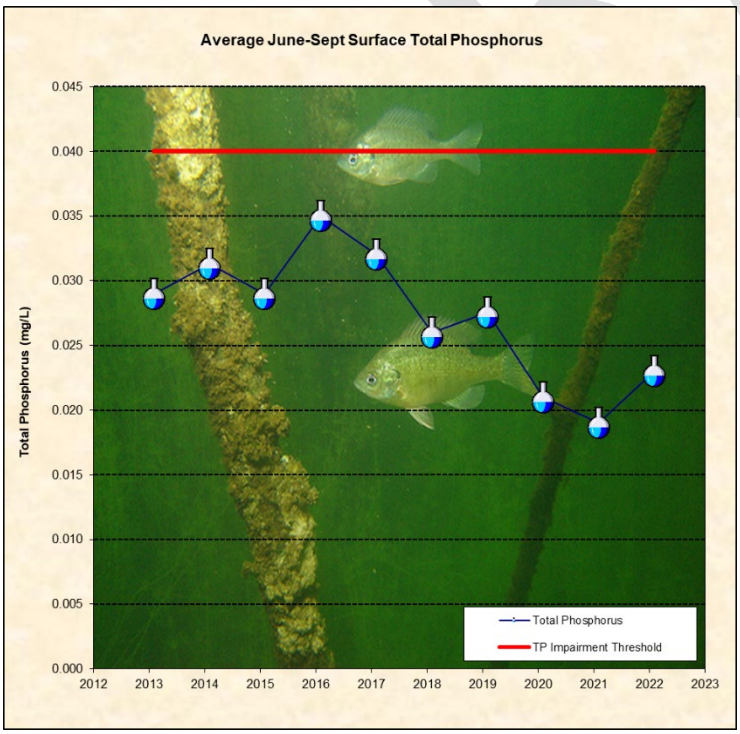
2022 Lake Grade: A

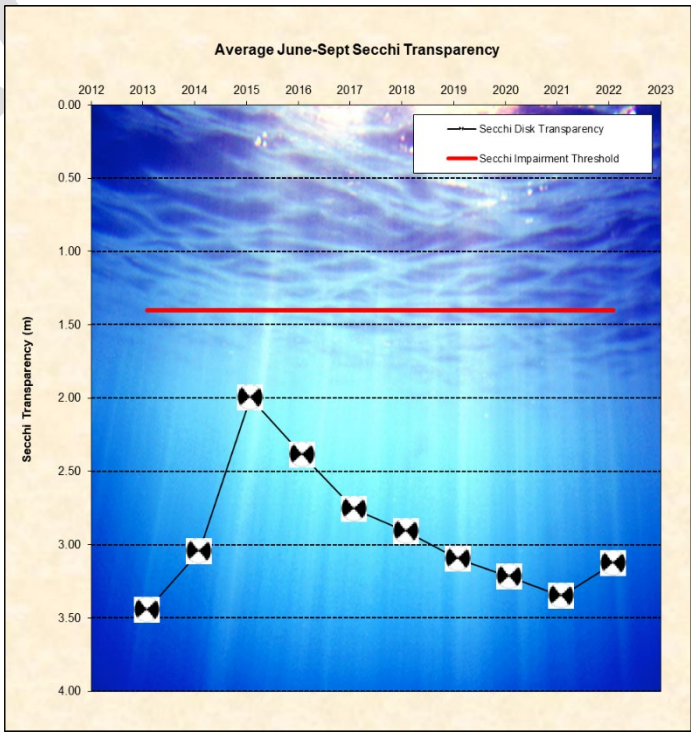
- DNR ID #: 820132
- Municipality: City of Grant
- Location: Section 23, T30N-R21W
- Lake Size: 15 Acres
- Maximum Depth (2022): 28 ft
- Ordinary High Water Mark: 968.50 ft
- 100-Year High Water Level: 971.00 ft
- 8% Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Based on chlorophyll-α data, the lake is classified as mesotrophic according to the Carlson Trophic State Index.
- Using the Kendall's Tau correlation test ($p<0.05$) a statistically significant **improving** trend for the average Secchi transparency, average chlorophyll-α, and average total phosphorus.
- The major land use is rural/agricultural.
- The lake stratified in 2022 with a thermocline between 4 and 5 meters.
- This lake is categorized as a deep lake according to the Minnesota Pollution Control Agency's standards.





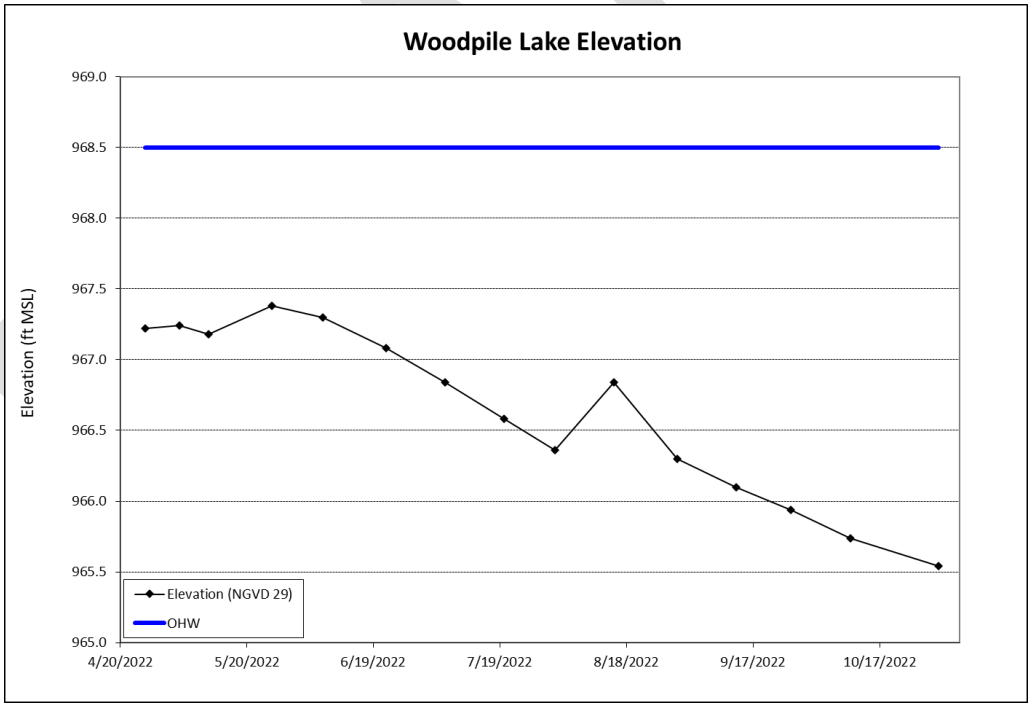
Date/Time	Total Phosphorus (mg/L)	Uncorrected Trichromatic Chlorophyll-*a* (ug/L)	Pheophytin-Corrected Chlorophyll-*a* (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depth (m)	Surface Temperature (Celsius)	Surface Dissolved Oxygen (mg/L)
4/26/2022 8:14	0.033	8.4	7.2	0.75	1.68	6.9	12.47
5/11/2022 11:30	0.013	1.4	1.3	0.66	3.20	16.8	9.01
5/26/2022 8:15	0.024	3.4	2.7	0.57	3.35	16.2	8.86
6/7/2022 10:00	0.016	1.9	1.9	0.64	3.66	20.8	9.06
6/22/2022 10:27	0.023	5.2	4.9	0.64	3.66	26.2	7.93
7/6/2022 7:57	0.036	6.3	5.6	0.69	3.20	24.9	8.26
7/20/2022 10:55	0.028	5.9	4.9	0.67	3.05	26.5	7.71
8/1/2022 10:28	0.020	7.2	6.4	0.69	3.35	24.9	12.92
8/15/2022 13:00	0.029	8.3	7.4	0.68	2.44	23.3	9.93
8/30/2022 8:30	0.024	6.6	6.0	0.61	2.13	22.9	10.35
9/13/2022 8:00	0.014	6.5	5.6	0.64	3.20	21.5	9.72
9/26/2022 9:11	0.018	4.4	3.7	0.65	3.51	17.6	6.97
10/10/2022 11:21	0.029	4.5	3.7	0.58	3.05	14.7	10.27
2022 Average	0.024	5.4	4.7	0.65	3.04	20.2	9.50
2022 Summer Average	0.023	5.8	5.2	0.66	3.13	23.2	9.21

Water quality thresholds are 0.04 mg/L TP, 14 µg/L CL-a, 1.4 m Secchi depth*

Shallow lake water quality thresholds are 0.06 mg/L TP, 20 µg/L CL-a, 1.0 m Secchi depth*

	High	High Date	Low	Low Date	Average
2022 Elevation (ft)	967.38	5/26/2022	965.54	10/31/2022	966.64

*Data requirements and determinations of use assessment according to the MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters: "Samples must be collected over a minimum of 2 years and data used for assessments must be collected from June to September. Typically, a minimum of 8 individual data points for TP, corrected chlorophyll-a (chl-a corrected for pheophytin), and Secchi are required. Data used for phosphorus and chlorophyll-a calculations are limited to those collected from the upper most 3 meters of the water column (surface). If more than one sample is collected in a lake per day, these values are averaged to yield a daily average value. Following this step, all June to September data for the 10-year assessment window are averaged to determine summer-mean values for TP, corrected chl-a, and Secchi depth. These values are then compared to the standards and the assessment is made."



Lake Water Quality Summary										
	Lake Grades (May-Sept)									
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Total Phosphorus (mg/l)	A	A	A	B	B	B	C	B	B	B
Chlorophyll-*a* (ug/l)	A	A	A	A	A	A	A	B	A	A
Secchi depth (ft)	A	A	A	A	B	B	B	C	A	A
Overall	**A**	**A**	**A**	**A-**	**B+**	**B+**	**B**	**B-**	**A-**	**A-**

APPENDIX B –STREAM DATA

Total Phosphorus and Total Suspended Solids Loading Tables

Field Water Quality Data Tables

Table 1. Brown's Creek at Highway 15 2022 Total Suspended Solids (TSS) and Total Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	**Start**	**End**	**TSS (mg/L)**	**TP (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval Volume (ac-ft)**	**Interval TSS (lb)**	**Interval TP (lb)**
*Base**			*5*	*0.087*	*1/1/2022 0:00*	*3/5/2022 0:00*	*16,329,600*	*375.07*	*5,097*	*88.69*
*Storm/Snowmelt**			*4*	*0.117*	*3/5/2022 0:00*	*3/5/2022 16:00*	*259,200*	*5.95*	*65*	*1.89*
*Base**			*5*	*0.087*	*3/5/2022 16:00*	*3/16/2022 12:00*	*2,808,000*	*64.50*	*876*	*15.25*
Snowmelt Grab*	3/16/2022 14:11	3/16/2022 14:11	4	0.117	3/16/2022 12:00	3/20/2022 9:00	1,506,600	34.60	376	11.00
*Base**			*5*	*0.087*	*3/20/2022 9:00*	*3/22/2022 11:00*	*630,000*	*14.47*	*197*	*3.42*
*Storm**			*82*	*0.173*	*3/22/2022 11:00*	*3/23/2022 0:00*	*234,000*	*5.37*	*1,198*	*2.53*
*Base**			*5*	*0.087*	*3/23/2022 0:00*	*4/25/2022 14:30*	*10,161,900*	*233.41*	*3,172*	*55.19*
Base			*5*	*0.087*	*4/25/2022 14:30*	*4/30/2022 1:30*	*1,230,760*	*28.27*	*384*	*6.68*
Storm			*82*	*0.173*	*4/30/2022 1:30*	*5/1/2022 12:30*	*1,254,990*	*28.83*	*6,424*	*13.55*
Base			*5*	*0.087*	*5/1/2022 12:30*	*5/5/2022 8:30*	*2,124,650*	*48.80*	*663*	*11.54*
Base Grab	5/6/2022 8:43	5/6/2022 8:43	2	0.045	5/5/2022 8:30	5/7/2022 8:30	643,100	14.77	80	1.81
Base			*5*	*0.087*	*5/7/2022 8:30*	*5/11/2022 20:30*	*1,194,020*	*27.43*	*373*	*6.48*
Storm Composite	5/11/2022 22:10	5/12/2022 13:52	213	0.203	5/11/2022 20:30	5/12/2022 21:30	1,459,060	33.51	19,401	18.49
Base			*5*	*0.087*	*5/12/2022 21:30*	*6/16/2022 8:30*	*11,838,400*	*271.91*	*3,695*	*64.30*
Base Grab	6/17/2022 8:30	6/17/2022 8:30	6	0.160	6/16/2022 8:30	6/18/2022 8:30	672,538	15.45	252	6.72
Base			*5*	*0.087*	*6/18/2022 8:30*	*7/7/2022 8:30*	*6,337,790*	*145.57*	*1,978*	*34.42*
Base Grab	7/8/2022 8:14	7/8/2022 8:14	4	0.113	7/7/2022 8:30	7/9/2022 8:30	657,052	15.09	164	4.63
Base			*5*	*0.087*	*7/9/2022 8:30*	*7/23/2022 13:30*	*3,516,710*	*80.77*	*1,098*	*19.10*
Storm			*82*	*0.173*	*7/23/2022 13:30*	*7/24/2022 14:30*	*357,430*	*8.21*	*1,830*	*3.86*
Base Grab	7/27/2022 13:28	7/27/2022 13:28	9	0.106	7/24/2022 14:30	7/28/2022 13:30	1,029,290	23.64	578	6.81
Base			*5*	*0.087*	*7/28/2022 13:30*	*8/18/2022 17:30*	*4,414,320*	*101.39*	*1,378*	*23.97*
Storm Composite	8/19/2022 5:32	8/20/2022 18:29	16	0.169	8/18/2022 17:30	8/20/2022 18:30	803,929	18.47	803	8.48
Base Grab	8/26/2022 8:15	8/26/2022 8:15	3	0.090	8/20/2022 18:30	8/28/2022 23:30	1,801,410	41.38	337	10.12
Storm Composite	8/29/2022 1:00	8/29/2022 9:14	18	0.148	8/28/2022 23:30	8/29/2022 9:30	164,709	3.78	185	1.52
Base			*5*	*0.087*	*8/29/2022 9:30*	*9/11/2022 13:30*	*2,667,290*	*61.26*	*833*	*14.49*
Base Grab	9/12/2022 13:03	9/12/2022 13:03	3	0.047	9/11/2022 13:30	9/13/2022 13:30	339,518	7.80	64	1.00
Base			*5*	*0.087*	*9/13/2022 13:30*	*10/12/2022 9:30*	*5,541,658*	*127.29*	*1,730*	*30.10*
Base Grab	10/13/2022 9:26	10/13/2022 9:26	5	0.051	10/12/2022 9:30	10/14/2022 9:30	448,873	10.31	140	1.43
Base			*5*	*0.087*	*10/14/2022 9:30*	*10/26/2022 14:30*	*2,558,070*	*58.76*	*798*	*13.89*
*Base**			*5*	*0.087*	*10/26/2022 14:30*	*1/1/2023 0:00*	*15,775,650*	*362.35*	*4,924*	*85.68*
Storm Average			82	0.173						
Base Average			5	0.087						
All Average			26	0.114						
Total							**98,760,517**	**2,268**	**59,093**	**567**
Brown's Creek Major Subwatershed Total Acres							3,532			
Total TSS/TP(lb/ac/yr)									16.73	0.161
Total TSS/TP (kg/ha/yr)									18.75	0.180

Italics indicate estimated concentrations based on average base and storm flow concentrations.
*Interval volumes were estimated using similar flow conditions.

Table 2. Brown's Creek at McKusick Road 2022 Total Suspended Solids (TSS) and Total Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	Start	End	TSS (mg/L)	TP (mg/L)	Start	End	Interval Volume (cf)	Interval Volume (ac-ft)	Interval TSS (lb)	Interval TP (lb)
*Base**			*4*	*0.083*	*1/1/2022 0:00*	*3/5/2022 0:00*	*24,494,400*	*562.61*	*6,116*	*126.91*
*Storm/Snowmelt**			*17*	*0.273*	*3/5/2022 0:00*	*3/6/2022 0:00*	*777,600*	*17.86*	*825*	*13.25*
*Base**			*4*	*0.083*	*3/6/2022 0:00*	*3/15/2022 14:00*	*5,382,000*	*123.62*	*1,344*	*27.89*
Snowmelt Grab*	3/16/2022 14:41	3/16/2022 14:41	17	0.273	3/15/2022 14:00	3/20/2022 9:00	5,175,000	118.86	5,492	88.19
*Base**			*4*	*0.083*	*3/20/2022 9:00*	*3/22/2022 10:00*	*3,175,200*	*72.93*	*793*	*16.45*
*Storm**			*247*	*0.731*	*3/22/2022 10:00*	*3/23/2022 1:00*	*1,512,000*	*34.73*	*23,314*	*69.00*
*Base**			*4*	*0.083*	*3/23/2022 1:00*	*3/30/2022 1:00*	*7,862,400*	*180.59*	*1,963*	*40.74*
*Storm**			*247*	*0.731*	*3/30/2022 1:00*	*3/30/2022 11:00*	*396,000*	*9.10*	*6,106*	*18.07*
*Base**			*4*	*0.083*	*3/30/2022 11:00*	*4/5/2022 17:00*	*3,780,000*	*86.82*	*944*	*19.59*
*Storm**			*247*	*0.731*	*4/5/2022 17:00*	*4/6/2022 3:00*	*432,000*	*9.92*	*6,661*	*19.71*
*Base**			*4*	*0.083*	*4/6/2022 3:00*	*4/20/2022 14:00*	*8,744,400*	*200.85*	*2,184*	*45.31*
*Storm**			*247*	*0.731*	*4/20/2022 14:00*	*4/20/2022 21:00*	*264,600*	*6.08*	*4,080*	*12.07*
*Base**			*4*	*0.083*	*4/20/2022 21:00*	*4/23/2022 20:00*	*1,853,100*	*42.56*	*463*	*9.60*
*Storm**			*247*	*0.731*	*4/23/2022 20:00*	*4/24/2022 1:00*	*198,000*	*4.55*	*3,053*	*9.04*
*Base**			*4*	*0.083*	*4/24/2022 1:00*	*4/30/2022 2:00*	*3,027,600*	*69.54*	*756*	*15.69*
*Storm**			*247*	*0.731*	*4/30/2022 2:00*	*4/30/2022 5:00*	*108,000*	*2.48*	*1,665*	*4.93*
*Base**			*4*	*0.083*	*4/30/2022 5:00*	*4/30/2022 8:00*	*105,300*	*2.42*	*26*	*0.55*
*Storm**			*247*	*0.731*	*4/30/2022 8:00*	*4/30/2022 15:00*	*554,400*	*12.73*	*8,548*	*25.30*
*Base**			*4*	*0.083*	*4/30/2022 15:00*	*5/5/2022 9:00*	*4,924,800*	*113.12*	*1,230*	*25.52*
Base Grab*	5/6/2022 9:16	5/6/2022 9:16	3	0.039	5/5/2022 9:00	5/7/2022 9:00	1,123,200	25.80	210	2.73
*Base**			*4*	*0.083*	*5/7/2022 9:00*	*5/11/2022 15:00*	*2,478,600*	*56.93*	*619*	*12.84*
Base			*4*	*0.083*	*5/11/2022 15:00*	*5/11/2022 21:00*	*145,231*	*3.34*	*36*	*0.75*
Storm Composite	5/11/2022 21:13	5/12/2022 2:02	153	0.897	5/11/2022 21:00	5/12/2022 3:00	1,226,200	28.16	11,712	68.66
Base			*4*	*0.083*	*5/12/2022 3:00*	*5/19/2022 16:00*	*12,873,600*	*295.69*	*3,215*	*66.70*
Storm			*247*	*0.731*	*5/19/2022 16:00*	*5/19/2022 20:00*	*156,747*	*3.60*	*2,417*	*7.15*
Base			*4*	*0.083*	*5/19/2022 20:00*	*5/28/2022 4:00*	*6,813,910*	*156.51*	*1,701*	*35.31*
*Base**			*4*	*0.083*	*5/28/2022 4:00*	*5/30/2022 22:00*	*1,936,440*	*44.48*	*484*	*10.03*
*Storm**			*247*	*0.731*	*5/30/2022 22:00*	*5/31/2022 10:00*	*432,000*	*9.92*	*6,661*	*19.71*
*Base**			*4*	*0.083*	*5/31/2022 10:00*	*5/31/2022 16:15*	*209,250*	*4.81*	*52*	*1.08*
Base			*4*	*0.083*	*5/31/2022 16:15*	*6/15/2022 12:15*	*6,905,750*	*158.62*	*1,724*	*35.78*
Storm			*247*	*0.731*	*6/15/2022 12:15*	*6/15/2022 17:15*	*85,886*	*1.97*	*1,324*	*3.92*
Base Grab	6/17/2022 8:58	6/17/2022 8:58	6	0.129	6/15/2022 17:15	6/18/2022 9:15	964,286	22.15	361	7.77
Base			*4*	*0.083*	*6/18/2022 9:15*	*6/25/2022 4:15*	*1,817,570*	*41.75*	*454*	*9.42*
Storm			*247*	*0.731*	*6/25/2022 4:15*	*6/25/2022 11:15*	*118,505*	*2.72*	*1,827*	*5.41*
Base			*4*	*0.083*	*6/25/2022 11:15*	*6/27/2022 20:15*	*620,819*	*14.26*	*155*	*3.22*
*Base**			*4*	*0.083*	*6/27/2022 20:15*	*7/7/2022 11:45*	*2,416,860*	*55.51*	*604*	*12.52*
Base Grab	7/8/2022 9:03	7/8/2022 9:03	6	0.134	7/7/2022 11:45	7/12/2022 18:45	1,265,970	29.08	474	10.59
Storm			*247*	*0.731*	*7/12/2022 18:45*	*7/13/2022 0:45*	*62,361*	*1.43*	*962*	*2.85*
Base			*4*	*0.083*	*7/13/2022 0:45*	*7/23/2022 13:45*	*2,339,980*	*53.75*	*584*	*12.12*
Storm			*247*	*0.731*	*7/23/2022 13:45*	*7/24/2022 10:45*	*247,350*	*5.68*	*3,814*	*11.29*
Base Grab	7/27/2022 14:00	7/27/2022 14:00	4	0.078	7/24/2022 10:45	7/31/2022 20:45	1,755,750	40.33	438	8.55
Storm			*247*	*0.731*	*7/31/2022 20:45*	*8/1/2022 4:45*	*98,348*	*2.26*	*1,516*	*4.49*
Base			*4*	*0.083*	*8/1/2022 4:45*	*8/7/2022 20:45*	*1,497,500*	*34.40*	*374*	*7.76*
Storm			*247*	*0.731*	*8/7/2022 20:45*	*8/8/2022 8:45*	*200,160*	*4.60*	*3,086*	*9.13*
Base			*4*	*0.083*	*8/8/2022 8:45*	*8/12/2022 6:45*	*953,804*	*21.91*	*238*	*4.94*
Storm			*247*	*0.731*	*8/12/2022 6:45*	*8/12/2022 15:45*	*113,165*	*2.60*	*1,745*	*5.16*
Base			*4*	*0.083*	*8/12/2022 15:45*	*8/18/2022 16:45*	*1,412,700*	*32.45*	*353*	*7.32*
Storm Composite	8/18/2022 18:45	8/19/2022 4:47	331	0.530	8/18/2022 16:45	8/19/2022 5:45	284,847	6.54	5,886	9.42
Storm			*247*	*0.731*	*8/19/2022 5:45*	*8/20/2022 14:45*	*793,004*	*18.21*	*12,228*	*36.19*
Base Grab	8/26/2022 9:03	8/26/2022 9:03	4	0.075	8/20/2022 14:45	8/27/2022 20:45	1,835,030	42.15	458	8.59
Storm			*247*	*0.731*	*8/27/2022 20:45*	*8/28/2022 5:45*	*194,828*	*4.47*	*3,004*	*8.89*
Base			*4*	*0.083*	*8/28/2022 5:45*	*8/28/2022 23:45*	*351,186*	*8.07*	*88*	*1.82*
Storm Composite	8/29/2022 0:30	8/29/2022 9:40	258	0.767	8/28/2022 23:45	8/29/2022 9:45	491,140	11.28	7,910	23.52
Base			*4*	*0.083*	*8/29/2022 9:45*	*9/11/2022 14:45*	*3,665,730*	*84.20*	*915*	*18.99*
Base Grab	9/12/2022 14:14	9/12/2022 14:14	3	0.079	9/11/2022 14:45	9/13/2022 14:45	441,774	10.15	83	2.18
Base			*4*	*0.083*	*9/13/2022 14:45*	*9/20/2022 19:45*	*1,657,750*	*38.08*	*414*	*8.59*
Storm			*247*	*0.731*	*9/20/2022 19:45*	*9/21/2022 0:45*	*64,788*	*1.49*	*999*	*2.96*
Base			*4*	*0.083*	*9/21/2022 0:45*	*10/12/2022 10:45*	*5,105,850*	*117.28*	*1,275*	*26.46*
Base Grab	10/13/2022 10:48	10/13/2022 10:48	2	0.050	10/12/2022 10:45	10/14/2022 10:45	548,290	12.59	68	1.71
Base			*4*	*0.083*	*10/14/2022 10:45*	*10/26/2022 14:45*	*3,499,840*	*80.39*	*874*	*18.13*
*Base**			*4*	*0.083*	*10/26/2022 14:45*	*11/8/2022 19:00*	*3,984,750*	*91.53*	*995*	*20.65*
*Storm**			*72*	*0.277*	*11/8/2022 19:00*	*11/10/2022 12:00*	*959,400*	*22.04*	*4,312*	*16.59*
*Base**			*4*	*0.083*	*11/10/2022 12:00*	*12/13/2022 20:00*	*10,080,000*	*231.53*	*2,517*	*52.23*
*Storm/Snowmelt**			*72*	*0.277*	*12/13/2022 20:00*	*12/16/2022 13:00*	*1,404,000*	*32.25*	*6,311*	*24.28*
*Base**			*4*	*0.083*	*12/16/2022 13:00*	*1/1/2023 0:00*	*5,008,500*	*115.04*	*1,251*	*25.95*
Storm Average			247	0.731						
Base Average			4	0.083						
All Average			72	0.277						
Total							**163,409,449**	**3,753**	**172,292**	**1,282**
Brown's Creek Major Subwatershed Total Acres							3,999			
Total TSS/TP (lb/ac/yr)									43.08	0.321
Total TSS/TP (kg/ha/yr)									48.29	0.359

Italics indicate estimated concentrations based on average base and storm flow concentrations.

*Interval volumes were estimated using similar flow conditions.

Table 3. Brown's Creek at Stonebridge Trail 2022 Total Suspended Solids (TSS) and Total Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	**Start**	**End**	**TSS (mg/L)**	**TP (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval Volume (ac-ft)**	**Interval TSS (lb)**	**Interval TP (lb)**
*Base**			*7*	*0.091*	*1/1/2022 0:00*	*3/5/2022 0:00*	*28,576,800*	*656.38*	*12,488*	*162.34*
*Storm/Snowmelt**			*21*	*0.239*	*3/5/2022 0:00*	*3/6/2022 0:00*	*864,000*	*19.85*	*1,133*	*12.89*
*Base**			*7*	*0.091*	*3/6/2022 0:00*	*3/15/2022 14:00*	*5,961,600*	*136.93*	*2,605*	*33.87*
Snowmelt Grab*	3/16/2022 14:57	3/16/2022 14:57	21	0.239	3/15/2022 14:00	3/20/2022 9:00	6,210,000	142.64	8,141	92.65
*Base**			*7*	*0.091*	*3/20/2022 9:00*	*3/22/2022 10:00*	*3,616,200*	*83.06*	*1,580*	*20.54*
*Storm**			*241*	*0.572*	*3/22/2022 10:00*	*3/23/2022 1:00*	*1,728,000*	*39.69*	*25,997*	*61.70*
*Base**			*7*	*0.091*	*3/23/2022 1:00*	*3/30/2022 1:00*	*9,676,800*	*222.26*	*4,229*	*54.97*
*Storm**			*241*	*0.572*	*3/30/2022 1:00*	*3/30/2022 11:00*	*468,000*	*10.75*	*7,041*	*16.71*
*Base**			*7*	*0.091*	*3/30/2022 11:00*	*4/5/2022 17:00*	*4,050,000*	*93.02*	*1,770*	*23.01*
*Storm**			*241*	*0.572*	*4/5/2022 17:00*	*4/6/2022 3:00*	*540,000*	*12.40*	*8,124*	*19.28*
*Base**			*7*	*0.091*	*4/6/2022 3:00*	*4/20/2022 14:00*	*9,056,700*	*208.02*	*3,958*	*51.45*
*Storm**			*241*	*0.572*	*4/20/2022 14:00*	*4/20/2022 21:00*	*277,200*	*6.37*	*4,170*	*9.90*
**Base*			*7*	*0.091*	*4/20/2022 21:00*	*4/23/2022 20:00*	*1,917,000*	*44.03*	*838*	*10.89*
**Storm*			*241*	*0.572*	*4/23/2022 20:00*	*4/24/2022 1:00*	*216,000*	*4.96*	*3,250*	*7.71*
**Base*			*7*	*0.091*	*4/24/2022 1:00*	*4/25/2022 15:00*	*1,368,000*	*31.42*	*598*	*7.77*
Base			*7*	*0.091*	*4/25/2022 15:00*	*4/30/2022 2:00*	*2,426,830*	*55.74*	*1,060*	*13.79*
Storm			*241*	*0.572*	*4/30/2022 2:00*	*4/30/2022 5:00*	*114,065*	*2.62*	*1,716*	*4.07*
Base			*7*	*0.091*	*4/30/2022 5:00*	*4/30/2022 8:00*	*110,830*	*2.55*	*48*	*0.63*
Storm			*241*	*0.572*	*4/30/2022 8:00*	*4/30/2022 15:00*	*597,049*	*13.71*	*8,982*	*21.32*
Base			*7*	*0.091*	*4/30/2022 15:00*	*5/5/2022 9:00*	*6,084,440*	*139.75*	*2,659*	*34.56*
Base Grab	5/6/2022 9:31	5/6/2022 9:31	3	0.053	5/5/2022 9:00	5/7/2022 9:00	1,143,970	26.28	214	3.78
Base			*7*	*0.091*	*5/7/2022 9:00*	*5/11/2022 21:00*	*2,214,770*	*50.87*	*968*	*12.58*
Storm Composite	5/11/2022 21:24	5/12/2022 2:43	339	0.771	5/11/2022 21:00	5/12/2022 3:00	987,057	22.67	20,889	47.51
Storm			*241*	*0.572*	*5/12/2022 3:00*	*5/13/2022 2:00*	*3,126,980*	*71.82*	*47,044*	*111.66*
Base			*7*	*0.091*	*5/13/2022 2:00*	*5/19/2022 16:00*	*5,962,530*	*136.95*	*2,606*	*33.87*
Storm			*241*	*0.572*	*5/19/2022 16:00*	*5/19/2022 20:00*	*127,274*	*2.92*	*1,915*	*4.54*
Base			*7*	*0.091*	*5/19/2022 20:00*	*6/16/2022 9:00*	*11,730,900*	*269.45*	*5,126*	*66.64*
Base Grab	6/17/2022 9:18	6/17/2022 9:18	15	0.145	6/16/2022 9:00	6/18/2022 9:00	586,337	13.47	549	5.31
Base			*7*	*0.091*	*6/18/2022 9:00*	*6/25/2022 5:00*	*1,624,570*	*37.31*	*710*	*9.23*
Storm			*241*	*0.572*	*6/25/2022 5:00*	*6/25/2022 11:00*	*108,050*	*2.48*	*1,626*	*3.86*
Base			*7*	*0.091*	*6/25/2022 11:00*	*7/7/2022 9:00*	*2,794,060*	*64.18*	*1,221*	*15.87*
Base Grab	7/8/2022 8:43	7/8/2022 8:43	7	0.106	7/7/2022 9:00	7/9/2022 9:00	456,742	10.49	200	3.02
Base			*7*	*0.091*	*7/9/2022 9:00*	*7/26/2022 14:00*	*3,475,740*	*79.83*	*1,519*	*19.74*
Base Grab	7/27/2022 14:11	7/27/2022 14:11	4	0.081	7/26/2022 14:00	7/31/2022 20:00	1,026,270	23.57	256	5.19
Storm			*241*	*0.572*	*7/31/2022 20:00*	*8/1/2022 2:00*	*80,545*	*1.85*	*1,212*	*2.88*
Base			*7*	*0.091*	*8/1/2022 2:00*	*8/7/2022 21:00*	*1,408,350*	*32.35*	*615*	*8.00*
Storm			*241*	*0.572*	*8/7/2022 21:00*	*8/8/2022 3:00*	*130,347*	*2.99*	*1,961*	*4.65*
Base			*7*	*0.091*	*8/8/2022 3:00*	*8/18/2022 18:00*	*2,463,030*	*56.57*	*1,076*	*13.99*
Storm			*241*	*0.572*	*8/18/2022 18:00*	*8/19/2022 19:00*	*535,732*	*12.31*	*8,060*	*19.13*
Storm Composite	8/19/2022 19:49	8/20/2022 14:09	55	0.266	8/19/2022 19:00	8/20/2022 15:00	432,415	9.93	1,485	7.18
Base Grab	8/26/2022 8:38	8/26/2022 8:38	6	0.094	8/20/2022 15:00	8/27/2022 21:00	1,875,130	43.07	702	11.00
Storm			*241*	*0.572*	*8/27/2022 21:00*	*8/28/2022 4:00*	*192,692*	*4.43*	*2,899*	*6.88*
Base			*7*	*0.091*	*8/28/2022 4:00*	*8/28/2022 23:00*	*411,856*	*9.46*	*180*	*2.34*
Storm Composite	8/29/2022 0:30	8/29/2022 10:08	247	0.678	8/28/2022 23:00	8/29/2022 11:00	658,648	15.13	10,156	27.88
Base			*7*	*0.091*	*8/29/2022 11:00*	*9/11/2022 14:00*	*4,056,610*	*93.18*	*1,773*	*23.04*
Base Grab	9/12/2022 14:45	9/12/2022 14:45	3	0.053	9/11/2022 14:00	9/12/2022 15:00	255,389	5.87	48	0.84
**Base*			*7*	*0.091*	*9/12/2022 15:00*	*9/20/2022 20:00*	*2,056,680*	*47.24*	*899*	*11.68*
**Storm*			*241*	*0.572*	*9/20/2022 20:00*	*9/21/2022 3:00*	*100,800*	*2.32*	*1,517*	*3.60*
**Base*			*7*	*0.091*	*9/21/2022 3:00*	*9/30/2022 8:30*	*2,392,200*	*54.95*	*1,045*	*13.59*
Base			*7*	*0.091*	*9/30/2022 8:30*	*10/12/2022 11:30*	*3,121,390*	*71.69*	*1,364*	*17.73*
Base Grab	10/13/2022 11:28	10/13/2022 11:28	14	0.105	10/12/2022 11:30	10/14/2022 11:30	619,989	14.24	542	4.06
Base			*7*	*0.091*	*10/14/2022 11:30*	*10/27/2022 14:30*	*4,510,700*	*103.61*	*1,971*	*25.62*
*Base**			*7*	*0.091*	*10/27/2022 14:30*	*11/8/2022 19:00*	*4,212,000*	*96.74*	*1,841*	*23.93*
*Storm**			*65*	*0.236*	*11/8/2022 19:00*	*11/10/2022 12:00*	*996,300*	*22.88*	*4,043*	*14.68*
*Base**			*7*	*0.091*	*11/10/2022 12:00*	*12/13/2022 20:00*	*11,520,000*	*264.60*	*5,034*	*65.44*
*Storm/Snowmelt**			*65*	*0.236*	*12/13/2022 20:00*	*12/16/2022 13:00*	*1,474,200*	*33.86*	*5,982*	*21.72*
*Base**			*7*	*0.091*	*12/16/2022 13:00*	*1/1/2023 0:00*	*5,342,400*	*122.71*	*2,335*	*30.35*
Storm Average			241	0.572						
Base Average			7	0.091						
All Average			65	0.236						
Total							**168,072,167**	**3,860**	**241,966**	**1,363**
Brown's Creek Major Subwatershed Total Acres							4,189			
Total TSS/TP(lb/ac/yr)									57.76	0.325
Total TSS/TP (kg/ha/yr)									64.74	0.365

Italics indicate estimated concentrations based on average base and storm flow concentrations.

*Interval volumes were estimated using similar flow conditions.

Table 4. Tributary to Long Lake at Marketplace Pond 2022 Total Suspended Solids (TSS) and Total Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	Start	End	TSS (mg/L)	TP (mg/L)	Start	End	Interval Volume (cf)	Interval Volume (ac-ft)	Interval TSS (lb)	Interval TP (lb)
*Intermittent Flow**			*5*	*0.144*	*1/1/2022 0:00*	*3/5/2022 0:00*	*5,443*	*0.13*	*2*	*0.05*
*Storm/Snowmelt**			*16*	*0.167*	*3/5/2022 0:00*	*3/5/2022 10:00*	*36,000*	*0.83*	*36*	*0.38*
*Intermittent Flow**			*5*	*0.144*	*3/5/2022 10:00*	*3/15/2022 12:00*	*8,712*	*0.20*	*3*	*0.08*
*Snowmelt**			*16*	*0.167*	*3/15/2022 12:00*	*3/22/2022 12:00*	*60,480*	*1.39*	*60*	*0.63*
*Storm**			*24*	*0.184*	*3/22/2022 12:00*	*3/23/2022 0:00*	*302,400*	*6.95*	*453*	*3.47*
*Base**			*5*	*0.144*	*3/23/2022 0:00*	*3/30/2022 1:00*	*91,260*	*2.10*	*28*	*0.82*
*Storm**			*24*	*0.184*	*3/30/2022 1:00*	*3/30/2022 11:00*	*99,000*	*2.27*	*148*	*1.14*
*Base**			*5*	*0.144*	*3/30/2022 11:00*	*4/4/2022 11:00*	*64,800*	*1.49*	*20*	*0.58*
*Storm**			*24*	*0.184*	*4/4/2022 11:00*	*4/6/2022 1:00*	*273,600*	*6.28*	*410*	*3.14*
*Base**			*5*	*0.144*	*4/6/2022 1:00*	*4/12/2022 20:00*	*88,020*	*2.02*	*27*	*0.79*
*Storm**			*24*	*0.184*	*4/12/2022 20:00*	*4/13/2022 6:00*	*82,800*	*1.90*	*124*	*0.95*
*Base**			*5*	*0.144*	*4/13/2022 6:00*	*4/20/2022 14:00*	*63,360*	*1.46*	*20*	*0.57*
*Storm**			*24*	*0.184*	*4/20/2022 14:00*	*4/20/2022 21:00*	*57,960*	*1.33*	*87*	*0.67*
*Base**			*5*	*0.144*	*4/20/2022 21:00*	*4/23/2022 19:00*	*37,800*	*0.87*	*12*	*0.34*
*Storm**			*24*	*0.184*	*4/23/2022 19:00*	*4/24/2022 0:00*	*45,000*	*1.03*	*67*	*0.52*
*Base**			*5*	*0.144*	*4/24/2022 0:00*	*4/30/2022 2:00*	*78,840*	*1.81*	*25*	*0.71*
*Storm**			*24*	*0.184*	*4/30/2022 2:00*	*4/30/2022 17:00*	*378,000*	*8.68*	*566*	*4.34*
*Base**			*5*	*0.144*	*4/30/2022 17:00*	*5/9/2022 17:00*	*116,640*	*2.68*	*36*	*1.05*
*Storm**			*24*	*0.184*	*5/9/2022 17:00*	*5/9/2022 20:00*	*5,400*	*0.12*	*8*	*0.06*
*Base**			*5*	*0.144*	*5/9/2022 20:00*	*5/11/2022 21:00*	*17,640*	*0.41*	*6*	*0.16*
*Storm**			*24*	*0.184*	*5/11/2022 21:00*	*5/12/2022 9:00*	*388,800*	*8.93*	*583*	*4.47*
*Base**			*5*	*0.144*	*5/12/2022 9:00*	*5/17/2022 10:00*	*65,340*	*1.50*	*20*	*0.59*
Base			*5*	*0.144*	*5/17/2022 10:00*	*5/19/2022 16:00*	*33,762*	*0.78*	*11*	*0.30*
Storm			*24*	*0.184*	*5/19/2022 16:00*	*5/20/2022 5:00*	*107,699*	*2.47*	*161*	*1.24*
Base			*5*	*0.144*	*5/20/2022 5:00*	*5/25/2022 2:00*	*244,709*	*5.62*	*76*	*2.20*
Storm Composite	5/25/2022 10:26	5/26/2022 4:25	26	0.219	5/25/2022 2:00	5/26/2022 5:00	266,999	6.13	433	3.65
Base			*5*	*0.144*	*5/26/2022 5:00*	*6/13/2022 8:00*	*491,674*	*11.29*	*153*	*4.42*
Storm			*24*	*0.184*	*6/13/2022 8:00*	*6/13/2022 12:00*	*5,943*	*0.14*	*9*	*0.07*
Base			*5*	*0.144*	*6/13/2022 12:00*	*6/15/2022 12:00*	*17,251*	*0.40*	*5*	*0.16*
Storm			*24*	*0.184*	*6/15/2022 12:00*	*6/15/2022 22:00*	*41,459*	*0.95*	*62*	*0.48*
Base Grab	6/16/2022 9:05	6/16/2022 9:05	7	0.225	6/15/2022 22:00	6/17/2022 9:00	74,493	1.71	33	1.05
Base			*5*	*0.144*	*6/17/2022 9:00*	*6/21/2022 2:00*	*57,786*	*1.33*	*18*	*0.52*
Storm			*24*	*0.184*	*6/21/2022 2:00*	*6/21/2022 6:00*	*5,591*	*0.13*	*8*	*0.06*
Base			*5*	*0.144*	*6/21/2022 6:00*	*6/25/2022 5:00*	*25,052*	*0.58*	*8*	*0.23*
Storm			*24*	*0.184*	*6/25/2022 5:00*	*6/25/2022 19:00*	*24,424*	*0.56*	*37*	*0.28*
Base			*5*	*0.144*	*6/25/2022 19:00*	*6/28/2022 6:00*	*33,695*	*0.77*	*11*	*0.30*
Storm			*24*	*0.184*	*6/28/2022 6:00*	*6/28/2022 11:00*	*8,686*	*0.20*	*13*	*0.10*
Base			*5*	*0.144*	*6/28/2022 11:00*	*7/3/2022 3:00*	*63,640*	*1.46*	*20*	*0.57*
Storm			*24*	*0.184*	*7/3/2022 3:00*	*7/3/2022 7:00*	*7,432*	*0.17*	*11*	*0.09*
Base			*5*	*0.144*	*7/3/2022 7:00*	*7/12/2022 19:00*	*120,140*	*2.76*	*37*	*1.08*
Storm			*24*	*0.184*	*7/12/2022 19:00*	*7/13/2022 0:00*	*7,327*	*0.17*	*11*	*0.08*
Base			*5*	*0.144*	*7/13/2022 0:00*	*7/23/2022 13:00*	*28,759*	*0.66*	*9*	*0.26*
Storm			*24*	*0.184*	*7/23/2022 13:00*	*7/23/2022 19:00*	*34,043*	*0.78*	*51*	*0.39*
Base Grab	7/25/2022 15:44	7/25/2022 15:44	5	0.114	7/23/2022 19:00	7/31/2022 20:00	133,045	3.06	42	0.95
Storm			*24*	*0.184*	*7/31/2022 20:00*	*7/31/2022 23:00*	*11,560*	*0.27*	*17*	*0.13*
Base			*5*	*0.144*	*7/31/2022 23:00*	*8/6/2022 9:00*	*50,743*	*1.17*	*16*	*0.46*
Storm			*24*	*0.184*	*8/6/2022 9:00*	*8/6/2022 13:00*	*19,497*	*0.45*	*29*	*0.22*
Base			*5*	*0.144*	*8/6/2022 13:00*	*8/7/2022 21:00*	*65,867*	*1.51*	*21*	*0.59*
Storm Composite	8/8/2022 0:00	8/8/2022 14:53	12	0.164	8/7/2022 21:00	8/8/2022 15:00	293,234	6.74	220	3.00
Base			*5*	*0.144*	*8/8/2022 15:00*	*8/12/2022 7:00*	*151,480*	*3.48*	*47*	*1.36*
Storm			*24*	*0.184*	*8/12/2022 7:00*	*8/12/2022 12:00*	*35,200*	*0.81*	*53*	*0.40*
Base			*5*	*0.144*	*8/12/2022 12:00*	*8/18/2022 17:00*	*188,805*	*4.34*	*59*	*1.70*
Storm Composite	8/18/2022 18:27	8/19/2022 0:06	47	0.206	8/18/2022 17:00	8/19/2022 1:00	246,840	5.67	724	3.17
Storm			*24*	*0.184*	*8/19/2022 1:00*	*8/19/2022 19:00*	*351,130*	*8.07*	*526*	*4.03*
Base Grab	8/25/2022 14:11	8/25/2022 14:11	2	0.093	8/19/2022 19:00	8/27/2022 21:00	386,297	8.87	48	2.24
Storm			*24*	*0.184*	*8/27/2022 21:00*	*8/28/2022 11:00*	*473,689*	*10.88*	*710*	*5.44*
Base			*5*	*0.144*	*8/28/2022 11:00*	*8/29/2022 0:00*	*236,698*	*5.44*	*74*	*2.13*
Storm Composite	8/29/2022 0:20	8/29/2022 3:55	10	0.146	8/29/2022 0:00	8/29/2022 4:00	191,499	4.40	120	1.75
Base			*5*	*0.144*	*8/29/2022 4:00*	*9/1/2022 7:00*	*435,118*	*9.99*	*136*	*3.91*
*Base**			*5*	*0.144*	*9/1/2022 7:00*	*9/7/2022 14:30*	*54,540*	*1.25*	*17*	*0.49*
Intermittent Flow			*5*	*0.144*	*9/7/2022 14:30*	*9/20/2022 19:30*	*6,852*	*0.16*	*2*	*0.06*
Storm			*24*	*0.184*	*9/20/2022 19:30*	*9/21/2022 1:30*	*40,719*	*0.94*	*61*	*0.47*
Intermittent Flow			*5*	*0.144*	*9/21/2022 1:30*	*10/12/2022 2:30*	*120,499*	*2.77*	*38*	*1.08*
Storm			*24*	*0.184*	*10/12/2022 2:30*	*10/12/2022 5:30*	*1,233*	*0.03*	*2*	*0.01*
Intermittent Flow			*5*	*0.144*	*10/12/2022 5:30*	*10/12/2022 13:30*	*16*	*0.00*	*0*	*0.00*
Storm			*24*	*0.184*	*10/12/2022 13:30*	*10/12/2022 19:30*	*3,803*	*0.09*	*6*	*0.04*
Intermittent Flow			*5*	*0.144*	*10/12/2022 19:30*	*10/27/2022 15:30*	*10,210*	*0.23*	*3*	*0.09*
*Intermittent Flow**			*5*	*0.144*	*10/27/2022 15:30*	*11/8/2022 18:00*	*1,046*	*0.02*	*0*	*0.01*
*Storm**			*24*	*0.184*	*11/8/2022 18:00*	*11/10/2022 10:00*	*108,000*	*2.48*	*162*	*1.24*
*Intermittent Flow**			*5*	*0.144*	*11/10/2022 10:00*	*12/13/2022 20:00*	*2,887*	*0.07*	*1*	*0.03*
*Storm/Snowmelt**			*16*	*0.167*	*12/13/2022 20:00*	*12/14/2022 12:00*	*57,600*	*1.32*	*58*	*0.60*
*Intermittent Flow**			*5*	*0.144*	*12/14/2022 12:00*	*1/1/2023 0:00*	*7,560*	*0.17*	*2*	*0.07*
Storm Average			24	0.184						
Base Average			5	0.144						
All Average			16	0.167						
Total							**7,753,526**	**178**	**7,112**	**79**
Brown's Creek Major Subwatershed Total Acres							410			
Total TSS/TP(lb/ac/yr)									17.35	0.192
Total TSS/TP (kg/ha/yr)									19.44	0.215

Italics indicate estimated concentrations based on average base and storm flow concentrations.

*Interval volumes were estimated using similar flow conditions.

Table 5. Brown's Creek Diversion Structure Drainage 2022 Total Suspended Solids (TSS) and Total Phosphorus (TP) Loading

	Sample Collection Time				Loading Interval					
Sample Type	Start	End	TSS (mg/L)	TP (mg/L)	Start	End	Interval Volume (cf)	Interval Volume (ac-ft)	Interval TSS (lb)	Interval TP (lb)
*Base**			*7*	*0.090*	*1/1/2022 0:00*	*3/5/2022 0:00*	*2,721,600*	*62.51*	*1,189*	*15.29*
*Snowmelt**			*30*	*0.215*	*3/5/2022 0:00*	*3/5/2022 10:00*	*144,000*	*3.31*	*270*	*1.93*
*Base**			*7*	*0.090*	*3/5/2022 10:00*	*3/15/2022 14:00*	*1,098,000*	*25.22*	*480*	*6.17*
*Snowmelt Grab**	*3/16/2022 14:31*	*3/16/2022 14:31*	*30*	*0.215*	*3/15/2022 14:00*	*3/19/2022 22:00*	*1,684,800*	*38.70*	*3,155*	*22.61*
*Base**			*7*	*0.090*	*3/19/2022 22:00*	*3/22/2022 12:00*	*558,000*	*12.82*	*244*	*3.14*
*Storm**			*203*	*0.595*	*3/22/2022 12:00*	*3/23/2022 4:00*	*460,800*	*10.58*	*5,839*	*17.12*
*Base**			*7*	*0.090*	*3/23/2022 4:00*	*3/30/2022 1:00*	*1,782,000*	*40.93*	*779*	*10.01*
*Storm**			*203*	*0.595*	*3/30/2022 1:00*	*3/30/2022 11:00*	*234,000*	*5.37*	*2,965*	*8.69*
*Base**			*7*	*0.090*	*3/30/2022 11:00*	*4/5/2022 17:00*	*1,620,000*	*37.21*	*708*	*9.10*
*Storm**			*203*	*0.595*	*4/5/2022 17:00*	*4/6/2022 3:00*	*252,000*	*5.79*	*3,193*	*9.36*
*Base**			*7*	*0.090*	*4/6/2022 3:00*	*4/20/2022 14:00*	*3,123,000*	*71.73*	*1,365*	*17.55*
*Storm**			*203*	*0.595*	*4/20/2022 14:00*	*4/20/2022 21:00*	*151,200*	*3.47*	*1,916*	*5.62*
*Base**			*7*	*0.090*	*4/20/2022 21:00*	*4/21/2022 11:45*	*185,850*	*4.27*	*81*	*1.04*
Base			*7*	*0.090*	*4/21/2022 11:45*	*4/23/2022 19:45*	*652,667*	*14.99*	*285*	*3.67*
Storm			*203*	*0.595*	*4/23/2022 19:45*	*4/24/2022 0:45*	*107,299*	*2.46*	*1,360*	*3.99*
Base			*7*	*0.090*	*4/24/2022 0:45*	*4/30/2022 1:45*	*1,655,360*	*38.02*	*723*	*9.30*
Storm			*203*	*0.595*	*4/30/2022 1:45*	*4/30/2022 17:45*	*492,923*	*11.32*	*6,247*	*18.31*
Base			*7*	*0.090*	*4/30/2022 17:45*	*5/5/2022 8:45*	*3,176,020*	*72.95*	*1,388*	*17.84*
Base Grab	5/6/2022 9:00	5/6/2022 9:00	3	0.074	5/5/2022 8:45	5/7/2022 8:45	707,617	16.25	133	3.27
Base			*7*	*0.090*	*5/7/2022 8:45*	*5/9/2022 17:45*	*494,335*	*11.35*	*216*	*2.78*
Storm			*203*	*0.595*	*5/9/2022 17:45*	*5/9/2022 20:45*	*36,467*	*0.84*	*462*	*1.35*
Base			*7*	*0.090*	*5/9/2022 20:45*	*5/11/2022 20:45*	*438,551*	*10.07*	*192*	*2.46*
Storm Composite	5/11/2022 21:27	5/12/2022 8:08	176	0.517	5/11/2022 20:45	5/12/2022 8:45	1,450,200	33.31	15,933	46.80
Base			*7*	*0.090*	*5/12/2022 8:45*	*5/17/2022 14:45*	*3,960,740*	*90.97*	*1,731*	*22.25*
Unexplained Event			*63*	*0.239*	*5/17/2022 14:45*	*5/19/2022 1:45*	*503,578*	*11.57*	*1,980*	*7.51*
Base			*7*	*0.090*	*5/19/2022 1:45*	*5/19/2022 13:45*	*61,752*	*1.42*	*27*	*0.35*
Storm			*203*	*0.595*	*5/19/2022 13:45*	*5/19/2022 19:45*	*89,543*	*2.06*	*1,135*	*3.33*
Base			*7*	*0.090*	*5/19/2022 19:45*	*5/24/2022 14:45*	*786,194*	*18.06*	*344*	*4.42*
Storm			*203*	*0.595*	*5/24/2022 14:45*	*5/25/2022 1:45*	*205,195*	*4.71*	*2,600*	*7.62*
Base			*7*	*0.090*	*5/25/2022 1:45*	*6/7/2022 15:45*	*2,269,610*	*52.13*	*992*	*12.75*
Unexplained Event			*63*	*0.239*	*6/7/2022 15:45*	*6/8/2022 2:45*	*167,286*	*3.84*	*658*	*2.50*
Base			*7*	*0.090*	*6/8/2022 2:45*	*6/13/2022 10:45*	*328,143*	*7.54*	*143*	*1.84*
Unexplained Event			*63*	*0.239*	*6/13/2022 10:45*	*6/15/2022 3:45*	*391,843*	*9.00*	*1,541*	*5.85*
Base			*7*	*0.090*	*6/15/2022 3:45*	*6/15/2022 12:45*	*31,820*	*0.73*	*14*	*0.18*
Storm			*203*	*0.595*	*6/15/2022 12:45*	*6/15/2022 19:45*	*51,985*	*1.19*	*659*	*1.93*
Base Grab	6/17/2022 8:47	6/17/2022 8:47	4	0.092	6/15/2022 19:45	6/20/2022 15:45	394,198	9.05	98	2.26
Unexplained Event			*63*	*0.239*	*6/20/2022 15:45*	*6/21/2022 16:45*	*118,581*	*2.72*	*466*	*1.77*
Base			*7*	*0.090*	*6/21/2022 16:45*	*6/25/2022 4:45*	*139,156*	*3.20*	*61*	*0.78*
Storm			*203*	*0.595*	*6/25/2022 4:45*	*6/25/2022 8:45*	*17,377*	*0.40*	*220*	*0.65*
Base			*7*	*0.090*	*6/25/2022 8:45*	*7/7/2022 9:45*	*526,264*	*12.09*	*230*	*2.96*
Base Grab	7/8/2022 9:22	7/8/2022 9:22	16	0.158	7/7/2022 9:45	7/9/2022 9:45	75,727	1.74	76	0.75
Base			*7*	*0.090*	*7/9/2022 9:45*	*7/26/2022 13:45*	*507,456*	*11.66*	*222*	*2.85*
Base Grab	7/27/2022 13:52	7/27/2022 13:52	7	0.089	7/26/2022 13:45	7/28/2022 13:45	62,177	1.43	27	0.35
Base			*7*	*0.090*	*7/28/2022 13:45*	*8/7/2022 20:45*	*275,737*	*6.33*	*120*	*1.55*
Storm			*203*	*0.595*	*8/7/2022 20:45*	*8/8/2022 2:45*	*38,955*	*0.89*	*494*	*1.45*
Base			*7*	*0.090*	*8/8/2022 2:45*	*8/18/2022 17:45*	*399,319*	*9.17*	*174*	*2.24*
Storm Composite	8/18/2022 18:46	8/19/2022 8:26	301	0.793	8/18/2022 17:45	8/19/2022 8:45	139,885	3.21	2,628	6.92
Base			*7*	*0.090*	*8/19/2022 8:45*	*8/24/2022 14:45*	*255,516*	*5.87*	*112*	*1.44*
Base Grab	8/25/2022 14:33	8/25/2022 14:33	7	0.096	8/24/2022 14:45	8/27/2022 20:45	109,031	2.50	48	0.65
Storm			*203*	*0.595*	*8/27/2022 20:45*	*8/28/2022 4:45*	*82,532*	*1.90*	*1,046*	*3.07*
Base			*7*	*0.090*	*8/28/2022 4:45*	*8/28/2022 23:45*	*211,623*	*4.86*	*92*	*1.19*
Storm Composite	8/29/2022 1:16	8/29/2022 9:42	132	0.474	8/28/2022 23:45	8/29/2022 9:45	320,265	7.36	2,639	9.48
Base			*7*	*0.090*	*8/29/2022 9:45*	*9/11/2022 13:45*	*1,294,600*	*29.74*	*566*	*7.27*
Base Grab	9/12/2022 13:50	9/12/2022 13:50	12	0.066	9/11/2022 13:45	9/13/2022 13:45	60,856	1.40	46	0.25
Base			*7*	*0.090*	*9/13/2022 13:45*	*9/23/2022 17:45*	*318,303*	*7.31*	*139*	*1.79*
Unexplained Event			*63*	*0.239*	*9/23/2022 17:45*	*9/27/2022 5:45*	*339,945*	*7.81*	*1,337*	*5.07*
Base			*7*	*0.090*	*9/27/2022 5:45*	*9/29/2022 15:45*	*82,837*	*1.90*	*36*	*0.47*
Unexplained Event			*63*	*0.239*	*9/29/2022 15:45*	*10/2/2022 6:45*	*187,631*	*4.31*	*738*	*2.80*
Base			*7*	*0.090*	*10/2/2022 6:45*	*10/12/2022 9:45*	*313,752*	*7.21*	*137*	*1.76*
Base Grab	10/13/2022 9:58	10/13/2022 9:58	3	0.052	10/12/2022 9:45	10/14/2022 9:45	74,187	1.70	14	0.24
Base			*7*	*0.090*	*10/14/2022 9:45*	*10/26/2022 10:45*	*510,987*	*11.74*	*223*	*2.87*
*Base**			*7*	*0.090*	*10/26/2022 10:45*	*11/9/2022 16:00*	*552,825*	*12.70*	*242*	*3.11*
*Storm**			*203*	*0.595*	*11/9/2022 16:00*	*11/10/2022 2:00*	*108,000*	*2.48*	*1,369*	*4.01*
*Base**			*7*	*0.090*	*11/10/2022 2:00*	*1/1/2023 0:00*	*2,018,520*	*46.36*	*882*	*11.34*
Storm Average			203	0.595						
Base Average			7	0.090						
All Average			63	0.239						
Total							**41,610,620**	**956**	**75,429**	**389**
Brown's Creek Major Subwatershed Total Acres							3,855			
Total TSS/TP(lb/ac/yr)									19.57	0.101
Total TSS/TP (kg/ha/yr)									21.93	0.113

Italics indicate estimated concentrations based on average base and storm flow concentrations.

*Interval volumes were estimated using similar flow conditions.

Table 6. Brown's Creek at Highway 15 2022 Field Water Quality Results

Date/Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (umhos/cm)	pH
3/16/2022 14:11	5.1	10.67		8.18
5/6/2022 8:43	6.4	9.43	327	7.87
6/17/2022 8:30	13.1	7.87	392	7.50
7/8/2022 8:14	16.2	8.06	362	8.01
7/27/2022 13:28	18.7	9.80	415	8.19
8/26/2022 8:15	12.3	8.50	321	7.76
9/12/2022 13:03	13.6	10.47	413	7.76
10/13/2022 9:26	7.3	9.80	325	7.63

Exceeds Water Quality Standard

Table 7. Brown's Creek at McKusick Road 2022 Field Water Quality Results

Date/Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (umhos/cm)	pH
3/16/2022 14:41	4.1	12.90	391	8.12
5/6/2022 9:16	7.7	11.68	242	8.07
5/12/2022 2:02	14.4	10.02	346	8.20
6/17/2022 8:58	18.2	8.40	466	8.24
7/8/2022 9:03	17.4	9.08	401	8.33
8/26/2022 9:03	13.9	9.74	366	8.21
9/12/2022 14:14	13.7	10.24	361	8.34
10/13/2022 10:48	7.9	10.50	543	8.36

Exceeds Water Quality Standard

Table 8. Brown's Creek at Stonebridge Trail 2022 Field Water Quality Results

Date/Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (umhos/cm)	pH
3/16/2022 14:57	3.6	13.20	379	8.09
5/6/2022 9:31	8.0	11.64	371	8.15
6/17/2022 9:18	15.2	11.50	348	8.27
7/8/2022 8:43	19.0	8.66	420	8.28
7/27/2022 14:11	18.9	8.81	444	8.39
8/26/2022 8:38	14.4	9.98	369	8.23
9/12/2022 14:45	14.8	9.72	443	8.22
10/13/2022 11:28	8.1	11.02	539	8.23

Exceeds Water Quality Standard

Table 9. Brown's Creek Outlet 2022 Field Water Quality Results

Date/Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (umhos/cm)	pH
1/4/2022 9:30	0.7	14.88		8.26
1/19/2022 12:05	-0.2	14.40	542	9.24
2/2/2022 11:53	0.0	14.46	338	8.90
2/16/2022 11:02	1.5	13.06	262	8.76
3/2/2022 11:15	2.2	13.46	617	8.46
3/16/2022 9:03	2.4	14.24	425	8.39
3/30/2022 14:52	2.1	14.20	464	8.09
4/13/2022 14:32	5.3	12.75	212	8.13
4/25/2022 13:41	4.8	13.62	214	8.32
5/10/2022 8:24	11.8	10.55	405	8.12
5/25/2022 8:53	11.5	10.71	342	8.31
6/7/2022 8:35	13.6	9.26		8.37
6/21/2022 15:15	20.9	9.33	468	8.36
7/6/2022 14:09	17.1	10.12	492	8.42
7/20/2022 9:40	17.1	9.52	498	8.42
8/3/2022 10:00	17.5	9.45	413	8.29
8/17/2022 9:40	14.6	10.22	385	8.20
9/2/2022 9:13	15.9	9.68	398	8.36
9/14/2022 14:10	13.9	10.90	414	8.56
9/28/2022 9:41	7.4	11.49	289	8.62
10/12/2022 8:45	11.0	10.80		8.77
10/24/2022 11:18	12.1	10.33		8.23
11/8/2022 13:56	6.3	12.60	418	8.02
11/22/2022 9:01	1.4	14.98		8.27
12/7/2022 9:48	0.5	14.55		8.07
12/14/2022 11:28	2.7	15.34		8.18
12/27/2022 10:45	0.9	14.98	474	8.67

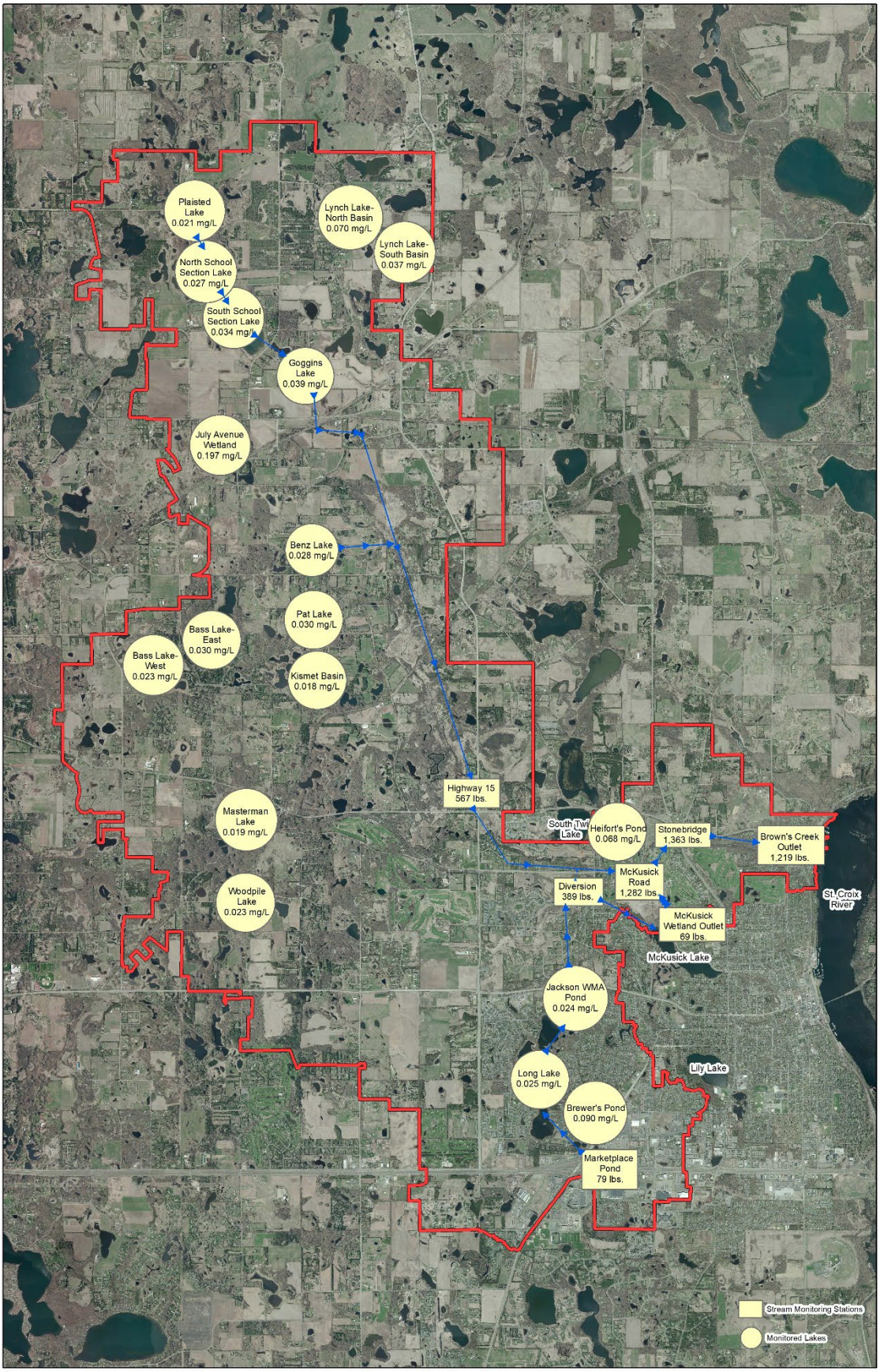
Exceeds Water Quality Standard

Table 10. Brown's Creek Diversion 2022 Field Water Quality Results

Date/Time	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (umhos/cm)	pH
3/16/2022 14:31	2.1	12.61	486	7.95
5/6/2022 9:00	11.2	9.95	502	7.96
6/17/2022 8:47	16.9	6.78	578	7.90
7/8/2022 9:22	18.8	4.64	593	7.79
7/27/2022 13:52	16.8	5.78	588	7.86
8/25/2022 14:33	16.5	6.14	515	7.88
9/12/2022 13:50	13.2	7.03	467	7.86
10/13/2022 9:58	8.7	7.21	697	7.80

Exceeds Water Quality Standard

APPENDIX C – 2022 BROWN'S CREEK TOTAL PHOSPHORUS FLOW CHART



GLOSSARY

Anoxic- Lacking oxygen.

Best Management Practice (BMP)- Any practice or constructed feature designed to reduce pollution, erosion, or other environmental degradation such as silt fence, rain gardens, storm water pollution prevention plans, buffer strips, etc.

Biota- Living organisms such as plants, animals, and bacteria.

Chronic Standard- The highest water concentration or fish tissue concentration of a toxicant or effluent to which aquatic life, humans, or wildlife can be exposed indefinitely without causing chronic toxicity.

Composite Sample- A collection of individual samples taken over the course of a storm and combined into a single sample to represent conditions throughout the entire storm event.

Discharge- The amount of water moving past a given point in a stream, usually measured in cubic feet per second, but may also be discussed as the total volume of water that flowed through a site in a year, measured in cubic feet.

Eutrophic- Bodies of water with high levels of biological productivity characterized by high amounts of aquatic vegetation with clear water, or minimal vegetation with green water due to algal growth shading out larger plants. These waters are often shallow, have excessive nutrients, and may experience severe algal blooms resulting in anoxic conditions and potential fish kills. Most district lakes fall within this classification.

External Load- Nutrients or pollution contributed from outside a water body such as atmospheric deposition or inlets from streams or pipes.

Final Acute Value (FAV)- An estimate of the concentration of a pollutant corresponding to the cumulative probability of 0.05 in the distribution of all the acute toxicity values for the genera or species from the acceptable acute toxicity tests conducted on a pollutant. This concentration is severe enough to rapidly induce a response, normally observed in 96 hours or less. Acute mortality can be expected above this concentration.

Gaining Stream- A stream which gains water through the stream bed from groundwater.

Hypereutrophic- Bodies of water with extremely high biological productivity and nutrients which often experience severe algal blooms, very low clarity, and limited aquatic life beyond algae and vegetation. Often have the appearance of “pea soup” in mid-summer.

Impaired Waters List/303(d) List- A section of the Clean Water Act which lists water bodies impaired by one or more pollutants for which a TMDL study should be completed.

Internal Load- Nutrients or pollution cycled within a lake from sediments, vegetation, or other sources within a water body.

Littoral- The area of a lake less than 15 feet deep dominated by aquatic vegetation.

Load/Loading- The amount of nutrients or pollutants from a source, usually expressed as pounds or pounds per acre.

Losing Stream- A stream which loses water through the stream bed to the groundwater.

Maximum Standard- The highest concentration of a toxicant in water to which aquatic organisms can be exposed for a brief time with zero or slight mortality. The max standard is half of the final acute value.

Mesotrophic- Bodies of water with an intermediate amount of biological productivity. These waters are typically clear water with healthy aquatic vegetation, some algal growth, and an intermediate amount of nutrients. When stratified, these waters may become anoxic near the bottom.

Non-point Source- A source of pollution from a undefined area such as runoff from a landscape.

Nutrients- Discussed in this report as total phosphorus (TP), total suspended solids (TSS) or sediment, and total Kjeldahl nitrogen (TKN).

Ordinary High Water Level (OHWL)- The boundary of public waters and wetlands determined by a level of water maintained with enough time to leave evidence upon the landscape, such as a change in natural vegetation from terrestrial to aquatic, or the top of the bank of a channel.

Oligotrophic- Bodies of water with low biological productivity characterized by clear water, low algal growth, low nutrient concentrations, minimal aquatic vegetation, and well-oxygenated water.

Point Source- A source of pollution from a single defined outlet such as a pipe.

Shallow Lake- A lake 50 acres or greater in size and less than 15 feet deep, or has greater than 80% littoral area.

Stratification- Separation of water within a lake based on density as a result of differences in water temperature from warm water near the surface and heavy, cold water near the bottom.

Thermocline/metalimnion- The boundary between warm and cold water within a stratified lake characterized by a sudden change in temperature and dissolved oxygen.

Total Maximum Daily Load (TMDL)- Defined by the Clean Water Act as the amount of a pollutant a water body can receive and still meet water quality standards. TMDL studies will often assign a point source load, non-point source load, internal load, and a margin of safety to each pollutant to guide management activities for load reductions from each source.

Project Name |	Brown's Creek Biological Assessments	**Date** |	05/01/2023
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, District Administrator		
From / Contact info |	Mike Majeski, Conservation Biologist		
Regarding |	Macroinvertebrate Data Summary_2015-2022		

Background

The BCWD has been conducting routine fish and macroinvertebrate assessments since 2015 to monitor changes in the biological community of Brown's Creek following implementation of numerous water quality projects in the watershed (see implementation activity under Stream Management, Goal A of the 2017-2026 Watershed Management Plan). The goals of BCWD's routine fish and macroinvertebrate assessments are to develop a more robust understanding of the variability of species composition over time and to develop a long-term trend analysis of changes to the biological community in Brown's Creek in response to on-going water quality projects implemented in the watershed. Macroinvertebrate assessments have been conducted annually as populations and species diversity can change quickly due to changes in their environment, in part due to their short life spans and sensitivities to changes in water quality. Conversely, fish have longer lifespans and populations are generally slower to respond to changes in their environment compared to macroinvertebrates. Therefore, fish surveys have been sampled every other year, with the last survey conducted in 2021 by the MNDNR.

The Minnesota Pollution Control Agency (MPCA) has been using this data to assess the watershed's specific water quality standards and designated uses as part of their long-term Intensive Watershed Monitoring Plan. As part of MPCA's biological assessment, fish and macroinvertebrate-based indices of biological integrity (IBI) have been developed to track long-term trends in the biological community of each watershed studied. Fish and macroinvertebrate IBI's are based on the number and diversity of fish and macroinvertebrate species present in a stream compared to what the stream is expected to support. The following is a summary of macroinvertebrate data collected from 2015-2022.

2022 Macroinvertebrate Assessment

Macroinvertebrates were sampled from three sites along Brown's Creek including the Headwaters, Middle Reach, and Gorge (Figure 1). In 2022, the sampling was conducted in May and September by EOR staff. Joel Chirhart from MPCA assisted with the May 2022 sampling effort and has developed the IBI data that has been reported by RMB Environmental Laboratories (RMB). Macroinvertebrate specimens were sent to RMB for taxonomic identification to the genus level, and a subsequent report was completed by RMB summarizing the macroinvertebrate IBI scores and results from the 2015-2022 surveys (Appendix A). Key findings from the macroinvertebrate surveys are provided below.

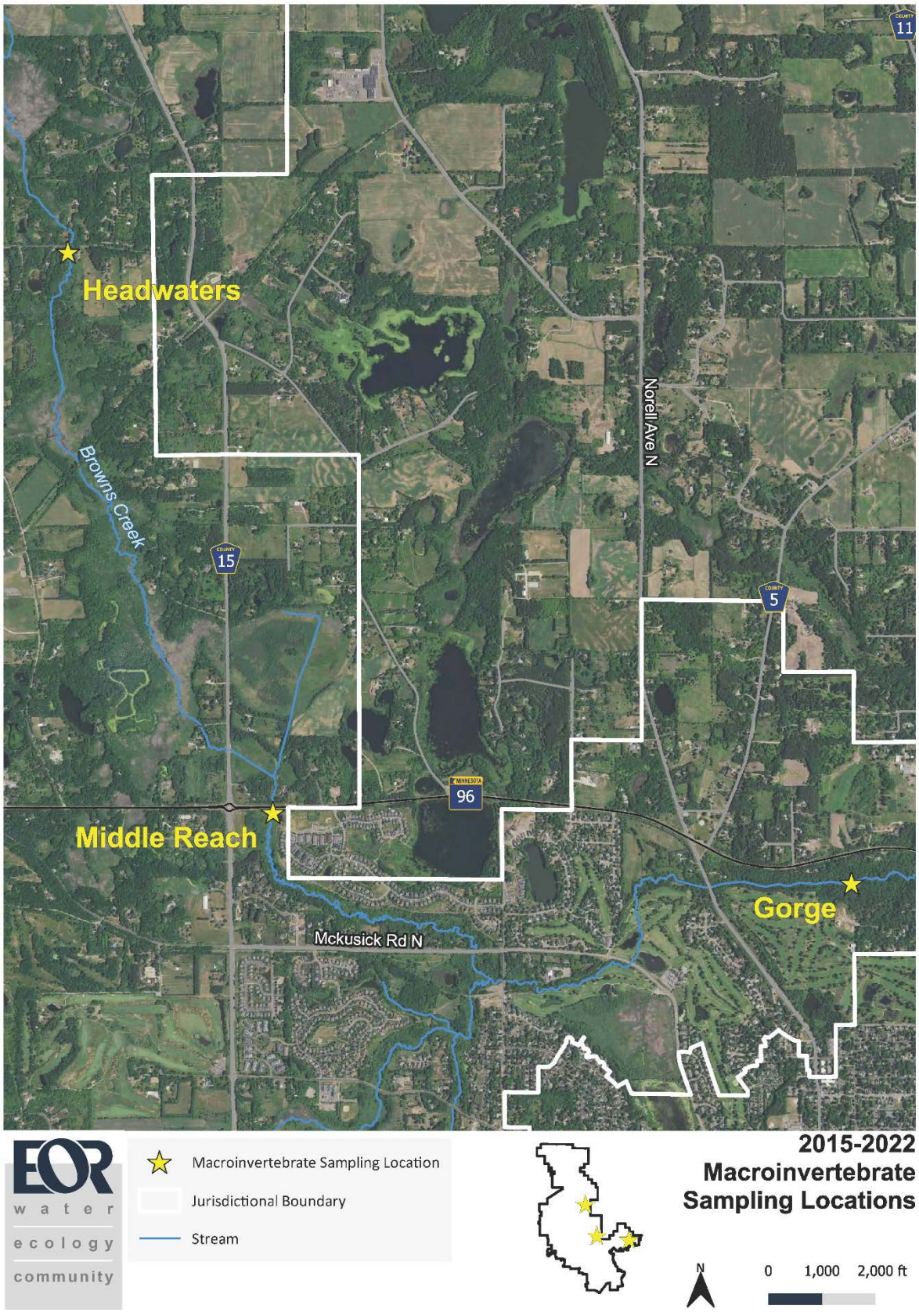


Figure 1. Macroinvertebrate sampling locations in the BCWD, 2015-2022

Key Findings

- Data collected from 2015-2022 indicate an overall upward trend in stream health and macroinvertebrate community quality.

- The calculated IBI scores from all 3 sites from 2015-2022 indicate a stable and improving macroinvertebrate community since 2015, with most macroinvertebrate IBI scores occurring between the General Use and Exceptional Use thresholds for the Southern Coldwater Streams region (Figure 2). Of the 12 samples that have scored above the Exceptional Use Threshold over the course of the project, 9 of those samples have occurred since 2019. Most notably, all three fall 2019 samples were above the Exceptional Use Threshold, a first for this study.

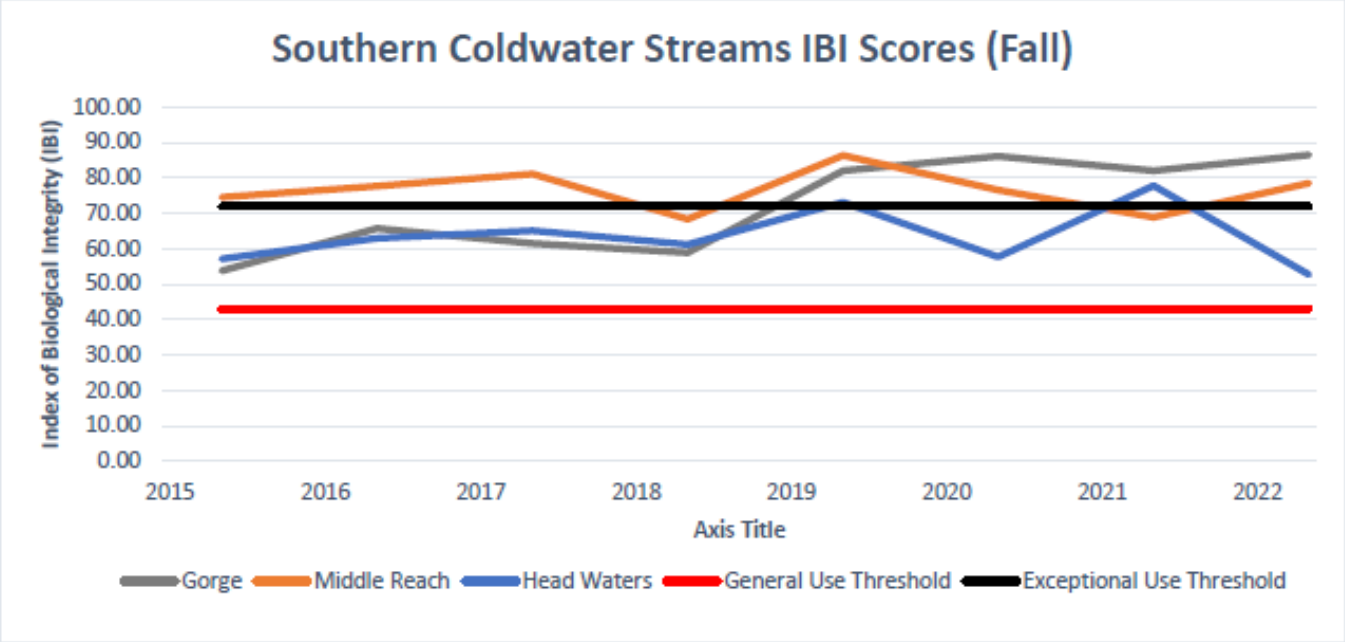


Figure 2. Fall Season IBI Scores from Brown's Creek and Associated General Use and Exceptional Use Thresholds. Source: RMB Macroinvertebrate Stream Monitoring Assessment 2015-2021 (Figure 6, Appendix A)

- The total number of taxa sampled from 2015-2022 indicates a diversity of species present across all 3 sites (140 unique taxa to date), with the three most dominant taxa having a medium-level tolerance to pollution. However, good numbers of intolerant taxa (species intolerant of pollution) are also present which indicates the stream provides ample habitat and water quality to support these sensitive species.

- The Perlodid stonefly has been collected every year from the Gorge site, indicating the creek provides ample habitat and oxygen levels for this pollution intolerant species. Perlodid stoneflies were also collected from the Middle Reach in 2020 and 2022.

- The average pollution tolerance score has decreased since 2015, indicating the creek is supporting a greater number of species that are considered intolerant to pollution (Figure 3). This trend is also reflective in the population size of intolerant species, with the number of intolerant specimens steadily increasing since 2015 (Figure 4). In addition, pollution intolerant taxa are present in good numbers at all 3 sampling sites and suggests Brown's Creek is providing suitable habitat and water quality for macroinvertebrates throughout the creek corridor.

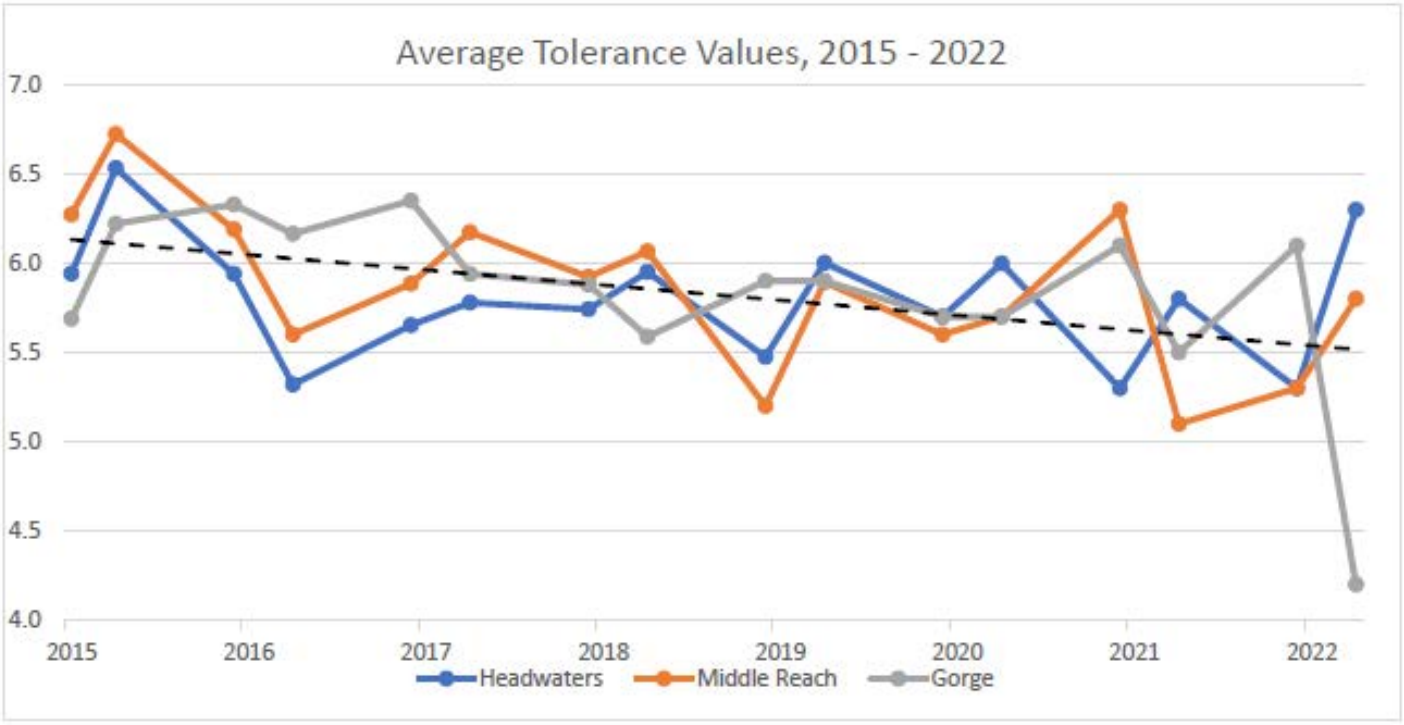


Figure 3. Average tolerance values for Brown's Creek macroinvertebrates. Source: Source: RMB Macroinvertebrate Stream Monitoring Assessment 2015-2022 (Figure 4, Appendix A)

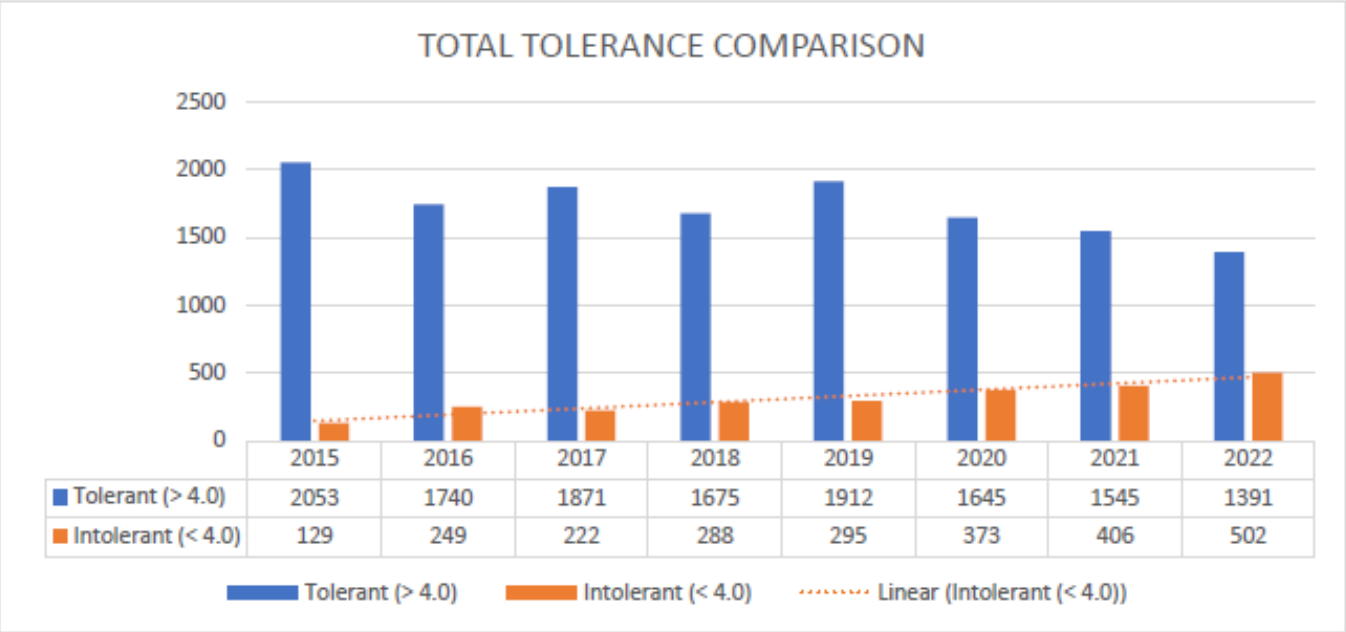


Figure 4. Comparison of tolerant to intolerant taxa in Brown's Creek. Source: RMB Macroinvertebrate Stream Monitoring Assessment 2015-2022 (Figure 10, Appendix A)

Appendix A

RMB Report: Macroinvertebrate Stream Monitoring Assessment 2015-2022

Macroinvertebrate Stream Monitoring Assessment 2015 – 2022

Emmons & Olivier Resources, Inc.

April 19th, 2023

RMB Environmental Laboratories
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Report Date: April 19th, 2023

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Joel Chirhart, Minnesota Pollution Control Agency: IBI calculations

Kaira Kamke: Report

Moriya Rufer: Report

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Introduction

Macroinvertebrates provide a valuable insight into the health of a stream ecosystem since most taxa require specific conditions to survive and thrive. Stream parameters like temperature, flow speed, substrate type, dissolved oxygen, and pollution inputs can all impact which invertebrates will be found at a site. Evaluating the invertebrate community in a stream or river can reveal impacts to the aquatic ecosystem and trends in the water quality.

From 2015 – 2022, aquatic macroinvertebrates were collected in May or June and September from Brown's Creek in Washington County, Minnesota. The Minnesota Pollution Control Agency (MPCA) Index of Biotic Integrity (IBI) was calculated for all stream sites to assess the water quality and compare sites. Samples were collected along the stream reach at the Headwaters, Middle Reach, and Gorge sites to evaluate how the quality changes along the gradient (Figure 1). Brown's Creek is located within the Southern Coldwater Streams invertebrate class (Figure 2). Samples were repeated each year beginning in 2015 to evaluate changes over time. The collection of this data is essential for compiling a baseline dataset of invertebrates found in this region, which can be used for assessments of impacts or future restoration projects on this stream.

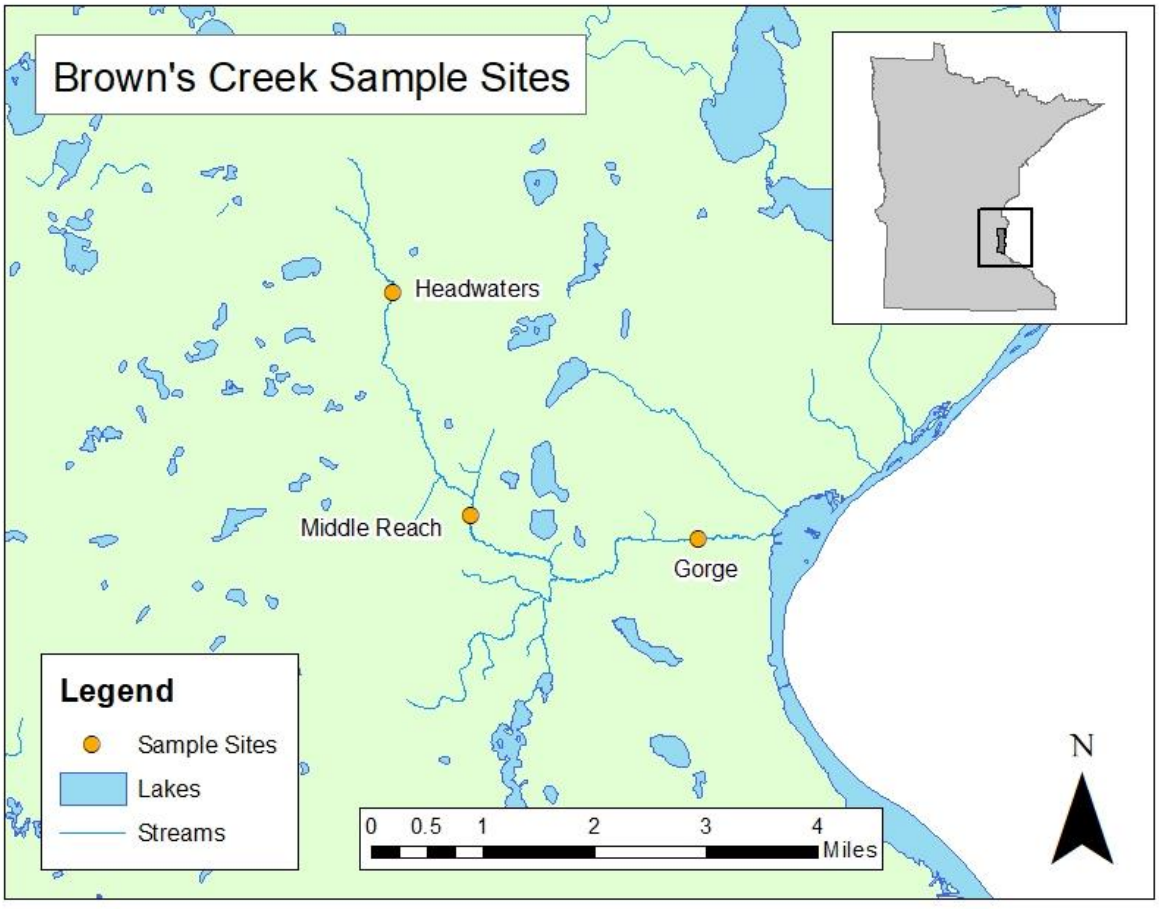


Figure 1: Macroinvertebrate monitoring sites in Brown's Creek, 2015-2022

Methods

Sample Collection

The aquatic macroinvertebrate samples collected from 2015 – 2022 were located at the Headwaters, Middle Reach, and Gorge sites of Brown's Creek. Samples were collected with a D-frame net following the MPCA's Standard Operating Procedure (SOP) for multi-habitat collection of stream invertebrates (MPCA). They were then preserved and delivered to RMB Environmental Laboratories, Inc. (RMBEL) in Detroit Lakes, MN for laboratory processing and data analysis.

Laboratory Processing

The macroinvertebrate samples were processed following MPCA methods, including sorting random subsamples to a target specimen count of 300. All taxa were enumerated and identified to genus level, with leeches and snails identified to species where possible. Representative taxa were retained in a project collection for internal quality control. Subsample picking and taxa identifications were both held to 95% efficiency in internal quality control checks.

Data Management and Assessment

The final data for each sample was entered into a spreadsheet and sent to Joel Chirhart at the MPCA to run the IBI database calculations. RMBEL staff used the macroinvertebrate community data to calculate general invertebrate metrics to accompany the IBI values and facilitate comparison among sites along the stream gradient and across years. Sites were mapped in ArcMap to regionally compare the samples, which are within the Southern Coldwater Streams invertebrate class (Class 9). These classes are derived from the Minnesota Department of Natural Resources (DNR) Ecological Classification System provinces and were developed based on major climate zones, native vegetation, and biomes.

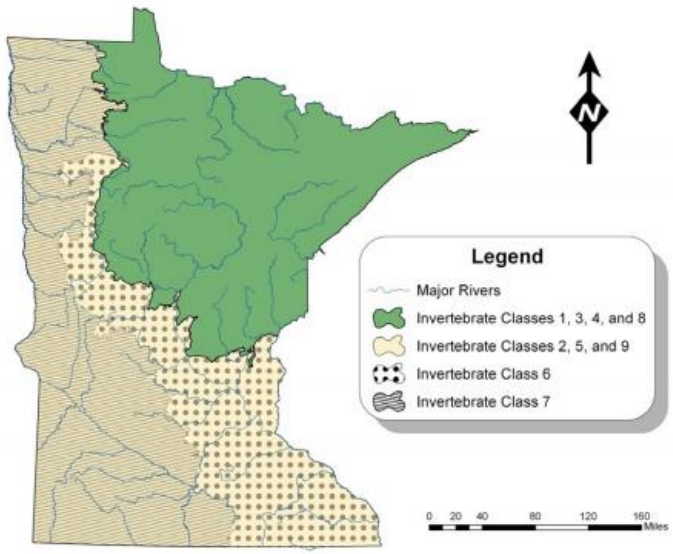


Figure 2: Map of Minnesota Pollution Control Agency invertebrate classes (MPCA)

Results

Macroinvertebrate Metrics

Macroinvertebrate metrics can provide a general overview of the health of a stream ecosystem relating to which taxa are dominant in a sample and how many taxa are intolerant to pollution impacts. Overall taxa richness is a common metric for water quality, since unimpacted stream systems typically show much more diversity than those with heavy impacts. The taxa richness values in this report include only unique taxa, and specimens that are immature or damaged and left at a higher taxonomic level were omitted from the metric. This may present some discrepancies from previous reports sent, in which all taxa were included in the richness values, regardless of whether they were unique to the rest of the community composition. Evaluating certain taxa groups that generally prefer specific conditions can give an idea of whether the stream quality is higher or lower than other sites. These include Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), which typically are found in unpolluted waters, as well as Chironomidae (midges) which tend to dominate in highly impacted sites. Additionally, the presence of taxa that are intolerant to pollution can indicate higher quality waters. These metrics are explained in Table 1; they have been calculated for all the samples throughout this project and are listed in Tables 2 – 7.

Table 1. Explanations of the macroinvertebrate metrics

Metric	Explanation	Response
Taxon Richness	**The total number of taxa found in the sample (genus level, family level for Chironomidae)**	**Higher numbers indicate better water quality and habitat quality**
EPT Richness	**The total number of Ephemeroptera (mayflies), Plecoptera (Stoneflies), and Trichoptera (caddisflies) in the sample. These taxa are considered generally intolerant to pollution.**	**Higher numbers indicate better water quality and habitat quality**
Plecoptera Richness	**The total number of Plecoptera (stoneflies) taxa in the sample. Plecoptera are intolerant to pollution and are clean water indicators.**	**Higher numbers indicate better water quality and habitat quality**
Percent Chironomidae	**Generally, the more chironomids in a sample, the more impacted the site is.**	**Lower numbers indicate better water quality and habitat quality**
Average Tolerance	**The average tolerance value of all the taxa in the sample on a 0-10 scale, with 0 being intolerant to organic pollution and 10 being tolerant to organic pollution**	**Lower numbers indicate better water quality and habitat quality**
Intolerance	**Number of taxa with tolerance values less than or equal to 4**	**Higher numbers indicate better water quality and habitat quality**

2015 Results

This macroinvertebrate survey began in 2015 with two samples collected per year at the Headwaters, Middle Reach, and Gorge sites of Brown's Creek. Overall, there were 53 unique taxa found in the samples this year. Most of the samples showed high taxon richness values, with the most diversity found at the Headwaters and Middle Reach sites (Table 2). All samples had at least two taxa in the EPT group, which represent higher quality water. Plecoptera (stonefly) richness is a metric that can indicate unimpacted streams. Only one immature stonefly specimen was found at the Gorge site during this year of sampling. Stoneflies typically prefer to live in fast, cold waters with riffles, and even a stream with moderate impacts can be unsuitable for them.

The percent Chironomidae metric showed results from 0% up to only 11.7% in 2015. This taxa group tends to dominate in heavily impacted streams, so this low proportion of the community means that there are minimal high-impact pollutant sources affecting the stream. The average tolerance values of all taxa found in each sample were predominantly greater than 5.0, which indicates that most of the taxa are tolerant to higher levels of pollution or other impacts to the streams.

Every sample in 2015 included intolerant taxa in the community, which are specimens with a tolerance value of 4 or less. Even though most of the samples had dominating species with high tolerance values, the presence of intolerant taxa indicates the sites are also providing suitable conditions.

Table 2. Metrics for each sample site in 2015

Site	Taxon Richness	EPT Richness	Plecoptera Richness	Percent Chironomidae	Average Tolerance	Intolerance
Headwaters	**39**	**8**	**0**	**8.1%**	**6.1**	**2**
June	28	7	0	11.7%	5.9	2
September	18	4	0	1.1%	6.5	1
Middle Reach	**27**	**6**	**0**	**1.2%**	**6.5**	**2**
June	21	4	0	4.3%	6.3	2
September	28	5	0	0.0%	6.7	1
Gorge	**22**	**4**	**1**	**1.3%**	**5.8**	**4**
June	16	3	0	1.5%	5.7	3
September	11	2	1	0.9%	6.2	2

2016 Results

In 2016, the samples had a total of 55 different taxa found. The taxon richness values for each sample were mostly above 20, which represents a diverse community of invertebrates (Table 3). Only the Gorge sample from September showed a lower taxa richness than the other samples, with only 15 unique taxa. The EPT richness was also found to be high, with every sample having at least 3 different taxa from one of those insect groups. The Plecoptera richness was comparable to the 2015 samples, with only the Gorge site having stoneflies present, but they were found in both the May and September samples this year.

The percent Chironomidae was low again for the samples in 2016, with the highest only reaching 14.2%. However, the average tolerance values were slightly above 5.0 again, indicating the domination of tolerant taxa in the samples. Like 2015, each of the samples displayed intolerant taxa, so each site does not show the high impact levels that would prevent those species from occurring there.

Table 3. Metrics for each sample site in 2016

Site	Taxon Richness	EPT Richness	Plecoptera Richness	Percent Chironomidae	Average Tolerance	Intolerance
Headwaters	**36**	**8**	**0**	**6.0%**	**5.6**	**3**
May	20	4	0	7.6%	5.9	1
September	28	6	0	4.5%	5.3	3
Middle Reach	**36**	**7**	**0**	**6.8%**	**5.8**	**3**
May	20	3	0	14.2%	6.2	1
September	23	5	0	1.4%	5.6	3
Gorge	**27**	**3**	**1**	**11.6%**	**6.2**	**2**
May	21	3	1	12.2%	6.3	1
September	15	3	1	1.1%	6.2	1

2017 Results

The macroinvertebrate samples taken in 2017 again showed high-quality water overall, with 60 unique taxa found across all the sites (Table 4). The taxon richness was higher for most of the samples than in previous years, and all sites had several EPT taxa present. Plecoptera were again found only at the Gorge site, but in both the spring and fall samples. The Chironomidae proportion was higher in some of the sites this year than in previous years, with the most being present in the Headwaters sample from May. However, most of the midge taxa found were *Diamesa* and *Parametriocnemus*, which both have moderate tolerance values of 5.0 and 5.2, respectively. Midges that dominate in heavily impacted streams tend to have tolerance values much higher than those found in this sample. The average tolerance values for the samples were like previous years in the 5.5 – 6.5 range, and each site had some intolerant taxa found.

Table 4. Metrics for each sample site in 2017

Site	Taxon Richness	EPT Richness	Plecoptera Richness	Percent Chironomidae	Average Tolerance	Intolerance
Headwaters	**31**	**6**	**0**	**33.2%**	**5.7**	**4**
May	18	3	0	51.5%	5.7	2
September	23	4	0	4.8%	5.8	3
Middle Reach	**37**	**8**	**0**	**8.9%**	**6.1**	**5**
May	19	3	0	19.6%	5.9	2
September	28	6	0	1.3%	6.2	4
Gorge	**34**	**6**	**1**	**20.5%**	**6.1**	**3**
May	20	3	1	34.5%	6.4	1
September	27	5	1	11.7%	5.9	3

2018 Results

The metrics for 2018 sample sites show high stream quality, most like 2017 than previous years, and the samples included 64 different taxa across all samples (Table 5). All samples showed exceptionally high taxon richness values, with the Gorge site being at a similar level to the other sites. All sites had at least two EPT taxa present, and again the only Plecoptera specimens found this year were at the Gorge site in both samples. The percent Chironomidae metric was slightly lower across most of the sites compared to previous years. Like 2017, the highest percent Chironomidae value was in the May Headwaters sample, but again the community consisted mostly of moderate-tolerance species. The average tolerance values are like previous years, and all samples had some intolerant taxa present this year, so the sites also provide suitable conditions for these species.

Table 5. Metrics for each sample site in 2018

Site	Taxon Richness	EPT Richness	Plecoptera Richness	Percent Chironomidae	Average Tolerance	Intolerance
Headwaters	**35**	**6**	**0**	**18.7%**	**5.9**	**4**
May	24	2	0	35.8%	5.7	2
September	26	5	0	4.9%	6.0	3
Middle Reach	**37**	**6**	**0**	**7.3%**	**6.0**	**4**
May	21	3	0	13.8%	5.9	2
September	25	4	0	0.9%	6.1	3
Gorge	**36**	**8**	**1**	**11.5%**	**5.7**	**5**
May	27	6	1	17.9%	5.9	3
September	24	5	1	5.4%	5.6	3

2019 Results

In 2019, the samples included 58 unique taxa and showed an ongoing trend of high stream quality (Table 6). The taxon richness values continue to show high levels of diversity throughout Brown's Creek. The May Headwaters community had a richness level higher than any sample in this project so far with over 30 unique taxa. The Middle Reach and Gorge sites showed diversity like previous years. All samples had at least 3 unique EPT taxa present, with the Gorge site showing the only Plecoptera specimens. However, this year both *Isoperla* and *Haploperla* were found at this site, which have moderately low tolerance values of 4.2 and 4.0, respectively.

The Chironomidae proportion was slightly higher in 2019 than in previous years in the Headwaters and Middle Reach sites with half to two-thirds of the May samples comprised of midges. This level of community domination would generally indicate a higher level of impact, although the majority of the Chironomidae community was again represented by *Diamesa*. The average tolerance values are also slightly lower than in previous years with all the samples remaining below 6.0, and all sites included intolerant taxa. This indicates that the stream community is stable and continuing to support the species that are intolerant to stream impacts.

Table 6. Metrics for each sample site in 2019

Site	Taxon Richness	EPT Richness	Plecoptera Richness	Percent Chironomidae	Average Tolerance	Intolerance
Headwaters	**39**	**8**	**0**	**40.3%**	**5.7**	**4**
May	32	4	0	67.0%	5.5	2
September	23	6	0	16.9%	6.0	3
Middle Reach	**32**	**9**	**0**	**28.4%**	**5.6**	**5**
May	19	3	0	54.8%	5.2	3
September	20	7	0	4.0%	5.9	4
Gorge	**31**	**9**	**2**	**11.3%**	**5.9**	**4**
May	24	6	1	25.3%	5.9	3
September	17	5	1	1.8%	5.9	2

2020 Results

In 2020, the samples included 54 unique taxa and showed an ongoing trend of high stream quality (Table 7). The taxon richness values continue to show high levels of diversity throughout Brown's Creek. All samples had at least 3 unique EPT taxa present. The Middle Reach and Gorge sites both showed Plecoptera specimens. This is the first year that Plecoptera has been found in the Middle Reach which could represent higher water quality in that area than in years past.

The average tolerance values for the samples were similar to 2019, with numbers falling between the 5.6 – 6.0 range which are slightly lower than in previous years. Each site had some intolerant taxa found which indicates that the stream community is stable and continuing to support the species that are intolerant to stream impacts.

This year there was a higher number of taxa with moderately low tolerance values ranging from 4.1 to 4.5. *Isoperla (TV=4.2)* was found in both Middle Reach and Gorge, *Ptilostomis (TV=4.4)* and *Pycnopsyche (TV=4.5)* were found in Headwaters, and *Antocha (TV=4.1)* was found in Gorge. A higher number of taxa with moderately low tolerance values is another indicator of good water quality.

The Chironomidae proportion was lower in 2020 compared to 2019 where we saw the highest numbers of any year sampled. Similar to 2019, the majority of the Chironomidae community was again represented by *Diamesa,* which has a moderate tolerance value compared to other midges.

Table 7. Metrics for each sample site in 2020

Site	Taxon Richness	EPT Richness	Plecoptera Richness	Percent Chironomidae	Average Tolerance	Intolerance
Headwaters	**36**	**7**	**0**	**23.8%**	**5.8**	**2**
May	22	3	0	35.9%	5.7	2
September	25	6	0	11.4%	6.0	3
Middle Reach	**32**	**10**	**1**	**18.1%**	**5.7**	**5**
May	16	6	1	28.5%	5.6	3
September	22	5	0	18.1%	5.7	3
Gorge	**29**	**7**	**1**	**14.2%**	**5.7**	**5**
May	20	5	1	21.1%	5.7	2
September	22	7	1	6.6%	5.7	5

2021 Results

In 2021, the samples included 52 unique taxa and showed an ongoing trend of high stream quality (Table 8). The taxon richness values continue to show high levels of diversity throughout Brown's Creek. All samples had at least 4 unique EPT taxa present. The Gorge site showed Plecoptera specimens for both sample occurrences.

The average tolerance values for the samples in 2021 were similar to 2020, with numbers falling between the 5.6 – 6.0 range which are slightly lower than in previous years. Each site had some intolerant taxa found which indicates that the stream community is stable and continuing to support the species that are intolerant to stream impacts.

This year again there was a higher number of taxa with moderately low tolerance values ranging from 4.1 to 4.5. *Ptilostomis (TV=4.4)* was found in Headwaters. *Isoperla (TV=4.2), Pycnopsyche (TV=4.5)* and *Antocha (TV=4.1)* were found in Gorge. A higher number of taxa with moderately low tolerance values is another indicator of good water quality.

The Chironomidae proportion was lower in 2021 compared to 2020 and substantially lower to 2019 where we saw the highest numbers of any year sampled. The majority of the Chironomidae community was represented by *Polypedilum,* which has a high tolerance value compared to other midges. The second highest number of midges were represented by Diamesa which has a lower tolerance value and has been the most prevalent genus found in past years. The lower Chironomidae numbers this year are a good sign since most of MN had experienced low water conditions over the summer of 2021. Lower water conditions usually result in warmer water temperatures which helps Chironomidae development. EPT richness remained stable from Spring to fall sampling and increased in the Middle Reach which is similar to past years and a great sign that taxa can maintain richness even in low water conditions.

Table 8. Metrics for each sample site in 2021

Site	Taxon Richness	EPT Richness	Plecoptera Richness	Percent Chironomidae	Average Tolerance	Intolerance
Headwaters	**28**	**8**	**0**	**6.0%**	**5.5**	**5**
May	20	5	0	9.7%	5.3	4
September	21	5	0	2.4%	5.8	3
Middle Reach	**40**	**9**	**0**	**15.6%**	**5.7**	**5**
May	25	4	0	30.8%	6.3	3
September	24	7	0	3.1%	5.1	3
Gorge	**28**	**7**	**1**	**14.7%**	**5.8**	**3**
May	22	5	1	24.9%	6.1	2
September	16	5	1	4.5%	5.5	2

2022 Results

In 2022, the samples included 50 unique taxa and showed an ongoing trend of high stream quality (Table 8). The taxon richness values continue to show high levels of diversity throughout Brown's Creek. All samples had at least 5 unique EPT taxa present. All samples had at least 20 unique taxa with the highest being 28 representing a heathy and diverse community of invertebrates. The Gorge site showed Plecoptera specimens for both sample occurrences. Middle Reach showed plecoptera specimens for its spring sample.

The average tolerance values were like years past for Headwaters and Middle Reach. Gorge site had a normal average tolerance in the spring; but showed a much lower average tolerance value for its fall sample due to the abundance of the caddisfly Glossosoma (TV=1.1), Protoptila (TV=1.4) and riffle beetle Optioservus (TV=3.1). Each site had at least 5 intolerant taxa which indicates that the stream community is stable and continuing to support the species that are intolerant to stream impacts.

The Chironomidae proportion was average for Headwaters which typically shows higher numbers than the other two sites. The majority of the Chironomidae community was represented by Diamesa (TV=5.0), which has a lower tolerance value and has been the most prevalent genus found in past years. Middle Reach and Gorge came back with lower than average Chironomidae numbers which are similar to 2015 where we had the lowest numbers of all year's sampled.

Table 9. Metrics for each sample site in 2022

Site	Taxon Richness	EPT Richness	Plecoptera Richness	Percent Chironomidae	Average Tolerance	Intolerance
Headwaters	**32**	**7**	**0**	**26.2%**	**6.0**	**8**
May	25	5	0	41.4%	5.3	6
September	22	5	0	10.8%	6.3	6
Middle Reach	**37**	**10**	**1**	**4.5%**	**5.6**	**7**
May	25	8	1	5.1%	5.3	5
September	28	7	0	4.0%	5.8	6
Gorge	**33**	**10**	**1**	**3.9%**	**5.1**	**8**
May	26	7	1	3.5%	6.1	5
September	20	8	1	4.2%	4.2	7

2015 – 2022 Comparisons

The general macroinvertebrate metrics are best used in combination to determine the health of a stream ecosystem. However, a few of the metrics can give an overall glimpse into how stream health is changing over time. The taxa richness represents how many unique specimens are present in a sample, which is an indication of biological community stability. Streams with high taxa richness are better able to respond to and recover from impacts to the water quality. In this project, the taxa richness for all samples ranges from 11 to 32, and over the years of this project, the communities present appear to be stable and showing an increasing trend in richness (Figure 3). This indicates that the stream ecosystem is healthy and successfully recovering from any disturbances or impacts that

may have occurred in the years prior to the survey. Several of the 2015 samples did not meet the target specimen count of 300 specimens when the entire sample was sorted, and this can affect the metric results. However, even with these low counts, the spring samples still showed a high taxa richness that is comparable to the community sampled in the following years. The Headwaters sample from May 2019 showed 32 unique taxa, which was higher than in any of the previous samples, indicating that the stream has a very stable and diverse community present. Samples from 2021 showed lower taxa richness than 2019 but remained comparable with earlier years of sampling. 2022 showed continued improvement. We had a record low for average tolerance from the fall Gorge site which also resulted in a record high in IBI scoring from that same site. The total tolerance comparison across all years shows a strong increase in intolerant taxa along with a decrease in tolerant taxa. Decreasing tolerance values along with stable taxa richness and lower Chironomidae numbers are all great indicators that conditions are improving for Brown's Creek.

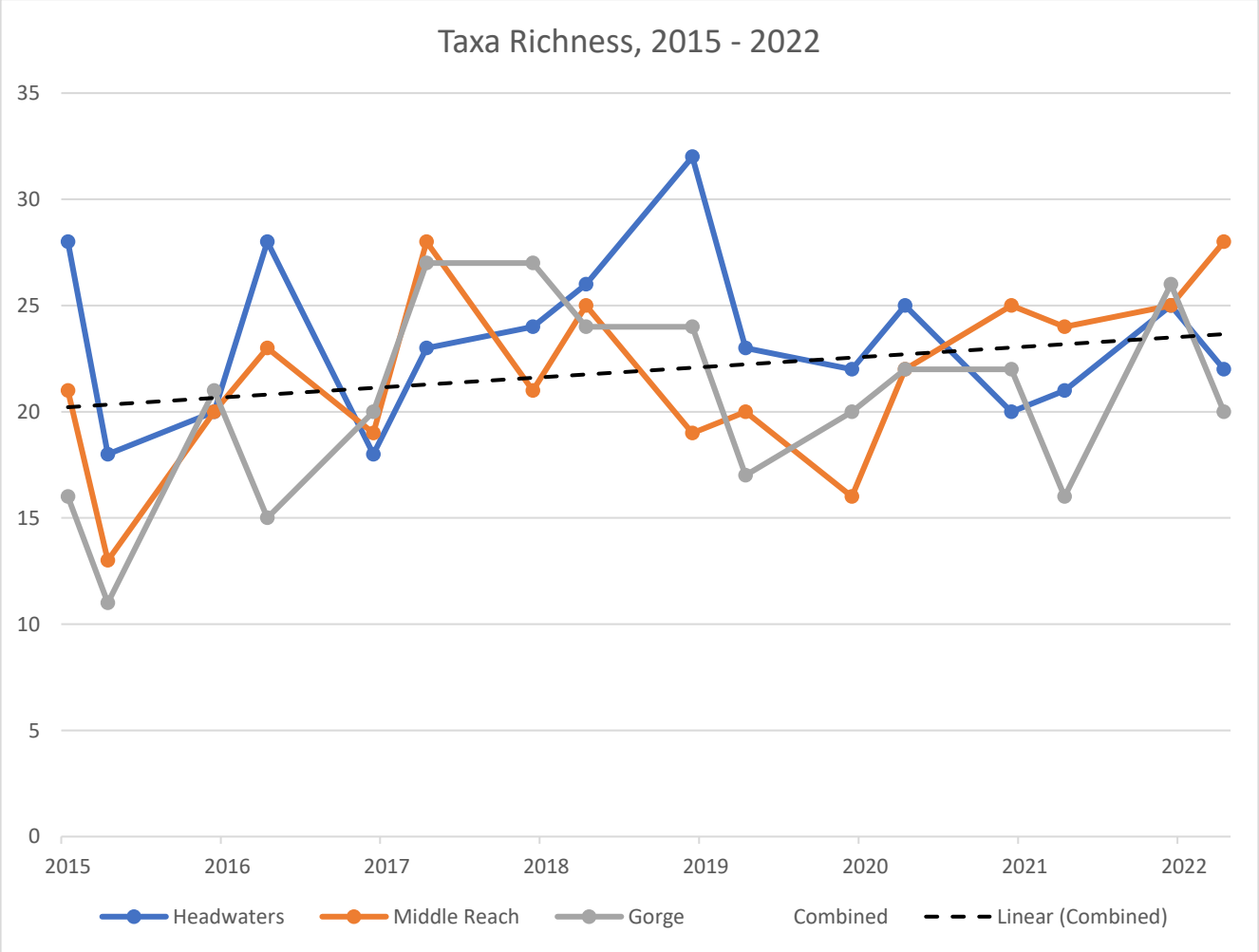


Figure 3: Taxa richness values for Brown's Creek samples from 2015 to 2022

The average tolerance value metrics can also give a good insight into stream health since it consists of a weighted average calculation. The Brown's Creek samples show an interesting pattern over the course of the years surveyed (Figure 4). In 2015, there were high values across the sites, and then some fluctuation in the tolerance values over the rest of the years. Natural fluctuations in community composition can occur year to year and are a normal occurrence in this tolerance range of 5.5 to 6.5. There is a slight decreasing trend developing over the years, showing that the stream community can support more specimens that are intolerant to impacts. This is an indication of good water quality and a stable aquatic ecosystem. The Headwaters and Middle Reach sites tend to follow the same pattern throughout the sample period, indicating similar conditions at those two sites. However, the Gorge samples follow a different pattern, showing a higher tolerance score in 2016 and 2017 when the other two sites showed much lower scores. This could be due to a disturbance or impact occurring to Brown's Creek between the Middle Reach and Gorge sample sites. However, the disturbance is not severe enough to have strongly altered the other metrics in the Gorge samples, so the stream community is able to recover before reaching this last sample site. In 2020 & 2021, we see more consistent taxa in Headwaters and Middle Reach. Gorge showed more variation than in years past when compared with the other two sites; this could be due to low water levels in the fall. There is a down trend in average tolerance values and it seems that the numbers of intolerant taxa have been rising year after year which is a great sign that conditions are improving. Even thou numbers of unique taxa have declined since 2018 in Brown's creek, the taxa with lower tolerance values have been increasing. As conditions improve in Brown's creek it allows taxa with lower tolerance values a chance to rebound and increase their populations from past numbers.

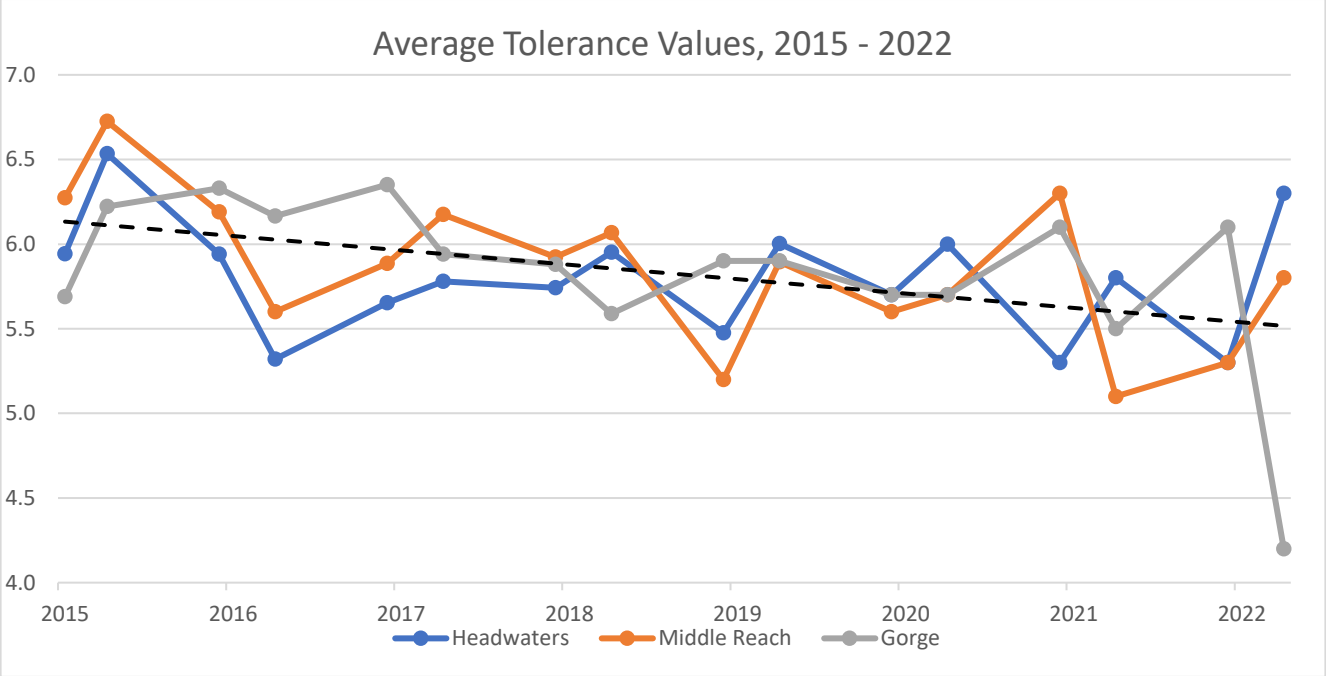


Figure 4: Average tolerance values for Brown's Creek samples from 2015 to 2022

Index of Biological Integrity (IBI)

The MPCA has developed a state-wide method of evaluating stream health using aquatic macroinvertebrates. This index gives each sample a numerical value that can be used to compare one site to another. It can also be used to monitor individual sites over time to determine whether the stream condition is improving or declining.

Due to the geographic differences throughout Minnesota and the variability in stream types, the state has been divided up into three regions that comprise nine different invertebrate stream classes (Figure 2). Each class has a different IBI calculation that best represents the invertebrate communities typically found within the region. They are based primarily on region, watershed size, thermal regime, and stream gradient (MPCA). The study area in this project is located within the Southern Coldwater Streams invertebrate class.

Tiered Aquatic Life Uses (TALU)

Stream health throughout Minnesota is evaluated for its capacity to sustain aquatic life, including the macroinvertebrates, fish, plants, and other organisms. The MPCA developed models with threshold IBI values that represent how well the stream can sustain aquatic life. These include *Exceptional Use* for high-quality streams, *General Use* for streams with light impacts, and *Modified Use* for areas with heavy impacts to the streams (Table 7). Each invertebrate stream class has different threshold levels based on the invertebrate communities typically found in that region. In this project, almost all samples were above the General Use Threshold, and several were above the Exceptional Use Threshold.

Table 10: Tiered Aquatic Life Uses as determined by the MPCA (MPCA 2014)

Use Category	Description
Exceptional Use	**Evident changes in structure due to loss of some rare native taxa; shifts in relative abundance; ecosystem level functions fully maintained**
General Use	**Overall balanced distribution of all expected major groups; ecosystem functions largely maintained through redundant attributes**
Modified Use	**Sensitive taxa markedly diminished; conspicuously unbalanced distribution of major taxonomic groups; ecosystem function shows reduced complexity and redundancy**

Table 11: Index of Biological Integrity (IBI) scores for Brown's Creek samples from 2015 to 2022

Sample Date		Headwaters	Middle Reach	Gorge
2015	June	53	64.6	62.2
	September	57.1	74.5	53.8
2016	May	51.7	44.8	41
	September	63	77.7	65.8
2017	May	49.8	56.1	35.2
	September	65.1	81.1	61.4
2018	May	53.8	66.6	52.4
	September	61.2	68.4	58.9
2019	May	42.9	48.9	51
	September	73.1	86.4	82
2020	May	63.3	64.5	53.2
	September	57.6	76.6	86.2
2021	May	72.5	43.3	48.4
	September	77.8	68.9	82
2022	May	59.1	75.1	78
	September	52.7	78.5	86.5

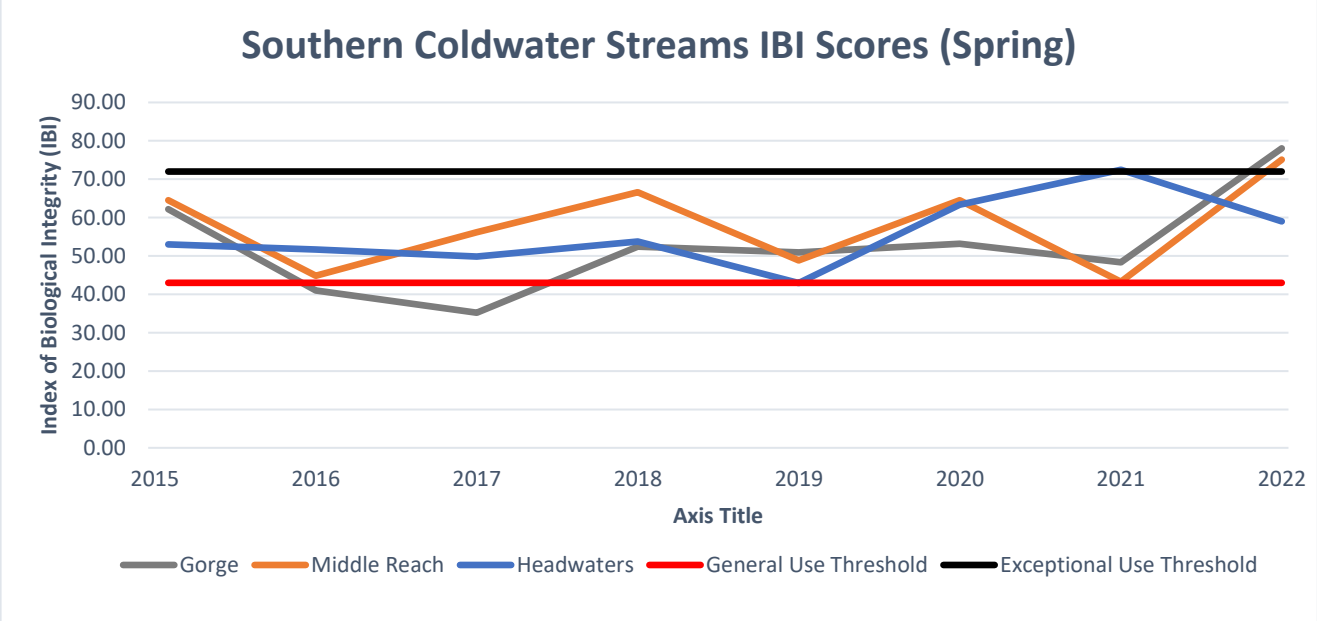


Figure 5: IBI scores, General Use Threshold, and Exceptional Use Threshold for Brown's Creek samples within the Southern Coldwater Streams class in spring 2015 - 2022

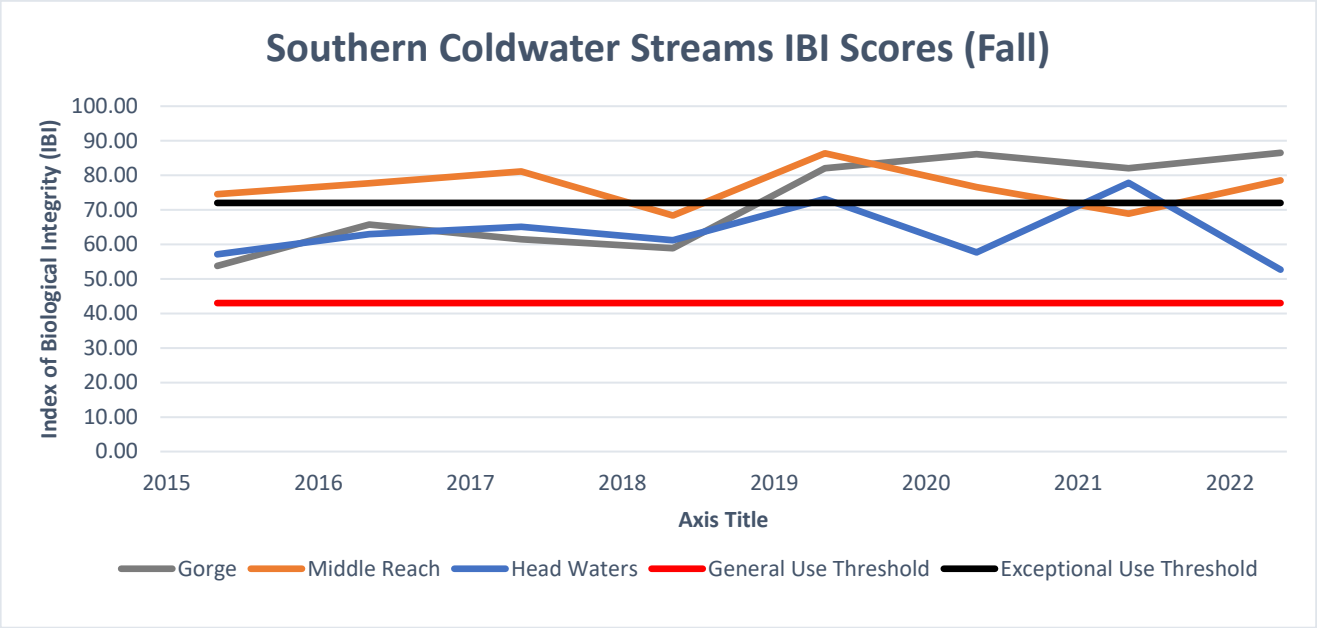


Figure 6: IBI scores, General Use Threshold, and Exceptional Use Threshold for Brown's Creek samples within the Southern Coldwater Streams class in fall 2015 - 2022

Southern Coldwater Streams region represents areas in the southern portions of Minnesota with deciduous broadleaf forests. This invertebrate class has an IBI General Use Threshold of 43 and an Exceptional Use Threshold of 72. In this project, almost all samples met the General Use Threshold, and several of the Middle Reach & Gorge samples exceeded the Exceptional Use Threshold as well as all the sites in September of 2019 (Table 7, Figure 5). The highest score was 86.5 from the September 2022 sample of the Gorge site and the lowest was 35.2 from the May 2017 sample of the Gorge site. There are natural fluctuations in the invertebrate community, causing the IBI scores to change over time. The samples taken in the fall of each year usually show a higher score than the spring samples, but overall, the scores are between the General and Exceptional Use Thresholds, indicating a stable aquatic community. Some of the samples in 2015 fell below the total specimen count of 265 recommended for the IBI calculation, which can affect the score outcome. However, even with the low counts, the IBI scores from 2015 still appear comparable to the results in the later years of this project.

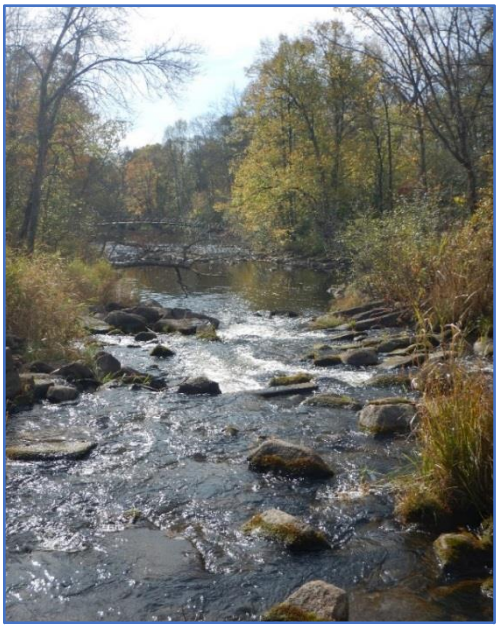
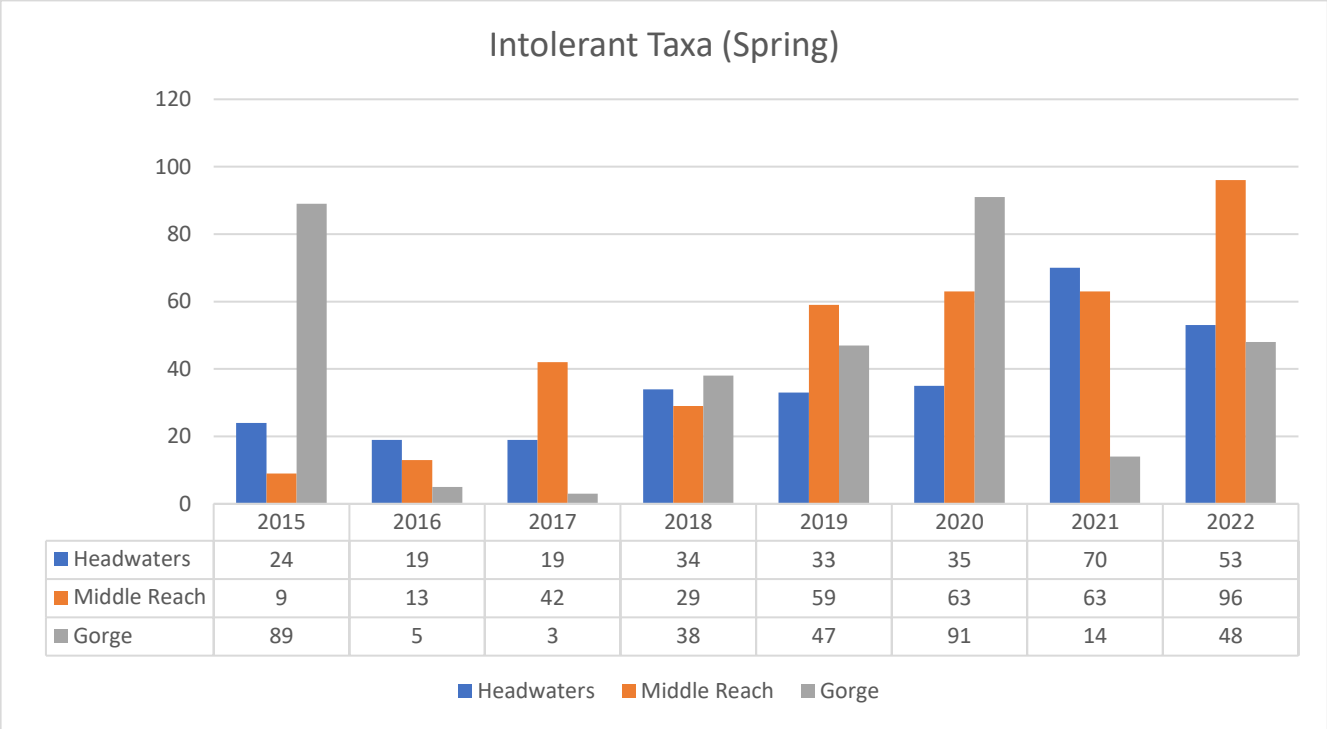
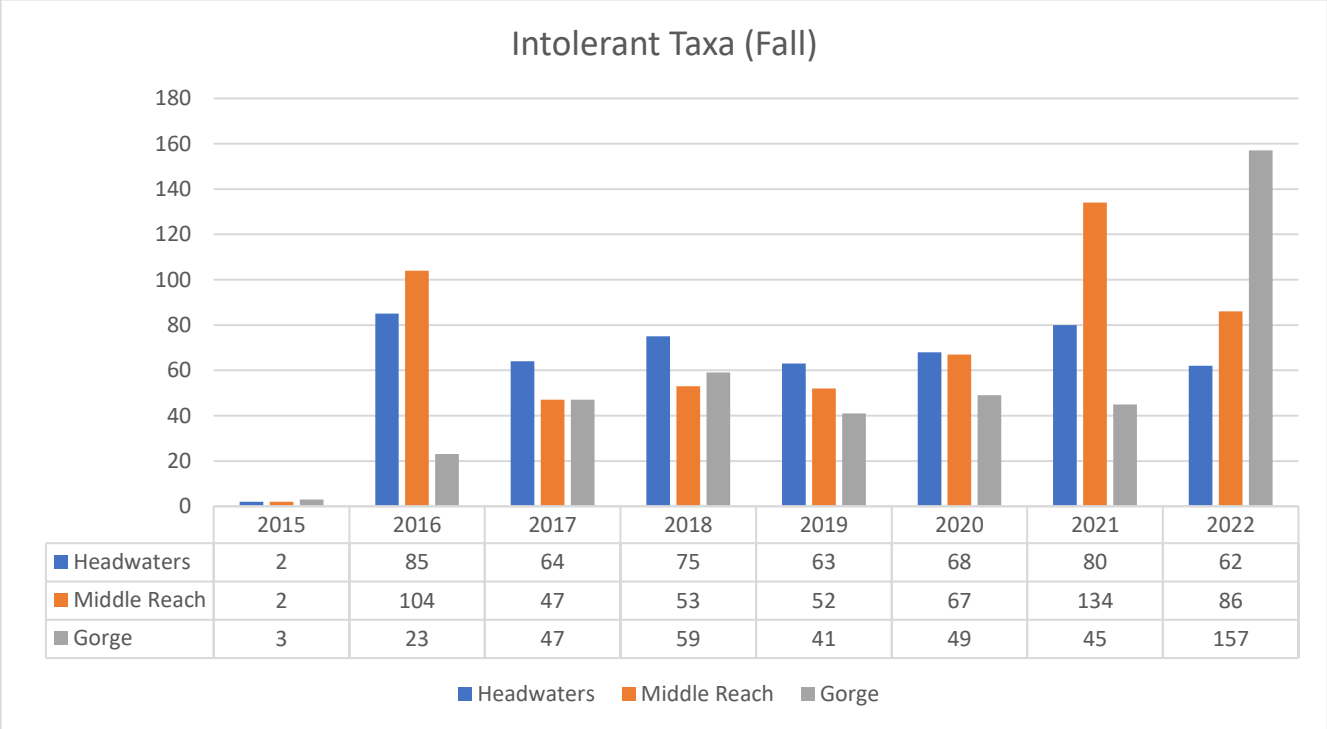


Figure 7: Example of a Southern Coldwater Stream sample site



	2015	2016	2017	2018	2019	2020	2021	2022
Headwaters	24	19	19	34	33	35	70	53
Middle Reach	9	13	42	29	59	63	63	96
Gorge	89	5	3	38	47	91	14	48



	2015	2016	2017	2018	2019	2020	2021	2022
Headwaters	2	85	64	75	63	68	80	62
Middle Reach	2	104	47	53	52	67	134	86
Gorge	3	23	47	59	41	49	45	157

Figure 8 & 9: Comparison of Intolerant taxa spring vs fall for Brown's Creek 2015 - 2022

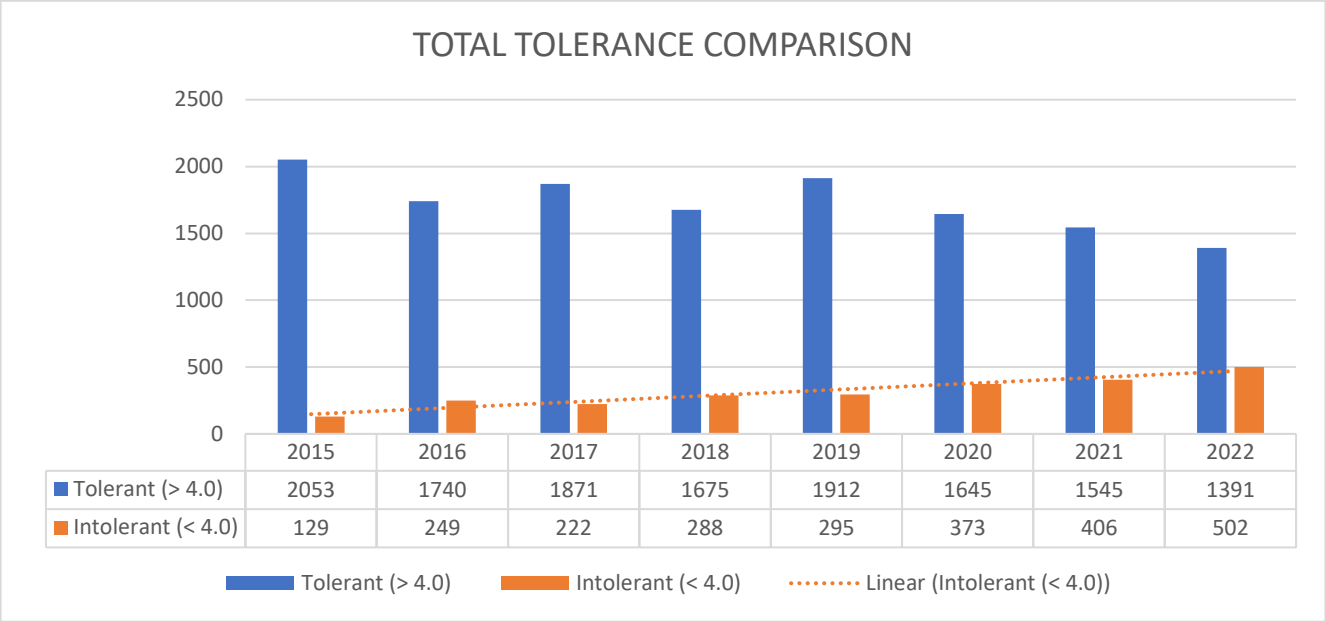


Figure 10: Comparison of Tolerant from Intolerant Taxa for Brown's Creek 2015 - 2022

Discussion

General Metrics

The macroinvertebrate communities sampled throughout this project included a wide variety of species, and the sample sites showed a range of metric results. Overall, there were 140 unique taxa across all the years of sampling, meaning that the Brown's Creek sites have diverse communities with seasonal fluctuations in the community composition (Appendix 1). The most prevalent taxa overall were scuds (*Gammarus*), blackflies (*Simulium*), and mayflies (*Baetis*). These taxa have medium-level tolerance values, so they are often found in higher densities in streams with moderate impacts. The dominance of tolerant taxa like these can cause the average tolerance value of a sample to be high. Most of the samples in this project had an average tolerance value between 5 and 7, with the lowest being 5.2 in the May 2019 Middle Reach sample and the highest being 6.7 in the September 2015 Middle Reach sample.

Despite the prevalence of tolerant species, all the samples included some intolerant taxa, indicating that the level of impacts on the streams was not high enough to prevent the sensitive species from living there. The next most abundant taxon was a riffle beetle (*Optioservus*) which is intolerant to impacts with a tolerance value of only 3.1. The abundance of these riffle beetles indicates that the stream is clean and fast enough to support a strong community of intolerant taxa. Intolerant taxa are any species with a tolerance value (TV) of 4 or less. In this project, these included the riffle beetle *Optioservus* (TV = 3.1), caddisflies *Neophylax* (TV = 3.2), *Glossosoma* (TV = 1.1) and Protoptila

(TV=1.4). This combination of taxa shows that while these streams likely have some urbanization impact, they also have pockets of good microhabitat and sufficient oxygen.

The EPT metric evaluates the diversity of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) in the samples. These insect groups are generally indicators of less impacted waters since they contain many intolerant species. In this project, the EPT values ranged from 2 to 7 unique taxa in each sample. While there are not definitive thresholds with this metric, sites with few or no EPT taxa likely have a substantial number of impacts and may be targeted for management practices to improve the watersheds that flow into these sites. The Plecoptera subset of the EPT metric is also evaluated since the stonefly group contains mostly intolerant species, and typically they require high-quality, well-oxygenated water. Two unique stonefly species were found during this project (*Isoperla* and *Haploperla*), and they have only been found in the Gorge & Middle Reach Sites. This group of insects is typically not very diverse in stream samples without strong riffles present to keep the water full of dissolved oxygen.

The Chironomidae fraction of a sample can also indicate general water quality. Even though this group is very diverse and includes midge species with tolerance values ranging from 0 to 10, generally they only dominate a sample at a site with heavy pollution impacts. The samples in this project ranged from 0% to 67% Chironomidae present, with some of the largest proportions seen in the May 2019 samples. Since most healthy streams have a diverse community of macroinvertebrates, the high numbers of midges seen in the spring samples initially seems like an indication of impact. However, with the change in community throughout the year and with such low Chironomidae proportions in the fall samples, Brown's Creek likely has minimal pollution impacts affecting the water quality, especially when looking at all the metrics in combination.

Invertebrate Stream Classes

Minnesota is divided up into invertebrate stream classes based on three geographic regions so the IBI values can be compared to streams within similar regions. These regions include Northern Forest Streams, Southern Streams, and Prairie Streams. The regions are then further divided based on whether the sample was taken from a site with riffle habitats present or only with glides and pools. This survey was located within the Southern Coldwater Streams class. Samples were taken from 3 dominant habitat types in a given reach per season (Either from riffles, pools, runs, glides, undercut banks, leaf packs, or wood debris.)

Each stream class has unique threshold values indicating the level of support for biological communities living there. The highest tier is the Exceptional Use Threshold which represents the highest quality streams that are providing maximum support for aquatic organisms. The next level is the General Use Threshold, which is the target level for streams that are healthy and functioning

despite any impacts to them. The lowest level is the Modified Use Threshold, which represents streams with heavy impacts that may be struggling to adequately support the aquatic communities living in them. Sites with IBI scores at or below the Modified Threshold should be prioritized over others for management practices or restorations to improve the stream health.

The Brown's Creek sites within the Southern Coldwater Streams region have been regularly fluctuating with the seasonal sampling over the years of this project. Most IBI scores fall between the General and Exceptional Use Thresholds. The pattern across the three sites shows increased scores in the fall with numbers closer to the Exceptional Use Threshold. The Spring samples show slightly lower scoring with numbers closer to the general use threshold. This pattern is normal for most streams with fall samples showing a better display of a stream's true macro community. With improving IBI scoring occurring over the summer, it's unlikely that any major pollution impacts are occurring along Brown's Creek between the sample points.

Limitations and Future Projects

This project contained a few limitations that may have affected some of the resulting data and statistics. During laboratory processing, some of the 2015 samples were completely sorted with the total number of specimens falling below the required 265 count needed for best application of the MPCA IBI calculation. This can slightly skew the resulting IBI score for those sites, but the taxa and tolerance values are still accurate and representative of the sample.

Further monitoring of these sites is recommended to continue establishing the baseline data for these aquatic communities. Each site is dynamic and seasonally changing, so continuing to collect data helps to eliminate the differences due to natural fluctuations in invertebrate communities. Additionally, if there are suspected pollution inputs to a stream or restoration projects in progress, monitoring before and after these impacts is recommended to assess how the biological community is affected.

Literature Cited

MPCA. 2014. Development of a macroinvertebrate-based Index of Biological Integrity for assessment of Minnesota's rivers and streams. Minnesota Pollution Control Agency, Environmental Analysis and Outcomes Division, St. Paul, MN.

MPCA. 2014. Development of biological criteria for tiered aquatic life uses: Fish and macroinvertebrate thresholds for attainment of aquatic life use goals in Minnesota streams and rivers. Minnesota Pollution Control Agency, Environmental Analysis and Outcomes Division, St. Paul, MN.

Appendix 1: Project Taxa List

	ORDER	FAMILY	GENUS	SPECIES
1	Acari/Hydracarina			
2	Amphipoda	Crangonyctidae	Crangonyx	
3		Gammaridae	Gammarus	lacustris
4		Hyalellidae	Hyalella	
5	Bivalva	Pisidiidae	Musculium	
6			Pisidium	
7			Sphaerium	
8	Clitellata/Oligochaeta			
9	Coleoptera	Dytiscidae	Agabus	
10			Ilybius	
11			Liodessus	
12			Uvarus	
13		Elmidae	Macronychus	
14			Optioservus	
15			Stenelmis	
16		Gyrinidae	Gyrinus	
17		Haliplidae	Peltodytes	
18		Hydrophilidae	Enochrus	
19			Hydrobius	
20			Hydrochara	
21			Hydrochus	
22			Tropisternus	
23		Scirtidae	Scirtes	
24	Collembola			
25	Decapoda	Cambaridae		
26	Diptera	Ceratopogonidae	Ceratopogon	
27			Dasyhelea	
28			Mallochohelea	
29		Chironomidae	Brillia	
30			Cardiocladius	
31			Chaetocladius	
32			Cladotanytarsus	
33			Conchapelopia	
34			Corynoneura	
35			Cricotopus	
36			Diamesa	
37			Diplocladius	
38			Eukiefferiella	
39			Eukiefferiella	claripennis gr.
40			Eukiefferiella	devonica gr.
41			Limnophyes	

	ORDER	FAMILY	GENUS	SPECIES
42		Chironomidae	Meropelopia	
43			Micropsectra	
44			Microtendipes	
45			Nanocladius	
46			Orthocladius (Orthocladius)	
47			Orthocladius (Symposiocladius)	lignicola
48			Paracricotopus	
49			Parametriocnemus	
50			Paratanytarsus	
51			Paratendipes	
52			Polypedilum	
53			Prodiamesa	
54			Rheocricotopus	
55			Rheotanytarsus	
56			Saetheria	
57			Stenochironomus	
58			Tanytarsus	
59			Thienemanniella	
60			Thienemannimyia gr.	
61			Tvetenia	
62			Tvetenia	bavarica gr.
63			Zavrelimyia	
64		Dixidae	Dixa	
65		Empididae	Hemerodromia	
66			Neoplasta	
67			Metachela	
68		Ephydridae		
69		Limoniidae	Antocha	
70			Molophilus	
71		Pediciidae	Dicranota	
72		Simuliidae	Simulium	
73			Prosimulium	
74		Stratiomyidae	Odontomyia	
75		Syrphidae	Chrysogaster	
76		Tabanidae	Chrysops	
77		Tipulidae	Antocha	
78			Dicranota	
79			Hexatoma	
80			Limnophila	
81			Limonia	
82			Ormosia	
83			Pedicia	
84			Pilaria	
85			Tipula	

	ORDER	FAMILY	GENUS	SPECIES
86	Ephemeroptera	Baetidae	Baetis	
87	Gastropoda	Ancylidae	Ferrissia	
88		Lymnaeidae	Stagnicola	
89		Physidae	Aplexa	
90			Physa	acuta
91			Physa	gyrina
92			Physella	
93		Planorbidae	Gyraulus	parvus
94			Micromenetus	
95		Valvatidae	Valvata	perdepressa
96	Hemiptera	Belostomatidae	Belostoma	
97		Corixidae	Hesperocorixa	
98			Sigara	
99		Gerridae	Aquarius	
100			Gerris	
101		Pleidae	Neoplea	
102		Veliidae	Microvelia	
103	Hirudinida	Erpobdellidae	Dina	parva
104		Erpobdellidae	Erpobdella	punctata
105		Glossiphoniidae	Glossiphonia	complanata
106			Helobdella	stagnalis sp. group
107			Placobdella	
108		Haemopidae	Haemopis	
109	Isopoda	Asellidae	Caecidotea	
110			Oniscus	
111	Lepidoptera	Pyralidae		
112	Mermithida	Mermithidae		
113	Odonata	Aeshnidae	Aeshna	
114			Boyeria	
115	Odonata	Calopterygidae	Calopteryx	
116		Coenagrionidae		
117	Plecoptera	Chloroperlidae	Haploperla	
118		Perlodidae	Isoperla	
119	Trichoptera	Brachycentridae	Brachycentrus	
120		Glossosomatidae	Glossosoma	
121			Protoptila	
122		Hydropsychidae	Ceratopsyche	
123			Cheumatopsyche	
124			Hydropsyche	
125			Parapsyche	
126		Hydroptilidae		

	ORDER	FAMILY	GENUS	SPECIES
127		Lepidostomatidae	Lepidostoma	
128		Leptoceridae	Oecetis	
129		Leptoceridae	Triaenodes	
130		Limnephilidae	Anabolia	
131			Limnephilus	
132			Pycnopsyche	
133		Philopotamidae	Chimarra	
134		Phryganeidae	Ptilostomis	
135		Polycentropodidae	Polycentropus	
136		Psychomyiidae	Lype	
137		Uenoidae	Neophylax	
138	Tricladida			
139	Trombidiformes	Sperchontidae	Sperchon	
140		Limnesiidae	Limnesia	

Project Name |	Brown's Creek Biological Assessments	**Date** |	5/9/2023
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, BCWD Administrator		
From / Contact info |	Mike Majeski, Conservation Biologist		
Regarding |	2023 Macroinvertebrate Assessment Proposed Scope of Services		

Background

The BCWD has been conducting routine fish and macroinvertebrate assessments since 2015 to monitor changes in the biological community of Brown's Creek following implementation of numerous water quality projects in the watershed (see implementation activity under Stream Management, Goal A of the 2017-2026 Watershed Management Plan). The goals of BCWD's routine fish and macroinvertebrate assessments are to develop a more robust understanding of the variability of species composition over time and to develop a long-term trend analysis of changes to the biological community in Brown's Creek in response to on-going water quality projects implemented in the watershed. Macroinvertebrate assessments have been conducted annually as populations and species diversity can change quickly due to changes in their environment, in part due to their short life spans and sensitivities to changes in water quality. Conversely, fish have longer lifespans and populations are generally slower to respond to changes in their environment compared to macroinvertebrates. Fish surveys were conducted by Saint Mary's University in 2017 and 2019, and historically, the MNDNR has been conducting fish surveys on a 5-7 year cycle, with the last survey conducted in 2021.

Scope of Services

This scope of services is to continue annual sampling of macroinvertebrates at the three historical sites along Brown's Creek (Headwaters, Middle Reach and Gorge). Macroinvertebrate sampling will occur in September of 2023, and specimens will be sent to RMB Labs for taxonomic identification. The results of the assessments will be summarized in a brief technical memo that will include a comparison of the 2023 data to previously collected data (2015-2022).

Deliverables

- Macroinvertebrate assessment technical memorandum and data submission to MPCA

Estimated Hours and Cost

EOR - 16 hours: $2,567

EOR - mileage and sample shipments: $60

RMB - macroinvertebrate specimen ID & report: $1,170

Total: $3,797

Board Action

1. Approve this Scope of Services in the amount of $3,797 from account number 947-0018 to conduct the 2023 Macroinvertebrate Assessment as outlined above.

Project Name |	Brown's Creek Stream Visual Assessment & Geomorphic Survey	**Date** |	05/2/2023
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, District Administrator		
From / Contact info |	Mike Majeski & Dan Mossing		
Regarding |	SVAP & Geomorphic Data Assessment and Drone Flight Upstream of Manning Avenue		

Background

In response to specific questions related to sediment contributions to Brown's Creek and habitat quality, the District has made a commitment to conduct reoccurring riparian assessments and geomorphic surveys of Brown's Creek to better understand how the channel condition and riparian vegetation changes over time. The BCWD 2017-2026 Watershed Management Plan includes "monitoring the geomorphology of Brown's Creek and its tributaries on a biennial basis" for the purposes of evaluating stream health and identifying potential sediment loads to the creek.

Within the last five years the BCWD has investigated the use of drones to supplement the riparian assessments. The drone flights are useful for identifying areas of bank erosion and channel obstructions and allow the District to efficiently locate obstructions and other stream-related issues along the channel in remote reaches and wetland areas that are difficult to traverse on foot, especially the wetland-dominated reach upstream of Manning Avenue.

EOR conducted baseline geomorphic surveys along Brown's Creek in 2007 & 2008 as part of the Brown's Creek TMDL project, and baseline visual stream assessments were completed in 2016. Following BCWD Board approval to replicate the visual assessments and geomorphic surveys, EOR completed the stream visual assessments in 2021 and the geomorphic stream surveys in 2022. The field work included a drone survey upstream of Manning Avenue, visual stream assessments from Manning Avenue to the St. Croix River, and geomorphic surveys at historic locations to monitor channel change over time. In addition, the data collected from this assessment was used by the District in 2022 to pursue funding for District stream projects over the next 5 years for the 2017-2026 Watershed Management Plan. The following memo summarizes the findings of the field assessment.

Stream Visual & Drone Assessments

Drone Survey Upstream of Manning Avenue

A drone flight was conducted on April 11, 2022 from Manning Avenue upstream to the headwaters north of 110th Street. Minor channel obstructions were observed from the drone including two small beaver dams at the same locations identified in 2016. No significant channel obstructions or signs of bank erosion were observed, but one new tributary crossing was identified upstream of Manning Avenue, southwest of 97th St. N. Select images taken from the drone flight are included in Appendix A, and the complete drone flight video has been archived at the BCWD office.

Stream Visual Assessment

The Stream Visual Assessment Protocol (SVAP) was used to assess the creek from Manning Avenue to the St. Croix River. The SVAP is a stream assessment tool developed by the NRCS to evaluate the overall condition of wadeable streams, their riparian zones, and their instream habitats. Since publication of the initial version of the SVAP in 1998, the protocol was re-issued in 2009 as SVAP2 and has taken on broader applications as a tool to evaluate quality criteria for conservation planning, identify potential resource concerns, and assess trends in stream and riparian conditions over time. The tool assesses visually apparent physical, chemical, and biological features within a specified reach of a stream corridor. Due to its qualitative nature, the protocol may not detect all causes of resource concerns, especially if such causes are a result of land use changes in the watershed.

Each stream reach was assessed by eleven SVAP2 elements (described in Appendix B) and rated with a value of 1 to 10. Generally, a score of 10 is of reference reach quality, a score of 5 has moderate impacts, and a score of 1 indicates the stream is severely impacted. Twenty-eight stream reaches were assessed from Manning Avenue to the St. Croix River (Figure 1). The lowest score of the all the reaches assessed was 4.9. This reach is associated with a private parcel immediately north of Highway 96 where the stream banks have been stabilized with rock riprap and the adjacent riparian corridor was comprised of mowed lawn. Although the stream banks are very stable in this reach, the SVAP2 adversely scores rock riprap due to its negative influence on near-stream habitat such as overhanging vegetation and undercut banks. In addition, the presence of mowed lawn within the floodplain negatively impacts the scores of other elements including riparian vegetation quantity and quality. The highest scores from the assessment included two consecutive reaches downstream of Highway 96 (scores of 9.0) and four consecutive reaches in the Brown's Creek gorge (scores of 9.1). Both areas are located in high quality riparian corridors with diverse native vegetation and very good instream habitat. These sites have stable stream banks, a functional and connected floodplain, and diverse instream habitats with exposed substrates that support a variety of macroinvertebrates. Reaches that scored "Fair" included the creek section recently proposed for stream restoration between McKusick Road and the Brown's Creek State Trail. These reaches contained an incised channel, a disconnected floodplain, eroding banks, and poor riparian vegetation dominated by invasive species including common buckthorn, honeysuckle, and Amur maple. See Appendix B for scores of all 28 reaches assessed.

Geomorphic Surveys

Geomorphic surveys were conducted at the same locations where baseline geomorphic surveys were completed in 2007 and 2008 and extended from Manning Avenue to the St. Croix River (see cross section plots on pages 4-8). Bank erosion rates measured at established creek cross section locations ranged from 0.1 to 0.2 feet/year, with localized bank erosion rates at a few cross sections that were near 0.5 feet/year. In the Brown's Creek gorge, bank erosion rates were very low (less than 0.1 feet/year) due to presence of bedrock and coarse substrates that protect the stream banks. Variables that affect the observed bank erosion rates include bank cover (vegetation, wood, or rock), the degree of channel incision, channel sinuosity, bank soils composition (silt/clay versus peat or sandy loam), and channel slope. Based on the cross sections surveyed between 2007/2008 and 2022, a greater amount of bank erosion has occurred between Millbrook and the Oak Glen golf course, and at a localized reach north of Oak Glen golf course compared to other reaches surveyed. Although

sediment and nutrient loading calculations from these reaches were beyond the scope of this effort, the proposed Brown's Creek Park Restoration project overlaps a significant portion of this eroded section and will reduce sediment and nutrient loads to Brown's Creek. Future stream restoration efforts should focus on the reach upstream of the western McKusick Road crossing and the reach north of Oak Glen golf course upstream of the Stone Arch Bridge.

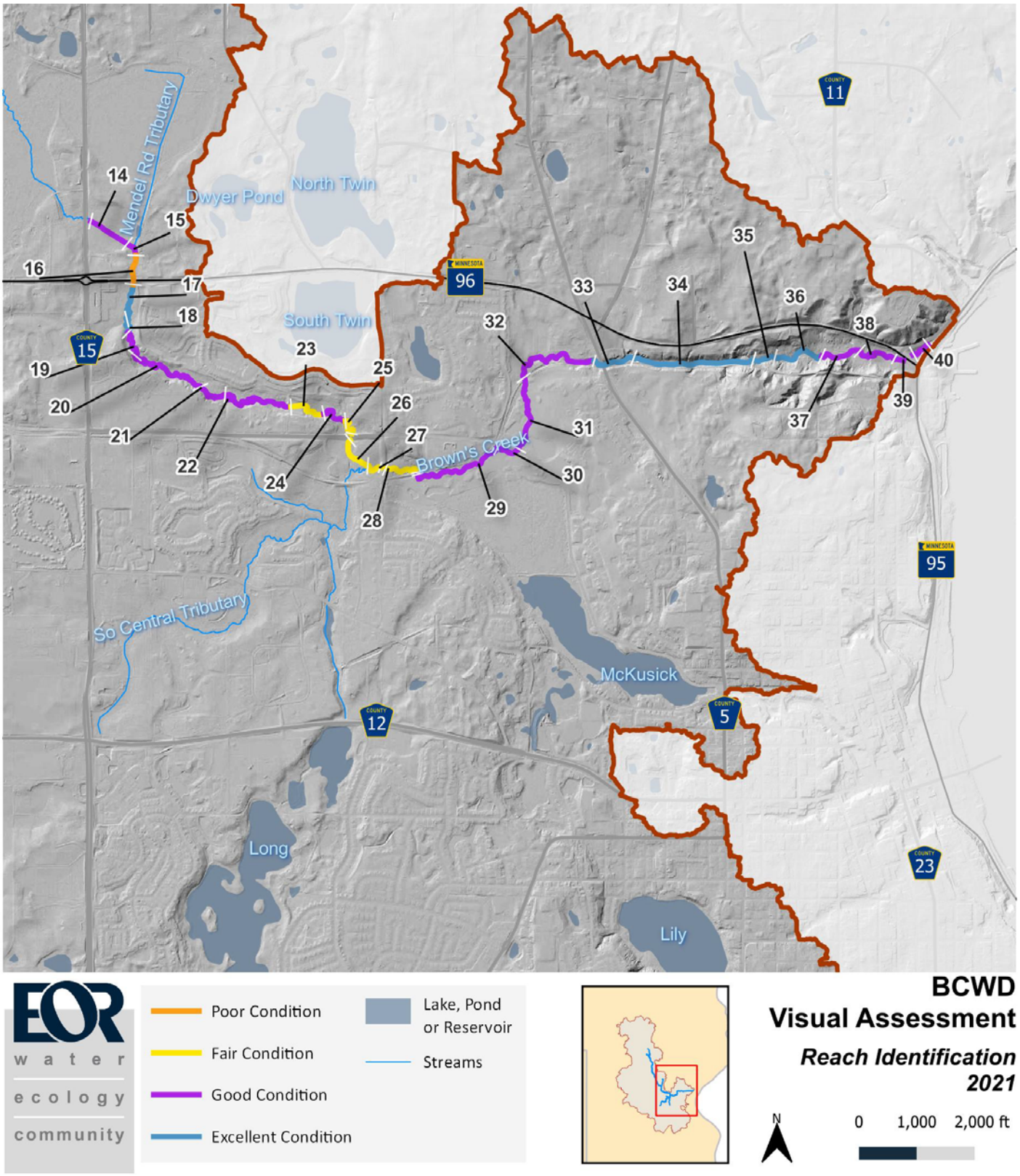
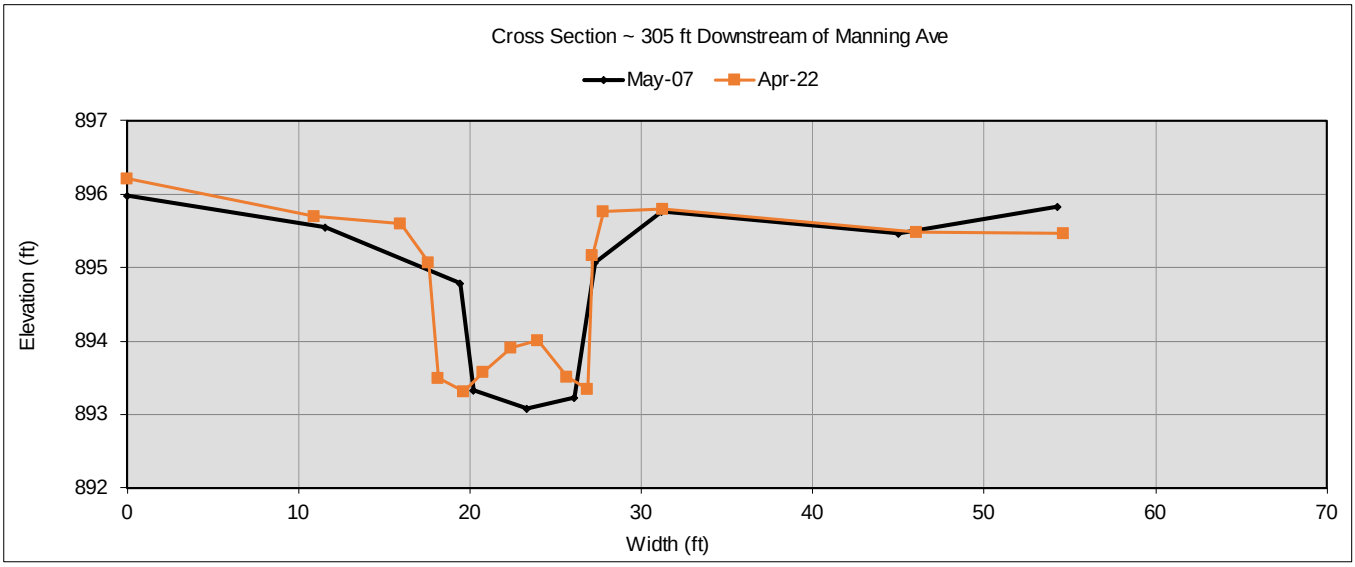
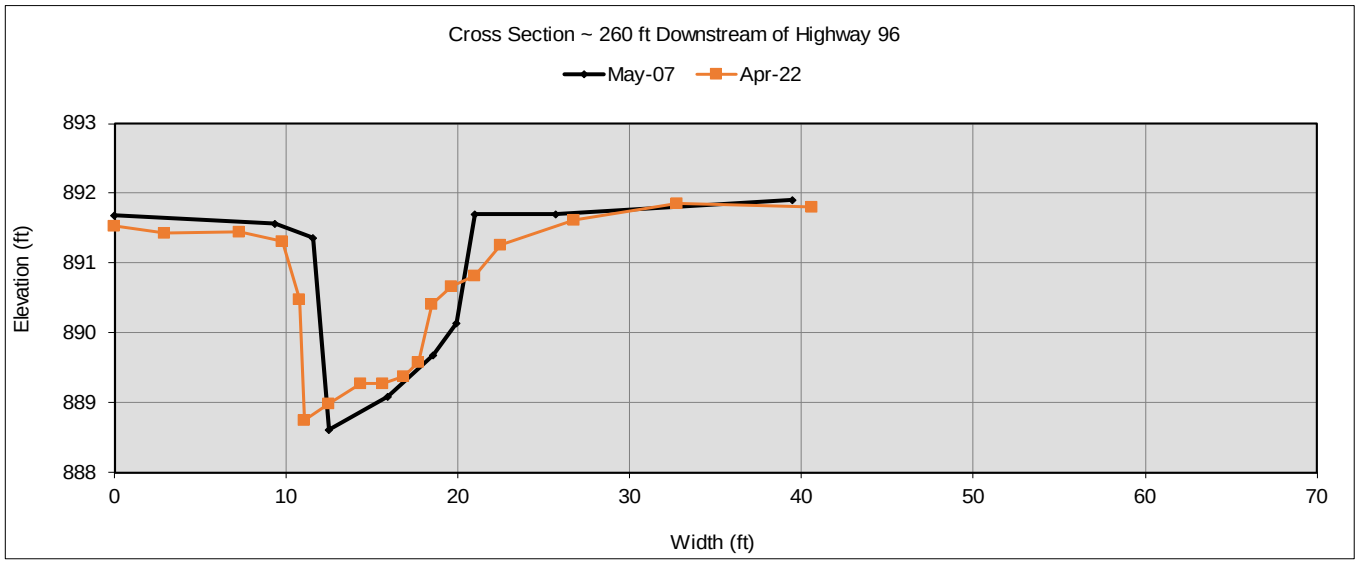
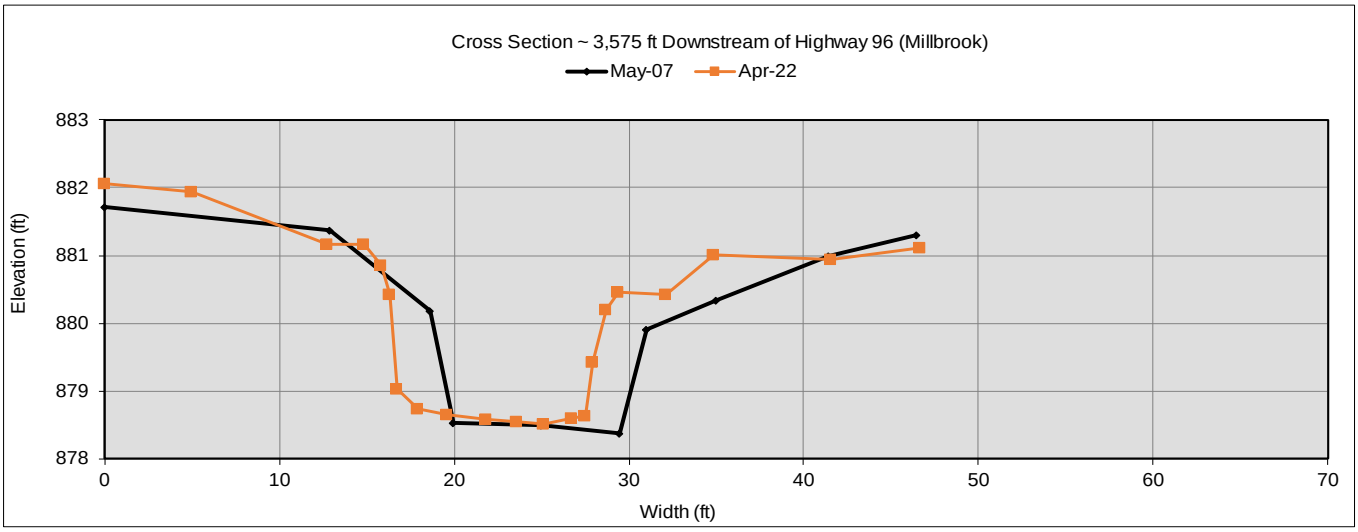


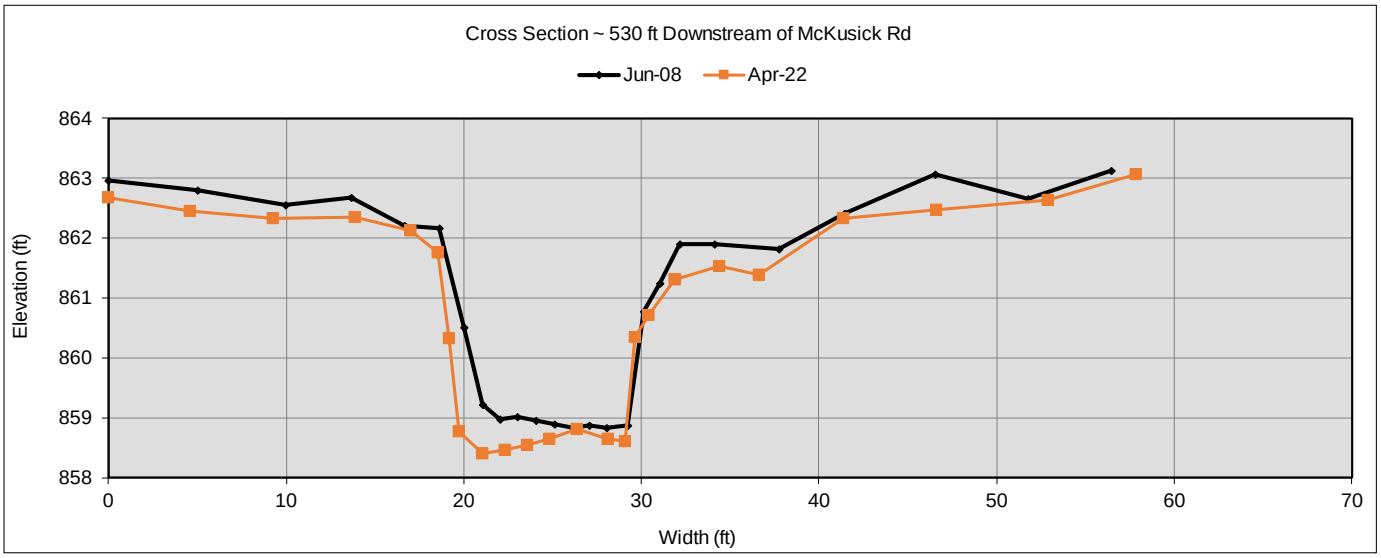
Figure 1. SVAP2 reaches assessed from Manning Avenue to the St. Croix River. Refer to Appendix B for individual reach scores

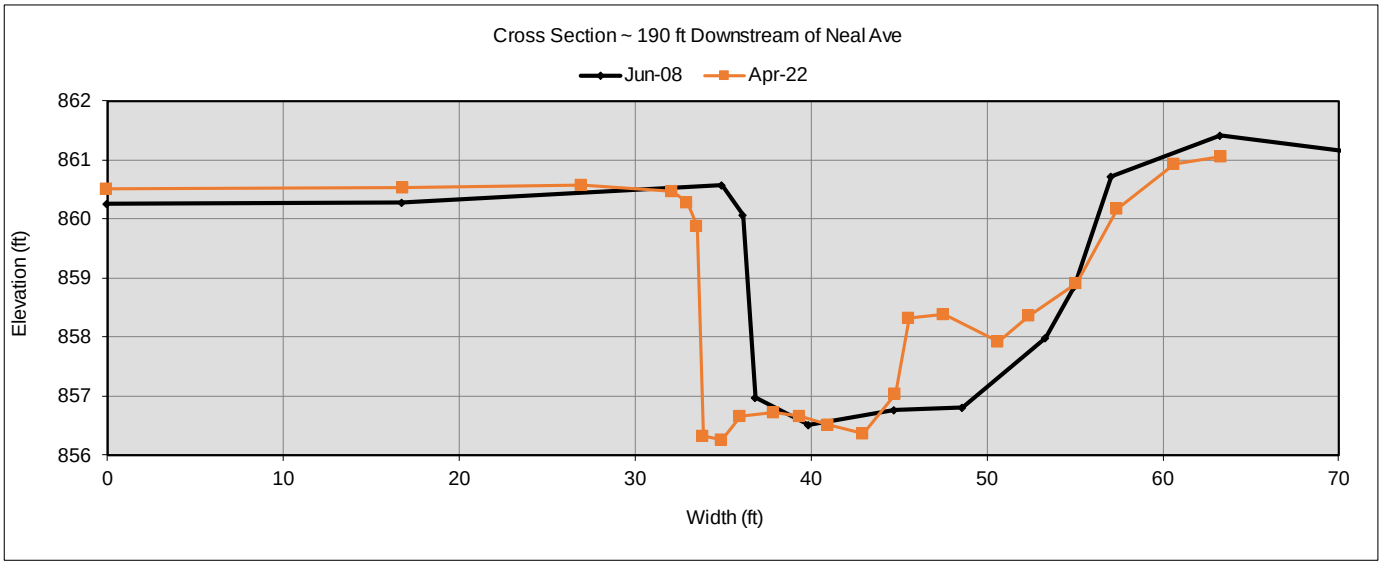

Cross Section ~ 305 ft Downstream of Manning Ave
May-07
Apr-22
Elevation (ft)
897
896
895
894
893
892
0
10
20
30
40
50
60
70
Width (ft)

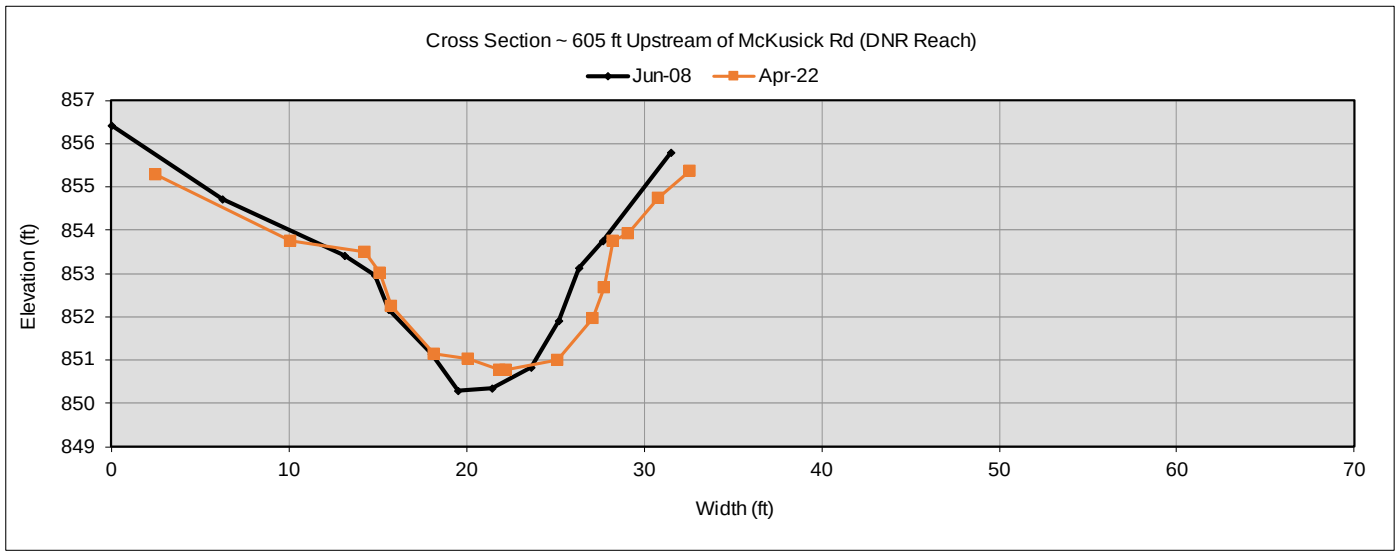

Cross Section ~ 260 ft Downstream of Highway 96
May-07
Apr-22
Elevation (ft)
893
892
891
890
889
888
0
10
20
30
40
50
60
70
Width (ft)

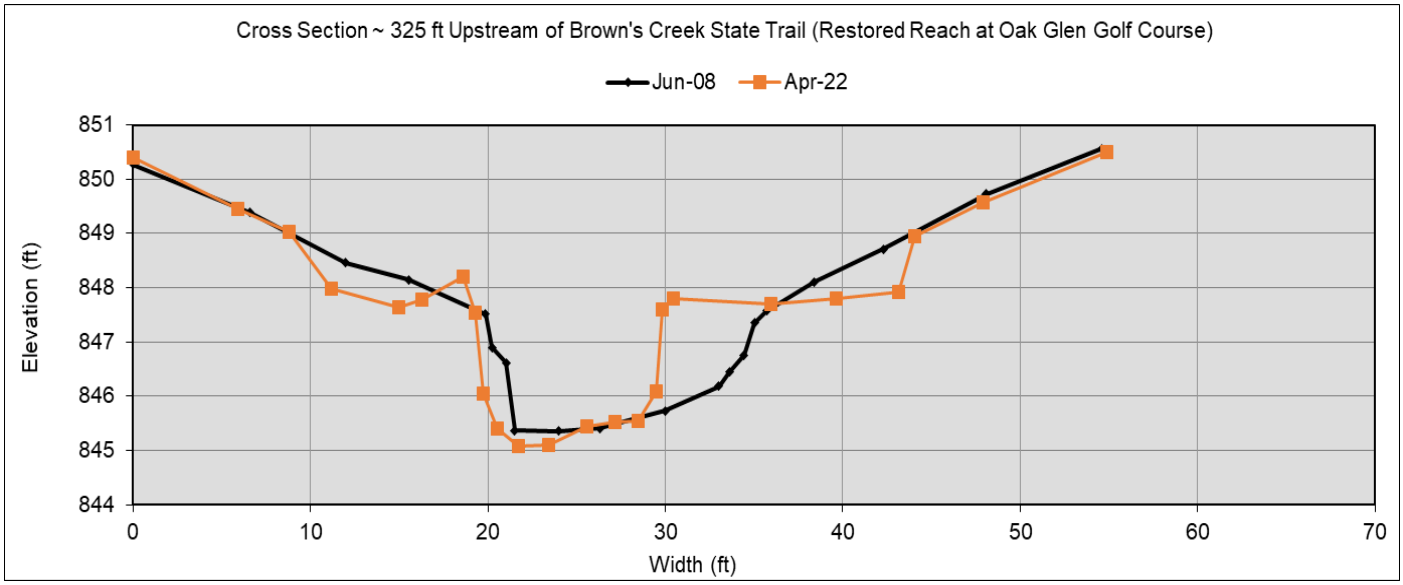

Cross Section ~ 3,575 ft Downstream of Highway 96 (Millbrook)
May-07
Apr-22
Elevation (ft)
883
882
881
880
879
878
0
10
20
30
40
50
60
70
Width (ft)

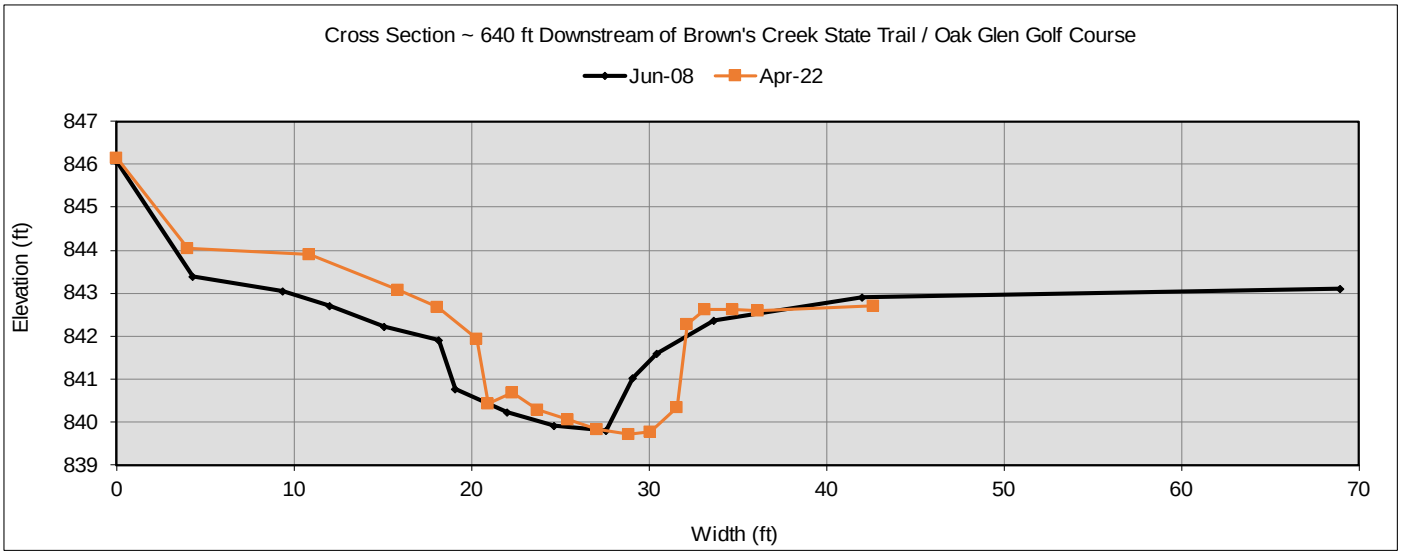

Cross Section ~ 630 ft Upstream of McKusick Rd
May-07
Apr-22
Elevation (ft)
869
868
867
866
865
864
0
10
20
30
40
50
60
70
Width (ft)

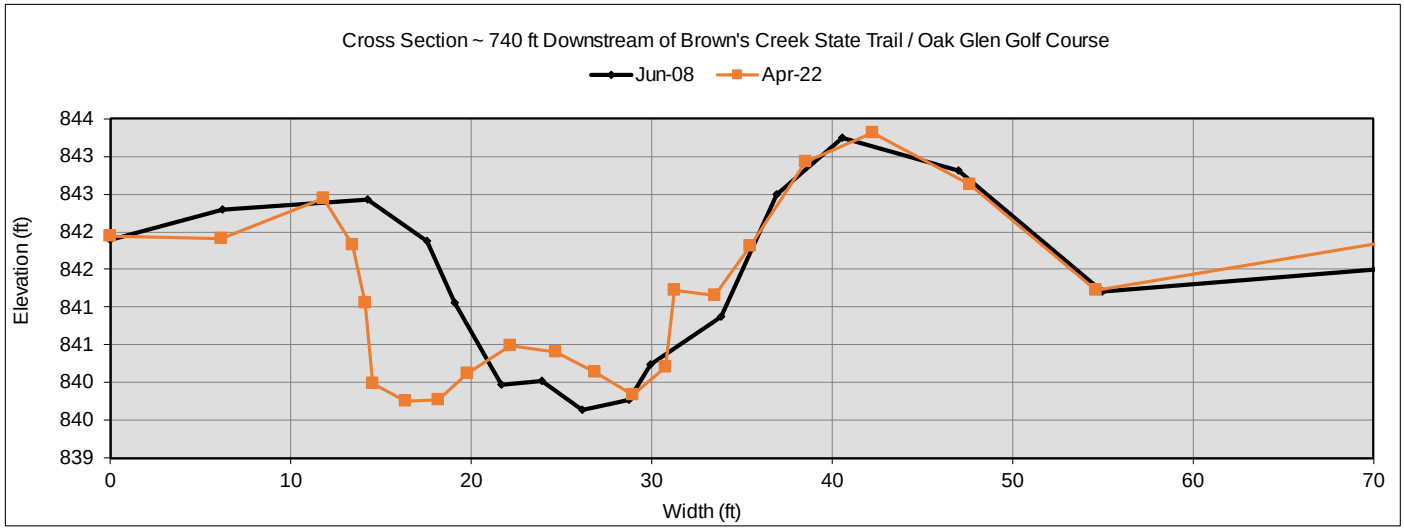

Cross Section ~ 530 ft Downstream of McKusick Rd
Jun-08
Apr-22
Elevation (ft)
864
863
862
861
860
859
858
0
10
20
30
40
50
60
70
Width (ft)

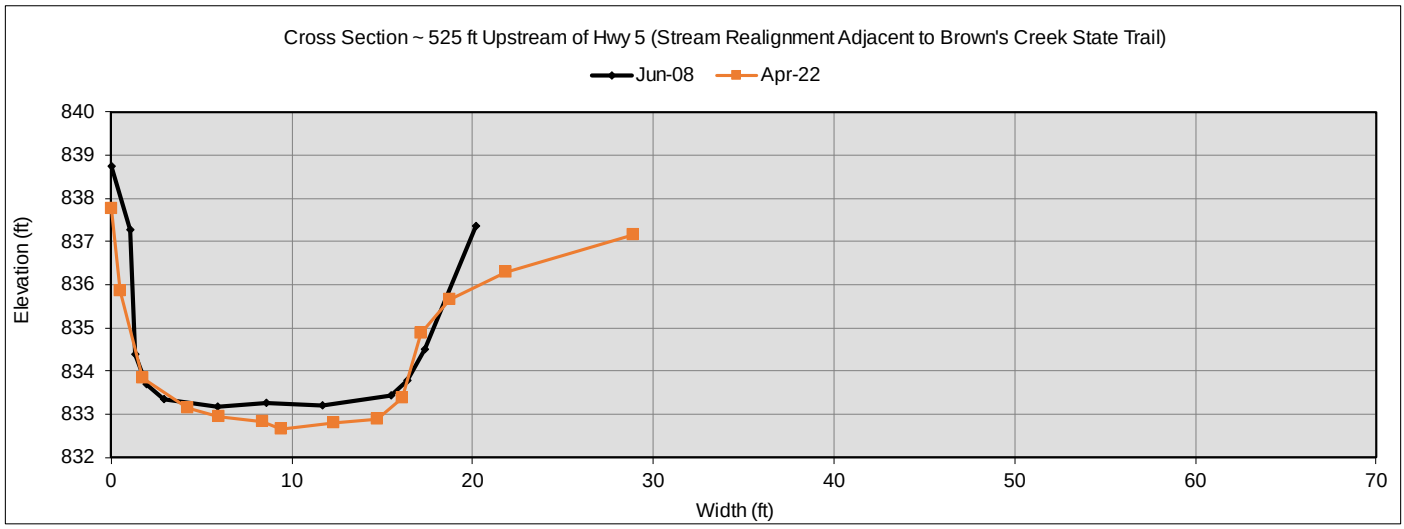

Cross Section ~ 190 ft Downstream of Neal Ave
Jun-08
Apr-22
Elevation (ft)
862
861
860
859
858
857
856
0
10
20
30
40
50
60
70
Width (ft)

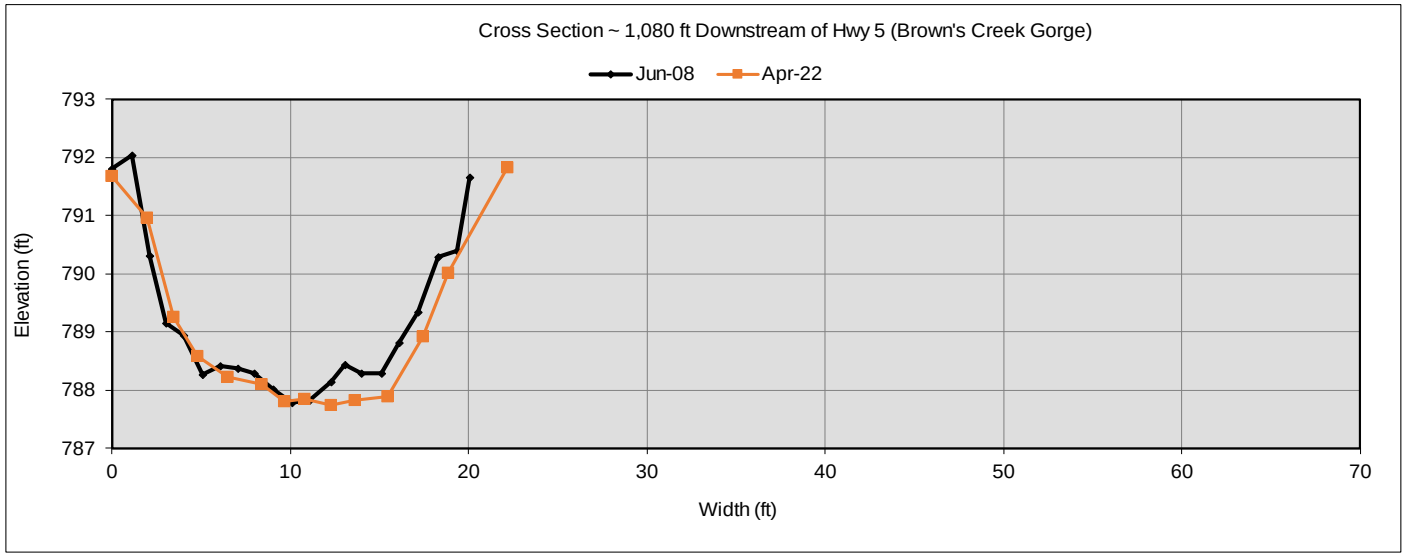

Cross Section ~ 605 ft Upstream of McKusick Rd (DNR Reach)
Jun-08
Apr-22
Elevation (ft)
857
856
855
854
853
852
851
850
849
0
10
20
30
40
50
60
70
Width (ft)

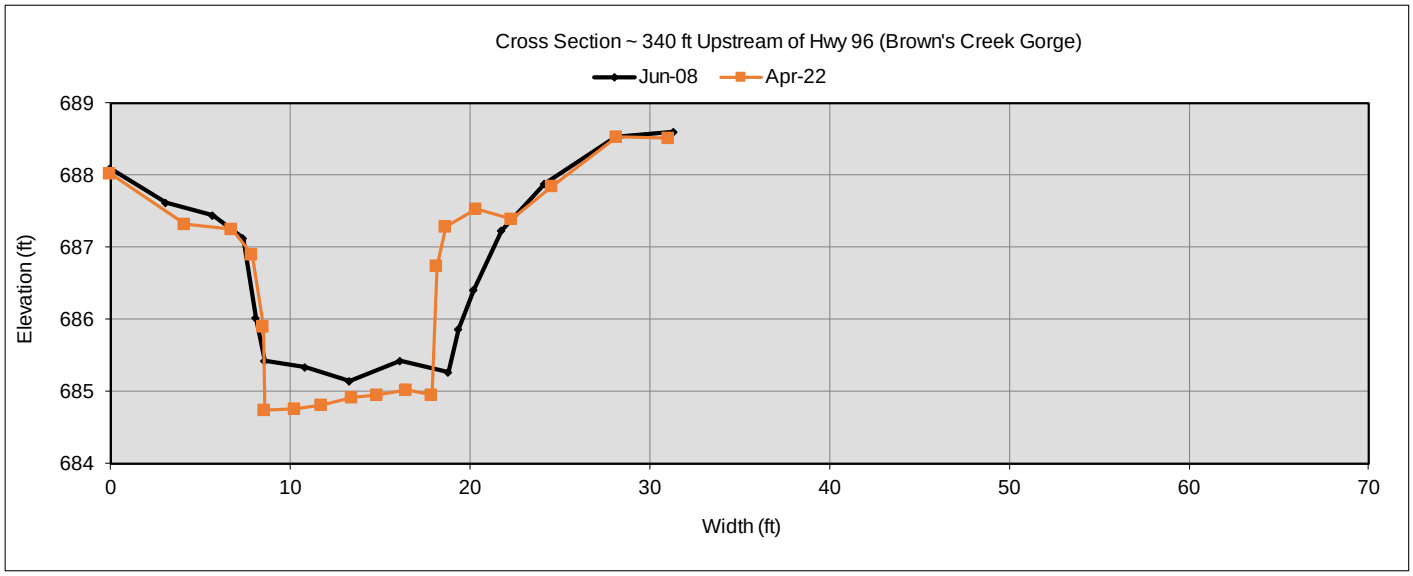

Cross Section ~ 325 ft Upstream of Brown's Creek State Trail (Restored Reach at Oak Glen Golf Course)
Jun-08
Apr-22
Elevation (ft)
851
850
849
848
847
846
845
844
0
10
20
30
40
50
60
70
Width (ft)


Cross Section ~ 640 ft Downstream of Brown's Creek State Trail / Oak Glen Golf Course
Jun-08
Apr-22
Elevation (ft)
847
846
845
844
843
842
841
840
839
0
10
20
30
40
50
60
70
Width (ft)


Cross Section ~ 740 ft Downstream of Brown's Creek State Trail / Oak Glen Golf Course
Jun-08
Apr-22
Elevation (ft)
844
843
843
842
842
841
841
840
840
839
0
10
20
30
40
50
60
70
Width (ft)


Cross Section ~ 525 ft Upstream of Hwy 5 (Stream Realignment Adjacent to Brown's Creek State Trail)
Jun-08
Apr-22
Elevation (ft)
840
839
838
837
836
835
834
833
832
0
10
20
30
40
50
60
70
Width (ft)


Cross Section ~ 1,080 ft Downstream of Hwy 5 (Brown's Creek Gorge)
Jun-08
Apr-22
Elevation (ft)
793
792
791
790
789
788
787
0
10
20
30
40
50
60
70
Width (ft)


Cross Section ~ 340 ft Upstream of Hwy 96 (Brown's Creek Gorge)
Jun-08
Apr-22
Elevation (ft)
689
688
687
686
685
684
0
10
20
30
40
50
60
70
Width (ft)

Appendix A

Select Images from the Drone Flight Upstream of Manning Avenue

Image of the headwaters of Brown's Creek and the beginning of perennial flow

Small wood bridge over Brown's Creek in the headwaters reach north of 110th St

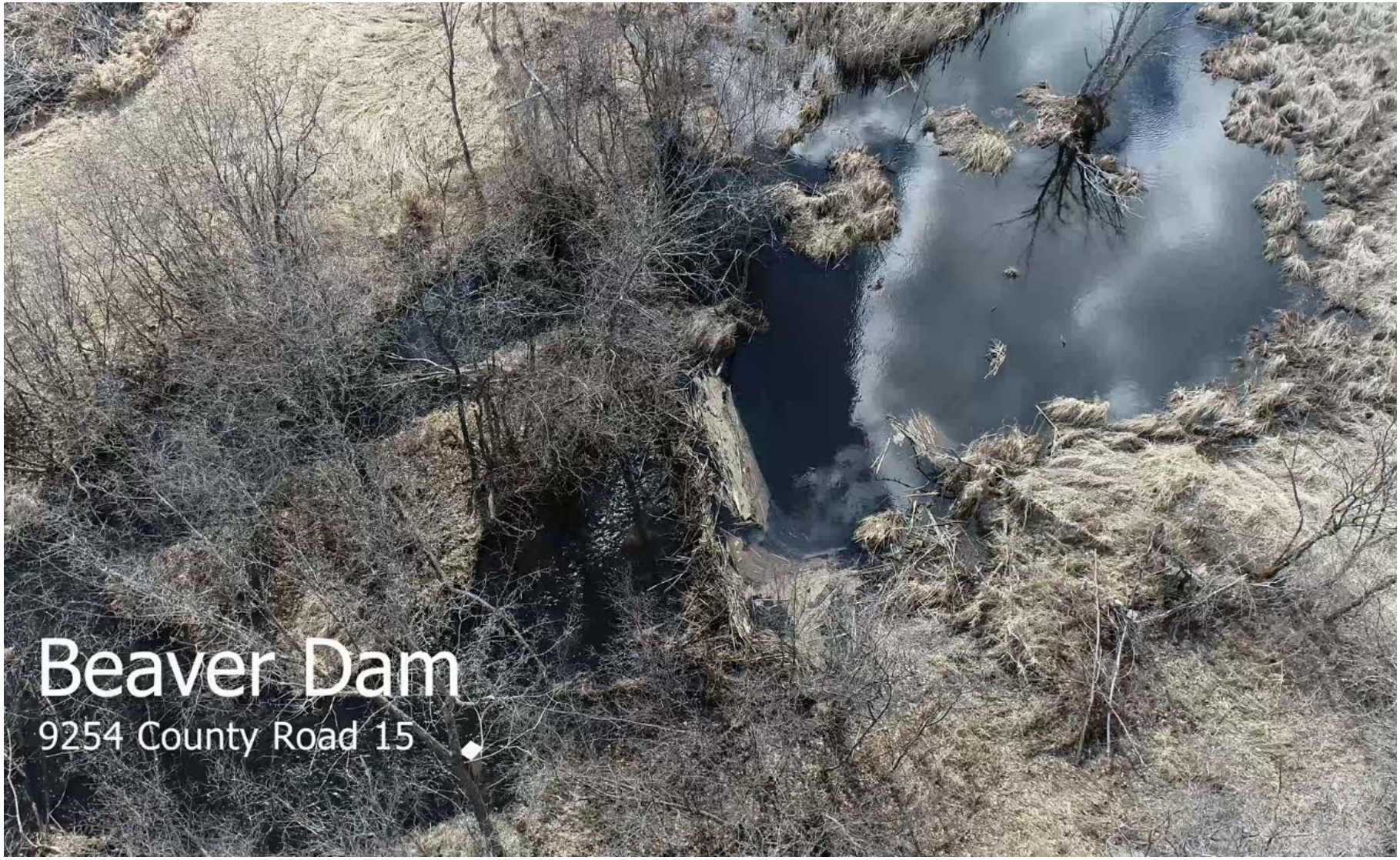
Driveway crossing and small foot bridge over Brown's Creek just upstream of 110th St

Twin culverts under a trail crossing downstream of 110th St

Location of previous large beaver dam (yellow line) that spanned the entire floodplain downstream of the Gateway Trail

Wood bridge and small beaver dam (yellow oval) near private parcel west of 97th St. N / downstream of the Gateway Trail

New bridge crossing (yellow circle) over a small tributary southwest of 97th Street N



Beaver dam located upstream of Manning Avenue

Appendix B

SVAP2 Element Descriptions and Individual Reach Scores from Brown's Creek

Channel Condition

Channel condition is a description of the geomorphic stage of the channel as it adjusts its shape relative to its floodplain. Channel adjustments that result in a dramatic drop in streambed elevation (incision) or excessive deposition of sediment that raises the bed elevation (aggradation) affect the degree of bank shear and often decrease stream channel stability.

Hydrologic alteration

Hydrologic alteration is the degree to which hydrology and streamflow conditions differ from natural, unregulated flow patterns. Streamflow regime affects the distribution and abundance of stream species and influences the health of streams through physical and chemical processes.

Bank Condition

Stable streambanks are essential components of functional physical habitat and biological communities. Accelerated bank erosion can cause excess fine sediment to build up in a stream which can impact certain aquatic species and often results in water quality impacts within the system and downstream resources.

Riparian Quantity

The riparian area is the vegetated zone adjacent to a stream that functions as a transitional area between the stream and the adjacent upland. Riparian vegetation thrives on the moisture provided by streamflow and ground water associated with the stream corridor. Riparian areas may or may not include floodplains and associated wetlands, depending on the valley form of the stream corridor.

Riparian Quality

The composition of vegetation within the riparian corridor includes both the herbaceous layer and the canopy layer, and the degree of invasive species present can impact the composition and distribution of native species present along the stream. Riparian corridors with significant massings of invasives species typically result in low diversity of the herbaceous layer and may result in exposed soils due to dense shade.

Canopy Cover

In forested riparian areas, shading of the stream is important because it helps maintain cool water temperatures and limits algal growth. Cool water can hold more dissolved oxygen than warm water. When streamside vegetation is removed, the stream is exposed to the warming effects of the sun, causing the water temperature to increase and dissolved oxygen to decrease for longer periods during the daylight hours and for more days during the year.

Water Appearance

The water appearance assessment element compares turbidity, color, and other visual characteristics of water with those from a reference reach. The assessment of turbidity is the depth to which an object can be clearly seen, typically measured with a turbidity-tube or water quality sonde.

Barriers to Aquatic Species Movement

Passage barriers may prevent the movement or migration of fish, limit access to spawning or foraging habitats, and isolate populations of fish and other aquatic animals. Natural physical barriers include waterfalls, cascades, large rapids, and beaver dams. Fabricated physical barriers include dams, sills, culverts, weirs, and other structures.

Riffle Embeddedness

Riffles are critical for maintaining high species diversity and abundance of macroinvertebrates and provide spawning and foraging opportunities for fish. Embeddedness measures the degree in which gravel and cobble substrates are covered (or embedded) by fine sediment. Embeddedness relates directly to the availability and suitability of stream substrates as habitat for macroinvertebrates, fish, and other aquatic organisms.

Fish Habitat Complexity

The dynamic features of stream corridors create diverse habitat types and conditions for fish and invertebrates. Quality fish habitat contains a variety of different habitat types created by various combinations of water quality and quantity, water depth, velocity, channel substrates (sand, gravel, cobble, wood), and aquatic & riparian vegetation. The greater the variety of habitat features, the more likely a stream can support a diversity of aquatic species.

Pools

Streams with a mix of shallow and deep pools offer diverse habitats for a variety of aquatic species. In general, a deep pool has a water depth that is 2 times the maximum depth of its upstream riffle while a shallow pool has a water depth that is less than 2 times the maximum depth of its upstream riffle.

Reach ID	Total Element Score	Reach Score	Channel Condition	Hydro Alteration	Bank Condition		Riparian Quantity		Riparian Quality		Canopy Cover	Water Appearance	Fish Barriers	Riffle Embeddedness	Fish Habitat Complexity	Pools
					Righ bank	Left Bank	Righ bank	Left Bank	Righ bank	Left Bank						
14	109	**8.3**	10	10	10	10	10	10	6	6	1	9	10	5	5	7
15	104	**7.4**	9	10	7	7	9	9	5	5	10	9	10	5	5	4
16	68	**4.9**	8	10	1	1	2	2	1	1	7	9	10	5	4	7
17	118	**9.0**	9	10	10	10	10	10	8	8	1	9	10	7	6	10
18	118	**9.0**	9	10	10	10	10	10	8	8	1	9	10	7	6	10
19	111	**8.5**	8	10	9	9	10	10	8	8	1	9	10	6	5	8
20	105	**7.9**	7	10	8	8	10	10	7	7	2	9	10	5	6	6
21	102	**7.3**	7	10	6	6	10	10	5	5	9	9	10	2	6	7
22	101	**7.2**	7	10	6	6	10	10	5	5	8	9	10	2	6	7
23	97	**6.9**	6	10	5	5	10	10	5	5	7	9	10	2	6	7
24	118	**8.4**	9	10	8	8	9	9	6	6	10	9	10	8	6	10
25A	120	**8.6**	10	10	9	9	10	10	6	6	10	9	10	8	6	7
25B	94	**6.7**	5	8	5	5	10	10	4	4	10	9	10	2	6	6
26	90	**6.4**	4	6	6	6	10	10	5	5	6	9	10	2	6	5
27	92	**6.6**	5	5	6	8	9	9	3	3	9	9	10	5	6	5
28	90	**6.4**	5	5	6	7	8	8	3	3	10	9	10	5	6	5
29	124	**8.9**	9	10	9	9	8	8	8	8	10	9	10	8	8	10
30	124	**8.9**	9	10	9	9	8	8	8	8	10	9	10	8	8	10
31	112	**8.4**	9	10	9	9	7	7	7	7	3	9	10	7	8	10
32	116	**8.3**	9	10	9	9	7	7	7	7	7	9	10	7	8	10
33	127	**9.1**	9	10	9	9	10	10	7	7	10	9	10	9	8	10
34	127	**9.1**	9	10	8	8	10	10	8	8	10	9	10	9	8	10
35	127	**9.1**	9	10	8	8	10	10	8	8	10	9	10	9	8	10
36	127	**9.1**	9	10	8	8	10	10	8	8	10	9	10	9	8	10
37	123	**8.8**	9	10	6	6	10	10	8	8	10	9	10	9	8	10
38	113	**8.1**	6	10	6	6	10	10	8	8	9	9	10	6	7	8
39	118	**8.4**	9	10	9	9	10	10	6	6	6	9	10	6	8	10
40	115	**8.2**	9	10	9	9	10	10	6	6	5	9	10	5	7	10

Reach Score Grading System
1 - 2.9 Severely Degraded
3 - 4.9 Poor
5 - 6.9 Fair
7 - 8.9 Good
9 - 10 Excellent

SVAP2 scores of 28 reaches along Brown's Creek from Manning Avenue and the St. Croix River, listed upstream to downstream. Refer to Figure 1 for a map of the reaches

Project Name |	Trout Habitat Preservation Project (THPP)	**Date** |	5/03/2023
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, District Administrator		
From / Contact info |	Derek R. Lash, PE, CPESC		
Regarding |	THPP Trench Inspection Results		

Background

At the February 9, 2022, Board Meeting, EOR presented the Board with a technical memorandum summarizing the performance of the Trout Habitat Preservation Project (THPP) through 2021. The main finding of that memorandum is that the THPP is experiencing decreased performance and needs a retrofit. In response to the finding, the BCWD Board of Managers requested that EOR submit a scope of services to conduct a feasibility study to evaluate retrofit options for the project.

At the June 8, 2022, Board Meeting Derek Lash and Camilla Correll presented a scope and fee estimate summarizing work for a THPP Retrofit Feasibility Study. The Board of Managers asked whether lower-cost options – such as asking a neighboring farmer to scarify the basins to increase infiltration was an option. The managers requested to schedule a site visit with staff and managers to help the managers better understand the issues and options.

On July 27th BCWD managers and staff, as well as EOR staff visited the site.

At the August 10, 2022, Board meeting Derek Lash and Camilla Correll attended the meeting to discuss next steps following the site visit. Derek revisited the engineer's memo reviewing options for improving performance of the stormwater infiltration facilities constructed for the THPP.

The managers discussed the infiltration trench which was added to the THPP in 2007 and its impact on the overall performance of the project. Karen Kill described the overall performance of the system by citing the infiltration rates included in the 2021 THPP Monitoring Report. The managers discussed task 3 specifically, which would provide infiltration rate information on the trench investigation to determine where the system has failed (e.g., at the surface under the gravel filter or at the bottom at the BMP interface with the underlying soils).

Inspection Summary and Results

On October 27, 2022, engineering staff from EOR visited the THPP site to perform an inspection of the infiltration trench. Staff included Derek Lash, Ellen Kimlinger, Brian Rucker, and Jay Michels. The tasks included a visual inspection of the trench surface and assessment of the infiltration performance of the trench. Per the Minnesota Stormwater Manual (Stormwater Manual) visual inspection is a Level 1 Assessment and infiltration performance (Capacity Testing) is a Level 2 Assessment. For this inspection, a standard Level 1 Assessment and a non-standard Level 2 Assessment was performed. A Level 1 Assessment typically takes one day to complete, and a standard Level 2 Assessment can take up to a week for a more rigorous test. For reference, the Stormwater Manual includes four levels of assessment. In the end, the objective is to determine if the stormwater BMP is malfunctioning.

Trench Dimensions

The EOR team measured the horizontal dimensions of the trench surface and the depth to the bottom of the PVC pipe observation well. Based on the visible pea gravel the trench surface measurements were similar (8-feet wide X 20-feet long) to those specified on the THPP Infiltration Trench & Outlet Modification plan set dated October 2006. However, the depth measured approximately seven (7) feet deep compared to the 10-foot depth as specified on the plan set. It is important to acknowledge the plan set includes a note that states "The trench depth may vary depending on soils found. Modified as directed by the Engineer." Therefore, it is presumed the trench was constructed to a depth where suitable soil (sand) was encountered as described in the THPP Infiltration Recovery Technical Memorandum prepared by EOR staff on April 6, 2006. The 2006 memorandum included results from soil borings drilled in the vicinity of the trench which indicated coarse sand between two (2) and 10 feet below the ground surface.

Trench Surface

In addition to recording dimensions of the trench, samples of the pea gravel surface material were collected and submitted to a soil testing laboratory to determine the particle size distribution. Pea gravel is typically considered a 3/8-inch diameter aggregate and is usually washed to remove smaller soil particles such as silt and clay. Samples collected appeared to be relatively clean, which was supported by the laboratory material test report indicating no more than 4.5% of the material passing the No. 200 (P200) or 75-micron (0.0029 inches / 0.07366 millimeters) Sieve Size. In comparison, the Stormwater Manual engineered (bioretention) media mix specification for infiltration or modified filtration practices typically specifies a portion of the mix to include construction sand with a maximum percentage of material passing the No. 200 Sieve Size of 3%.

The filter fabric specified on the plan set was to be a material with a transmissivity of no less than 100 gallons per minute. For infiltration trenches, the Stormwater Manual specifies a Minnesota Department of Transportation (MnDOT) Type I non-woven geotextile (Mirafi 140N, Amoco 4547, Geotex 451, etc.). The filter fabric reviewed in the 2007 photo construction record appears to be a woven monofilament silt fence type material given the narrow strips (3-feet +/-) that were installed versus a roll of fabric that is typically the full width (10-feet) of the trench.

Infiltration Performance

Following the review of the trench geometry and surface materials, the trench was then flooded with water pumped from the adjacent pond. The pond water was visually clean with no sediment or debris observed. The pumped water filled the trench and covered the entire surface in approximately 45 minutes. Once the trench was filled, EOR staff recorded the infiltration rate and observed the water to draw down 32 inches (2.67-feet) below the trench surface in approximately one (1) hour. Given the high rate of infiltration, the recording time to drain the trench was stopped after the first hour. Based on the observed infiltration rate, it is presumed it would take an additional 1.5 to 3 hours to fully drain the trench under the field conditions.

Conclusions and Next Steps

The trench dimensions measured in the field reflect the width, length, and depth as specified in the THPP Infiltration Trench & Outlet Modification plan set dated October 2006. In addition, the surface is covered with approximately 4 inches of pea gravel and filter fabric in accordance with the plans, though it is not known if the filter fabric meets the specification of 100 gallons per minute transmissivity.

The trench surface pea gravel appeared relatively clean, and based on the findings from the laboratory results the amount of silt and clay material is minimal (P200 allowable of 3.0% versus measured of 4.5%).

Lastly, the infiltration performance appears more than adequate to meet industry standards of an infiltration trench. Per the Stormwater Manual the drawdown period for an infiltration practice is typically 48 hours (generally for BMPs with vegetation) which is a performance characteristic a Level 1 Analysis cannot confirm. But, given how quickly the trench drained it is presumed it would meet this standard under dry conditions. The caveat being, the inspection was performed on a dry trench with no water in the adjacent pond, which may impact the trench performance if standing water or ground water impedes flow from the trench.

In conclusion, the results of inspecting the THPPP trench suggest it has sufficient capacity to continue to function as designed. However, it is still unknown why the infiltration rate for the infiltration basin has depreciated as observed in the 2021 monitoring. We recommend testing the lower elevations of the infiltration basin following the protocols of a Level 2 Assessment that is used to determine infiltration capacity or rates. The cost to perform that work can be found in the following table and will take approximately 2 days to complete the field testing and 1 to 2 days to prepare a summary of the testing. This work will primarily be performed by a geotechnical testing firm using a Double Ring Infiltrometer or similar device.

Additional Testing Scope

The following table outlines the cost and hours anticipated for testing the infiltration basin.

Task	Description	Hours	Cost
1. EOR Project Management & Coordination	Coordinate the testing work with a geotechnical subconsultant to conduct infiltration testing. Prepare a summary of results.	10 to 15	$2,100.00
2. Geotechnical Subcontractor Infiltration Testing	Conduct up to four double-ring infiltrometer or similar tests on the large infiltration basin. Perform side by side tests on the existing vegetation and sediment, as well as on an area void of vegetation or sediment.	20 to 30	$4,400.00
	Total	**30 to 45**	**$6,500.00**

If approved, this work would be conducted in the summer once the basin has dried.

Requested Action

Authorize the engineer to coordinate and manage infiltration testing for not to exceed $2,100 and subcontract for geotechnical investigation for not to exceed $4,400.

memo

Project Name |	BCWD Permit Program	**Date** |	May 3, 2023
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, District Administrator		
From / Contact info |	Paul Nation, John Sarafolean / EOR		
Regarding |	May Permit Inspection Update		

Background

BCWD has an on-going permit review process in support of the District Rules. Developments within the District Jurisdictional Boundary are reviewed for compliance with the Rules and conditions of the permit. This memo documents inspections from 3/28/2023 through 5/3/2023.

Inspection of Existing Permits

Project Name	Permit ID	Date	Grade
White Oaks Savanna	17-01	3/28/2023	B
		4/5/2023	B
		4/21/2023	B
Heifort Estate	18-02	4/5/2023	C
		4/21/2023	**D**
White Pine Ridge	20-12	4/5/2023	C
		4/21/2023	B
Westridge Block 1 Lot 1	21-09	4/5/2023	C
		4/21/2023	C
Bond Residence	21-22	4/5/2023	B
		4/21/2023	B
White Oaks Savanna Lot 104	21-35	3/28/2023	C
		4/5/2023	C
		4/21/2023	C
Valdres Residence (WOS Lot 110)	21-36	3/28/2023	C
		4/5/2023	B
		4/21/2023	B
Gonyea Homes at White Pine Ridge	22-02	4/5/2023	C
		4/21/2023	B
GreenHalo Builds at Westridge	22-03	4/5/2023	C
		4/21/2023	C
GreenHalo Builds at Boutwell Farm	22-08	4/5/2023	C

		4/21/2023	C
Wiechmann Residence (WOS Lot 106)	22-11	3/28/2023	**D**
		4/5/2023	**D**
		4/21/2023	**D**
		4/28/2023	**D**
		5/2/2023	**D**
7171 Mid Oaks Ave Pool	22-12	4/5/2023	B
Cahill Residence (Heritage Ridge Lot 5/6)	22-14	4/5/2023	B
		4/21/2023	B
Read Residence	22-17	4/5/2023	B
Kreller Residence	22-21	3/28/2023	B
Ferguson Residence (Heritage Ridge Lot 4)	22-23	4/5/2023	B
		4/21/2023	B
Benjamin-Mohammed Residence (WOS Lot 109)	22-24	3/28/2023	C
		4/5/2023	C
		4/21/2023	C
3823 Tending Green	22-26	3/28/2023	B
GreenHalo Builds at Boutwell Farm – Lot 1	23-03	4/5/2023	**D**
		4/21/2023	**D**
		4/28/2023	**D**
		5/2/2023	**D**

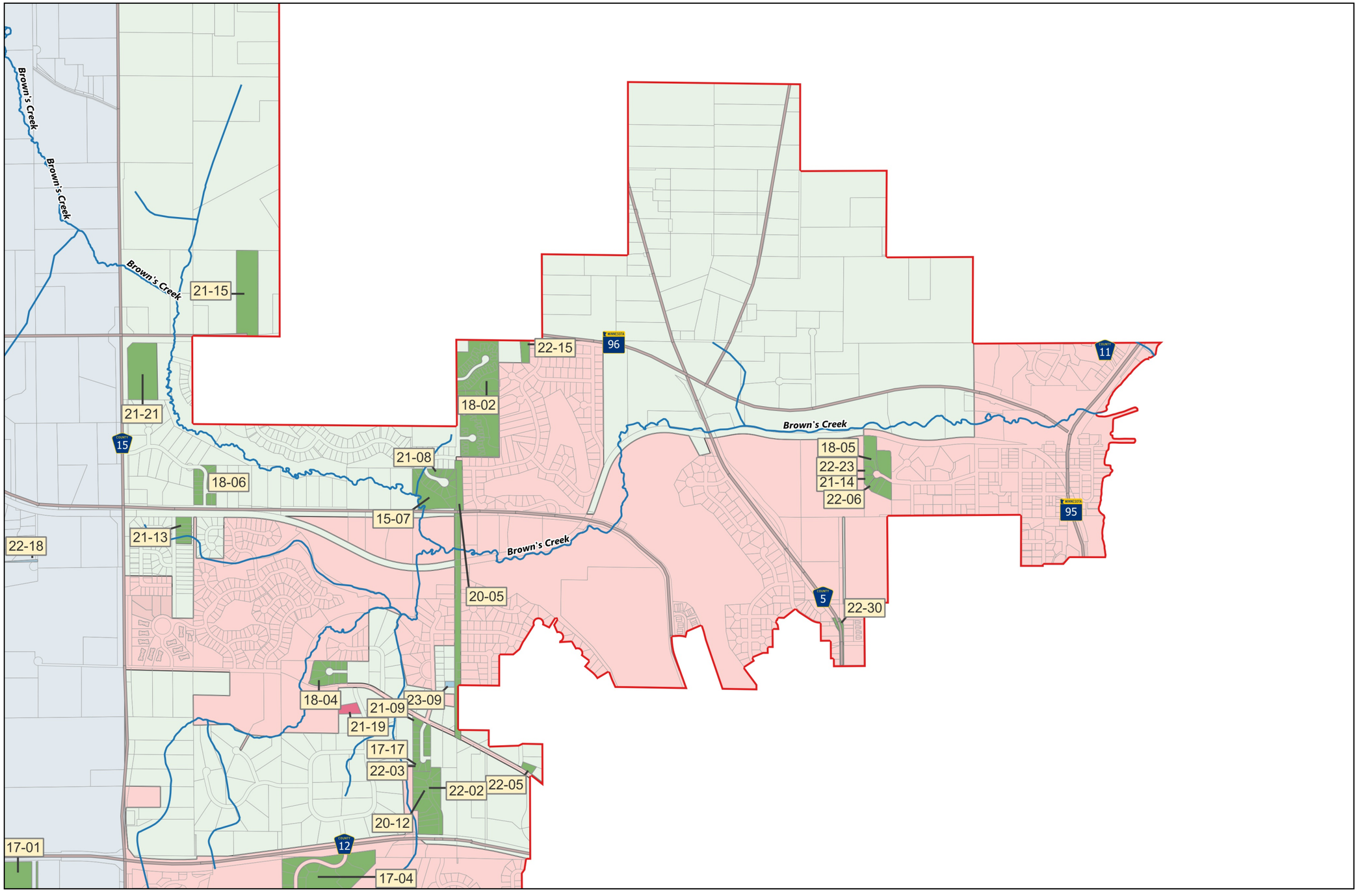
Explanation of Grades:

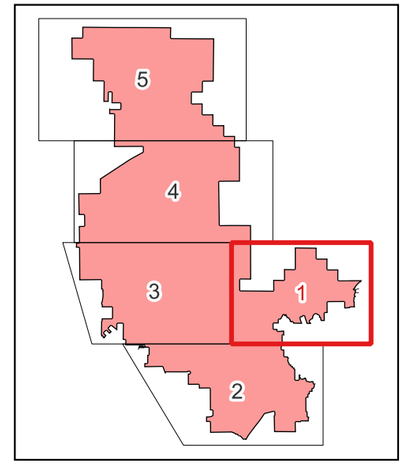
Permit 18-02, Heifort Estate: Inspection grades for this site are due to poor upkeep of erosion prevention and sediment control measures. Specifically, a soil pile has been left in a swale draining to Heifort Pond and has deposited sediment within the buffer to the pond. Ongoing issues related to restoration of the buffer following an NOPV in August 2020 also contributed to the poor grades. BCWD inspectors will be meeting with the BCWD administrator to determine next steps which could include an NOPV and enforcement hearing at the June board meeting.

Permit 22-11, Wiechmann Residence: Inspection grades for this site are due to lack of stabilization of bare soils, including a large sediment stockpile, which has resulted in failure of perimeter silt fencing and deposition of sediment within the buffer to an on-site wetland. An NOPV was issued on 4/24/2023. Since then, the silt fence has been repaired, a portion of the sediment stockpile has been hauled offsite, the site has been regraded, and sediment has been removed from the infiltration basin forebay. An enforcement hearing has been scheduled for the May board meeting if remaining action items from the NOPV are not addressed.

Permit 23-03, Boutwell Farm Lot 1: Inspection grades for this site are due to a soil stockpile placed into a constructed infiltration basin. An NOPV was issued on 4/13/2023. Since then, the stockpile has been removed, but no other action has been taken to restore the infiltration basin. An enforcement hearing has been scheduled for the May board meeting.

Permit No.	Applicant/Permit Name	Status
15-07	Brown's Creek Cove	Active
16-03	The Ponds at Heifort Hills	Active
17-01	White Oaks Savanna	Active
17-04	The Lakes of Stillwater	Active
17-17	Westridge	Active
18-02	Heifort Hills Estates	Active
18-04	Boutwell Farm	Active
18-05	Heritage Ridge	Active
18-06	Nottingham Village	Active
20-05	Neal Avenue Reconstruction	Active
20-12	White Pine Ridge	Active
21-07	Brown's Creek Cove Lot 11	Active
21-08	Brown's Creek Cove Lot 14	Active
21-09	Westridge B1L1	Active
21-13	Marylane Gateway	Active
21-14	Heritage Ridge (lot 3)	Active
21-15	Schwartz Residence	Active
21-21	Millbrook West Park	Active
22-02	White Pine Ridge, remaining lots	Active
22-03	Westridge, remaining lots	Active
22-05	13290 Boutwell Rd N	Active
22-06	Heritage Ridge Lot 2	Active
22-08	Boutwell Farm, remaining lots	Active
22-14	Cahill Residence (Heritage Ridge Lots 5/6)	Active
22-15	13199 Dellwood Rd	Active
22-18	Stillwater Oaks	Review
22-23	Ferguson Residence (Heritage Ridge Lot 4)	Active
22-30	CSAH 5 Phase 2	Active
23-09	Kirn Residence	Review





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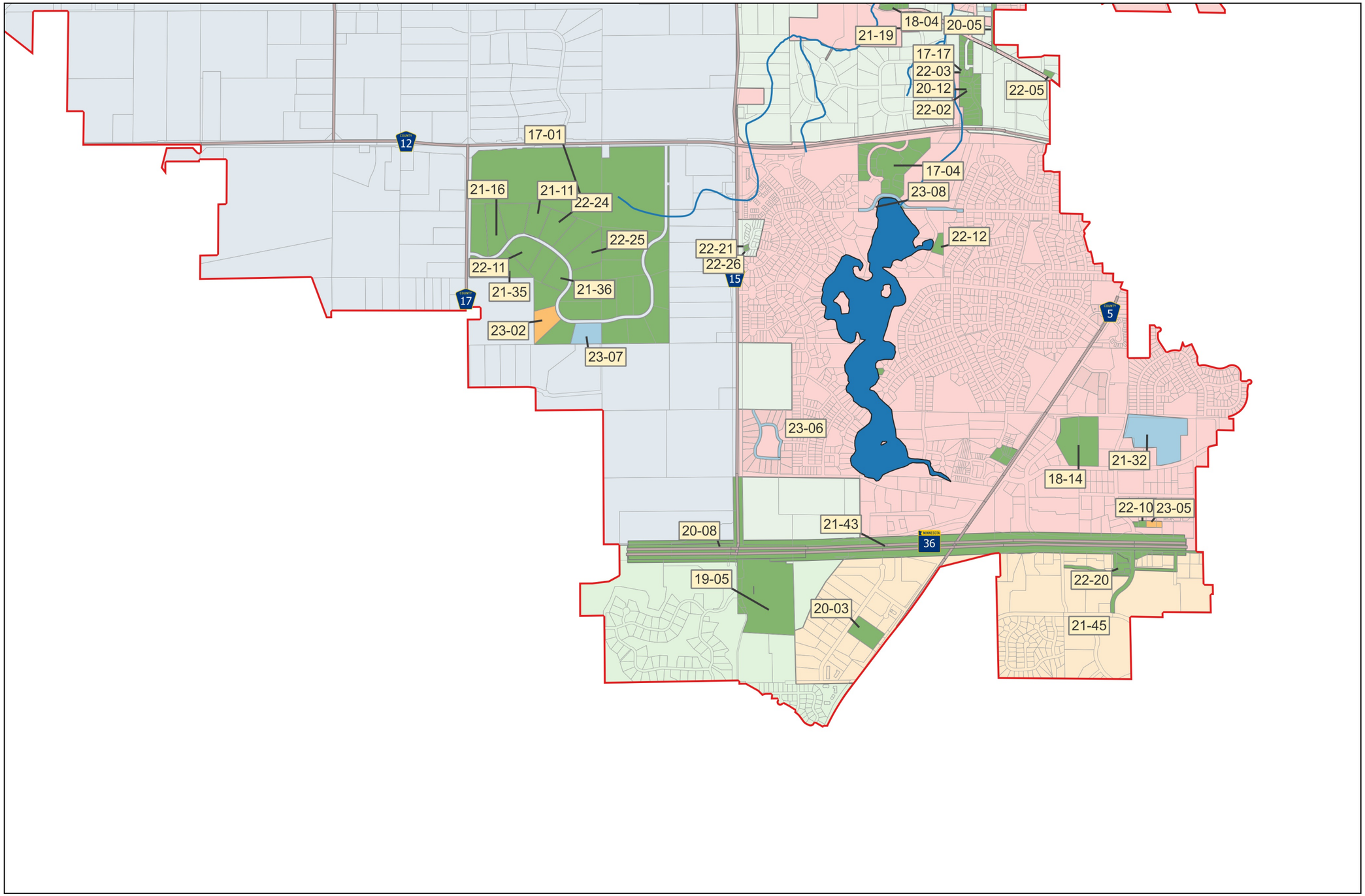
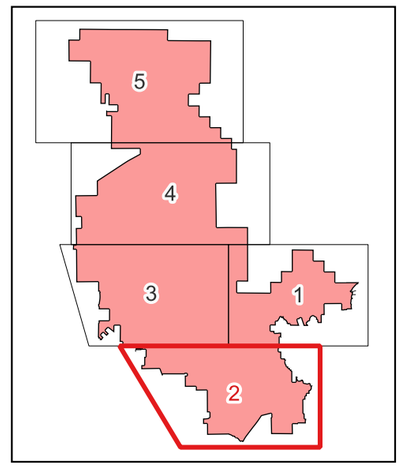


Permit No.	Applicant/Permit Name	Status
17-01	White Oaks Savanna	Active
17-04	The Lakes of Stillwater	Active
17-14	Parkwood Townhomes	Active
17-17	Westridge	Active
18-04	Boutwell Farm	Active
18-11	Ridgecrest	Active
18-14	St. Croix Valley Recreation Center Expansion	Active
19-05	Central Commons	Active
20-03	Twin Cities Orthopedics	Active
20-05	Neal Avenue Reconstruction	Active
20-08	TH36 CSAH 15 Interchange	Active
20-12	White Pine Ridge	Active
21-09	Westridge B1L1	Active
21-11	Hegarty Residence (WOS Lot 107)	Active
21-16	Ignagni Residence - WOS B1L2	Active
21-24	Nepal Residence - WOS B1L3	Active
21-32	Lakeview EMS	Review
21-35	WOS Lot 104	Active
21-36	Valdres Residence (WOS Lot 110)	Active
21-43	MnDOT TH-36	Active
21-45	Norell Avenue Improvements	Active
22-02	White Pine Ridge, remaining lots	Active
22-03	Westridge, remaining lots	Active
22-05	13290 Boutwell Rd N	Active
22-08	Boutwell Farm, remaining lots	Active
22-10	Caribou	Active
22-11	Wiechmann Residence	Active
22-12	7171 Mid Oaks Ave Pool	Active
22-19	Miller Flood Protection	Active
22-20	Popeyes OPH	Active
22-21	Kreller Residence	Active
22-24	Benjamin-Mohammed Residence (WOS Lot 109)	Active
22-25	Miller-Duis Residence (WOS Lot 113)	Active
22-26	3823 Tending Green	Active
23-02	Tweden Residence	Pending
23-05	Rocket Carwash	Pending
23-06	Stillwater 2023 Street Improvements	Review
23-07	Villa Rococo Residence	Review
23-08	72nd St Improvement	Review
23-09	Kirn Residence	Review



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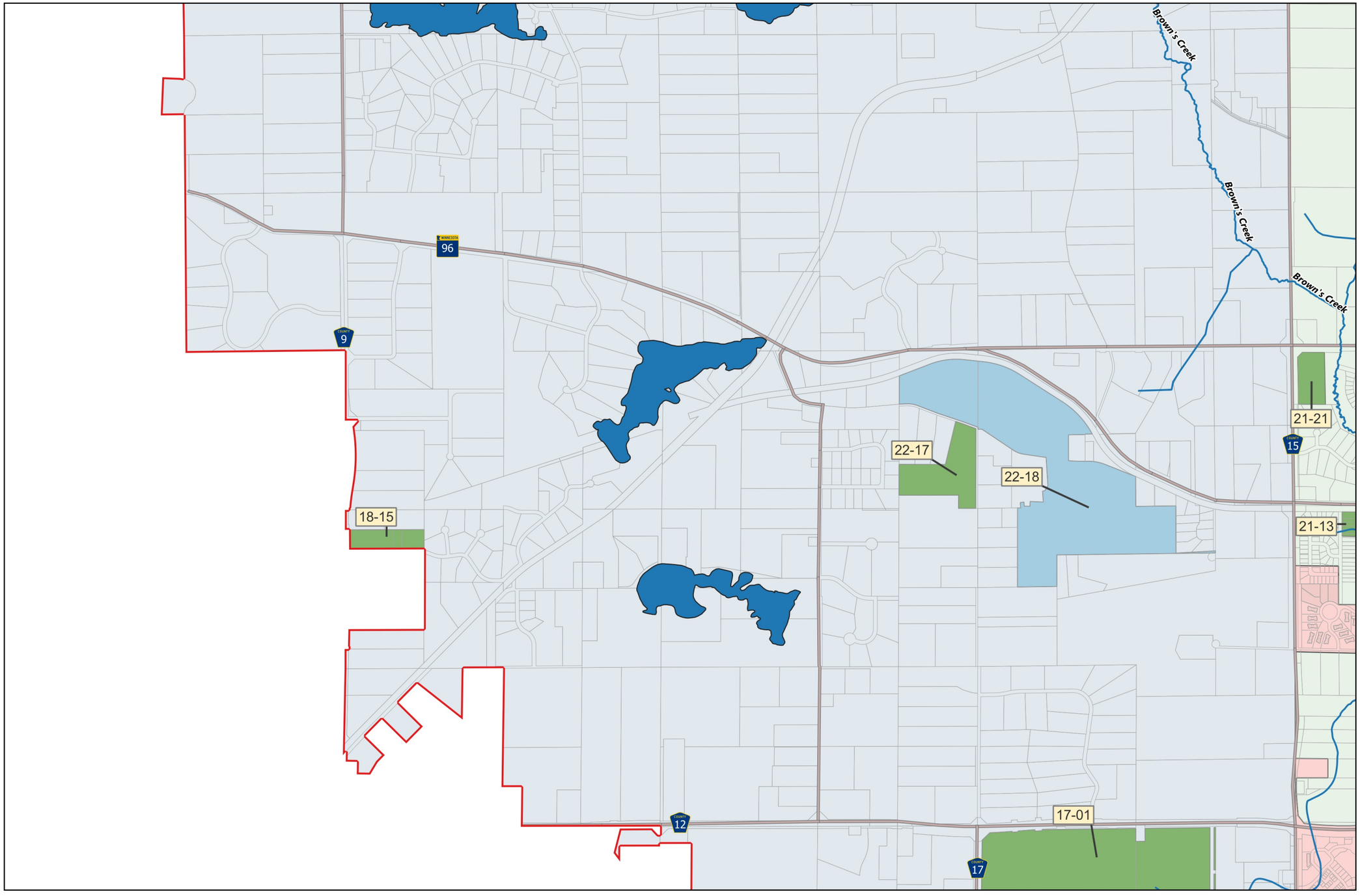
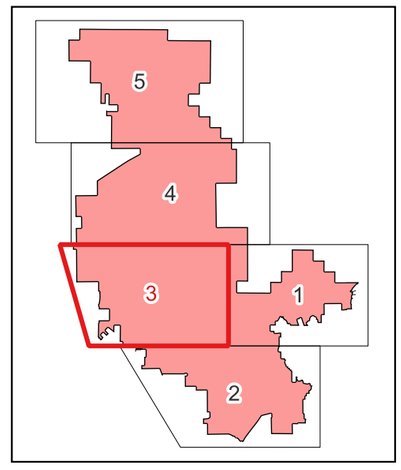
Permit No.	Applicant/Permit Name	Status
17-01	White Oaks Savanna	Active
18-15	Rogness Residence	Active
21-13	Marylane Gateway	Active
21-21	Millbrook West Park	Active
22-17	Read Residence	Active
22-18	Stillwater Oaks	Review





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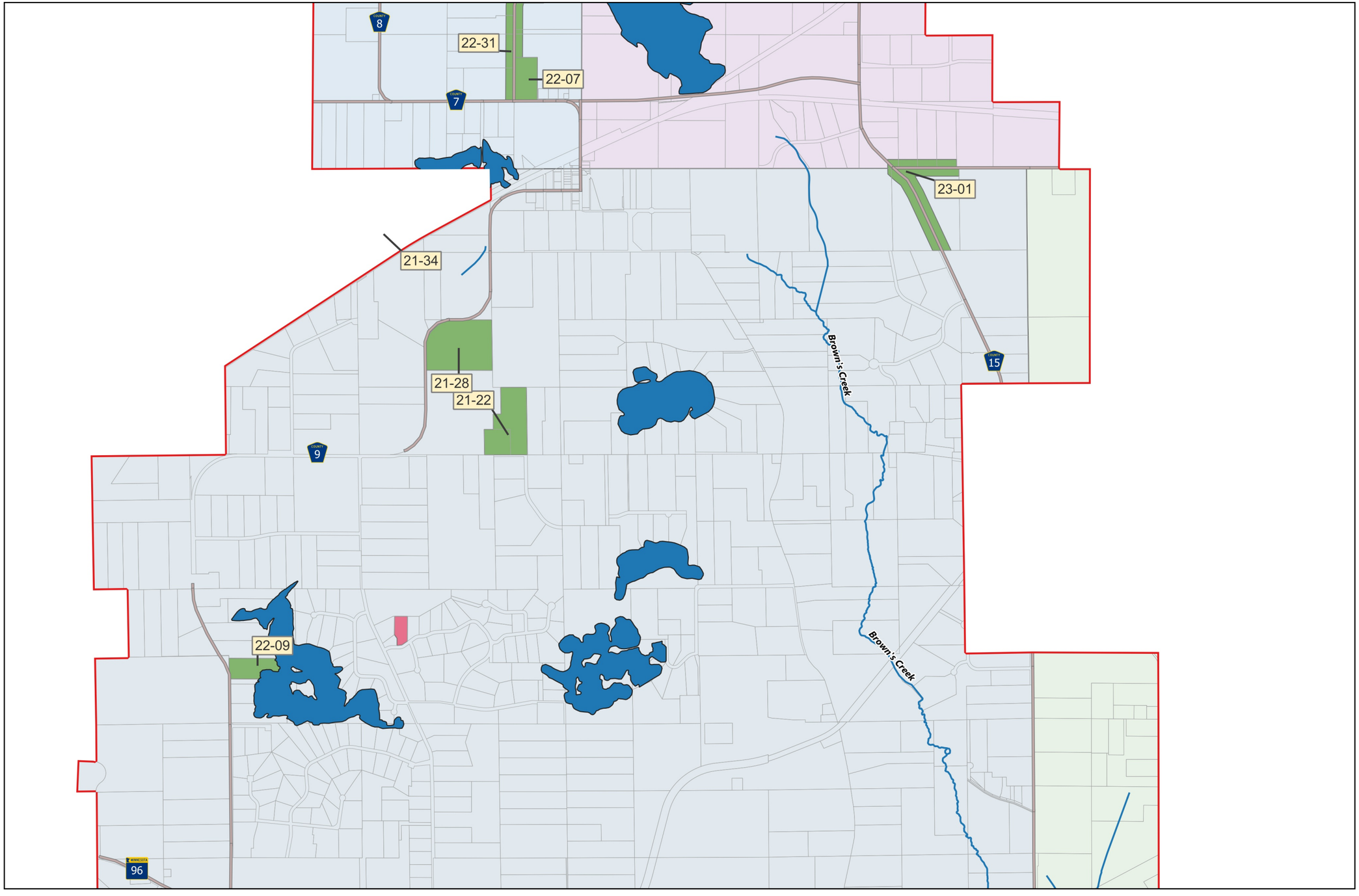
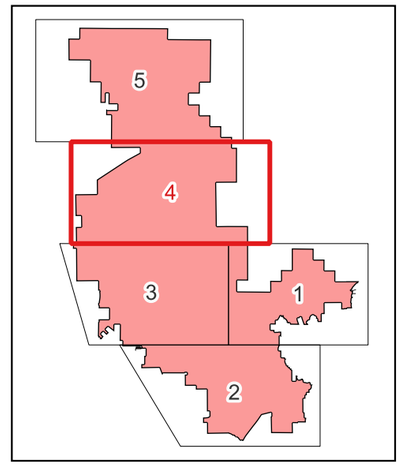
Permit No.	Applicant/Permit Name	Status
21-22	Bond Residence	Active
21-28	Guerrino Residence	Active
21-34	Fahey Residence	Active
22-07	Liberty Classical Academy	Active
22-09	Helmer Residence	Active
22-31	County Road 57 Culverts	Active
23-01	County Road 61 Improvements	Active





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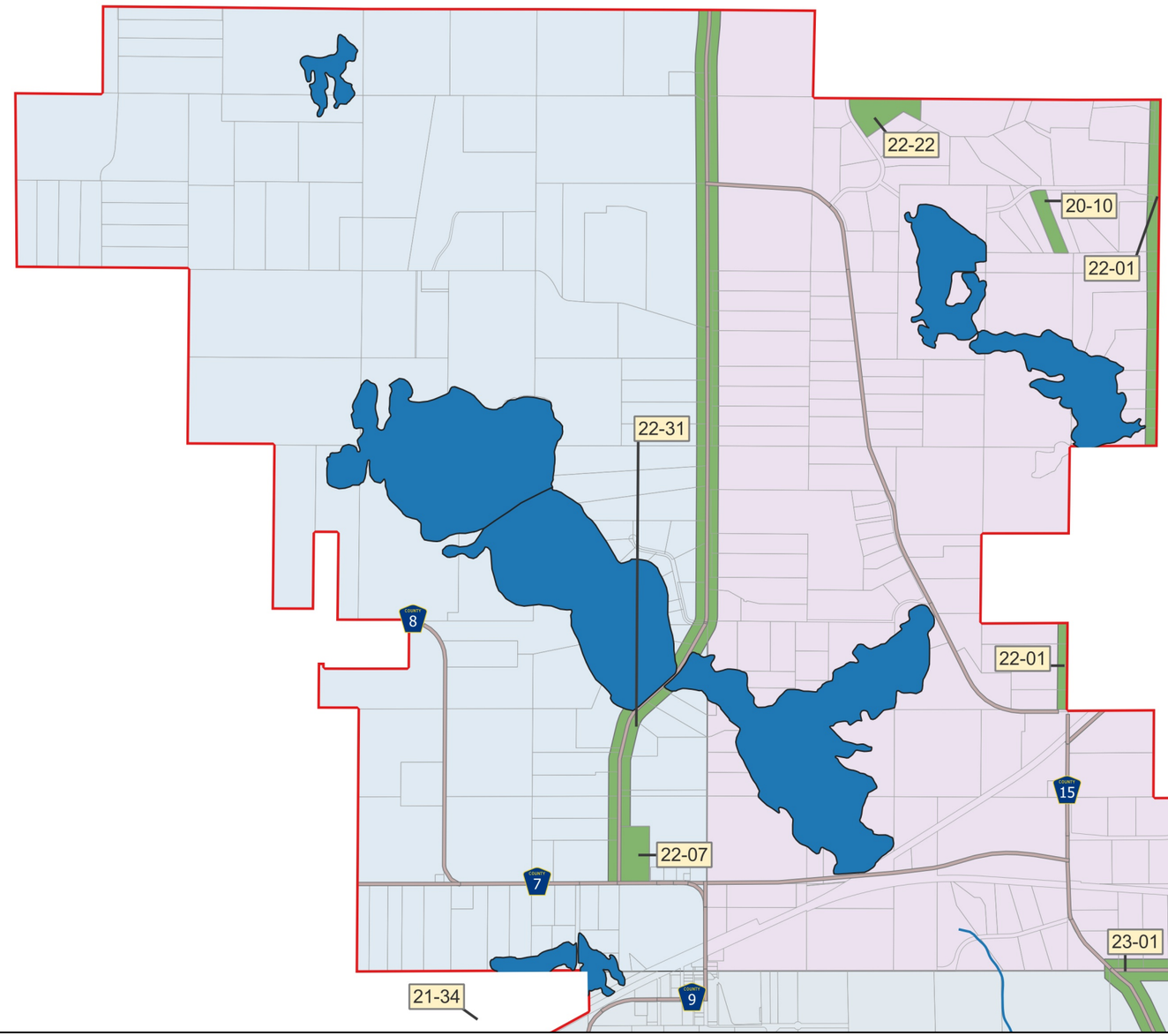
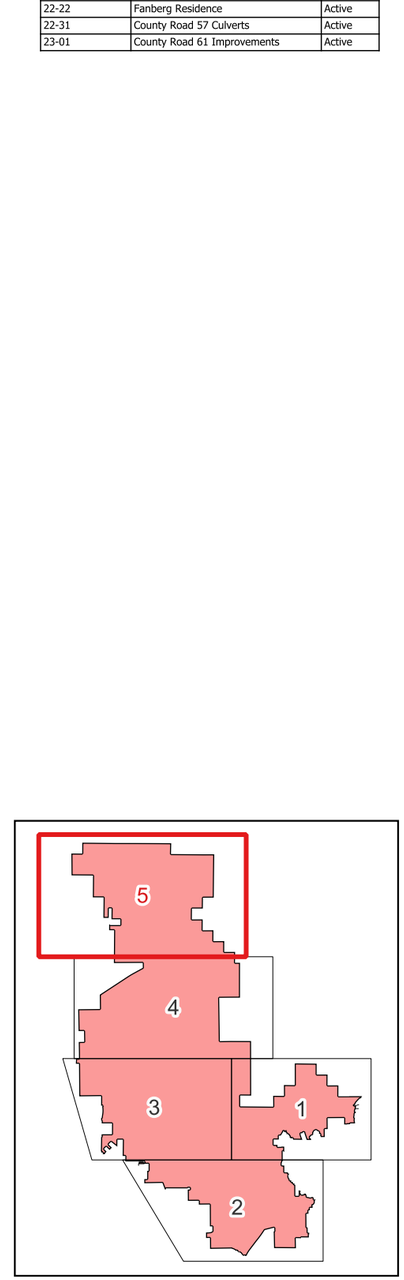
Permit No.	Applicant/Permit Name	Status
20-10	Wahlquist Residence	Active
21-34	Fahey Residence	Active
22-01	CSAH 15 Culverts	Active
22-07	Liberty Classical Academy	Active
22-22	Fanberg Residence	Active
22-31	County Road 57 Culverts	Active
23-01	County Road 61 Improvements	Active





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